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DECEMBER 19, 1958

electronics

engineering issue

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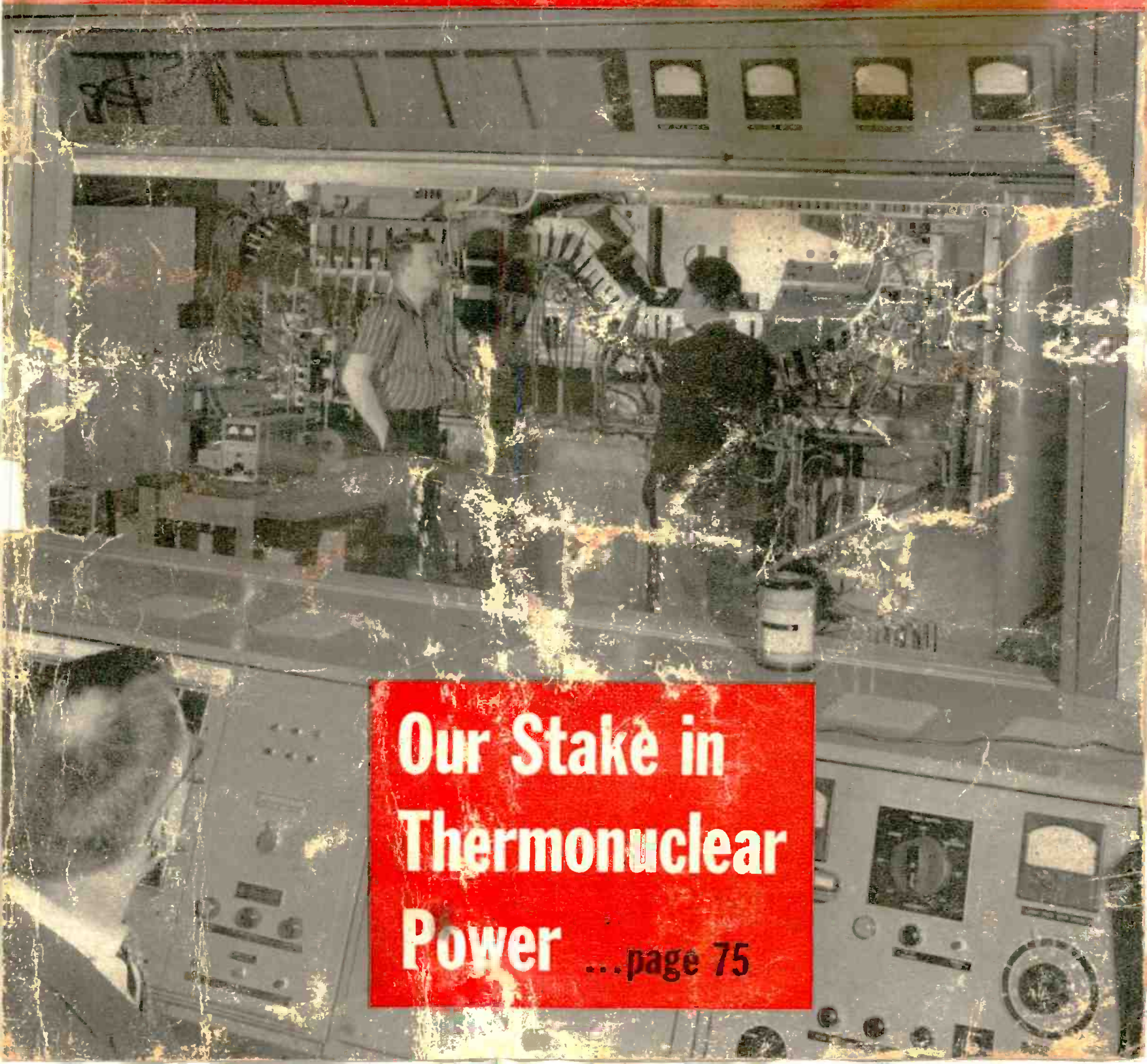

Our Stake in Thermonuclear Power

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electronics engineering issue

A McGRAW-HILL PUBLICATION • VOL. 31, NO. 51 • DECEMBER 19, 1958

Issue at a Glance

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DIGEST continued

electronics

Dec. 19, 1958 Vol. 31, No. 51

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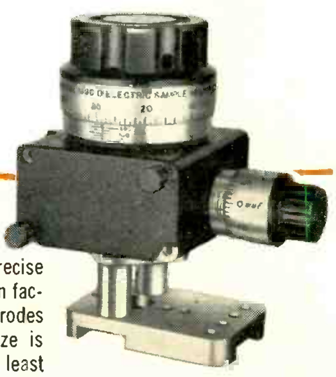

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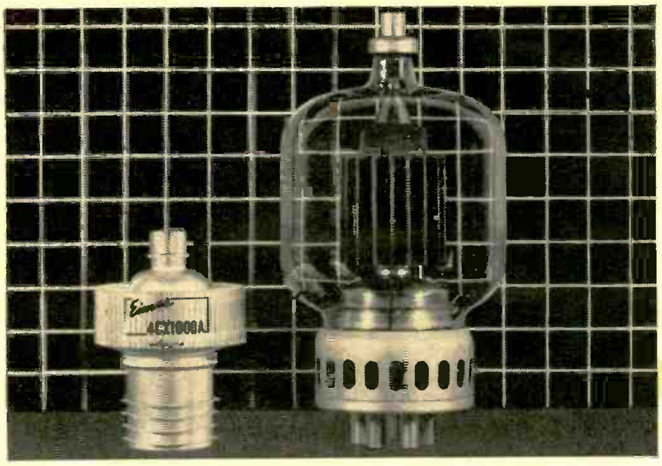
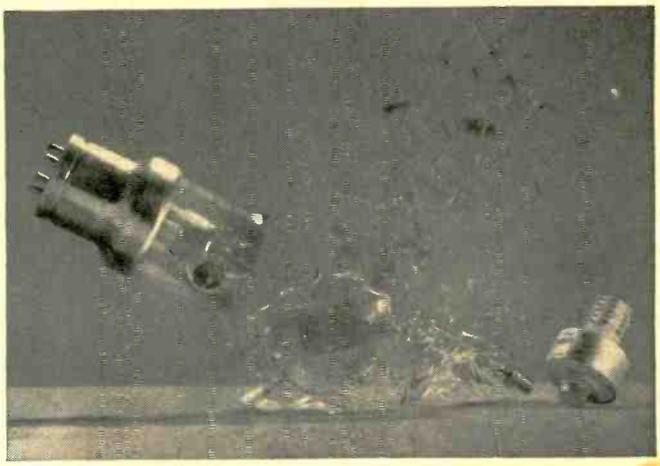
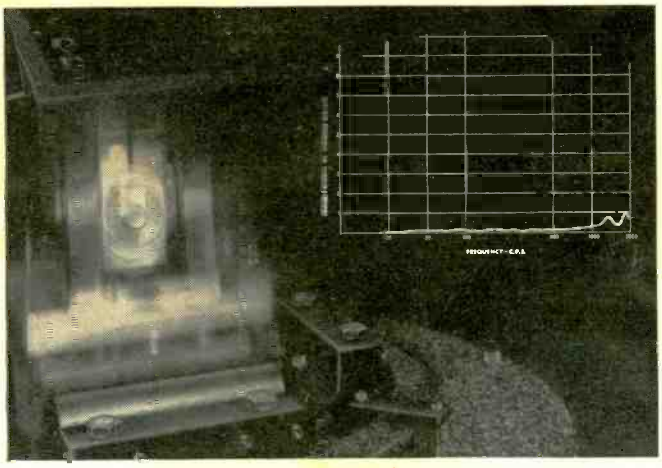


SMALLER SIZE



IMPACT SURVIVAL



VIBRATION SURVIVAL

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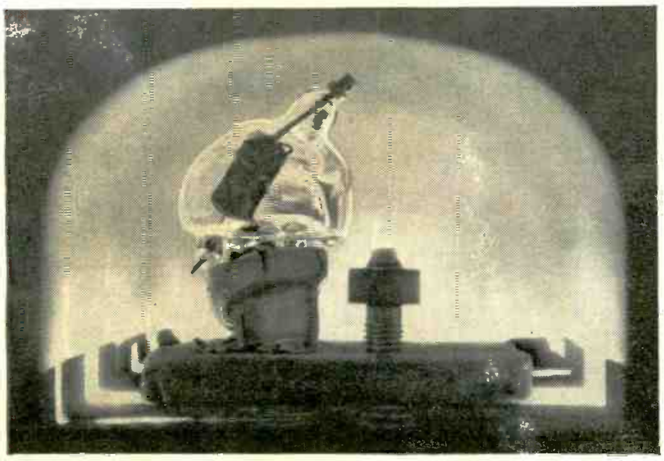
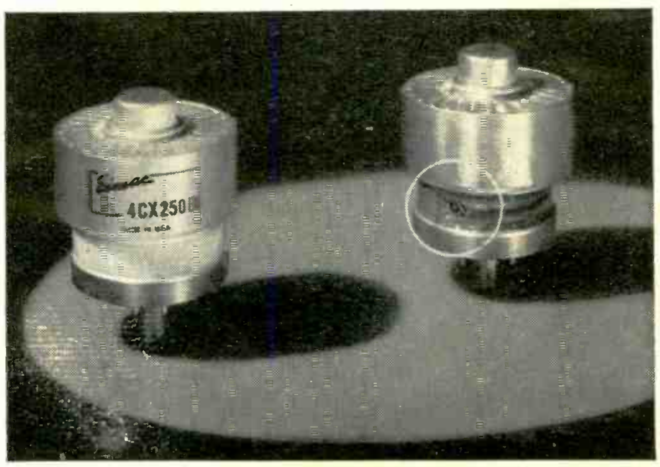


EXTREME HEAT SURVIVAL



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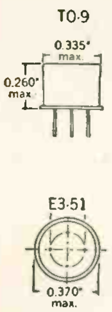
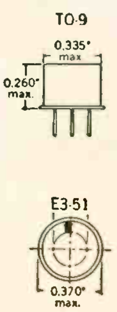


	Type	I_{EO} or I_{CO} at V_{CB} = 20 Vdc μA	V_{CE} max. volts	H_{FE}† ave.	r_b' f = 1Mc ohms	r_c kilohms	Noise Figure db (max.)	C_{ob} f = 100Kc ave. μμf	$f_{\alpha b}$ ave. Kc
PNP	2N327A	0.005	−40	15	1200	500	30	65	200
	2N328A	0.005	−35	30	1400	500	30	65	300
	2N329A	0.005	−30	60	1500	500	30	65	400
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

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

FOR SMALL SIGNAL APPLICATIONS

Temperature Range −65°C to +160°C



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

*V_C = 5V; I_E = 3mA

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ELECTRONICS NEWSLETTER

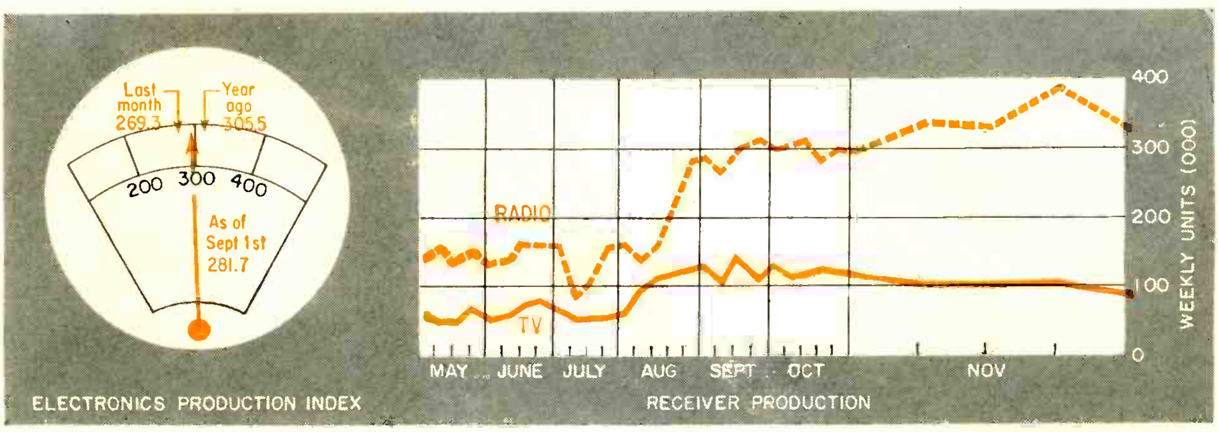
SUBMARINE ELECTRONICS development, much of it now only in the idea stage, may hold the key to effective antisub warfare in the future. This was indicated in a recent talk to the National Security Industrial Association in New York by Capt. Richard B. Laning, USN, who commanded the atomic submarine *Seawolf* during its voyage under the Arctic icecap. Broad design objectives, Laning indicated, are: use of more automatic devices, fewer men; miniaturized electronic digital computers and communications gear; smaller and improved sensors and data-handling systems; and generally increased reliability of parts. Laning, newly assigned to the office of the Chief of Naval Operations, invited industry inquiries, said further elaboration of needs can't be made public.

JAPANESE ELECTRONIC products made under license agreements with U. S. firms at relatively low unit cost will be bought by American firms and sold in world markets. That's the implication of a long-range export program with General Electric just announced by Toshiba, 20 percent owned by GE. Transistors, tubes, other electronic devices and, apparently, assembled radio and tv sets are involved. Products will be branded "GE Made in Japan" and will be sold only outside the U.S. Two other U.S. firms are reported negotiating with Hitachi and Mitsubishi for similar agreements.

SMALL ELECTRONICS FIRMS' hopes for more military business may be buoyed in 1959. Reason: The last Congress made the Small Business Administration a permanent agency and strengthened it through the Small Business Investment Act that authorized SBA to advance $250 million for long-term needs. SBA's job is to loan money, get small business its share of military work. New agency stature is seen in recent blanket contract set-asides that it arranged with the armed services for small business; these were previously negotiated for individual contracts.

SOLID-STATE commercial data-processing system using magnetic amplifiers was announced this month by Remington Rand Univac. Equipment will rent at $6,950 a month, with purchase price of $347,500. Firm said U.S. deliveries would start next June. Solid-state sophistication is said to reduce computer size, maintenance problems and power requirement. Novel 18,000 rpm drum holds 50,000 characters.

SOVIET SCIENTISTS may be experimenting with a tv relay station aboard an earth satellite, according to an Oslo newspaper. Tv sets in Larvik, Norway, which often pick up Soviet tv programs, recently received a new test program. Difference: antennas were turned to the west; as many as five "ghosts" appeared at times.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	Nov. 28, '58	Nov. 21, '58	Nov. 29, '57
Television sets, total	99,618	116,530	123,844
Radio sets, total	338,887	390,019	357,881
Auto sets	109,098	137,678	109,372

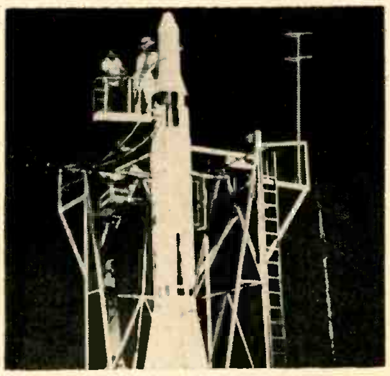
STOCK PRICE AVERAGES

(Source: Standard & Poor's)	Dec. 3, '58	Nov. 26, '58	Dec. 4, '57
Radio-tv & electronics	74.02	68.96	44.84
Radio broadcasters	77.13	73.77	53.65

FIGURES OF THE YEAR

Totals for first nine months

	1958	1957	Percent Change
Receiving tube sales	291,718,000	341,663,000	−14.6
Transistor sales	30,387,277	18,842,300	+61.3
Cathode-ray tube sales	5,844,665	7,308,552	−20.0
Television set production	3,572,189	4,589,164	−22.2
Radio set production	8,178,821	10,764,454	−24.0
TV set sales	3,468,090	4,452,041	−22.1
Radio set sales (excl. auto)	4,903,676	5,840,372	−16.0



Polaris test vehicle will get first ocean launching from recently-commissioned USS Observation Island as . . .

Missile System Goes to Sea

New electronic-laden ship swings into operation in Navy's Fleet Ballistic Missile Program

NORFOLK NAVAL SHIPYARD, VA.—Navy's Fleet Ballistic Missile Program recently took a big step forward here with the commissioning of the *USS Observation Island*, a floating electronic test bed and launching pad for Polaris.

The converted 17,600-ton vessel will be a proving ground for the Polaris missile, as well as for launching, handling, fire control and navigation equipment and for the Navy operational crew. Much of the electronic equipment on the new ship is gear that has been successfully checked out on the earlier experimental ship, the *USS Compass Island* (ELECTRONICS, p 28, Mar. 7).

Going one step further than its predecessor, the *Observation Island* will actually launch Polaris test missiles. Navy says the new ship "ranks in evolution with the first carrier operated aircraft, inasmuch as this is the first time the complete ballistic missile system has been taken to sea."

A week before the commissioning, a dummy slug was fired from the ship into the Elizabeth River. Future launchings will take place in the Atlantic off the coast of Cape Canaveral. Ground-based launchings, meanwhile, will continue from Cape Canaveral's Ship's Motion Simulator. The equipment was designed and manufactured by the Loewy Hydropress div. of Baldwin-Lima-Hamilton to simulate conditions encountered at sea.

Navigation gear on the two experimental ships is Sperry's dual SINS (Ship's Inertial Navigation System), which was successfully checked out on the *Compass Island*.

Working in conjunction with SINS will be Sperry's NAVDAC (Navigation Data Assimilation Center), a system which takes all navigational data from other sources—sonar, celestial fixes and dead reckoning—and then collates, analyzes, decodes and automatically feeds the information back into the system.

The new ship's fire control system, developed by GE, will continually provide accurate information on the vessel's position, direction and speed to the missile guidance equipment. Ship motions, such as roll, pitch, yaw and others, are automatically accounted for.

Precalculated target data is fed into computers manually. The intelligence thus derived is transmitted to the missile's guidance system by Sperry's Gyro Transfer Table System (GTTS). There will be two GTTS aboard *Observation Island*.

The fire control system also provides data required for operational control of the missile launching, including monitoring and controlling countdown.

The entire fire control system consists of more than two dozen enclosures and consoles.

Other Sperry navigation gear includes Loran-C, a dual gyro-compass system; a Jog Log, a means of measuring ocean currents; and an automatic steering system.

Polaris missile system development is managed by Lockheed. In addition to coordination of overall design, research, development and test programs, Lockheed is developing the missile frame and reentry body. Firm also operates the flight test base at Canaveral for the Navy and is coordinating an on-the-job training program for Navy personnel.

Missile guidance is the responsibility of GE and MIT. Launching and handling system is by Westinghouse. Instrumentation is by Interstate Electronic Corp. SINS for the five future Polaris submarines are being developed by both Sperry and Autonetics div. of North American. The first sub, the *USS George Washington*, is scheduled to be launched next spring. The entire Polaris system is slated to be operational in 1960.

New Equipment For Moon Shot

FOURTH U.S. shot at the moon, and first one for the Army Ballistic Agency, differed considerably in planned trajectory and equipment used from previous three USAF attempts.

Army employed a Jupiter IRBM as booster, 11 scaled-down Wac Sergeants for second stage, three Wac Sergeants for third stage, and a single one attached to the 13-lb payload as the fourth stage.

Instead of achieving a lunar orbit, Army's payload, developed and put together at CalTech's JPL, was designed to pass the moon and orbit around the sun. It didn't reach goal, but went 66,654 mi.

Central data collection was at JPL, where an IBM 704 was recently installed for data reduction chores.

Three Microlock stations, operating on different frequency than

(Continued on p 12)

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Electrical Overload Protection . . . Magnetic circuit breaker, front panel mounted. Unit cannot be injured by short circuit or overload.

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used for USAF shots, were designed to track the vehicle—a Doppler system at Cape Canaveral, a station utilizing a 10-ft tracking antenna in Puerto Rico, and a specially-built radio telescope station using an 85-ft parabolic antenna located at Goldstone Dry Lake, 30 miles north of Barstow, Calif.

Stations at Manchester, England, Singapore, and Hawaii, all used for USAF's shots, provided back-up of official information, but were not official tracking stations for the project.

In advance planning, it was agreed not to telemeter command signals to the vehicle after launch, as was the case with Pioneer, nor utilize any earth-triggered interrogation systems.

British Exports Setting Record

BRITISH radio-electronic exports reached a new monthly high of almost $12 million in October, bringing to $102.7 million the export total for the first 10 months of 1958. In releasing the figures, the British Radio Industry Council said it expects a record export total for the year.

Capital goods, including transmitters, other communications gear, navigational aids and industrial electronic items, accounted for $35.7 million in the 10-month period.

Tube exports of $11.8 million in the same period topped the total for all of 1957 by $840,000. Radio and tv sets, sound reproducing equipment and components made up the remainder.

New Conference Idea Succeeds

DALLAS—Electronics industry engineers may find themselves attending something new in technical sessions next year.

It's this: Virtually all-question-and-answer technical sessions, with papers being made available before conventions and, at sessions, given only in synopsis form.

The idea was tried here recently

WASHINGTON OUTLOOK

WASHINGTON is trying to tidy up the U.S. space exploration program which in recent months has deteriorated into a bureaucratic hodge-podge threatening to hold up high-priority projects.

Battle lines shape up like this: On one hand, the Army and Air Force are arrayed against the Defense Department's Advanced Research Projects Agency, which is supposed to direct and coordinate military space projects. On the other, the military services are lined up against the National Aeronautics and Space Administration.

The administration is moving slowly to resolve the disputes by compromise. To some observers, though, the compromises are likely to aggravate the administrative confusion.

Take the Army's rocket and space research centers which NASA has tried to take over. Under a new agreement, the Army's Jet Propulsion Laboratory at Pasadena, Calif., which designed the Explorer satellites and the Pioneer III lunar vehicle, has been transferred to NASA.

The laboratories of the Army Ballistic Missile Agency at Huntsville, Ala., however, where Wernher von Braun and his famed team of scientists hold forth, will remain an Army installation but will be "immediately, directly, and continuously responsive to NASA requirements."

Sticky situation arises from the decision to allow the Army to determine when ABMA facilities are available for NASA projects. But NASA seems to hold the whip hand. The Pentagon has sorely restricted the Army's missile and space function. So ABMA will be more dependent on NASA for assignment of projects and allocation of funds.

Meanwhile, the Pentagon has been shaken by ARPA's attempt to take over supervisory or budget control of a group of projects managed or started by the Air Force: The X-15 rocket airplane, Dyna-Soar orbital bomber, Sentry reconnaissance satellite, Midas early-warning satellite. The agency, whose exact future is still up in the air, is already in charge of advanced research for the Air Force's BMEWS and the Army's Nike-Zeus.

Recently, ARPA announced a new space program, "Project Discoverer," to be managed by the Air Force and to run indefinitely at a cost of several hundred millions. Purpose is to experiment with reentry and recapture techniques and to test military space hardware, such as guidance systems, satellite stabilization gear, infrared warning satellites and other vehicles. Lockheed is system contractor.

- **Getting a workable data-processing system** is considered a weak link in the government's five-year master plan to bring order into air traffic control. Most of the Federal Aviation Agency's $40-million R&D budget will go for electronics. By 1963, the agency will have a new air traffic control system in the New York area. System will be then installed across the country.

  One of the development-from-scratch items that FAA needs is a method of displaying both radar information and synthetically-generated information on a single tube. Other items under development for the control system include a 3-D radar; a collision avoidance system being developed by Bendix; and a master communication system being developed by RCA for delivery by May 1959.

at the Electronic Industries Association's third conference on Reliable Electrical Connections—and it was a smash hit.

The conference was attended by 370 delegates and 35 papers were discussed, with the program keyed mainly to audience participation. Delegates' comments were extremely favorable. Most seemed to think they were able to explore subjects more thoroughly.

Representatives of other technical groups were present to see how the plan worked.

The six conference sessions covered Specifications for Electrical Connectors, Specifications for Electrical Connections, Effect of Environment on Electrical Connections, Design and Evaluation, Manufacturing and Process, and Quality Control.

Space Electronics Group Formed

New electronics committee of the National Aeronautics and Space Administration is due to start work early in 1959 as one of 13 new Research Advisory Committees.

NASA Administrator T. Keith Glennan said the committees, including one on control, guidance and navigation, would provide technical counsel, review research going on and pick problems for investigation by NASA or other agencies.

Glennan also said the committees will act as media for the interchange of information about technical investigations and developments between researchers in industry, universities and government.

Tv Construction Booms Overseas

Report from U.S. Information Service is that tv station construction abroad boomed during third quarter of 1958.

During that period a total of 79 new tv stations went on the air. In the preceding quarter 57 started.

USIA estimates that present world overseas total of 639 stations may reach 706 by end of this year.

MILITARY ELECTRONICS

• **Mission and traffic control** system for North American's USAF F-108 long-range, Mach 3 interceptor is being developed by Federal Division of International Telephone & Telegraph. System will carry out communications, identification and landing-aid functions.

Air conditioning and pressurization systems for both the F-108 and B-70 will be developed and manufactured by Hamilton Standard div., United Aircraft Corp. Temperatures up to 600 F, generated by the planes' high speeds, make cooling of the crew and electronic equipment of critical importance. Firm says about half the multimillion dollar project will be subcontracted.

• Sperry Echo Enhancer (SEE), electronic system which makes miniature target drones look like bombers on radarscopes, has been used in a series of successful flight tests at Cape Canaveral and in the New York area. Weighing less than 20 lbs, SEE consists of a traveling wave tube, miniaturized power package and antenna.

• **Forty percent of Navy's R&D** budget goes for systems leading to ultimate hardware, such as Polaris, Rear Adm. John T. Hayward, Assistant Chief, Naval Operations for R&D, told American Ordnance Assoc. in New York. Sixty percent goes for basic, applied and supporting research.

Navy now has 1,500 basic research contracts with nonprofit institutions.

Busy New York trucking terminal platform (left) is scanned by 10 tv cameras which allow operators to govern cargo movements as . . .

C-C Tv Speeds Freight

Ten-camera closed-circuit tv system was placed in operation last week to help regulate traffic in a major New York trucking terminal.

The cameras provide visual coverage of a 43-bay loading dock which services as many as 800 trucks a day. Coaxial cables transmit the camera pickup to a central dispatch office containing 10 monitors.

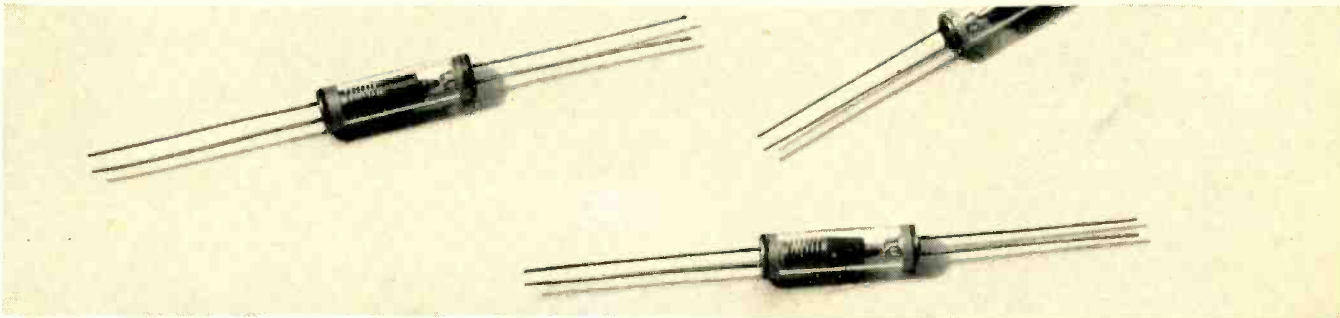
Nine of the cameras are stationary. The tenth can be rotated, and is equipped with a revolving lens turret which can provide views into the interiors of trailer trucks being loaded. A two-way intercom system provides audio communication between the dispatch office and various loading docks.

The Yale Transport Corp., which purchased the installation from Dage Tv division of Thompson Ramo Wooldridge for $25,000, says system will allow the firm to save considerable time and money.

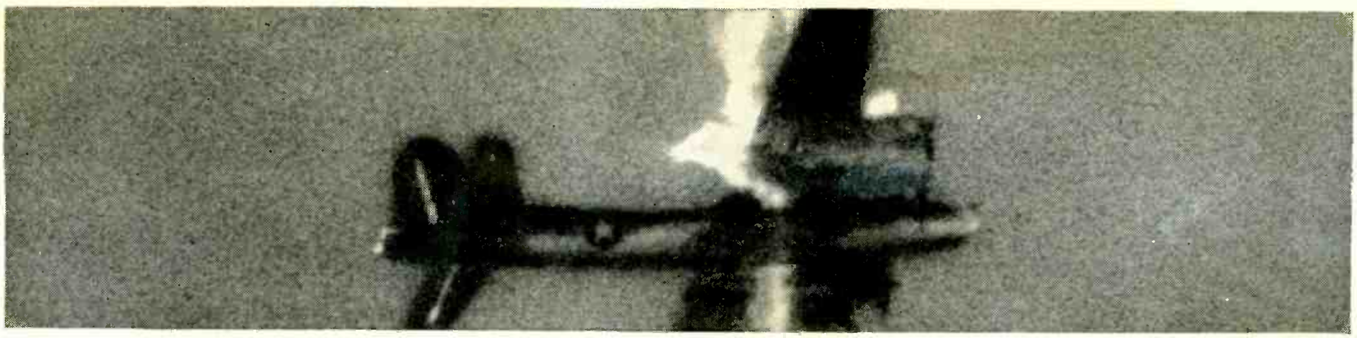
The New York trucking company also uses a large scale IBM system which, among other functions, originates punch cards serving as bills of lading, billing documents and customer receipts.

As a truck is loaded at the New York dock, a talker equipped with headphones and speaker describes the packages being carried aboard,

HUGHES THERMAL RELAYS



FOR RELIABILITY



IN GUIDED MISSILES

Hughes now makes commercially available a completely reliable single action switch. Used in the Falcon, field proven as a reliable missile, this Hughes relay is engineered to meet the most exacting of requirements.

With unusual speed of action, firing signal triggers the release of constrained contact...contact closes upon fixed contact point...switch circuit becomes permanently closed.

In a typical application, 3.0 volts DC applied to a firing circuit of 1.2 ohms fires within 0.3 seconds.

For additional information please write: Hughes Products, Marketing Department, International Airport Station, Los Angeles 45, California.

SPECIFICATIONS

MECHANICAL—Body Size: Maximum diameter 0.252"; length .920". Total weight: Less than 0.1 oz.

ELECTRICAL—**Before Firing:** Insulation resistance is greater than 200 megohms. Minimum breakdown voltage 600 volts.

Firing: 2 volts minimum required. Actual voltage dependent upon closing time desired.

After Firing: Circuit resistance less than 0.3 ohm.

ALTITUDE—Any.

OPERATING TEMPERATURE: −55°C to +125°C.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

SEMICONDUCTOR DEVICES • STORAGE AND MICROWAVE TUBES • CRYSTAL FILTERS
OSCILLOSCOPES • RELAYS • SWITCHES • INDUSTRIAL CONTROL SYSTEMS

CIRCLE 9 READERS SERVICE CARD

giving destination, customer, contents and other information to punch-card operators in the offices. By the time the truck is loaded, a complete record of its cargo has been made.

When the card is completed, it is fed to another IBM machine connected by teleprinter wires to identical punch card equipment in the other cities served by the trucking firm. At these locations, information pertinent to the area is extracted and a duplicate set of punch cards is made automatically. This allows the out-of-town terminals to anticipate what cargo will be arriving from New York.

Sees Transistors Opening New Era

"A NEW ERA in communications" is coming through the use of transistors, the national conference of IRE's Professional Group on Vehicular Communications was told recently.

The talk, by W. J. Weisz of Motorola, was one of 16 papers dealing with aspects of mobile communications. The conference also heard papers on antennas and hand-held microphones.

Also included in the meeting were discussions of factors affecting the implementation of FCC's new split-channel regulations.

FINANCIAL ROUNDUP

• **Hycon Mfg. Co.**, Pasadena, Calif., sells controlling interest in **Hycon Eastern**, Cambridge, Mass., to **Western Union** and members of Hycon Eastern management. Some 340,000 of 631,000 shares of outstanding common were sold. Nine hundred thousand dollars of Hycon Eastern debt, held by Hycon Mfg., was exchanged for same amount of convertible preferred. Also, $135,-000 of advances from former parent were funded into a 10-month note.

• **Tenney Engineering**, environmental equipment manufacturer of Union, N. J., lists its common stock on the American Stock Exchange. Stock had previously been traded over-the-counter. Behind decision to list on a national exchange are plans for acquisition of electronic and environmental equipment manufacturing firms through exchange of securities.

• **Topp Industries**, Los Angeles, Calif., sells wholly-owned subsidiary **Heli-Coil Corp.** of Danbury, Conn., to a group of investment bankers headed by W. C. Langley & Co., for $3.5 million. H-C had been purchased in Nov., 1956, for $2.3 million. Topp makes electronic test instruments, components and sub assemblies. Heli-Coil makes coiled wire screw thread inserts and tools for application of the inserts. Topp plans to use proceeds to finance expansion of industrial controls division and anticipated production increases of **United States Semi-conductor Corp.** of Phoenix, Ariz. Negotiations for purchase of semiconductor firm by Topp are underway.

• **Cardinal Instrumentation** of L. A. plans to issue 240,000 shares of common stock at $1.25 per share. This Regulation A issue has been filed by notification and is exempt from SEC registration. Firm makes temperature sensing systems, thermocouple junctions and transistor testers. Myron A. Lomasney & Co. will handle the underwriting on an all or none basis.

• **Burndy Corp.** of Norwalk, Conn., manufacturer of electronic hardware and components, adopts employee stock purchase plan. Employees were given right to purchase Burndy stock at as low as 95 percent of the market price at date of offer. Plan was set up as means of improving company performance by giving employees extra shake in business. The program also serves to provide additional capital.

MEETINGS AHEAD

Jan. 12-14: Reliability and Quality Control, Nat. Symp., PGRQC of IRE, ASQC, EIA, Bellevue-Stratford Hotel, Philadelphia.

Jan. 13-14: Cathode Ray Tube Recording, Systems Development Corp., Engineers Club, Dayton, O.

Jan. 14: Computers and Medical Diagnosis, Rockefeller Institute, New York City.

Jan. 21-23: Southwest Electronic Exhibit, Arizona State Fairgrounds, Phoenix, Ariz.

Jan. 29-30: Long-Distance Transmission by Waveguides, Institution of Electrical Engineers, London, England.

Feb. 1-6: American Institute of Electrical Engineers, Winter General Meeting, Statler Hotel, New York City.

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

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

Feb. 17-20: Western Audio Convention, Audio Eng. Soc., Biltmore Hotel, Los Angeles.

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

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

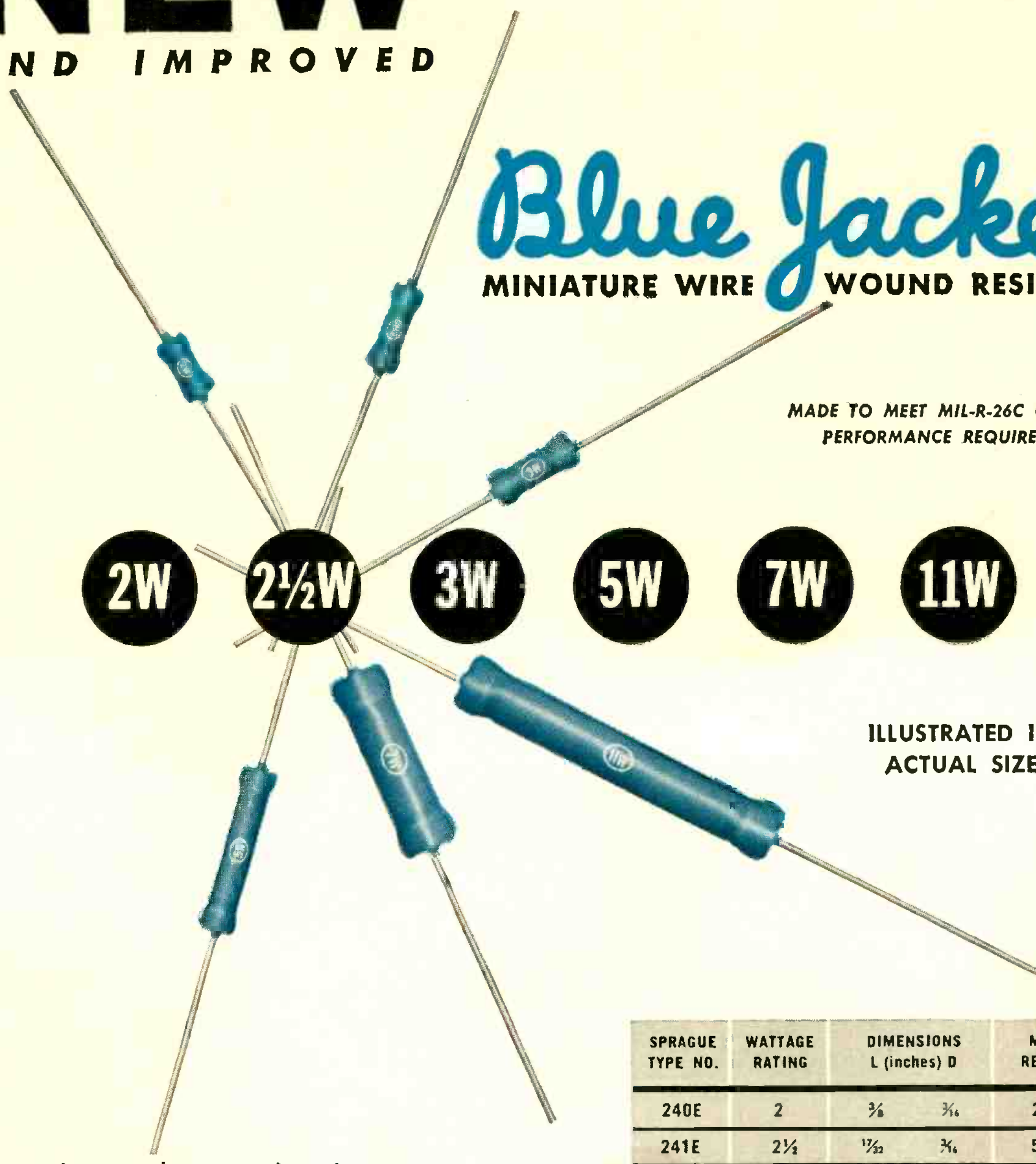
Mar. 15-18: National Assoc. of Broadcasters, Annual Convention, Conrad-Hilton Hotel, Chicago.

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

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

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

NEW
AND IMPROVED



Blue Jacket®
MINIATURE WIRE WOUND RESISTORS

MADE TO MEET MIL-R-26C CHAR. "V" PERFORMANCE REQUIREMENTS

ILLUSTRATED IN ACTUAL SIZE

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS L (inches)	D	MAXIMUM RESISTANCE
240E	2	3/8	3/16	2,700 Ω
241E	2½	17/32	3/16	5,000 Ω
242E	3	17/32	13/64	10,000 Ω
243E	5	15/16	13/64	30,000 Ω
244E	7	1⅛	5/16	30,000 Ω
245E	11	1⅞	5/16	50,000 Ω

Now a new improved construction gives even greater reliability and higher wattage ratings to Sprague's famous Blue Jacket miniature axial lead resistors.

Look at the small sizes shown in the illustrations above and you will recognize how ideal they are for use in miniature electronic equipment with either conventional wiring or printed wiring boards.

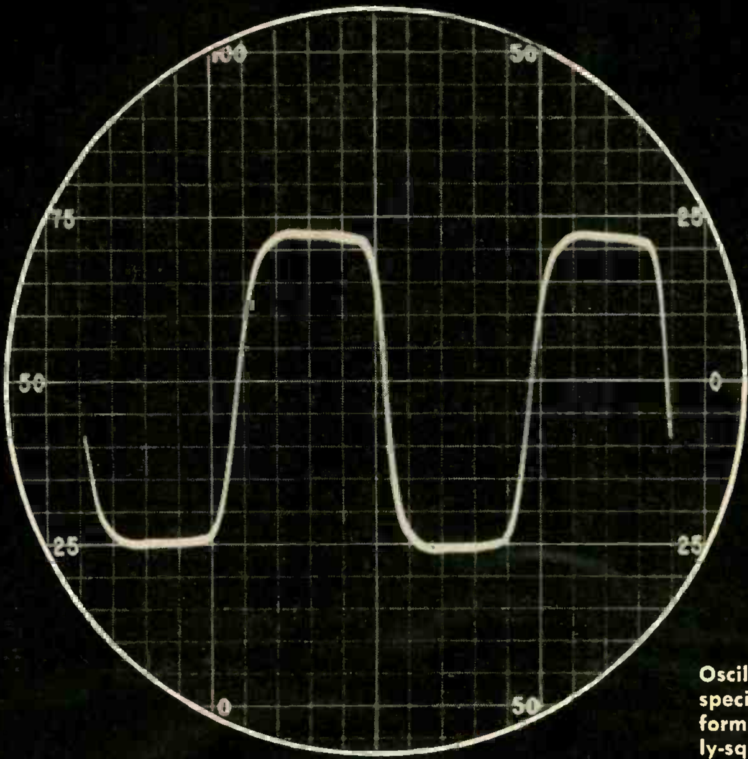
For the full technical story on these dependable miniaturized resistors, write for Engineering Bulletin 7410.

SPRAGUE ELECTRIC COMPANY • 35 MARSHALL STREET • NORTH ADAMS, MASS.

SPRAGUE®

THE MARK OF RELIABILITY

SPRAGUE COMPONENTS: RESISTORS • CAPACITORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS



Oscillogram showing ac output of special Sola Constant Voltage Transformer (input to rectifier). The nearly-square wave shape allows highly-conservative rectifier loading and contributes to minimum ripple.

EFFICIENT, regulated DC power supply

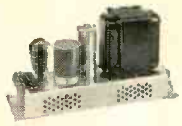
Can you use a ±1% regulated dc power supply that has no filter choke drops . . . that has an unusually low ratio of size and weight to power output? If so, consider a Sola Regulated DC Power Supply.

This unique power supply combines: 1) a Sola Constant Voltage Transformer, 2) a semi-conductor rectifier, and 3) a high-capacitance filter without choke.

The special Sola transformer output (illustrated above) is virtually a square wave, peak to rms. ratio, approximately 1.06 to 1. It not only minimizes ripple, but limits peak voltage to rectifier.

The current-limiting action of the Sola transformer permits the use of enormous capacitance for filtering, by controlling capacitor charging, thereby protecting it, and the rectifier junctions.

This dc source will give you exceptional performance on intermittent, pulse, and variable loads. The Sola regulated dc supply is very reliable, simple, and compact. It's moderately priced.



Fixed output — six ratings available from stock

Adjustable output — six ratings from stock

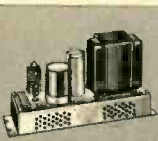
Custom-designed units produced to your specs

Write for Bulletin 7L-DC-235

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

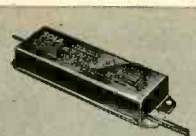
SOLA

CONSTANT VOLTAGE TRANSFORMERS



REGULATED DC POWER SUPPLIES

MERCURY LAMP TRANSFORMERS



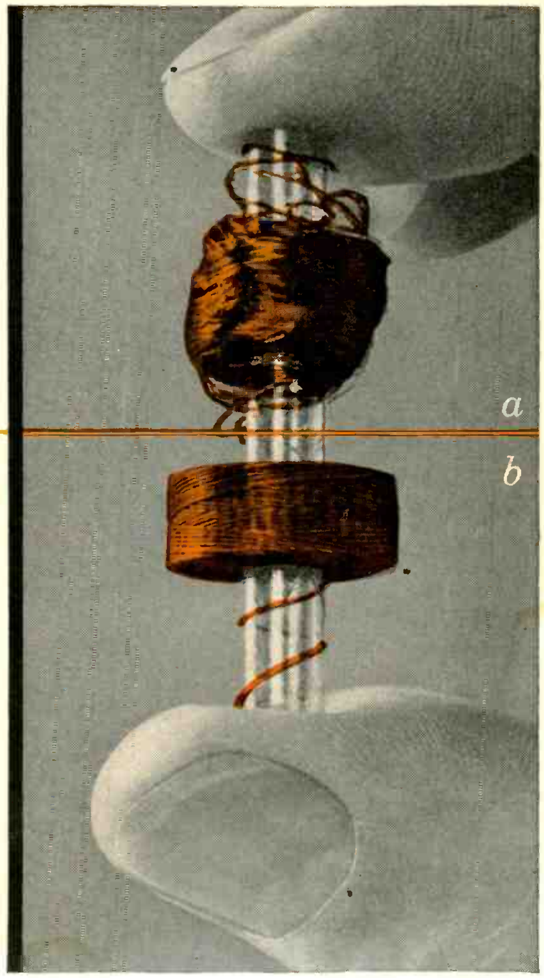
FLUORESCENT LAMP BALLASTS

A DIVISION OF BASIC PRODUCTS CORPORATION

If you have this problem, investigate

GRIP-EZE®

—an example of Phelps Dodge's realistic approach to Magnet Wire research



THE PROBLEM: To develop a solderable film-coated wire without fabric for winding universal lattice-wound coils without adhesive application.

THE SOLUTION: Phelps Dodge Grip-eze—a solderable film wire with controlled surface friction for lattice-wound coils that provides mechanical gripping between turns and keeps wire in place.

EXAMPLE: Coils wound with (a) conventional film wire; (b) Grip-eze. Note clean pattern of Grip-eze as compared to fall-down of conventional film wire.

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

FIRST FOR LASTING QUALITY —FROM MINE TO MARKET!

PHELPS DODGE COPPER PRODUCTS CORPORATION

PHELPS DODGE COPPER PRODUCTS
CORPORATION

INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA

CIRCLE 12 READERS SERVICE CARD

your two best friends... "the man ahead" and "the man behind"

That man just ahead of you hopes you'll take his job away from him. He's plain selfish about it . . . that way you push him up the ladder, too.

The fellow right behind you, what about him? He's another good friend. Just help make him more capable of capturing your present spot . . . see, now he's pushing you!

How can you serve yourself better than you ever have before? By upgrading your own job performance. By learning all you can about other functions of your company's business. By putting today's problems together with tomorrow's promises . . . and becoming more and more knowing about both, right here in the high-utility pages of this one specialized publication.

This, don't ever forget, is your own magazine — for you and men like yourself to work things out together — to find new and better ways to make progress and profits. McGraw-Hill editors, who live on your street, unceasingly strive to make it the single greatest community of interest for your industry. And the more effort they put into it, the easier it is for you to get more out of it for every reading minute invested.

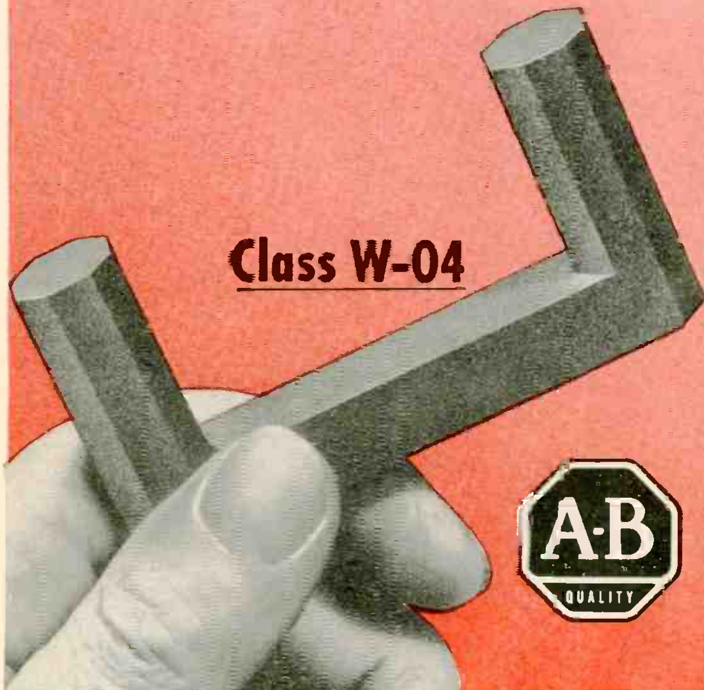
Look ahead, read ahead, get ahead. Live this secret. Share it. After you've read this issue so satisfyingly, hand it over to that man one step below. Show him how much there's in it for him, too. A few issues from now, we'll bet he looks you in the eye and says, "Thanks, friend. I just got my own subscription."

McGRAW-HILL SPECIALIZED PUBLICATIONS

The most interesting reading for the man most interested in moving ahead

NEW Power Ferrite

for Flyback Transformers offers



- **Higher Flux Density**
- **Lower Core Losses**
- **Higher Curie Point**

Now, with Allen-Bradley's new Class W-04 ferrite, you can design smaller flyback transformers with smaller cores. This saves space . . . saves weight . . . saves copper . . . and you have a saving in over-all cost.

Specify Allen-Bradley's new W-04 ferrite for your flyback transformers. The table below compares its superior properties with Allen-Bradley's "premium quality" W-03 ferrite.

Write for complete data, today!

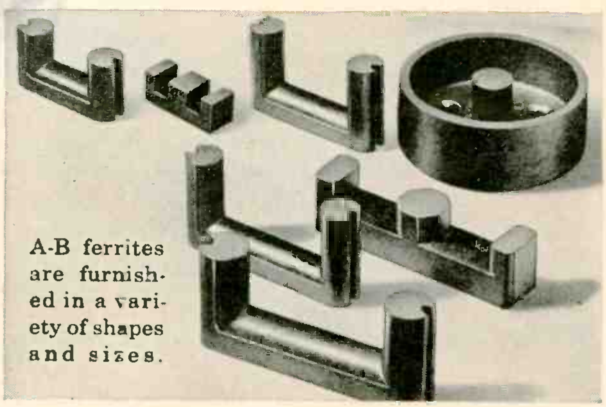
Class	Temp. °C	B_{max}* in Gauss at 10 Oe	Core Loss P_h in μWatts/cm3cps, B = 1350 Gauss, 16 Kcps	B = 1350 Gauss, 60 Kcps	B = 1800 Gauss, 16 Kcps	B = 1800 Gauss, 60 Kcps	μ_{max}*	μ_0 at Room Temp.	B_u**	μ at B_u †	Curie Temp °C
W-04	25	4900 ± 10%	3.8 ± 20%	5.3 ± 20%	6.4 ± 20%	9.0 ± 20%	7000 ± 30%	2000	2700 ± 15%	6000 ± 25%	225
	115	3700 ± 10%	3.8 ± 20%	5.3 ± 20%	6.4 ± 20%	9.0 ± 20%	7000 ± 30%				
W-03	25	4200 ± 10%	4.1 ± 20%	5.5 ± 20%	6.9 ± 20%	9.1 ± 20%	6000 ± 30%	2000	2100 ± 15%	5600 ± 25%	180
	115	2800 ± 10%	4.2 ± 20%	6.5 ± 20%	6.9 ± 20%	10.0 ± 20%	6000 ± 30%				

*B_{max} and μ_{max}. Frequency—16 Kcps.

**Usable flux density—flux density at which the 115°C permeability is equal to ½ of the 25°C permeability.

†Permeability of the core at 25°C at B_u.

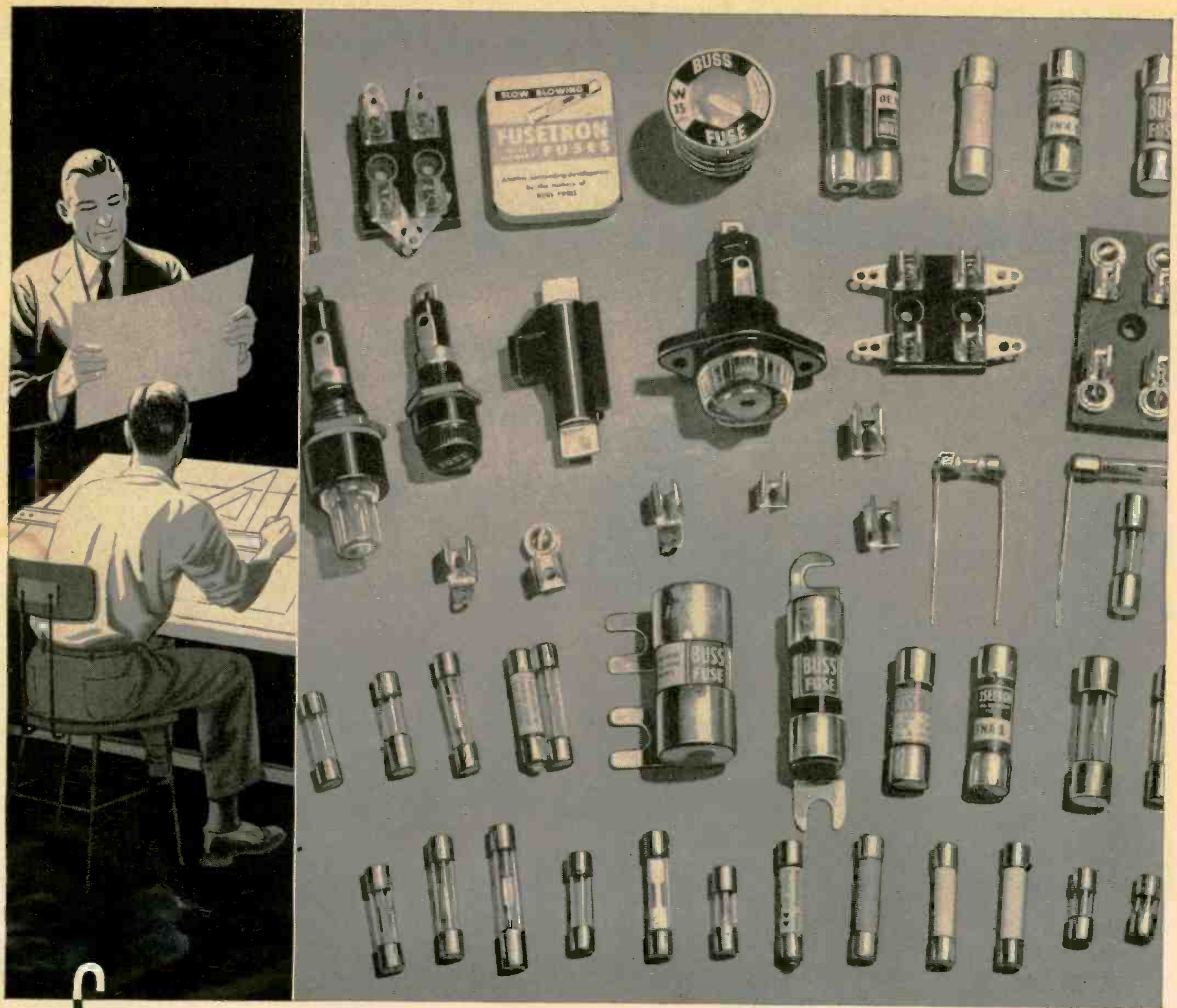
Allen-Bradley has also developed new square-loop power ferrites (R-03), and ferrites for transistorized medium frequency inverters (W-07). Our engineers will be glad to assist you with your ferrite problems.



A-B ferrites are furnished in a variety of shapes and sizes.

ALLEN-BRADLEY CO.
ELECTRONIC COMPONENTS
QUALITY

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.



Guard against needless trouble and shutdowns

. . . by specifying dependable BUSS fuses!

Should a fuse fail to protect your equipment if electrical trouble occurs . . . unnecessary damage results. Or, if a fuse blows needlessly your equipment is shutdown without good cause.

Why risk faulty fuses causing trouble and reflecting on the service and reliability of your equipment? You can be sure of dependable electrical protection by specifying BUSS fuses.

Every BUSS fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

One source for all your fuse needs.

To meet your needs, — the BUSS line of fuses is most complete . . . plus a companion line of fuse clips, blocks and holders.

To help you on special problems in electrical protection . . .

. . . BUSS places at your service the facilities of the world's largest fuse research laboratory and its staff of engineers. If possible, our engineers will help you select a fuse readily available in local wholesalers' stocks so users can easily obtain fuses for replacement.

For more information on the complete line of BUSS and FUSETRON Small Dimension Fuses and Fuseholders, write for bulletin SFB.

Bussmann Mfg. Division
McGraw-Edison Co., University at Jefferson, St. Louis 7, Mo.

125B

BUSS fuses are made to protect — not to blow, needlessly

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

BUSS MAKES A COMPLETE LINE OF FUSES FOR HOME, FARM, COMMERCIAL, ELECTRONIC, AUTOMOTIVE AND INDUSTRIAL USE.

CIRCLE 15 READERS SERVICE CARD

MAXIMUM TELEMETERED RESPONSE THROUGH FLAT AMPLITUDE AND CONSTANT DELAY

In keeping with its reputation as a pioneer in the field of toroids, filters and related networks, Burnell & Co. now offers a complete line of low pass and band pass constant delay filters for standard RDB telemetering channels. These Burnell constant delay filters combine accurate amplitude and phase to effectively limit intelligence distortion and false transients to a minimum. Telemetered signals from off course missiles or those in distant or terminal flight are no longer blocked by attenuation and noise.

Amplitude and Phase Necessary

For maximum performance of telemetering systems, it is recognized that filtering of sampled data requires *both* linear phase and flat amplitude in the pass band. However, until recently a combination of the two in one unit had not been available.

Combination Achieved

Existing sub carrier discriminators afford no better than a choice of flat amplitude pass band with *non-linear* phase in one filter or a constant time delay filter with *distorted amplitude.* In contrast, Burnell constant delay filters combine both—are flat within 3 db over the pass band—1½ db for the low pass filters—and possess a time delay constant within 5%.

Write for Bulletin CD 051

TECHNICAL DATA

FOR ± 7½% PASS BAND

1. Flat within 3 db over pass band
2. 21 db at ± 15% of center freq.
3. 40 db at ± 22% of center freq.
4. Time delay over the pass band, constant to ± 5%

FOR ± 15% PASS BAND

1. Flat to 3 db over pass band
2. 23 db at ± 30% of center freq.
3. 40 db at ± 44% of center freq.
4. Time delay over pass band constant to ± 7%

Input impedance — 500 ohms

*Output impedance — 500 ohms and high impedance for operation to a grid

*optional impedance available on special order.

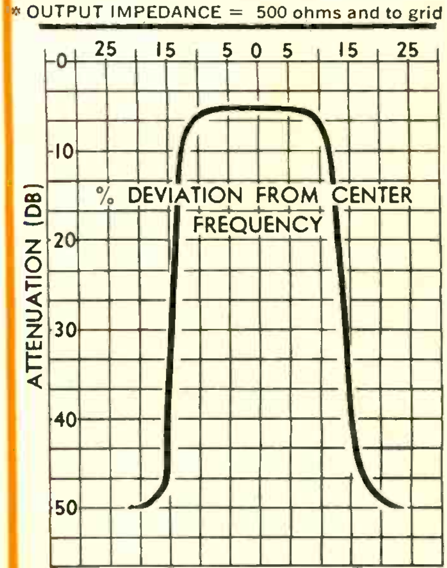
CONSTANT DELAY BAND PASS

Channel	Frequency	Part #	Delay in ms.	B/W
1	.4 KC	S-60051	34.00	15%
2	.56 KC	S-60052	24.30	15%
3	.73 KC	S-60053	18.60	15%
4	.96 KC	S-60054	14.20	15%
5	1.3 KC	S-60055	10.50	15%
6	1.7 KC	S-60056	8.00	15%
7	2.3 KC	S-60057	5.93	15%
8	3.0 KC	S-60058	4.40	15%
9	3.9 KC	S-60059	3.38	15%
10	5.4 KC	S-60060	2.44	15%
11	7.35 KC	S-60061	1.80	15%
12	10.5 KC	S-60062	1.26	15%
13	14.5 KC	S-60063	0.91	15%
14	22. KC	S-60064	0.60	15%
15	30. KC	S-60065	0.44	15%
16	40. KC	S-60066	0.33	15%
17	52.5 KC	S-60067	0.252	15%
18	70. KC	S-60068	0.189	15%
A	22. KC	S-60069	.305	30%
B	30. KC	S-60070	.224	30%
C	40. KC	S-60071	.168	30%
D	52.5 KC	S-60072	.128	30%
E	70. KC	S-60073	.096	30%

CASE SIZE—2″ x 3½″ x 4 13/16″

* INPUT IMPEDANCE = 500 ohms

* OUTPUT IMPEDANCE = 500 ohms and to grid

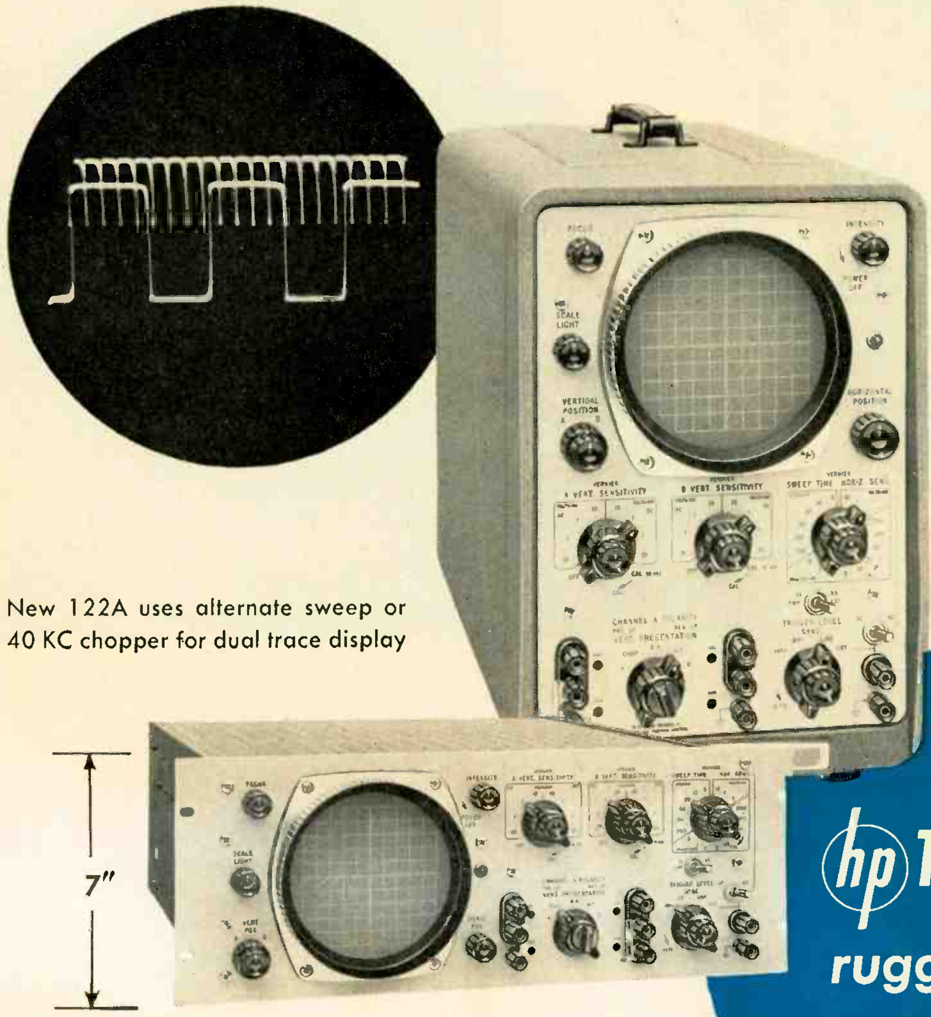


Burnell & Co., Inc.
PIONEERS IN TOROIDS, FILTERS AND RELATED NETWORKS

EASTERN DIVISION
10 PELHAM PARKWAY
PELHAM, NEW YORK
PELHAM 8-5000
TWX PELHAM 3633

PACIFIC DIVISION
720 MISSION ST.
SOUTH PASADENA, CALIFORNIA
RYAN 1-2841
TWX PASCAL 7578

At last! A PRECISION DUAL

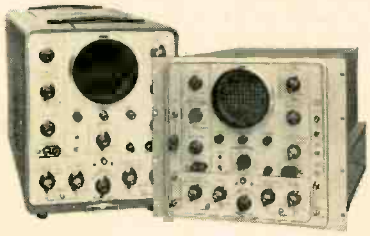


New 122A uses alternate sweep or 40 KC chopper for dual trace display

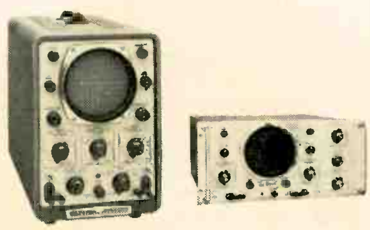
New -hp- 122A/AR

rugged cabinet or 7" high rack mount

Other high performance, direct reading,



-hp- 150A/AR, DC to 10 MC. 24 sweep times, 0.02 sec/cm to 15 sec/cm. Plug-ins for high gain or dual channel use. Rack mount, $1,200; cabinet model, $1,100.



-hp- 130B/BR, DC to 300 KC. Similar X, Y amplifiers, 21 sweep times, 1 μsec/cm to 12.5 sec/cm. Balanced input 5 most sensitive ranges. Includes times-5 magnifier. $650.

-hp- 120A/AR, DC to 200 KC. 15 sweep times, 1 μsec/cm to 0.5 sec/cm. Times-5 magnifier, automatic trigger. Simple to use, rugged, outstanding value. $435.

200 KC SCOPE WITH TRACE PRESENTATION!

Big-scope versatility at moderate cost!

Here at last is a 200 KC oscilloscope — priced at just $625 — giving you "big-scope" versatility and the time-saving convenience of simultaneous two-phenomena presentation.

Engineered to speed industrial, mechanical, medical and geophysical measurements in the 200 KC range, the new *-hp-* 122A has two identical vertical amplifiers and a vertical function selector.

The amplifiers may be operated independently, differentially on all ranges, alternately on successive sweeps, or chopped at a 40 KC rate.

Other significant features include universal optimum automatic triggering, high maximum sensitivity of 10 mv/cm, 15 calibrated sweeps with vernier, sweep accuracy of ±5% and a "times-5" expansion giving maximum speed of 1 µsec/cm on the 5 µsec/cm range. Trace normally runs free, syncing automatically on 0.5 cm vertical deflection, but a knob adjustment eliminates free-run and sets trigger level as desired between —10 and +10 volts. Rack or cabinet mount; *rack mount model only 7" high.*

For complete details, write or call your *-hp-* representative, or write direct.

BRIEF SPECIFICATIONS

Sweep: 15 calibrated sweeps, 1-2-5 sequence, 5 µsec/cm to 0.2 sec/cm, accuracy ±5%. "Times-5" expander, all ranges. Vernier extends 0.2 sec/cm range to 0.5 sec/cm.

Trigger selector: Internal + or –, external or line. Triggers automatically on 0.5 cm internal or 2.5 v peak external. Displays base line in absence of signal. Trigger level selection –10 to +10 v available when automatic trigger defeated.

Vertical Amplifiers: Identical A and B amplifiers, 4 calibrated sensitivities of 10 mv/cm, 100 mv/cm, 1 v/cm and 10 v/cm; ±5% accuracy. Vernier 10 to 1.

Balanced (differential) input available on all input ranges. With dual trace, balanced input on 10 mv/cm range. Input impedance 1 megohm with less than 60 µµf shunt. Bandwidth DC to 200 KC or 2 cps to 200 KC when AC coupled. Internal amplitude calibrator provided.

Function Selector: A only, B only, B-A, Alternate and Chopped (at approx. 40 KC).

Horizontal Amplifier: 3 calibrated sensitivities, 0.1 v/cm, 1 v/cm, 10 v/cm. Accuracy ±5%. Vernier 10 to 1.

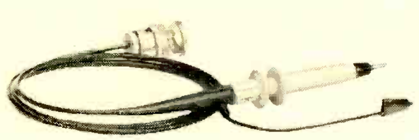
Bandwidth DC to 200 KC or 2 cps to 200 KC, AC coupled.

General: 5AQP1 CRT, intensity modulation terminals at rear, power input approximately 150 watts, all DC power supplies regulated.

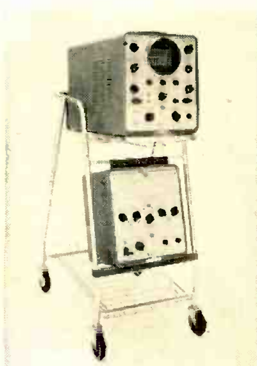
Price: (Cabinet or rack mount) $625.00.

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

automatic trigger *hp* oscilloscopes



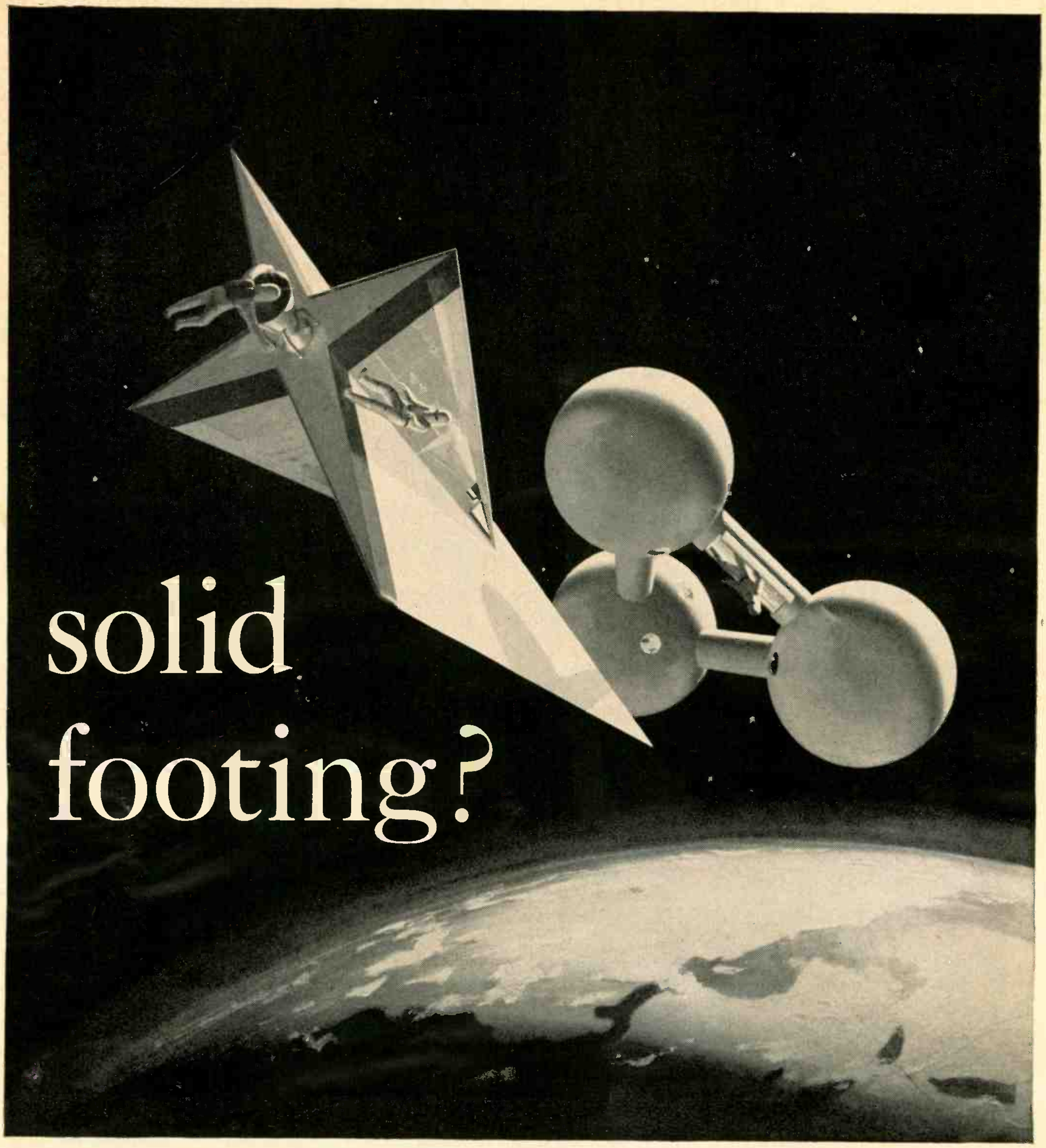
-hp- AC-21C Voltage Divider Probe. 50:1 divider with 10 megohm input impedance and 2.5 µµf capacitance. For *-hp-* 150A but usable with most scopes, VTVM's, preamps. $25.



-hp- 115A Testmobile for 150A, other scopes. Tilts scope to 30° in 7½° stages. Heavy chrome tube construction, 4" rubber tired wheels, rolls easily, folds compactly for storage. $80.

-hp- 116A Storage Unit ($22.50) hangs on 115A, holds three 150A plug-ins or **-hp- 117A Accessory Drawers,** $10 each.

HEWLETT-PACKARD COMPANY
5027A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
CABLE "HEWPACK" • DAVENPORT 5-4451
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS



To a man floating weightless around Space Station C, these are perhaps meaningless words—but *solid footing* is highly important to most of us who live and work on the surface of the earth.

Autonetics has established a solid footing in inertial guidance through 12 years of successful development and production of airborne and ocean-going systems, as well as systems for space applications.

The healthy growth of the Autonetics Guidance Engineering department—based on a number of highly diversified contracts—has created new senior-level positions in the fields of electro-mechanical component development and system analysis.

Well qualified, experienced men will find solid footing in this permanent, progressive, and successful organization—plus the chance to create and to grow in one of today's most challenging fields.

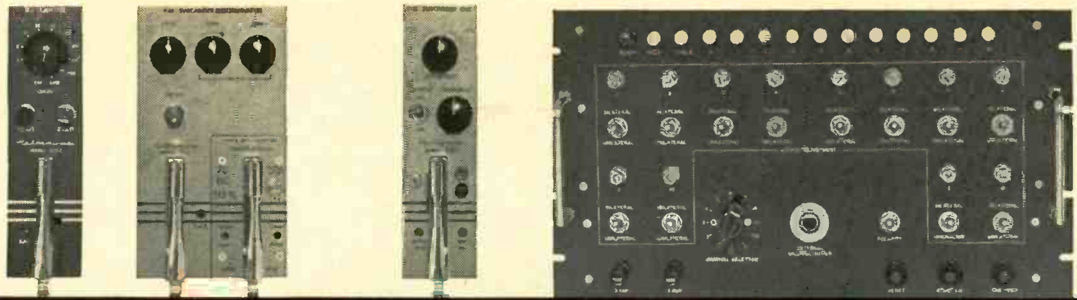
But time's a-wasting. *Now* is the time to find out what the future holds for *you* at Autonetics.

Please send your resume to Mr. L. M. Benning, Manager, Employment Services, 9150 E. Imperial Highway, Downey, California.

NERVE CENTER OF THE NEW INDUSTRIAL ERA **Autonetics**

A DIVISION OF NORTH AMERICAN AVIATION, INC.

No. 90



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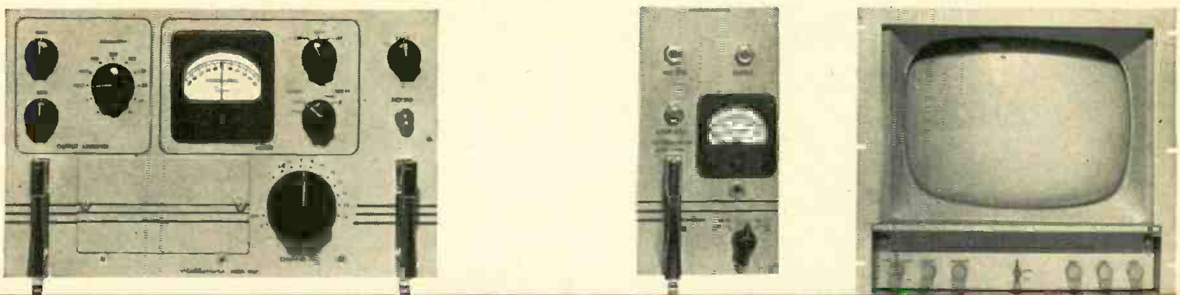


5 6 7

CHOOSE YOUR "BUILDING-BLOCKS"... SYSTEMS OR PLUG-IN SYSTEM COMPONENTS BY HALLAMORE

Successful performance of systems contracts for all branches of the United States Armed Forces provides the background for the Hallamore "Building-Block" principle...making possible the quick supply of reliable systems and system components so urgently required in the accelerated missile and satellite programs. Choose from these typical Hallamore "Building-Blocks" for adaptation in your current project. 1. DC Amplifier (drift less than ±2 Microvolts) 2. Phase-lock Discriminator (applying a concept new to telemetry) 3. FM Subcarrier Oscillator (linear...stable...internal bias) 4. Channel Calibrator (0.1% absolute accuracy) 5. Band-switched Discriminator (compact...single control switching) 6. Summing Amplifier (18 channels plus internal reference oscillator) 7. Closed circuit T.V. monitoring systems. 8. Complete Missile Telemetry Systems.
Write Dept. 20J, 8352 Brookhurst Avenue, Anaheim, California/TWX Code: AH-9079

HALLAMORE ELECTRONICS COMPANY *a division of The Siegler Corporation*

Engineers ... for ideal working conditions with a dynamic, creative organization address resume to Chief Engineer.

8

New environmental lab provides rigid in-plant testing of <u>all</u> Westinghouse electronic transformers

Westinghouse Specialty Transformer Department has established a new qualification testing laboratory in the Greenville, Pennsylvania, plant. It is fully equipped for in-plant environmental testing—humidity, altitude and temperature cycling—as well as shock and vibration testing.

Specifically designed for testing the complete line of Westinghouse MIL-T-27A electronic transformers, these facilities are also available for all other Westinghouse electronic transformers—whether for MIL-specs or non-military applications. Here is extra assurance that you get the same rugged dependability in all Westinghouse electronic transformers—regardless of use.

The test lab permits in-plant testing of all types of electronic transformers—hermetically sealed to open type—according to MIL-T-27A and MIL-T-9219 specifications for Grades 1 through 6. These units include the Westinghouse hermetically sealed MIL-T-27A transformers, Grades 1 and 4, and the Westmold, Westseal and molded case transformers, MIL-T-27A, Grades 2 through 6, or MIL-T-9219.

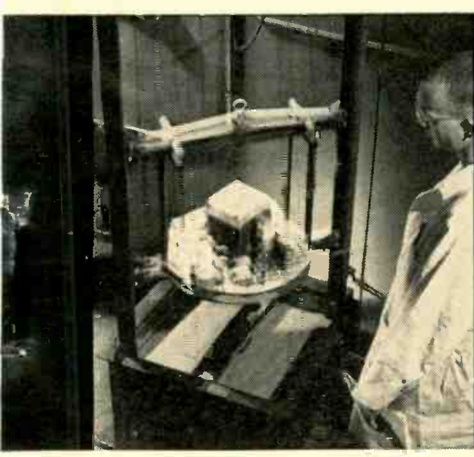
Located at the point of manufacture, this laboratory now means single responsibility by Westinghouse for design, manufacture and testing of the MIL-specs transformers—and non-military transformers—with less delays and faster delivery.

Call your Westinghouse representative for the full story of how in-plant testing in this new laboratory can aid *your* production. Ask, too, about the Westinghouse MIL-T-27A electronic transformers. J-70897

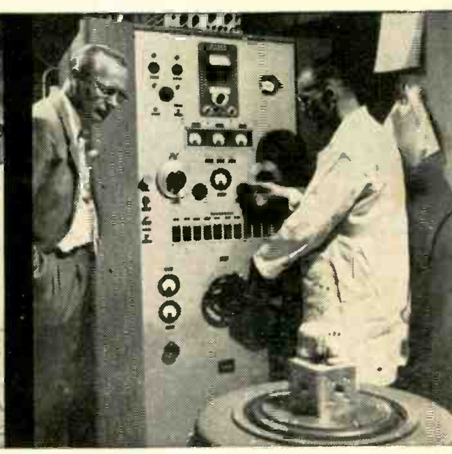
YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS

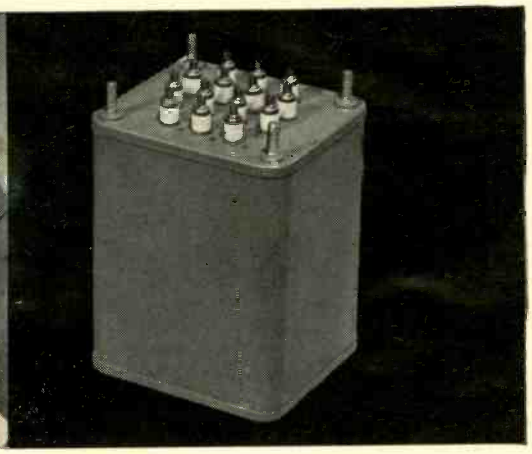
DEPENDABILITY MIL-SPECS TRANSFORMERS



Westinghouse electronic transformers being shock-tested according to specifications of MIL-T-27A with new in-plant qualification testing equipment.

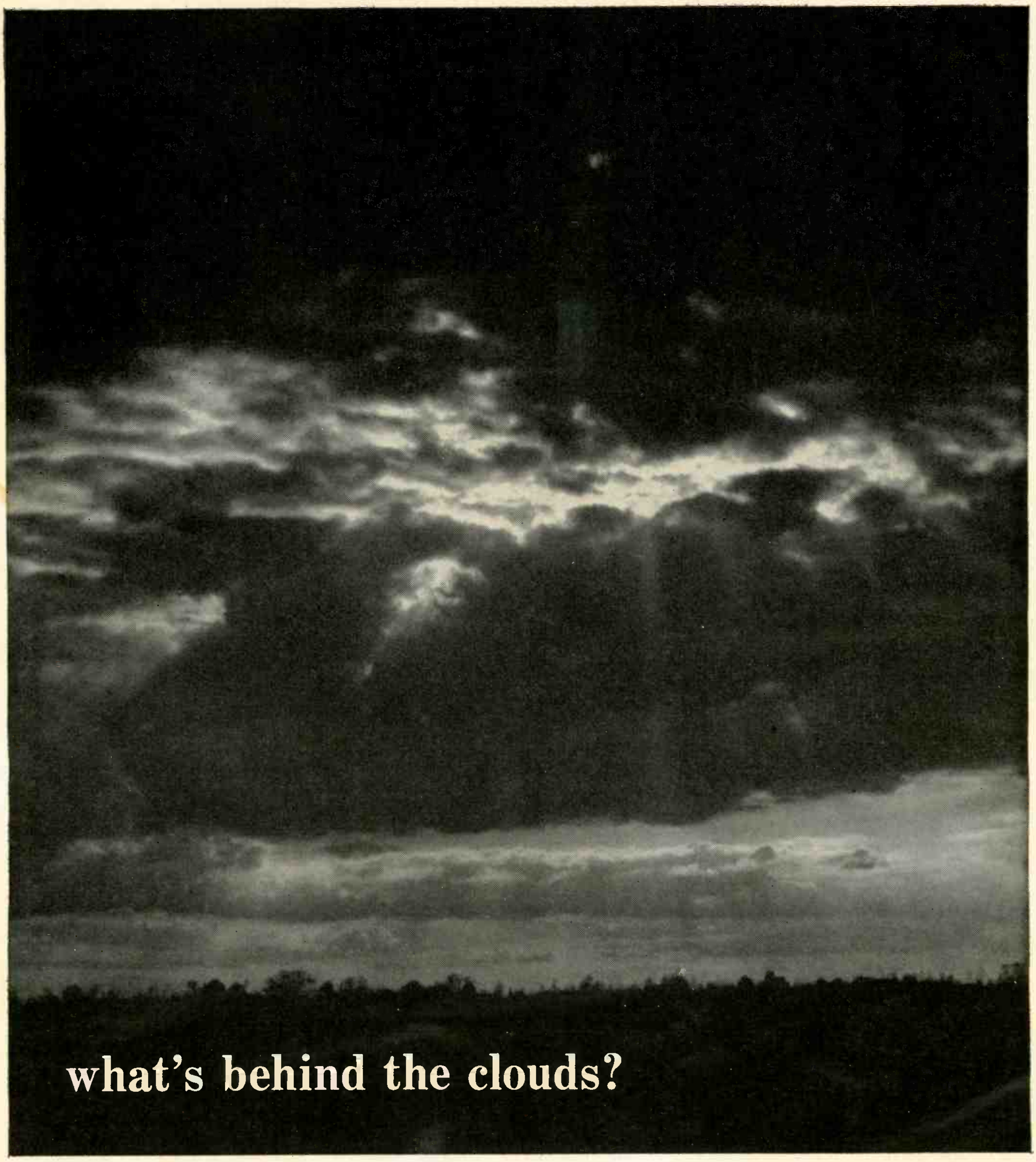


P. K. Goethe, Specialty Transformer Engineering Manager at the Greenville plant, observes shake-down run of vibration test equipment in new laboratory.



Particularly designed for power applications involving 60-400 cycles, the Westinghouse hermetically sealed MIL-T-27A transformers are available in the complete line of standard MIL-T-27A case sizes.

CIRCLE 22 READERS SERVICE CARD



BEHIND THE CLOUDS hides a cunning enemy with ever-improving weapons to threaten our security. To deter these airborne aggressors is the job of the all-weather interceptor, our first line of defense.

Partaking in a giant chess game, a Hughes Airborne Systems Engineer is constantly fed intelligence information regarding the most recent enemy advances. He asks the question, "How effective are present interceptors against the new enemy capabilities, and how can we counter this challenge?"

The Hughes Airborne Systems Engineer is concerned with the design of hardware, but he does not design hardware. He is more interested in the broader systems aspects. Taking an analytical approach, he must solve the interacting problems of performance, reliability, maintainability, and operability.

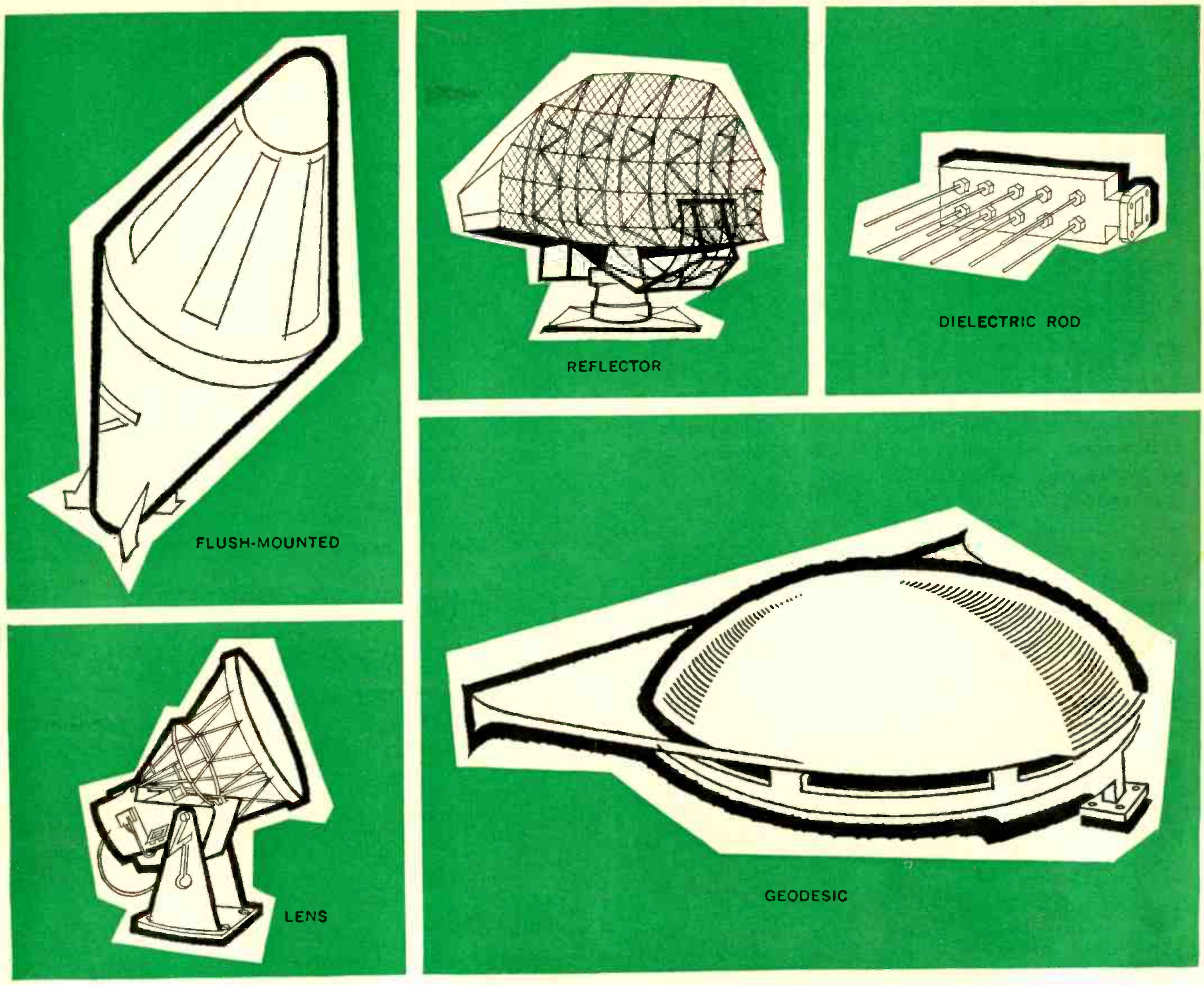
If this type of systems engineering interests you, investigate the assignments now open in:

SYSTEMS ANALYSIS • SYSTEMS EVALUATION
SYSTEMS DESIGN • SYSTEMS FLIGHT TEST
SYSTEMS DESIGN CO-ORDINATION

The salary structure for these positions reflects the advanced nature of the assignments. Please inquire by writing directly to Dr. Allen Puckett, Associate Director, Hughes Systems Development Laboratories.

HUGHES AIRCRAFT COMPANY
CULVER CITY 34, CALIF.

HUGHES



ANTENNAS

Sperry can help you suppress side lobes, improve resolution, scan at higher speed

Sperry microwave antennas are currently used in a wide number of highly specialized military, naval and aviation applications – from missile guidance to electronic countermeasures.

If your project requires microwave antenna design or production, Sperry can help you.

Right now, in a completely equipped new plant at Clearwater, Florida, Sperry antenna engineers are busy designing and producing many new advanced types of microwave antennas, such as 70 kmc geodesic antennas and dielectric rod arrays. Backing them up, in addition to complete laboratory and production facilities, is a new antenna range equipped with the latest automatic recording equipment which is capable of handling large apertures and aircraft model pattern work. Supporting the antenna engineers are highly qualified engineers and physicists specializing in the related fields of electronics, mechanical design, electromagnetic physics and advanced system techniques.

With sunny weather the year round, Clearwater weather permits running radiation patterns nearly every day. We have engineers, facilities and the weather—all necessary factors for solving your problems. Write us for more information on any phase of microwave antenna development.

SPERRY

SPERRY MICROWAVE ELECTRONICS COMPANY, *CLEARWATER, FLORIDA · DIVISION OF SPERRY RAND CORPORATION*

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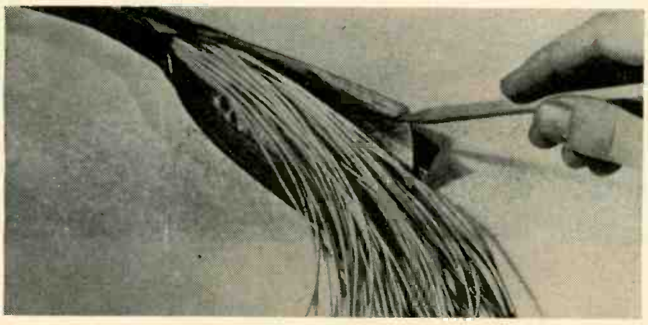
ZIPPERTUBING NEW PRODUCTS

SHIELDED ELECTRONIC CABLES IN ONE STEP

Multi-conductor electronic cable or harnesses which require RF, UHF, magnetic or radiation shielding can be quickly made up with the revolutionary, new shielded ZIPPERTUBING. Lamination of pure metal foil to the inner surface of ZIPPERTUBING jacketing provides shielded cable at a fraction of the cost of conventional tinned copper wire shielding plus outer jacketing. This new process also permits 100% effective shielding of main cable and branchouts without tedious hand wrapping, thereby saving up to 90% in labor cost.

RF and UHF Shielded ZIPPERTUBING consists of a vinyl saturated fiberglas jacket laminated to pure aluminum or copper foil. RF shielded jacketing is flame resistant and has a temperature range of -40°F. to 392°F.



A typical multi-conductor cable with a shielded ZIPPERTUBING jacketing. The pencil shows the laminated metal foil.

Magnetic shielded ZIPPERTUBING consists of Conetic steel laminated between layers of vinyl, Mylar* or fiberglas. Additional laminations may be specified for increased protection. With each additional layer, the amount of magnetic shielding is squared.

Radiation shielded jacketing is made of vinyl covered lead saturated glass cloth. It may be used for constructing new cables or as an outer protective jacketing over existing cables that may be replaced when contaminated.

The ZIPPERTUBING shielded cables are particularly easy to ground through a wide variety of methods. One of the most popular consists of a 1/16" copper tinned braid which is machine sewn to the inner flap of any shielded jacketing at the factory. This process permits the user to effectively ground the cable at any desired point.

ZIPPERTUBING shielded jackets are available in 3/8" I.D. and up, in 1/8" increments and are provided in a wide selection of colors. Complete technical information is available upon request.

FREE CABLE CALIPER

Zippertubing cable caliper has been specially developed for showing the actual diameter of any multi-conductor electronic cable at a glance. It also indicates the proper size of Zippertubing for a tight-fitting cable jacket. The Zippertubing caliper is handy for measuring any cylindrical object up to 2" in diameter. It will be furnished free on request.

*Trademark of duPont.

Type ALAS Thermazip.

THERMAZIP Resists Missile Firing

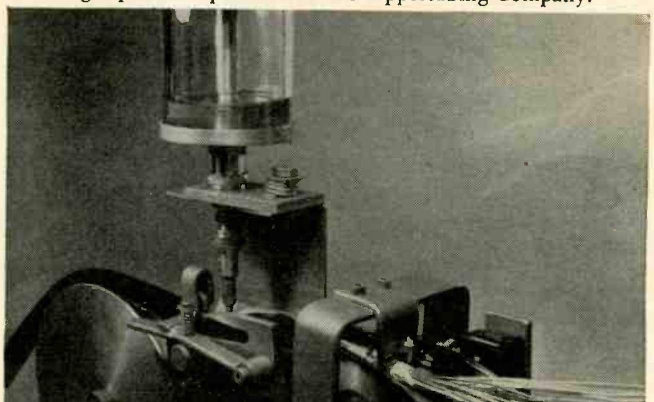
Zippertubing THERMAZIP, known as type ALAS, will withstand operating temperatures of 2000°F. This was proved in recent firings of major ICBMs where THERMAZIP was used to protect electronic cables exposed to the direct launching blast of the missile. This revolutionary jacketing has survived two launchings and has completely protected the cables it enclosed.

THERMAZIP is made of aluminized reflective asbestos fiber which quickly zips around the cable. A double external flap protects the point of closure. Other materials available include aluminized silicon rubber-coated glass cloth with great corrosion resistance for protection from -100°F. to 500°F. Plain asbestos THERMAZIP is also available.

AUTOMATIC CABLE MACHINE SUCCESSFUL

Since its recent announcement, the new Zippertubing automatic cablemaking machine has been successfully used by many manufacturers for making their own multi-conductor electronic cables. The revolutionary machine automatically makes cables with up to 108 conductors and applies either shielded or regular jacketing in a one-step operation. Labor costs, capital equipment expenditures and production lead time are drastically reduced.

The inexpensive machine is available on lease, lease-purchase or outright purchase plans from The Zippertubing Company.



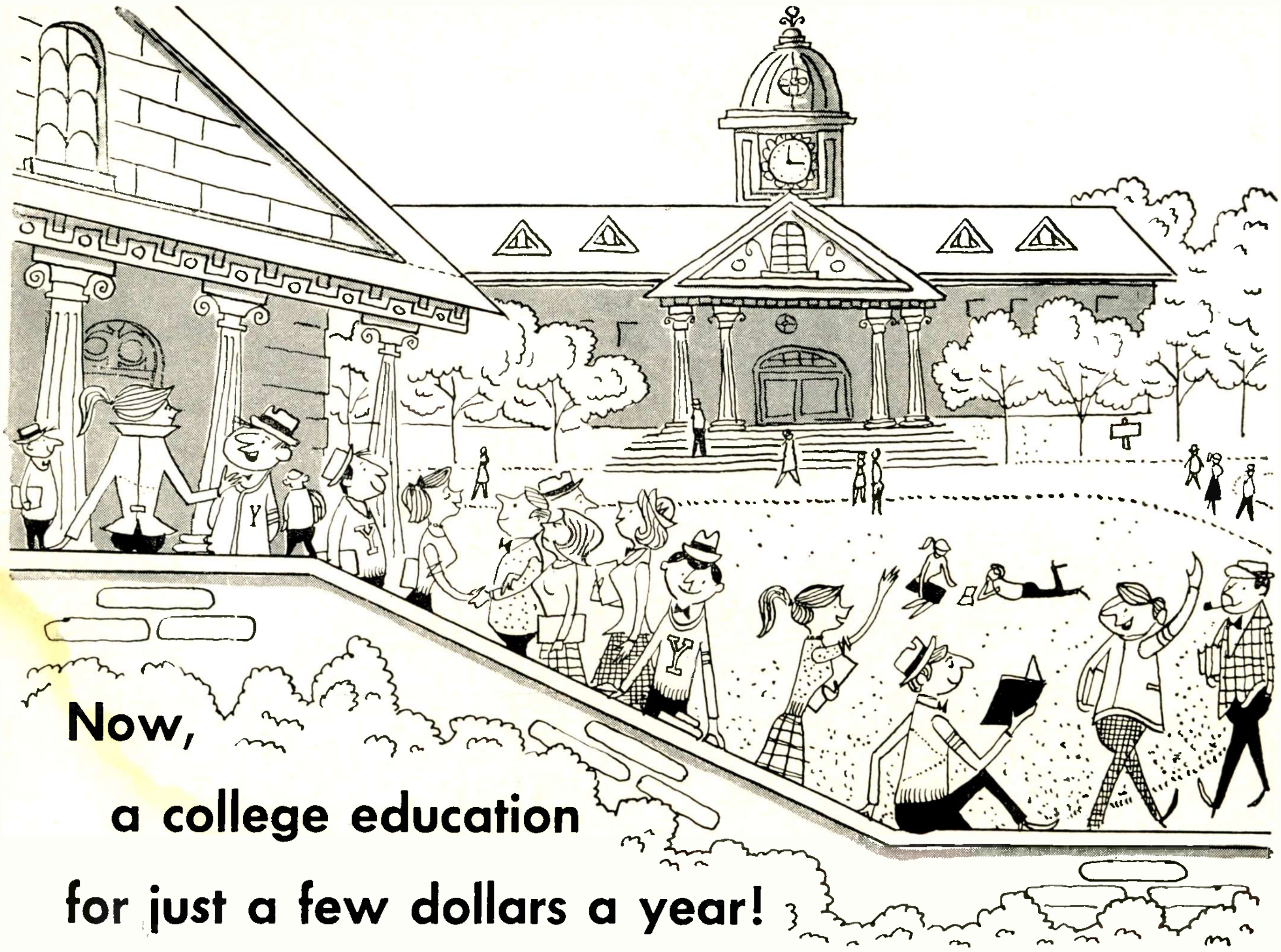
Close-up of cable machine head showing cable being formed and sealed.

For complete catalog information or field engineering service, write to:

The Zippertubing Co., 752 So. San Pedro St., Los Angeles 14, Calif. TWX [illegible]. Sales offices and warehouses in all principal cities.

CIRCLE 25 READERS SERVICE CARD

CIRCLE 26 READERS SERVICE CARD→



Now, a college education for just a few dollars a year!

Some time ago, a man called your name, and you walked across a stage, and were handed a diploma. Were you proud! You were educated. The world was your oyster.

You promised yourself then that you would keep your education alive. That you'd go back and earn that graduate degree. Or brush up at night school, or some summer seminar. But then you met that pretty girl. A few years later – the stork, the new house on Cedar Road . . . everything seemed to happen at once.

Meanwhile, back on the job, you were busier and busier. Company expanding. New products. New problems. Nights when you got home, you were really beat. After dinner, you'd park yourself in your easy chair, find your mind wandering to the future – "Am I slipping? Is management passing me by?"

May we help you help yourself? May we suggest a method for moving ahead, a proved road to new opportunity? Do you know that you can still get that advanced education you promised yourself – and for just a few dollars a year?

Yes, you can get it right here in the pages of this publication. The currency of news and fact about your industry as only McGraw-Hill's editorial facilities and competence can bring it to you. The knowledge that is the power of authority. For here you learn the most efficient, adult way – by active participation. You share common problems, objectives, and job interests with men just like yourself.

If you are so fortunate as to have a personal subscription to this McGraw-Hill magazine, the few dollars it costs you will return you many thousands in greater distinction in your present work – richer dividends in promotion. If you happen to share your copy on a routing list . . . please consider the advantages of your own subscription. But no matter whose copy you read, really read it! Every extra minute you put into it is preferred stock in your own future.

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The most interesting reading for the man most interested in moving ahead

1958 Index to electronics

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Items for which the page reference is marked "EAW", "CD" and "PT" are editorial material published in Electrons at Work, Component Design and Production Techniques departments, respectively.

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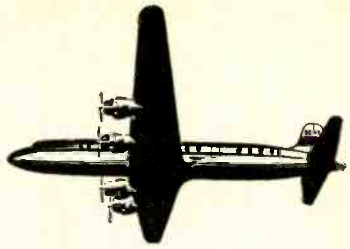
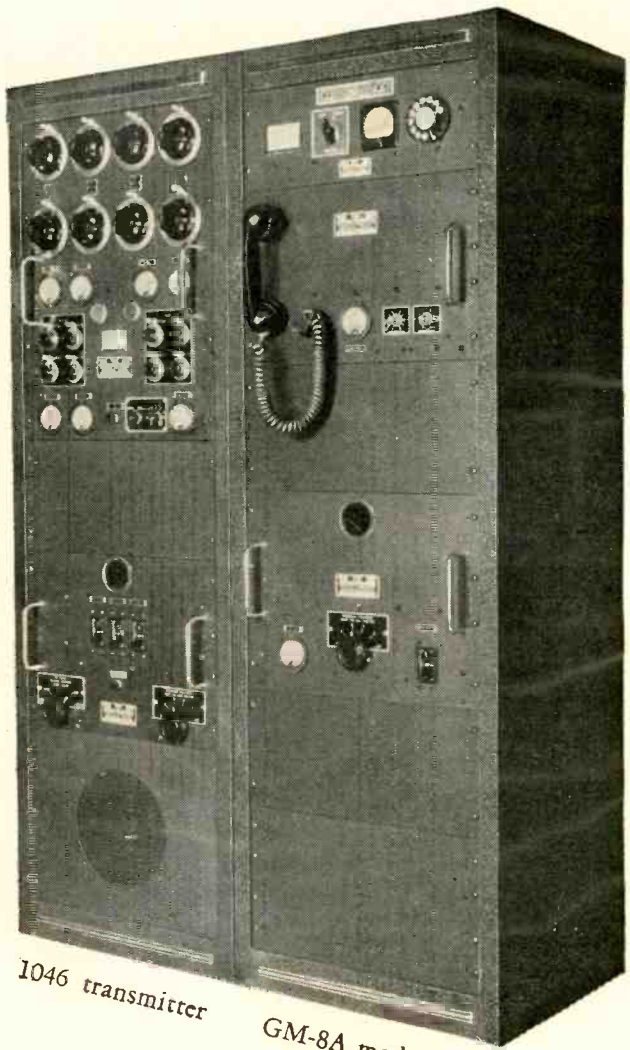
* Not included in original byline

AEROCOM'S 1046 H. F. TRANSMITTER



POWER + STABILITY

1000 WATTS WITH .003% STABILITY



1046 transmitter GM-8A modulator

Rugged, versatile general purpose H. F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0° to +50°C.). Excellent for point-to-point or ground-to-air communications.

Multi-channel operation on telegraph A1, or telephone A3 with GM-8A modulator ... new Aerocom 1046 can be *remotely controlled* with TMC-R at control position and uses only one pair of telephone lines. In A3 operation, the local dial control panel is located in modulator cabinet.

Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to +50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

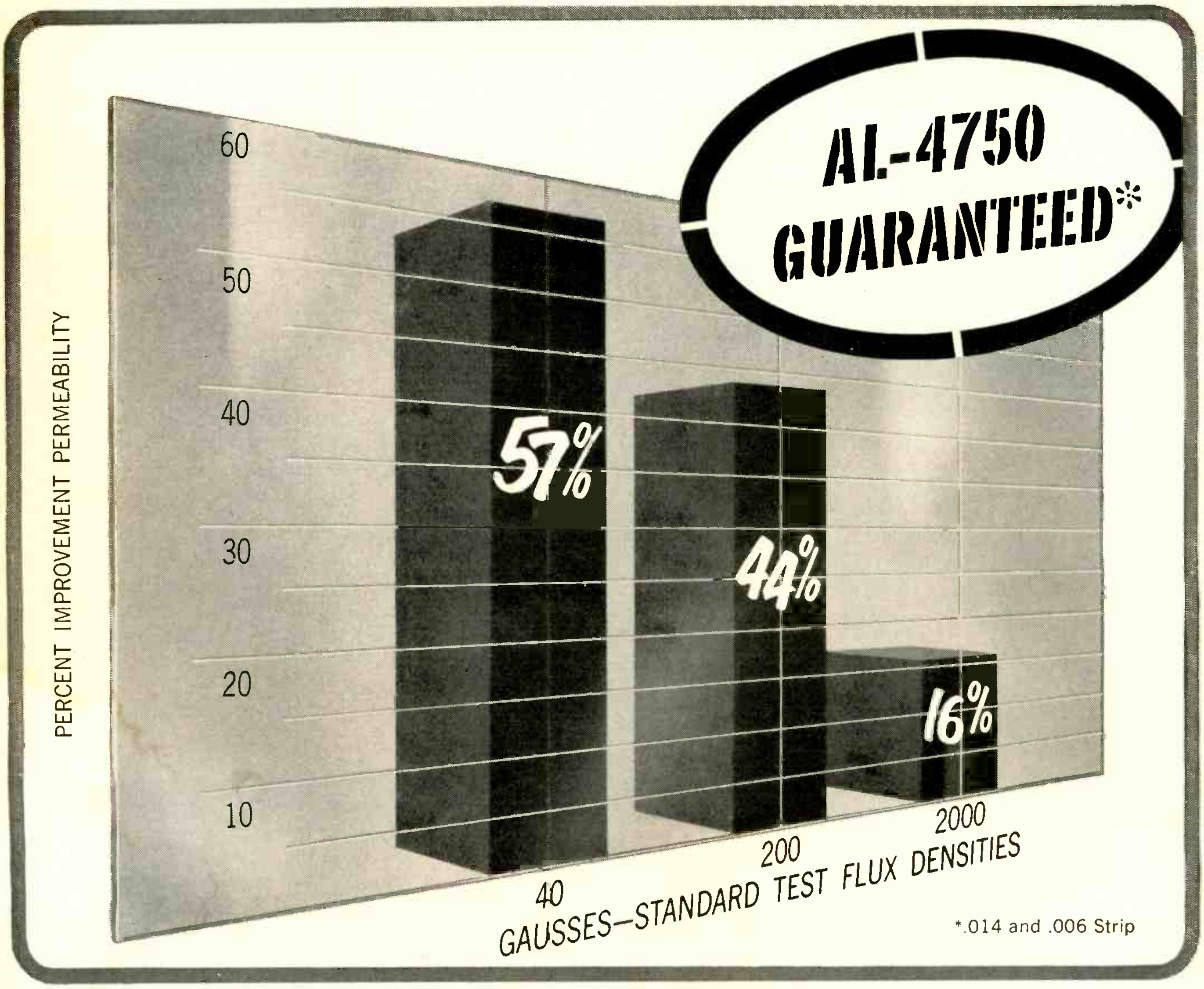
Complete technical data on request

Now! Complete-package, 192 channel, H. F., 75 pound airborne communications equipment by Aer-O-Com! Write us today for details!

AER-O-COM

105

3090 S.W. 37th AVENUE MIAMI 33, FLORIDA



GUARANTEED PERMEABILITY... and at higher values than old average values in AL-4750

AL-4750 nickel-iron strip now has higher permeability values than ever before . . . and the new, higher values are guaranteed. For example, using the standard flux density test, at 40 induction gausses, AL-4750 now has 57% higher permeability than in the past. And permeability values are guaranteed.

This guaranteed permeability means greater consistency and better predictability for magnetic core performance . . . permits careful, high performance design.

The improvement in AL-4750 didn't just happen. It is the result of Allegheny's electrical alloy research and production program in nickel-bearing steels. A similar improvement has been made in AL Moly Permalloy. And research is continuing on silicon steels including AL's famous Silectron (grain oriented silicon steel), as well as on other magnetic alloys.

Another service of Allegheny Ludlum includes complete facilities for the fabrication and heat treatment of laminations. Years of experience in AL's lamination department means that Allegheny Ludlum has encountered and solved most problems common to core materials. This practical know-how is available to all. Call us for prompt technical assistance. Write for blue sheet EM-16 for complete data on AL-4750.

Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. E-12.

WSW 7269

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STEELMAKERS TO THE ELECTRICAL INDUSTRY

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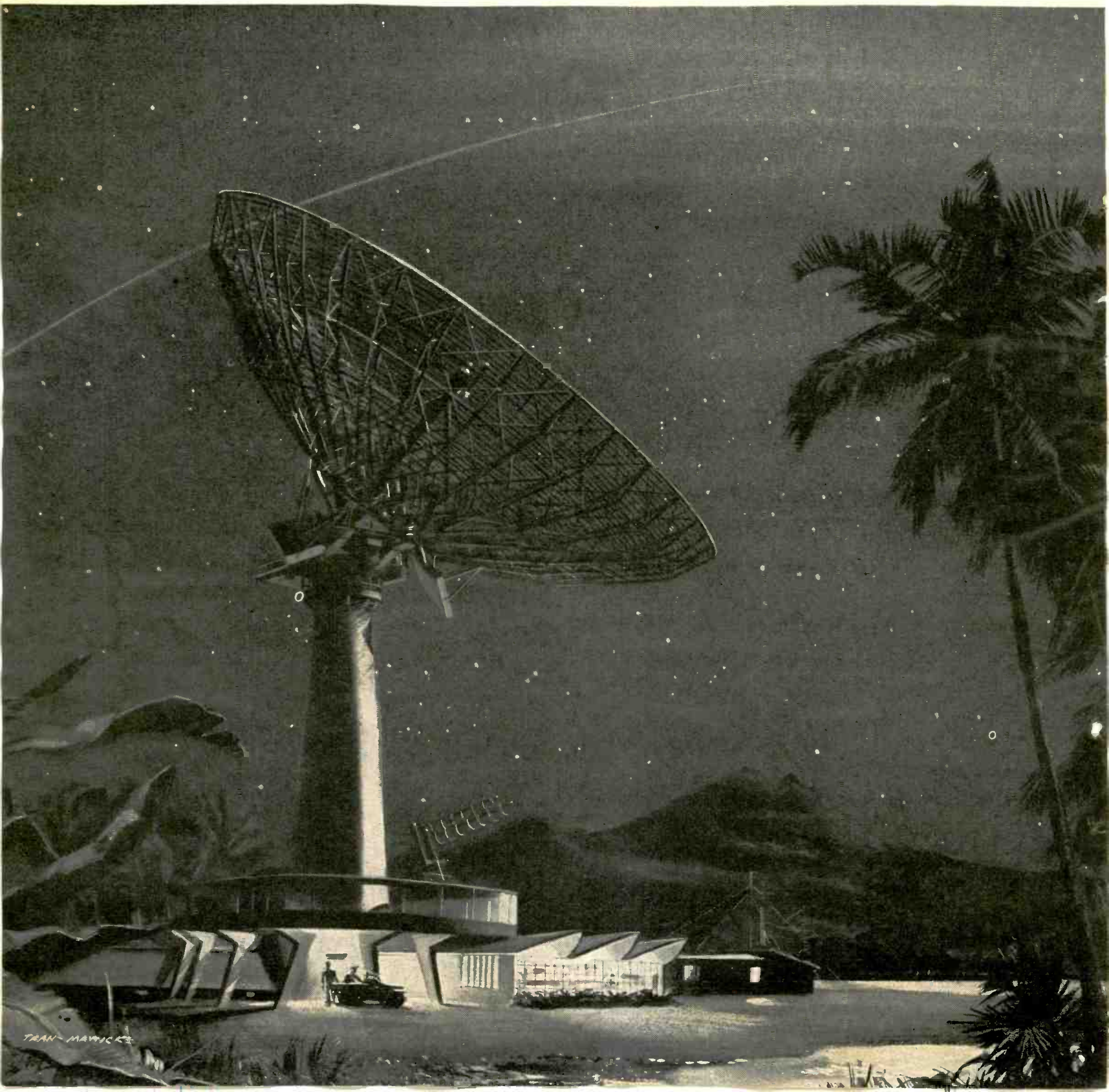
READY FOR TOMORROW'S CIRCUITS—

Only tubes can perform many difficult jobs of tomorrow's advanced systems and still give the performance, flexibility, and reliability you require. The significance of these tube advantages is increasing through General Electric's program to improve constantly such 5-Star qualities as known, predictable reliability.



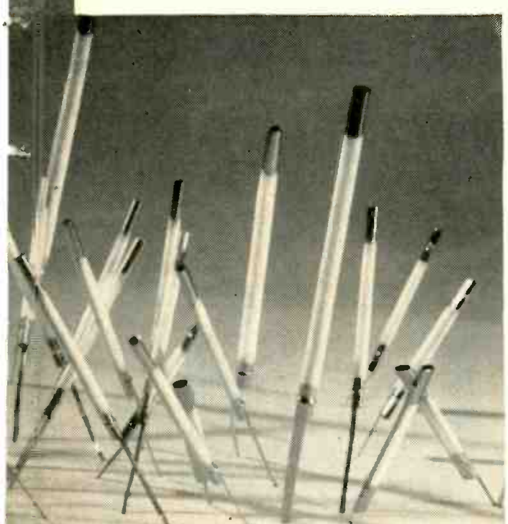
GENERAL ELECTRIC 5-STAR TUBES!

ELECTRONIC TUBES are, and will remain, superior in these areas of performance:

- Proved reliability.
- VHF and UHF capability, and flexibility at these frequencies.
- One third the number of devices.
- Economy.
- Stable under ambient-temperature variations. Tolerate high temperatures.
- Low noise in wide-band RF circuits.
- High-voltage capabillty.
- Uniform product, with predictable performance to ratings.

This margin of superiority grows as General Electric's active program of improvement makes 5-Star Tubes still more efficient and reliable. Design; manufacture; test; application—every product stage from development to final use in circuits shows progress in materials, methods, or both, as illustrated and described below.

14,000 tubes, using various cathodes and cathode coatings, make up one of many tests by General Electric to help determine the specifications for future 5-Star Tubes having even better performance. Equipment designers can be sure that General Electric leadership in high-reliability tubes is being maintained and strengthened; that 5-Star types will continue to meet the challenges of advanced electronic circuitry.



PROGRESS IN DESIGN. New cathodes for G-E 5-Star Tubes reduce interface and degradation of characteristics throughout life, mean built-in reliability. 100% tube stabilizing—used only by General Electric—adds to cathode and tube dependability and long life. New glass technology gives G-E tubes greater resistance to heat.

PROGRESS IN MANUFACTURE. Ultrasonic cleaning now is used for critical tube parts. This further extends General Electric's famed SNOW WHITE technique for excluding impurities of all kinds—notably dust and lint—during 5-Star Tube manufacture... A new direct-flow coating method for tube heaters accurately centers the wire, and provides an even coating, for more uniform insulating properties.

PROGRESS IN TESTING. General Electric's new impulse test, with vibrational output measured both in peak and integrated values, promotes lower-noise tubes where shock and vibration occur. Interface life tests; 100% DC testing for shorts and opens: these are among the many checks that make 5-Star tubes constantly more reliable.

For further information, phone nearest office of the G-E Receiving Tube Department below:

EASTERN REGION
200 Main Avenue, Clifton, New Jersey
Phones: (Clifton) GRegory 3-6387
(N.Y.C.) WIsconsin 7-4065, 6, 7, 8

CENTRAL REGION
3800 North Milwaukee Avenue
Chicago 41, Illinois
Phone: SPring 7-1600

WESTERN REGION
11840 West Olympic Boulevard
Los Angeles 64, California
Phones: GRanite 9-7765; BRadshaw 2-8566

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GENERAL ELECTRIC

12-11-207

CIRCLE 34 READERS SERVICE CARD

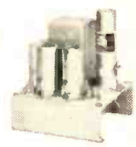
FREQUENCY STANDARDS

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*

Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

*3⅛" high
400 - 1000 cy.



FREQUENCY STANDARD
TYPE 50L

Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.

Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*

Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

*3½" high
400 to 500 cy.
optional

FREQUENCY STANDARD
TYPE 2005

Size, 8" x 8" x 7¼" High
Weight, 14 lbs.

Frequencies: 50 to 400 cycles (Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD *NEW*
TYPE 2007-6

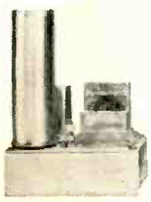
TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.

Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007-6 (± .02% at —50° to +85°C)
R2007-6 (±.002% at +15° to +35°C)
W2007-6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A

Size
8¾" x 19" panel
Weight, 25 lbs.

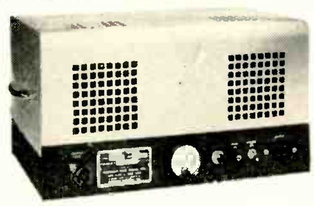
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)



FREQUENCY STANDARD
TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.

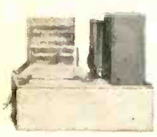
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.



FREQUENCY STANDARD
TYPE 2111C

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.

Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.



ACCESSORY UNITS
for TYPE 2001-2

L—For low frequencies multi-vibrator type, 40-200 cy.
D—For low frequencies counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

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Watch Master
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HUDSON precision quality metal components are produced by cost-reducing mass production methods. The HUDSON production department is equipped with batteries of standard and special presses ranging up to 300 tons. HUDSON performs a wide range of operations to meet your needs.

4 STANDARD PRECISION DRAWN INSTRUMENT CASES

Standardized cases include over 1400 different sizes, with both inside and outside covers, in six standard metals. Hudson offers the engineer a range of closures unequalled in the industry.

3 MIL-T-27A CLOSURES FROM AF TO OA

Cases and covers now offered by HUDSON from types AF to OA inclusive. Immediate shipment from large stock supplies. Cover assemblies to MIL-T specifications also available.

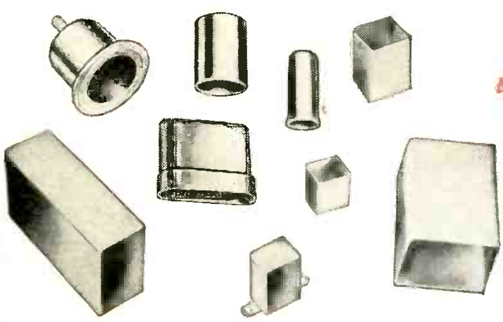
2 SPECIAL FACILITIES FOR TRANSISTOR CLOSURES

HUDSON'S newly installed 10 station automatic presses speed production on your transistor caps. Closures for transistors, diodes and other miniature components to specifications.

1 COMPLETE SERVICE ON MU METAL FABRICATION

HUDSON is now able to supply MU Metal closures in all standard sizes and shapes. Stock supply assures prompt delivery. Consult HUDSON on all your electrical alloy requirements.

HUDSON service is complete . . . includes sheet metal fabrication, spot welding, heliarc welding and silver soldering. HUDSON designers and production engineers will be happy to help work out your problems.



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Among the many forms of silver and silver alloys manufactured by Handy & Harman are:

Fine silver (wire, strip and foil) • Silver anodes and grain for plating • Silver contact alloys • Silver powders • Silver flake, paints and paste • Silver brazing alloys • Silver electronic solders • Silver sintered metals • Solder-flushed silver alloys • Silver chloride and oxide • Coin silver (wire and strip) • Silver bi-metals

The increased acceptance of silver powder and flake in electronic circuitry and components has created a demand for a source that can supply these materials at a consistently high level of quality.

Handy & Harman manufactures silver powder and flake in all types and forms, for use in formulations on printed circuitry and wiring, resistors, condensers, thermistors, printed terminal strips on glass, ceramics or plastic laminates, etc.

If you are working on conductive or resistive coatings where you require excellent electrical conductivity, Handy & Harman will welcome the opportunity to assist you in the choice – or discussion of *any* silver product that may interest you. Write for Technical Bulletin A-4 on Silver Conductive Coatings and Bulletin A-5 on Silver Powder and Flake.

Our technical service and field application experience are at your disposal... we welcome inquiries on products and product problems involving any form of silver.

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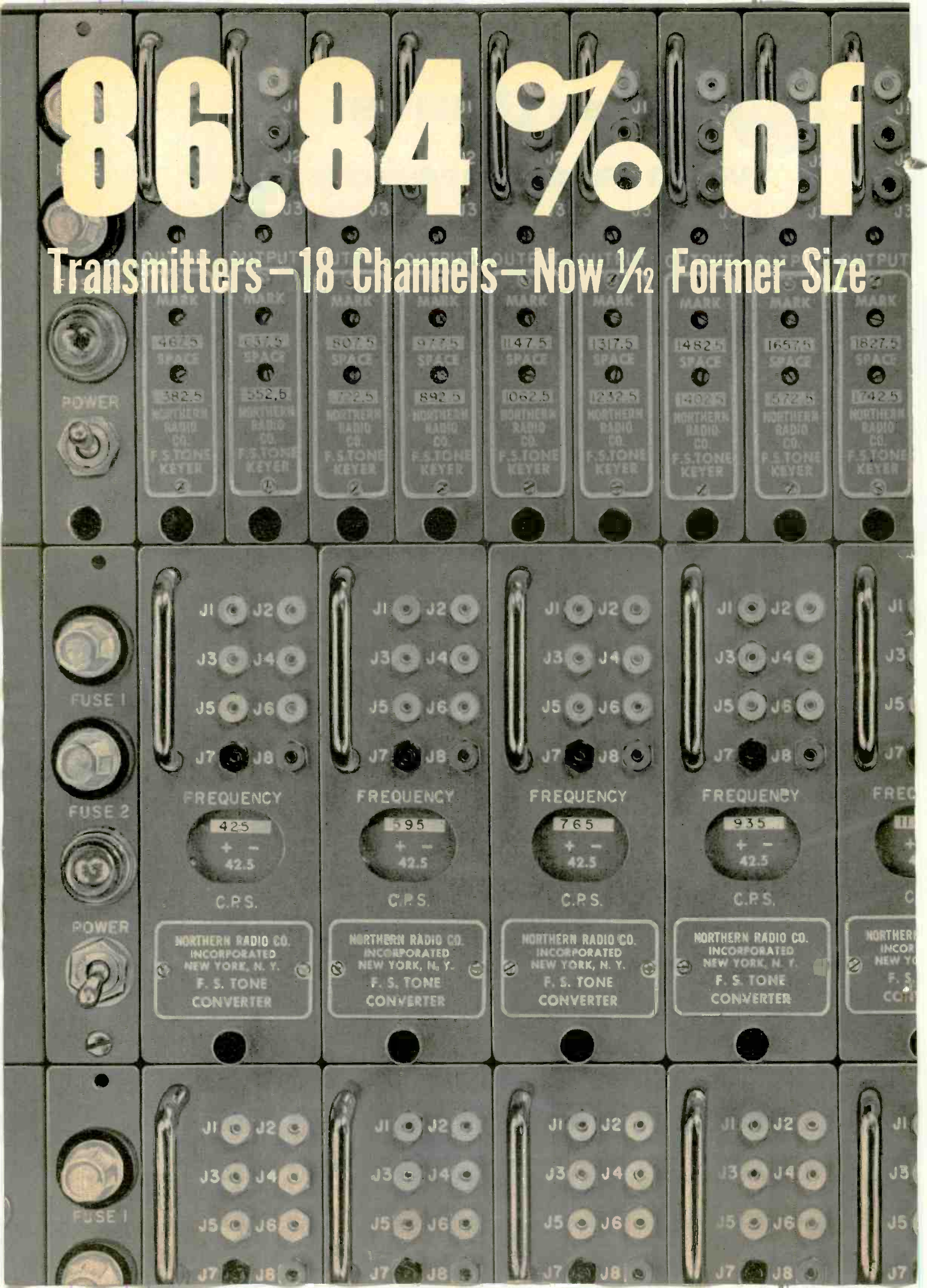
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Receivers—18 Channels—Now 1/6 Former Size
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. . . the most MINIFIED of them all
NORTHERN RADIO
Transistorized
18 channels in only 15¾" panel space
Top shelf shows 18 Frequency Shift Tone Keyers. Type 211 Model 1; Next 2 shelves contain 9 each Frequency Shift Tone Converters, Type 212 Model 1;
FREQUENCY SHIFT TONE KEYER—Type 211 Model 1
Keying inputs, levels & impedances: 1. Contact keying (internal battery to "dry" contacts) [illegible] ma. min.; 2. DC current pulses, positive or negative, neutral or polar, high range, 220 ohms, 30 ma. min. low range, 2200 ohms, 0.5 ma. min.; 3. DC voltage pulses, positive or negative, neutral or polar, high range, 100,000 ohms, 10 volts min., low range, 2200 ohms, 1 volt minimum.
Frequency Stability: Standard Networks ±2 cps total for all causes including ±10% line voltage change and ±25°C. from 25°C. temperature change.
Harmonic Content. All harmonics of the tone are more than 50 db below output level.
Output Frequencies: All standard VF carrier channels from 425 to 3315 cps. Bandwidth dependent on keying speed requirements. Other frequencies and bandwidths available on special order.
Output Level & Impedance: 5 dbm maximum, into 600 ohms, unbalanced. May be paralleled with any number of other Keyers operating on different frequencies in the same audio system.
Power Requirements: 14 V DC 15 MA. Two transistorized power supplies and one automatic change-over relay are mounted on the rear of each mounting shelf.
Dimensions: 7/8" wide x 5¼" high x 10½" deep.
FREQUENCY SHIFT TONE CONVERTER—Type 212 Model 1
Input Level & Impedance: −48 dbm to +6 dbm into 600 ohms, unbalanced. May be paralleled with any number of other converters operating on different frequencies in the same audio system.
Input Frequencies: All standard telegraph VF channels from 425 to 3315 cps. Bandwidth dependent on keying speed requirements. Other frequencies and bandwidths available on special order.
Output: Neutral DC voltage pulses of 10 volts maximum across a 2000 ohm external load. Polar pulses ±10 volts across a 2000 ohm external load. Output drives appropriate voltage-to-current converters, such as Northern Radio Type 213 Transistor Relay, which provides proper teleprinter operating currents. Printers which are already equipped with internal repeating relays may be driven directly from the normal output terminals of the Type 212 Converter when so desired.
Power Requirements: 14 V DC at 30 MA. Two transistorized power supplies and one automatic change-over relay are mounted on the rear of each mounting shelf.
Dimensions: 1⅞" x 5¼" x 11¾" deep. For rack mounting a number of these units, a shelf assembly is available accommodating nine (9) units in a panel height of 5¼".
Write for complete technical data.
NORTHERN RADIO CO., INC. 147 W. 22nd Street, New York 11, N. Y.
Pace-Setters in Quality Communications Equipment
In Canada: Northern Radio Mfg. Co., Ltd., 1950 Bank St., Billings Bridge, Ottawa, Ontario
*Illustrated: 86.84% of actual width, 71.43% of actual height.

TUNG-SOL POWER TRANSISTORS IMPROVED THREE WAYS BY:

NEW Cold-Weld

SEAL

Tung-Sol's new true cold-weld seal represents a major advance in transistor technology. An exclusive Tung-Sol development, cold-weld sealing increases TO-3 outline package efficiency and brings designers a threefold bonus in over-all transistor performance.

Improved thermal qualities. The cold-weld process produces a hermetic, copper-to-copper seal and makes possible a 100% copper transistor with thermal properties superior to previous high power types.

Improved reliability. Cold-weld encapsulation eliminates heat damage, "splash", and heat-caused moisture that can impair transistor performance.

Longer efficient life. Even through temperature fluctuations that cause "breathing", the cold-weld seal stays vacuum-tight, moisture-proof—result of actual integration of the copper molecules during sealing.

Tung-Sol power switches with the new cold-weld seal withstand the most rigid combination of tests given any transistor—the 100 psi "bomb" immersion test and the critically sensitive Mass Spectrometer leak test. Further, they meet all military environmental requirements. For full data on the improved Tung-Sol types . . . to fill any transistor need, contact: Semiconductor Division, Tung-Sol Electric Inc., Newark 4, New Jersey.

THESE TUNG-SOL HIGH POWER (TO-3 OUTLINE) TRANSISTORS FEATURE THE NEW, COLD-WELD SEAL

Type	BVCES (V_{BE} = +1.0v) Volts (Min)	BVCEO (I_B = 0) Volts (Min)	hFE (I_C = 1.0 A)	hFE (I_C = 2.0 A)
2N378	—40	—20	50	30
2N379	—80	—40	50	30
2N380	—60	—30	70	50
2N459	—105	—60	50	30

TO-3

IMPROVED SPECIFICATIONS OF TUNG-SOL COLD-WELDED HIGH POWER TRANSISTORS.

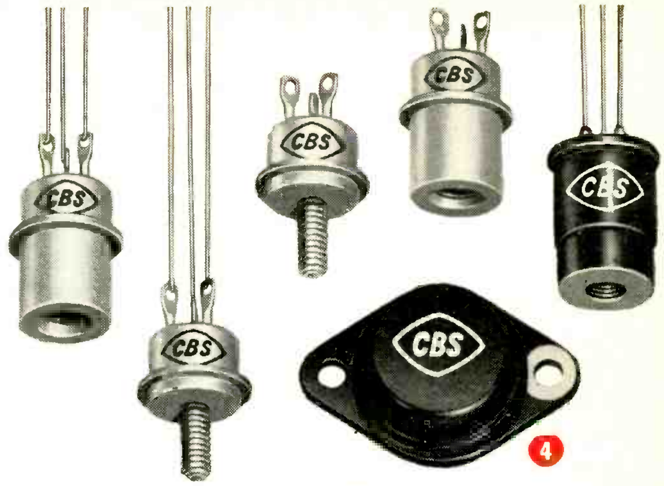
Collector Dissipation @ 25°C*...50 Watts
Collector Dissipation @ 55°C*...25 Watts
Thermal Resistance............1.2° C/Watt Max.
I_{CBO} @ V_{CB} = —25v T = 25°C...0.5 Ma Max.
I_{CBO} @ V_{CB} = —25v T = 85°C...7.5 Ma Max.
Storage Temperature..........—55 to +100°C

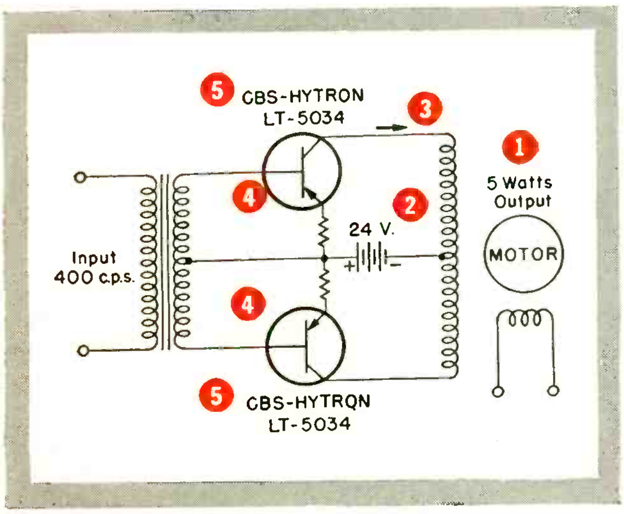
*Mounting base temperature

ts TUNG-SOL®

CIRCLE 42 READERS SERVICE CARD

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‡	30V	60V	100V	120V	Packages#
60	LT-5028	LT-5034	LT-5042	LT-5051	Diamond
	LT-5027	LT-5033	LT-5041	LT-5050	Male
	LT-5026	LT-5032	LT-5040	LT-5049	Female
40	LT-5025	LT-5031	LT-5039	LT-5048	Diamond
	LT-5024	LT-5030	LT-5038	LT-5047	Male
	LT-5023	LT-5029	LT-5037	LT-5046	Female
20	LT-5022	2N157	2N157A	LT-5045	Diamond
	LT-5021	LT-55	LT-5036	LT-5044	Male
	2N156	2N158	LT-5035	LT-5043	Female

Minimum Breakdown Voltage†

30-WATT GROUP
Types Available

Current Gain‡	30V	60V	80V	100V	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

Minimum Breakdown Voltage†

40-WATT GROUP
Types Available

Current Gain‡	30V	60V	80V	100V	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

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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DC INSTRUMENTS—A four or five digit Bridge Module combined with a Power Unit Module provides proven accuracy of 0.01%. The basic 100 microvolt sensitivity can be extended to 1 microvolt with the new low level DC Amplifier Module.

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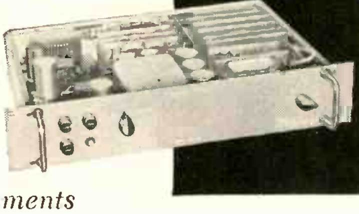
OUTPUT CONTROL—In addition to the illuminated read-out for operator surveillance, E-I systems provide contact closures which completely define the measurement, and the signal channel. E-I manufactures a complete series of Print-Control Modules to process data for series or parallel entry in printed tape, punched tape, punched card and electric typewriter data recorders.

STORAGE, TIME, PROGRAM—The E-I line includes off-the-shelf modules for data storage, time base and programming functions.



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for consistent performance, reliability, and accuracy. E-I equipment and systems reflect the maturity of engineering and production know-how of the leader in the digital instrumentation field.

The complete line of digital instruments

WRITE FOR COMPLETE SPECIFICATIONS

Electro Instruments, Inc.

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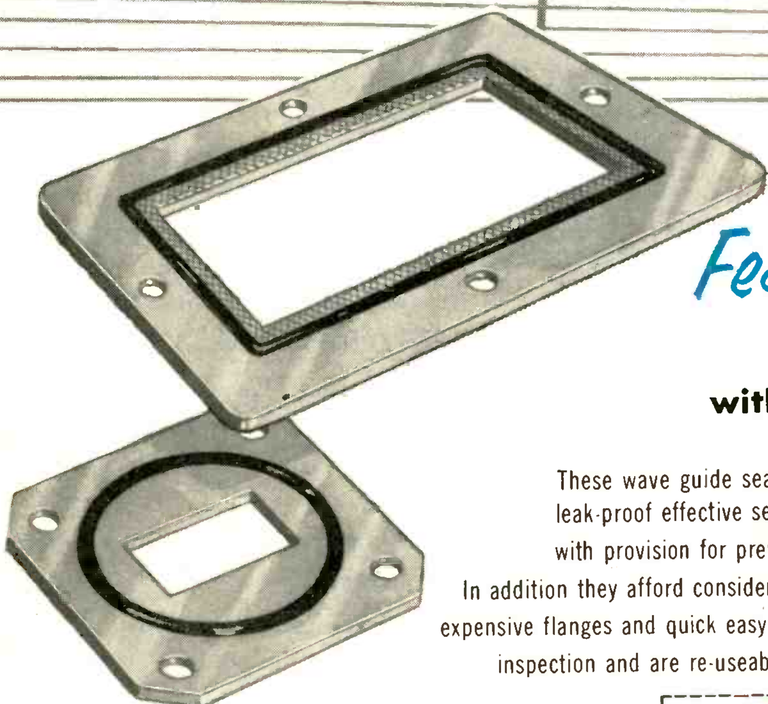
CIRCLE 46 READERS SERVICE CARD→

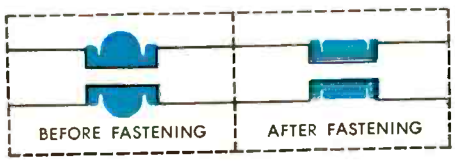
Now... Gask-O-Seals® For Wave Guide Connectors



Featuring... **NO LEAKAGE**
plus electrical continuity
with no arcing or burning!

These wave guide seals, developed by Parker Seal Company offer leak-proof effective sealing while affording electrical continuity with provision for prevention of R/F leakage and interference. In addition they afford considerable savings by requiring simple, less expensive flanges and quick easy assembly. They assure visual installation inspection and are re-useable.

Series 5600 fits all EIA (RETMA) L-band guides WR90 thru WR2300. Others for X-band guides, as well as specials. For complete details send for catalog.



Parker SEAL COMPANY *

A DIVISION OF Parker-Hannifin CORPORATION

CULVER CITY, CALIFORNIA

* formerly Franklin C. Wolfe Co.

MEETING MIL-T-19500A
Military Specification For Transistors

Stringent military requirements demand that transistors do not fail in operation.

The tests described below are performed on all General Transistor types to insure continuous, high quality performance. Every production lot is sampled on a daily basis. The criterion for these tests is MIL-T-19500A, Military Specification for Transistors.

Prior to, and upon completion of each of the mechanical tests described below; collector cutoff current, emitter cutoff current, and D. C. current gain are measured and recorded. The end point valves of these critical electrical parameters must not exceed the limits as set forth in the applicable military specification.

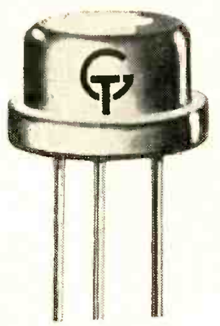
1. **Physical dimensions**—The transistor is examined to verify that all physical dimensions are as specified.

2. **Lead solder test**—The leads of the transistor are immersed for 10 seconds in molten solder, at 230°C, to a point of 1/16 of an inch from the case of the transistor.

3. **Temperature cycling test**—The transistor is subjected to five temperature cycles:—65°C minimum temperature for 15 minutes, room ambient temperature for 5 minutes, and 85°C maximum temperature for 15 minutes.

4. **Glass strain test**—The transistor is completely immersed in water at 85°C for 15 seconds and, immediately thereafter, in water at 0°C for 15 seconds.

5. **Moisture resistance test**—The transistor is subjected to varying temperature and humidity cycles: 25°C with 50% relative humidity, 65°C with 90-95% relative humidity, and then back to 25°C with 50% relative humidity. One cycle is 8 hours in duration, and the test consists of 10 cycles.



General Transistor's JETEC 30 Case

6. **Shock test**—The transistor is subjected to five blows from each of four different orientations, each with an acceleration of 500G and a duration of 1ms.

7. **Centrifugal acceleration test**—The transistor is restrained by its case. A centrifugal acceleration of 20,000G is then applied to the transistor for one minute in each of three different orientations. The acceleration is then gradually decreased to zero.

8. **Vibration, fatigue test**—The transistor is rigidly fastened on a vibration platform and is subjected to a simple harmonic motion at a single frequency between 40 and 100 cps, for 32 hours in each of three orientations, with a constant peak acceleration of 10G.

9. **Salt spray (corrosion) test**—After 100 hours of salt spray, the transistor is washed, brushed, air blasted, and then permitted to dry for 24 hours at 40°C. The transistor is then examined for any destructive corrosion or loss of plating which interferes with mechanical or electrical performance.

10. **Lead fatigue**—Any two consecutive leads on each transistor are selected. A pull of 16 ounces is applied to each lead, for three 90° arcs of the case. The transistor is then examined for broken leads.

11. **Storage life test**—The transistor is stored at a temperature of 85°C for a period of 1000 hours. During this test, measurements are made at intervals of 0, 250, 500 and 1000 hours.

12. **Operation life test**—For a period of 1000 hours and at a temperature of 25°C, the transistor is subjected to the operation life test. During this test, measurements are made at intervals of 0, 250, 500 and 1000 hours.

Write for transistor Application Note 3-58 "The Effects of Long Term Aging on Computer Transistors."

GENERAL TRANSISTOR CORPORATION

91-27 138th PLACE • JAMAICA 35, NEW YORK

CN

The G-E Power Tube Microwave Laboratory is located at Stanford Industrial Park, Palo Alto, California where it was one of the Park's pioneer installations. Its scientists and engineers have the advantage of technical exchange with the faculty and research staff of Stanford University, as well as extensive opportunities for graduate training. Constant technical liaison is also maintained with General Electric's own Research and General Engineering Laboratories, Schenectady, N.Y.

HIGH-POWER KLYSTRONS WITH WIDE TUNING ARE DESIGN GOALS OF GENERAL ELECTRIC

The Microwave Laboratory of the G-E Power Tube Department at Palo Alto, California, is placing major emphasis on the development of a line of advanced-design, high-power klystrons to meet the requirements of radar detection systems and missile guidance systems, as well as navigational equipment of the future.

The requirements for greater operating flexibility, longer life, and higher reliability are being satisfied through the development of klystrons with wider tuning ranges and higher tuning linearity sufficient to enable single-knob control. To achieve wide-range tuning, an exclusive cavity and tuner are employed, consisting of a ring-type tuning vane mechanically coupled to a high-precision single-knob tuning control. Multiple cavity designs and stagger tuning techniques in combination permit broadband operation. The single-knob control permits extremely rapid tuning, while the high tuning linearity permits precise resettability.

Klystron development is only one of a broad range of microwave activities being conducted at the General Electric Microwave Laboratory. Applied research, advanced development, and prototype design are conducted in all areas of microwave tubes and microwave techniques. Technical inquiries pertaining to advanced microwave tube development are invited. *Power Tube Department, General Electric Company, Schenectady, New York.*

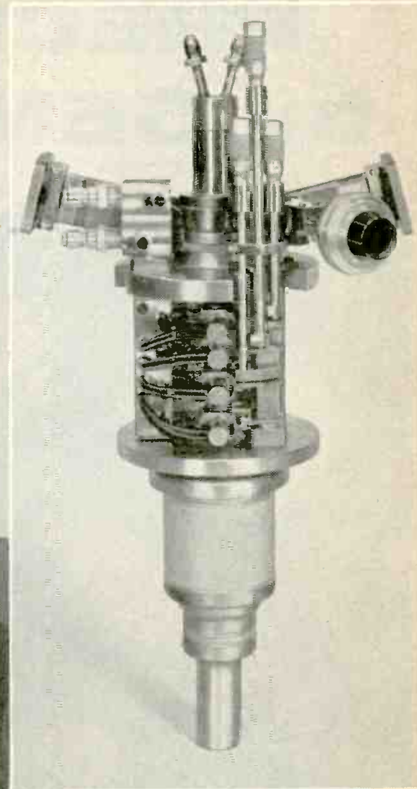
* * *

Professional opportunities available for electron tube production, engineering, and scientific personnel. Inquiries are invited.

The extensive program of the General Electric Microwave Laboratory on advanced microwave components and techniques includes the following:

CW klystron amplifiers	Pulse klystron power amplifiers
Super-power klystrons	High-power pulsed TWT amplifiers
Voltage-tunable oscillators	Medium-power CW TWT amplifiers
High-power duplexers	Low-noise, broadband TWT amplifiers
Microwave filters	Frequency multiplier TWT amplifiers

RANGES AND HIGH LINEARITY MICROWAVE LABORATORY

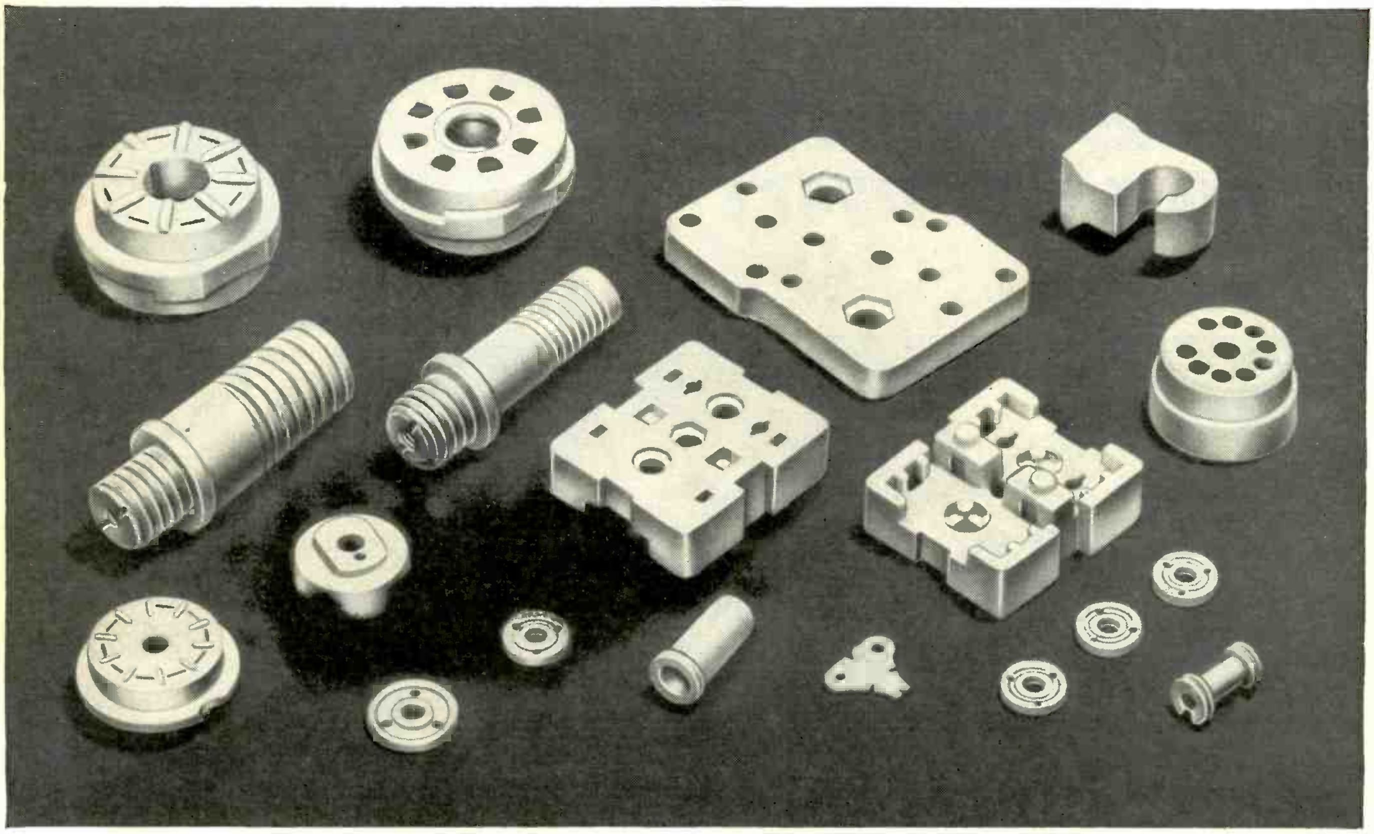


▲ Typical of a family of high-power klystrons under development is this 1-KW CW power output tube (solenoid and cover removed) which tunes over a 1000 mc range at X-band, with 40 db gain. All tubes in this family are of rugged, metal-ceramic construction to meet performance standards of military specifications, and employ an extremely long-life, single-knob tuner. Other designs include high-power tubes for L, S and X bands.

◀ Controlled temperature processing of new materials contributes towards improvement in high-emission density cathodes for high-power beam tubes. L. to R., J. F. Kane, consulting engineer, with associates J. N. Lind, D. W. Latshaw and J. P. Fitzpatrick. In foreground, laboratory technician Paul A. Smith.

No. 1 solution to dielectric problems–

PRECISION STEATITE by GENERAL CERAMICS



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- Widely varying ambient temperature
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- Low electrical loss at high frequency
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- Extreme immunity to environmental conditions

G-C electrical ceramics are news! Offering a far higher degree of dimensional accuracy than ever before possible, *precision* dielectrics provide a far greater design latitude in all types of electronic and electrical equipment. These new high accuracy ceramics are another example of General Ceramics progressive manufacture . . . better products at lower cost through advanced research and improved methods of production. Why not ask for all the facts on *precision* electrical ceramics, now! Write General Ceramics Corporation, Keasbey, New Jersey, Dept. E.

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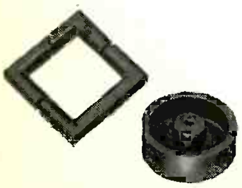
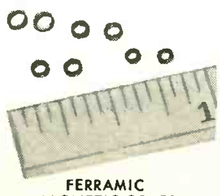
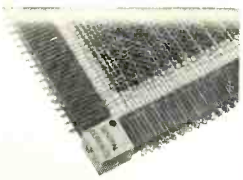


FERRAMIC CORES



FERRAMIC MAGNETIC CORES



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"ADVAC" HIGH TEMPERATURE SEALS

SOLDERSEAL TERMINALS

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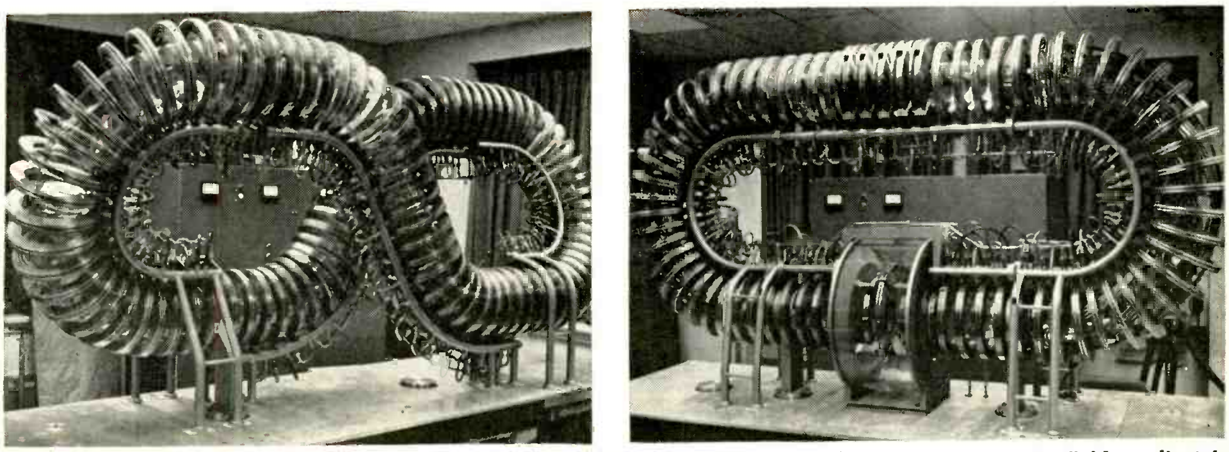


Demonstration models of stellarator. Figure-eight shape, left, overcomes effect of diminishing magnetic-field gradient in dissipating plasma stream. Racetrack, stellarator right, uses special helical field windings, achieves the same result

Our Stake in Thermonuclear Power

Experiments aimed at achieving controlled thermonuclear reactions use components like those used in high-power transmitters; also microwave interferometers and other instruments. Plasma studies may blaze a trail to more efficient industrial-type gas tubes

By JOHN M. CARROLL, Managing Editor

LAST MONTH the press got its first close look at Project Matterhorn. This is part of the Atomic Energy Commission's recently declassified Project Sherwood, code name for AEC activities in controlled thermonuclear reactions.

Project Matterhorn, being carried out at the James Forrestal Research Center, Princeton University, is one of four major U. S. efforts in controlled thermonuclear research. Other projects are underway at Los Alamos, Livermore and Oak Ridge. Smaller efforts are in progress at various colleges and universities including New York University. Projects are also under way in the United Kingdom and the USSR. Projects have been started in Sweden, France, Germany and Canada.

Scope of the Work

By controlled thermonuclear reactions man is trying to harness the tremendous energy released in the hydrogen bomb. The thermonuclear reaction or nuclear fusion makes use of deuterium, a heavy isotope of hydrogen. A deuterium atom consists of a proton and neutron in the nucleus, and one orbital electron. In one of the three thermonuclear reactions two deuterons or deuterium nuclei, unite to form helium-3 and a neutron. This reaction is accompanied by a release of energy.

In a second thermonuclear reaction two deuterons combine to form a tritium nucleus and a proton. Tritium is another isotope of hydrogen, which has two neutrons in its nucleus. While deuterium is not radioactive and is found in water, tritium is radioactive with a half-life of about 12 years and does not exist in nature.

In the third thermonuclear reaction a deuteron combines with the tritium nucleus to form helium-4 and a neutron, again with release of energy. Thermonuclear reactions

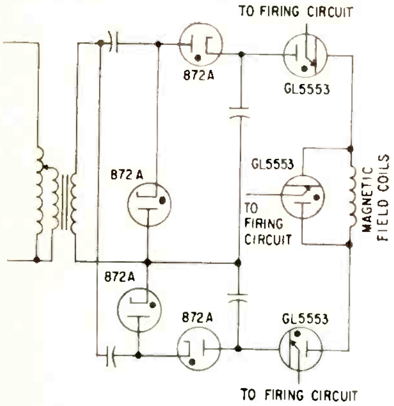


FIG. 1—Charging and firing circuits for model B-65 Stellarator

are of interest, not only because of the tremendous energy released but also because the final reaction by-products need not be radioactive. Furthermore, the raw material, deuterium, is relatively common in contrast with the rather scarce fuels required in nuclear fission reactions.

So far thermonuclear reactions have been achieved only in the hydrogen bomb and in the sun and stars. The thermonuclear reactions occur only at temperatures of about one hundred-million deg C.

Stellarators

At Matterhorn, researchers are trying to achieve controlled thermonuclear reactions by use of stellarators. A stellarator consists of an evacuated tube in the form of either a figure 8 or an oval. Deuterium gas at low pressure is injected into the tube and is confined in a so-called magnetic bottle by the magnetic confining field. The magnetic bottle must be used because no physical container is able to withstand the extreme temperatures required for thermonuclear reactions. At high temperatures, the deuterium atoms are stripped of their electrons; the resulting assemblage of protons and electrons is known as plasma, called by some the fourth state of matter.

All this is of interest to electronic engineers for two reasons: a great deal of electronic equipment is used in creating the environment in which it is hoped that thermonuclear reaction may take place, and also in measuring the results of the experiments. Secondly work with plasmas is providing a better understanding of electrical conduction in gas. This knowledge may be applied in the design of improved gas-filled electron tubes for industrial use and in the development of new electronic devices using plasma.

Confining Field

To confine the plasma, fields of the order of 50,000 gauss are required. In an oval-shaped or racetrack stellarator there are two sets of magnetic confining field windings; the main windings and a set of secondary helical windings. The helical windings prevent the plasma stream from dissipating itself because of a diminishing gradient of magnetic field extending outward from the center of the torus. In one stellarator a current of 10,000 amp at 24,000 volts is used to create the magnetic confining field.

An electronic charging and firing circuit as shown in Fig. 1 can be used to supply the necessary voltage and current used in this circuit. The current is pulsed at the rate of 1 pulse per minute. The current pulse has a useful length of about 1/10 sec.

The divertor indicated in Fig. 2 is used to skim off the outer layer of ionized gas to reduce contamination of the plasma.

Ohmic Heating

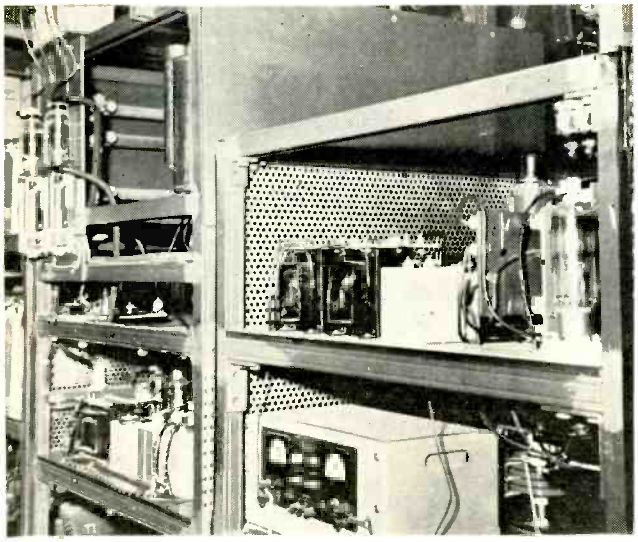
The second function of the stellarator is to heat the magnetically confined gas to thermonuclear temperature. Temperatures of 100-million degrees Centigrade have not yet been achieved and the push towards these temperatures is one of the main efforts in thermonuclear research. One method of heating the plasma is ohmic which entails passing a high electrical current through the plasma stream. Ohmic heating uses electronic charging and firing circuits. As in the magnetic confining field circuit, a bank of capacitors is discharged through a winding. In the ohmic heating circuit, a winding about an iron core constitutes the primary of a transformer. The tube of ionized gas in itself is the step-down transformer secondary winding. In one stellarator the ohmic heating power amounts to about 450 volts at 3,000 amperes.

Magnetic Pumping

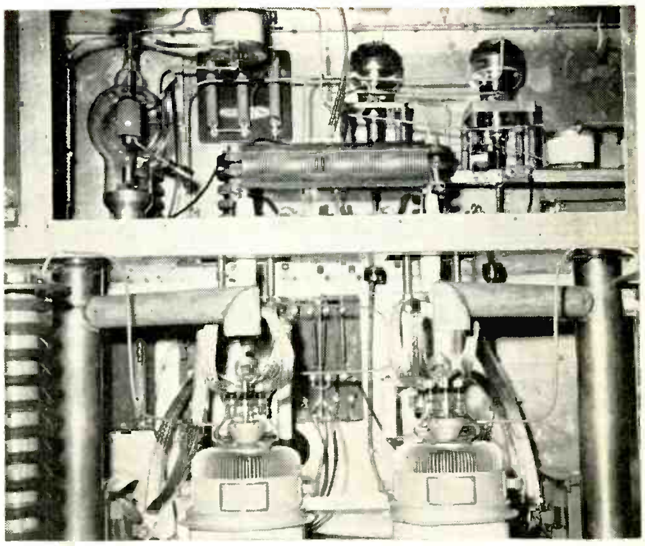
The ohmic heating method will only raise the ionized gas temperature to about a million degrees Centigrade. A technique called magnetic pumping is being used to achieve additional heating. Magnetic pumping makes use of ion cyclotron resonance. By this technique the plasma stream is alternately squeezed and allowed to expand. A radio-frequency field is applied at one or more points around the tube of gas. The r-f field alternately compresses and

Table I—Characteristics of Stellarators

Model	Vacuum System	Magnetic Confining Field	Ohmic Heating	Magnetic Pumping
B1	2 in. tube 450 cm. length	Electronic charging and firing; 30,000 gauss	Electronic charging and firing	None
B3	2 in. tube 252 in. length	Electronic charging and firing; 50,000 gauss	Electronic charging and firing	Will use magnetic pumping
B65	4 in. tube 207.4 in. length	Electronic charging and firing; 22,000 gauss	Electronic charging and firing	12 mc system; 1 megawatt average power, 10 millisec pulse
ETUDE	1.9 in. tube 260 cm. length	D-c operated 8,000 gauss	Electronic; 30 kw push-pull amplifier: 60–100 pps	None
B66 (under const)	———	Electronic charging and firing	Electronic charging and firing	Yes
C	8 in. tube 40 ft. length	Motor generator, electronic output control; 50,000 gauss	Electronically programmed 6 parallel 15030's delivering 34,000 amp at 5 kv to plasma	4 parallel 15030's delivering 28 megawatts, can go to 50 megawatts



Charging circuits for stellarator use mercury vapor rectifiers, right foreground, and ignitions, left rear



Master oscillator-driver of test generator delivers 57 kw average power during pulses

expands the gas. This action further increases the temperature of the plasma. One magnetic pumping circuit uses an 8-mc r-f generator that delivers a 10-millisecond pulse with an average power during the pulse of one megawatt.

Test Equipment

A radio-frequency generator, used to test components to be used in experiments, delivers 14 megawatts at 2,000 volts. It consists of a master oscillator and driver operating on 250 kilocycles with an average pulse power output of 57 kilowatts. This drives the final amplifier consisting of two RCA type A-15030 superpower beam triodes.

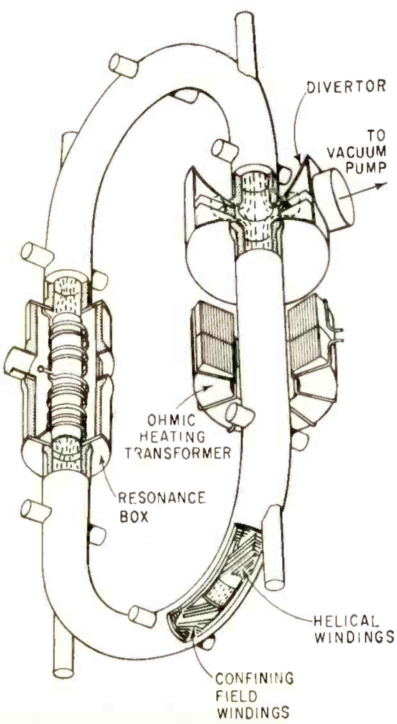


FIG. 2—Model B-65 stellarator indicating major system components

One important parameter in thermonuclear studies is the electron density of the ion stream. Electron density is measured by a microwave interferometer. This instrument measures the phase shift of a microwave beam passing through the plasma stream. With increased plasma densities researchers have had to go higher and higher in microwave interferometer frequency. In some experiments they are now using a 75 kilomegacycle interferometer.

C Stellarator

The most ambitious undertaking yet at Project Matterhorn is construction of the so-called C stellarator. See Table I. This unit will use a race-track shaped, 8-in. diameter vacuum tube 40 ft. long. The magnetic confining field will be 50,000 gauss. It will be supplied by a motor generator system capable of delivering 4.3 megawatt of peak pulse power. The motor-generator system will be electronically controlled.

Ohmic heating for the *C* stellarator will be electronically programmed. It will use 6 parallel 15030's delivering a total of 34,000 amp at 5 kv to the plasma.

For magnetic pumping the C stellarator will use 4 parallel 1530's delivering a total of 28 megawatts. By adding tubes, magnetic-pumping circuit output can be increased to 50 megawatts. The magnetic pumping will have three frequency ranges: 30 to 100 kc supplied by a spark gap; 100 kc to 2 mc; and 15 to 40 mc. The last two will be supplied by electron tubes.

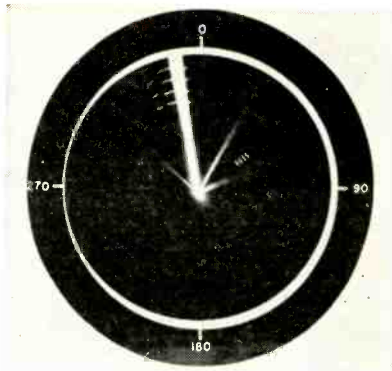
Future

Construction of the C stellarator is being undertaken by C Stellarator Associates, an organization jointly operated by Allis-Chalmers and Radio Corporation of America. Estimated cost of the *C* stellarator is $35 million of which only $8 million is earmarked for land and buildings.

Although no one has thus far demonstrated the feasibility of controlled thermonuclear reaction, scientists feel convinced that it is possible. For our own industry the project provides a small but important market for instruments and electronic components. But even more, these experiments give better understanding of ionized gases which will be important in design of improved industrial tubes.

Experimental technique will also aid in design of higher powered transmitters for communications and industrial use.

Radar communications countermeasures simulation equipment in operation. Multitarget generator producing large targets with antenna pattern simulator controlling basic i-f signal of high power



Screen pattern simulates noise jamming from high-intensity source

Electronic Simulator Gives

VARIOUS jamming and deception techniques used against radars can be simulated by the equipment to be described. Basic operation of the simulator is to furnish a 30 or 60-mc carrier output which can be connected to the receiver i-f strip of a radar set to simulate received signals. The carrier can be amplitude or frequency-modulated by sine-wave, square-wave, sawtooth or noise waveforms and pulse modulated by pulses of adjustable rate, duration and pairing. Also available are 30 and 60-mc superregenerative noise sources. They can be amplitude and pulse modulated by the previously mentioned waveforms.

A program generator is used primarily with radars having ppi presentations. Two simulated targets furnished can be controlled manually in azimuth, range and size. One of them can be moved automatically in any desired manner by a cam-operated program. Time-delayed and random targets are also available in the equipment.

A pulse modulator is available for use against tracking radars. It furnishes two simulated target pulses with various types of modulation, range variation and relative amplitude control. Output is a pulse-modulated 30- or 60-mc carrier.

An L-band (1,100-1,400 mc, 5-w output), an S-band (2,600-3,400 mc, 2 w) and an X-band (8,500-10,000 mc, 60-100 mw) unit are provided. Each contains facilities for amplitude and pulse modulation by external waveforms and for frequency sweeping with an internal sine-wave oscillator or external waveform generator. For the L-band unit, frequency sweeping up to 100 mc is available; for S-band, 200 mc and for X-band, narrow-band f-m from an external source is included.

An antenna pattern simulator consists of a cam-driven variable attenuator which can be connected to the i-f output of the basic unit or pulse modulator. It can be connected also to the synchro system of the radar set being used to produce a variation of output to simulate antenna directivity.

Table I—Antenna RPM-PRF—Target Width Time

Antenna rpm	Radar pps	One deg of scan in millisec
6	200	28
12	400	14
18	600	9.3
30	1000	5.6
45	1500	3.4
60	2000	2.8

Multitarget Generator

Illustrated in block-diagram form in Fig. 1 is the multitarget generator. It produces simultaneously specific and random individual targets and target groups which can be controlled manually in width (angular displacement) and length (radial displacement).

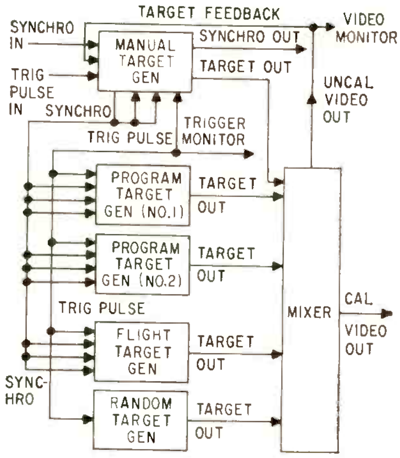


FIG. 1—Block diagram of multitarget generator for countermeasures

The targets and target groups can also be varied manually or automatically in range and azimuth.

A target mixer provides individual amplitude control of target pulses received from each generating subchassis. The mixer also provides calibrated attenuation of the combined target-pulse output. Uncalibrated target pulses can be coupled back to the manual-target generator to provide a gating action which is necessary when video signals appear in the trigger input to the manual-target generator.

The manual-target generator receives synchronizing signals and trigger pulses from the external equipment and relays them to other target-generating subchassis and display devices.

Each of the two program-target generators produces three target

Simulator provides jamming and interference waveforms required to produce effects of most known techniques. Waveforms at L, S and X band and at 30- and 60-mc i-f can be simulated. Single targets and target groups are programmable in speed, course, pulse and azimuth width

By **LEOPOLD STERNLICHT,** Group Leader, The Hallicrafters Co., Chicago, Ill.

Countermeasures Targets

groups which can be controlled individually. They are initiated and synchronized by the trigger pulses and synchro signals received from the manual-target generator.

The flight-target generator produces the target groups which can be controlled only in range and azimuth collectively. The first and third target group can be controlled within limits with reference to the second group. Range and azimuth of the second group can be varied either manually or automatically.

The random-target generator is triggered by the manual-target generator but does not receive synchro voltage since the possibility of target recurrence at the same location must be eliminated. Three channels are triggered simultaneously by the input trigger pulse.

Target-Generator Theory

All that is required to place a target on the screen of the ppi is delay in synchronism with the transmitted pulse energy and rotational correlation between target and radar azimuth.

The simulated target should have the same pulse width and prf as the ppi upon which the target is to be displayed. These rho-theta coordinates are translated to a time delay by positioning of a phantastron and a rotating synchro control transformer. In each case, delayed pulses are gated by the azimuth gate to give the targets a given azimuth width. When random targets are required, target width is established by multivibrators and gating signals.

Figure 2 shows a block diagram of the random-target generator. Each one of three channels generates a different target sequence. Each target consists of a number of pulses whose spacing is dependent upon trigger rate. Pulses can be controlled in width. Time delay between targets appearing on the screen is also controllable.

All targets are initiated by the manual-target generator which triggers the blocking oscillator. The oscillator shapes the trigger pulses prior to injecting them into the variable 65 to 2,400-μsec delay phantastron circuits. The delay circuits also provide selection of the range over which the targets will appear with a MILES MAX RANGE control.

Output of the phantastron is coupled to the azimuth gate circuit which feeds the target generator.

A PRF MATCH control for the

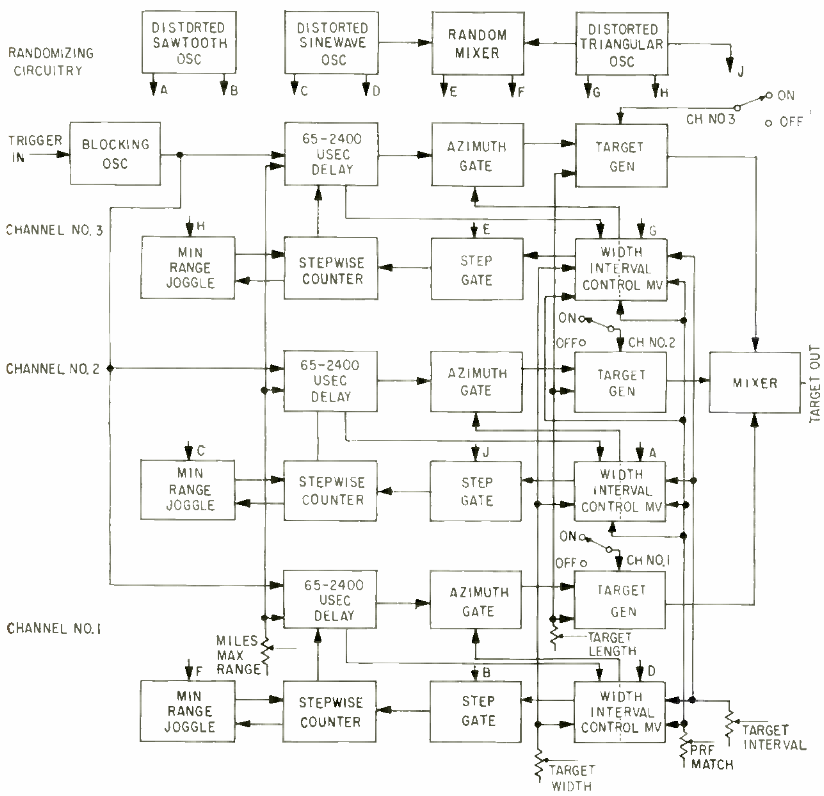


FIG. 2—Block diagram of random-target generator

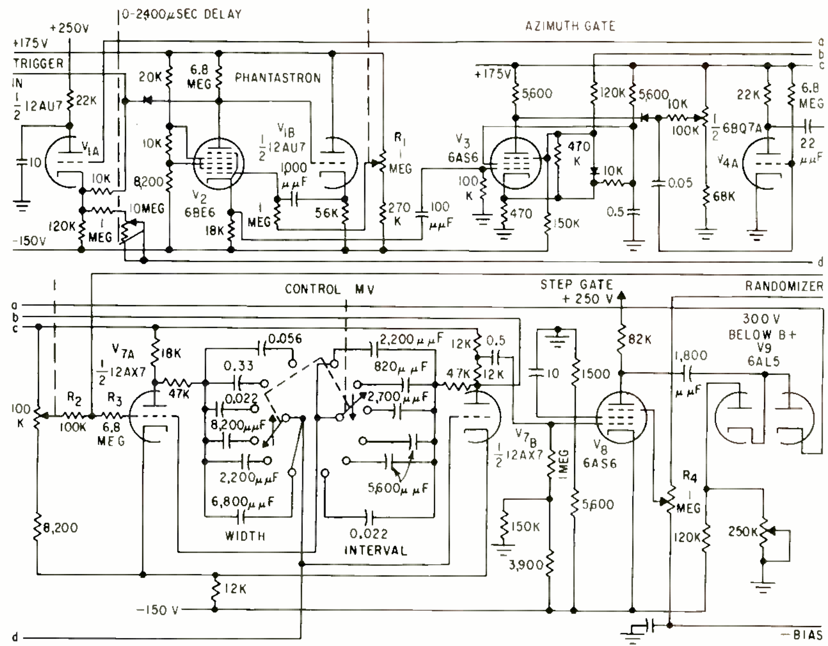


FIG. 3—Partial schematic of the random-target generator

multivibrator changes the duration of each positive half-cycle of the waveform being produced. The TARGET INTERVAL control changes the duration of the negative half-cycle. Output from the width side of the multivibrator is fed simultaneously to the azimuth gate and the step-wise delay counter. In this manner, the number of pulses fed to the target generator by the azimuth gate is controlled and the stairstep waveform output of the stepwise counter is generated to control the time delay of the phantastron. This delay in turn determines the range at which the target will appear. Output from the stepwise counter is fed to the minimum range joggle and coupled back to the counter to change the stairstep action of the circuit by a small amount.

Randomizing Circuits

Randomization of the targets is accomplished with three low-frequency oscillators and a mixer. Outputs of the oscillators produce the varying range and azimuth targets from scan to scan. A sawtooth waveform is fed directly into the step gate of channel one and into the control multivibrators of channel two. Outputs from a sine and triangular wave oscillator are fed to the random mixer, to the minimum range joggle circuits of channels two and three and to the control multivibrator of channels one and three. Signals from the random mixer are fed to the minimum range joggle circuits of channel one and to the step-gate circuit of channel three. Injection of these signals into the three channels causes sufficient randomization of the targets.

Scanning Rates

Table I lists antenna rpm, radar pps and time required for one deg of scan for typical scanning rates used in radar equipment. For example, to produce a one deg target on the ppi screen, the azimuth gate remains open for 28 millisec. Output of the azimuth gate is then closed for a predetermined time by the interval pulse of the control multivibrator.

The target generator produces a target one-deg wide when it receives trigger pulses which are spaced five millisec apart. At a pulse width of five millisec, only 25 μsec of the 28 available are used to produce a one-deg target. Persistency of the screen and the blooming effect of the beam produce the illusion of a solid target.

Maximum target size is 10 deg. Maximum interval between targets is set to equal minimum target width. Minimum interval may be ½ of the minimum target width. The circuit permits a target width variable from one to eight deg. With an eight-deg target width, the minimum interval between targets that can be selected is adjustable from 0.5 to two deg.

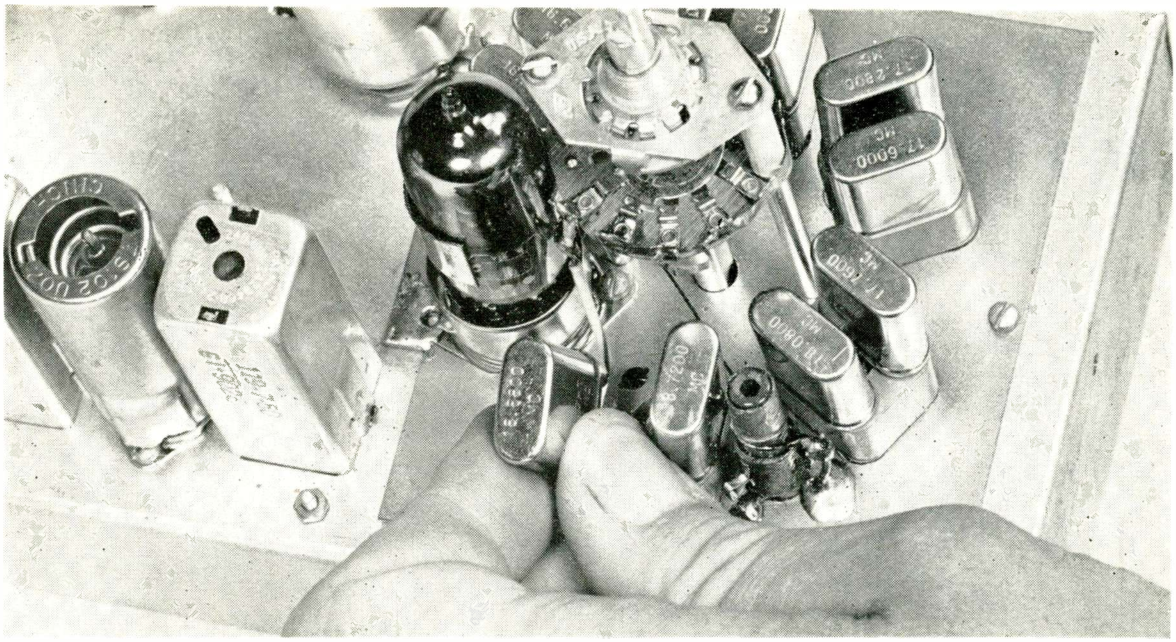
Random Generator

Figure 3 is a partial schematic diagram of the random-target generator. A switch provides interval and width timing functions for the control multivibrator by selecting a set of capacitors for variable R-C grid time constants. Potentiometer R_1 sets the potential at the control grid of V_2 and effects an average range control for the pulse delay.

Trigger output of the blocking oscillator is fed to the cathode of V_{1A}. Output of the step-delay counter V_{9A} and V_{9B} is applied to the grid of V_{1A} and varies the delay of the phantastron. As the d-c level of this step voltage increases, the delay increases. But when the voltage reaches a predetermined maximum, it is returned to minimum and the step-increase voltage process recommences.

The range phantastron produces targets over a range of 25 to 250 miles. Differentiated output of the phantastron is coupled into the first control grid of V_3, the azimuth gate control. Output of the control multivibrator is fed into the second control grid. Output wave train is a group of negative pulses occurring only when the second control grid is in the width portion of the positively held grid of V_{4A}. During the width portion of the control multivibrator a flat-top waveform is produced which is coupled to the target generators.

Randomization is applied to the control multivibrator at the junction of R_2 and R_3 and to the step gate at potentiometer R_4. The target width and number of targets are continuously changed from scan to scan. The step gate amplifier output of V_8 is a 300-volt pulse clamped at B+. Variable grid potential, due to randomization at R_4, produces variable amplitude pulses to the step-counter diodes V_{9A} and V_{9B}. The stair-step is then d-c coupled to the grid of V_{1A} producing a randomized increase in the step voltage. Since the steps are increasing randomly, the range step of the targets are different for each sector.



Closeup view of the ten-channel crystal turret assembly. This arrangement introduces negligible lead inductance, prevents spurious oscillator modes

Crystals Stabilize Multichannel F-M Monitor

Ten-channel f-m broadcast monitor, made highly stable by crystal control of the local oscillator, serves as a versatile instrument for network operation. High sensitivity and signal-to-noise ratio coupled with low drift and distortion preserves broadcast quality

By LESTER A. KARG, Karg Laboratories, Inc., South Norwalk, Connecticut

STRINGENT REQUIREMENTS for tuners to monitor high quality f-m broadcasts dictate a crystal-controlled superheterodyne receiver to assure on-frequency operation regardless of line-voltage fluctuation, aging of components or accidental mistuning by the operator.

Though the single-channel crystal-controlled monitor serves this purpose, added versatility at little additional cost is obtained in designing the monitor as a multichannel tuner. In network operation, air checks may be made of several transmitters from a central location, or comparisons of broadcast quality of several competing stations may be made. Commercial recording services can tape clients' programs from a number of stations with the same assurance of stability and accurate tuning as with a bank of single-channel monitors thus saving in initial investment and maintenance.

Relay Application

For relay work, where broadcasts are picked up from a distant transmitter for rebroadcasting, flexibility in the choice of program sources without sacrificing stability is afforded. In this application, the tuner is frequently used in conjunction with a high-gain rotatable antenna. A field-strength meter is useful in orienting the antenna.

To preserve the quality of the broadcast, the tuner is designed for high signal-to-noise ratio at low microvolt thresholds. For rebroadcasting or tape recording, signals less than 40 db above the noise are of little use. The high signal-to-noise ratio should be obtainable in a normal environment including the usual man-made noise sources rather than in a filtered, field-free screened booth.

Other necessary requirements

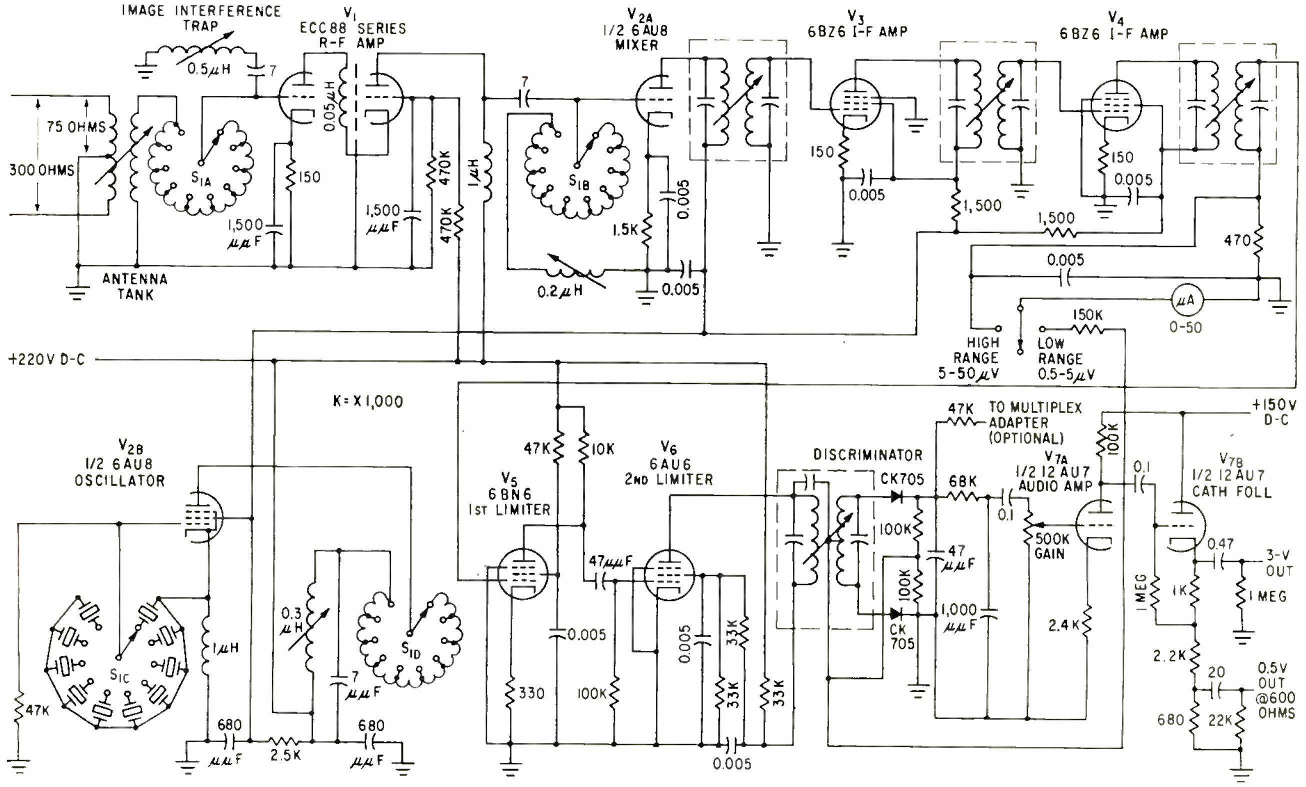


FIG. 1—Schematic diagram of the ten-channel crystal-controlled f-m monitor. Alignment procedure is simplified because, despite tight coupling of oscillator V_{2B} to mixer V_{2A}, crystal control prevents oscillator pulling. Tight coupling at a low oscillator output level also avoids spurious radiation

for such a tuner are low distortion levels and imperceptible hum. For convenience in patching into the studio audio distribution system, a 600-ohm line output is desirable.

Quartz-crystal frequency control has a reputation for the utmost in stability. It can be shown that crystals with the common frequency tolerance of 0.005 percent are several orders of magnitude more accurate than required for f-m broadcasting. Assuming discriminator linearity of 300 kc, the crystal oscillator may be permitted to slip 75 kc (referred to the intermediate frequency) before distortion from nonlinearity of the detector becomes a factor.

Frequency Modes

At the highest frequency of operation, which is 107.9 mc, the oscillator output is at 97.2 mc. Because of the impracticability of fundamental crystals of this frequency, 5th mode operation is chosen. The crystal fundamental is $97.2 \div 5 = 19.45$ mc. Thus $19.45 \times 10^6 \times 0.00005 = 0.9725$ kc (the maximum crystal frequency error). The error at the 5th mode is 4.86 kc at the oscillator frequency. Therefore the maximum error from −55 C to 90 C is less than 5 kc compared with the allowable error of 75 kc.

Discriminator

Thermal drift of the discriminator in crystal-controlled tuners must be minimized because it can be an appreciable part of the 75-kc tolerance. A high grade of materials and construction in the discriminator is necessary to take full advantage of the quartz-stabilized local oscillator. Ceramic coil forms and moisture-proofed windings are indicated. In addition, temperature compensating capacitors in close proximity to the discriminator coils are used. An additional hedge in the choice of discriminator is a wide-band design. The requirement for frequency stability in the discriminator is reduced in inverse ratio to the discriminator peak-to-peak bandwidth.

The choice of a discriminator transformer having peak-to-peak separation of 600 kc is based on a compromise between immunity to drift, linear relation between deviation and recovered audio, noncritical alignment and a reasonable level of recovered audio. In the present design, 0.5-v rms is recovered at medium audio frequencies for the 75-kc deviation corresponding to 100-percent modulation. This level of signal is adequate to insure a good signal-to-noise and hum ratio in the audio amplifier. As an aid in obtaining a reasonable audio level from the detector in spite of the wide-band discriminator (audio output is inversely proportional to the peak-to-peak separation) the final limiter tube is operated with relatively high electrode potentials.

A schematic of the tuner circuit is shown in Fig. 1.

Crystal Oscillator

Because of the relatively high fundamental frequencies of the crystals (15-19 mc) and the possibility of operation in spurious modes, the oscillator crystals are arranged in a turret so that uniformly low lead inductances are introduced when connecting the crystals into the oscillator circuit. When the oscillator output frequency is 5 times the crystal fundamental, adequate oscillator injection into the mixer tube dictates the use of a high-g_m tube. The 6AU8 pentode section V_{2B} with its plate at 220 v and screen at 120 v operates the crystal within its rating. The plate section is tuned by a high-Q coil through approximately 78 to 98 mc. Mixer V_{2A} is deliberately overexcited to allow for the gradual drop in oscillator output as the tube ages. Oscillator tube g_m can drop about 50 percent before conversion gain is reduced.

To minimize the oscillator radiation problem, the power output of the oscillator is kept below 20 mw. Adequate injection is accomplished by tight coupling to the mixer. In an uncontrolled oscillator, this ordinarily results in oscillator pulling by the mixer tuned circuit. This interdependence makes r-f alignment difficult, especially when the ratio of oscillator to carrier frequency is as small as 1.1 to 1, as it is in an f-m tuner with 10.7-mc i-f. With a crystal oscillator, pulling is almost impossible.

Mistuning of the oscillator output circuit will not affect frequency, merely the amplitude. In fact, with a signal tuned in, the output circuit tuning slug may be varied throughout its range without affecting the received signal except for a variation in gain. It is desirable, however, to tune the output circuit if for no other reason than to suppress harmonics other than the fifth. To accomplish this tuning, the output is maximized by observing a vtvm connected to the discriminator test point when the selector switch is set to the highest frequency and a signal source is connected to the antenna input. Successively lower frequency crystals are switched in and the small incremental inductances adjusted to maximize the gain on each channel in turn.

Tracking

This process is repeated to adjust the mixer tuning and the antenna input circuit tuning. In each case, broadcast signal may be substituted for a signal generator, providing exact alignment without an expensive generator.

When r-f and oscillator alignment is completed, the tuner has been tracked at ten points in contrast to the usual two-point tracking for continuous tuners. Furthermore, the tracking has been accomplished exactly on each of the desired frequencies. Since the shunt circuit capacitance is the same for all frequencies, high circuit impedance is maintained throughout the band. Selectivity, bandwidth and sensitivity are constant for all channels.

An incidental advantage of crystal control accrues because the high-Q crystal is the sole frequency-determining factor. Even if the tube or other oscillator circuit components are microphonic, no amount of vibration will create frequency modulation of the oscillator. Hum modulation of the oscillator due to $B+$ ripple or heater-cathode leakage also cannot occur.

R-f Amplifier

The ultimate sensitivity of the tuner depends largely on the performance of the r-f amplifier stage in terms of gain and noise. The familiar series circuit is excellently suited to the requirements of f-m reception. The ECC88 twin-triode V_1 boasting a g_m of 12,500 provides excellent noise performance in this configuration.

The mixer function is conveniently performed in the triode section V_{2A} of the 6AU8. The minor noise contribution of the mixer following the high-gain r-f amplifier is minimized by the use of the triode.

I-f Amplifier

In contrast to some design objectives where i-f gain is carried to a high level so that internal tube noise saturates the limiter, the present design represents a balance between r-f and i-f gain such that a small signal about 20 db above the noise will saturate the limiter. This avoids the difficulty present in receivers with excess i-f gains which are characterized by roar between stations exceeding the modulation level of a strong station.

The present design utilizes two high-g_m i-f stages V_3 and V_4 using 6BZ6 tubes. A signal of a few microvolts at the antenna terminals causes the 6BN6 gated-beam tube V_5 to operate in the rectangular knee portion of its characteristic. The absence of a charging circuit in this stage avoids pulse-stretching.

Second limiter V_6 is a common pentode saturation type. To provide enough audio output to give a high signal-to-noise ratio despite the use of a wide-band discriminator, V_6 is operated with fairly high electrode potentials. With first limiter V_5 operating on low signals, the function of the second is to hold large signals constant before the demodulation process. Without the use of agc, the recovered audio is held within 0.5 db for signals from 5 to 100,000 μv.

Signal Strength

Although a tuning meter is unnecessary in the case of a fixed-tuned multichannel receiver, a field strength meter is a useful adjunct when an antenna rotator is used. To give an indication on a wide range of signals, two ranges of signal strength are selected by a switch. The low range gives indications from 0.5 to 5 μv and the high range from 5 to 50 μv. The constants in each circuit are arranged to cause saturation as the meter approaches 80 percent of full scale on either range to prevent overloading the meter. The grid current of the gated-beam limiter V_5 gives useful indications for the higher signals. The current in one half of the detector load is used to indicate small signals.

After standard deemphasis, the signal is amplified in tube V_{7A} and fed to cathode follower V_{7B} to provide about 4 v of audio at maximum gain setting with a 100-percent modulated signal. A divider provides a 0.5-v signal at the 600-ohm level. Distortion cancellation is employed between sections to yield a harmonic distortion level below 0.1 percent. Hum output is 78 db down. Audio-frequency response is within 1 db from 15 cps to 30,000 cps.

In developing a tuner for the exacting requirements of monitoring, rebroadcasting, and tape recording, the requirements of critical music lovers are also met. Using exactly the same principles, the pretuned, multichannel crystal-controlled tuner has been packaged as a high-fidelity instrument. The fixed-frequency tuner provides a signal source with the same reliability and freedom from distortion as with tape recorders or record players.

Watch Timer With

Watchmakers test instrument features a simple time base, with high linearity achieved by two-stage d-c amplifier with unity gain, back-coupled to R-C integrator. Time-base reference, synchronized with master clock, can check accuracy of any timing device

By S. T. KIEWIED, Australian Oil Refining Pty. Ltd., New South Wales, Australia

A WORTHWHILE improvement over existing sawtooth generators was developed in an application that required a simple time-base reference circuit that would combine linearity, low current drain, rapid flyback, stability, and suitability for low frequencies. Neither a Miller integrator nor a bootstrap circuit would satisfy these needs.

A highly linear time base, synchronized with a master clock, is used as a watchmakers or jewelers test instrument to assure accuracy of a timepiece under construction or repair.

Basic System

Figure 1 is a block diagram of the watch timer. The tick of an accurate master clock, the reference timepiece, is amplified and synchronizes the time base. The tick of a watch under test is amplified likewise, and the output connected to the vertical-deflection plates of a crt, as well as to a small speaker to make the ticks audible.

The switch allows the tick trace of the master clock to be shown on the crt screen. If the test watch is perfectly timed, the trace will remain in the same position. For a slow watch, the tick trace will shift in the same direction as the sweep and vice versa.

A timepiece with an eight-day mainspring can be adjusted to better than two seconds gain or loss per week, especially if it is tested in the same position and at substantially constant temperature. This accuracy, five parts per million, compares favorably with a precision tuning-fork standard and is nearly as good as a crystal oscillator.

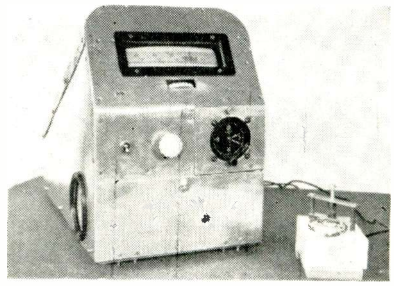
A Miller integrator was not suitable for the watch-timer application, due to the annoying step at the beginning of the trace and relatively slow flyback. Although Miller-integrator linearity is good, it deteriorates when more tubes are added for push-pull and faster flyback. Also, the time base is complicated by one or more clamping diodes.

The bootstrap circuit shows no step, but linearity is not as good as the Miller circuit, since cathode-follower action in the bootstrap results in less than unity gain and a capacitor acting as a floating battery, further reduces gain.

Time-Base Circuit

In this time base circuit, Fig. 2, the voltage change appearing across capacitor C is applied to a two-stage direct-coupled amplifier with unity gain. Output is fed back into the R-C integrator network, so that the voltage change at both ends of R is

Watch timer, used in a jewelers workshop, checks faulty timepiece



Front-panel view of watch timer showing test watch mounted on hollow block

the same. The charging current into C, therefore, is constant. Push-pull output is obtained from the anodes, connected directly to the X-plates of the crt. Unity gain for both stages is accomplished by a large amount of negative feedback. For the first stage this is nearly 100 percent. For the second stage, it depends upon the magnitude of the negative supply voltage, but is about 50 percent.

Direct couplings are used to avoid exponential nonlinearity.

By adjusting feedback, the charging current can be made to increase or decrease during the forward stroke. A position is found where the current is constant. The easiest way to adjust the time base is to set it at a low frequency, connect a voltmeter across the integrator resistor and adjust feedback until the meter shows no fluctuation.

Any leakage across capacitor C can be compensated by slightly raising the gain. If the leakage resistance is represented by R_s, the required gain is $A = 1 + R/R_s$.

The capacitor is discharged by the trigger circuit T. Here a gas triode furnishes extremely rapid

Precise Time Base

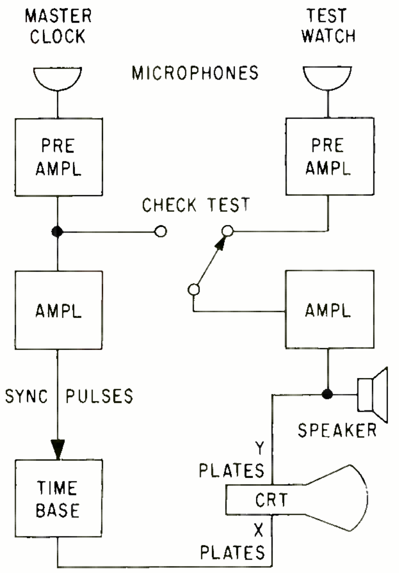


Fig. 1—Master clock synchronizes time base that is compared to test watch

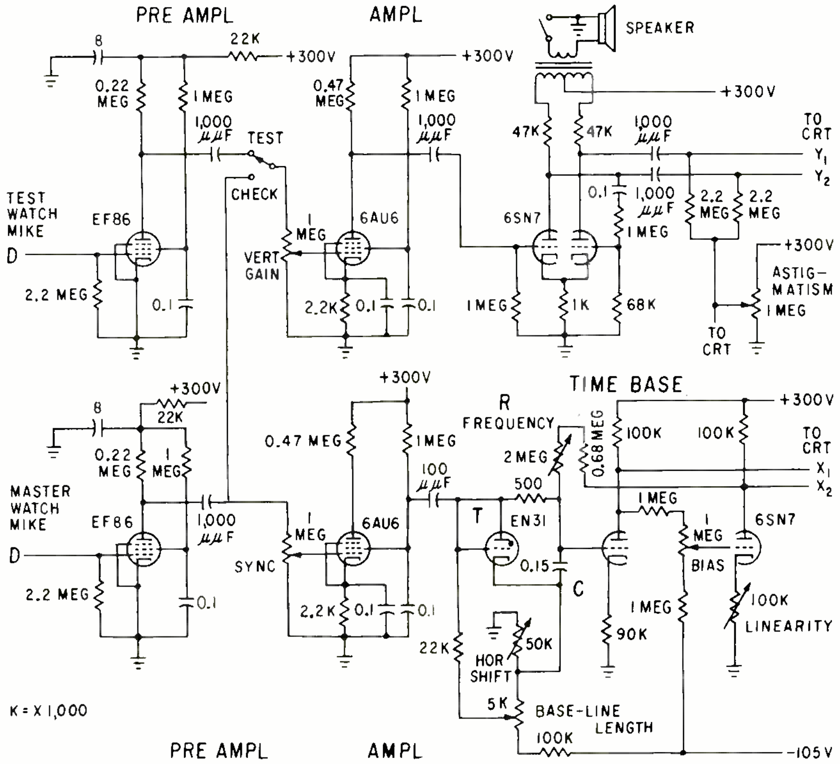


Fig. 2—Large amount of feedback in timer circuit results in extreme stability

flyback. For higher frequencies, any suitable trigger such as a Schmitt may be used with reduced output impedance. For highest sweep speeds, high-slope pentodes are indicated instead of a twin triode, with low-value load resistors augmented by peaking arrangements.

Large feedback makes the time base extremely stable, with distortion reduced to a vanishingly low figure. After initial adjustment, no further settings are necessary. Base-line length is set by altering the voltage at which the trigger circuit fires. In the watch-timer circuit, this is done by adjusting the grid bias of the gas triode. The trace can be shifted by varying the grid bias to either triode of the time base.

This simple timebase has the added advantage of low-power operation: about 2 ma at an output of 220-v peak-to-peak. The push-pull arrangement insures steady drain from the power supply.

The sweep frequency range for the timer components shown in Fig. 2 is approximately 3 to 12 cps.

Crystal vibration microphones pick up the tick. Standard microphone inserts with the diaphragm removed proved suitable.

The amplifiers are conventional except that low frequencies were removed to avoid extraneous low-frequency noise that might cause annoying patterns on the screen. The trace contains detail for timing and fault-finding purposes, and the audible tick from the 3-in. speaker sounds convincingly natural.

Construction

The reference timepiece, mounted on the face of the timer, serves a triple purpose: a synchronizer for the time base, an indicator of the time interval required for checking the watch under test, and of course for indicating the correct time.

A stock power transformer was used that had a low-leakage field with copper winding around the core. Shielded primary and heater windings are provided. The high voltage for the crt was kept fairly low to get sufficient horizontal sensitivity. Simple stabilization was applied to the B+ voltages by two VR-150's for the positive supply, and one VR-105 for the negative supply. In future models it would be advantageous to use a 150-v negative supply.

Since over 90 percent of all watches have a tick frequency of five per second, or 18,000 beats per hour, one reference timepiece with this beat covers most requirements. Additional master watches with other beats, are kept for special applications.

A rectangular scope, was used with the tube positioned at a 30-deg angle.

For timing a watch, a transparent flexible strip, marked in five-second intervals, was chosen to fit over the face of the crt screen. The strip is moved until the zero mark coincides with the tick trace and the gain or loss in seconds per day is read off after an interval of one minute.

The only controls on the face of the instrument are strip adjust, vertical gain and speaker on-off.

Split Reflector for

Dividing the single-layer pillbox into two halves, with metal septum, corrects impedance mismatch of this type of line feed antenna. Technique applies to parabolic reflectors and other microwave antennas, and provides antenna designer with new design tool to increase radiated power while maintaining narrow beamwidth

By R. L. MATTINGLEY, B. McCABE and M. J. TRAUBE,

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REFLECTED IMPEDANCE mis-match of a single-layer pill-box line-feed antenna used at microwave frequencies produces an undesirably high voltage standing-wave ratio and its implication of reduced power radiated into space.

A new procedure, developed to correct these difficulties, compartments the single-layer pillbox (Fig. 1A) into two halves by a metal septum extending from the middle of the feed orifice to the back edge (Fig. 1B). No deterioration of the far-field pattern is produced. Preliminary measurements of voltage standing wave ratio do not exceed 1.35 over a 12 percent frequency band, plus minor lobe discrimination of 18.5 db. Improved results are anticipated with refinements in components that will soon be available.

The split reflector technique may also be extended to paraboloidal reflectors (Fig. 2). While no order-of-magnitude improvements in operation of the single-layer pillbox are claimed, the antenna designer is provided with a new tool that should prove useful in a variety of applications.

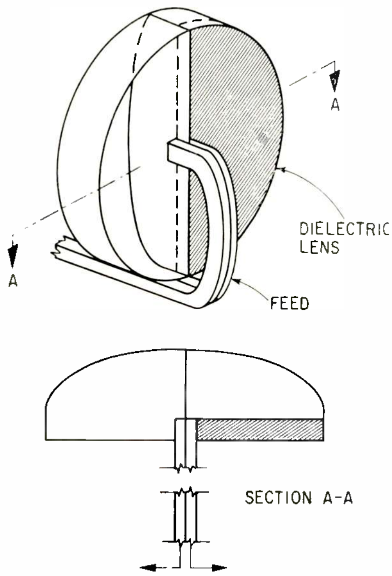


FIG. 2—Split reflector technique can be extended to parabolic reflectors

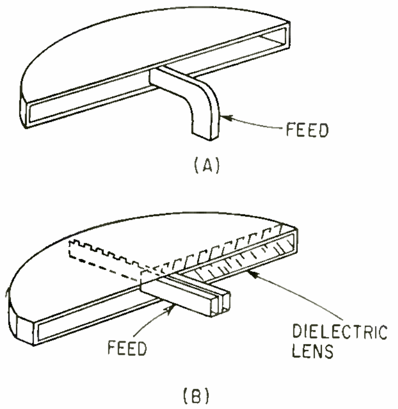


FIG. 1—The single-layer pillbox (A) is split into two halves by a metal septum (B) which extends from the middle of the feed orifice to the back edge

Single-Layer Pillbox

As seen in Fig. 1A the single-layer pillbox involves closely spaced parallel metal plates together with a reflecting wall, usually parabolic in contour. This arrangement is an attractive line feed structure, rugged and simple to maintain adequate control over dimensional variations. However, the necessary placement of the feed orifice in the direct path of reflected rays at the center of the aperture causes energy to be reflected directly back into the feed orifice from the parabolic surface of the pillbox. The undesirably high voltage standing-wave ratio and reduced power radiated into space have been improved by vertex plates[1], directional couplers[2], feed displacement, isolators, mechanical displacement of one reflector half with respect to the other[3], and other methods which attempt to improve impedance match. However these methods have either proved inadequate or have required complex structures.

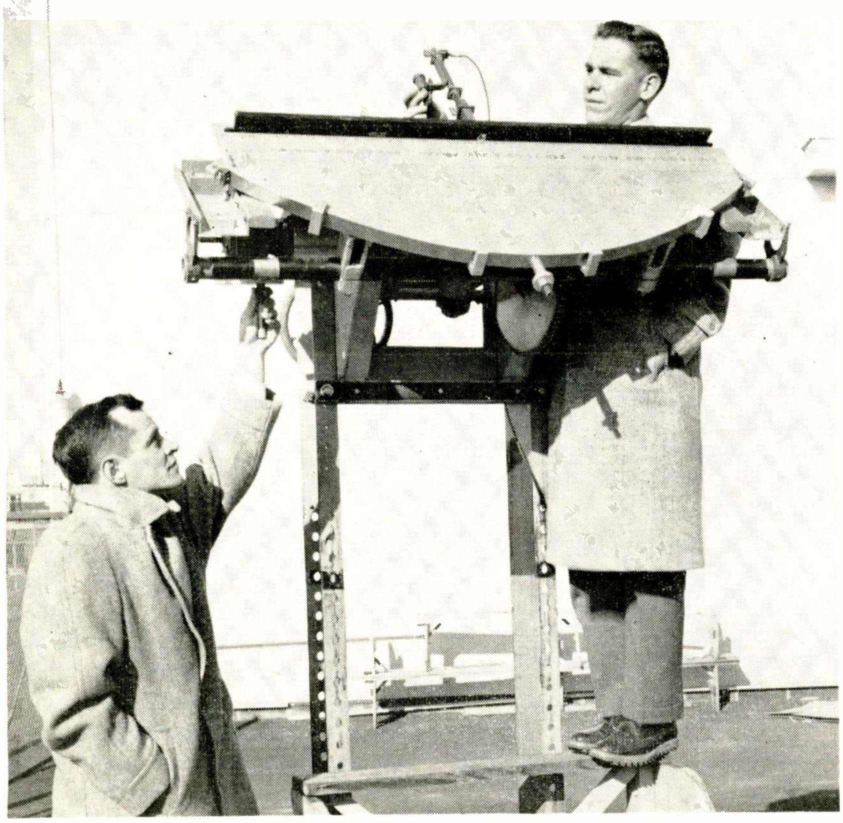
Split-Reflector Technique

Splitting the single-layer pillbox into two halves (Fig. 1B) offers a promising technique, free of previous difficulties. Each half is fed by conjugate output ports of a short-slot hybrid coupler.[4] Details of the feed are shown in Fig. 3.

Polarization of the E vector is horizontal, and the short-slot hybrid section is coupled along the broad wall of the waveguide. Voltages at the output ports of the hybrid are in phase quadrature. Thus each half is illuminated equally in amplitude, but with a 90 degree phase difference.

A phase-correcting section is necessary to establish an equiphase surface at the line feed aperture. In this case, a dielectric delay section was selected. Calculations show that at the extreme ends of a 12 percent frequency band, the right and left sides of the aperture will be less than 5 degrees out of phase (for a relative dielectric constant

Microwave Antennas



Authors McCabe and Traube are seen making adjustments to center-feed antenna system that improves the impedance properties of a single-layer pillbox line feed antenna used in the microwave portion of the frequency spectrum

FIG. 4—Typical radiation pattern of septumated single-layer pillbox with accelerating lens; f_o = 16,500 mc

of 1.25). A 5 degree maximum phase variation causes a shift in the main beam of the antenna of approximately 1/36 of a beamwidth measured at the 3 db points.

Experiments[5] have shown that a maximum reduction in gain of less than 0.1 db will be caused by the 5 degree phase variation. Attenuation loss in a dielectric section, computed for a number of frequencies, shows that the one-way loss would be about 0.01 db.

Neglecting dispersion, the more general formulation results:

$$\theta = \frac{\Delta f}{2 f_0} \text{ (beam angle)}$$

Here θ is the boresight shift, and f_o is the center frequency. For 12 percent (± 6 percent) bandwidth, $\Delta f / f_o = 0.06$ which gives $\theta = (0.03)$ (beam angle) differing only slightly from the beam-angle/36 value previously obtained.

The dielectric section must be placed in the pillbox half excited by the orifice that is not in line with the feed. Correspondingly, an acceleration section could be positioned in the half in line with the feed. Thus the voltage in the auxiliary waveguide leads that in the directly coupled waveguide.

It has been verified, both experimentally and analytically that in the broadwall coupler, the voltage in the auxiliary arm leads that in the main arm. In the narrow wall coupler, the voltage in the auxiliary arm lags.

The action of the compartmented pillbox depends upon the symmetry of reflections from its two halves. Reflections from the right compartment have their counterpart in the left side of the box. These reflections enter the short-slot hybrid in phase quadrature and are absorbed in a resistive termination connected to the appropriate hybrid port. Any asymmetrical reflections are visible, partially at least, to the generator.

Phase corrector reflections may be minimized by appropriate design. A binomial or Tchebycheff step in the phase correcting section can be used. However, a limitation inherent in this hybrid-compartmented antenna system can be made clear by considering the following.

Assume first that the interface between the air and refracting material within the pillbox can be

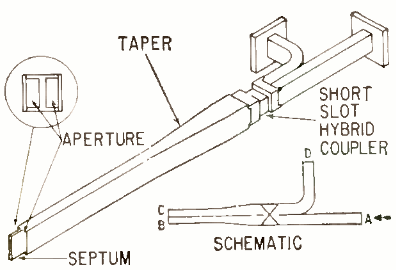


FIG. 3—Details of dual feed horn

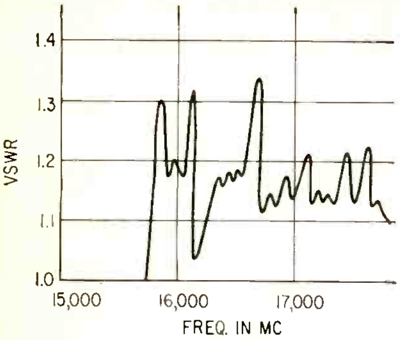


FIG. 5—Voltage standing wave plotted against frequency

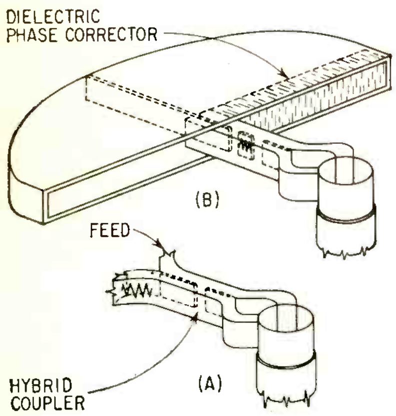


FIG. 6—Circularly polarized rotating joint uses hybrids for the quarter wave plates (A) as well as for the antenna feed (B)

made reflectionless and second that the hybrid is ideal. Even so, there is 180 degree difference between the path lengths traversed by the energy which arrives back at the feeds after reflection by the discontinuity at the guided-unguided interface. The generator sees all of this reflection which can be minimized by increasing the plate spacing to diminish the λ_g/λ ratio or tapering to reduce discontinuity at the guided-unguided transition.

Test Results

A single layer compartmented pillbox operating in the K_u frequency band (16,500 mc), was chosen because of the ease in handling physical antennas. The radiating aperture was 45½ inches (about 64 wavelengths). An equivalent aperture at L-band would be about 50 feet.

A typical radiation pattern, Fig. 4, shows the depth of the nulls, indicating that the feed structure is well-focused, and the 18.5 db side lobe discrimination. Beam-width, measured as 1.05 degrees, is compared with one degree measured with the same pillbox using an ordinary waveguide feed. A good check on the phase corrector is easily obtained by interchanging the feed and absorber. Equal split beams are obtained only when the phase corrector is just the correct length.

Figure 5 plots the voltage standing wave ratio over the 12-percent frequency band. The maximum voltage standing wave ratio is 1.35 (2.6 db) and is to be compared with the maximum standing wave ratio of 4 db for the same pillbox with an ordinary waveguide feed. Hybrid measurements show a mismatch of about 1.2 db. This mismatch, added to the 1.6 db ascribable to the mismatch at the pillbox aperture, yields approximately the value observed. Improved short-slot hybrids, currently in development, can reduce the 2.6 db mismatch to perhaps 2 db.

The power loss implicit in this arrangement should not be overlooked. Most of the 4 db mismatch observed before compartmenting can be assigned to symmetrical reflections. Hence, the power loss, given by (voltage reflection coefficient)^2 = $(0.23)^2$, has an upper bound of 5 percent.

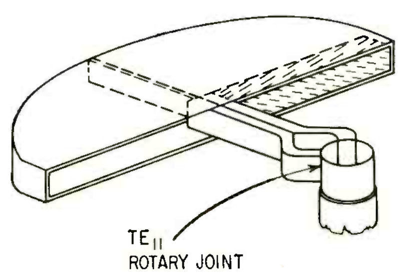


FIG 7—Components of the circularly polarized rotating joint are mechanically juxtaposed to serve as a TE_{11} rotary joint feed

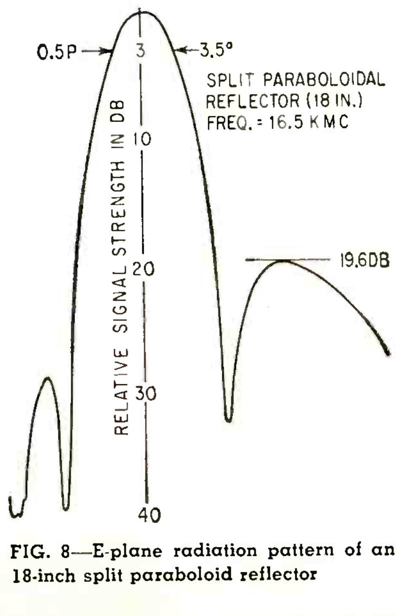


FIG. 8—E-plane radiation pattern of an 18-inch split paraboloid reflector

Circular Polarization

The compartmented antenna lacks only the requisite orthogonal separation of polarization in its two halves to be classed as a sort of circularly polarized antenna. The combination of this antenna type with a circularly polarized TE_{11} rotating joint is particularly interesting.

In a circularly polarized rotating joint two quarter-wave plates are used; one converts the input from linear to circular polarization and the other reestablishes linear polarization in the output. Thus considered separately, the antenna rotary joint combination would seem to require two quarter-wave plates plus the hybrid feed as in Fig. 6A. However, these three units can be collapsed into one. In Fig. 6B hybrids are used for the quarter-wave plates as well as for the antenna feed. In Fig. 7 the two components of circular polarization differing 90 degrees in time phase, are led off in separate waveguides and are mechanically juxtaposed to serve as the feed system. The hybrid quarter-wave plate can be replaced by any quarter-wave plate (array of pins, dielectric fin, etc.) without affecting the action described.

Parabolic Reflector

In the paraboloidal reflector, (Fig. 3), a metallic plate splits the paraboloid into two halves and again a hybrid coupler illuminates each half in phase quadrature. A dielectric phase corrector is applied to the appropriate half. This antenna structure was built using an 18 inch paraboloidal reflector. Figure 8 is the E-plane radiation pattern for this antenna.

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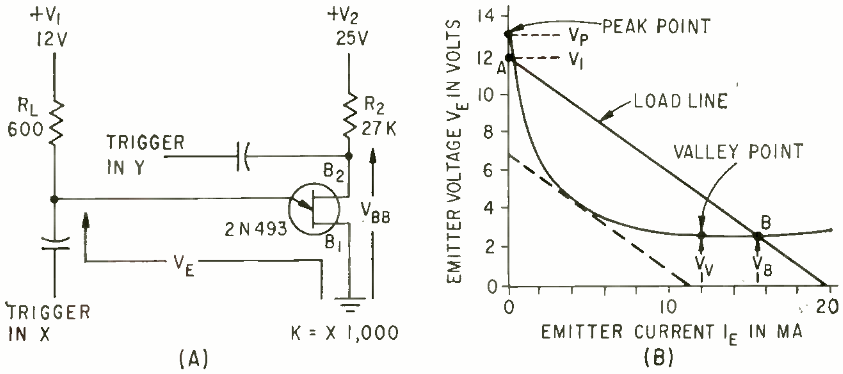


FIG. 1—Basic bistable circuit (A) and emitter characteristic of the unijunction transistor (B). Shown are two stable operating points

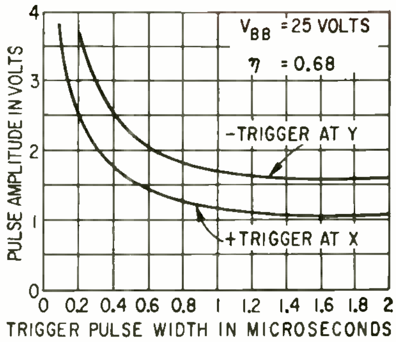


FIG. 2—Trigger amplitude is plotted as a function of pulse width

Bistable Circuits Using Unijunction Transistors

Unijunction transistor simplifies bistable-circuit design and permits operation at high ambient temperatures. Use of negative resistance region as one stable state decreases power requirements and increases switching speed. Modified circuit has clamping diode that holds emitter voltage below peak-point voltage. Ring-counter application explained

By T. P. SYLVAN Application Engineer, General Electric Company, Syracuse, New York

DEVELOPMENT of new active and passive components has greatly simplified circuit design. The number of components previously considered essential for electronic circuits can be reduced through redesign with more functional components.

The silicon unijunction transistor is an example of an active component whose characteristics simplify relaxation-oscillator and timing-circuit design and provide the advantages of increased stability with temperature, life and supply-voltage variations.[1] Modified relaxation-oscillator circuits function as pulse generators, pulse amplifiers, sawtooth generators and frequency dividers. Still other circuits[2] have been designed as free-running or one-shot multivibrators with only one unijunction transistor required.

Negative-resistance characteristics of the unijunction transistor make possible the design of bistable circuits with a single unijunction transistor. But the design and analysis of these circuits markedly differ from those of bistable circuits made with more conventional junction transistors.

Basic Bistable Circuit

The basic form of the unijunction transistor bistable circuit is shown in Fig. 1 together with the corresponding emitter characteristic curve. The two stable operating points A and B of the circuit occur at the intersection of the load line formed by R_L and V_1 and the characteristic curve. Point A is in the cutoff region where the emitter diode is reverse biased. Point B is in the saturation region where the emitter is conducting and the emitter voltage is low. The slope of the emitter characteristic curve in the saturation region is 0 to 40 ohms, while the slope of the emitter characteristic in the cutoff region is greater than 10 megohms.

For reliable bistable circuit operation the supply voltage V_1 must be less than the peak-point voltage V_P. Otherwise, point A would cease to be stable for the circuit. In addition, the value of resistor R_L must be small enough so that point B falls to the right of the valley point for all operating conditions. If point B were to fall to the left of the valley point in the negative-resistance region, then the circuit could be regenerative and point B

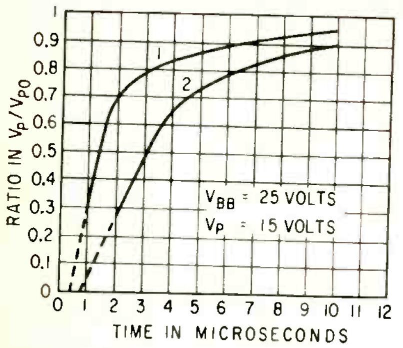


FIG. 3—Recovery characteristics of peak-point emitter for 2,200-ohm load resistor and 8-milliamps emitter current (1) and 1,000-ohm load resistor and 16-milliamp emitter current (2)

would not be an unconditionally stable operating point.

With the operating point at A, the bistable circuit of Fig. 1A is off because there is only a small current flowing through the load R_L and through the emitter of the transistor. Power dissipation in the load during the off state is determined by the size of R_L and by the less than one μa leakage current of the emitter and is less than 10^{-8} watt. In the on state, which corresponds to operating point B, about 135 milliwatt is delivered to the load and 45 milliwatt is dissipated in the emitter circuit.

Trigger Input

A positive trigger with an amplitude greater than (V_P − V_1) applied at point X or a negative trigger applied at input Y turns the bistable circuit on. If the trigger is applied at input Y, it must be negative with an amplitude greater than $(V_P - V_1)/\eta$ where η is the intrinsic standoff ratio of the unijunction transistor. Triggering at point X essentially raises the load line on the characteristic curve while triggering at input Y lowers the emitter characteristic curve by changing the effective value of V_{BB}.

A negative trigger pulse of amplitude $(V_B - V_V)$ applied at input X turns off the bistable circuit of Fig. 1A. Because the emitter input impedance in the on state is quite low, the output impedance of the trigger source must also be low. The circuit can also be turned off with a trigger at input Y but only if point B is slightly to the left of the valley point and is close to the point of instability. But triggering it at input Y deprives the circuit operation of the flexibility necessary for practical applications and also reduces the permissible range of the load current.

There is still another method of turning the bistable circuit off. Momentary reduction of V_1 moves the load line down on the characteristic. And when the loadline intersects the emitter characteristic below cutoff at 7 volts, shown by dotted lines in Fig. 1B, the circuit is turned off.

If the load resistor R_L is connected between base B_1 and ground, the circuit can be turned on by a negative pulse applied at base B_1 or at base B_2. It can be turned off by a positive pulse applied at base B_1. The current gain between emitter and base B_1 provides higher switching efficiency, but current flows through the load in the off condition.

To turn the transistor on in any bistable circuit, the emitter voltage must be raised to a value greater than the peak-point voltage. Or the peak-point voltage must be dropped below the emitter voltage by decreasing the voltage at base B_2. The emitter current must also be greater than the peak-point emitter current I_p, if the transistor is to turn on. The peak-point current is generally about 4 μa at 25-v interbase voltage and a temperature of 25 C.

When trigger pulses are used, the required pulse amplitude increases as the pulse width is decreased. Minimum required trigger-pulse amplitude is shown in Fig. 2 as a function of pulse width. The required trigger amplitude at base B_2 is greater than the required trigger amplitude at the emitter by a factor $1/\eta$.

Although trigger requirements for turning the transistor off are complex, as a rule, turnoff is faster as the value of the emitter current immediately before turnoff is decreased. Faster turnoff is obtained if the emitter is driven negative with respect to base B_1 and if base B_2 is kept out of saturation. Current can flow either in or out of the emitter on turnoff. When the emitter is driven negative with respect to base B_1 on turnoff, the emitter diode exhibits storage effects similar to those of some types of junction diodes.

On turnoff, recovery is not complete even after the emitter ceases to conduct. The effective peak-point emitter voltage V_p recovers toward the steady state value V_{po} as shown in Fig. 3. The turnoff circuit time constant must be designed so that the emitter voltage rises more slowly than V_p; otherwise, the emitter conducts before recovery is complete and the transistor cannot be turned off.

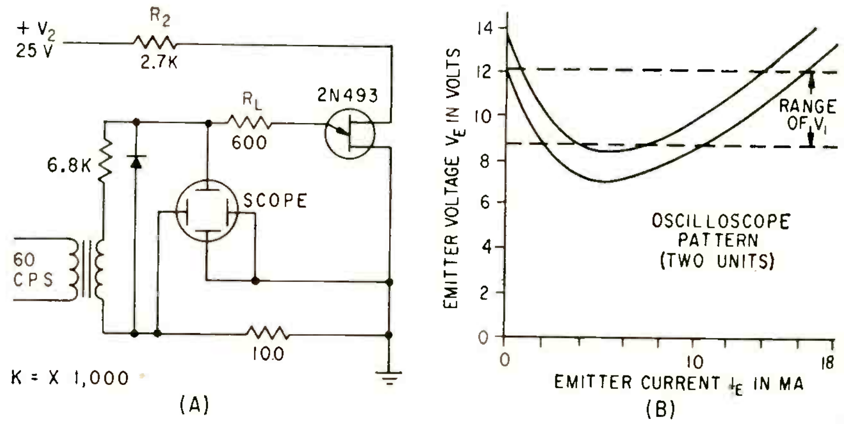


FIG. 4—Test circuit has scope (A) with pattern (B) indicating characteristics

Test Circuit

Because of the nonlinear emitter characteristics, the design of the bistable circuit of Fig. 1A is ordinarily difficult. While graphical design techniques do ease the task, taking measurements and plotting the emitter characteristic curves

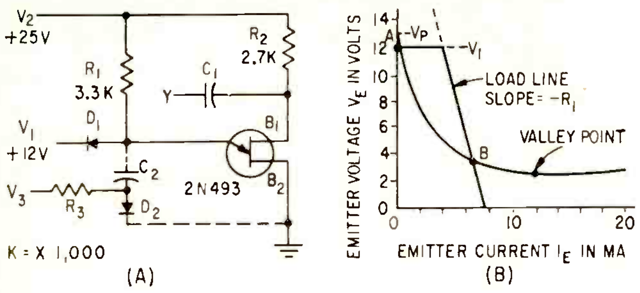


FIG. 5—Modified circuit uses emitter voltage clamping (A) and has unusual turnoff technique (B)

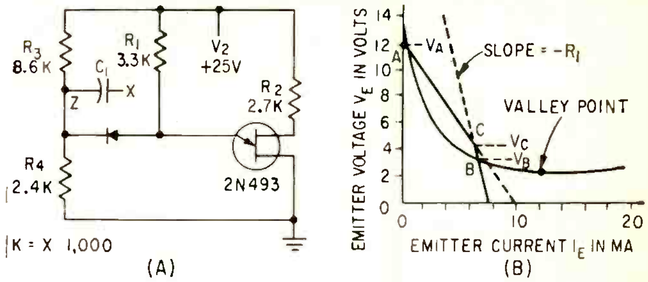


FIG. 6—Bistable circuit with diode decoupling needs only small negative trigger at X for turnoff

involves considerable work. The design and testing can be greatly simplified with an oscilloscope as indicated in Fig. 4A. The load resistor R_L is in series with the emitter and the characteristic curves for the complete circuit are displayed on the scope.

Acceptable operating voltages lie between the dotted horizontal lines which intersect the characteristic curves in two regions of positive slope. For example, if the two characteristic curves in Fig. 4B correspond to limit samples of a certain type of unijunction transistor, the acceptable range of operating voltage is between the dotted lines.

Modified Bistable Circuit

In Fig. 5 another version of the bistable circuit has a clamping diode to hold the emitter voltage below the peak-point voltage. When a negative trigger at base B_2 turns on the transistor, the clamping diode is back-biased and the resistor R_1 is the emitter load. Since the transistor is biased at point B in the negative resistance region, operation is stable provided the capacitance between emitter and base B_1 is kept below a critical value. The critical capacitance value depends on bias point B, increasing as the valley point is approached. The value of the critical capacitance is greater than 50 $\mu\mu$f if the bias point B is below 5 v.

When the transistor is biased in the negative resistance region in the on state, the power required for turnoff and the turnoff time are both greatly reduced. An interesting technique for turnoff is indicated by the dotted portion of the circuit of Fig. 5B. When V_3 is negative, the diode D_2 is reverse-biased and the dynamic resistance in series with the capacitor C_2 is sufficiently high to stabilize the transistor at the bias point B. When V_3 is positive, the diode D_2 is biased in the forward direction and its dynamic resistance decreases as the forward current increases. When the total dynamic resistance around the loop ($D_2 - C_2 - E - B_2$) becomes negative, the circuit is regenerative, and the transistor turns off.

Still another bistable circuit is shown in Fig. 6. Here the slope of the loadline between points A and C is determined by the parallel combination of R_1, R_3 and R_4. When the transistor is on, the voltage at terminal Z is equal to V_c. The diode is thus back-biased by a voltage $V_c - V_B$ so that the emitter is decoupled from point Z and the capacitor C_1 does not cause transistor unbalance at bias point B. Only a small negative trigger is needed at input X to turn off the unijunction transistor.

Ring Counter

The ring counter circuit shown in Fig. 7 illustrates an application of the bistable circuit of Fig. 1. Resistors R_6 and R_7 correspond to the emitter load resistor and keep the voltage at the collector of Q_5 less than the peak-point voltage of the unijunction transistors when the supply voltage is turned on. Transistor Q_1 is turned on by the set switch and maintained in the on state by the current flowing through R_6 and the diode D_1. When the first trigger pulse is applied, the current from R_6 is diverted to ground through the collector of Q_5 and then Q_1 turns off. The voltage at base B_2 of Q_1 rises and Q_2 is turned on through C_2. At the end of the trigger pulse, Q_2 is maintained in the on state by the current flowing through R_6 and D_2. Each successive trigger pulse advances the count one stage to the right.

The circuit shown in Fig. 7 operates over 20 to 40 v and with trigger-pulse widths between 6 and 9 μsec. The operating frequency range is 0 to 40,000 cps and the circuit performs satisfactorily at ambient temperatures up to 110 C.

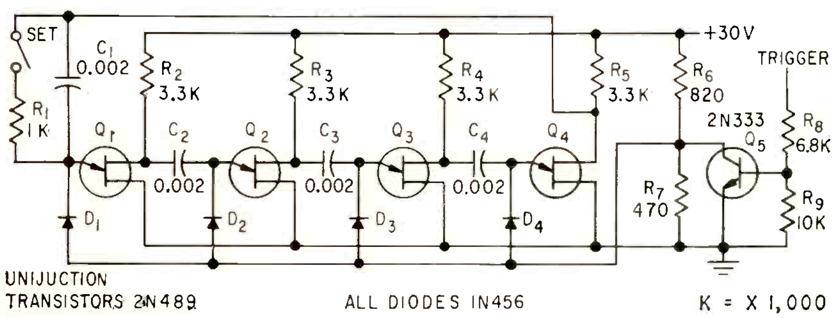


FIG. 7—Ring counter operates at frequencies up to 40,000 cps

REFERENCES

(1) T. P. Sylvan, Design Fundamentals of Unijunction Transistor Relaxation Oscillators, *Electronic Equipment*, Dec. 1957.

(2) E. Keonjian and J. J. Suran, Unijunction Transistor Forms Flip Flop, ELECTRONICS, p 165, Sept. 1957.

Phase-Selective Gate

Two unmatched diodes are used in phase-selective circuit. Phase reference voltage controls diodes so that they conduct only when in-phase signal component is passing through maximum and quadrature is passing through minimum. Useful output can be obtained with quadrature component of signal 30 db greater than in-phase component

By BENJAMIN FENNICK
Systems Engineering Dept., Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.

QUADRATURE VOLTAGES in servo loops can overload amplifiers and seriously reduce amplification of in-phase signals. These voltages can also reduce accuracy and overheat motors. The circuit to be described rejects quadrature and delivers an in-phase a-c signal.

Existing Methods

A variety of methods have been developed for cancelling or rejecting quadrature voltages. All are relatively complex, expensive and often have environmental limitations.

Two circuits used for eliminating quadrature are the Ramey saturable reactor and the diode discriminator. Both circuits require matched components and both yield d-c outputs. Matching components is expensive and difficult, especially when they are to be used over the wide temperature ranges required of military equipment.

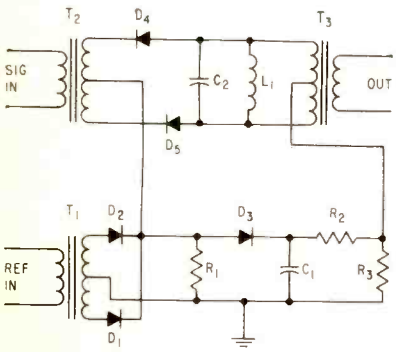


FIG. 1—Reference voltage in phase with useful component of signal is rectified to permit gate diodes to conduct only when in-phase signal is at maximum

The d-c output provided by these circuits is suitable for driving saturable reactors and other devices. However, in many applications, it is necessary to operate with an a-c signal. If followed by a transistor amplifier, the Ramey or diode discriminator must be followed by a modulator, which introduces additional matching and drift problems.

When used with a modulator, a relatively high signal level is required for proper operation. Therefore, amplification must precede the quadrature-rejection stage. If the signal-to-quadrature ratio is small, the phase shift of this amplifier becomes critical. Still another problem is the possibility of saturating the amplifier with the excessive quadrature.

The phase-selective gate circuit described here rejects quadrature without requiring matched components, operates satisfactorily at low signal levels and produces an a-c output. Because of these advantages, this circuit is being used in a military jet automatic pilot.

Theory of Operation

Quadrature rejection is achieved by using a phase-reference voltage to permit two unmatched diodes to conduct only at the instant that the in-phase component is passing through maximum and the quadrature component is passing through zero. The pulses produced are filtered to obtain a sinusoidal output that can be fed into a transistor servo amplifier.

The reference voltage is fed into a full-wave rectifier consisting of transformer T_1, diodes D_1 and D_2 and resistor R_1, as shown in Fig. 1. The reference voltage is in quadrature with the useful component of the signal. The unfiltered, positive, rectified voltage appearing across resistor R_1 is fed to the centertap of transformer T_2 secondary.

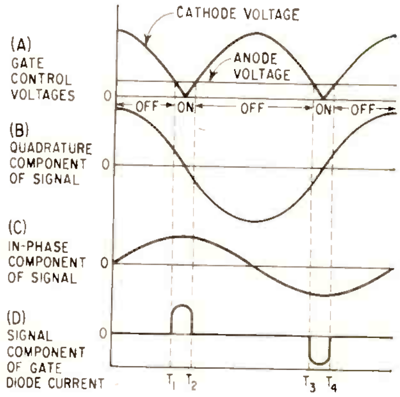


FIG. 2—Voltages on gate diodes limit conduction to times T_1-T_2 and T_3-T_4, resulting in current pulses of in-phase signal shown at (D)

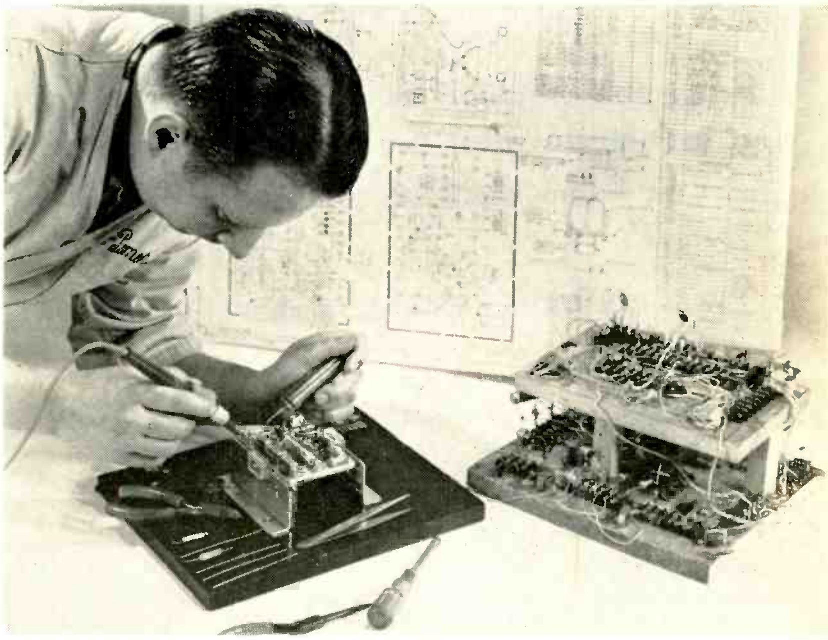
The rectified current peaks are conducted through diode D_3 to capacitor C_1. Capacitor C_1 charges to approximately the peak value of the rectified voltage, maintaining a d-c voltage across resistors R_2 and R_3. Resistors R_2 and R_3 form a voltage divider for obtaining a small d-c voltage. This voltage from their junction is fed through the centertap of the primary of transformer T_3 to gate diodes D_4 and D_5.

The phase relationships in the diode gate are shown in Fig. 2. The gate anode voltage in Fig. 2A is the small d-c voltage developed

Rejects Quadrature

across R_3 and fed to the anodes of diodes D_4 and D_5 from T_3.

The unfiltered, rectified cathode voltage from T_2 is also shown in Fig. 2A. When this positive voltage exceeds the small positive d-c anode voltage, the gate diodes cannot conduct. This condition is illustrated in Fig. 2A before time T_1. At time T_1, the cathode voltage becomes equal to the anode voltage. Between time T_1 and T_2, the cathode is less positive than the anode, permitting the gate diodes to conduct. Between time T_2 and T_3, the cathode voltage is more positive than the anode voltage, cutting off the gate diodes. Between time T_3 and T_4, the gate diodes are permitted to conduct again.



Assembling the phase-selective gate circuit. Breadboard model is shown at right

Quadrature Signal

The quadrature component of the signal is shown in Fig. 2B. Between time T_1 and T_2 and between time T_3 and T_4, when the gate diodes are conducting, the quadrature component of signal is going through zero. (The duration of the conducting period shown in Fig. 2 has been exaggerated to clarify the illustration; in normal operation conduction time is extremely short.) During the remainder of the cycle, the gate diodes are cut off. Therefore, only a negligible portion of the quadrature component of the signal appears in the output.

The in-phase component of the signal is shown in Fig. 2C. Between time T_1 and T_2 and between time T_3 and T_4, when the gate diodes are conducting, the in-phase component of signal is going through maximum. Therefore, the in-phase component appears in the output.

The signal component of current through the gate diodes is shown in Fig. 2D. This current waveform consists of positive and negative pulses. From these pulses, the fundamental frequency is selected and the harmonics rejected by the parallel network of capacitor C_2 and inductor L_1, which are resonant at the fundamental frequency (Fig. 1). The signal is coupled to the output through transformer T_3.

Practical Circuit

A practical application of the phase-selective gate circuit is shown in Fig. 3. The values shown in the schematic were selected for a 400-cps servo amplifier. The use of the common-collector circuit (cathode follower) at the input was to develop high input impedance.

The d-c voltage for the anodes of the gate diodes was developed by a bleeder from the d-c supply instead of by the method described previously. The 1,000-ohm load resistor was used to simulate the input impedance of a common-emitter amplifier stage. The quadrature reference voltage was obtained by shifting the phase of the 400-cps power approximately 90 degrees with the 0.27-μf capacitor, the 2,800-ohm resistor and transformer T_1. The reference voltage is approximately 20 volts a-c across each half of the secondary of T_1.

The circuit in Fig. 3 yielded an output of about 5 millivolts for a nominal in-phase input of 25 millivolts. Input impedance is 200,000 ohms. Power gain is approximately 8 (9 db). The circuit is required to handle 0.5 volt of quadrature, but as much as 2 volts of quadrature could be introduced at the input without appreciable change in the output. This performance is maintained over a temperature range of about −54 to 100 C.

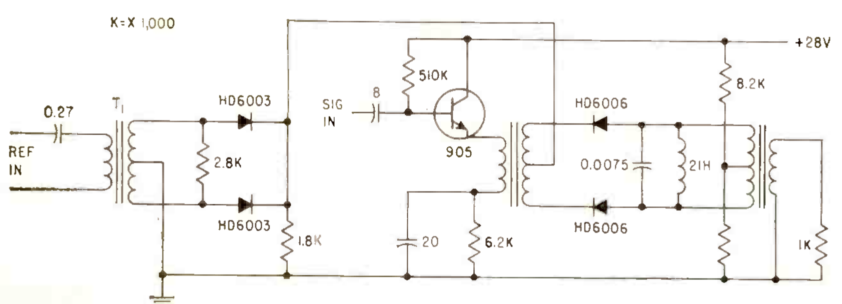


FIG. 3—Circuit uses common-collector configuration to get higher input impedance

Line Resonator Chart

Nomograph simplifies calculations required to design capacitance-shortened quarter wavelength transmission line resonators. Ordinates establish capacitance and line length as products of frequency

By **WALTER DAUKSHER,** Airborne Instruments Lab., Mineola, N. Y.

CAPACITANCE-SHORTENED quarter wavelength transmission line resonators are often used in r-f circuitry in the vhf and uhf ranges. Design of such resonators consists of solving the transcendental equation $X = Z_o \tan \theta$ for the dependent variable, after assigning values (or a range of values) to the two independent variables.

Parameter calculations for these resonators are simplified by the accompanying nomograph that establishes capacitance and line length as products of frequency. On this chart, the fC ordinate is equal to frequency times capacitance, and the fl ordinate is equal to frequency times line length.

Use of nomograph and simple arithmetic solves capacitance and line-length requirements.

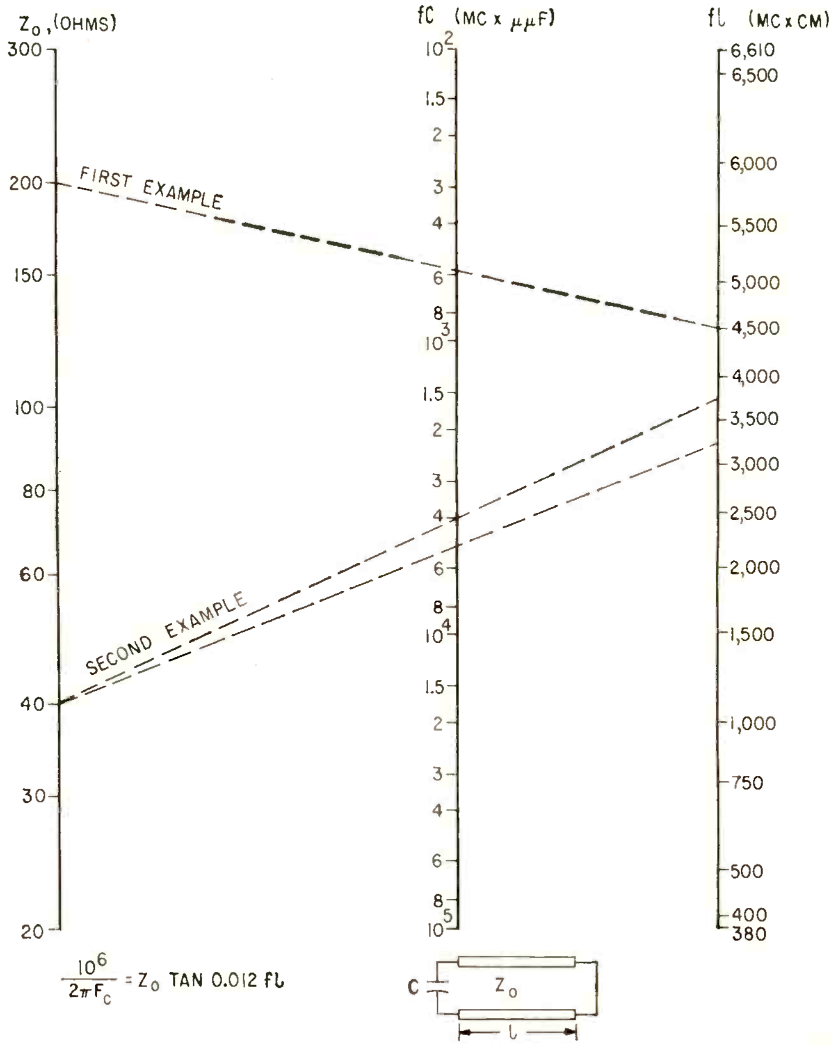
Examples

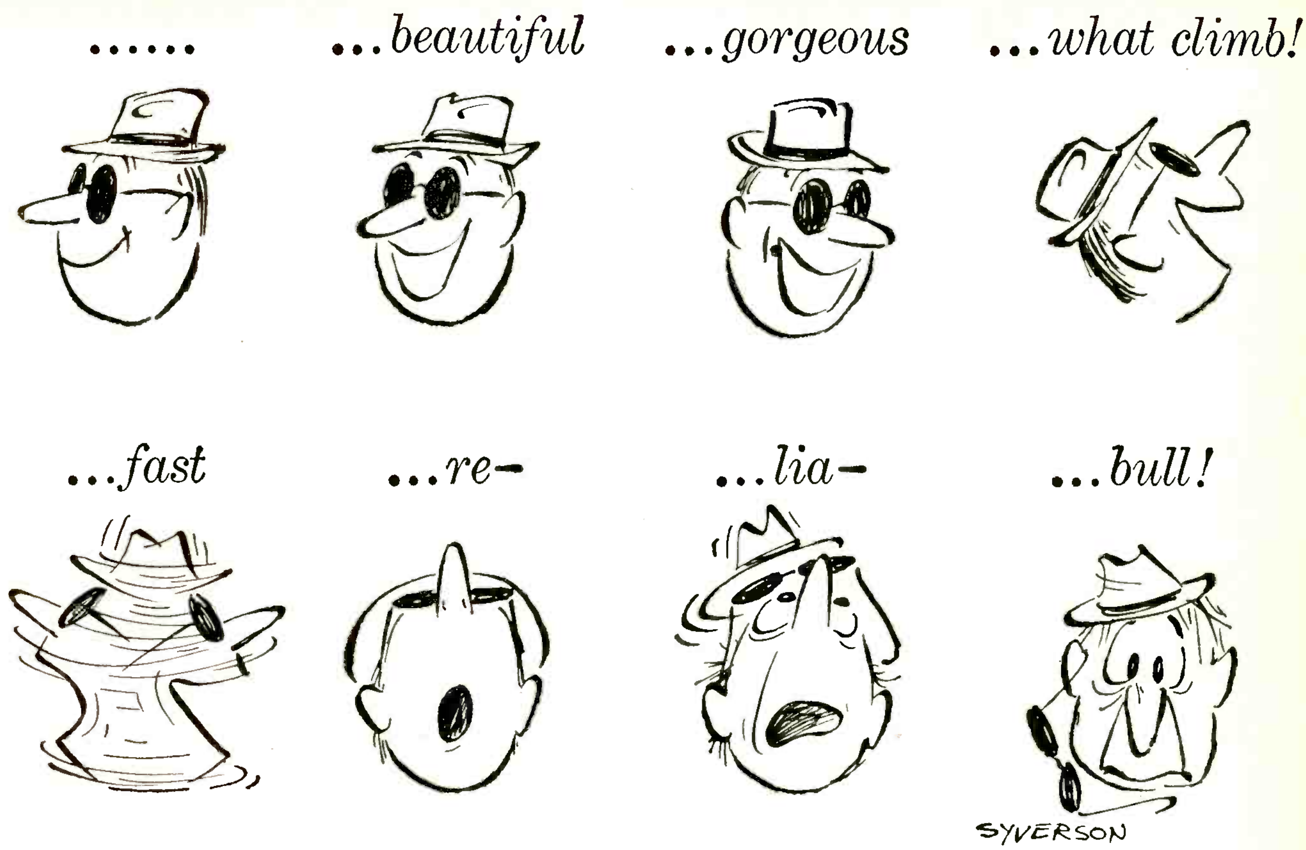
A 200-ohm transmission line, 30-cm long, is to be used as a resonator at 150 mc. Determine the capacitance required.

At $Z_o = 200$ ohms, and $fl = 4{,}500$ (i.e., 150×30), read $fC = 580$. Capacitance is then found to be 3.87 $\mu\mu$f by dividing 580 by 150 mc.

A 40-ohm coaxial line is to be used to tune a tube with 2-$\mu\mu$f capacitance over the range of 2,000 to 2,500 mc. Determine the line lengths required.

At $Z_o = 40$, and $fC = 4{,}000$ $(2{,}000 \times 2)$, read $fl = 3{,}800$. Also at $fC = 5{,}000$ $(2{,}500 \times 2)$, read $fl = 3{,}300$. The line lengths are then found to be 1.9 cm (3,800 divided by 2,000), and 1.32 cm (3,300 divided by 2,500).





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Balloon Telemeters Solar Effects

TEN-HOUR recording of the effects of a violent explosion on the sun was made recently by Kinsey Anderson, State University of Iowa physicist. The solar disturbance occurred on Aug. 22 and 23. The recording will probably be the last until 1970, when the next peak of intense solar activity occurs.

The unusual effects of the storm were picked up by instruments attached to a Skyhook balloon. The balloon drifted about 20 miles above the surface of the earth at Fort Churchill, Canada.

The data received during the solar storm identified the radiation as being predominantly protons and possibly a few other heavy nuclei. It is not now known where these particles originate. Anderson is not convinced that the protons come directly from the sun, even though they are associated with solar disturbances. They may originate from some other source, and only be speeded earthward by forces from the earth itself. However, they may be activated by the intense energy from the sun.

Time Interval

The balloon-borne instruments stopped sending data after ten hours aloft. A second launching showed the radiation still present some hours later. The effects of the storm are believed to have been felt on earth for about 18-hrs.

Anderson originally had hoped for 50 and 100-hour long flights at 108,000 ft. The telemetering equipment worked only 30 hours at that height, however, because −60 degree temperatures froze the battery packs after the sun dropped below the horizon.

Crystal scintillators were used instead of geiger counters in the radiation-detection package. The other measuring devices were an ion chamber and a counter-telescope which determine the properties of the particles.

Circuit Evens Scope Brightness

By **J. K. GOODWIN** East Leake, N. Loughborough, Leics, England

PHOTOGRAPHING oscilloscope presentations can be aided with a relatively simple circuit. It is a separate unit from the oscilloscope and may be used with most general purpose oscilloscopes.

When a low-level signal and high-voltage pulses are displayed on a cathode-ray tube, the low-level signal appears to be very much brighter than the high-voltage pulses. This is because of the increase in scanning area and velocity of the spot during the period of the high-voltage pulses.

When attempting to photograph such a display, the low-voltage signal is overexposed and the high-voltage signal is underexposed.

The circuit compensates the difference in brightness automatically and produces a trace that decreases bias on the cathode of the cathode-ray tube as amplitude increases.

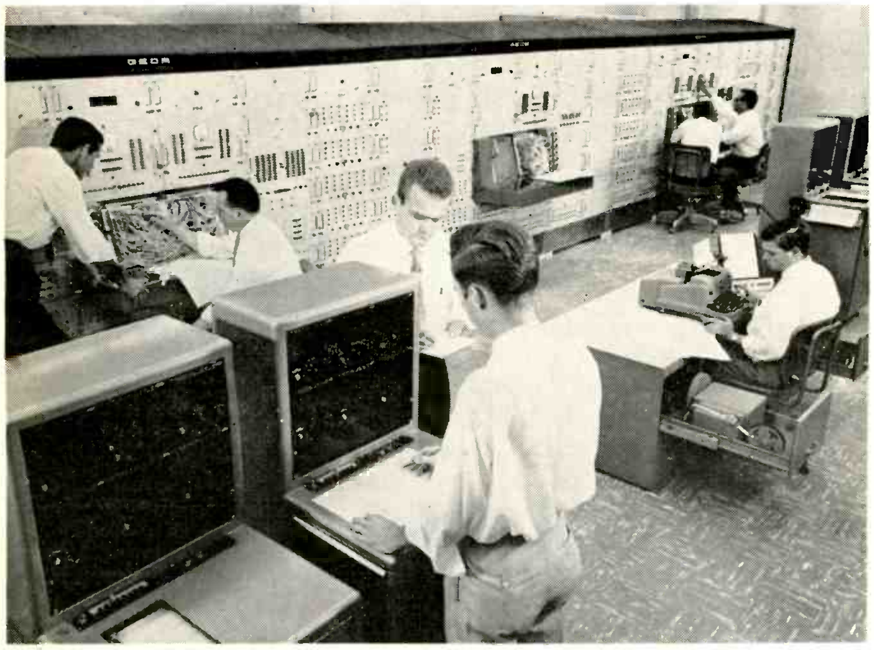
Amplifier V_1 in Fig. 1 has a gain of about ten. It is coupled to V_2, a conventional phase splitter feeding diodes V_3 and V_4. The diodes are connected as a full-wave rectifier. If a sine wave is applied to the circuit, output will consist of the original positive half of the wave followed by the negative half which has been inverted.

Inverting the negative part of the waveform is necessary to ensure that brightening is uniform and not confined to one or other half of the displayed signal.

Pentode V_5 amplifies output from diodes V_3 and V_4 to about 75 volts without distortion. Gain is stabilized by a small amount of negative feedback.

Diode clamp V_6 limits output to ±50 volts, so that the cathode-ray

Computer Speeds Missile Design



Forty-ft analog computer was installed at Martin's guided missile and electronics center, Orlando, Fla. Five-ton system built by Goodyear Aircraft permits electronic simulation of missile and aircraft flight long before prototype has been built

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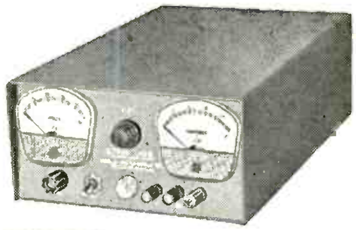
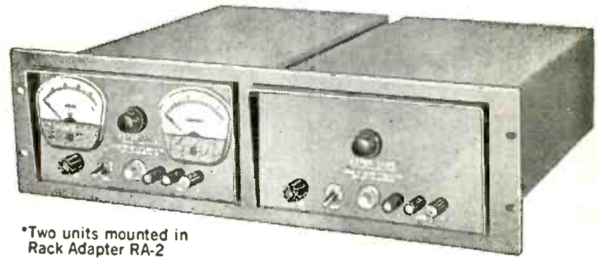
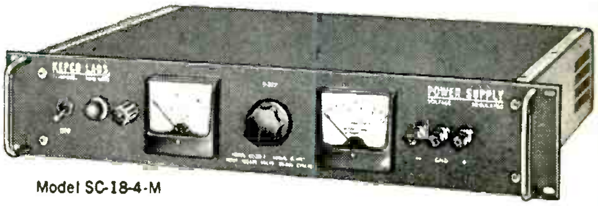


Model SC-18-2-M



*Two units mounted in Rack Adapter RA-2



Model SC-18-4-M

* VOLTAGE REGULATED POWER SUPPLIES

MODEL	OUTPUT VOLTS DC	OUTPUT AMPERES DC	OUTPUT IMPEDANCE DC-1KC	OUTPUT IMPEDANCE 1KC-100KC	SIZE W	SIZE H	SIZE D
SC-18-0.5	0-18	0-0.5	.04	.4	8¼"	4 5/32"	13⅝"
SC-18-1	0-18	0-1	.02	.2	8¼"	4 5/32"	13⅝"
SC-18-2	0-18	0-2	.01	.1	8¼"	4 5/32"	13⅝"
SC-18-4	0-18	0-4	.005	.05	19"	3½"	13"
SC-36-0.5	0-36	0-0.5	.08	.8	8¼"	4 5/32"	13⅝"
SC-36-1	0-36	0-1	.04	.4	8¼"	4 5/32"	13⅝"
SC-36-2	0-36	0-2	.02	.2	19"	3½"	13"
SC-3672-0.5	36-72	0-0.5	.15	1.0	8¼"	4 5/32"	13⅝"
SC-3672-1	36-72	0-1	.08	.8	19"	3½"	13"

Patent Pending

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- **REGULATION:** 0.1% for line changes 105-125 volts at any output voltage in the range minimum to maximum.

  0.1% or 0.003 volt for load changes 0 to maximum (whichever is greater) at any output voltage in the range minimum to maximum.
- **RIPPLE:** 1 mv. RMS.
- **RECOVERY TIME:** 50 microseconds.
- **STABILITY:** (for 8 hours) 0.1% or 0.003 volt (whichever is greater).
- **AMBIENT OPERATING TEMPERATURE:** 50°C maximum. Over-temperature protection provided. Unit turns off when over-temperature occurs. Power-on-off switch on front panel resets unit.
- **TEMPERATURE COEFFICIENT:** Output voltage changes less than 0.05% per °C.
- **SHORT CIRCUIT PROTECTION:** No fuses, circuit breakers or relays! Designed to operate continuously into a short circuit. Returns instantly to operating voltage when overload is removed. Ideal for lighting lamps and charging capacitive loads.
- **OVER-CURRENT CONTROL:** Can be set from 0 to 120% of full load. Current is limited to preset value for any load including short circuit.

- **REMOTE PROGRAMMING** at 1000 ohms per volt is provided. Remote programming allows mounting a voltage control at a remote point.
- **REMOTE ERROR SIGNAL SENSING** is provided to maintain stated regulation directly at load.
- **CONSTANT CURRENT OPERATION:** These units can be set up for constant current operation without internal modification.
- **POWER REQUIREMENTS:** 105-125 volts, 50-65 cycles. 400 cycle units available.
- **OUTPUT TERMINATIONS:** DC terminals are clearly marked on the front panel. All terminals are isolated from the chassis. Either positive or negative terminal of each DC output may be grounded. A terminal is provided for connecting to the chassis. The DC terminals, the remote programming terminals and the remote error signal sensing terminals are brought out at the rear of the unit.
- **CONTROLS:** Power-on-off switch, one turn voltage control, on front panel. Over-current control on rear of unit. Ten turn voltage control available on special order.
- Continuously Variable Output Voltage. No voltage switching.
- Suitable for square wave pulsed loading.
- Either positive or negative can be grounded.
- Units can be series connected.
- High efficiency
- Low heat dissipation.
- Compact, light weight
- For bench or rack use.
- Color: Gray hammertone. (Special finishes available).

ORDERING INFORMATION:

Units without meters use model numbers indicated in table. To include meters add M to the Model No. (e.g. SC-18-1-M).

*Rack adapter for mounting any two 8¼" x 4 5/32" units is available. Model No. RA2 is 5¼" high 19" wide.

*Rack adapter for mounting any one 8¼" x 4 5/32" unit is available. Model No. RA3 is 5¼" high 19" wide.

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tube is not damaged by excessively high cathode voltage.

To photograph displays of pulses that have fast rise and decay times, it is necessary to differentiate the input waveform slightly so that only the edges are brightened.

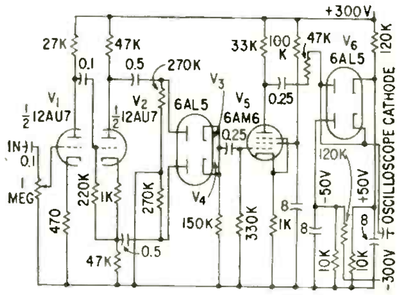


FIG. 1—Amplitude of signal to be displayed controls scope brightness by controlling voltage on cathode of cathode-ray tube

The circuit is set up by applying the input to the oscilloscope and to the brightening circuit. The display is set to its correct amplitude, and the brightening control is used to produce an evenly bright display. Some balance is required between the brightening control and the brilliance control of the oscilloscope.

Although this method gives a good approximate setting, it may be necessary to make small adjustments when the first section of film has been developed.

Magnetic Amplifiers Aid D-C Measurement

By M. H. GOOSEY, JR. and A. C. LAPSLEY

Savannah River Lab, E. I. du Pont de Nemours and Co., Aiken, South Carolina

FREQUENTLY need arises for measuring small direct currents in a circuit at high voltage with respect to ground. It is often necessary to isolate the high voltage from a second circuit that measures current.

A simple and reliable method was devised to make such measurements using a magnetic amplifier. The amplifier also amplifies the d-c current.

In one application, the method was used to measure current from an ion chamber. The circuit, shown in Fig. 1, measures currents in the

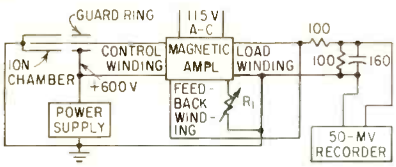


FIG. 1—Magnetic amplifier isolates high voltage from recorder measuring small direct currents

range from zero to 5 μa.

Voltage for the ion chamber is applied through the control winding, so that it operates at chamber voltage. The feedback winding controls gain and increases stability.

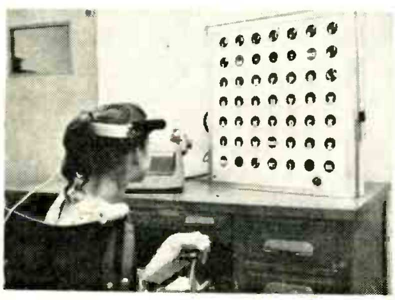
Resistor R_1 controls coupling between the feedback and load windings. Linearity of the amplifier is also affected by R_1. With R_1 equal to 268 ohms, output is linear to ± 0.5 percent of full scale.

In initial tests, 1,200 volts was applied to the control winding of the magnetic amplifier without voltage breakdown. The circuit has performed satisfactorily under continuous operation with 600 volts applied to the control winding.

In another application, the anode current of a multiplier phototube was indicated directly on a millivolt recorder. Anode current was passed through the control winding and the load winding was coupled to the recorder.

Input current of one μa produced a full-scale recording on a 2-mv recorder. Currents as low as 10^{-8} amp were measured using a battery-operated electrometer between multiplier phototube and amplifier.

Photocells Enable Paraplegics to Type



Photoelectric cell panel board enables paraplegics to operate typewriter at speed approaching 30 words a minute. Device was developed by Dr. Alan Ziskind, Boston University School of Medicine, and Richard Ziskind.

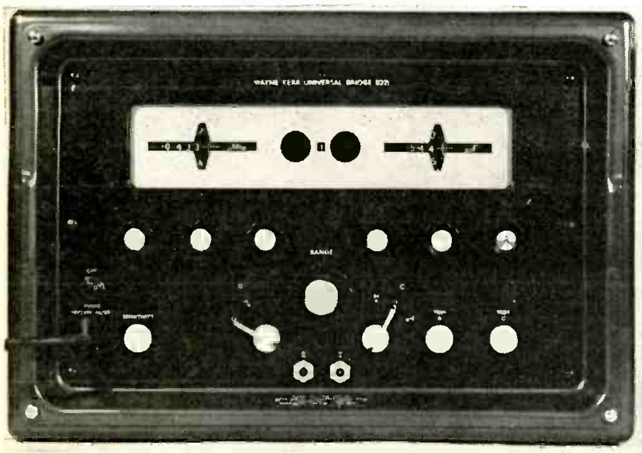


FIG. 1—Front-panel view of universal bridge showing how dial mechanism places decimal point

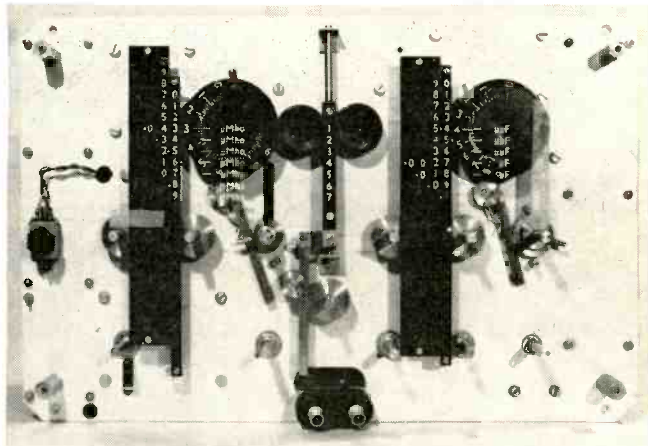


FIG. 2—Center rack and pinion move Plexiglas into position to select desired impedance range

Bridge Features Automatic Dial

IN DEVELOPMENT of a transformer ratio arm bridge, Wayne Kerr Co., Ltd., of Chessington, Surrey, England, found that a new dial mechanism would be necessary to cope with the range of measurement of the instrument. Conventional methods using skirted dials with numerous ranges and multiplier factors were too cumbersome.

An automatic dial mechanism was designed with the following optimum design criteria: Eliminate multiplying factors. Eliminate a large calibrated dial scale. Provide an automatic, numerical display of two measured variables, both resistive and reactive, with a minimum of manipulation. And, in any measurement, provide a minimum of four significant figures in discrimination of final balance.

Design Features

Multiplying factors were eliminated by having the range switch place the decimal location in the two apertures as shown in Fig. 1. By rotation of the range switch, the center rack and pinion shown in Fig. 2, move the large, clear Plexiglas into position to select the desired range of impedance. The range switch is connected to the transformer tappings by a rotary step switch, as shown in Fig. 3.

Human error is obviated by automatic placing of the decimal and the units of measurement. Integers are placed in the apertures by revolving the six fluted knobs on either side of the range switch. Two knobs are for decade switching and one for vernier adjustment for each variable. By rotating the decade switches, the black engraved plates are moved into position by the rack and pinion mechanisms. Decade knobs are marked from 0 to + which represents the number 10 to allow for range overlap. Decades are connected to the standards and transformer tappings by rotary step switches.

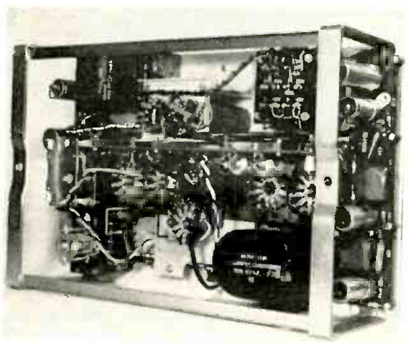


FIG. 3—Range switch is connected to transformer tappings by rotary step switch shown in center

The large dial scale is eliminated by this technique. A direct reading is provided that automatically inserts the integers, decimal location and units of measurement in the apertures.

By full use of the two decades and one variable, the discrimination of final balance to four significant figures can be obtained readily.

Standards employed are resistive and capacitive. By positioning the two winged selector switches, shown in Fig. 1, the sense of the connections of the standards to the transformer are reversed. This action provides for measurement of an impedance in any quadrant of the complex plane. Also, one switch provides for the shifting of the effective impedance of one standard with respect to the other. In effect, the capacitance is shifted by a factor of 0.1 by moving the connection to the transformer to another tapping to accomplish a 10:100 shift in transformer turns.

The instrument is distributed in the United States by Wayne Kerr Corp., Philadelphia, Pa.

Four-Conductor Stretch Cable

INERTIA LOADS of 800 G's are withstood by Stretch Wire Corp.'s SWA-4 four-conductor cable. Designed for use on any requirement of 50 w or less, the cable shown in the accompanying illustration has an easy extension factor of 200 percent and return.

Individual conductors will take over 500,000 cycles in a flexing test without breakdown. Electrical characteristics are: resistance, 0.55

New accessory permits Genisco C181 Rate of Turn Table to be operated at any angle from horizontal to vertical

Fred Davenport, Lockheed radio-radar technician, tests pitch-yaw gyros used in the *Electra*, Lockheed's fast, new prop-jet, on the first *tiltable* Genisco C181 Rate of Turn Table.

A new, vertical-drive accessory permits the C181 to operate in *any* position. Now, gyros or complete gyro packages can be tested at any angle up to 90° from horizontal, either side of center, without changing the test set-up.

With the accessory installed, overall performance of the turntable is unaffected by its position. Rotation is infinitely variable from 0.01° to 1200° per second. Constancy of angular velocity is within 0.1%, including wow and drift errors.

The new vertical drive accessory can be installed at the factory, and is also available in kit form for modification by users of machines already in the field. The new tilt stand (shown above) provides a convenient method of tilting and accurately positioning the machine at any angle.

Detailed information on both the vertical drive accessory and tilt stand is available and will be sent upon request.

More than 400 Genisco Rate of Turn Tables are now in use.

ACCESSORIES ADD TO ACCURACY AND CONVENIENCE OF THE C181

Braking System—Generates a step impulse of angular deceleration. Particularly useful in evaluating damping characteristics of rate gyros and angular accelerometers.

Precision Strobe—For use in monitoring rates where line frequency is questionable or where gyro accuracy is better than line frequency.

Slip Clutch—Allows table to be stopped by hand for minor adjustments to test package while drive system continues to operate.

Low Rate Readout—For accurate rate indication below 10°/sec.

Mounting Stands—Available in portable, fixed and the new tilt models.

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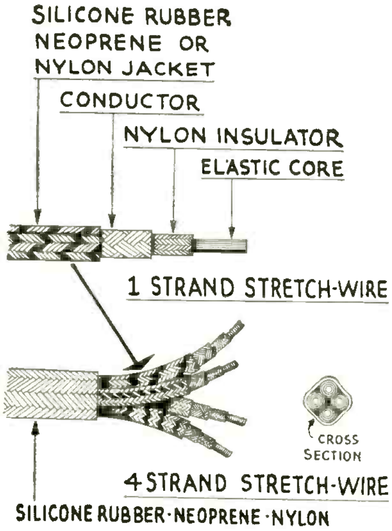

ohm per conductor per relaxed foot —0.18 ohm extended; inductance, 0.30 μhy; capacitance, 44 $\mu\mu$f per relaxed foot and insulation between conductors will withstand 900 v.

The New Rochelle, N. Y. firm also has in production one-, two- and three-conductor constructions. Terminations are available in spade, round, flag or as required.

New Synchro Design Makes Accurate Units

NEW MIL SPEC S-20708 spells out greater accuracies for 60- and 400-cps synchros than the specs it supersedes. But at least one manufacturer is in production with units of greater accuracies than called for by the new spec. The firm is the Ketay Department of the Norden Division of United Aircraft Corp. in Commack, L. I. The design technique used is known as Thru-Bore construction.

Five-Minute Accuracy

Mr. Bernard Levine, General Manager of Ketay states, "This new concept of design will enable the users of synchros, primarily the military, to completely revise current specifications with regard to accuracy. There are now available synchros with accuracies of better than five minutes and less on normal production runs—35 to 50 percent more accurate than the newest Navy specifications, thereby giving system designers a new availability of accuracy and reliability. This Thru-Bore construction

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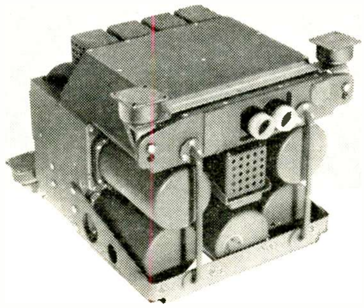
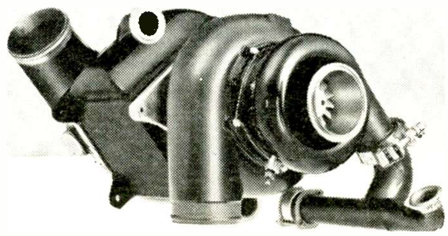
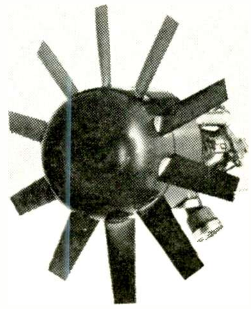
The A3J "Vigilante," equipped with vital AiResearch subsystems



Centralized Air Data Computing System



Refrigeration Package



Ram Air Turbine

North American Aviation's twin-jet A3J "Vigilante" is the Navy's newest attack weapon system . . . an all-weather, carrier-based, 30,000 lb. thrust aircraft which delivers both conventional and nuclear weapons from high or low altitudes at supersonic speeds.

Contributing to the success of the first aircraft produced under the Navy's weapon system management concept is the following AiResearch equipment:

AiResearch Centralized Air Data Computing System provides information for the major flight data subsystems dealing with bombing, navigation, engine inlet control, radar, automatic flight control and includes cockpit indicators showing true air speed, altitude and engine inlet air temperature.

AiResearch Environmental System Components for personnel and compartment air conditioning and pressurization include: cabin pressure regulators, safety valves, cabin refrigeration package, equipment compartment refrigeration package, primary heat exchangers, pressure suit heat exchangers and water-alcohol tanks for evaporative cooling.

AiResearch Ram Air Turbines provide power for operation of surface controls, instrumentation and landing gear in case of emergencies. Also included are miscellaneous valves and electro-mechanical equipment.

Systems engineering, support services and systems management have enabled AiResearch to integrate these vital subsystems into North American's A3J.

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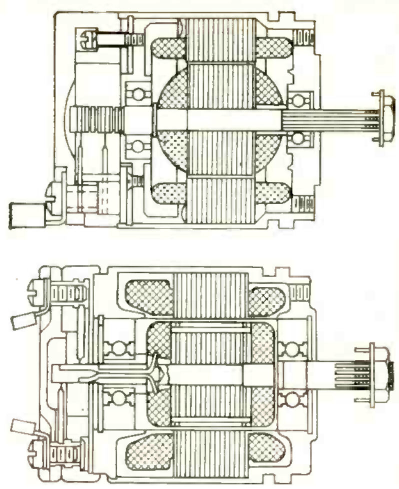


FIG. 1—Simplified cross-section of old synchro (above) and new (below)

is providing greater stability over a broad temperature range coupled with increased ruggedness."

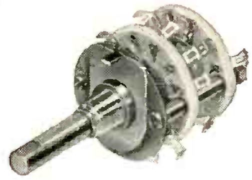
Error Sources

Reference to the simplified cross-sectional views of new and old Mil units manufactured by Ketay in Fig. 1 will aid in understanding the means by which the increased accuracies come about. In the old type, the primary factor contributing to error is nonuniformity of the air gap between rotor and stator. A second source of error is possible nonconcentricity between the bearings and bearing seats, between the rotor and rotor seat and of the stator itself. Still another error source is out-of-round conditions after assembly.

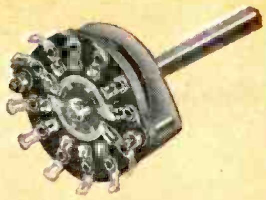
In the new-style units, there is only one machining operation with a resultant decrease in error possibilities. In addition, use of a special potting compound aids in preventing troubles arising from shock, temperature and humidity.

Because of the increased accuracy of the new construction, a synchro one or more sizes smaller than that previously required can often be used. Even though stainless-steel housings are used for all new units to avoid clamping problems and to match the temperature coefficient of expansion of the stack, weight reduction results from the ability to use smaller sized units

With the new synchros, single-speed system accuracy, in many cases, is as good as that of two-speed systems with the older types.



Type F: Miniature 12-position, 30-60° throw, can be mounted in 1-5/16" circle; phenolic, Mycalex or steatite.

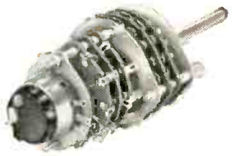


Type H: Standard 12-position; 1-7/8" diameter; 15-30-60° throw; phenolic, Mycalex or steatite.

Types J, K, N: 1-17/32" diameter; provides for flexibility of layout; interchangeable sections, phenolic or steatite.

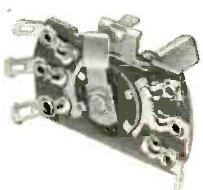
Type L or DL: Using dual eyelet fastening; 18-position; mounts in 2-9/32" circle, phenolic, Mycalex.

Special Switches

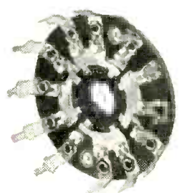


Multiple Shafts combined to operate snap switches and potentiometers; many different section types.

Type MF: 24-position switch may be mounted in 2-5/16" circle; in phenolic insulation.



Series 20: Simple switch for tone controls, band switching, and talk-listen circuits.



For Printed Circuits: Special lug design for insertion into printed circuit boards.

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● No matter what you need in low-current switches, you are most sure to find it in an OAK switch design. In the last 25 years, OAK has produced over a quarter billion switches—rotary, slider, pushbutton, plug, and door switches—in thousands of variations. Why not take advantage of OAK's unmatched, switch engineering background . . . production facilities . . . and huge inventory of tooling?

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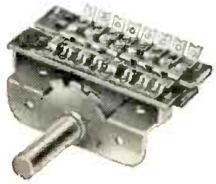
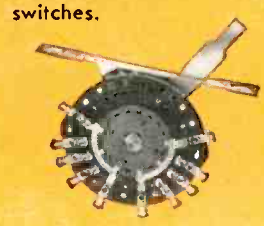
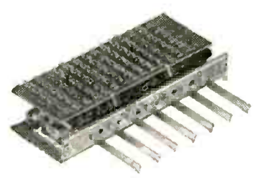
Type 160 Rotary Slider: 7/8" height allows shallow chassis; leads are readily accessible.



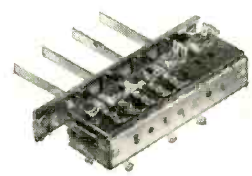
Type 185: New lever-operated version of the standard Oak rotary switches.



Type 130 Pushbutton: Available with from one to 24 buttons, 32 contacts each button.



Type 80 Pushbutton: Very adaptable. Used in communication equipment; economical for less complex applications.



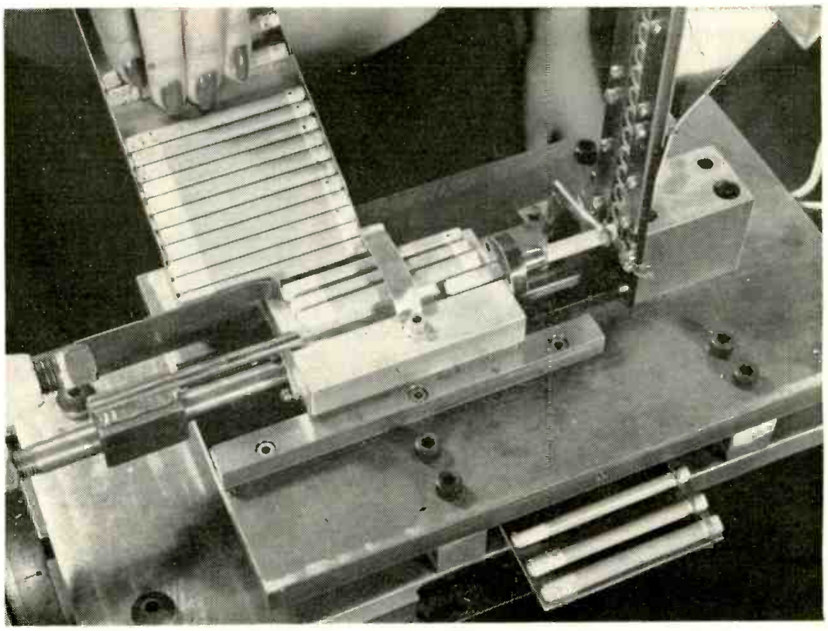
Shaper Ram Drives Core Swager

By M. MASTIN, Packard-Bell Electronic Corp., Los Angeles, Calif.

INSTALLATION of silver washers on delay line ceramic cores improves electrical contact and provides physical support when the washers are soldered to the header's coil mounting plate.

A machine fixture has been devised which positions and swages the washer on the core 15 times faster than hand operations permit. The swaging device can be mounted on any standard shaper. After the desired number of cores has been modified, the device can be dismantled and the shaper returned to normal use. The setup shown was mounted on a 20-year-old 8-inch shaper which had been sitting idle.

The swaging device consists of 5 principal parts: an adjustable positioning rod which is driven by the shaper ram and which alternately drives and retracts a sliding V-block, a swaging anvil, unloading stop and swaging punch. The unloading stop is pivoted to swing forward under pressure from the swaging punch. The anvil is fixed.



Washer has been swaged on core at right center. When V-block is fully retracted, core will drop into unloading chute

Parts Loading

Initially, both cores and washers are loaded into chutes. As each washer drops into swaging position, it is stopped and held in front of the hole in the anvil. The washers are held by 2 very light pressure hinges. The cores are guided into the V-block's groove by strip metal fingers on the block.

When at the back of its travel, the adjustable positioning rod retracts the block, dropping a core into the grove. At the beginning of its advance, the rod moves the core through the punch. After engaging the block, the rod drives the core through the washer. Pressure from the punch reduces the inside diameter of the washer in 6 places, swaging it to the core.

As the positioning rod retracts and drags the block back, the unloading stop prevents the core from following. Inside the anvil hole is a spring-loaded ejection rod which forces the core past the washer holders. The core drops through a slot into the unloading chute. A new core has now entered the block.

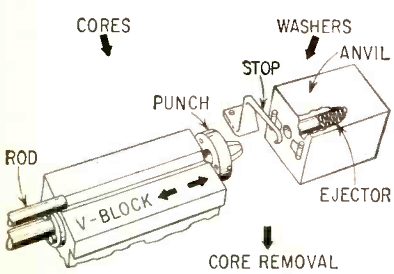


Diagram of relative position and motion of swager parts

Air Eases Operator's Workload

COMPRESSED AIR cylinders are frequently used at Westinghouse Electric Corp.'s Tv-Radio Division, Metuchen, N. J., to give women the added muscle required in some assembly line operations.

Operator fatigue was encountered when ordinary clippers were used to snip the ends of component leads in printed wiring boards. Manufacturing engineers rigged the clippers with an air cylinder so the operator need only press a trigger. Clipping rate is 2 per second.

Chain, spring mechanize clippers

The clippers are bolted at the hinge to a supporting frame. Bicycle chain is strung between the ends of the handles and the plunger of a small air cylinder is fastened to the center of the chain. A small

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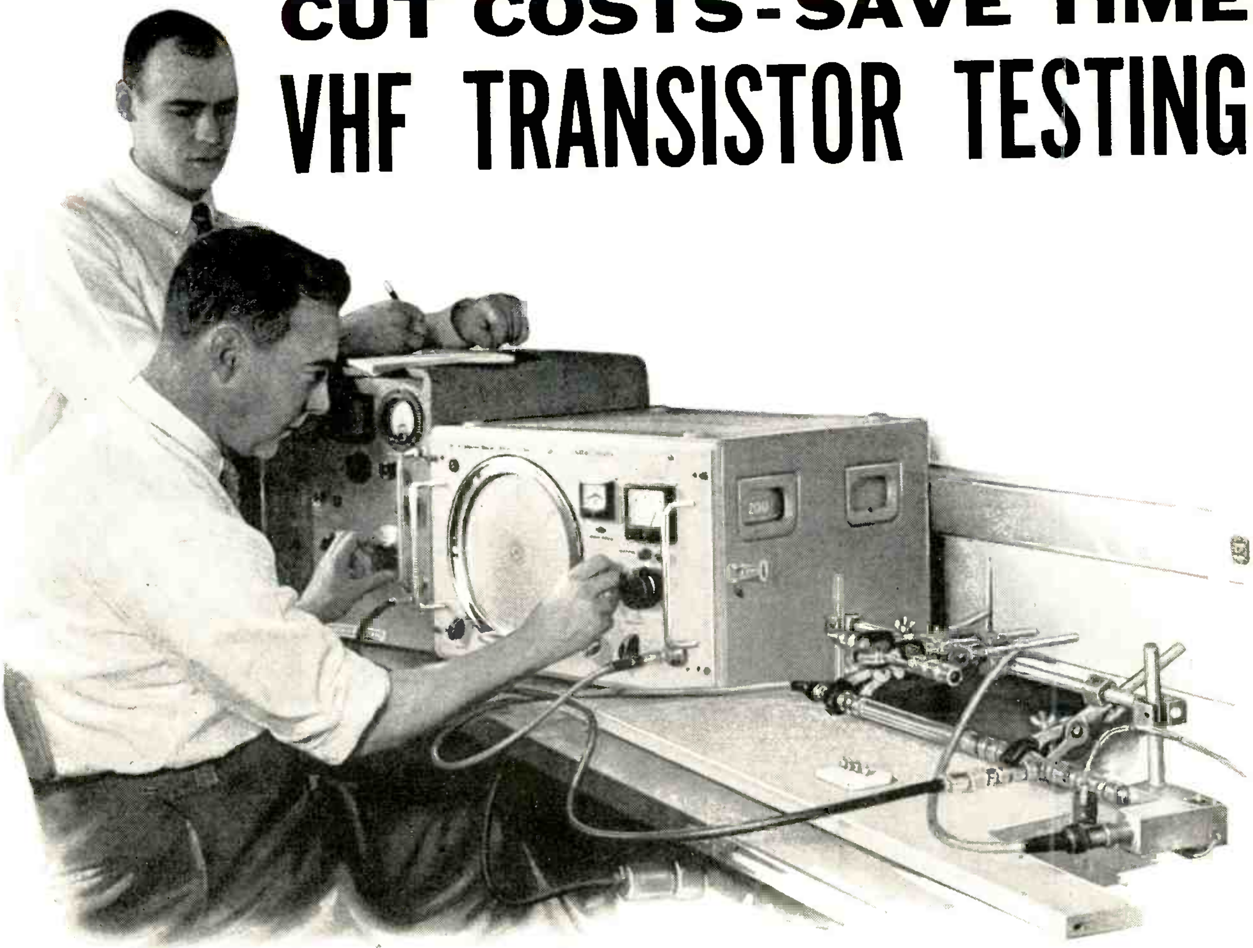

Engineers at Bell Telephone Laboratories measure transistor characteristics. From left, equipment includes signal generator, Federal's Diagraph and special coaxial jig set-up.

Eliminate Costly Adjustments, Calibrations and Conversions . . .

Leading transistor developers and manufacturers save valuable engineering time with the Federal Diagraph*. Complex reflection coefficients, immittance and other transmission characteristics are measured by simple adjustments of three controls. No recalibrating is needed to measure at different frequencies across the band. Set-up time is cut to a minimum . . . complex calculations and conversion tables eliminated. Data are read directly from any of five interchangeable charts suitable for filing or reproduction.

Save supervision time . . . technicians can operate the Federal Diagraph with greater accuracy due to the inherent simplicity of measurement and the built-in "self-checking" system.

* Manufactured by Rohde & Schwarz

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For high-frequency transistor testing as well as general two and four terminal measurements on coaxial systems—production or laboratory—routine or development—get greater flexibility and efficiency over a longer period of time with the Federal Diagraph.

Write for additional application data.** Live demonstrations of the Diagraph are available by special request on company letterhead.

SPECIFICATIONS

TWO MODELS IN STOCK: FT-ZDU 30 to 300 mc; FT-ZDD 300 to 2400 mc.
CHARACTERISTIC IMPEDANCE: 50 ohms.
MEASURING RANGE: Impedance . . . 1 to 2500 ohms; Phase . . . 0 to 360°; Attenuation . . . 0 to 30 db.
ACCURACY: Amplitude . . ±3%; Phase ±1.5°.
TERMINALS: Type N.
POWER SUPPLY: 115 volts (or 220 volts), 50 to 60 cycles.
DIMENSIONS: 22" x 14" x 19".
WEIGHT: 135 pounds.

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Cylinder shoulders weight of chassis

coil spring snaps the handles apart after each snip.

Another air cylinder is used to lift assembled television chassis so they can be placed in cabinets for final assembly and test. There is not enough room to mount the cylinder vertically, so it is mounted horizontally, using pulley wheels on either side of the cylinder to translate horizontal motion into vertical motion.

Fastening the completed chassis in position in the cabinet is also air-assisted. The cylinder is placed on the roller conveyor line at a section hinged to swing up away from the operator.

The operator first positions the cabinet, which has been preassembled to the paperboard shipping pallet. She pushes twin buttons to upend the chassis, fastens cabinet

Air tilts conveyor, drives screws

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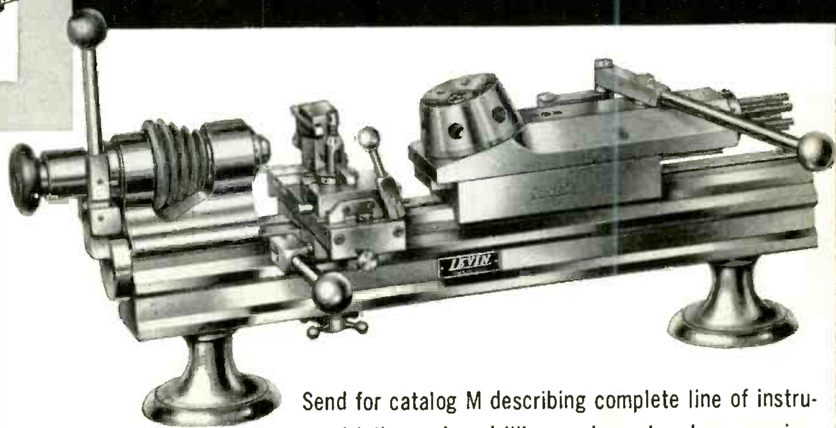

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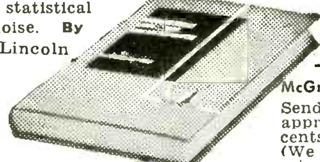

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For price and terms outside U.S., write McGraw-Hill Int'l., N. Y. C. FL-12-19 and chassis with self-tapping screws and an air-driven screwdriver, releases a safety catch and presses a return button. The assembly is shoved to the next station when the conveyor sections line up.

The tote tray holding small parts for the operation hangs free beneath the tilt section of the conveyor. The pallet is cut away to accommodate the screwdriver. Conveyor rollers are replaced with skate wheels. While tilted, the cabinet rests on padded uprights which tilt with the conveyor section.

Refrigerant in Coils Dries Vacuum Coater

HUMIDITY LESSENS efficiency of vacuum metallizing equipment and other vacuum production equipment, particularly in warm climates. Water vapor imposes an extra load on the diffusion pumping system.

Best way to remove this moisture from equipment and work pieces, according to F. J. Stokes Corp., Philadelphia, Pa., is with a refrigerated cold trap which condenses the vapor to ice before it reaches the pumping system.

The firm has mechanically refrigerated cold traps which consist of a cooling coil in an adapter flange for mounting between the diffusion pump and the high vacuum valve. A compact compressor supplies refrigerant to the coil, keeping its temperature at −115 F or lower.

The location of the coil isolates it from atmospheric and roughing pressure, minimizing ice buildup. It also isolates it from the metallizing heat. Ice is removed by recycling hot gas from the compressor.

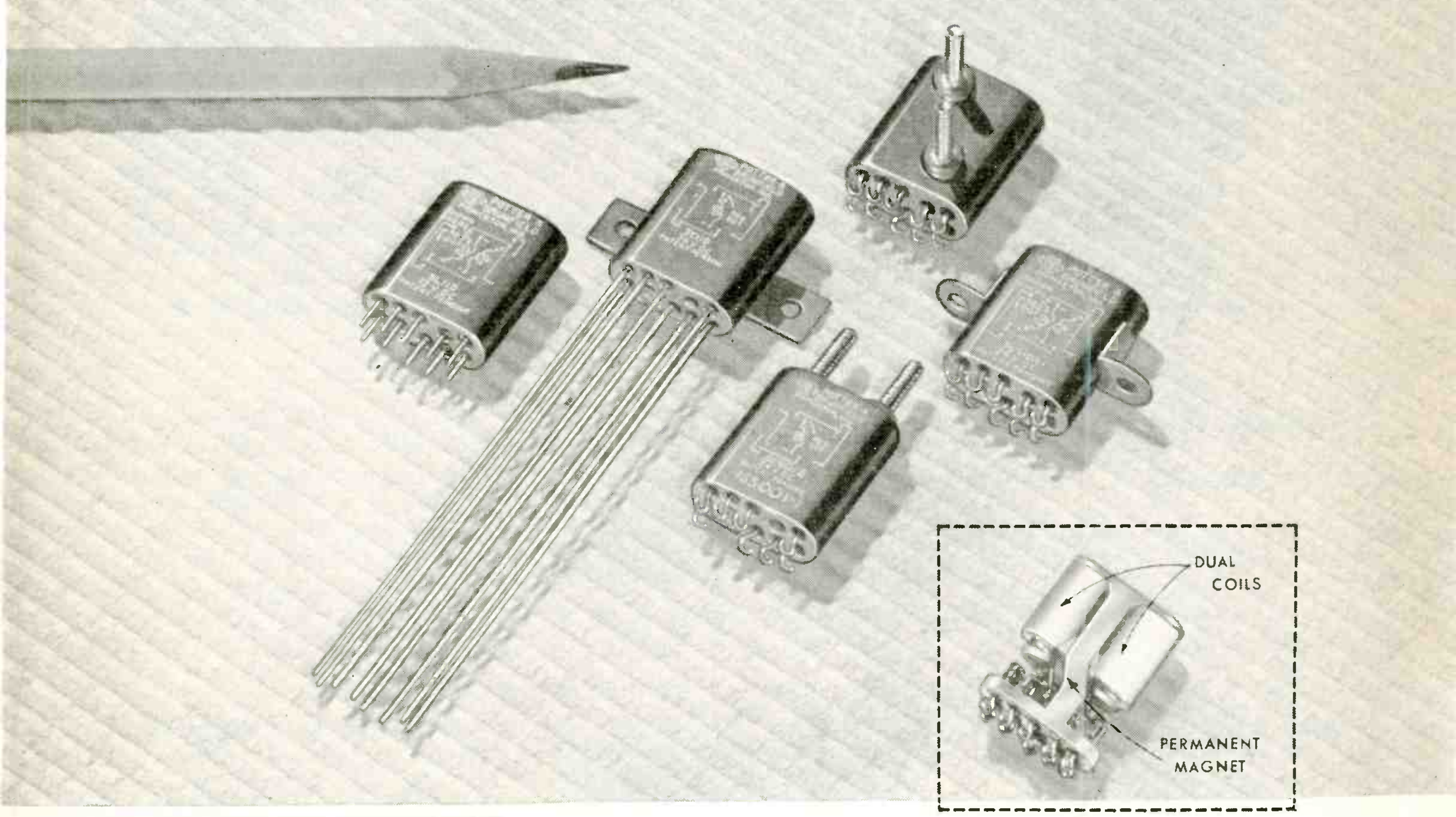
Fluorescent Epoxies Show Voids in Coat

FLUORESCENT EPOXY bonding, coating and potting compounds by Carl H. Biggs Co., Los Angeles, Calif., contain a built-in method of testing for skips and voids. The voids show up as dark areas when the plastic is viewed under black light after application.

P&B MICRO-MINIATURE RELAYS LEAD IN

performance

SHOCK: 100g* VIBRATION: 30g to 2000 cps*

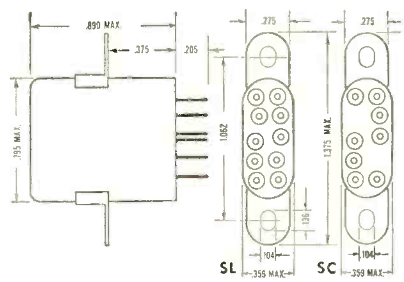


*NO CONTACT OPENING

New P&B crystal-case size relays, the SC and the SL (magnetic latching), show amazing shock and vibration capabilities. They absorb shocks of 100g and vibrations 30g to 2000 cps. without contact openings!

A highly efficient magnetic structure utilizing a permanent magnet makes possible at least twice the contact pressure found in DPDT relays of comparable size. One watt of power for three milliseconds operates either relay. Transfer time is unusually fast —0.5 milliseconds maximum.

For more information, contact your P&B sales engineer, or write Potter & Brumfield, Princeton, Indiana.



SL—dual coil latching relay. Operates on a 230 mw, 3 ms. pulse at 25° C. Permanent magnet latch locks the armature in either position.

SC—non-latching relay with series-connected dual coils. Operates on approximately 260 mw at 25° C. Coils must remain energized to hold the armature in the operate position.

SC and SL Series Engineering Data

GENERAL:
Insulation Resistance: 10,000 megohms, min.
Breakdown Voltage: 1,000 V. RMS.
Shock: 100g for 11ms.
Vibration: 30g 55 to 2000 cps.; 0.195" max. excursions from 10-55 cps.
Temperature Range: —65° C. to + 125° C.
Weight: 15 grams without mounting bracket.
Operate Time: 3 MS. max. with 550 ohm coil @ 24 V. DC. (SL: 630 ohm coil at 24 V. DC).
Transfer Time: 0.5 MS max.
Terminals: (1) Plug-in for microminiature receptacle of printed circuit board.
(2) Hook end solder for 2 #24 AWG wires.
(3) 3" flexible leads.
Enclosure: Hermetically sealed.

CONTACTS:
Arrangement: 2 Form C.
Load: 2 amps @ 28 V. DC, resistive; 1 amp @ 115 V. 60 cycles AC, resistive.
Pressure: SC—16 grams min.; SL—20 grams min.

COIL:
Power: SL—230 mw @ 25° C.
SC—260 mw @ 25° C.
Resistance: SL—10,000 ohms per coil max.
SC—20,000 ohms max.
Duty: Continuous.

MOUNTINGS:
Bracket, stud and plug-in.

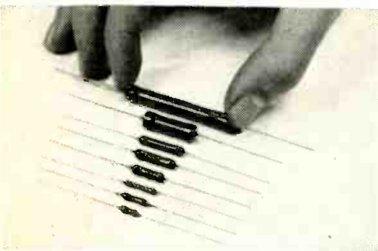
P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD INC.

PRINCETON, INDIANA · SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

CIRCLE 70 READERS SERVICE CARD

NEW PRODUCTS



Insulated Resistors

subminiature

DALE PRODUCTS, INC., Box 136, Columbus, Neb., announces deposited carbon film resistors that are fully insulated and yet maintain subminiature size. Type DCF resistors are coated with a new compound which offers outstanding durability under mechanical shock and provides extreme stability. The new series has eight sizes, ranging from 7/64 by 5/16 in. to 5/16 by 2 1/16 in.; with a selection of five wattage ratings, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, 1 and 2 w. Resistance range is from 1 ohm to 50 megohms, depending on size and type. Standard tolerance is 1 percent. **Circle 300 on Reader Service Card.**

Silicon Rectifiers

epoxy encapsulated

TEXAS INSTRUMENTS INC., 6000 Lemmon Ave., Dallas 9, Texas, announces a new series of low cost diffused silicon rectifiers. Featuring an average rectifier forward current of 750 ma, the units are packaged in a nylon-cased epoxy capsule and pass MIL-STD-202A immersion tests. This shell provides an insulated case with minimum lead-to-case insulation resistance of 10^{10} ohms at 600 v. Typed as the 1N2069, 1N2070, and 1N2071, the three silicon rectifiers have peak inverse voltages of 200, 400 and 600 v, respectively. They also highlight a six-ampere recurrent peak current and a surge (turn-on) current over 32 amperes for one millisecond. **Circle 301 on Reader Service Card.**

Voltage Quantizer

transistorized

HOOVER ELECTRONICS CO., 110 W. Timonium Rd., Timonium, Md. Vernitel, a new instrumentation technique, may be added to existing f-m/f-m transmission systems to

give them the accuracy of pcm. It consists of a special quantizer and differential amplifier which continuously separates an input voltage into 16 discrete levels and provides a vernier or residue voltage representing the analog scale between quantized increments. Each of these voltages is used to control a standard f-m subcarrier oscillator. **Circle 302 on Reader Service Card.**

H-V Capacitors

low inductance

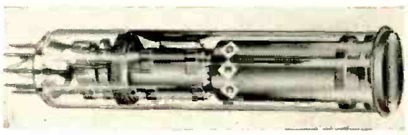
AXEL ELECTRONICS DIVISION, Axel Bros., Inc., 134-20 Jamaica Ave., Jamaica, N. Y., has available a line of tubular capacitors with low inductance for h-v service. The low-

cost energy storage capacitors are designed for fast discharge applications requiring high peak energy within a short time constant. They feature precision-rolled aluminum foil electrodes separated by polyester film dielectric. Assembled electrodes are held in a hermetically sealed, liquid-filled phenolic case, and are electrically connected to the metal end caps. **Circle 303 on Reader Service Card.**

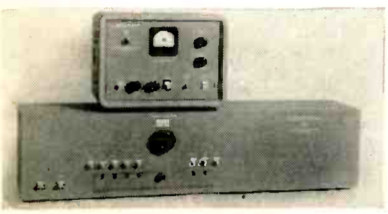
Ruggedized Vidicon

short length

GENERAL ELECTRODYNAMICS CORP., Garland, Texas. The 7226A vidicons feature 150 ma heaters, 5.150 in. overall length, increased sensitivity and improved persistence characteristics. The nonmicrophonic camera pickup tube is built to exceed the requirements of MIL-E-5272A. It will give quiescent picture quality under severe noise, vibration and shock conditions. The GEC particle shield permits the operation of these tv camera pickup tubes in any position with-



out damage to the photoconductive surface, even in severe environments. **Circle 304 on Reader Service Card.**

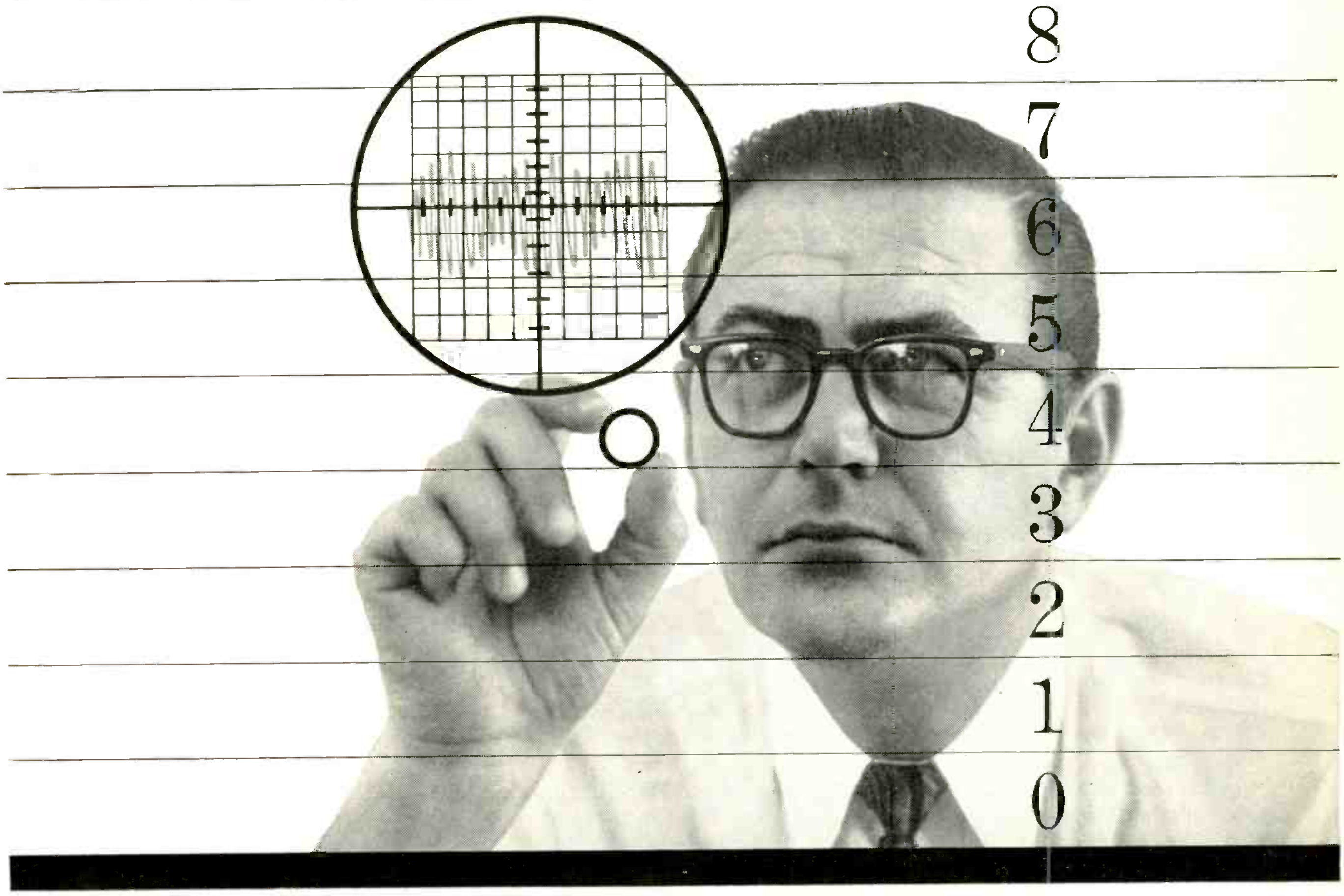


Phase Meter

high frequency

AD-YU ELECTRONICS LAB., INC., 249 Terhune Ave., Passaic, N. J. A new high frequency phase meter can be used from 15 mc up to 500 mc with an accuracy of 0.05 deg or 1 percent of the dial reading. It is especially suitable for measuring phase angle or time delay of radar i-f amplifiers and other h-f transmission systems where phase shift is important for faithful re-

NO ROOM FOR ERROR...AT THE COUNTDOWN...



Linear accelerometer needs no heater jacket–reliability and accuracy from

–65°F TO +200°F

When critical missile and aircraft testing demands an accelerometer of accurate, reliable operation over wide temperature range, specify Statham Model A501.

The remarkable design feature of the Model A501 lies in the use of gas damping. This method of damping permits the operation of the unit over a –65°F to +200°F range without use of a heater jacket. It produces–flat up to 500 cycles per second–reliable signals of rapidly changing acceleration.

Statham instruments are specified by leading manufacturers and government facilities...wherever accuracy, reliability, and superiority are required.

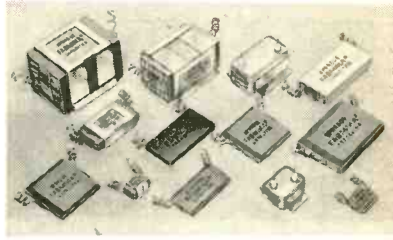
For detailed technical data to answer *your* application needs, write for Bulletin Number A501TC.

Range:	±5 to ±50 g
Excitation:	5 volts DC or AC (rms)
Output:	±20 millivolts
Non-linearity and Hysteresis:	Not more than ±1% full scale
Weight:	6½ ounces

Statham

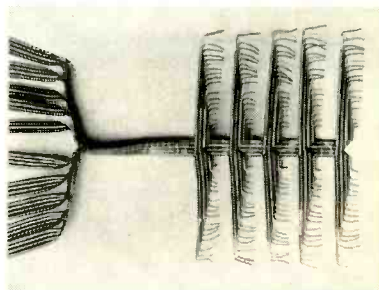
accuracy / integrity / reliability

Statham Instruments, Inc. 12401 West Olympic Boulevard, Los Angeles 64, California production of intelligence. The instrument consists of two parts: a phase indicator unit and a time delay unit. Circle 305 on Reader Service Card.



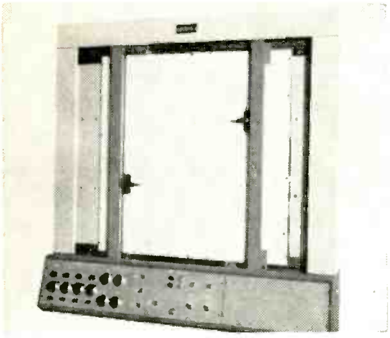
Capacitors
high temperature

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass., introduces its new stacked-foil Fabmika capacitors designed for operation at high temperatures. They rely on a new dielectric for their heat resistant properties. This dielectric consists of especially processed silicone-bonded mica paper. It can function effectively at temperatures up to 260 C, and, in special designs, up to 310 C. Engineering bulletins 1500, 1510, and 1520, giving complete details, are available on letterhead request.



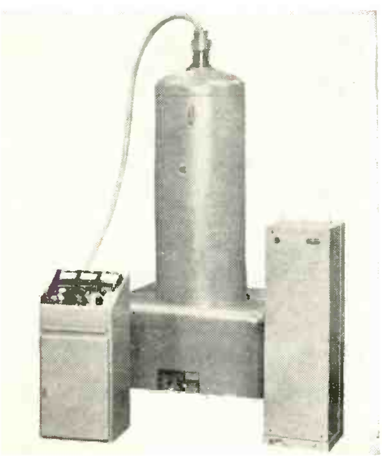
Flat Cable
multiconductor

SPECTRA-STRIP WIRE & CABLE CORP., P. O. Box 415, Garden Grove, Calif. Precision wiring can now be made routine by using Spectra-Strip flat cable. Interconductor capacitance is controlled by the relative position of the wires in the cable, and is uniform from cable to cable. This enables a harness to be engineered for maximum electrical efficiency. Illustrated is a 200-conductor harness and even if one terminal board were completely out of sight, any circuit could be located at the other end immediately by its position in the cable. Circle 306 on Reader Service Card.



X-Y Plotter transistorized

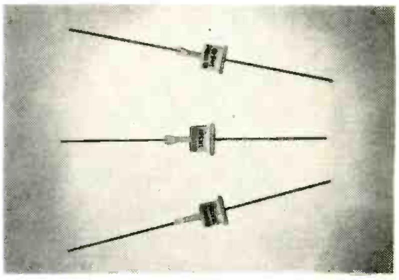
Electronic Associates, Inc., Long Branch, N. J. Model 205 S&T transistorized Variplotter sets new standards of speed and reliability in graphical presentation of analog computer output. The instrument packs great speed, large 30 by 30 in. plotting surface, and high reliability in a small package. Servo motors operating at 400 cps provide high dynamic speed. Coupled with the reduced size and weight (250 lb) are the advantages of flexibility of operating position. It will operate in any position from horizontal to vertical. Circle 307 on Reader Service Card.



H-V Generators electrostatic type

Beta Electric Division of Sorensen & Co., Richards Ave., South

Norwalk, Conn., has available the complete line of Sames electrostatic generators (so-called from their manufacturer, Societe Anonyme de Machines Electrostatiques, Grenoble, France). Available with adjustable outputs of 50, 80, 100, 140, 150, 250, 300 and 600 kv, these power supplies have found wide application in Europe for testing of cable insulation, alternator windings and other dielectrics, flocking, electrostatic painting and precipitation, electron and nuclear particle accelerators and similar applications. **Circle 308 on Reader Service Card.**



Silicon Rectifiers double-diffused

COLUMBUS ELECTRONICS CORP., 1010 Saw Mill River Road, Yonkers, N. Y., has announced double diffusion processed silicon rectifiers in the Jetec series 1N536 through 1N540 and in the Jetec series 1N-2080 through 1N2086. Available in hermetically sealed, axial lead top hat design, the units achieve high rectification efficiency through a combination of low forward drop and low leakage currents. The devices withstand high overload currents. Other features include 500 to 750 ma rectified current and up to 600 peak inverse volts without heat sink. **Circle 309 on Reader Service Card.**

Microminiature Relay hermetically sealed

TELECOMPUTING CORP., 915 N. Citrus Ave., Los Angeles 38, Calif. The TC microminiature relay is designed for applications where size and weight are critical. Life expectancy exceeds 1,000,000 cycles at the full noninductive contact load of 2 amperes, 28 v d-c at 125 C ambient. On dry circuits a minimum of 10,000,000 operations are guaranteed. The relay is hermetically sealed for operation from sea level to 100,000 ft altitude at −65 C to +125 C. Standard 15 g relays and models for vibration loads exceeding 30 g are available. Circle **310 on Reader Service Card.**

Miniature Motor meets MIL-M-8609

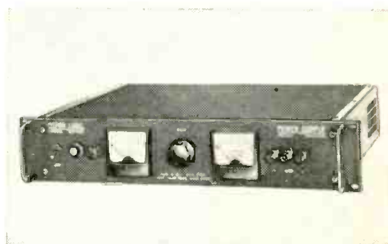
Western Gear Corp., P. O. Box 182, Lynwood, Calif., announces design of a new miniature motor, model 2PP1, rated at 1/100 h-p at 11,000 rpm. It has been qualified to MIL-M-8609 specification. The 26.5 v d-c motor is 1.18 in. in diameter, 1.9 in. long and weighs $3\frac{1}{2}$ oz. Life is 500 hr without change of brushes. **Circle 311 on Reader Service Card.**

Voltage Supplies ultrastable

American Electronic Laboratories, Inc., 121 N. 7th St., Philadelphia 6, Pa., has available ultrastable low-voltage, high current d-c voltage supplies. Units are available in 6 v and 12 v models. Both models will supply up to 30 w of output, and regulation to line variation is 0.01 percent. No-load to full-load regulation is 0.05 percent. Output impedance of the 6 and 12 v units is 0.0006 ohm and 0.0024 ohm respectively. Maximum rms value of noise and ripple is 1 mv. Both units have recovery times of 1 millisec. Circle 312 on Reader Service Card.

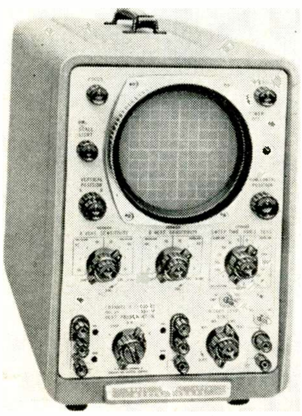
Torque Indicator digital unit

Performance Measurements Co., 15301 W. McNichols, Detroit 35, Mich., announces a new digital torque indicator that also supplies an output proportional to horsepower. With this instrument it is no longer necessary to compute horsepower readings from speed and torque data. The output from the mode DTI-2, combined with that of a d-c tachometer generator, is fed to a strip chart recorder for a continuous direct horsepower reading. The unit is claimed to have exceptional freedom from line voltage variations, servo amplifier gain changes and ambient temperature fluctuations. Circle 313 on Reader Service Card.



V-R Power Supply delivers 0-32 v

Kepco Laboratories, Inc., 131-38 Sanford Ave., Flushing 55, N. Y. Model SC-32-2.5 transistorized power supply delivers 0 to 32 v, 0 to 2.5 amperes. Regulation for line or load is less than 0.01 percent or 0.002 v, whichever is greater. Ripple is less than 1 mv rms. Recovery time is less than 50 μsec. Stability for 8 hours is less than 0.01 percent or 0.002 v, whichever is greater. Operating ambient temperature is 50 C maximum. Temperature coefficient is less than 0.01 percent per deg C. Output impedance is less than 0.01 ohm. **Circle 314 on Reader Service Card.**



Oscilloscope dual trace unit

HEWLETT-PACKARD Co., 275 Page Mill Rd., Palo Alto, Calif., has available a new 200 kc oscilloscope with dual trace presentation. Model 122A has twin vertical amplifiers and a vertical function selector. The amplifiers may be operated independently, differentially on all ranges, alternately on successive sweeps, or chopped at a 40 kc rate. Engineered to speed industrial, mechanical, medical and geophysical measurements in the 200 kc range, model 122A triggers automatically and has a maximum sensitivity of 10 mv/cm. One knob selects any of 15 calibrated sweeps from 5 μsec/cm to 200 millisec/cm in a 1-2-5 sequence. **Circle 315 on Reader Service Card.**

Digital VOM portable model

FRANKLIN ELECTRONICS INC., Bridgeport, Pa. A new low-cost, portable, digital volt-ohmmeter accurately measures d-c from 0.01 to 1,000 v, positive or negative; a-c from 0.01 to 1,000 v up to 100 kc;

1958-59 electronics BUYERS' GUIDE REVISIONS

Revised and corrected Product Listings

AMPLIFIERS—*Transistor*
Miami Instrument Co. Box 384, Tamiami Sta., Miami 44, Fla.

CAPACITORS—*Fixed*
Ceramic
Feed Through
Fixed Composition
High Voltage
Mica
Plastic
Silvered Mica

CAPACITORS—*Variable*
Trimmer—Ceramic
Tuning—Receiving
ERIE RESISTOR CORP., Erie, 6, Pa. ADV. PG. 140, 141

FURNACES—*Electric*

OSCILLATORS—*Backward Wave*
STEWART ENGINEERING CORP., Box 277, Soquel, Calif. ADV. PG. 456

GENERATORS—*Ultrasonic*
ULTRASONIC EQUIPMENT
Branson Instruments, Inc., 1 Brown House Rd., Stamford, Conn.

INFRARED EQUIPMENT
Barnes Engineering Co., 30 Commerce Rd., Stamford, Conn.

INVERTERS—*DC-AC*
Continental Electric Co., Inc., 334 Ferry St., Newark 5, N. J.

MICROWAVE ACCESSORIES OF ALL TYPES
Microtech, Inc., 2975 State St., Hamden, Conn.

MOTORS—*Servo*
DYNAMIC INSTRUMENT CORP., 59 New York Ave., Westbury, N. Y. ADV. PG. 540

TOROIDS
TORWICO ELECTRONICS, INC., 1090 Morris Ave., Union, N. J. ADV. PG. 461

TRANSFORMERS—*r-f & i-f*
Radio Industries, Inc., 5225 Ravenswood Ave., Chicago 40, Ill.

MANUFACTURERS INDEX
Instrument Electronics Corp., P.O. Box 830, 90 Main St., Port Washington, N. Y.

Bold facing and advertising page number omitted in the following:

RECTIFIERS—*Silicon*
NORTH AMERICAN ELECTRONICS, INC., 210-212 Broad St., Lynn, Mass. ADV. PG. 558

TUBING—*Fibre*
not TUBING—Fabric
NATIONAL VULCANIZED FIBRE CO., P.O. Box 311, Wilmington 99, Del. ADV. PG. 360

ULTRASONIC EQUIPMENT
BRANSON ULTRASONIC CORP., 1 Brown House Rd., Stamford, Conn. ADV. PG. 557

Corrected Addresses

CANS
CASES
Diode & Transistor
Instrument & Meter

METAL PARTS
Deep-Drawn
Small Metal Stampings
HUDSON TOOL & DIE CO., INC., 18-38 Malvern St., Newark 5, N. J. ADV. PG. 203

COILS
a-f Choke
Choke
Filter Choke
r-f Choke
r-f Choke, Heavywire (Low Voltage)

RELAYS
Power
Rotary
Sensitive

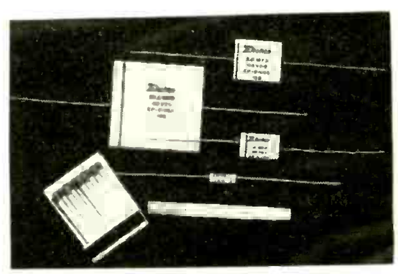
TRANSFORMERS—*Power*
Voltage Regulating

TRANSFORMERS, *Miniature*
Douglas Randall, Inc., 6 Pawcatuck Ave., Westerly, R. I.

and resistance from 10 ohms to 1 megohm. Easy-to-read visual display of all readings appears on a prominent bank of illuminated numbers arranged in three columns on the front panel. **Circle 316 on Reader Service Card.**

Thyratron spade-type lugs

ELECTRONS, INC., 127 Sussex Ave., Newark, N. J., announces a new, compact xenon-filled thyratron for ignitron firing and motor control. Termed the ELC3J/L, the tube has spade lug connections to eliminate tube failure due to poor socket connections. Since it contains no mercury, neither its life nor reliability of control are adversely affected by ambient temperatures or mounting position. **Circle 317 on Reader Service Card.**



Tiny Capacitors metallized paper

ELECTRON PRODUCTS CO., 430 North Halstead Ave., Pasadena, Calif., announces the new EP series subminiature metallized paper capacitors for use in circuits employing up to 100 v. Extremely rugged and reliable, they are de-

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•

You'll get it quicker if your postal zone number is on the order blanks, return envelopes, letterheads.

The Post Office has divided 106 cities into postal delivery zones to speed mail delivery. Be sure to include zone number when writing to these cities; be sure to include *your* zone number in *your* return address — after the city, before the state.

signed for applications such as wave filters, transistor circuitry and general electronic use where reduction in size and weight limit the use of larger components. Triangular, half-round sections and numerous other form factors are available in all capacitance values. Circle 318 on Reader Service Card.

Servo Amplifier transistor-magnetic

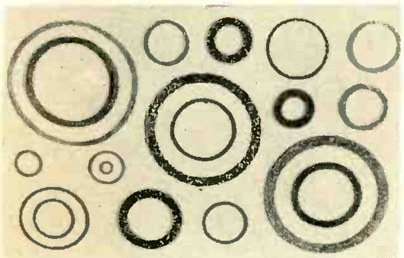
KEARFOTT CO., INC., 1500 Main Ave., Clifton, N. J., has introduced a miniature high gain transistor-magnetic servo amplifier ideally suited for high speed, high shock and vibration aircraft and missile applications. Rated for operation at temperatures ranging between − 55 C to + 100 C, the compact amplifier features silicon transistors in its servo amplifier section, together with an integral fast response magnetic amplifier. The unit can drive such Kearfott servo motors as the R119-2, a 115-v unit, and R124-4, a 26-v motor. Circle 319 on Reader Service Card.

Data-Gage collection/control

TEXAS INSTRUMENTS INC., Industrial Instrumentation Division, P. O. Box 6027, Houston 6, Texas. The Data-Gage, previously manufactured by TI as a fluid level data collecting system, has been extended to be applicable to any industrial use requiring both data collection and remote control of on-off devices. The transistorized system is composed of a receiver console unit located at the central operating point; a field selector unit that can read and control 100 locations or be cascaded to control 1,000; a common analog input unit for all analog output transducers, and the necessary transducers and control elements. **Circle 320 on Reader Service Card.**

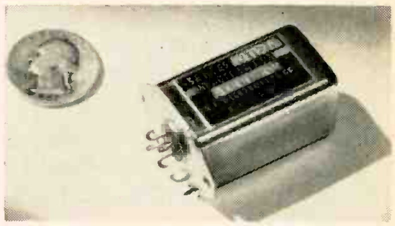
Preamplifiers high frequency

A. R. & T. Electronics, Inc., 1101 McAlmont St., Little Rock, Ark., announces a complete line of low noise, high frequency preamplifiers. Standard series A models are fixed-tuned units available with flat bandwidths in the range of 50 to 500 mc. Standard series B preamplifiers are available for any center frequency in the range of 100 to 250 mc, with 3 db bandwidths of 8 to 20 mc, depending on frequency center. **Circle 321 on Reader Service Card.**



Gaskets for rfi shielding

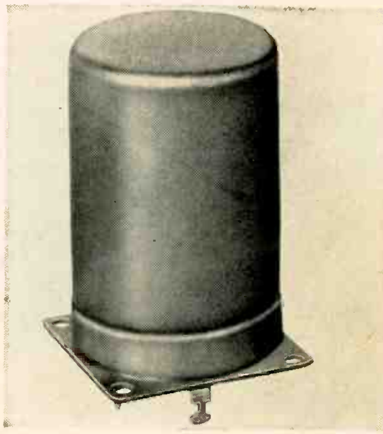
Technical Wire Products, Inc., 48 Brown Ave., Springfield, N. J. A complete line of gaskets, used to shield wire-guide joints, feed-through interference filters and other openings in rfi shields, are die-formed from knitted wire mesh. Units can be made in almost any shape required and a wide range of alloys is available to assure corrosion compatibility of the gaskets with the mating surface of the rfi enclosures. The resiliency of the mesh makes a positive shield possible even where the surfaces of the enclosure are uneven. **Circle 322 on Reader Service Card.**



Oscillators

factory pretuned

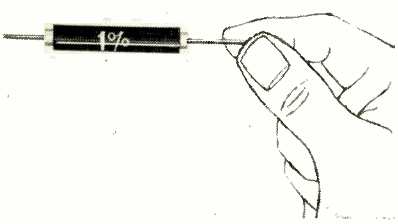
MF Electronics Co., 122 E. 25th St., New York 10, N. Y. Series 101 and 102 audio tone oscillators operate from a choice of one out of two standard voltages (12 v or 28 v). Overall frequency accuracy in the 102 series is ±2 percent; in the 101 series, ±5 percent. Standard frequencies are available in the range from 400 cps to 30 kc. Harmonic distortion is in the order of 1 percent total. **Circle 323 on Reader Service Card.**



Transformers

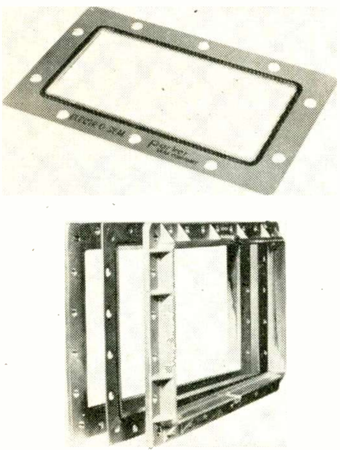
hermetically sealed

United Transformer Corp., 150 Varick St., New York 13, N. Y., announces high power transistor transformers in both driver and voice coil types. The H-280 driver type has a primary impedance of 200 ohms center tapped with secondary 400 ohms split. The H-281 is a 5-w output from 48 ohms center tapped to 16, 8, 4 ohms. The H-282 is a 10-w output from 20 ohms center tapped to 16, 8, 4 ohms. All are wide frequency range suited to 30-20,000 cycles service. Circle 324 on Reader Service Card.



Resistors deposited carbon

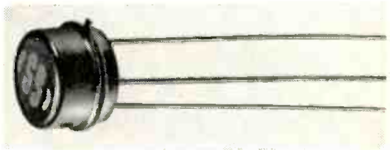
WELWYN INTERNATIONAL INC., 3355 Edgecliff Terrace, Cleveland 11, Ohio. Type N deposited carbon resistors are available in a complete line of values from 10 ohms to 100 megohms. They feature a tough durable thermoplastic molded insulation which results in an economically priced resistor of improved endurance and long-term stability. Continuous operation at 150 C has caused no damage to either the insulating material or the resistor. Circle 325 on Reader Service Card.



Waveguide Seals prevent r-f leakage

PARKER SEAL CO., a division of Parker-Hannifin Corp., 10567 W. Jefferson Blvd., Culver City, Calif. A complete line of seals for WR-series and X-band waveguides,

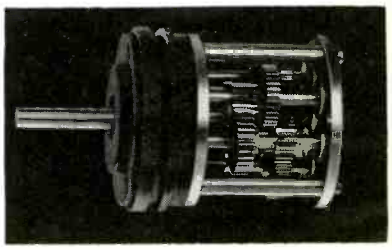
which provide no-leakage fluid sealing, prevent r-f leakage and eliminate burning and/or arcing, has been developed. Called Electr-O-Seals, they are made to fit EIA standard guides and, in addition to positive sealing, provide savings by making special machining of flanges unnecessary. The inside metal mating edges of the seal are knurled to assure positive electrical contact. They are also reusable. Circle 326 on Reader Service Card.



Silicon Transistors

pnp alloyed

SPERRY SEMICONDUCTOR DIVISION, Sperry Rand Corp., South Norwalk, Conn., announces four new silicon *pnp* transistors for 1 to 4 mc operation in severe airborne and missile environments. They incorporate "micro-control" a new design feature that holds input resistance in all units to a uniform value to provide greater freedom in circuit design and construction. Selection problems are reduced by the uniform 35-ohm value, which is one-third the input resistance heretofore realized in megacycle transistors. Circle 327 on Reader Service Card.

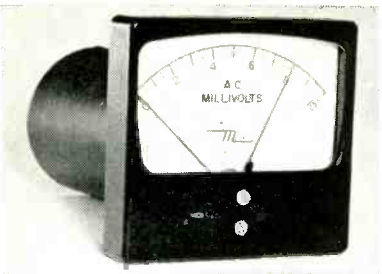


Gear Heads

and speed reducers

SYNCHROSOLVE, INC., 269 Green St., Brooklyn 22, N. Y., announces gear heads and speed reducers from size 8 to 18. All units have a high torque transmittal capacity to size ratio; maximum backlash of 30 minutes; will operate from −55 to

+150 C; conform to all applicable military specifications. Circle 328 on Reader Service Card.



Voltmeter

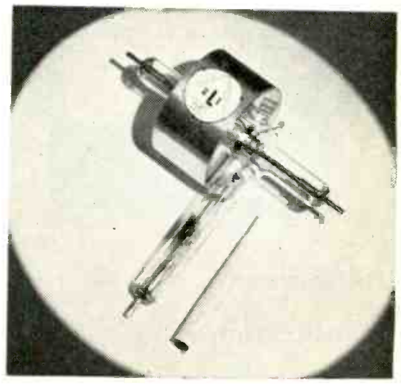
built-in control

METRONIX, INC., Chesterland, Ohio, has developed a panel-mounted electronic voltmeter with built-in control features. Available in both a-c and d-c models, it combines the locking contact control action of a meter-relay with the specialized measuring ability of a vtvm. Typical applications include controlling amplitude limits, automatic ground-testing of missile parameters, and monitoring signals from strain gages and load cells. Circle 329 on Reader Service Card.

Signal Sources

ten-watt units

LEVINTHAL ELECTRONIC PRODUCTS, INC., 760 Stanford Industrial Park, Palo Alto, Calif. Available in a series of four units covering the band from 1 to 11 kmc, the new model 231T signal sources include a signal generator followed by a low-level twt amplifier driving a high-level twt output stage. Internal modulation facilities are provided for pulse, square-wave and f-m operation. In the manufacture of these signal sources primary attention was given to stability, reduction of incidental f-m and a-m, input filtering, and voltage regulation. **Circle 330 on Reader Service Card.**



H-V Relay Assembly low power consumption

RESITRON LABORATORIES, INC., 2908 Nebraska Ave., Santa Monica, Calif., has developed a high voltage, high vacuum relay assembly, type XAC-22, which can be actuated by means of an a-c voltage source at any frequency from 40 to 10,000 cps. The new unit eliminates the need for an external d-c power supply as required in many types of high vacuum relays and is available in coil voltages from 12 to 120 v. **Circle 331 on Reader Service Card.**

Indicator shows phase sequence

OPAD ELECTRIC CO., 69 Murray St., New York 7, N. Y. Model VA5 phase sequence indicator provides a means of instantly determining the order in which the voltage peaks occur in a three phase 115 v 400 cps power line. This panel mounting instrument has been designed for built-in applications and is ideal for integration in test stands, panel boards and special equipment whose satisfactory operation is dependent upon proper phase sequence. Circle 332 on Reader Service Card.

TR Tubes for —55C to ±125C

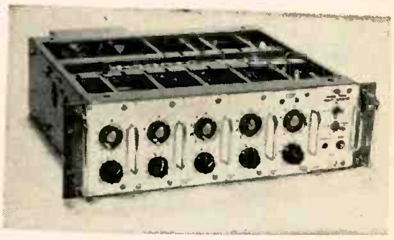
Bomac Laboratories, Inc., Salem Road, Beverly, Mass., announces a new line of extended temperature range TR tubes. They are self-contained and capable of meeting all standard electrical and mechanical specifications between temperatures of —55 C to ±125 C. All tubes are interchangeable with present JAN TR tubes in current use. Circle 333 on Reader Service Card.

Vibration Meter wide applications

Wayne Kerr Corp., 2920 N. 4th St., Philadelphia 33, Pa. Type B-731A vibration meter may be used for vibration tests to meet JAN-MIL specs in electronic components; to measure vibration in rotating shafts or bearings; on a production line for determining sizes and grades of parts for tolerance; and for testing members of airframes, either in wind tunnels or on actual airframes. The meters find application where safety considerations make it necessary to have the indicating instruments remote from the machinery and the probe. Circle 334 on Reader Service Card.

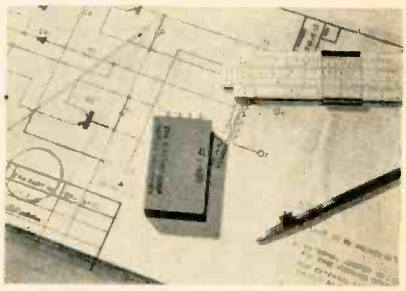
A-C Voltmeter long life

Ballantine Laboratories, Boonton, N. J. Model 300D is a general purpose, precision, laboratory electronic a-c voltmeter designed to operate for extended periods of time with freedom from recalibration and servicing. Essentially it comprises a high impedance attenuator followed by a feedback stabilized amplifier which feeds an average responding rectifier-meter circuit. Voltage range is 1 mv to 1,000 v rms in 6 decade ranges (0.01, 0.1, 1, 10, 100 and 1,000 v full scale). **Circle 335 on Reader Service Card.**



Preset Counter p-c plug-in modules

ELECTRO-PULSE, INC., 11861 Teale St., Culver City, Calif. Printed circuit plug-in modules serve as separate counting decades and functional block units in the versatile make-up of a new line of counting equipment. The five decade preset counter model 7250C typifies this design approach. It operates to 100 kc as a counter and will recycle without missing counts at rates to 5 kc. The instrument features high input sensitivity, pulse and variable duration or locking relay contact output, and provision for electronic or switch gating of the input. **Circle 336 on Reader Service Card.**

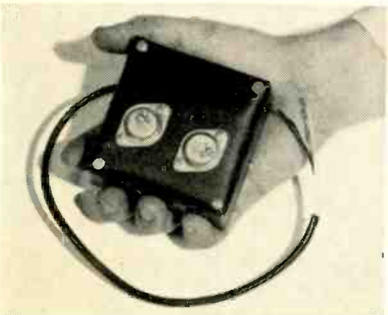


Transient Filters for transistors

E.R.A. ELECTRIC CORP., 67 E. Centre St., Nutley, N. J., announces a line of transient filters which are intended for all types of switching applications. These Slim Tran transient filters are connected to the d-c input of the transistor circuitry and eliminate hash and noise transmission to the external circuitry as well as protecting the switching transistors against line conducted transients. Stock units are available for center keying frequencies of 60, 400, 2,000 and 5,000 cps. D-C ratings extend up to 5 amperes. Circle 337 on Reader Service Card.

Twin Pentode sharp cutoff

RADIO CORP. OF AMERICA, Harrison, N. J. The 4BU8 is a sharp-cutoff twin pentode of the 9-pin miniature type intended for use in agc amplifier circuits and sync circuits of tv receivers. It utilizes a common cathode, a common grid No. 1, a common grid No. 2, two grids No. 3, and two plates. Each of the grids No. 3 has a separate base-pin terminal and may be used independently as a control electrode. Circle 338 on Reader Service Card.



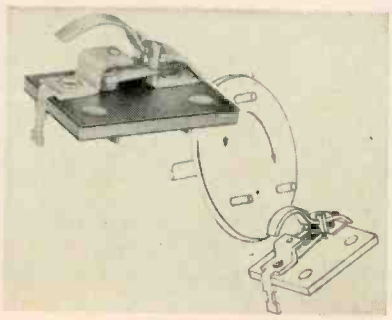
Power Supply all-transistor

P. R. MALLORY & CO., INC., DuQuoin, Ill. A compact, rugged power supply for converting from battery to B voltages has been developed for use in military and commercial communications and electronic equipment where highest reliability is required. Only 3½ in. sq and 1.7 in. high, it has no moving parts, glass tubes or vibrators. It uses printed circuitry and a transistorized 2,000-cycle inverter-rectifier system. Unit is self-starting at temperatures down to −55 C; is rated for ambient temperatures from −55 C to +71 C. Circle 339 on Reader Service Card.

Monitor

checks relay chatter

MuTronics, Inc., 1514 South La Cienega Blvd., Los Angeles 35, Calif., has developed a new, thyratron controlled monitor for checking chatter in relays. Model CCM-1 utilizes a continuous red neon lamp when an indication of contact opening in excess of selected time interval occurs. Ten durations can be selected by a single front panel control. Control positions are at 10 μsec intervals with a range of 10 to 100 μsec. Circle 340 on Reader Service Card.



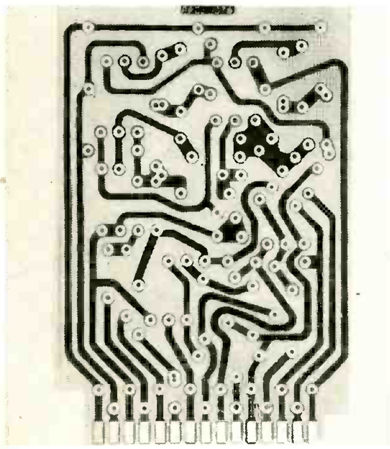
Snap-Action Switch

new actuator design

Cherry Electrical Products Corp., 1650 Deerfield Rd., Highland Park, Ill. The S30-97A snap-action switch offers long life and accuracy for linear cam, rotary and rotary pin actuation. It is specifically designed to accept clockwise and counter-clockwise cam actuation with equal precision. Positive stop protects switch mechanism from damage due to excessive overtravel. The compact cam switch can be gang mounted to provide electrical control for multiple circuit variations. Operating force can be varied from 2 to 7 oz. Circle 341 on Reader Service Card.

ITV System
with light control

KinTel, a Division of Cohu Electronics, Inc., 5725 Kearny Villa Road, San Diego 12, Calif. The 1987 television system features an automatic, built-in light control capable of compensating for light-level variations of up to 1,000:1. In addition, a white clipper circuit minimizes the effect of extremely bright objects in the viewing field. To gain maximum reliability, all components within the system are operated at less than 75 percent of their nominal operating level. Circle 342 on Reader Service Card.



Imbedded Circuitry
high reliability

Beck's, Inc., 300 E. Fifth St., St. Paul 1, Minn. Imbedded in the base material and protected by an insulating cover, "imbedded circuitry" offers reliability beyond any existing industrial or military specification. Using a conductor of three to six times the thickness of ordinary surface-type circuitry, and because of the slight tapered shape of the etched conductor, "imbedded circuitry" is actually locked-in-place and will not lift, peel, or separate from the base material under the most severe conditions. It has greatly improved surface resistivity, dielectric strength, and physical rigidity. Circle 343 on Reader Service Card.

Literature of

MATERIALS

Cable Shielding. Magnetic Shield Division, Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill. Data sheet 140 illustrates and describes new bidirectional Netic Co-Netic foil strips for magnetically and electrostatically shielding communication cables, eliminating crosstalk, and permitting clearer sound transmission. **Circle 344 on Reader Service Card.**

COMPONENTS

Miniature Delay Lines. Columbia Technical Corp., 61-02 31st Ave., Woodside 77, N. Y. Bulletin 78 describes the new MiniLines-circuit elements that are resin-encapsulated and combine, in a small volume, outstanding electrical characteristics with extreme mechanical strength. **Circle 345 on Reader Service Card.**

High-Pressure Seals. Automatic & Precision Mfg. Co., 252 Hawthorne Ave., Yonkers, N. Y. Bulletin HEX-10 illustrates and describes single-unit high pressure seals for commercial and military subminiature toggle and push-button switches. **Circle 346 on Reader Service Card.**

Transistor Circuitry Case. Vector Electronic Co., 1100 Flower St., Glendale 1, Calif. Bulletin 54A covers the Frame-Loc case, a slender flush type with snap-out side panels intended particularly for transistor circuitry and p-c boards in small pluggable units. **Circle 347 on Reader Service Card.**

Servo Components. Precision Mechanisms Corp., 577 Newbridge Ave., East Meadow, N. Y. Six-page bulletin No. 102-58 describes a complete line of predesigned mechanisms and components for the servo and instrument fields. **Circle 348 on Reader Service Card.**

Tantalum Capacitors. Fansteel Metallurgical Corp., North Chicago, Ill. Bulletin 6.100-3 covers

the Week

the PP type general purpose tantalum capacitors. It contains application information, specifications, ratings and ordering references. Circle 349 on Reader Service Card.

EQUIPMENT

D-C Power Supply. General Electric Co., Schenectady 5, N. Y. Bulletin GEC-1505 covers a line of voltage-stabilized d-c power supply units. Photos, lists of benefits, typical data table, schematic diagram, and current-limiting effect curve illustrate key features. **Circle 350 on Reader Service Card.**

Multipurpose Electrometer. Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, Ohio. Volume 6 No. 1 of *Engineering Notes* illustrates and describes model 610 electrometer which can be used as a voltmeter, ammeter, ohmmeter and d-c preamplifier. **Circle 351 on Reader Service Card.**

Transistorized D-C Supplies. Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn., announces a product data sheet on the Q-Nobatrons, a line of transistorized low-voltage high-current d-c supplies, with outputs of 6, 12 or 28 v, at 15 or 30 w. **Circle 352 on Reader Service Card.**

Precision Rally Computer. Kearfott Co., Inc., 1500 Main Ave., Clifton, N. J. A recent bulletin illustrates and describes a precision rally computer which features continuous computation and display of time, speed and distance. **Circle 353 on Reader Service Card.**

FACILITIES

Technical Studies. Sloan Research Industries, Inc., 526 N. Milpas St., Santa Barbara, Calif. An 8-page illustrated brochure provides information on the application of its electron microscope and x-ray diffraction laboratories to various electronic and industrial problems. **Circle 354 on Reader Service Card.**

Barden Unveils New Facility

THE Barden Corp. recently announced official opening in Danbury, Conn., of a modern and fully equipped plant for the manufacture of instrument precision ball bearings.

The $2,500,000 facility stands on a 21-acre hilltop site. The aluminum and concrete building contains 125,000 sq ft of floor space. In addition to the manufacturing area, it has a cafeteria, dispensary and clinic, and other employee services.

Its one-floor manufacturing area allows production to flow smoothly around a core of service activities central to all departments. Machine operations are in open, uncluttered expanses, with such essential services as power, coolant and hydraulic lines supplied from low stanchions instead of overhead pipes.

Because of the extremely close tolerances to which the precision ball bearings are made, optimum cleanliness is a prime requisite, particularly in final inspection, assembly, testing and inner packaging. These operations are sealed off from the noncritical departments and are subject to the most thorough precautions to prevent entry of dirt or dust.

The Barden Corp. reports it was founded in 1942 "to produce ball bearings to a higher degree of precision than had ever before been uniformly attained." It is still devoted exclusively to the production of bearings, particularly for the increasingly complex needs of the aircraft and instrument industries. New plant represents the latest step in a continuing effort to raise standards of performance and precision to meet today's technological requirements, firm says.

Appoint Scott V-P at Webcor

CHICAGO'S Webcor, Inc., has named Hoyle U. Scott vice president for its Electronics Division. He will be headquartered in the Ring Building in Washington, D. C.

This is a new position created for better handling of Webcor's increased government and contract business, and to facilitate contract liaison in the research, development and production of electronics and electromechanical equipment for the defense industries of the armed forces.

Prior to joining Webcor, Scott was assistant head of the Electronic Countermeasures Branch, Avionic Division, Bureau of Aeronautics, Navy Department.

West Receives New Assignment

AUTONETICS, Downey, Calif., has appointed W. J. West to the post of project engineer for reliability on weapon system 133A (Minuteman).

Prior to assuming his new position, West had served as the department's staff specialist in systems analysis. He first joined Autonetics in 1956. Before that, he had 12 years of broad experience in the electronics field, with several years of specialization in radar and radiation.

From 1948 to 1956 he served as responsible engineer on various projects with the California Research Co.

Science Industry Center Set Up

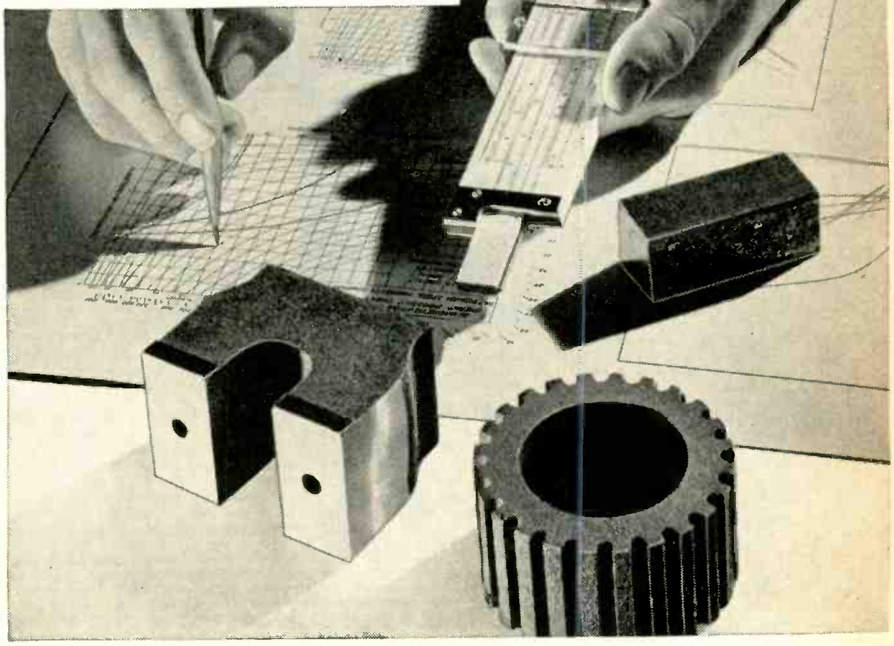
A PLANNED SCIENCE INDUSTRY center has been established to meet the needs of science-oriented industries seeking suitable accommodations at the nation's capital. Designed expressly for such industries, and to meet the growing demand for efficient plant sites as well as prestige location, the center is situated only minutes away from key government agencies, in nearby Montgomery County, adjoining Washington's northwest section, and is known as Washington-Rockville Industrial Park.

Power Sources Hires Cameron

NEW chief engineer at Power Sources, Inc., Burlington, Mass., is

How Magnet Specialists Can Help Improve Your Product, Cut Design and Production Costs

A close look at your product in the light of modern magnetic technology may reveal ways to improve designs and manufacturing methods with resulting lower costs. Here's a good way to begin.



STUDY THE MAGNETS YOU'RE USING

If your product now employs a permanent magnet, review these considerations:

1. Is the magnet right for the job?
2. Would a larger or smaller magnet improve the design, permit larger physical tolerances, etc?

Example: A manufacturer was using Alnico V magnets in a high-quality intercom unit. Magnetic experts studied the design and found that 83% of the energy of the magnet was nullified in actual operation of the unit. Equivalent results could be obtained with a smaller Alnico magnet or lower cost magnetic materials.

3. Are all close tolerances in the design essential to the performance of the product?

Example: A radar manufacturer — to meet required tolerances—specified an I.D. grind on a permanent magnet used in conjunction with a magnetron assembly. Cost of the magnet was $2.26. Study showed that the I.D. grind was not necessary, and the new magnet price is 81.7¢ each.

4. Would a different magnet material perform more efficiently in this application?
5. Can the design of the magnet itself be modified for greater efficiency, lower cost?

Example: A manufacturer of small electric motors used two Alnico V magnets and two pole pieces in a motor assembly. These four elements have been eliminated in a design that uses one Indox ring magnet — a multiple saving in material, parts and labor.

TOOLING WITH MAGNETS

Literally thousands of manufacturers have cut factory costs with permanent magnets in tooling, processing, material handling and production devices. A partial list of the most common applications will indicate the wide range of jobs a permanent magnet can do effectively and at low cost.

PARTS CONVEYOR
Magnets eliminate clamps and hooks, simplify loading and removal of parts.

CHIP RETRIEVER
Collects chips and other iron particles from coolant, lubricant, etc.

PIPE ROLL
Handles ferrous pipe and tubing at high speed without slippage.

SHEET FANNER
"Fans" sheet steel in stacks to simplify pickup and handling.

FLOOR SWEEPER
Picks up iron scrap, tools, etc. from plant floors, drives and parking lots.

TOOL HOLDER
Keeps tools handy and orderly, speeds work.

SEPARATORS
Magnetic pulleys, plates or drums remove tramp iron from non-ferrous materials in every industry.

RESEARCH AND DEVELOPMENT

Magnetics is a highly specialized science. Too often, competent engineers who are without the required testing facilities and experience will spend months studying a magnetic circuit for a proposed product, finalizing a design that could have been completed in a few weeks with the help of specialists.

Nobody knows magnetics like Indiana Steel Products... and Indiana makes all kinds of magnet materials, can recommend exactly the *right* magnet for your specific application. You are invited to consult with our engineers and scientists on any problem involving permanent magnets. Write today for new free catalog, "Cast and Sintered Alnico Permanent Magnets." Ask for Catalog No. 19-A12.

THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA

WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS

INDIANA PERMANENT MAGNETS

IN CANADA: The Indiana Steel Products Company of Canada Limited, Kitchener, Ontario

Fred M. Cameron, Jr.

He was formerly with Ferranti Electric, Inc., White Industries, Inc., and Raytheon Mfg. Co., where he was chief engineer of the New Hampshire plant prior to joining Power Sources.

In his new capacity, Cameron will be responsible for the planning, design and development of power supplies, d-c inverters, and other equipment using transistorized and magnetic circuitry.

ECS Appoints Engineering Mgr.

JACK ROSENBERG was recently appointed manager of engineering for Electronic Control Systems, the Los Angeles facility of the Electronics Division of Stromberg-Carlson, Rochester, N. Y.

Rosenberg, who joined ECS in 1954, was the project engineer in charge of the development of the Digimatic line of controls for machine tools and other precision equipment. From 1951 to 1954 he was employed by the Electronics Laboratory of General Electric Co. on digital telemetry and control projects.

Maxson Hires Charles H. Lilly

NEWLY appointed liaison engineer for the Old Forge, Pennsylvania Manufacturing Division of The W. L. Maxson Corp. is Charles H. Lilly. He will coordinate product design between the Old Forge Division and the Research and Development and Instruments Division in New York City.

Prior to joining Maxson, which specializes in missile systems and components and other military electronic equipment, Lilly worked for the Philco Corp. since 1951. His last position was as an engineering group supervisor in the Philadelphia Industrial Group.

Ray Destabelle Moves to TIC

TECHNOLOGY INSTRUMENT CORP. of California has appointed Ray Destabelle to the post of chief engineer, Transducer Division, at the TIC Santa Monica plant.

Prior to joining TIC, Destabelle served with Servomechanisms, Inc., Task Corp. and North American Aviation, Inc.

News of Reps

Cozzens and Cudahy, Inc., of Evanston, Ill., is appointed sales rep for Weinschel Engineering, Kensington, Md. Territory covered will be Wisconsin, Minnesota, Iowa, northern Illinois, and western Indiana.

Moulthrop and Hunter of San Francisco will now handle both the Chicago and Stancor lines of stock transformers for Chicago Standard Transformer Corp. in the northern California area.

Lenz Electric Mfg. Co., Chicago, Ill., has named **Eichorn and Melchior, Inc.**, of San Francisco, as sales reps for northern California and Nevada.

The Genalex core line of Wallace E. Connolly & Co., Menlo Park, Calif., is now being sold in the New England states by **John V. Muddle** of Ashland, Mass.

Columbine Sales and Engineering Co. of Denver is named to represent the Electronics Division of Iron Fireman Mfg. Co., Portland, Ore., in the Rocky Mountain area.

NEW BOOKS

Guided Missiles

By LT. GEN. CHARLES T. MYERS, USAF.

McGraw-Hill Book Company, New York, 1958, 575 p, $8.00.

HERE is a readable and well-illustrated elementary manual on design, theory and some operational aspects of guided-missile systems. It is a direct reproduction of an Air Force training manual, written for the orientation of personnel with relatively narrow background and experience in guided-missile technology.

Beginning with fundamental physical principles, the text indicates the logical development of the guided missile. It is not intended as a design manual and, although there is some quantitative discussion of the missile system, the major emphasis is to impart qualitative understanding of the component parts.

Contents—Specifically, the text is introduced with a history of the guided missile and some of the relationships existing between the Air Force research and development organization and the missile in its various phases of design, test and production. This is followed with basic material on aerodynamics and propulsion, which is informative and well done. A section on the physics peculiar to guided missile systems is, essentially, a rudimentary survey of elementary science. In some areas, and specifically in the subsection on transistors, the information is not relevant background to the material following in the main parts of the book.

Components—Good sections on missile components, including gyros, synchros and related transducers, computational elements, timers and hydraulic servos, hold much useful information. Rudimentary data on radio, light and inertial sensors is contained and digital and analog computers are also treated.

This material is followed by assembly of the component building blocks into subsystems and finally completed systems. Illustrative examples of command, inertial and homing systems are given.

Particularly interesting are some ideas on procedures used for checkout of control systems. Of note, also, are the treatments of missile instrumentation and test and guided missile tactics, including good data on warhead and fuse considerations.

In summary, this is a book for technicians involved in or associated with guided-missile systems and for the more technically trained practicing engineer who desires a knowledge of missile fields relating to his own area of specialty. The treatment of aerodynamics and propulsion are well suited to the possible needs of the electronics engineer; however, the latter is not liable to derive new information in his own major area of specialization. With this understanding of the textbook's aims, it is then seen to represent an enjoyable, carefully written and accurate, though elementary, treatment of modern guided-missile technology.—A. E. NASHMAN, *Executive Engineer, ITT Laboratories, Nutley, New Jersey.*

THUMBNAIL REVIEWS

Operational Mathematics. By R. V. Churchill, McGraw-Hill Book Co., Inc., New York, 1958, 337 p, $7.00. This second edition is concerned primarily with the theory and applications to Laplace and other integral transforms. It represents an extensive revision of the author's "Modern Operational Mathematics in Engineering."

Electronic Instrumentation for the Behavioral Sciences. By C. C. Brown and R. T. Saucer, Charles C. Thomas, Publisher, Springfield, Ill., 1958, 159 p, $5.50. A simplified presentation of basic electronic theory necessary for instrumentation problems, this book is intended for nonengineers in experimental research. One chapter, Stimulus Generators and Input Transducers, may be of interest to engineers interested in medical electronics.

Handbook of Electronic Circuits. By RCA Service Co., Howard W. Sams & Co., Inc., Indianapolis, Ind., 1958, 66 p, $1.00. Circuit diagrams and descriptions of some of the most commonly used basic electronic circuits employed in military and commercial equipment. Component failure analysis for each circuit is included.

Recent Raytheon achievement in Radar

MOVING-TARGET INDICATOR is just one of the many dramatic achievements Raytheon engineers are making in radar every day. This development applies the electronic memory of a recording storage tube to a standard plan-position indicator (PPI).

ADVANTAGES: (1) trail of the moving target is displayed on the scope to permit immediate analysis of target course without the necessity of manual plotting. (2) Scope brightness is uniform and at a sufficient level for lighted area viewing!

HOW IT WORKS: both live and stored data are shown on a two-layer, two-color phosphor CRT on a time-shared basis—the stored pattern being read out onto the scope in the time between successive PPI sweeps. A yellow dot indicates the target and a blue-white trail depicts the history of its motion.

To the man who is looking for
FRONTIER PROJECTS IN ELECTRONICS:

As an engineer or scientist who wants to accomplish more in 1958, you naturally want to be where new things are happening.

Whatever your specialized background and interests, chances are you'll find a current Raytheon project that offers exceptional opportunity for you to put your scientific skill and creative imagination to work.

Raytheon's constant expansion during 1958 covers advanced activities in:

COMMUNICATIONS (Commercial and Military)—scatter, microwave relay, multiplex, mobile transistorized equipment.

COUNTERMEASURES—radar countermeasures equipment, advanced study projects.

RADAR (Pulse and CW Systems)—search, fire control, bombing, navigation, and guidance, air-traffic control, weather and marine, military and commercial.

MARINE EQUIPMENT—submarine, ship and airborne sonar, depth sounders, direction finders, radars.

GUIDED MISSILES—prime contracts:
Navy Sparrow III (air-to-air)
Army Hawk (ground-to-air)

MICROWAVE TUBES—"Amplitrons," magnetrons, klystrons, traveling wave tubes, storage tubes, backward wave devices.

SEMICONDUCTORS—devices, materials and techniques; silicon and germanium.

• • •

For interview at your convenience, please write to:
E. H. Herlin, Professional Personnel Section
P.O. Box 237, Brighton Station, Boston 35, Mass.

Excellence in Electronics RAYTHEON **RAYTHEON MANUFACTURING COMPANY**

COMMENT

Broadband Generator

I read with some concern the article in the Nov. 7 ELECTRONICS on our model 900 sweep generator ("Broadband Generator Has Wide and Narrow Sweeps," p 88, Nov. 7). I was concerned because I was given full credit for the authorship of the article, and this is a considerable distortion of the facts.

The article was in fact coauthored by our chief test-equipment engineer, Ken Simons. But frankly, if the credit is to be shared, the lion's share belongs to Mr. Simons. He not only wrote the major portion of the article, but is the one man primarily responsible for the creation of the model 900.

CAYWOOD C. COOLEY, JR.
JERROLD ELECTRONICS CORP.
PHILADELPHIA

When the article was printed, Mr. Cooley's name appeared as sole author. To make matters worse, my picture was printed in the lead illustration with the caption "*Technician* lines up . . . equipment."

I resent being labeled as a technician. I deeply resent being robbed of whatever prestige may be attached to authorship of the article, and to responsibility for the design of the unit . . .

As the publisher of a national magazine with a wide circulation, you have a tremendous responsibility towards the engineers whose work makes your magazine possible. What is printed in, or omitted from, your pages can have a profound effect on the reputation of an individual, and an engineer's reputation is one of his greatest assets.

K. A. SIMONS
JERROLD ELECTRONICS CORP.

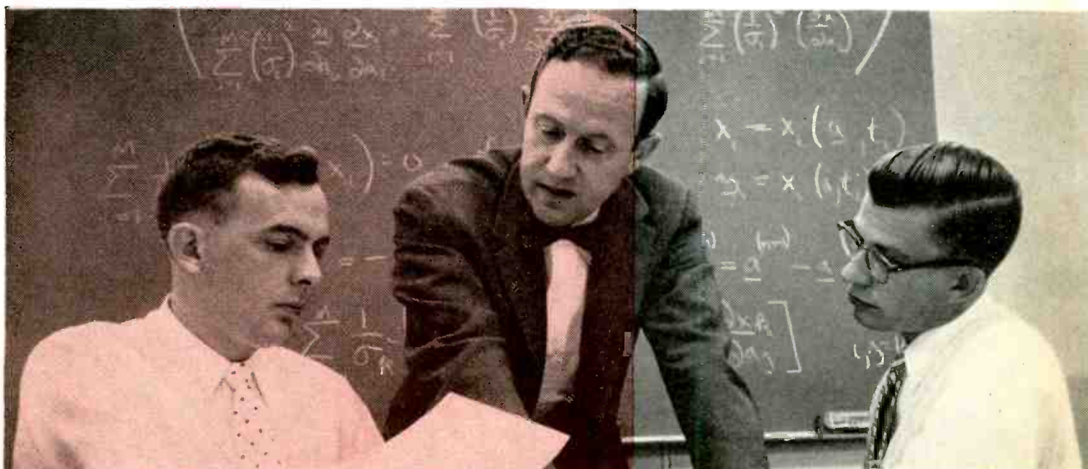
We can certainly understand and deeply sympathize with author Simons' reaction to the double affront. We also recognize the responsibility which we have toward the engineers who read our magazine, and toward those who contribute to its features. It is the bitter truth, however, that errors do sometimes creep into all things under mortal control.

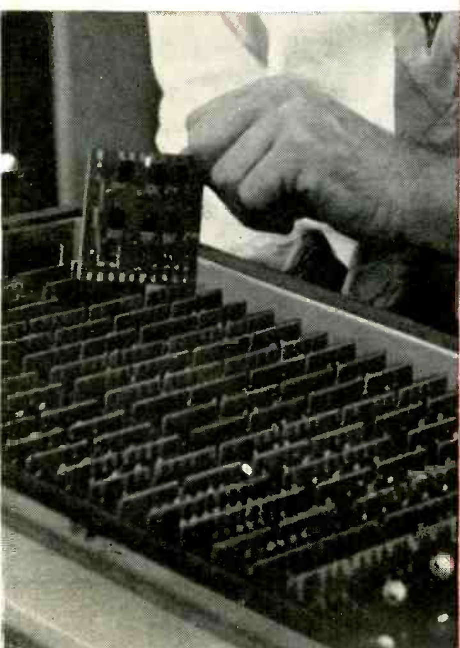
New electronics frontiers

Advanced systems research, to meet the demands of complex modern weapons systems, is among the many new activities that attract engineers and scientists to IBM. This research encompasses over-all planning of methods for the detection of flying objects . . . feasibility studies of guidance, detection and defensive systems . . . specification of radically new equipment for terrestrial and stellar navigational problems. Academic studies of logistics, operations research, information and communications theory are also part of this new research at our Kingston facility.

A CAREER WITH IBM. A recognized leader in the electronic systems field, we present unusual opportunities for technical achievement and professional advancement. With a secure position in commercial sales, IBM offers stability, liberal company benefits, company-paid relocation expenses and advancement on merit. Salaries are commensurate with ability and experience.

KINGSTON, N. Y., is a pleasant Hudson River valley community. It combines country living with easy proximity to New York and other metropolitan areas.





ASSIGNMENTS
open in these development areas:

- **Cryogenics**
- **Digital Computer Design and Programming**
- **Guidance and Detection Systems Analysis**
- **Low-Temperature Physics**
- **Magnetic Devices**
- **Optical Systems for Data Presentation**
- **Solid-State Physics**

QUALIFICATIONS: B.S., M.S., or Ph.D. Degrees in Electrical Engineering, Physics, Mathematics or related disciplines. Industrial experience is desirable.

Write, outlining qualifications and experience, to:

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IBM Corporation
Military Products Division
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R & D
Advanced Electron Devices Solid State Components & Networks

Three Positions Of Singular Interest To Physicists And/ Electronic Engineers

General Electric's Electronics Laboratory—an organization conducting applied research and advance development in every branch of electronics—has openings for men qualified for the following individual responsibilities.

1 To carry out experimental studies on electron optics for special devices such as infrared cameras and/or develop electron-solid-state devices utilizing electron beams interacting with electro magnetic fields.

2 To conduct experimental studies related to masers, parametric amplifiers, infrared detectors, thermoelectric-thermionic power sources, and other advanced electron devices.

3 To assume responsibility for analytical design of, and applied research in magnetic and dielectric solid state devices, sonic transducers, and filters with LC networks.

The professional environment here is one of vigorous intellectual interaction between colleagues working in diverse areas of electronic research and development. More than 70% of the Professional Staff have advanced degrees.

Requirements for all three positions: PHD in Applied Physics or Electronics (EE) or MS plus three years' applicable professional experience.

Please write to:

Mr. Robert F. Mason
Div. 27-WX
Electronics Laboratory
Located at Electronics Park

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Syracuse, New York

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...where Motorola offers great opportunities!

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Why not work where it's fun to live, and where the work is rewarding in every way? Find out more about engineering opportunities in this happy land of sunshine.

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If you are qualified for any of the positions below, write or wire today.

ELECTRONIC ENGINEERS, MECHANICAL ENGINEERS, PHYSICISTS

System Analysis, Design and Test
Radar — Communications
Navigation — Missile Guidance
Digital Computers
Data Processing and Display

Circuit Design, Development and Packaging
Microwave — Pulse and Video
Antenna — Digital and Analog
R-F and I-F — Transistor
Automatic Test Equipment
Servos

Technical Writers & Illustrators

Write:
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Western Military Electronics Center
Motorola, Inc., Dept. A-12
8201 E. McDowell Road
Phoenix, Arizona

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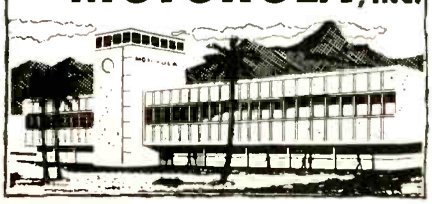

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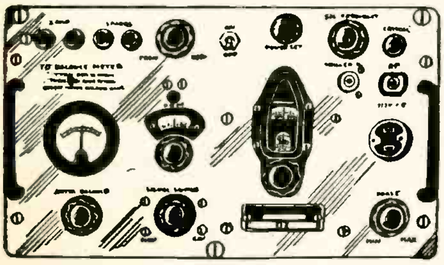

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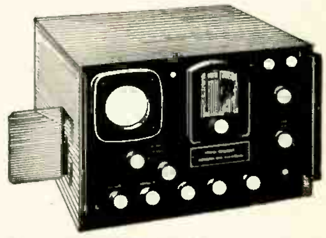

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5200 GAUSS	5200 GAUSS	1500 GAUSS
Airgap ½"	Airgap ½"	Airgap 2¼"
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Size: 7" High	Size: 7" High	Size 6" High
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Weight: 9¾ lbs.	Weight: 13 lbs.	Weight: 20 lbs.
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ACTUAL SIZE PHOTO

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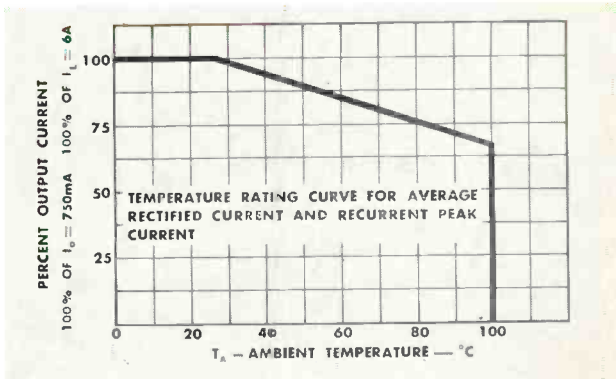
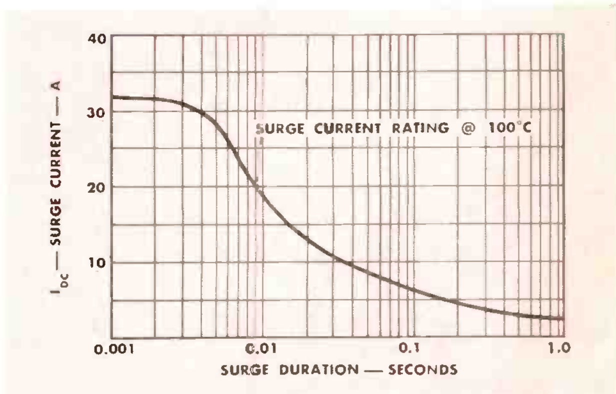


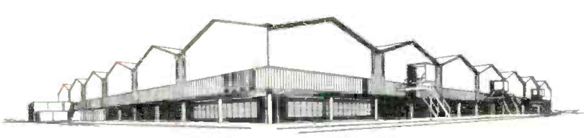


Max Ratings at 25°C

		1N2069	1N2070	1N2071	
PIV	Peak Inverse Voltage	200	400	600	V
Vrms	RMS Voltage	140	280	420	V
I_o	Average Rectified Forward Current	750	750	750	mA
i_f	Recurrent Peak Current	6	6	6	A
T_A	Operating Temperature	———	to +100	———	°C

Electrical Specs at 100°C

	1N2069	1N2070	1N2071	
Maximum Dynamic Reverse Current	.2	.2	.2	mA
Maximum Dynamic Forward Voltage Drop	.6	.6	.6	V



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