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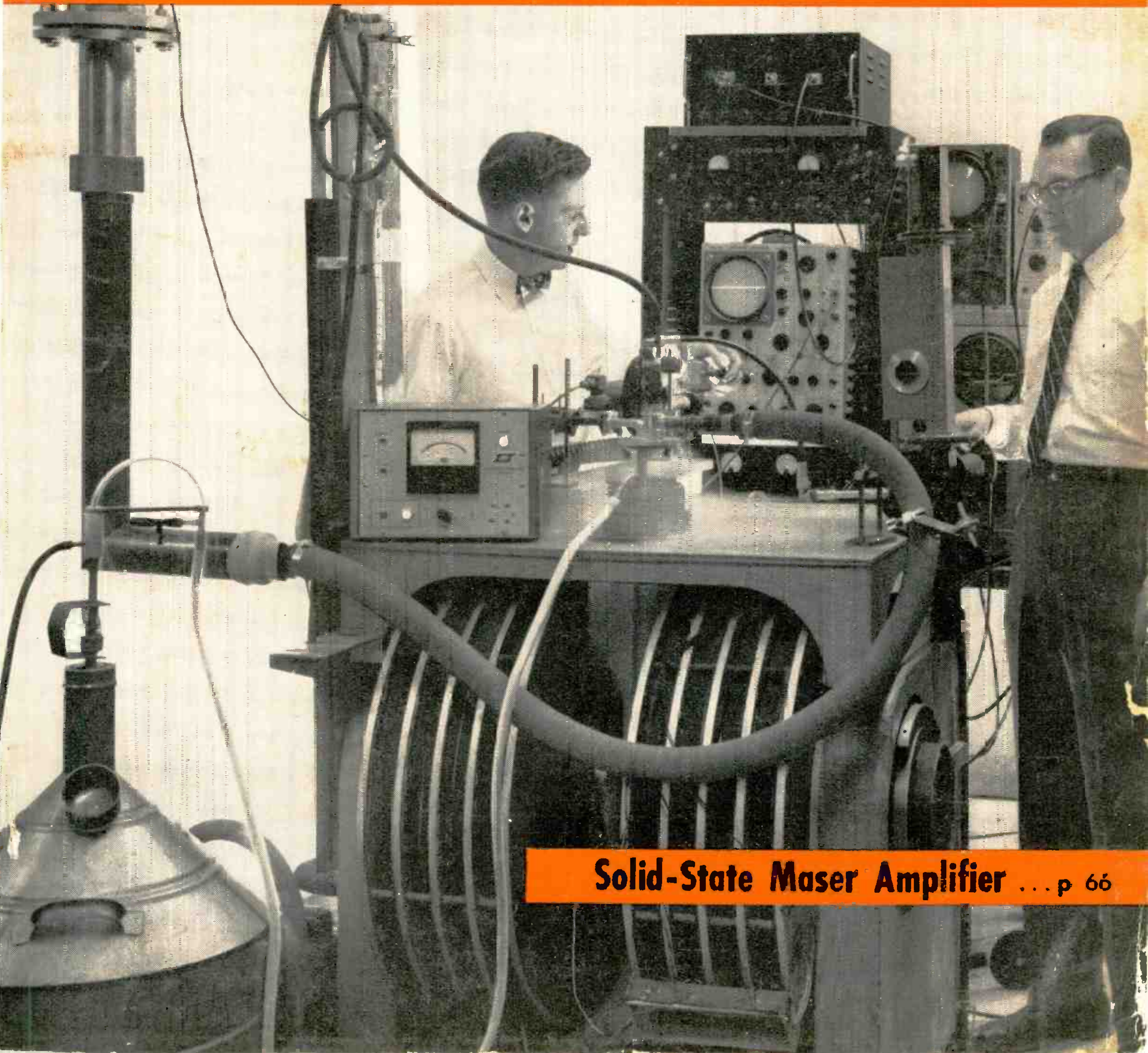
APRIL 25, 1958

electronics

engineering edition

Ferrite Radiators For Missiles ...p 49

Convention Technical Highlights ...p 62



Solid-State Maser Amplifier ...p 66

electronics engineering edition

A McGRAW-HILL PUBLICATION • VOL. 31, NO. 17 • APRIL 25, 1958

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electronics

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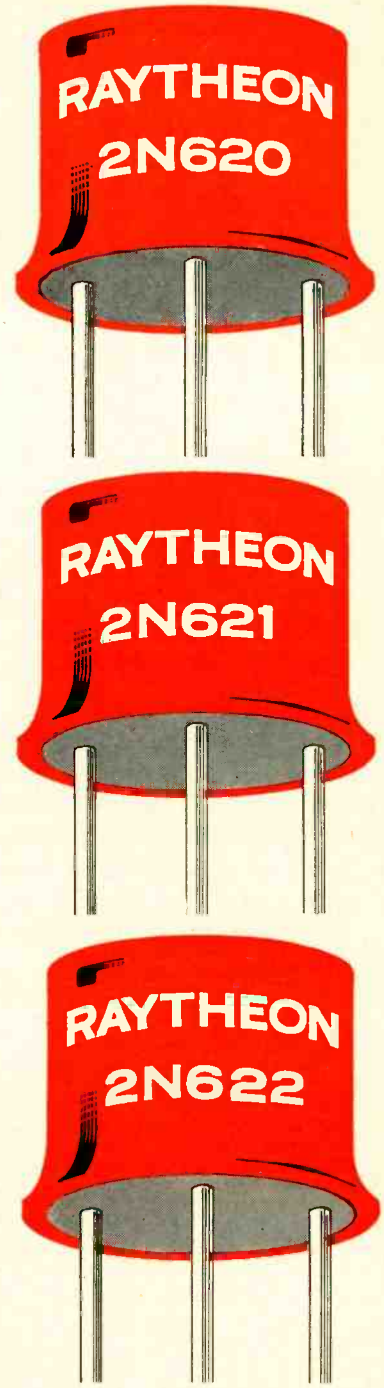
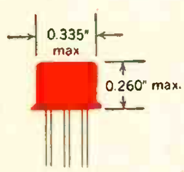


New NPN SILICON TRANSISTORS



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NEW RAYTHEON NPN HIGH TEMPERATURE SILICON TRANSISTORS

Type	Reverse Current at —20V		Beta	Base Resistance ohms	Collector Resistance kilohms	Noise Figure db(max.)	Collector Capacity μμf	Alpha Freq. Cutoff KC
	Collector μA	Emitter μA						
2N619	0.005	0.005	14	2000	500	30	35	200
2N620	0.005	0.005	25	2500	500	30	35	350
2N621	0.005	0.005	50	2700	500	30	35	500
2N622	0.005	0.005	20	2400	500	15	35	300

RAYTHEON PNP HIGH TEMPERATURE SILICON TRANSISTORS

Type	Reverse Current at —20V*		Beta	Base Resistance ohms	Collector Resistance kilohms	Noise Figure db(max.)	Collector Capacity μμf	Alpha Freq. Cutoff KC
	Collector μA	Emitter μA						
2N327A	0.005	0.005	14	1200	500	30	65	200
2N328A	0.005	0.005	25	1400	500	30	65	300
2N329A	0.005	0.005	50	1500	500	30	65	400
2N330A	0.005	0.005	18	1300	500	15	65	250

All ratings are for 25°C. For all types: Dissipation Coefficient in air, 0.4°C/mW; infinite sink, 0.25°C/mW.

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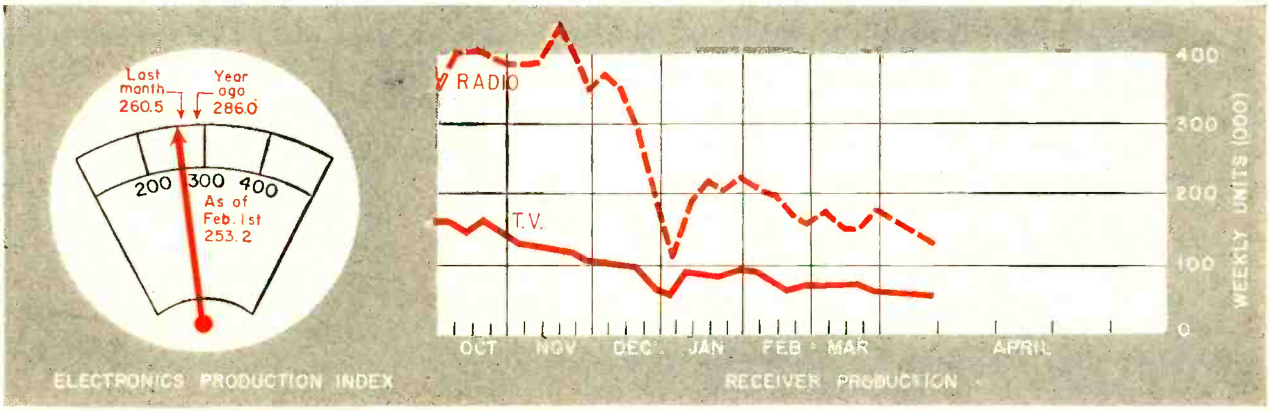
ELECTRONICS NEWSLETTER

ENGINEERING BACHELOR'S DEGREES in 1956-57 totaled 31,211 compared to 26,306 in the previous year, but fell short of the 34,000 advance estimate. September engineering freshmen numbered 78,757, and total enrollment for first engineering degrees reached a high of 268,-761. That's the word from the Scientific Manpower Commission and the Engineering Manpower Commission of the Engineers Joint Council. They report M. S. engineering degrees in 1956-57 up to 5,093 from 4,705 the year before, and Ph.D.'s off 14 to 596.

ION ROCKET ENGINE using chemical propellant was described this month to an aeronautics meeting of the Society of Automotive Engineers. Vaporized propellant feeds into an electrically charged chamber, said R. H. Boden, project engineer at North American Aviation's Rocketdyne division. Then an electron is knocked off each molecule of vaporized propellant, the remaining molecule becoming a positive ion. Newly created ions are pulled out of the chamber by the attraction of an electrostatic field, then jolted by 12,000-v to effective velocities of 300,000-400,000 mph. Speeding ion current would be directed through a 9-in. diameter cylindrical chamber 2 ft long. Propulsion results from vehicle's reaction to ion escape. Leftover electrons similarly ejected would add slightly to thrust. Ion propulsion, declared Boden, would supplement chemical and nuclear rocket engines. He explained that about one pound of thrust would be produced by a 400,000-mph ion stream, enough in space to accelerate a 5-ton vehicle to thousands of mph. Development of a usable ion rocket engine, he added, centers on thrust chamber investigations, propellant studies and development of high specific power generation systems.

AIRLINES' REQUIREMENTS for new and improved instruments on turbine-powered planes are being circulated by the International Air Transport Association. IATA states requirements for a two-position idle setting for jet engine controls; accurate ambient air temperature gauge; mass fuel flow meter; "GO/NO-GO" indicator; and improved artificial horizon.

FERRITE-CORE MEMORY and improved input-output equipment have helped to make Burroughs' new Udec III digital computer 50-100 times faster than Udec II. Not for sale, Udec III is now devoting about 40 percent of its time to Burroughs' own research problems, and the remainder to contracting services—mostly for the Atlas ICBM. It assimilates computer logic for debugging the Atlas computer, and can simulate the program structure of that computer. Udec III is also used in evaluation of weapons system design procedure.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	Apr. 4, '58	Mar. 28, '58	Apr. 5, '57
Television sets, total	70,309	78,057	102,300
Radio sets, total	148,040	195,005	283,754
Auto sets	41,698	61,701	97,644

STOCK PRICE AVERAGES

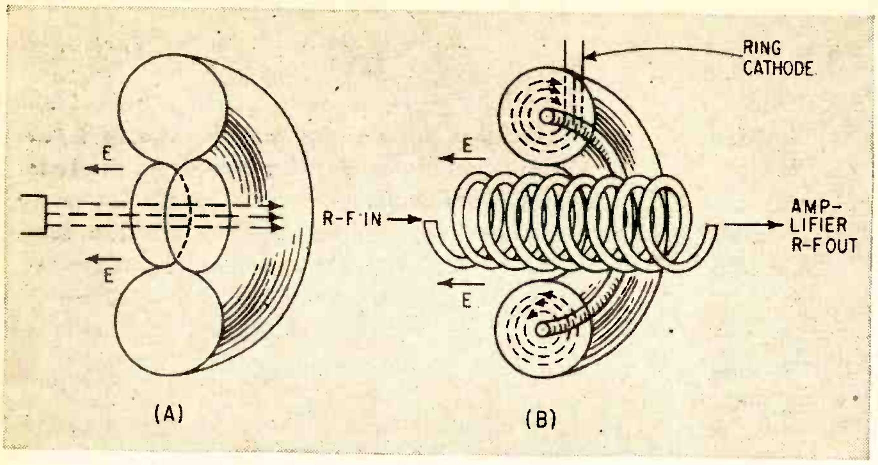
(Source: Standard & Poor's)	Apr. 9, '58	Apr. 2, '58	Apr. 10, '57
Radio-tv & electronics	44.89	45.01	49.87
Radio broadcasters	57.09	57.01	67.28

FIGURES OF THE YEAR

Totals for first two months

	1958	1957	Percent Change
Receiving tube sales	56,466,000	82,031,000	−31.2
Transistor production	6,061,955	3,221,000	+88.2
Cathode-ray tube sales	1,178,046	1,489,223	− 2.1
Television set production	804,396	914,887	−12.1
Radio set production	1,903,418	2,350,294	−19.0
TV set sales	1,030,213	1,148,796	−10.3
Radio set sales (excl. auto)	954,705	1,088,392	−12.3

MORE FIGURES NEXT PAGE



Conventional klystron (A) compared with antiklystron (B) shows duality of mechanical and electronic operation as . . .

Antiklystron Causes Stir

Electron resonance in plasmas, rather than cavity dimensions, is the operating key

MICROWAVE AMPLIFICATION received a novel twist a week ago when Zarem Tchernov of the Institute of Radioelectricity and Electronics, Moscow, USSR, described a new device that combines some of the characteristics of the traveling wave tube with the physical appearance of a klystron.

He called the device an antiklystron amplifier. Details were revealed in a paper presented at a 3-day symposium on electronic waveguides sponsored by the Polytechnic Institute of Brooklyn, the IRE and the Armed Forces.

One advantage of the device is its ability to generate reasonably high powers at submillimeter wavelengths (60 kmc on up) a feat now extremely difficult. Since the antiklystron does not require a magnetic field as a twt does, it is smaller and lighter than a comparable twt. Like a twt, it can be electronically tuned.

Commercial implications of the device were evidenced by the number of manufacturers of microwave tubes who asked Tchernov for more information.

Centrifugal electrostatic focusing (cef) is used to cause electrons injected into a toroid by a ring cathode to orbit about the center conductor within the toroid. Thus a plasma is formed. The electron-resonance frequency of the plasma is a function of the orbiting velocity and determines the operating frequency of the device.

Its name, antiklystron results from the duality that exists between frequency determining elements of a klystron (cavity dimensions) and those of the antiklystron (orbiting dimensions). By launching r-f energy down a helix that passes through the center of the toroid, amplification is obtained through the interaction of the r-f waves and the electron-plasma within the toroid surrounding the helix.

The device is tuned electronically by varying the d-c potential between the center conductor and outer shell of the toroid, thereby varying the electron orbits hence their resonance frequency. With the addition of external feedback circuits it can be made to oscillate.

The final part of the program was a panel discussion on the future outlook of solid state devices and electron tubes. The discussion was limited to noise, frequency, power and bandwidth considerations. Some conclusions were that solid-state devices such as the maser (see p 66) have already approached noise temperatures near absolute zero.

Electron tubes will require work in the area of cathode temperature reduction to further decrease their noise.

Outlines Future Military Needs

SPECIFIC WEAPONS problems the electronics industry will be called upon to solve in the near future were recently revealed by Rear Adm. J. P. Monroe, Commander, Naval Air Missile Test Center, Point Mugu, Calif., at the Western Space Age Conference in Los Angeles. They include:

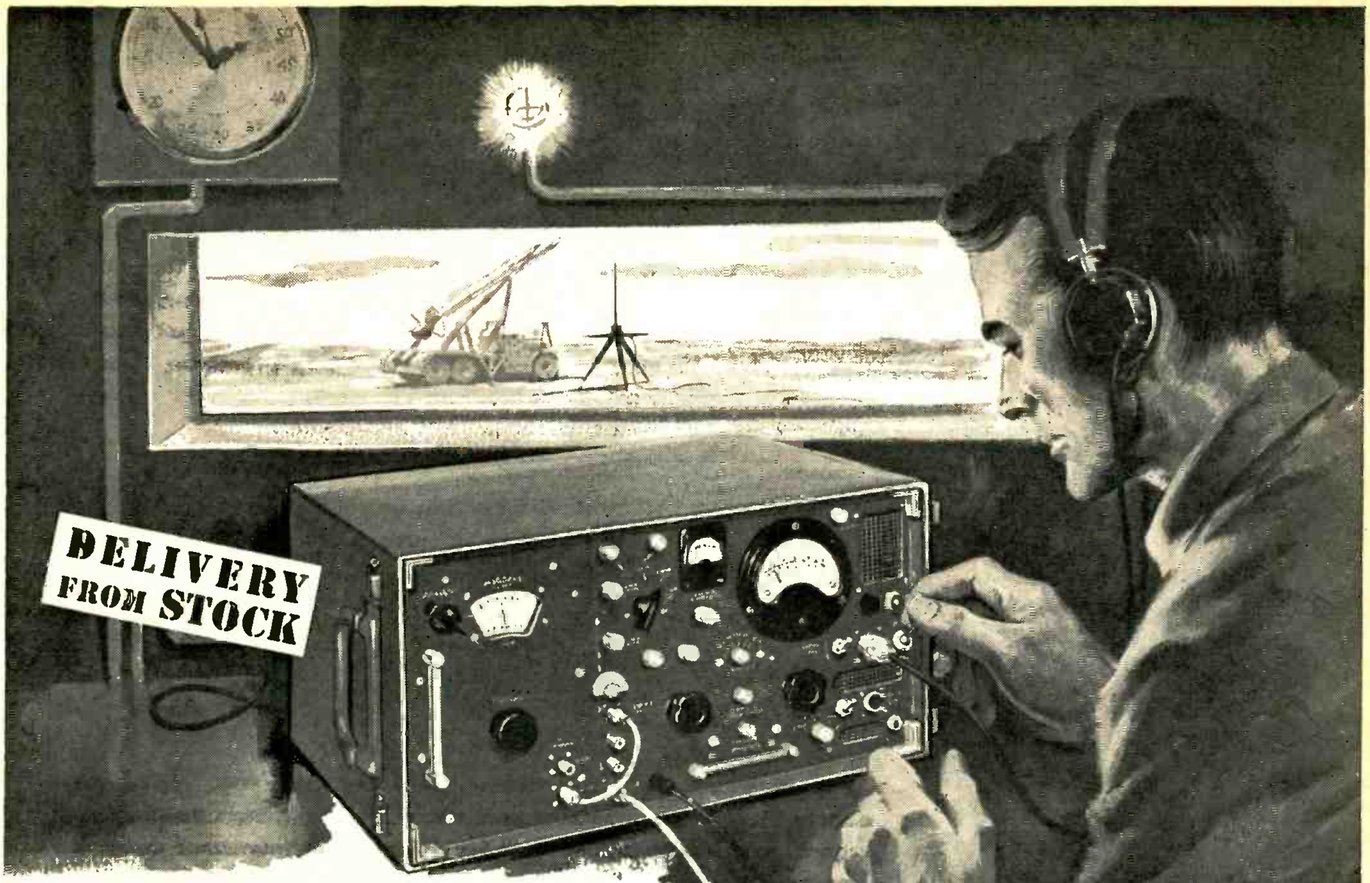
- Lightweight high resolution tv cameras with a long range, high signal-to-noise radio transmitter for use in unmanned satellites.
- Low current consumption tv tape recorders.
- Method or device for passive ranging on targets providing the same quiet capability possessed by passive sonar equipment.
- Method of increasing radar

TRANSISTOR AND TUBE SALES, MONTHLY

(Source: EIA)	Feb. '58	Jan. '58	Feb. '57
Transistors, units	3,106,708	2,955,247	1,785,000
Transistors, value	$6,806,562	$6,704,383	$5,172,000
Receiving tubes, units	29,661,000	26,805,000	44,460,000
Receiving tubes, value	$25,650,000	$23,264,000	$36,631,000
Picture tubes, units	556,136	621,910	728,363
Picture tubes, value	$11,210,527	$12,341,927	$13,134,778

EMPLOYMENT AND EARNINGS

(Source: Bur. Labor Statistics)	Feb. '58	Jan. '58	Feb. '57
Prod. workers, comm. equip.	349,800	362,000	394,600
Av. wkly. earnings, comm.	$79.75	$79.15	$80.18
Av. wkly. earnings, radio	$78.98	$77.40	$76.80
Av. wkly. hours, comm.	38.9	38.8	40.7
Av. wkly. hours, radio	39.1	38.7	40.0



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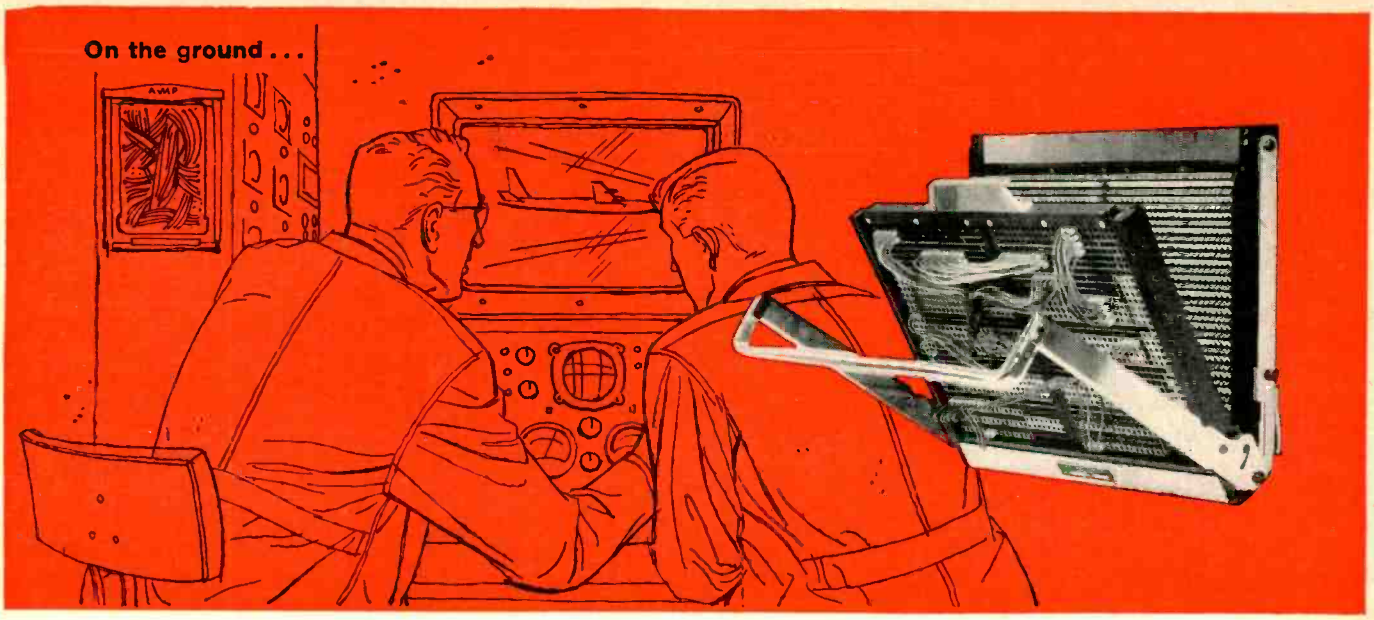

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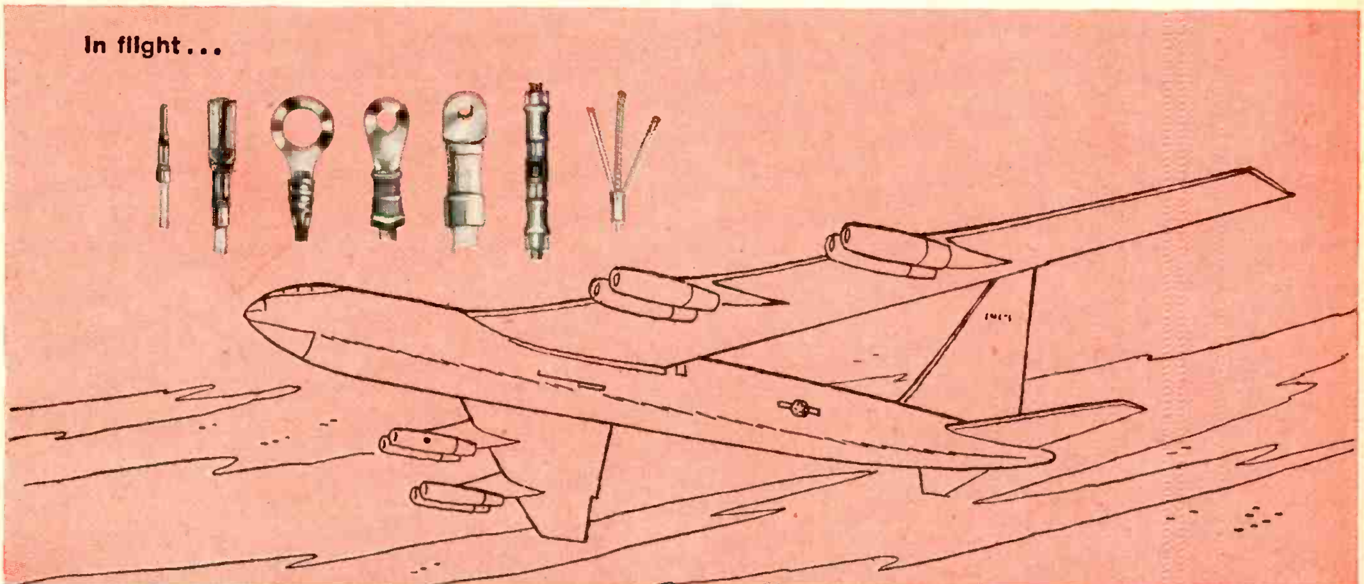
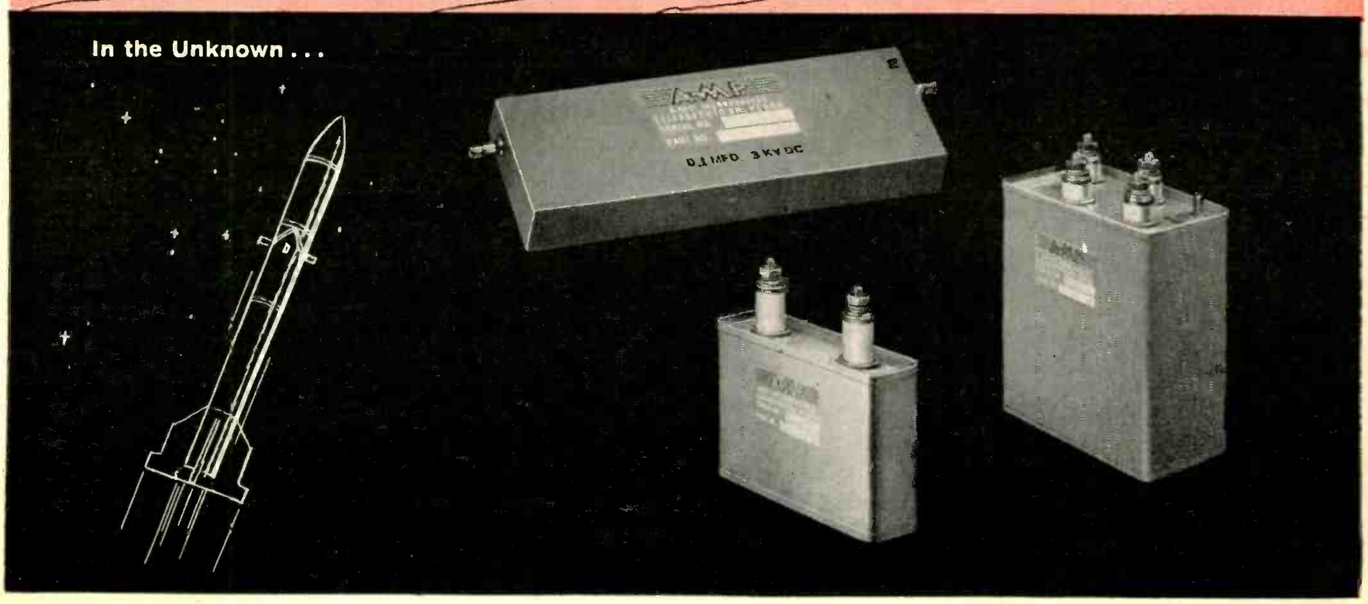




reflectivity of small high speed expendable targets.

- Gyro for inertial systems that is not critically sensitive to environmental changes.
- For missile testing, gear is needed to determine missile acceleration and velocity, precise miss distance and point of closest approach.
- For R&D firings, a three dimensional pictorial display of missile trajectory and target location is needed.
- Self contained airborne fire control system for Navy fighters. In the field of Mach 2 fighters an automatic system—possibly tied in with a shipborne computer—is needed which displays on the fighter radar scope the required course of action, or actually controls pilot through the preliminary phases of an attack. This would eliminate the shipboard fighter controller faced with a 3,000 knot closing speed.
- Missile launching equipment designed for housing in the space of a single van or at least in few enough vans to take the same road on the same day.

Japanese Make Giant Computer

JAPANESE commercial computer activity has now spread to large-scale electronic computers. This month Nippon Telephone and Telegraph Corp. announced completion of a giant parametron computer (photo).

NTT's computer uses 5,000 tiny parametrons. This magnetic computer element is a ferroesonant circuit made up of a toroid with resistive and capacitive elements added to form tuned circuits.

Toroid uses a saturable core whose inductance varies with the applied signal current. System uses

WASHINGTON OUTLOOK

NEWEST MAJOR MISSILE project—Air Force's Minute Man solid-propellant, long-range ballistic missile—is starting to shape up. The Air Research and Development Command is now reviewing bids from dozens of companies for contracts on the overall weapon system and on major subsystems. Selections will be made this summer.

The project will be run along the lines of Thor IRBM, and Atlas and Titan ICBM's. There will be no prime producer with the overall weapon system contract. A team of contractors will run the project under the technical direction of Ramo-Wooldridge and the control of ARDC's Ballistic Missile Div., Inglewood, Calif. Separate prime contracts will be awarded for airframe, propulsion, guidance and nose-cone systems. Among the companies believed to be in the running for Minute Man guidance work are: Arma, Bell Labs, General Electric and Burroughs.

There had been considerable talk that Ramo-Wooldridge was dissatisfied with its role as system engineering contractor on the ballistic missile projects; the contract bans R-W from getting into production work in competition with other project contractors.

Total value of the first Minute Man contracts will come close to $100 million. While these will be the first R&D awards directly tied to the new project, the Air Force already has several study projects going which are closely related to the program research on miniaturization of guidance apparatus and the like. Presumably, the most successful contractors on these projects will be given new contracts for more advanced work on the new missile.

Minute Man is expected to function as both a 1,500-mile IRBM or a 5,000-mile ICBM—depending on the numbers of rocket stages to be put together. The scope of the R&D and future production programs depends on an upcoming Air Force decision of how far to take on the Navy's solid-propellant IRBM as a land-based missile to succeed the liquid-fueled Thor and Jupiter.

One top-level Pentagon official hints that contractor selection will be based to some extent on company backlogs. Assuming equal technical competence and quality of the bids, companies with diminishing missile backlogs stand the best chance for getting in on Minute Man.

- The Post Office Dept. is going to buy a prototype of a new automatic high-speed mail sorting machine designed to handle 36,000 letters an hour. The Rabinow Engineering Co., under contract with the National Bureau of Standards, developed the laboratory prototype. Sorting can be directed either by built-in electronic control, by manual operations or by a combination. Basically, letters will be coded by workers, then run through conveyor and electromechanical equipment that drops letters into various pockets.

  An electronic directory or translator looks up the destination of addresses of letters, and controls the dropping of the letter to its proper bin.

  The prototype will have 1,000 pockets, and will be put to use in a Post Office for trial.

CIRCLE 9 READERS SERVICE CARD

tion is made by telephone-type dial or numbered pushbuttons.

For mobile users, one manufacturer recently announced a system allowing units to dial one another as well as contact base stations. One such dial system has already been installed in a 70-unit network.

Pushbutton dialing saves money for mobile radio telephone users

Rural telephone subscribers in one Virginia area are using a newly installed pushbutton system.

The rocky terrain and scattered population in this area had up to now made it unfeasible to install telephone service. The combination of radio and pushbutton dialing now allows full-scale operation.

A similar system is slated for rural subscriber stations along the Louisiana coast.

Another recent use of dial systems in the mobile band is the service available to Columbus, Ohio telephone subscribers. A central operator wishing to contact a subscriber away from his office can now dial a four-digit code signal causing a pocket receiver to sound. The subscriber then calls operator for message.

FINANCIAL ROUNDUP

• **D. S. Kennedy** antenna manufacturer of Cohasset, Mass., became a publicly owned corporation about a week ago when 100,000 shares of its common stock were offered at $14.50 a share by W. C. Langley & Co. of New York City. Net receipts to Kennedy were $1,320,000 after deducting underwriting fee of $130,000, about nine percent. (Other details, ELECTRONICS, April 18, p 6.)

• **Edin Co.**, Worcester, Mass., manufacturer of medical and industrial instruments, announces it will merge soon with **Epsco, Inc.**, Boston, Mass., manufacturer of digital equipment. Edin will become a division of Epsco, but will continue operations at Worcester.

• **Technology Instrument** of Acton, Mass., registers 260,000 shares of its common stock with the Securities and Exchange Commission. Some 204,775 shares are outstanding, comprising holdings of L. E. Packard, board chairman, R. W. Searle, president and W. H. Long, former treasurer. Remaining 52,225 shares are to be issued by the company. All will be offered for public sale at $10 per share. S. D. Fuller & Co. of New York heads the underwriting group which will receive $1.50 per share commission.

The Acton firm makes precision potentiometers and other precision electronic components and measuring instruments. Proceeds to company will be used to finance expected increased volume on present products and marketing of newly developed precision potentiometers.

• **General Devices** of Princeton, N. J., plans to issue 40,000 shares of common stock. The issue will be offered to stockholders at rate of approximately 18.5 shares for each 100 shares held and at $3.50 per share. Unsubscribed shares will be offered to public. Proceeds will be used for expansion of plant and equipment and also for working capital. No underwriting is involved.

• **Waltham Precision Instrument**, Waltham, Mass., purchases assets of **Thermal Dynamic Products** of New York City for an undisclosed sum. Purchased firm will be operated as a division of Waltham. It gives Waltham access to the growing market for high temperature research and for environmental test equipment.

• **New Haven Clock and Watch** of Stamford, Conn., has been reorganized and placed under new management. The new group, headed by Max A Geller, chairman of the board, and Seth T. Harrison, president, received 850,000 of New Haven's 1,500,000 outstanding shares for sum of $200,000. **Condenser Products Company**, electronics division of the New Haven company, has resumed production. It makes high voltage power supplies and plastic capacitors.

Data Unit Aims Radar at Moon

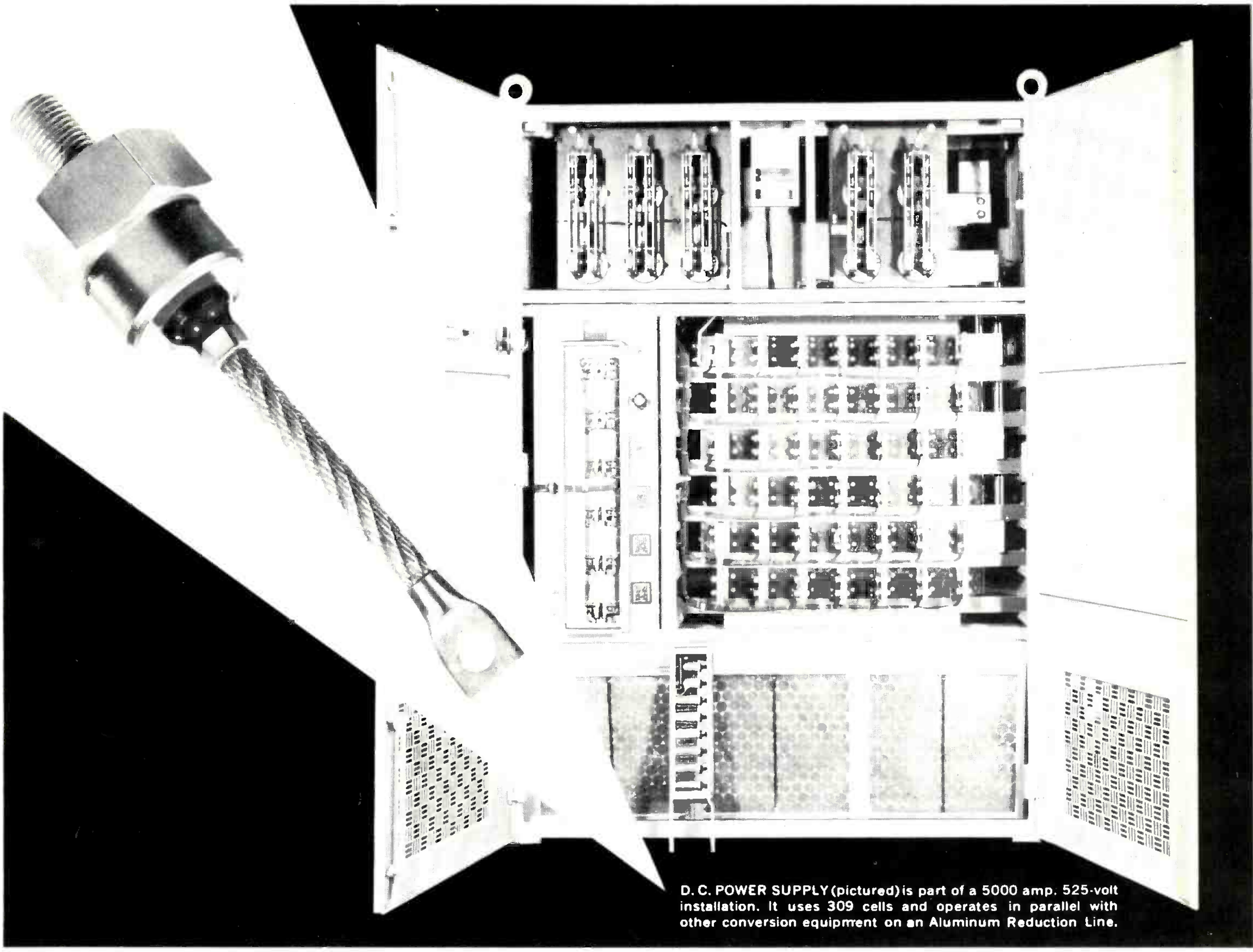
As MILITARY and civilian protagonists square off before Congress in hearings to determine who will be kingpin in space explorations, data-processing preparations for a "moon-shot" appear to be already underway within the Defense Dept. The Army has an electronic system that can keep a high-powered radar pointed right at the moon over an extended period. Moon movement for the next six months has been calculated and put on punch cards for a digital-analog data-processing and transmitting system.

Inference that military authorities are in the midst of planning for an instrumented "moon-shot" could be drawn from a technical paper at the IRE convention.

Paper was entitled "Digital Moon Radar Antenna Programmer With Analog Interpolator Servo," and was presented by Olaf A. Guzmann, U. S. Army Signal Engineering Laboratories, Fort Monmouth, N. J. The paper did not actually relate the system described with a definite plan for sending a rocket to the moon.

However, Guzmann declared the system is now being used for azimuth and elevation positioning of moon radars, and that calculated moon positions for a half year ahead are prepared on punch cards. Celestial coordinates are converted

CIRCLE 10 READERS SERVICE CARD→



D. C. POWER SUPPLY (pictured) is part of a 5000 amp. 525-volt installation. It uses 309 cells and operates in parallel with other conversion equipment on an Aluminum Reduction Line.

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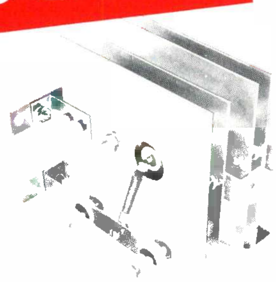
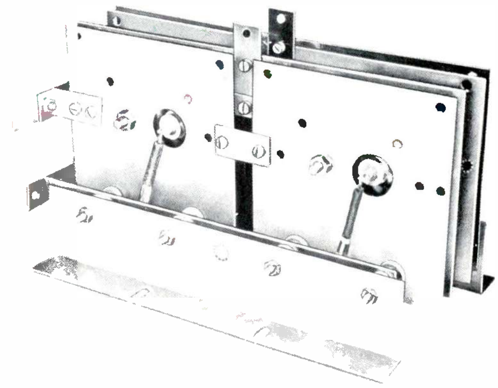
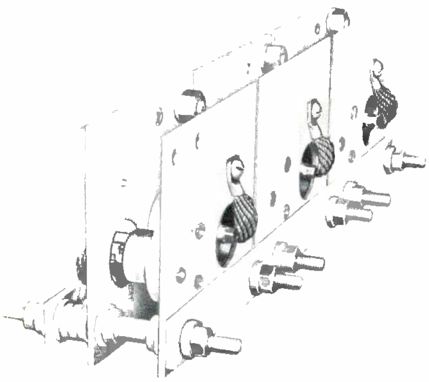
BRIDGES



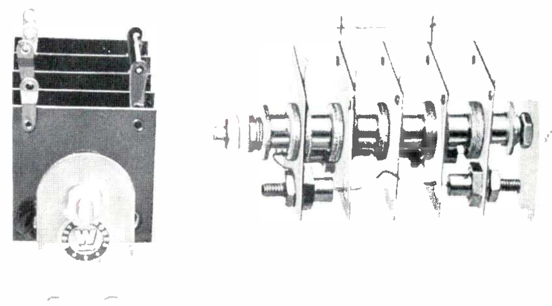
This is a 4-1-1 single-phase full-wave bridge using 303 cells on 5" x 5" copper plates. At an ambient temperature of 30° C, it will deliver up to 27 amperes d.c. with convection cooling, or 53 amperes d.c. with forced air cooling at 1000 l.f.m. The primary applications are d.c. power supplies, vibrator and magnet coil supplies, motor control, etc.



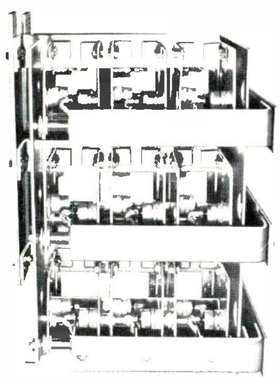
This is a 4-1-2 single-phase full-wave bridge using 302 cells on 5" x 5" copper plates. At an ambient temperature of 30° C, it will deliver up to 94 amperes d.c. with convection cooling, or 178 amperes d.c. with forced air cooling at 1000 l.f.m. The primary applications are d.c. power supplies, vibrator and magnet coil supplies, motor control, etc.



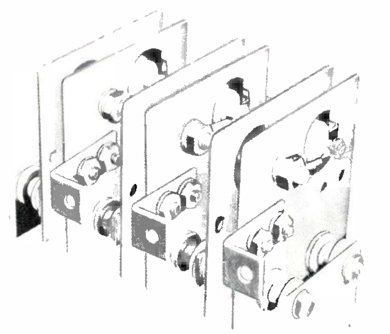
This is a 6-1-1 three-phase full-wave bridge using 322 cells on 5" x 5" copper plates. At an ambient temperature of 30° C it will deliver up to 132 amperes d.c. convection cooled, or 330 amperes d.c. with forced air cooling at 1000 l.f.m. The primary applications are welding, electro-plating, chemical reduction, arc furnaces, motor drive, battery chargers, etc.



This is a 4-1-1 single-phase full-wave bridge using 305 cells on 1½" x 1½" copper plates. At an ambient temperature of 30° C, it will deliver up to 3.2 amperes d.c. with convection cooling. The primary applications are power supplies, relays, solenoids, mag amps, etc.



This is a 6-1-6 three-phase full-wave bridge using 322 cells on 5" x 5" copper plates. At an ambient temperature of 30° C, it will deliver up to 780 amperes d.c. with convection cooling, or 1980 amperes d.c. with forced air cooling at 1000 l.f.m. The primary applications are electro-plating, battery forming, arc furnaces, chemical reduction, motor drive, etc.



This is a 6-1-1 three-phase full-wave bridge using 302 cells on 3" x 3" copper plates. At an ambient temperature of 30° C, it will deliver up to 61 amperes d.c. with convection cooling, or 132 amperes d.c. with forced air cooling at 1000 l.f.m. The primary applications are d.c. power supplies, vibrator and magnet coil supplies, motor control, etc.

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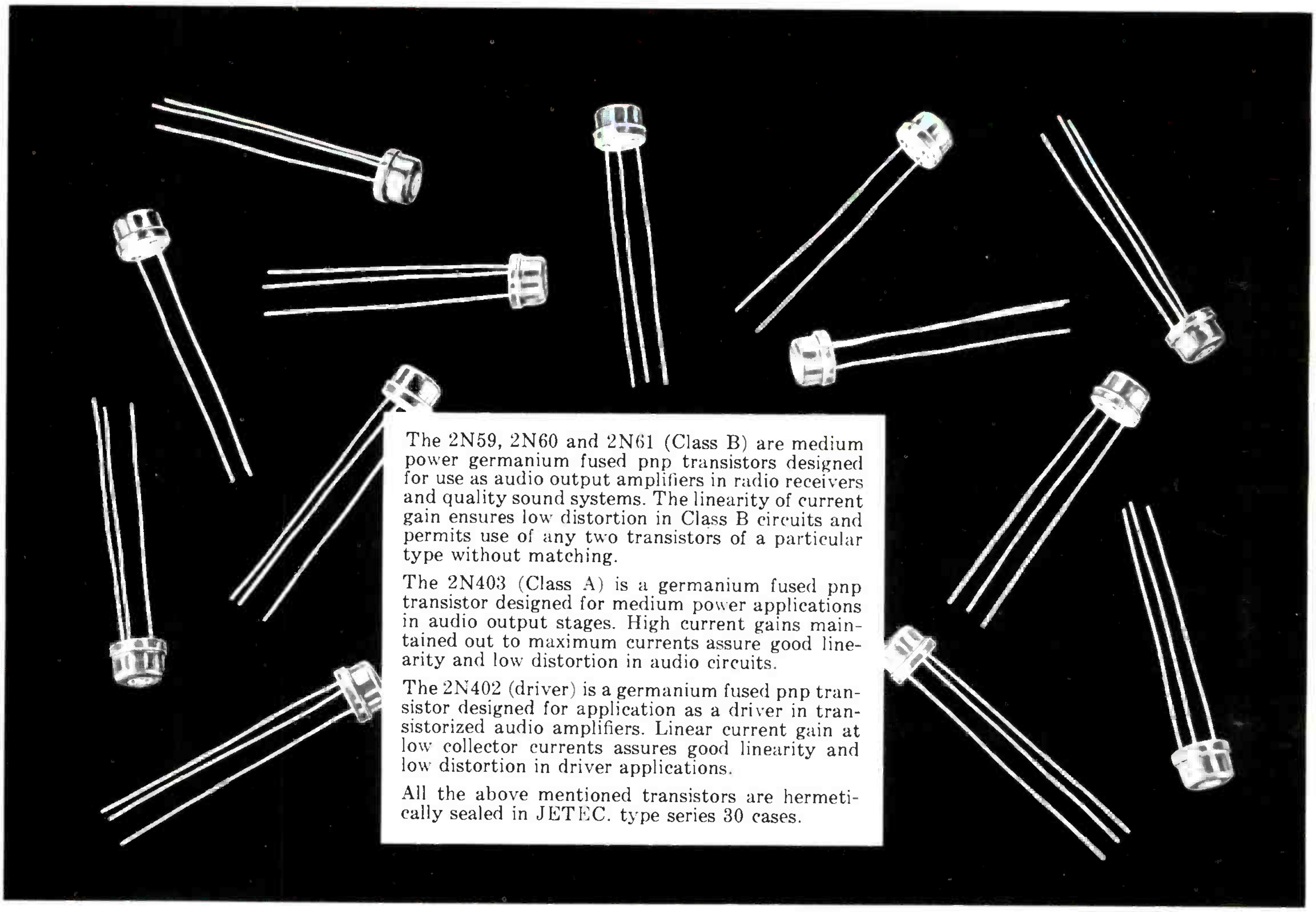

The 2N59, 2N60 and 2N61 (Class B) are medium power germanium fused pnp transistors designed for use as audio output amplifiers in radio receivers and quality sound systems. The linearity of current gain ensures low distortion in Class B circuits and permits use of any two transistors of a particular type without matching.

The 2N403 (Class A) is a germanium fused pnp transistor designed for medium power applications in audio output stages. High current gains maintained out to maximum currents assure good linearity and low distortion in audio circuits.

The 2N402 (driver) is a germanium fused pnp transistor designed for application as a driver in transistorized audio amplifiers. Linear current gain at low collector currents assures good linearity and low distortion in driver applications.

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Class B Applications							
2N59	−9	300	180	250*	30	−15†	+85°C
2N60	−9	300	180	250*	28	−15†	+85°C
2N61	−9	300	180	250*	26	−15†	+85°C
Class A Applications							
2N403	−9	30	180	500	34	−15†	+85°C
Driver Applications							
2N402	−9	2	180	10,000	39	−15†	+85°C

*Collector to Collector Load Impedance

†VCB = minus 20V

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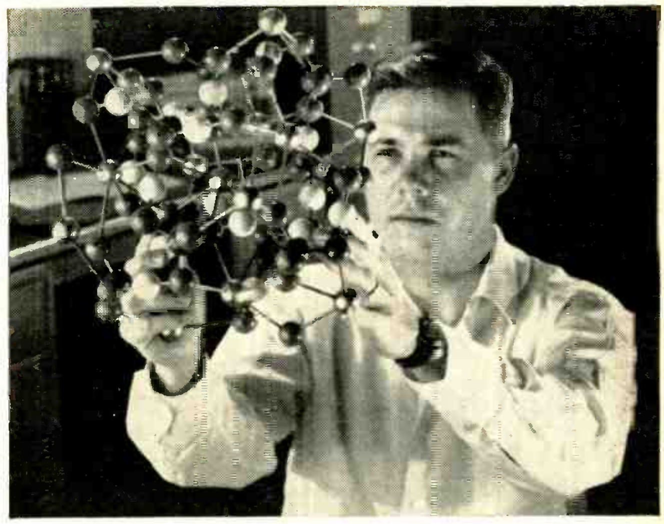


Dr. Walter Brown, physics graduate of Duke and Harvard Universities, bombards crystalline solids with one-million-volt electrons to study the nature of simple defects in crystals. Objective: new knowledge which may help improve transistors and other solid state devices for new and better telephone and military systems.

Peter Sandsmark, from Polytechnic Institute of Brooklyn, and his fellow electrical engineers develop a new microwave radio relay system able to transmit three times as much information as any existing system. Objective: more and better coast-to-coast transmission for telephone conversations and network television.

Bill Whidden, from Polytechnic Institute of Brooklyn, and George Porter, from Georgetown College, study new experimental telephone instruments designed to explore customer interest and demand. Objective: to make your future telephone ever more convenient and useful.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT to terrestrial coordinates and stored on magnetic tape.

In time synchronism, taped signals are fed into a digital-to-analog converter at intervals of three minutes, integrated, monitored and applied to a servo control system which positions the radar antenna.

Soviets Describe Huge Microscope

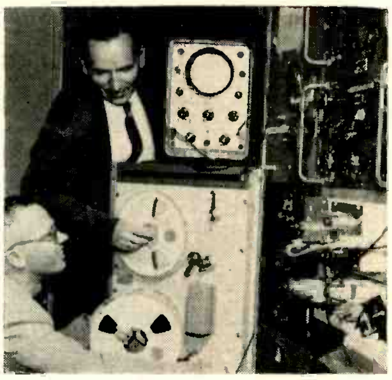
SOVIET SCIENTISTS have developed a "super electron microscope" producing enlargements by several millions and making even barium atoms visible. Microscope, says the newspaper Izvestia, is similar to electron beam tube of a tv set, with a flat-bottomed glass bulb serving as an image screen.

In the neck of the bulb are two metal pieces to which a wire loop is attached. At the end of the loop is a metal needle which points towards the screen, the needle serving as the negative electrical pole. Several thousand volts produce a beam of electrons from the needle, creating a magnified image of the needle point on the screen.

When gas is fed into the bulb and the gas molecules settle inside, the molecule on the very point of the needle is reproduced on the screen as if it were an extention of the needle. Its image is magnified tens of millions of times.

With this instrument, says Izvestia, studies of metal surfaces are possible using a needle made of the same material as that under investigation. Molecules of oxygen, pythalocyanin, anthracene and others have been studied under the new microscope.

Satellite Eye



Ampex recorder at Stanford Research Institute picks up radar traces for analysis and later reproduction. Built for atmospheric clutter studies, it has been observing the satellites as well

Community Tv Outside FCC

COMMUNITY TV antenna systems have won an important victory in a long-standing squabble with local tv stations. In a recent decision, the FCC dismissed a complaint brought by a handful of radio and tv broadcast stations against 288 community antenna systems in 36 states. The commission held that it has no power to regulate community antennas because they are not common carriers.

Most recent estimate shows about 650 systems extending tv reception to upwards of 2 million people throughout the country. One industry source sees another 1,000 communities as potential markets.

And there is still plenty of room for expansion of channel facilities and number of subscribers within existing systems.

Today the average number of subscribers per system is about 1,000, but the average potential per system is over 2,000.

Estimated capital investment in the industry is in excess of $500 million.

MEETINGS AHEAD

Apr. 24-26: National Academy of Sciences, U. S. National Comm., International Scientific Radio Union, Spring Meeting, Willard Hotel, Wash., D. C.

Apr. 27: Assoc. of Maximum Service Telecasters, Annual Meeting, Biltmore Hotel, Los Angeles.

Apr. 27-May 1: National Assoc. of Broadcasters, 36th Annual Convention, Biltmore and Statler Hotels, Banquet in Hollywood Palladium, Los Angeles.

Apr. 28-30: Middle Eastern District Meeting. AIEE, Sheraton Park Hotel, Washington, D. C.

Apr. 28-May 1: Sixth Annual Semiconductor Symposium of the Electrochemical Society, Statler Hotel, N. Y. C.

Apr. 29-30: Symposium on Electronic Scanning of Antennas, AFCRC and Rome Air Devel. Command, L. G. Hanscom Field, Bedford, Mass.

Apr. 30: Single Sideband Communications, report on, IRE, AIEE, 7 pm, Engineering Societies Building, N. Y. C.

Apr. 30-May 2: Seventh Regional Conf and Trade Show, IRE, State Fair Grounds, Sacramento, Calif.

May 4-7: Fourth National Flight Test Instrumentation Symposium, ISA, Park Sheraton Hotel, N. Y. C.

May 5-7: Professional Group on Microwave Theory and Techniques, PGMTT, Stanford Univ., Stanford, Calif.

May 6-8: Frequency Control Symposium, 12th Annual, U. S. Army Signal Engineering Labs, Berkeley-Carteret Hotel, Asbury Park, N. J.

May 6-8: Western Joint Computer Conf., First National Symposium on Modern Computer Design, Ambassador Hotel, Los Angeles.

May 12-14: National Aero. & Nav. Elec. Conf., PGANE, Biltmore Hotel, Dayton, Ohio.

May 12-15: Eighth Annual Research Equip. Exhibit and Instrumentation Symposium, National Institute of Health, Bethesda, Md.

May 13-15: Radio Tech. Comm. for Marine Services, Ben Franklin Hotel, Philadelphia.

May 19-21: Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago.

May 19-23: International Convention on Microwave Valves, Institute of Electrical Engineers, contact secretary, Savoy Place, London.

May 27-28: Second EIA Conf. on Maintainability of Electronic Equip., Univ. of Penn., Phila.

June 2-4: National Telemetering Conference, AIEE, ISA, ARS, Lord Baltimore Hotel, Baltimore, Maryland.

June 4-6: Armed Forces Communications and Electronic Assoc., Exhibit, Hotel Sheraton Park, Washington, D. C.

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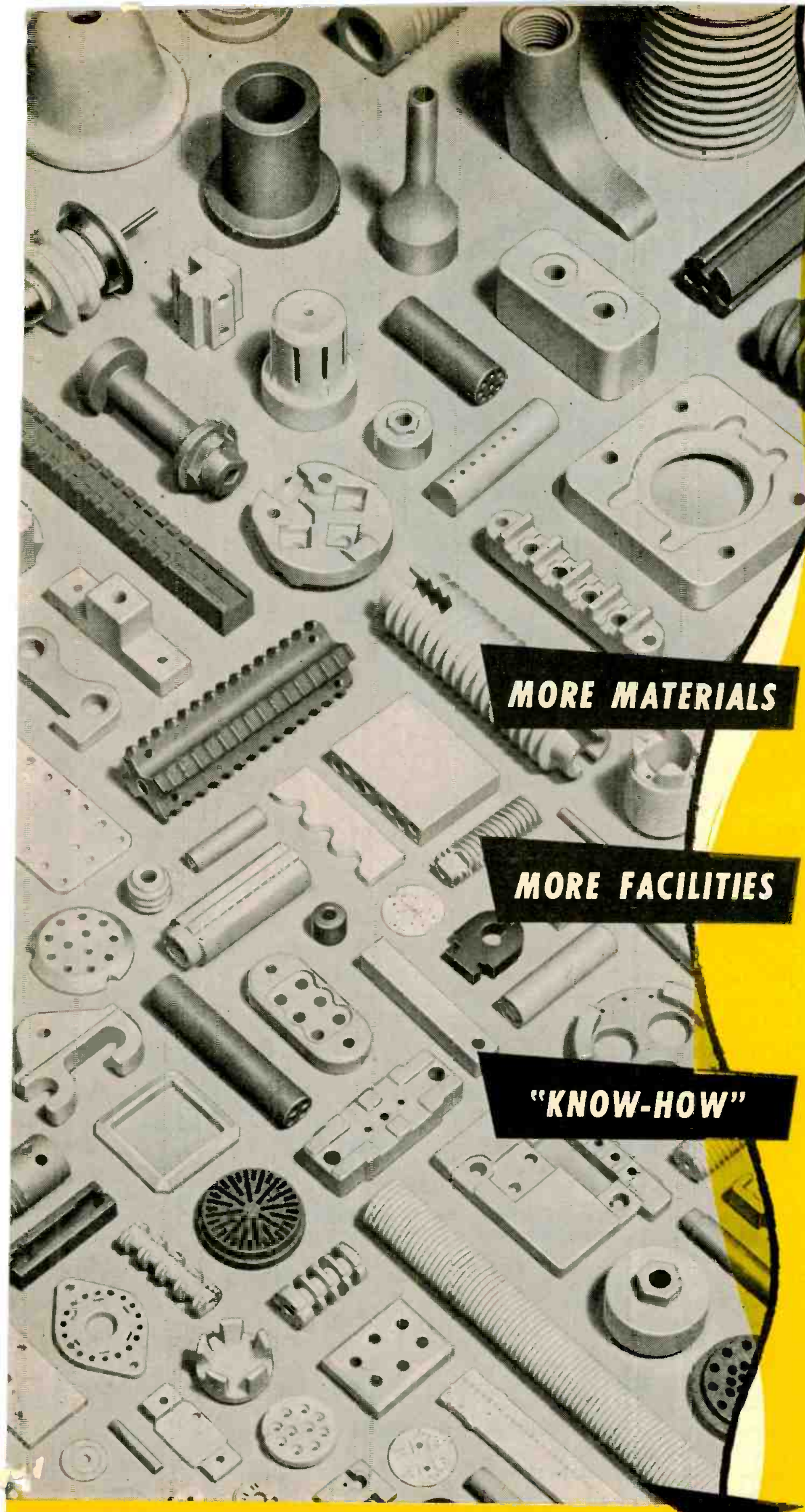

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STODDART & MILITARY TYPE	FREQUENCY	MIL-I-16910 (Ships)	MIL-I-6181	S.A.E.	A.S.A.	C.I.S.P.R.
NM-40A (AN/URM-41)	30cps-15Kc	CLASS '1'	Not Req'd	Not Req'd	Not Req'd	Not Req'd
NM-10A (AN/URM-6B)	14Kc-250Kc	CLASS '1'	Not Req'd	Not Req'd	C63.2 (Proposed)	Not Req'd
NM-20B (AN/PRM-1A)	150Kc-25Mc	CLASS '1'	CLASS '1' *CATEGORY 'A'	Not Req'd	C63.2 (Proposed)	**
NM-30A (AN/URM-47)	20Mc-400Mc	CLASS '1'	CLASS '1' *CATEGORY 'A'	APPROVED	C63.3 (Proposed)	**
NM-50A (AN/URM-17)	375Mc-1000Mc	CLASS '1'	CLASS '1' *CATEGORY 'A'	Not Req'd	C63.3 (Proposed)	Not Req'd

*MIL-I-6181C (Proposed)
**Can be supplied to C.I.S.P.R. Recommendations
S.A.E. (Society of Automotive Engineers)
A.S.A. (American Standards Association)
C.I.S.P.R. (Comite International Special des Perturbations Radioelectriques) (International Special Committee on Radio Interference)

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5 engineers, to measure over—
5 different frequency ranges, at—
5 different locations, at—
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New trends and developments in designing electrical products...

"Work backward"—a new design approach that's bringing the advantages of General Electric permanent magnets to fields traditionally reserved for electromagnets

A new approach to the design of motors, generators, relays, and similar products is making it possible to produce smaller, more efficient and economical units by using permanent magnets, instead of electromagnets.

The new approach is simply to "work backward." That is, design the most efficient magnet assembly first, and then the rest of the component.

In the past, where designers tried to replace electromagnets in these products, permanent magnets often proved uneconomical. Here's why:

The traditional approach was to work the permanent magnet into an *existing* design for a wire-wound field, to save the cost of new dies and other major manufacturing changes.

Under these conditions, permanent magnets will seldom show to best advantage. But, by using the "work backward" approach, many outstanding results can be obtained.

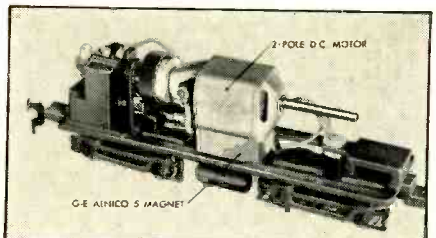


FIGURE 1 — G-E Alnico 5 magnet helps 2-pole motor develop 1/150 hp at 10,000 to 15,000 rpm.

For example, permanent magnets had been limited to fractional-hp applications, such as the 1/150-hp toy-locomotive motor in Figure 1.

But today, through imaginative design and more efficient alloys, permanent magnets are now used for rotors and stators in much larger equipment.

The DC tachometer generator in Figure 2, for example, uses a 2-lb. G-E Alnico 6 stator.

The permanent magnet provides greater reliability and accuracy than copper windings, over wide ambient temperatures. It eliminates an external power source and field regulating equipment. And, there is no replacement problem since the magnet — unlike wire — never burns out.

These are some of the advantages that can be realized from early consideration of the permanent magnet in design.

FIGURE 2 — 46-frame DC tachometer generator with Alnico 6 stator.

Alone, these can more than justify the cost of redesigning equipment to eliminate wound fields. Yet, there are other advantages that result from the magnet's ability to supply a constant field without external excitation, including:

- Elimination of field interruptions due to power failure.
- Elimination of heat and need for costly cooling equipment and insulation — thus conserving valuable weight and space.
- Elimination of danger from faulty wiring or damaged insulation.

These are important advantages where equipment must be reliable despite severe environmental conditions. But equally important to the designer is the permanent magnet's superior volumetric efficiency. A G-E Alnico magnet can usually supply a given magnetic field in a fraction of the space needed by even the best designed electromagnet.

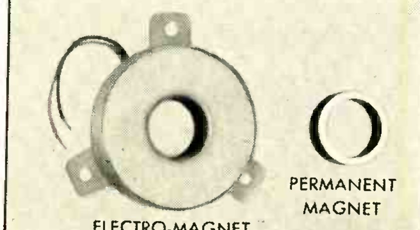


FIGURE 3 — TV-tube focusing magnets.

The TV-tube focusing magnets in Figure 3 gives some idea of the savings in space and weight a designer can effect.

The electromagnet weighs 2 lbs., and takes up 16.35 cubic inches. The G-E Alnico 5 permanent magnet weighs just 15 ounces, and requires only 1.30 cubic inches — a space-saving of 87%.

In addition to the problem of economics, two other traditional objections to permanent magnets have also been largely eliminated:

First, early permanent magnets were relatively unstable. But modern permanent magnet materials from improved manufacturing techniques are really "permanent" . . . even under temperature and humidity conditions ruinous to electromagnets.

Second, applications requiring "on-off" field action seemed outside the capabilities of permanent magnets. But modern design techniques have developed practical ways to handle this by shunting flux around the air gap.

With the new high-energy alloys and the development of more scientific design methods, the future for permanent magnets—and the opportunity for designers — is virtually unlimited.

For example, a recent use of the "work backward" approach has, for the first time, made it possible to use powerful Alnico magnets to supply uniform fields in equipment like traveling wave tubes.

General Electric Magnet Engineers have accumulated a wealth of information on the problems of redesigning for permanent magnets. They will share their knowledge with you at any stage of the magnet design project.

For more information, or the services of a G-E Magnet Engineer, write: *Magnetic Materials Section of General Electric Company, 7806 N. Neff Street, Edmore, Michigan.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

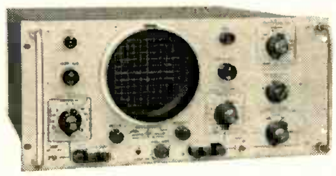
CIRCLE 17 READERS SERVICE CARD

Whichever -hp- oscilloscope these new, time-saving

dc to 10 MC — $1,100.00

-hp- 150A/AR High Frequency Oscilloscope.

World's premier hf oscilloscope. 24 direct-reading sweep times; sweeps 0.02 μsec/cm to 15 sec/cm. Universal automatic triggering wherein one preset condition insures optimum triggering. Plug-in amplifiers for high gain or dual channel operation (see opposite page). Cabinet (150A) $1,100.00. Rack (150AR) $1,200.00.



dc to 300 KC — $650.00

-hp- 130A/BR Low Frequency Oscilloscope.

Similar horiz. and vert. amplifiers; input circuits balanced on 6 most sensitive ranges. Single ended input dc or ac coupled; direct reading, needs no pre-amplifier with many transducers. Brilliant, high resolution trace. Universal automatic trigger. *-hp-* 130BR (rack) similar to 130A except includes x 5 magnifier for all ranges which expands fastest sweep to 0.2 μsec/cm. 130A (cabinet) or 130BR (rack) $650.00.

New amplifiers and accessories

-hp- 152B Dual Trace Differential Amplifier

New plug-in amplifier providing differential input and dual traces electronically switched between A and B channels at either 100 KC or on alternate sweeps. Sensitivity range 0.05 v/cm to 50 v/cm, input attenuator with 9 calibrated ranges in 1-2-5-10 sequence and vernier. $250.00.

-hp- 153A Very High Gain Amplifier

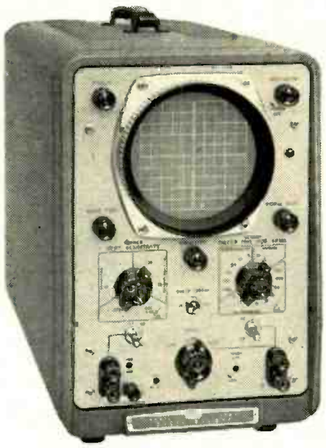
New plug-in permitting *-hp-* 150A to be used for many direct measurements from transducer without *preamplification.* Pass band dc to 500 KC, sensitivity 1 mv/cm to 125 v/cm, balanced input on the 6 most sensitive ranges. 15 calibrated ranges in 1-2-5-10 sequence, 1 mv/cm to 50 v/cm; plus vernier. $125.00.

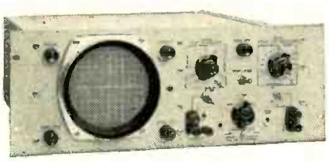
-hp- 151A High Gain Amplifier

For either 150A or 150AR, high gain unit with 5.0 mv/cm sensitivity, frequency response dc to 10 MC. 12 calibrated ranges on 0.5, 1-2-5 sequence. 1 megohm input impedance with 27 μμf shunt. Pass band rise time 0.035 μsec. Has 2 BNC terminals. $200.00.

hp provides 6 different oscilloscopes!

you choose, you get convenience features...





dc to 200 KC—$435.00

-hp- 120A/AR Industrial Oscilloscope.

For lab or production line work, outstanding value and performance. Automatic trigger, 15 calibrated sweeps in 1-2-5 sequence, sweep speed range 1 μsec/cm to 0.5 sec/cm, x 5 sweep expansion all ranges, automatic synchronizing on all internal or external voltages, including line power. High sensitivity, calibrated vertical amplifiers, all power supplies regulated. 120AR rack mount instrument only 7″ high. Utmost dependability; extra rugged construction. 120A (cabinet) or 120AR (rack) $435.00.

immediate delivery; see your -hp- rep now

direct reading, high accuracy

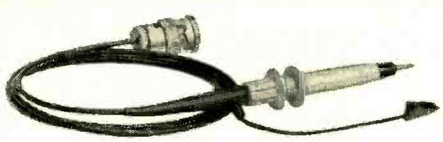
universal automatic triggering

color-coded controls, simplest to use

"no-pre-amp" operation from many transducers

highest performance, outstanding value

increase convenience of your 150A



-hp- AC-21C 50:1 Voltage Divider Probe

A 50:1 divider with high 10 megohm input impedance and low 2.5 μμf input capacitance. Convenient "pen" size for maximum handling ease. Probe has durable, attractive nylon barrel, alligator clip contactor. $25.00.

-hp- 115A Oscilloscope Testmobile

Most convenient mobile oscilloscope mounting. For 150A Oscilloscopes but usable with other instruments. Rolls easily on large 4″ rubber-tired wheels. Extra-sturdy construction of 7/8″ tube stock, gleaming chrome throughout. Oscilloscope shelf tilts 30° in four 7-1/2° increments for better viewing. $80.00.

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

HEWLETT-PACKARD COMPANY

4649A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
CABLE "HEWPACK" • DAVENPORT 5-4451
FIELD ENGINEERS IN ALL PRINCIPAL AREAS

See your -hp- representative!

CIRCLE 19 READERS SERVICE CARD

ALL NEW!

Veeder-Root
Panel-Mounted High Speed
Electrical Counters

...with electric resetting in 1/10th of a second

These new Series 1591 Electrical Counters fill the gap between standard and electronic counters for industrial, data processing, or laboratory and scientific uses. They're designed for accuracy and long life at very high speeds (rated at 3000 counts per minute, with extended test-runs up to 6000 cpm).

And they have the unmatched convenience of *instant push-button resetting*, either mechanically right on the machine . . . or electrically from a distance. Panel-groups of these counters can be placed right in your office . . . *and one button can reset an entire panel.* Counters feature large figures, small size, low-wattage coils for continuous duty and other V-R vantage points on which patents are pending.

These new and different counters are the latest evidence that Veeder-Root design and development always keep pace with modern counting requirements. Write for specifications and prices.

Added Evidence that Everyone Can Count on

VEEDER-ROOT
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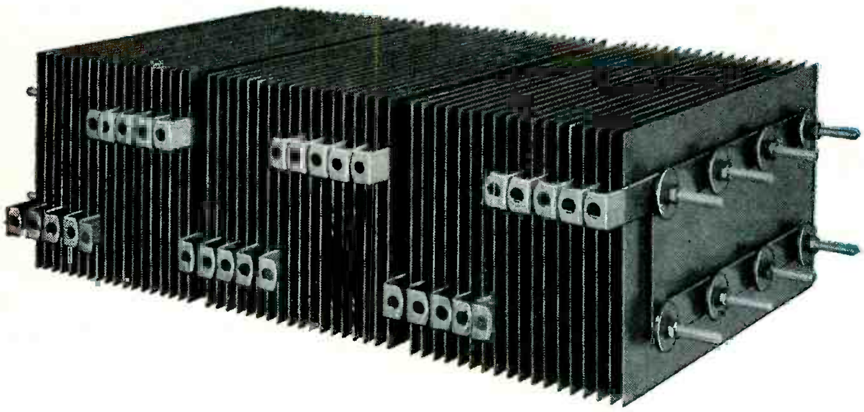
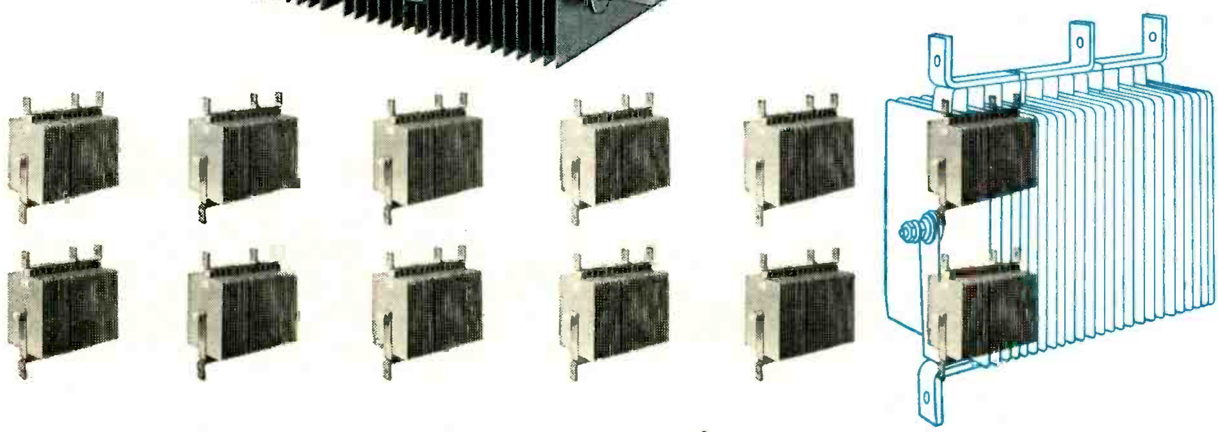
Single New Rectifier Outperforms



12 full size conventional stacks!



Radio Receptor HCD* Petti-Sel

*High current density

Industrial Type Selenium Rectifiers

Produced by the improved new vacuum process developed by Siemens of West Germany and now manufactured exclusively by Radio Receptor in the U.S.

Smaller cell sizes

Lower voltage drop

No artificial barrier

Negligible aging with an estimated life of 100,000 hours!

Because the exclusive Siemens vacuum process eliminates the need of an artificial barrier layer, it is possible for Radio Receptor to offer smaller cell sizes operating at high current density, yet with lower voltage drop. In actual dimensions this means that just *one* RRco. HCD rectifier measuring 8″ x 16″ x 25″, rated at 26V AC, 4500 amps DC, replaces *twelve* usual stacks 6″ x 7¼″ x 10″.

RRco. Petti-Sel rectifiers do far more than save space. They reduce assembly time, require fewer connections and cost less per ampere. Their dependability has been proved for years in European circuits and the outstanding electrical characteristics are not even approached by other standard cells available today. For further information please write today to Section E-4R.

Radio and Electronic Products Since 1922

Semiconductor Division

RADIO RECEPTOR COMPANY, INC.

A Subsidiary of General Instrument Corporation

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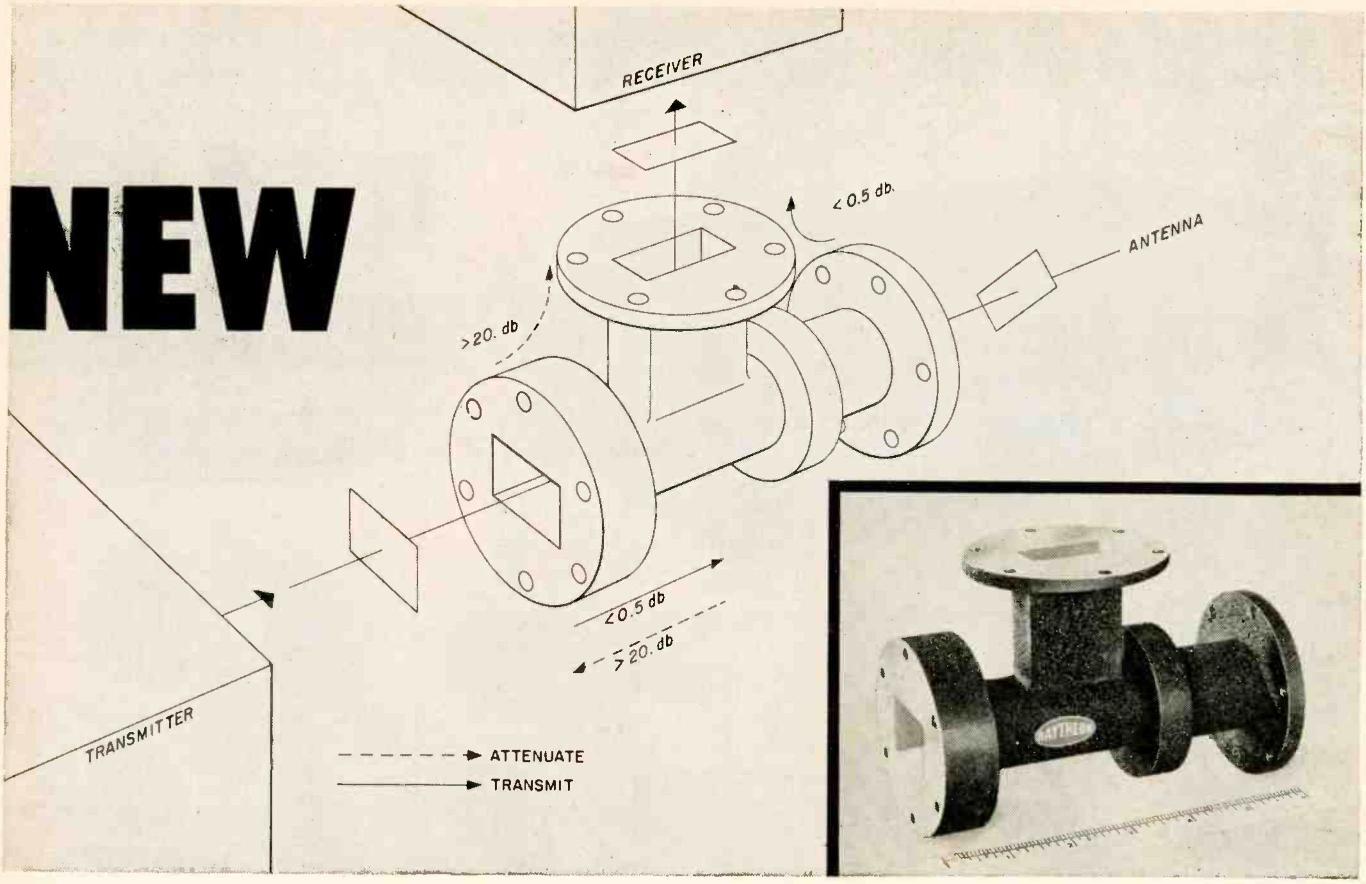
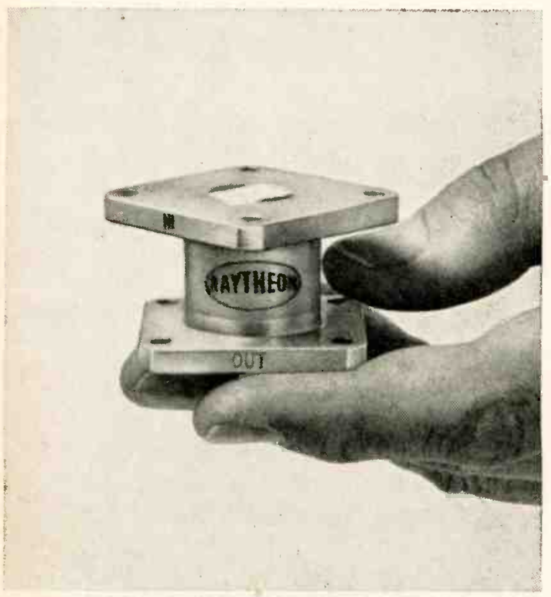
Radio Receptor products for Industry and Government:
Germanium and Silicon Diodes, Selenium Rectifiers, Thermatron Dielectric Heating Generators and Presses, Communications, Radar and Navigation Equipment

NEW



MICROWAVE FERRITE CIRCULATOR . . .



RAYTHEON MINIATURIZED X-BAND ISOLATORS weigh as little as 2.2 oz. For somewhat different requirements in the lower frequency L-band, Raytheon recently introduced the first high-power L-band isolator commercially available.

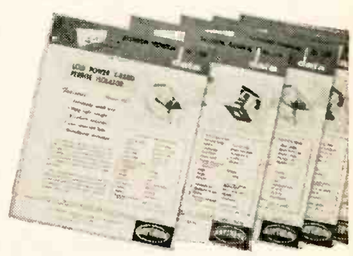
Compact C-band unit replaces gas-tube duplexer; needs no external power.

System designers: This new circulator is lighter and more compact than the differential phase-shift type unit and readily replaces typical TR or ATR gas tubes in C-band microwave transmission systems.

The Raytheon Model CCM1 weighs less than 5 lbs. and is less than 6 inches long. Its permanent magnet design eliminates the need for external drive power. The CCM1 reduces requirements for filters and klystron isolation common to systems using T-junction duplexers.

With Raytheon's advanced microwave component designs like this new C-band circulator, systems designers now have more freedom than ever before to design compact lightweight packages. Other devices now available and in advanced stages of development include isolators, both high and low power, ranging from L-band to Ku-band; ferrite switches; modulators; and side-band generators.

FOR COMPLETE FACTS or assistance in solving your microwave ferrite component problems, simply write to the address below, outlining your requirements.



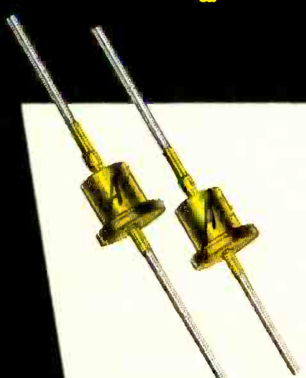
Excellence in Electronics RAYTHEON

RAYTHEON MANUFACTURING COMPANY
Special Microwave Device Group
100 River Street, Waltham 54, Massachusetts

GENERAL INSTRUMENT
SEMICONDUCTORS

important news for AIR FORCE contractors...

AUTOMATIC
silicon rectifiers
designed to meet the NEW
USAF specification MIL-E-1/1089



PIGTAIL TYPES*

1N538 (USAF)
1N540 (USAF)
1N547 (USAF)

* Do not confuse these USAF types with commercial types having the same numbers.

AVAILABLE FOR IMMEDIATE DELIVERY
IN LARGE SCALE PRODUCTION QUANTITIES

General Instrument's semiconductor manufacturing skill assures contractors fast delivery of these special new pigtail type silicon rectifiers now covered by this Air Force specification. AUTOMATIC's outstanding group of USAF type silicon rectifiers meets and often exceeds the rigorous MIL-E-1/1089 (USAF) specification – And expanded facilities permit us to deliver them in quantity at prices that reflect volume production.

AUTOMATIC MANUFACTURING DIVISION also offers the industry's most complete line of silicon rectifiers for an extensive range of applications including types for magnetic amplifiers, power supplies, D.C. blocking and germanium replacement, as well as types for general purpose use.

Would you like a set of our engineering data sheets? Please write us today!

Maximum Values for AUTOMATIC Military Type Silicon Rectifiers meeting MIL-E-1/1089 (USAF) Specification

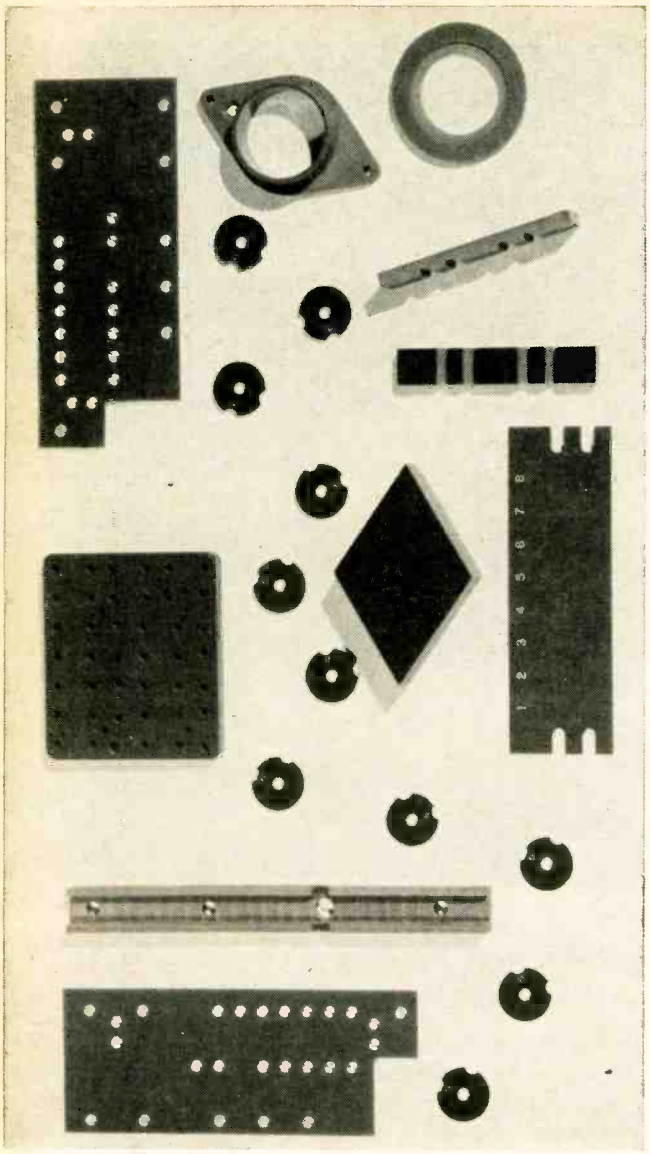
Type No.	Peak Reverse Voltage (VDC)	DC Output Current @ 25° C. Ambient (MA)	DC Output Current @ 150° C. Ambient (MA)	Maximum Reverse Current* (MA)	Mounting	MIL-E-1 Technical Spec. Sheet No.
1N538 (USAF)	200	750	250	0.350	Pigtail	1089a
1N540 (USAF)	400	750	250	0.350	Pigtail	1089b
1N547 (USAF)	600	750	250	0.350	Pigtail	1089c

* Averaged over 1 cycle for inductive or resistive load with rectifier operating at full rated current at 150° C. ambients.

AUTOMATIC MANUFACTURING

AUTOMATIC MANUFACTURING
DIVISION OF GENERAL INSTRUMENT CORPORATION
65 GOUVERNEUR ST., NEWARK 4, N. J.

MASS PRODUCERS OF
ELECTRONIC COMPONENTS



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

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

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

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

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

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

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

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

CONTINENTAL-DIAMOND FIBRE
A SUBSIDIARY OF THE Budd COMPANY • NEWARK 16, DEL.

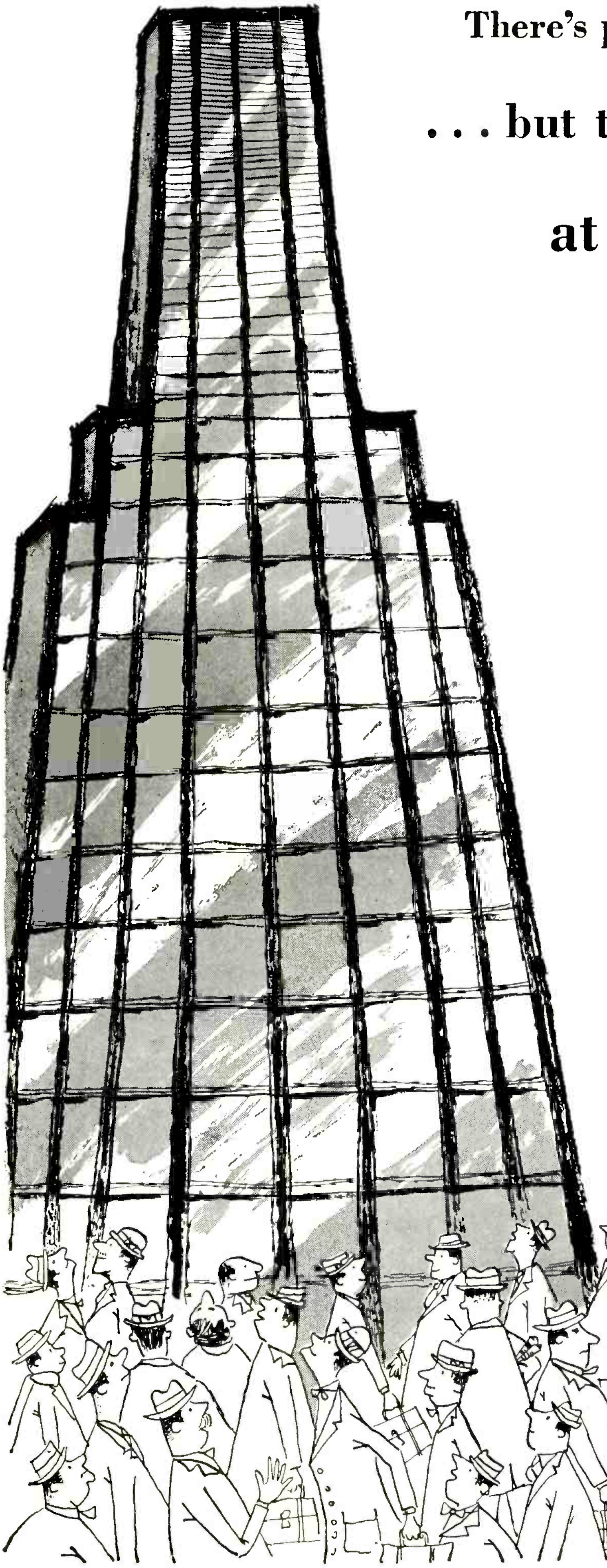
Typical Property Values—Dilecto Paper-Base Laminates in Sheet Form

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

CIRCLE 26 READERS SERVICE CARD

There's plenty of room at the top

. . . but there's lots more room at the bottom



Look around you. How many men do you see at about your job level and income? Know them pretty well, don't you? Are they smarter than you are? Do they work any harder? Do they possess some "something" that you don't have?

No, of course they don't. And yet, five years from now, some few of you are going to be lots closer to the top of your company. There's lots of room up there — management needs able-brains as never before. But, warning! There's still lots more room at the bottom!

Is there a shorter, surer route to that better job, that bigger paycheck, that pride of achievement? There is, but it's no Easy Street. You still have to supply the energy and effort. How? By digging in zealously with a more intensive, regular reading of the magazine you're holding in your hand right now. Look ahead, read ahead, get ahead.

McGraw-Hill editors write it exclusively for you. Nobody else. It's all about you and your job and your problems. Nothing else. News, fact, trends — today's tasks and tomorrow's opportunities. As inspiring as it is informative. Reads lively. Keeps you on your toes. Makes important people notice you. What's more — you'll enjoy it . . . for it's just about as personal as any publication could ever hope to be.

McGRAW-HILL SPECIALIZED PUBLICATIONS

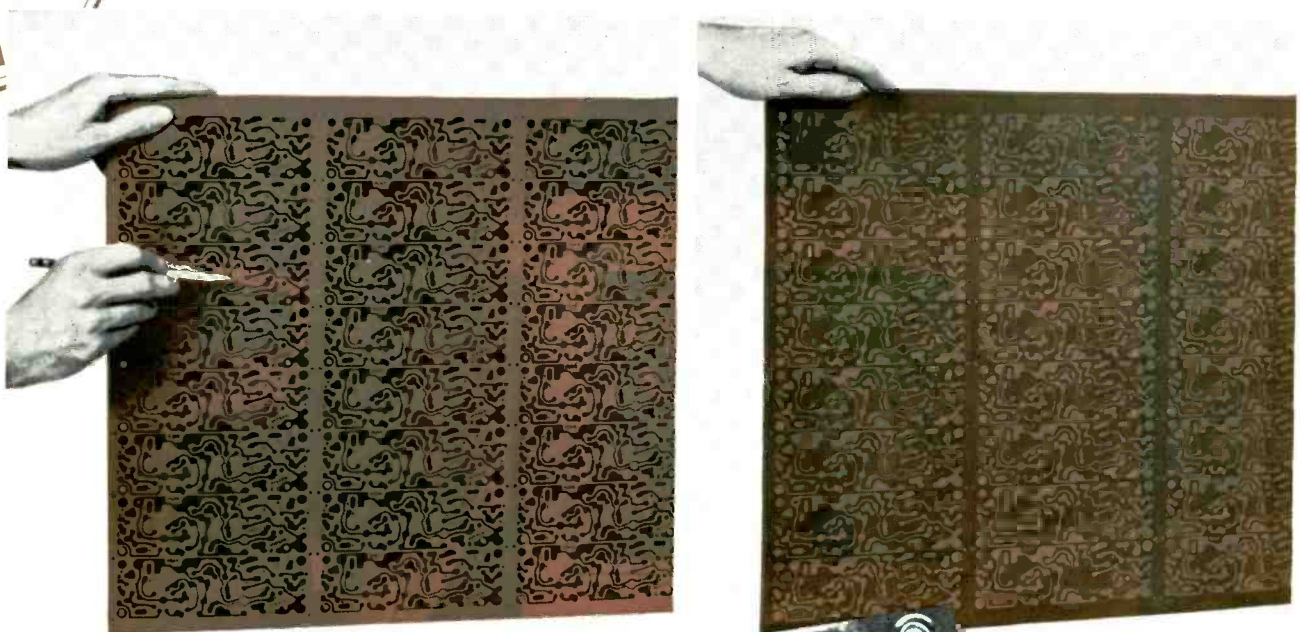
The most interesting reading for the man most interested in moving ahead

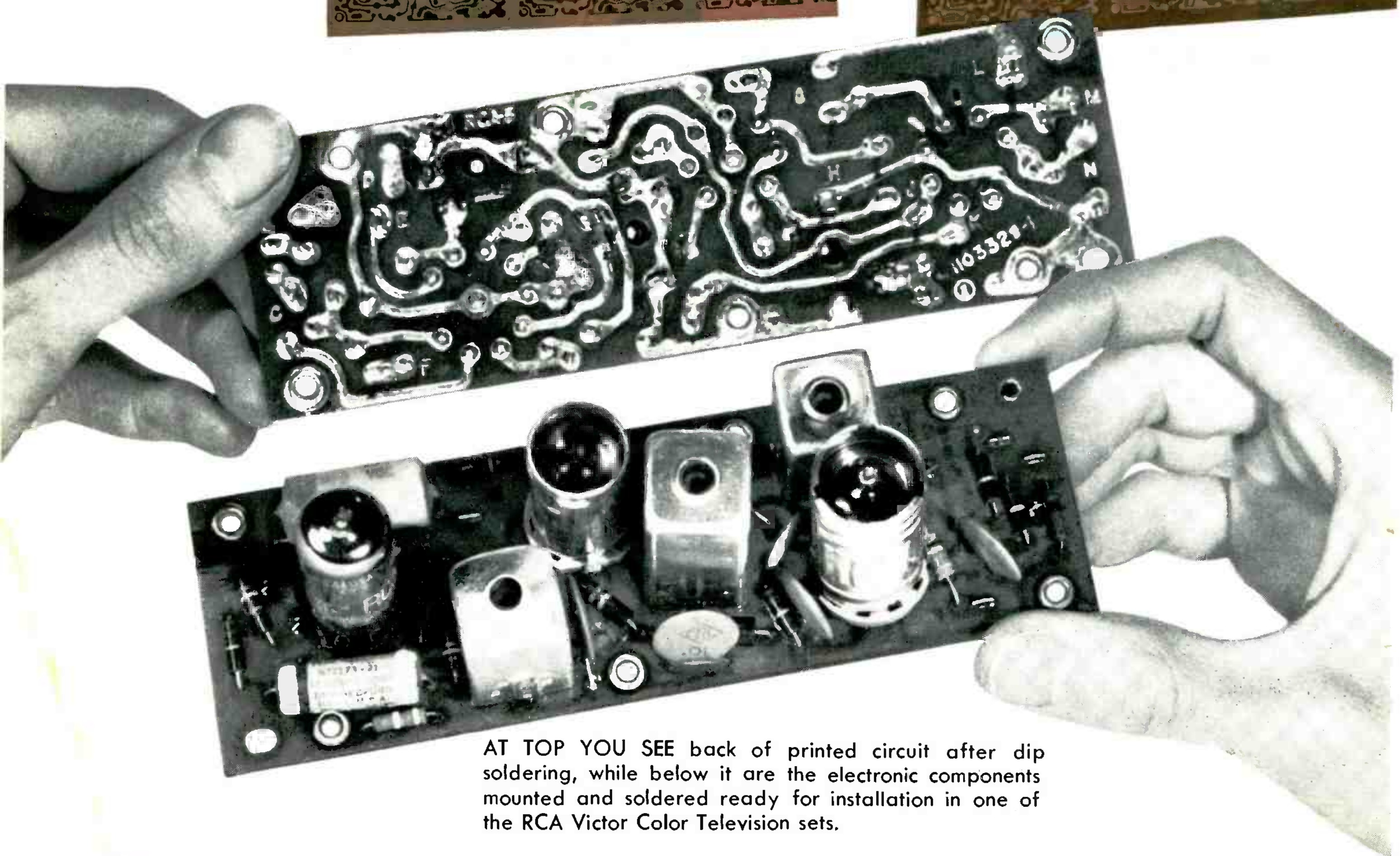
CIRCLE 28 READERS SERVICE CARD →

RCA VICTOR USES

for its printed circuits in...

MULTIPLE PRINTED CIRCUITS showing laminated board using Revere Rolled Copper with resist applied (left) and with circuit etched (right).





AT TOP YOU SEE back of printed circuit after dip soldering, while below it are the electronic components mounted and soldered ready for installation in one of the RCA Victor Color Television sets.

REVERE ROLLED COPPER

In the type of color television set turned out by RCA Victor there can be no margin for error. That is why RCA Victor Engineers when they turned to printed circuits for their color TV sets thoroughly tested the various materials available. Here are the reasons they use Revere Rolled Copper:

1. Even the finest lines are comparatively free from pits, pinholes and other imperfections.
2. Thickness is consistently uniform without sacrifice of conductivity, resulting in etching at better production rates.
3. There are no peaks or valleys in its smooth, hard surface of uniform density. This permits resist to clean off easily because there are no pores to hold resist and cause trouble when soldering.
4. Revere Rolled Copper is relatively free from oxidation as it comes from the mill and is without lead inclusions. Has longer shelf life without the need for a major cleaning operation prior to soldering.
5. Its clean surface permits fluxes to wet readily.
6. In the automatic soldering operation it makes possible a uniform solder coat, free of skips or bald spots.

And these are the very reasons why you should insist that Revere Rolled Copper be specified by you when ordering blanks from your laminator.

It is available in unlimited quantities in standard coils of 350 lbs. in widths up to 38" and in .0014, .0028 and .0042 gauges, weighing approximately 1 oz. and 2 oz. and 3 oz. per square foot or heavier if required. Many users have found that because of its unique characteristics 1 oz. Revere Rolled Copper can be used instead of the 2 oz. required when other kinds of copper are used, thus effecting still greater savings in material cost. Revere Rolled Copper exceeds requirements of standard specifications and meets Electrolytic Tough Pitch Copper ASTM B5 specification for purity with 99.9% minimum.

Consult your laminator regarding the use of Revere Rolled Copper for your printed circuits, or contact the Revere Representative nearest you through the yellow pages of your local telephone directory.

REVERE DOES NO LAMINATING OF PRINTED CIRCUIT BOARDS, MAKING ONLY THE ROLLED COPPER.

REVERE ROLLED COPPER CAN ALSO BE FURNISHED ROLLED DOWN TO .0006 FOR COIL WINDING APPLICATIONS.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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Mills: Rome, N. Y.; Baltimore, Md.; Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Brooklyn, N. Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities, Distributors Everywhere.

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All business is specialized

...and nothing specializes on your business like your business paper

Here's a smart business man. He spends his time where every sitzmark parks a prospect at his feet. It's simple sense: He *specializes* . . . and it *pays*!

Your business is specialized, too . . . and so is your business paper. The time you spend with it pays . . . for its editors are experts in your specialty. They scout the field . . . report what's good that's new . . . find ideas that worked . . . suggest methods to keep you a leap ahead of competition.

The ad pages are as specialized as the editing. They, too, tend strictly to business . . . your business. They bring you data on new products, new materials . . . gather in one place a raft of ideas on where-to-buy-what, or how to make (or save) a dollar.

That's help you can't find concentrated into such quick reading time *anywhere* else! It's help that puts many a man out front in his field, as a specialist who knows what's what today . . . sees what's coming tomorrow. It's simple sense to read every page, every issue.

This business paper in your hand has a plus for you, because it's a member of the Associated Business Publications. It's a paid circulation paper that must earn its readership by its quality . . . And it's one of a leadership group of business papers that work together to add new values, new usefulness, new ways to make the time you give to your business paper still more profitable time.

A copy of this quick-reading, 8-page booklet is yours for the asking. It contains many facts on the benefits derived from your business paper and tips on how to read more profitably. Write for the "WHY and HOW booklet." Room 2710.

McGRAW-HILL PUBLISHING COMPANY
330 West 42nd St., New York 36, N. Y.

One of a series of advertisements prepared by THE ASSOCIATED BUSINESS PUBLICATIONS

Can this experience in unique cooling applications help solve a problem for you?

Custom designed cooling is our business at Ellis and Watts. For example, we have recently engineered and built highly specialized equipment for the following applications:

- Liquid coolers for electronic components (bulletin 94)
- Cooling Klystrons with air to liquid heat exchangers (bulletin 95)
- Special units to cool airborne electronic gear (bulletin 99)
- Cooling equipment for huge complex electronic computers (bulletin 102)
- Electronic console and rack coolers (bulletin 105)
- Small portable field units to cool huts filled with electronic gear for missile ground support, battlefield television, communications and radar (bulletin 106)
- Conditioning systems for Radome shelters (bulletin 108)
- Mobile cooling units for trailer-mounted electronic systems for missile and aircraft ground support (bulletin 111)
- Units to cool automatic landing devices for carrier and land-based aircraft (bulletin 122)
- Cooling equipment for fixed or mobile flight training simulators (bulletin 124)
- Dewpoint control equipment for pressurized radar waveguides (bulletin 128)

These are but a few examples. On land (MIL-E-5272A), on the sea (MIL-E-16400B), in the air (MIL-E-5400B)—even in outer space (MIL-E-8189A)—E-W specialized cooling equipment guarantees the performance of your electronic systems, independent of environmental conditions, for military or commercial applications.

If your project involves cooling . . . it's a job for Ellis and Watts. We are staffed with specialists who will analyze your requirements, submit a proposal, design and build equipment promptly and to your complete satisfaction. Field installation and maintenance services available.

Ellis and Watts Products, Inc., Dept. E, Cincinnati 36, Ohio
Please send the following information:

☐ Bulletin 94 95 99 102 105 106 108 111 122 124 128 (circle numbers desired)
☐ Cooling load calculating Nomogram
☐ Booklet "How to determine requirements for cooling electronic equipment"

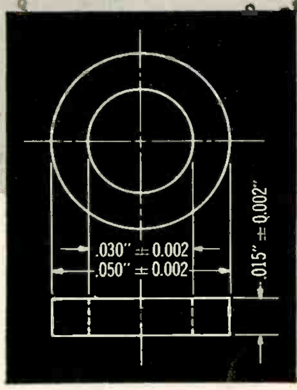
Name...Title...
Company...
Address...
City...Zone............State...............................

ELLIS AND WATTS PRODUCTS, INC.

Cincinnati 36, Ohio.

Designers and builders of MIL-AC Units

CIRCLE 31 READERS SERVICE CARD

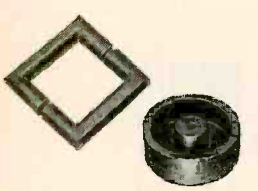


50 MIL O.D. Memory Cores for Transistorized High Speed Memories

These new 50 mil O.D. cores are now available in General Ceramics S-4, the material that has proven so successful in such vitally important systems as the SAGE computer. Switching time is less than one microsecond with 550 ma full drive. At recommended operating conditions, the "ONE" output voltage is greater than 60 millivolts; the "ZERO" output voltage is less than 6 millivolts. Cores are provided in two quality levels, to .015 AQL and to 6.5 AQL. Dimensions are .050" O.D., .030" I.D. and .015" in height, all with tolerances of ± .002". General Ceramics has designed and built special equipment for core testing to insure that each unit meets established electrical properties. 50 mil O.D. cores are supplied in production quantities in two quality levels. Parts are shipped according to MIL Specification 105A to 0.015 AQL or 6.50 AQL. For complete information on this core write General Ceramics Corporation, Keasbey, New Jersey, for Bulletin 326; address Dept. E.

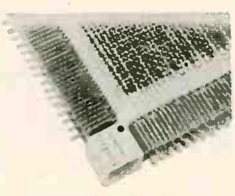
GENERAL CERAMICS

Industrial Ceramics for Industrial Progress... Since 1906

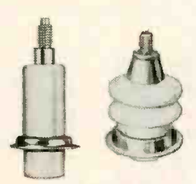


FERRAMIC CORES

PRECISION STEATITES

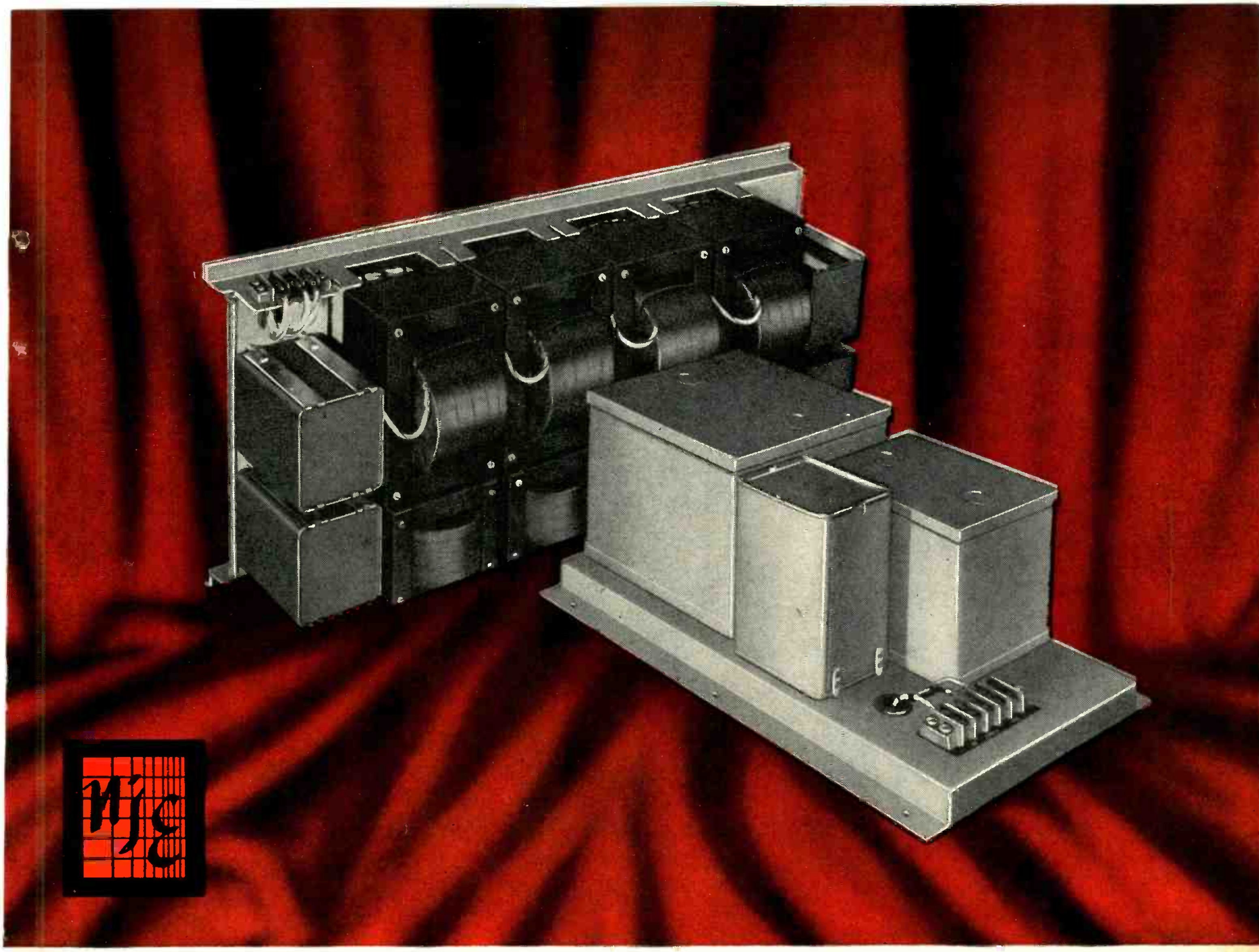


MAGNETIC MEMORY PLANES



"ADVAC" HIGH TEMPERATURE SEALS

SOLDERSEAL TERMINALS



MODEL CRM-20-AA-3M
Designed to conform to MIL-T-27A, Grade 3, Class T, Life Expectancy X. Capacitor to JAN-C-25A.
Input 100-130V, 60 cps, output 115V ±1%, 60 cps, "constant RMS", at 2000VA.

MODEL CAV-5-AA-1M
Designed to conform to MIL-T-27A, Grade 1, Class T, Life Expectancy X. Capacitor to JAN-C-25A.
Input 100-130V, 60 cps, output 115V ±1%, 60 cps, "constant average" at 500VA.

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TRANSIENT RESPONSE:
Recovery time to the ±1% region (after 10% line "step" or 25% load "step") is less than 35 milliseconds.

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EFFICIENCY:
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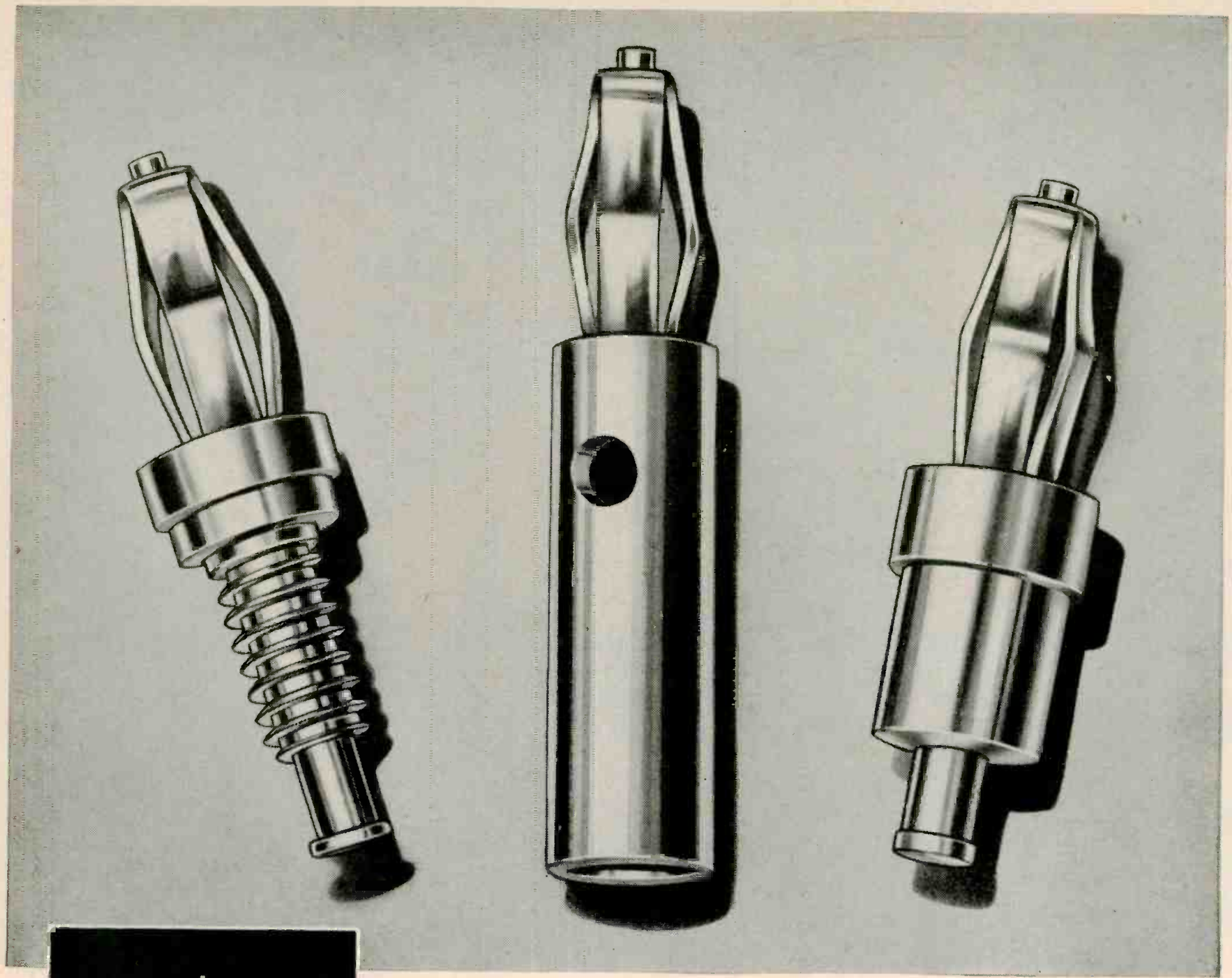
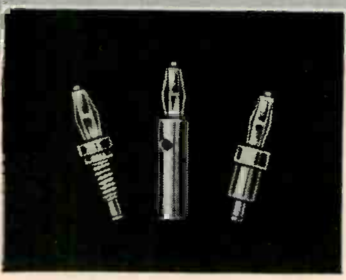


6 times enlargement



Actual size

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Pins are available in a variety of types, for assembly by staking . . . with nuts and washers . . . with soldered tails . . . with multiple plug-in features. Springs are designed to fit .093 sockets.

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MODEL SRU-210 SPECIFICATIONS

Frequency range	15.8 kmc–16.2 kmc
Power output	20 mw (min.)
Reflector voltage	0 to –500 vdc
Beam voltage	350 v (max.)
Heater voltage	6.3 v
Heater current	.6 amp (max.)

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Ruggedized SRU-210 reflex klystron for very high altitude application

Sperry developed the new SRU-210 reflex oscillator specifically to operate reliably under the extremely severe conditions encountered by high-altitude aircraft and missiles. Its special features make it just as useful, however, for ground radar and missile test equipment.

The screw-type tuner, for example, is ruggedized to operate at high altitude without pressurization, and it requires only 5 to 6 ounce-inches of torque. Another important feature of the SRU-210 is its insulated leads which prevent high-altitude arc-over. And, its cathode operates at lower temperatures which means the SRU-210 requires less input power than similar-type tubes.

Write or phone the nearest Sperry district office for application data on the new SRU-210 klystron.

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Gold Coated Copper Wire & Racks
Filter Pads
Silver Anode Ends
Silver Tank Scrapings

Production Operations

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Silver on Steel Bearings
Silver Steel Turnings
Silver Blanking Scrap, Stampings, Strip, Wire
Silver Grindings
Silver Copper Scrap
Silver Powder Mixtures
Silver Screen Scrap
Silver Solder Scrap
Silver Brazing Alloy Scrap
Silver Contact Scrap
Silver & Gold Bi-Metal Scrap
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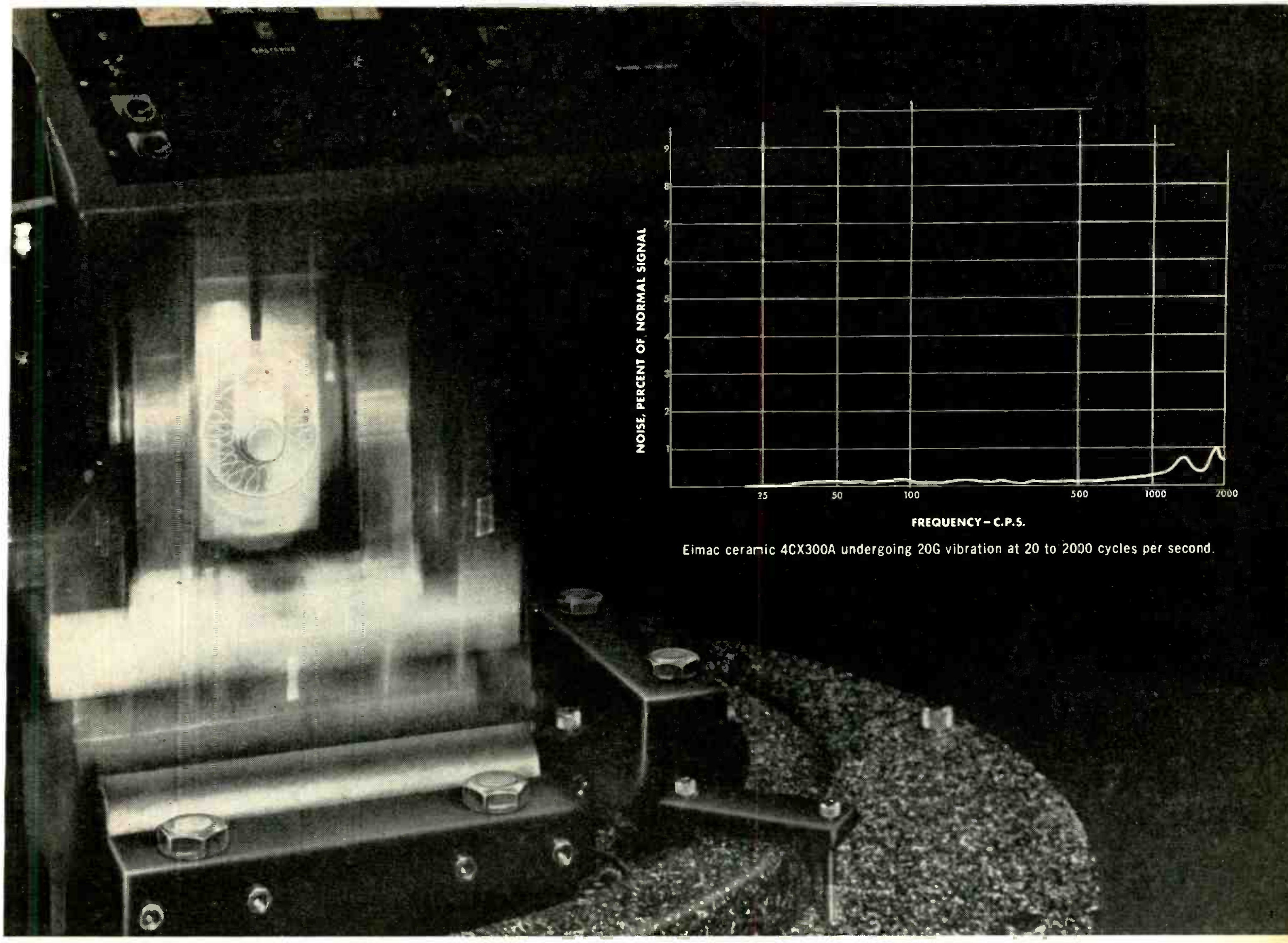
CIRCLE 36 READERS SERVICE CARD

CIRCLE 37 READERS SERVICE CARD →



Eimac ceramic 4CX300A undergoing 20G vibration at 20 to 2000 cycles per second.

Third in a series describing the advantages of ceramics in electron tubes. Previously discussed: impact and heat.

Surviving Vibration is an Eimac Ceramic Tube Extra

High reliability in severe environments is an important vacuum tube requirement in many aeronautical applications. An important aspect of this reliability is a tube's ability to operate under extreme vibration without envelope damage, introducing noise or developing interelectrode short circuits. Eimac ceramic design incorporates many advanced features that improve tube performance under these conditions.

In the illustration an Eimac ceramic 4CX300A, 300 watt tetrode, is being operated in a circuit while undergoing 20G vibration at 20 to 2000 cycles per second. The exceptionally low noise level, produced under these conditions shown in the graph above, remains less than 1% of normal signal over the entire test range.

Other advantages of Eimac ceramic tubes are: resistance to damage by shock or high temperature; compactness without sacrifice of power; ability to withstand rigorous processing techniques that lead to high tube reliability, uniformity and longevity.

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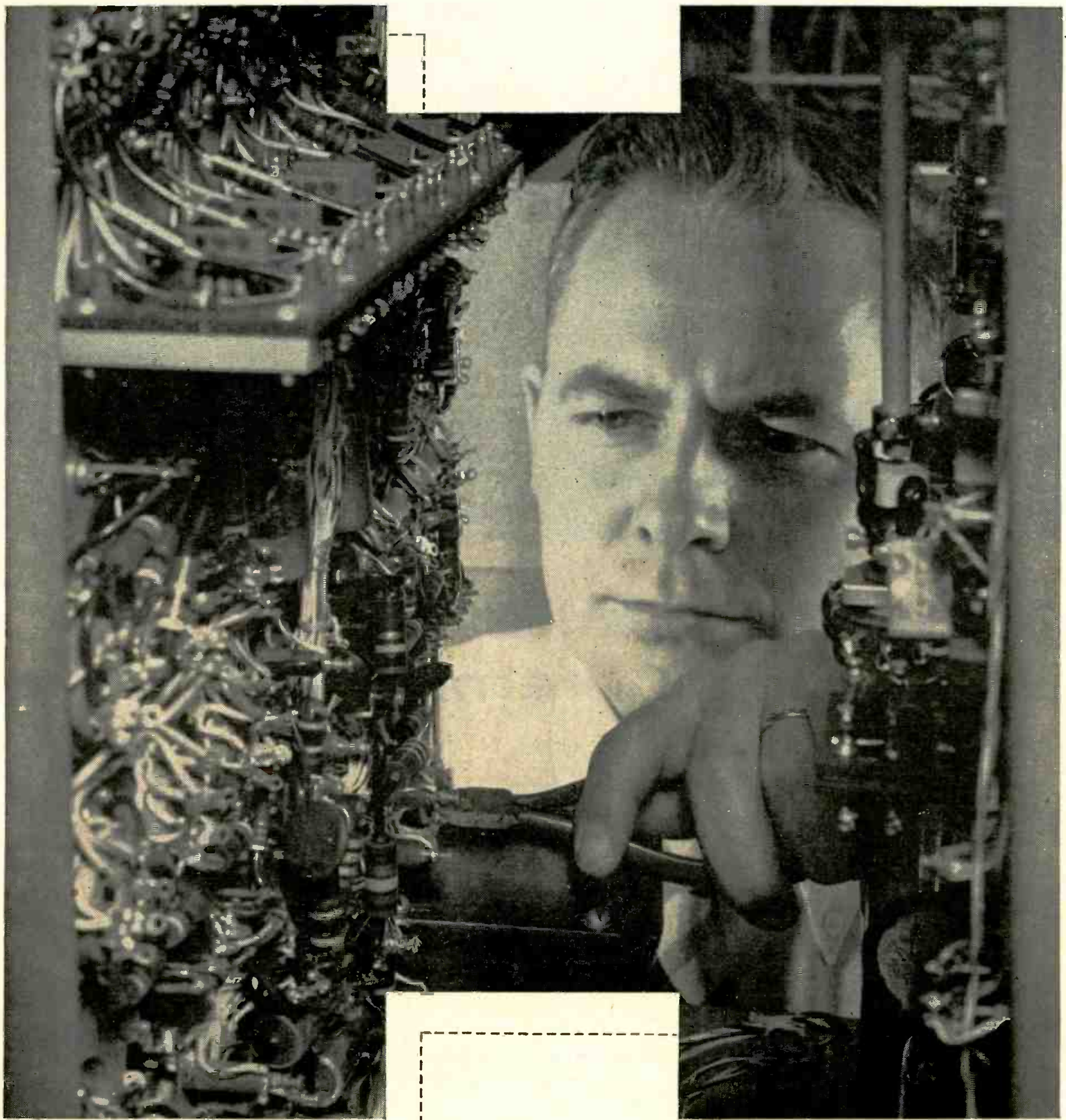
THE JOB HE HOLDS



NEVER EXISTED BEFORE

It takes a wizard to test a wizard

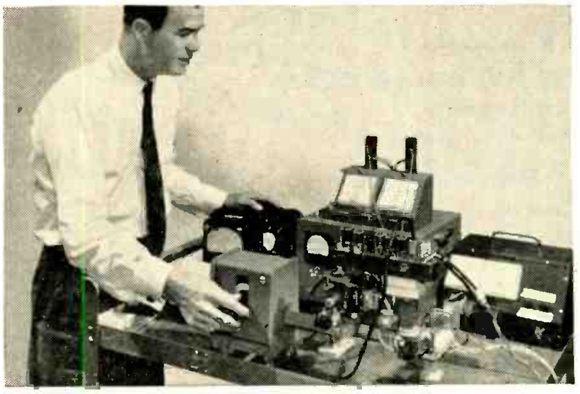
Hughes Electronic Systems are so advanced that only equally advanced test equipment can insure their operational reliability.

To develop and build these test "wizards" calls for a new kind of electronic engineer.

He must act as a connecting link between theory and application. To do this, he gathers all pertinent information concerning the capabilities designed into the system.

At the same time, he accumulates an intimate knowledge of the system's performance in the field.

In this way the Test Development Engineer can perfect complex equipment—like the test device at left—which insures "built-in reliability."



Basic materials research in the Semiconductor Division of Hughes Products opens wide new areas of applications. Other areas of this commercial electronics activity include electron tubes and industrial systems and controls.

This kind of close liaison between Research, Development, Manufacture and Field Evaluation is typical of all Hughes activities. You'll find it in the development and manufacture of radar warning systems . . . in guided missiles and commercial electronics products. The diversity of activity assures prospective employees the opportunity to build a rewarding career.

New commercial and military contracts have created an immediate need for engineers in the following areas:

Circuit Design	Systems Analysis
Reliability	Field Engineering
Communications	Semiconductor Applications
Microwaves	Semiconductor Sales

Write, briefly outlining your experience, to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 17-V, Culver City, California.

Research & Development of complex Hughes electronics armament systems is performed by the R&D Laboratories in Culver City. Embracing every advanced phase of electronics, this activity is pre-eminent in establishing new electronics frontiers.

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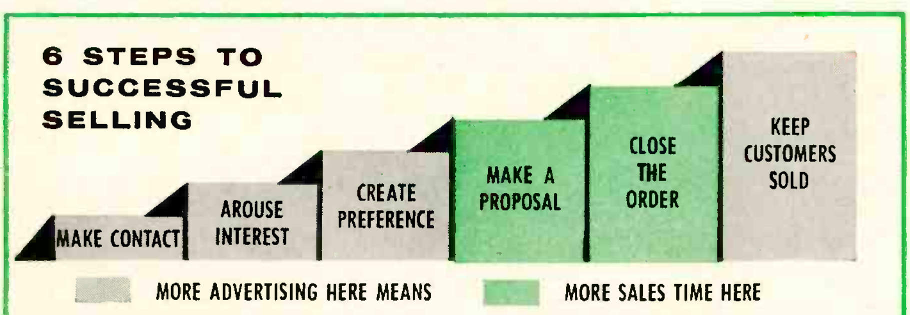
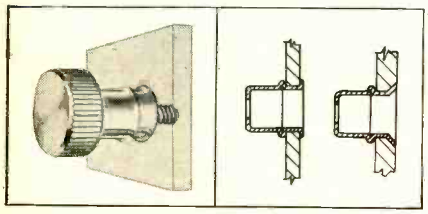


Mr. Havill is shown holding one of P&B's newest micro-miniature relays. The Princeton, Indiana, company manufactures nearly 60 different relay types.

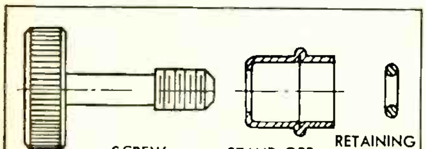
SELECT CLOSURE HARDWARE TO IMPROVE UTILITY, APPEARANCE, AND TO LOWER COST

QUICKLY INSTALLED SOUTHCO CAPTIVE PANEL SCREWS END MISALIGNMENT PROBLEM . . .



Simplicity of design contributes to clean, distinctive appearance and fast, low-cost installation. Stand-off is slipped into panel hole and secured by flaring. Screw is passed through stand-off and made captive by vinyl o-ring.

"Floating" screw design eliminates costly close tolerance manufacture and permits easy engagement regardless of panel distortion encountered under adverse use conditions.



SPECIFICATIONS

Material: Screw is brass, chrome plated; can be supplied in stainless steel. O-ring is vinyl plastic. Overall length of screw: 1 3/16" Depth of screw head: 1/4"

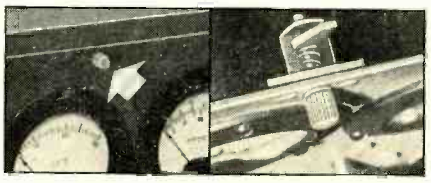
Sizes:

SCREW HEAD DIAMETER	THREAD SIZE
3/4"	1/4-20
9/16"	1/4-20, 12-24
7/16"	10-24, 10-32

Length of thread: 3/8"

Screw head is supplied plain, as shown, or slotted for screw driver.

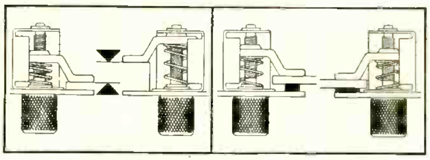
PRE-ASSEMBLED PAWL ADJUSTS TO DESIRED THICKNESS AND PRESSURE



This neat, compact Southco panel and door fastener is supplied assembled, requires but two rivets or bolts for low cost installation. It is available in three models—large, intermediate and midget.

The unique feature of Southco Pawl Fasteners is the fact that, by merely turning the knob, the pawl is adjusted to a wide range of frame thicknesses. This assures a tight grip without precision setting regardless of variations in frame or door dimensions or changes that are produced by wear or warping of sheets.

Pressure exerted by the pawl on the frame is controlled in the same way, by merely turning the knob. Against gasketed frames, pressure can be easily applied to compress the gasket.



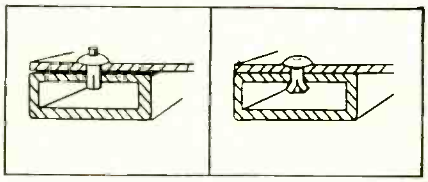
SPECIFICATIONS

Knob: Cadmium or chromium plated steel.

Head Styles: Protruding ribbed or knurled knob; flush screw driver slotted for large size only.

	LARGE	INTERMEDIATE	MIDGET
Knob diameter	7/8"	9/16"	11/32"
Total width	2 1/2"	1 3/4"	1 1/8"
Total height	1 5/16"	7/8"	35/64"
Back of panel depth	1 23/32"	1 1/4"	7/8"
Knob length	1 1/8"	15/16"	9/32"

FAST, HAMMER-DRIVEN BLIND RIVETS CUT INSTALLATION TIME



You "hit-the-pin" and the rivet's in. No special tools to limit production or require maintenance, no bucking, no finishing. For blind or open applications, Southco Drive Rivets save time, reduce costs.

Automatic "pull-up" action assures uniform, tight grip.

Southco Rivets are made of aluminum or cadmium plated steel with cadmium plated or stainless steel pins. Diameters are from 1/8" to 1/4", grip range is from 1/16" to 5/8".

Increased widespread use is due to low installed cost and elimination of down time and maintenance associated with fasteners requiring special tools.

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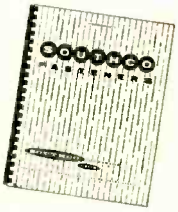
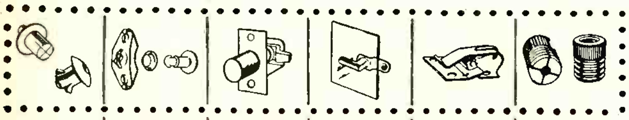


Send for your free copy of Handbook No. 7, just released. Gives complete data for designers on these and many other specialty fasteners. 52 pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 233 Industrial Highway, Lester, Pa.



BLIND RIVETS	1/4 TURN FASTENERS	ADJ. PAWL FASTENERS	DOOR LATCHES	RETAINING SPRINGS	ANCHOR NUTS

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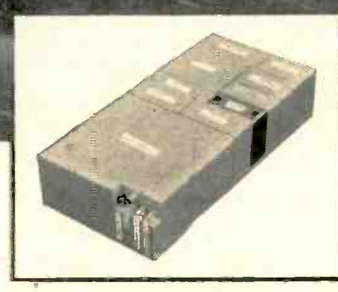

NAVTAC: "Pipeline" to a happy landing

The uniqueness of the new NAVTAC en route navigation and instrument landing system by Stromberg-Carlson is in its *combination* of functional modules.

The NAVTAC equipment is an assembly designed to provide high-performance aircraft with the TACAN navigational aid, plus marker beacon receiver, glide slope and runway localizer for instrument landing situations.

The entire system is packaged in a compact unit only 5" high, 10½" wide, 22" deep, and weighing only 47.5 lbs. Individual modules can be separated up to distances of several feet without any adverse effect on performance.

The equipment is designed to meet the rigorous environment of the high-performance aircraft of today and tomorrow. Its operating ambient temperature range is −60 to +125 degrees C. at altitudes up to 70,000 feet. Widespread use of semiconductors in the ILS receivers and TACAN circuitry means high reliability, small size and low power consumption.

Included in the design is the capability of performing complete preflight confidence tests with the use of a small auxiliary test set.

Complete technical details on the NAVTAC system are available on request.

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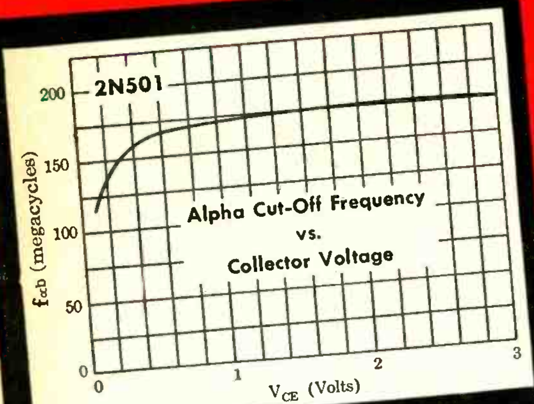

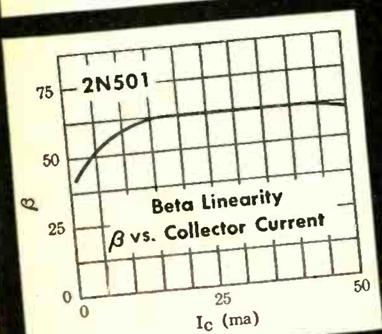

New family of Micro Alloy Diffused-base Transistors (MADT)*

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- High Oscillator efficiency at 200 mcs
- Amplifier gains of 10 db at 200 mcs

MADT FAMILY APPLICATIONS DATA

TYPE*	fmax	Power Gain	Oscillator Efficiency	Class of Use
2N499	250 mcs (min)	10 db at 100 mcs	25% at 100 mcs (min)	oscillator and amplifier to 100 mcs
2N500			25% at 200 mcs (min)	oscillator to 400 mcs
2N501	Ultra high-speed switch typical $t_r = 12$ mμsec; (18 max.); $t_s = 7$ mμsec; (12 max.); $t_f = 4$ mμsec; (10 max.). In circuit with current gain of 10 and voltage turnoff.			
2N502†	500 mcs	10 db at 200 mcs		amplifier to 250 mcs
2N503†		11 db at 100 mcs(min.)		amplifier to 100 mcs
2N504	50 mcs	46 db at 455 KC		high gain IF amplifier

* *Available in voltage ratings up to 35 V.*
† *In JETEC TO-9 Case (widely known as JETEC 30 Case).*

Here is a major breakthrough in the frequency barrier . . . a new family of *field-flow* Micro Alloy Diffused-base Transistors. Philco MADT's extend the range of high gain, high frequency amplifiers; high speed computers; high gain, wideband amplifiers and other critical high frequency circuitry.

MADT's are available to various voltage and frequency specifications for design of high performance transistorized equipment through the entire VHF and part of the UHF spectrum. These transistors range in f_{max} from 250 mc to as high as 1000 mc. MADT gains are typically 10 db at 200 mc and greater than 16 db at 100 mc. A low cost general purpose unit is available which will deliver typically 18 db at 50 mc and 32 db at 10 mc.

Make Philco your prime source of information for high frequency transistor applications.

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electronics
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APRIL 25, 1958

Ferrite Radiators Shrink Missile Antenna Systems

Procedure for predicting approximate radiation pattern for ferrite elements in a microwave antenna system uses random-balance technique. Results indicate that directivity property of ferrite elements permits ferrite arrays to provide half-power beam widths and side-lobe characteristics equal to those obtained with large conventional antenna systems. Gain of these ferrite arrays generally exceeds that of paraboloidal reflectors

By **H. C. HANKS, JR.**,
The Martin Company, Baltimore, Maryland

ANTENNAS used in propagating microwave energy generally have directive radiating characteristics—their patterns taking the form of either fan or pencil beams. The flared portion of a fan beam, representing a cosecant squared or similar type distribution, is normally generated using paraboloidal reflectors and slot arrays. Pencil beams, however, are generated using radiating elements in arrays.

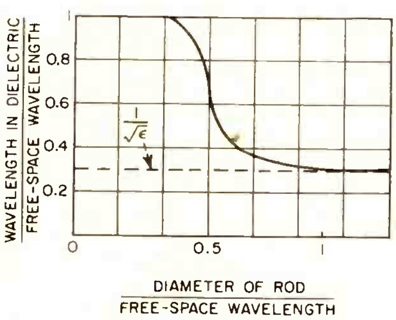
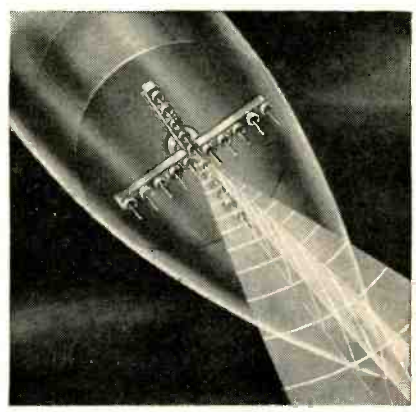


FIG. 1—Effective wavelengths plotted as function of ferrite rod diameter. Curve approaches the factor $\sqrt{\epsilon}$ asymptotically as diameter increases

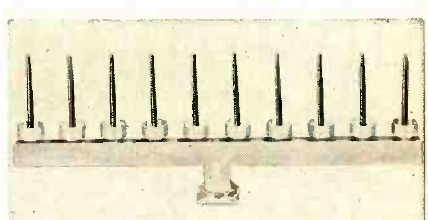
Metallic elements were employed as radiators until 1956 when ferrite elements were introduced.[1] This article discusses the characteristics of ferrite elements used as single and multiple pencil beam radiators.

Preliminary Considerations

In designing antenna arrays, both the array constant and the characteristics of each single element must be known. Since a ferrite rod can be considered as a dielectric antenna, the factors which determine the rod's radiating characteristics are its permeability and permittivity. Thus, if a ferrite rod has the same permeability-permittivity product as a dielectric rod and their diameters are equal, the radiation patterns will be identical. In this article, ferromagnetic



Two ten-element ferrite arrays mounted in ogive section of nose of a guided missile give idea of relative size



Ten-element ferrite array. This design was used to generate azimuth radiation pattern shown in Fig. 6

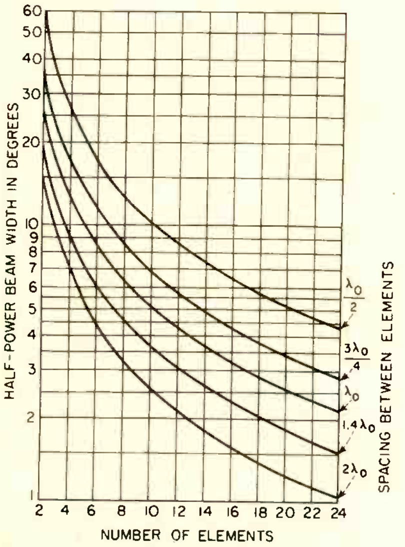


FIG. 2—Half-power beam width plotted as a function of the number of elements and spacing between elements. Elements were linear, phased uniformly and generated equal-amplitude patterns

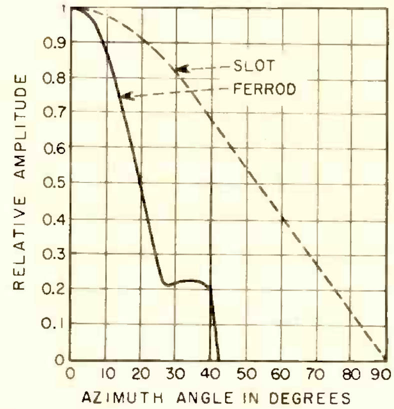


FIG. 4—Diffraction pattern for single ferrite and single slot element. Slot curve is shown for 76-deg half-power beam width; ferrite rod is shown for 28-deg half-power beam width

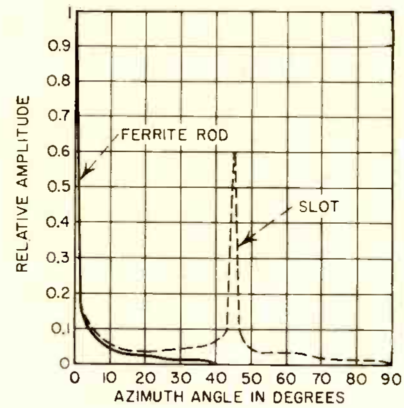


FIG. 5—Diffraction pattern for four-element linear array. Half-power beam width was 10 deg. Elements were phased uniformly and spaced $1.4\lambda_0$ apart, and generated patterns of equal amplitude

properties of the ferrite material are not used to explain unusual radiation characteristics.

Until now, all theoretical analysis has failed to predict the complete pattern for a ferrite or dielectric rod. The main beam of a dielectric rod can be predicted with sufficient accuracy using Kiely's equation[2]:

$$\frac{E_p}{E_{max}} = \left\{ (K-1)\sin\frac{\pi L}{\lambda_0}(K-\cos\theta) \Big/ (K-\cos\theta)\sin\frac{\pi L}{\lambda_0}(K-1) \right\}\cos\left(\frac{\pi d}{\lambda_0}\sin\theta\right) \quad (1)$$

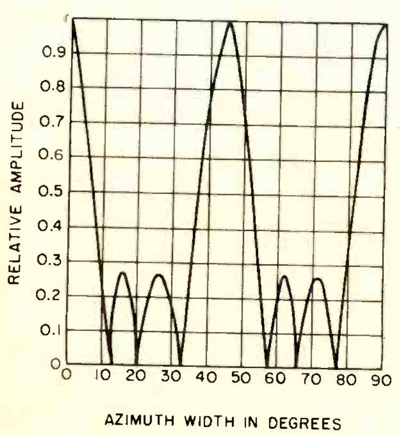


FIG. 3—Diffraction pattern of an isotropic four-element array. Half-power beam width was 11 deg. Elements were phased uniformly and spaced $1.4\lambda_0$ apart, and generated equal-amplitude patterns

where d is the diameter of the rod, λ is the wavelength in the dielectric, λ_0 is the free-space wavelength, and ϵ is the relative dielectric constant of the rod. This equation does not give an accurate representation of the amplitude or position of the side-lobe structure.

Equation 1 was developed by considering a ferrite rod as two diametrically opposed lines each of which is composed of arrays of point sources. Since each line of point sources becomes an end-fire array, the ferrite rod essentially consists of two end-fire arrays.

As the r-f energy travels along the ferrite rod, the magnitude of the energy decreases. If the rod is sufficiently long, there will be no energy at the end of the rod and no standing waves will be set up. This phenomenon causes the rod to radiate in a manner similar to that of a traveling-wave antenna.

The ferrite or dielectric rod acts as a leaky wave guide since the rod has a number of isotropic radiators along its surface. Such an array of isotropic radiators has a major lobe along its axis when the spacing and phasing are equal.

By having the phase difference greater than the spacing, a pattern of increased directivity results. However, if the phase difference becomes too great, the main lobe pattern will degenerate—that is, the magnitude of the side lobes will approach that of the main lobe.

Table I—Comparison of Ferrite Arrays and Reflector-Type Antennas at 10 Kmc

Beam width in degrees	Ferrod array size	Reflector size
0.1	45.3 ft	64 ft
0.2	22.6 ft	32 ft
0.5	9 ft	12.8 ft
1	54.4 in.	77 in.
3	18.1 in.	25.7 in.
5	11 in.	15.4 in.

Factors Controlling Radiation

Desired radiating characteristics can be produced by varying the parameters of the ferrite rod. The radiating pattern of a single ferrite rod is primarily a function of the dielectric constant of the ferrite and the diameter, length and shape of the rod.

The diameter and length control the phase variation along the surface of the rod. The ratio of the wavelength of the ferrite rod to the wavelength in free space when taken as a function of rod diameter is shown in Fig. 1. To prevent degeneration of the radiation pattern, it is necessary that the diameter be kept small enough to maintain a relative wavelength greater than 90 percent.

Beam width of the ferrite rod radiation pattern varies inversely with the length of the rod. Since the energy in the rod decreases along its length, there is a practical limit to the length of a ferrite radiator.

Because the ferrite rod is basically a traveling-wave antenna, it

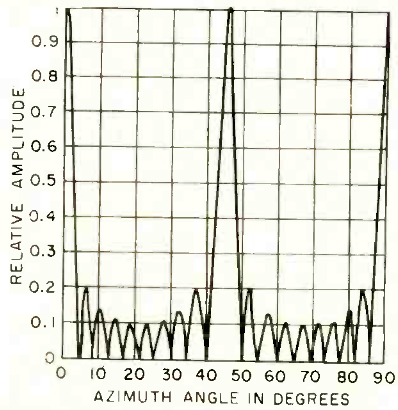


FIG. 6—Diffraction pattern for isotropic ten-element array. Half-power beam width was 3.6 deg. Elements were phased uniformly and spaced λ_o apart, and generated patterns of equal amplitude

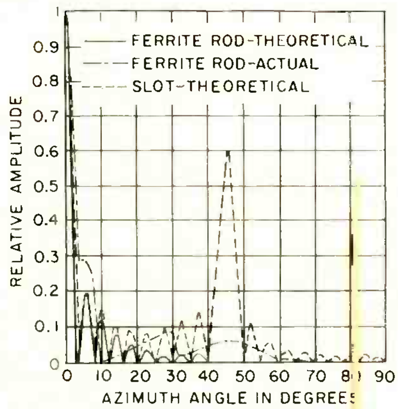


FIG. 7—Comparison of diffraction patterns of 10-element arrays. Actual diffraction pattern of ferrite rod is superimposed on theoretical diffraction patterns for a ferrite rod and slot

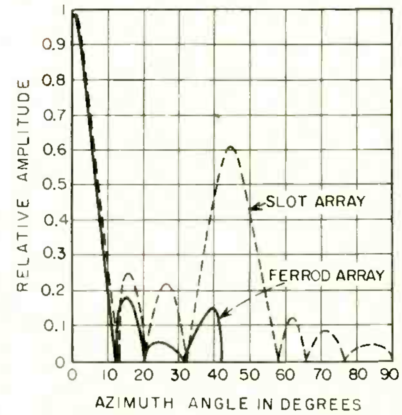


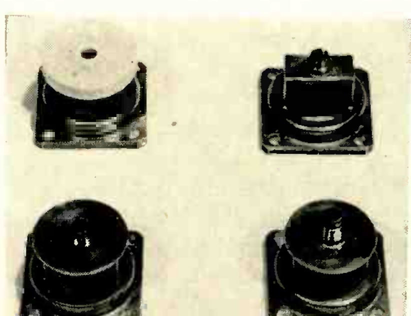
FIG. 8—Comparison of diffraction pattern of 40-element arrays. Rod pattern is superimposed on diffraction pattern of a slot. Only the envelope of maximum points is shown in the curve above

is desirable to eliminate standing waves. The abrupt discontinuity at the free end of the ferrite rod causes a mismatch in transferring energy into free space. The effect of this discontinuity can be overcome by tapering the rod along its length to a diameter which no longer permits retention of energy.

Tapering of the rod also offers the advantage of controlling the side-lobe level. Sufficient tapering can eliminate the side lobes altogether. When this occurs, however, the beam width of the main lobe increases. It is also possible to control the side lobes to a limited degree by changing the ground-plane configuration.

Spacing and Phasing

When using a ferrite rod in an array, it is not necessary to eliminate the element side lobes if they are located at a suitable angle.



Four of the ground planes used to determine affect of ground plane configuration on radiation pattern. Shape of ground plane controlled side-lobe pattern

The first thing to consider is the pattern produced by an array of isotropic radiators having the same spacing and phasing as that desired for the ferrite elements. Standard array equations were selected and subsequently programmed for solution on an electronic computer.

Effect of varying the spacing of isotropic elements in a linear array is shown in Fig. 2. Since many of the linear arrays investigated used a spacing of 1.4λ_o, the diffraction for isotropic elements having this particular spacing are discussed here. Also, the effects of using ferrite and slot elements are considered.

The diffraction pattern for a four-element array is shown in Fig. 3. At approximately 45 deg a major side lobe can be seen which is equal in amplitude to the main lobe.

The pattern for a single ferrite element and a slot element are shown in Fig. 4. Near the zero deg point, the patterns have nearly the same amplitudes on a normalized basis. At 45 deg, however, the ferrite element is more than 40 db below the peak while the slot is less than 7 db down.

Diffraction Patterns

Multiplication of the single element pattern by the array pattern results in patterns which have approximately the same beam width. This is shown in Fig. 5. The side-lobe level of the ferrite array is much less than that of the slot array.

To obtain the same side lobe level with a slot array, a Tchebyscheff distribution must be used. This approach results in either a wider beam width or a longer array when the beam width is kept constant. The importance of the single element pattern is demonstrated by the effect it has on the side-lobe level.

A ten-element isotropic array pattern is shown in Fig. 6. The first major side lobe occurs near the 45-deg point and has an amplitude equal to the main lobe. Once again the theoretical patterns differ from the actual patterns primarily in side lobe structure.

An actual pattern superimposed on the theoretical pattern for a ferrite array having ten elements is shown in Fig. 7. If the ferrite array is lengthened to 40 elements and compared to a slot array, the resulting pattern, shown in Fig. 8, has the same side-lobe relationships as noted previously.

When the size of a ferrite array is compared with the size of a conventional parabolic antenna, as shown in Table I, it can be seen that ferrite array is the smaller. If gains are compared, the ferrite antenna generally excels because the gain in a single element is approximately 16 db.

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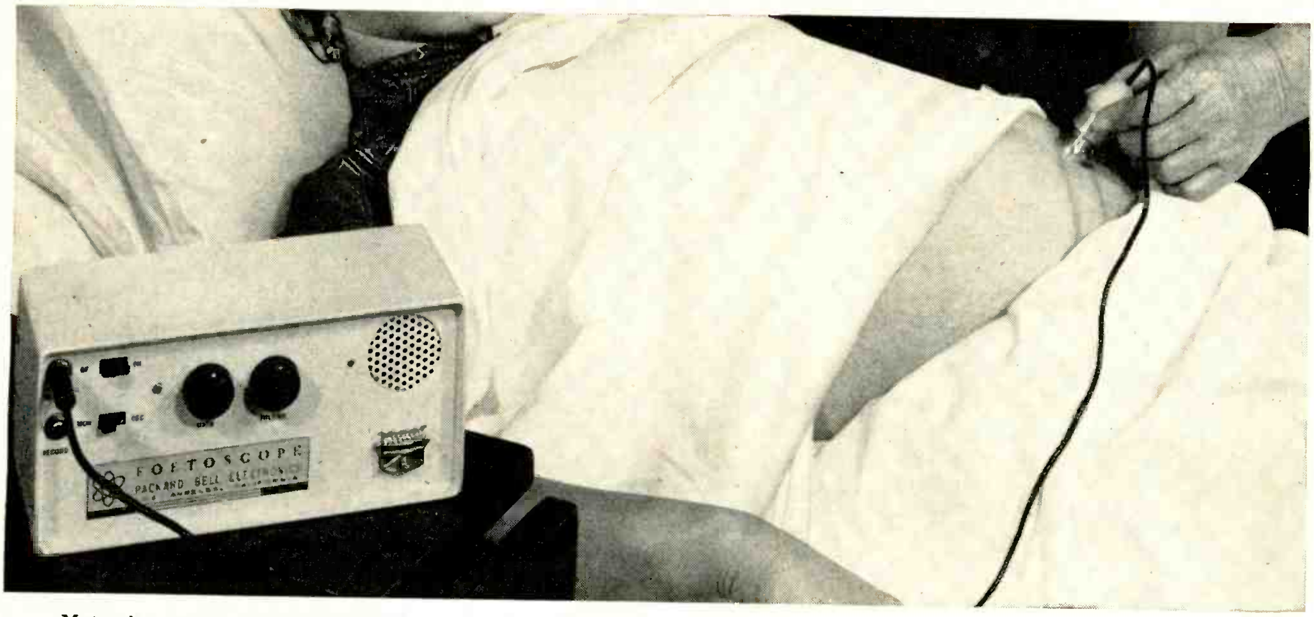
(1) F. Reggia et al, Ferrod Radiator Systems, IRE Convention Record, 1956, p 213-224.
(2) D. G. Kiely, "Dielectric Aerials", John Wiley & Sons



Maternity patient receives prenatal examination. Used with a recorder, instrument also analyzes adult heart action

Transistor Unit Detects

Amplified 2-to 3-cps signal from foetal heart modulates transistor oscillator operating between 800 and 1,200 cps. Frequency modulation technique overcomes poor low freqency response of human ear and loudspeakers. Device has additional cardiograph applications when used with recorder

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DETECTING FOETAL HEART sounds and amplifying them so that they are readily usable has been the subject of experimental work since 1906. This article reports another approach to the electronic problems involved and describes the equipment which resulted from a recent project.

The foetal heart beats approximately 125 to 180 times per minute. Thus, the fundamental frequency of the sound from a given foetus is somewhere in the range of two to three cps. The source of this sound lies inside the maternal abdominal cavity. The sound generated by the foetal heart must be conducted through a portion of the foetus and surrounding media to the external abdominal wall. This path attenuates low and high frequencies by different amounts.

Normal Techniques

The vibration that does get to the outer wall is normally picked up by the obstetrician with his stethoscope. This sound is conducted by actuating a column of air which directly connects to the eardrum, so that any change in the pressure of this column gives an audible sensation. This closed column of air does not exist when the sound is picked up by a microphone, amplified and converted to an audible acoustic signal. The coupling of a speaker to the air at low frequencies is slight since the air displacement at frequencies of a few cps is negligible. The spreading of the signal in the air further reduces the signal intensity so that by the time it reaches the ear it has been greatly attenuated. In addition, most ears will not detect an acoustical signal below 16 cps, making it almost impossible to use the technique of direct amplification unless the higher frequency com-

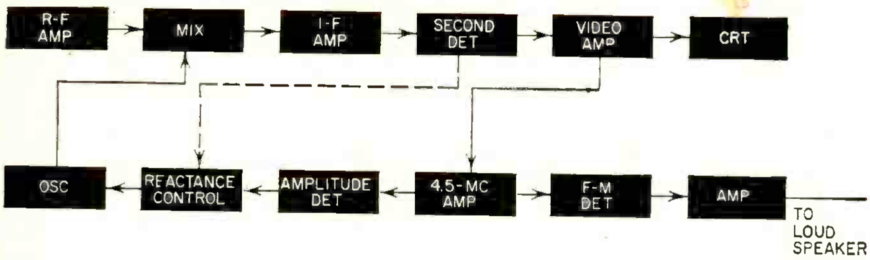

FIG. 1—Block diagram of the intercarrier sound aft control system used in Westinghouse tv receiver

Amplitude of 4.5-mc intercarrier sound signal controls sound-to-picture ratio to provide fine tv receiver tuning automatically. Control of oscillator frequency to maintain a constant intercarrier sound signal provides effective action on the intercarrier sound level. Automatic control of beats between the picture harmonics and the sound carrier closely approximates subjective manual tuning. Tuning is automatically maintained in the presence of sound-level changes in transmission or in reception

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Sound Signal Tunes

AUTOMATIC FINE TUNING, a desirable feature in television receivers, eliminates customer mistuning and oscillator drift. It also enhances remote control operation and provides the additional fine tuning precision required for effective reception of color tv signals.

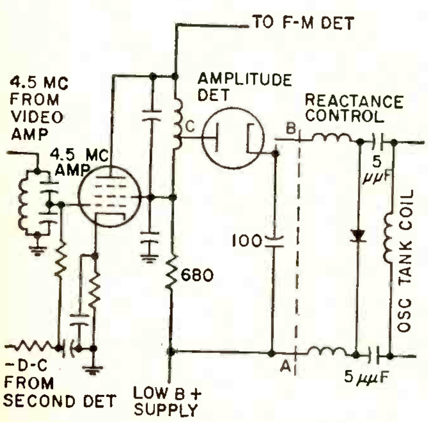


FIG. 2—Basic aft circuit. By opening the loop connection between the amplitude detector and the reactance control, terminals A and B, discriminator and reactance curves can be measured. Both curves give necessary automatic fine tuning information

A block diagram of a tv receiver that contains an aft system appears in Fig. 1. The block diagram is similar to the conventional intercarrier tv receiver except that an amplitude detector and a reactance control of the oscillator have been added.

The system uses the amplitude of the intercarrier sound signal and acts to maintain a constant 4.5-mc signal level at the reactance device by varying the oscillator frequency. From the second detector the 4.5-mc intercarrier signal is fed to the video amplifier and then a sound amplifier. The dotted interconnection between the second detector and the reactance control carries an auxiliary signal that increases the pull-in range of the system.

Frequency Correction

In a typical discriminator afc system the sound carrier at i-f is used as the signal applied to the discriminator, which in turn controls the reactance device. This type of system only corrects for frequency variations from the reference frequency of the discriminator and does not recognize the need for tuning the receiver to control the sound-to-picture ratio.

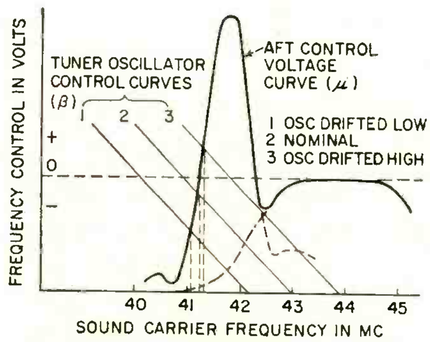


FIG. 3—Circuit of Fig. 2 accomplishes control function illustrated above

A system that controls oscillator frequency to maintain a constant level of the intercarrier sound signal contains certain characteristics. The agc system holds the picture level constant at the second detector. If the video and sound amplifier gains are constant, the 4.5-mc sound level at the second detector remains constant. This results in indirect control of the beats be-

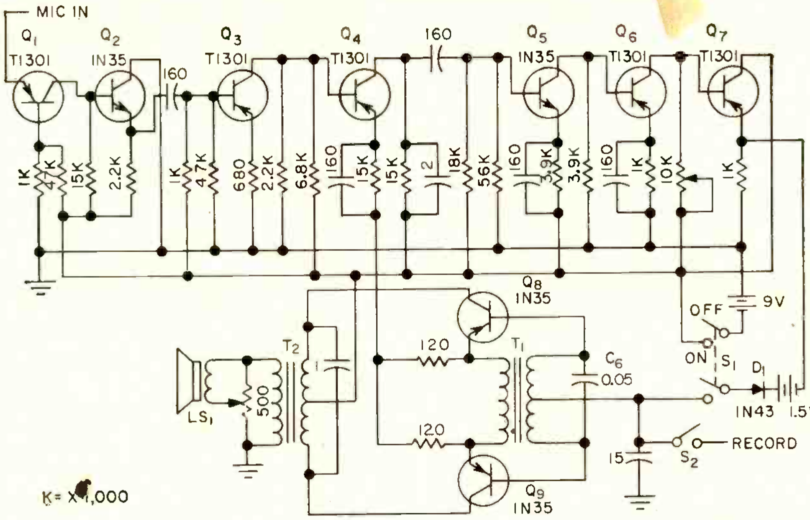


FIG. 1—Circuit schematic of foetal heartbeat detector. Amplifier low-frequency response is enhanced by large time constants in a-c coupled stages to insure that the low-frequency foetal heart signals are amplified

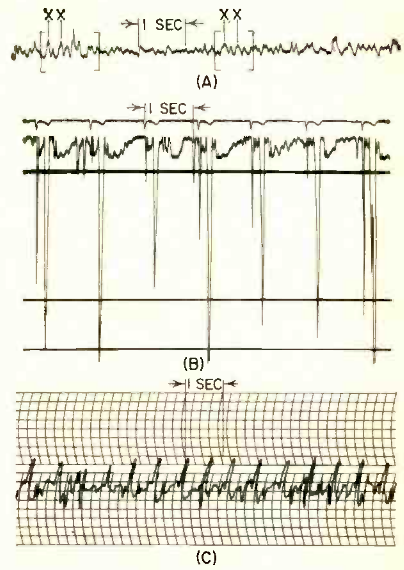


FIG. 2—Oscillograms of (A) 5-month foetus, (B) adult and (C) 4 year old boy

Foetal Heart Sounds

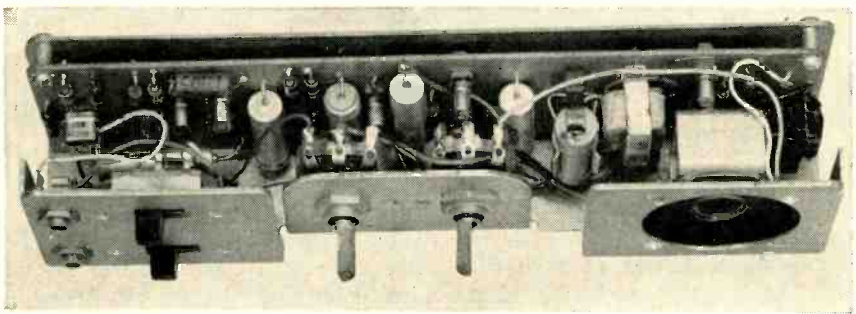
ponents alone are employed. These components occur at the same relative time as the foetal heartbeat, but may not coincide with the actual sound.

Circuit Description

The Foetoscope utilizes a carbon microphone, several transistor stages of amplification, an oscillator and a small speaker. The circuit diagram for the unit is shown in Fig. 1.

The transistorized amplifier uses direct-coupled stages wherever possible to pass the low-frequency signals. In those stages that are a-c coupled, large time constants are used. A potentiometer in the base lead of Q_7 provides gain adjustment. The output of this stage is fed through a battery and crystal diode to the center-tap of the oscillator coil T_1. The signal produces current changes in the coil and corresponding inductance changes in the secondary coil cause frequency modulation of the oscillator. By use of the frequency modulation technique, the low frequency component of the heartbeat can be heard in the form of an audible change in oscillator frequency which is set in the range of 800 to 1,200 cps. In this region the ear is quite sensitive and can readily detect small changes in frequency.

Figure 2A is a phonocardiograph of a five and a half month foetus, taken using this equipment. The sound from the foetal heart is indicated by the points marked *X*. This trace shows a repeating complex of signals, indicated by the brackets. The form of this particular complex indicates the possibility of the presence of more than one foetus.



Interior view of chassis shows construction details. Printed circuit and automatic insertion techniques are evident in compact unit

Other Uses

The possibility of using the instrument for other than foetal heart sounds is suggested by recordings made using a young man and a small boy as subjects. Figure 2B shows the recording of heart sounds of the young man. Here the positioning of the microphone was found to have a considerable effect on the waveforms obtained. Figure 2C shows the recording of the heart sounds of a four year old boy.

The sensitivity of the unit is great enough to provide for the distinguishing of the several heart sounds as various valve and muscle motions occur.

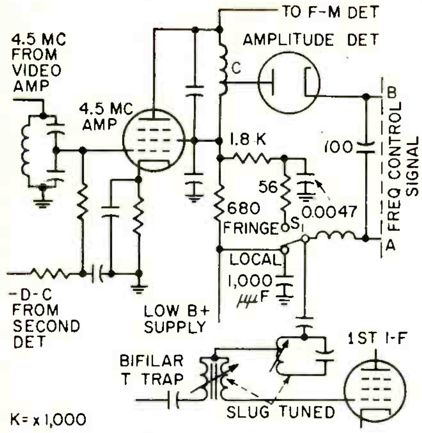


FIG. 5—Circuit shown disables sound trap and accomplishes fringe tuning

sistor is applied to A and B through the amplitude detector.

The reactance control is the frequency control element of the tuner oscillator and has a reactance that is a function of voltage. It produces the oscillator control curve shown in Fig. 3.

A crystal diode is connected in series with two 5-$\mu\mu$f capacitors across the oscillator tank circuit as shown. The frequency of the oscillator is varied as a function of loading on this crystal diode. In this circuit the load is not produced by a resistor but rather by an applied voltage that accomplishes the same purpose.

The lower the terminal voltage at points A and B, the heavier the loading and the lower the frequency. The crystal diode rectifies the oscillator voltage.

With an absence of signal input, the 4.5-mc intercarrier beat frequency will not be available at the amplitude detector. The second detector d-c voltage will be low or nonexistent. With a low bias, the 4.5-mc amplifier will develop a large voltage across the 680-ohm load. The polarity of this voltage is such as to back-bias the amplitude detector with the result that the reactance control terminals A and B will be unloaded and the oscillator frequency will be high as shown in Fig. 3.

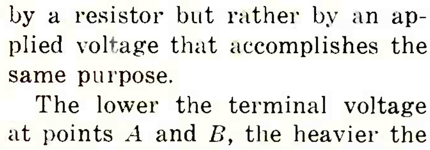


FIG. 6—Solid curve represents condition when a weak fringe signal is received. Dashed curve is plot of aft control voltage at reactance control terminals *A* and *B* shown in schematic of Fig. 5

Another condition to consider is when the signal has just been applied by switching to an active channel. Since the oscillator was high in frequency previous to the application of the signal, the frequency of the sound carrier will be on top of the i-f pass band. The 4.5-mc beat amplitude will be low because the picture carrier is down in the adjacent sound trap with the result that the oscillator frequency will not pull down. But the second detector d-c level is high and will bias off the 4.5-mc amplifier. The voltage across the 680-ohm resistor drops and the resistor loads the reactance control through the amplitude detector. The loaded reactance control pulls the oscillator frequency down. The sound carrier moves down the slope of the i-f pass band and the 4.5-mc beat amplitude increases until stabilization is achieved and correct lock-up results.

Fringe Tuning

With a weak fringe-area signal the receiver should be tuned so that the picture carrier is near the top of the i-f pass band for improved signal-to-noise ratio, considering resolution of secondary importance. The sound carrier of course will be lower in frequency. Also, under these conditions the d-c developed at the second detector is less and the 4.5-mc intercarrier beat amplitude may be somewhat reduced.

All these conditions are in the direction of less control voltage available for operating the reactance control to lower the frequency. The pull-in range is actually restricted. Pull-in may not be possible due to the spurious intersection of the aft control curve as the second detector d-c effect vanishes.

The intercarrier sound amplitude versus oscillator tuning is largely determined by the agc system and the i-f characteristic. The trap-in curve shown in Fig. 4 is the aft i-f response curve. The 4.5-mc amplitude curve is also shown for reference. This aft system may be considered as an automatic level control system for the sound carrier. An increase in sound carrier is accompanied by a shift in tuning, which tends to reestablish the same amplitude of the sound carrier.

The dashed i-f curve is similar to the i-f curve of intercarrier tv receivers except the trap is deeper

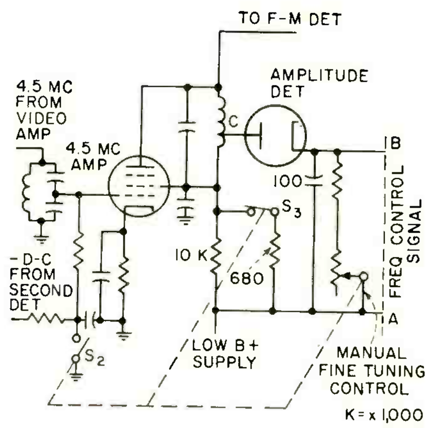
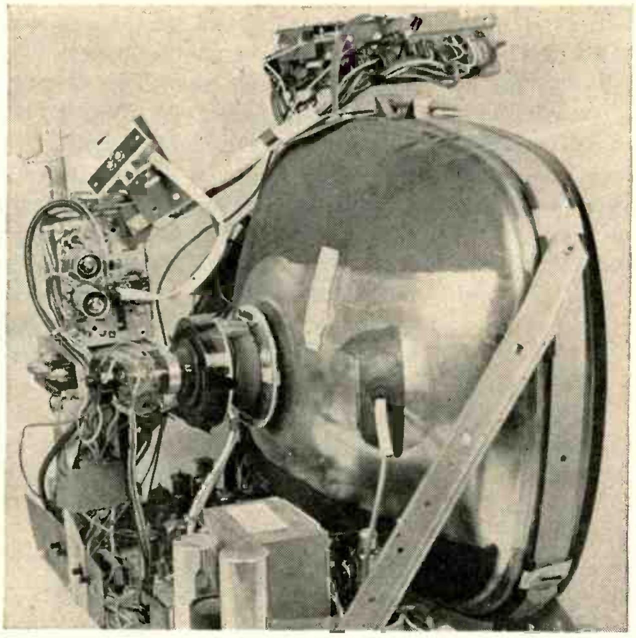
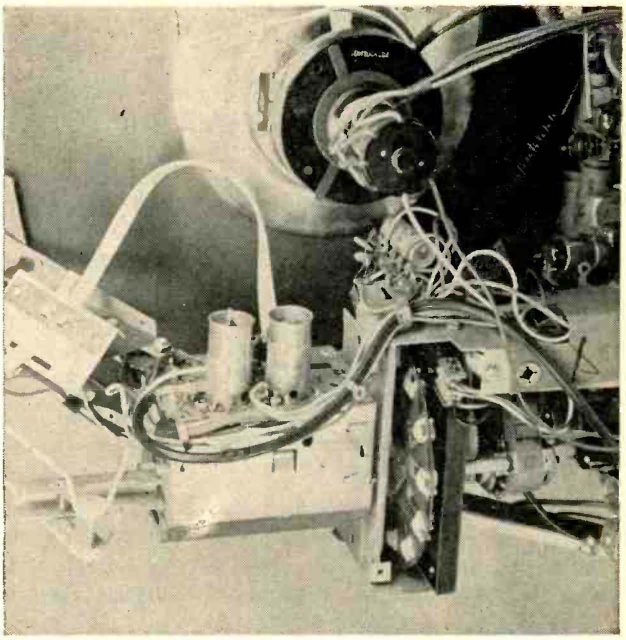


FIG. 7—Simplified circuit of automatic-manual operation with local-fringe switching omitted for clarity

and is tuned slightly lower in frequency. Also the outer band pop-up on the sound side is less. The solid curve shows the effect of removing the sound trap. The purpose of the i-f pass band shaping is to provide a desirable curve of 4.5-mc amplitude versus oscillator frequency. The 4.5-mc amplitude is readily determined from the i-f characteristic. The exact details of the agc system used affects the 4.5-mc amplitude curve, assumed to be a peak type operating on low-frequency video. The 4.5-mc amplitude can be determined for the two conditions of most interest: when the picture carrier is the strong signal at the second detector, and when the sound carrier is the strong signal at the second detector.

The first condition is for normal tuning and in this case the 4.5-mc beat is proportional to the

Internal view of tv receiver (left) showing, at left and top, the plastic bead drive used in channel selection and turret tuner. Nylon slides on wheel below turret turner (right) can be set to obtain best fringe or normal reception and skip unused channels. Programming switch is located beneath and to the right of nylon slide wheel. Local-fringe switch is at rear

Tv Automatically

tween the high-frequency components of the video signal and the sound signal.

In general, this is the same way a viewer tunes a receiver manually. Oscillator frequency is raised to increase picture sharpness until the benefit of increased sharpness is offset by the appearance of too much sparkle in the picture. This control is effective over transmission, antenna and receiver passband tilts and operates dynamically for the case of airplane flutter.

The method of tuning also provides considerable control over the 920-kc beat interference between the sound and chroma signal of color broadcasts.

AFT Measurement

To get a quantitative measure of aft systems it is necessary to analyze the discriminator (μ) and reactance (β) curves. These curves can be measured, if there is no interaction, by opening the loop connection between the amplitude detector and the reactance control. By measuring the discriminator voltage as the oscillator frequency is changed the discriminator curve can be plotted, and by applying a voltage to the reactance device and measuring frequency the reactance curve is obtained.

By superimposing these two curves, the closed-loop frequency is determined. Crossover points are stable if the slopes are opposite in sign. Stability also results if the slopes are the same sign and the magnitude of μ is less than the magnitude of β. However, in the latter case the loop gain is less than unity.

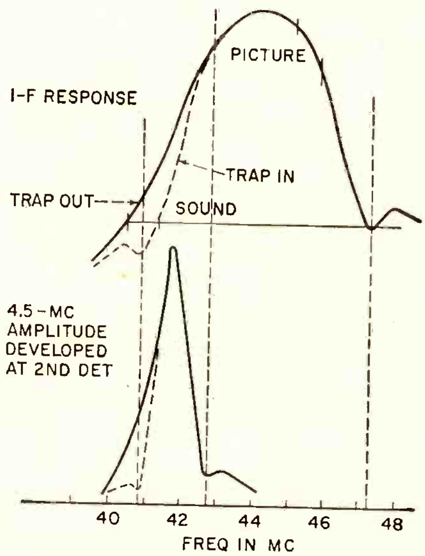


FIG. 4—Intercarrier sound amplitude against oscillator tuning is largely determined by receiver's agc system and characteristics of i-f system

Basic AFT Circuit

Figure 2 shows a simplified schematic diagram of the aft circuit that accomplishes the aft control function illustrated in Fig. 3. The circuit utilizes the 4.5-mc signal amplitude and the second detector d-c effect to develop the composite discriminator curve. The aft control voltage curve, Fig. 3, is a plot of the open circuit voltage that exists at the reactance control terminals *A* and *B* in Fig. 2. The amplitude detector rectifies the output of the 4.5-mc amplifier. This output is the 4.5-mc portion of the aft control function at terminals *A* and *B*.

The 4.5-mc amplifier also acts as a d-c amplifier for the second detector d-c level portion of the aft control function. The 680-ohm re-sound-carrier level at the second detector. The level of 4.5-mc sound with the sound in the trap is taken as reference. The procedure of computing the sound level below picture level is straightforward. The exact peak of the curve is not particularly important. It has an effect on pull-in time and hold-in range but in practice the peak can be limited to advantage.

The second condition occurs when the picture carrier is in the region of the adjacent channel sound trap. This part of the curve is important because the level of the 4.5-mc signal, when the oscillator is tuned to put the picture carrier in the adjacent sound trap, limits the pull-in range of the basic system.

Referring to the trap-out curve in Fig. 4, if the sound trap were disabled, the amplitude of the sound carrier would increase considerably but the aft system would lower the oscillator tuning to return the sound carrier to the same amplitude. This would cause the picture carrier to be tuned higher on the i-f pass band to the point of desired fringe tuning. The circuit that disables the trap and accomplishes this fringe tuning is shown in Fig. 5. This circuit is the same as the simplified aft circuit shown in Fig. 2 with some added components to enable switching for fringe operation.

A bifilar *T* trap is used in the grid of the first i-f stage as the sound trap. This type of trap provides the attenuation needed and the steep slope required for this aft system. With the LOCAL-FRINGE switch in the LOCAL position the sound trap returns to ground through the shielded cable, the switch arm and 1,000 $\mu\mu$f capacitor as shown. The r-f choke isolates the trap circuit.

With the switch in FRINGE position the sound trap is dampened by the 56-ohm resistor without affecting the normal shape of the i-f pass band. The 1,800-ohm resistor limits the amount of frequency pulling and its value determines the exact location of the picture i-f for fringe tuning.

In addition to removing the sound trap from the i-f pass band, the same switch contacts are used

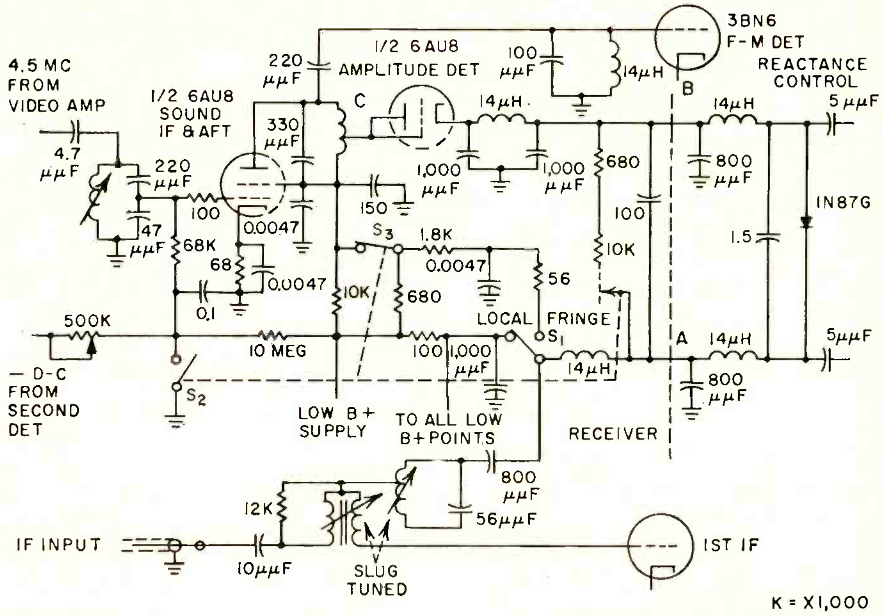


FIG. 8—Complete aft system combines features of fringe switching and automatic-manual operation. Switching transients are reduced by 180-$\mu\mu$f capacitor

to shift the d-c voltage applied to the reactance control by removing the voltage drop across the 680-ohm resistor. This prevents spurious lock-up of the aft control curve as the second detector d-c effect vanishes.

The dashed curve shown in Fig. 6 is a plot of the open circuit aft control voltage at the reactance control terminals *A* and *B* when a weak fringe signal is received with the switch S_1 in LOCAL. Little d-c change with tuning appears at the second detector when a fringe signal is received. As a result, it does not appear in the aft voltage curve. The oscillator control curve illustrates that a spurious lock-up could exist because of the intersection of the aft control curve at 42.75 mc.

With S_1 in FRINGE, the solid curve represents the condition when a weak fringe signal is received. The curve shows that the d-c level changes and the aft control curve

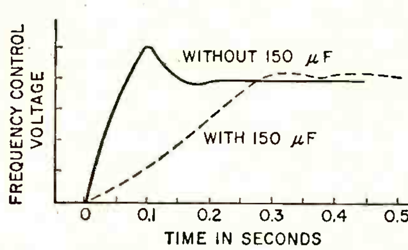


FIG. 9—Frequency control voltage at the reactance control terminals during pull-in

rises so that spurious lockup will not result. Fringe lock-up is almost one mc lower than the normal lock up, moving the picture carrier near the top of the i-f pass band, as desired for fringe tuning.

The automatic fine tuning circuit described is adapted for use in deluxe television receivers having programmed power tuning. In such sets, the fringe switching arrangement may be used and is easily programmed with power tuning. Channels may be selected as desired and the type of tuning, fringe or local, for each channel may be predetermined.

Manual Operation

In addition to local-fringe switching, manual fine tuning is provided to enable the viewer to minimize intereference displayed in the picture.

Figure 7 is a simplified circuit of the automatic-manual operation with local-fringe switching omitted. The manual fine tuning control is a variable resistor that loads the reactance control. A fixed series resistor limits loading as well as the fine tuning range. Switches S_2 and S_3 are shown in automatic and are part of the manual fine tuning control, open circuited in the maximum counterclockwise position.

In manual operation S_3 is open, increasing the plate-dropping resistor to 10,000 ohms. Increased voltage drop will back-bias the amplitude detector. With reduced plate and screen voltage, the sound amplifier acts as a limiter to maintain good sound performance. In automatic, the aft system provides limiting since it maintains the sound level constant. Since a requirement is that second detector d-c should not vary the bias on the 4.5-mc sound amplifier during manual fine tuning, S_2 is provided to short the d-c from the second detector to ground.

Complete Circuit

Figure 8 illustrates the complete aft circuit, combining the features of fringe switching and automatic-manual operation. Switch S_1 is shown in LOCAL and the 10,000-ohm manual control is shown ganged to switches S_2 and S_3, which are in automatic. The 4.5-mc amplifier is the pentode section of a 6AU8. The triode section is diode-connected and used as the amplitude detector.

The 100-ohm resistor, connected between S_1 and the low B+ supply terminal, carries all of the low B+ current of the chassis except the plate circuit of the 6AU8 amplifier. When the second detector d-c voltage biases off the 6AU8 amplifier, during pull-in, the low B+ supply voltage increases. This is due to regulation characteristics of the low B+ supply. Cutoff is not really achieved and a residual current flows through the 680-ohm plate load resistor, reducing the pull-in range. The voltage drop across the 100-ohm resistor is used to cancel this residual 4.5-mc amplifier plate

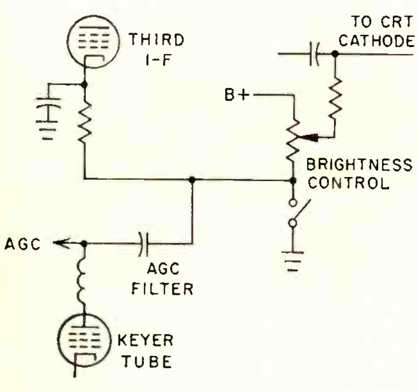


FIG. 10—Circuit shows how aft loop is held open during interchannel switching until the tuner turret falls into the proper detent corresponding to desired channel

current and improve pull-in.

The 150-μf capacitor, connected to the top of the d-c plate load of the 6AU8 amplifier, is required because of transient problems encountered when switching from manual to automatic operation. During manual operation, the voltage across the 150-μf capacitor is low to obtain limiter action in the 4.5-mc amplifier. The action of the 150-μf capacitor is to hold down gain and reduce pull-in time when switching from manual to automatic operation.

Frequency control voltage at the reactance control terminals during pull in is shown plotted in Fig. 9. The peak of the 4.5-mc aft control voltage is indicated in the solid curve as the oscillator is pulled

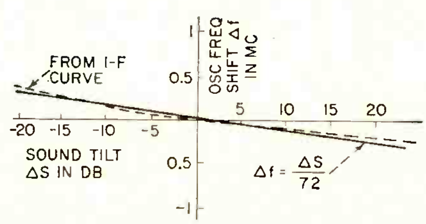


FIG. 11—Oscillator frequency change resulting from change in sound level

down with approximate stabilization at 0.15 sec. Depending on the signal being received, a spurious lock up can result with this peak voltage. The dashed curve illustrates that gain in the 4.5-mc amplifier is reduced and stabilization occurs at approximate 0.3 sec.

Switching Effects

Because of variations in signal strength as well as channel-to-channel variations in the reactance control, the receiver conditions during the time interval between channels must be considered. In areas where a signal is available the aft system may possibly effect an erroneous lock up on almost every channel or may possibly pull down and lock on the next lower channel.

One cause of this trouble results from the wiping action of the contacts in the turret-type tuner. On initial contact, the oscillator frequency is considerably lower than when the turret is finally in the detent. When the lower adjacent channel signal is present, the aft loop is closed and control information is available to cause the system to stabilize on the undesired lower channel. To correct this situation, the aft loop is held open during interchannel switching until the turret is in its proper detent.

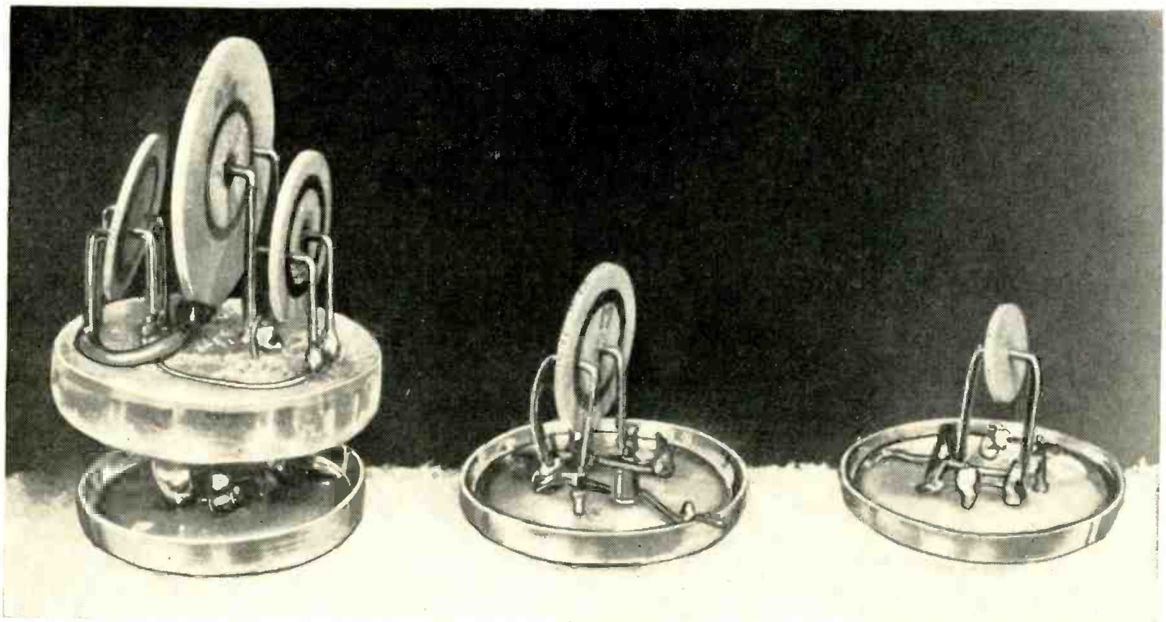
Figure 10 shows how this is accomplished. To open the aft loop, the third i-f tube is biased off by putting the cathode at B+ voltage. The switch is part of the power tuning mechanism and opens only during the time interval of channel selecting. This prevents the normal brightness flashing and noise that occurs when switching through unused channels. Other features presented include picture and sound muting.

Also shown in Fig. 10 is the agc filter capacitor connected to the switch. The capacitor corrects a transient problem caused by the relatively slow agc system stabilization when the aft loop is closed. Between channels, the agc filter capacitor is charged to B+ and has the polarity as shown. When the switch closes the capacitor discharges into the agc system to prevent any sudden build up of signal until the agc can stabilize.

Figure 11 shows the oscillator frequency change for a change of sound level. Essentially this is a measure of the combined picture and sound i-f slopes. The data plotted assumes a high β gain and shows that a 10-db sound tilt shifts the oscillator by 100-kc.

If the sound change is due to a transmission tilt the frequency change is in the direction to provide video compensation. The picture carrier moves down the i-f pass band to give high-frequency boost for downward tilts of sound and provides high-frequency attenuation for upward tilts.

On color broadcasts the beat between the sound and chroma signals at the receiver second detector influences receiver tuning. For this 920-kc beat to be invisible at normal viewing distances, the combined sound and chroma attenuation below picture level must be 30 db or more at the second detector. Attenuation in excess of the 30 db reference level is referred to as beat reserve.



Filters, left to right, are three-disk four-terminal, single-disk four-terminal, and single-disk two-terminal types

Ceramic I-F Filters Match Transistors

Barium titanate resonant filters used as i-f transformers provide reductions in size and cost with increased ruggedness, better skirt selectivity and lower insertion loss. Input and output impedances of units are compatible with those of transistors making them ideally suitable as interstage coupling devices

By DANIEL ELDERS and EMANUEL GIKOW

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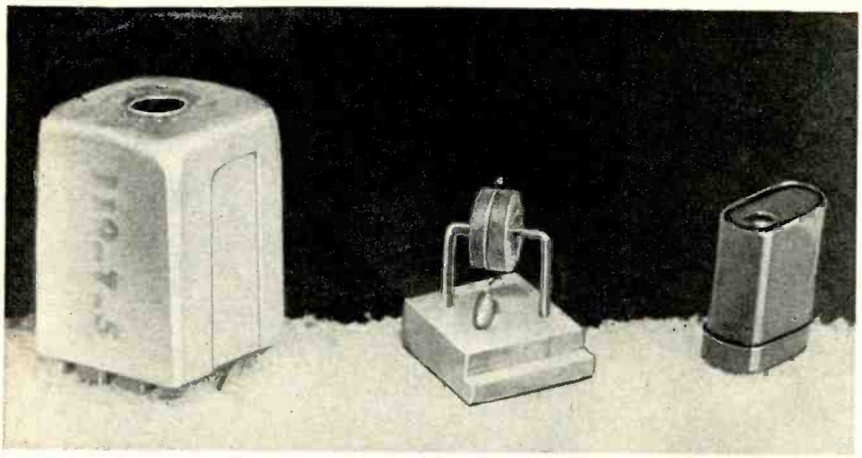
DIMENSIONAL CHANGES in piezoelectric materials become pronounced at the natural resonant frequency of the material. Since the effective Q of these mechanically resonant circuits compares favorably with those attainable by L-C components, it becomes possible to efficiently transmit electrical energy through a piezoelectric device over a band of frequencies.

Major interest in these filters is in their potential as a low cost, rugged miniaturized replacements for tuned passive i-f transformers. Consequently, development has been directed towards those midband frequencies which are normally used in the i-f portion of communication receivers.

Materials

Materials found suitable for filter applications are compositions based on barium titinate and solid-state solutions of lead-titinate and lead-zirconate. For proper operation, the materials must be permanently polarized by an electric field. Such a field is applied between electrodes while the material is heated in an oil bath. Usually, the material is heated above its Curie temperature. A typical procedure for the barium titinates is to apply a d-c electric field of 20 kv per cm with the unit heated above the Curie temperature of 120 C. This field is maintained until the unit cools to room temperature. Lead-titinate and lead-zirconate compositions are heated to 100 C, well below their Curie temperature of approximately 350 C. The material is polarized by a d-c field of 40 kv per cm applied at this temperature of 100 C for four minutes. The Curie temperature establishes the upper operating



Composite resonator, center, compared with single-tuned transformer, left, and transistor enclosed in case at right gives idea of relative size of components

limit of these filters, since exposure to a higher temperature would destroy the effect of polarization with consequent loss of the piezoelectric properties.

Although the natural resonance of piezoelectric ceramics is dependent on the dimensions, geometry of the resonator can vary considerably for a given resonant frequency. Two and four terminal thin disks vibrating radially have been studied. In the former each face of the disk is electroded as shown in Fig. 1A, while the latter has a small center electrode and a concentric ring electrode on each face as in Fig. 1B. In the polarizing process the field is applied between electrodes on opposite faces and results in an axial polarization.

Disk Thickness

Resonant frequency of a relatively thin disk is determined primarily by its diameter, which for a fundamental 455-kc unit would be of the order of 0.2 in. However, the ideal case of a thin disk is only approached, in the practical cases, so that the resonant frequency is modified by the thickness to diameter ratio.

Work in this direction has shown that over a range of thickness to diameter ratios of 0.04 to 0.1, the resonant frequency of the disks decreases as this ratio increases. It was also found that the resonant frequency increased as the electrode area decreased. These controls are incremental in their effect. Design control does not stop at this point, for, by proper placement of electrodes and operating at the first overtone, the simple two-terminal resonator can be converted to a four-terminal device. These two types of resonators which were shown in Fig. 1 constitute, in effect, the building blocks of further more complex filters. From an analysis of the equivalent circuit and a knowledge of the characteristics of the individual resonators, considerable work was done in designing composite filters with specific characteristics. In fact, it is now possible to tailor a filter to a given application.

The two-terminal disks have been primarily employed as elements of electric-wave filters, in Pi T, and L sections and combinations thereof. The four-electrode disks have bandpass characteristics and impedance transformations which ideally suit them as interstage coupling devices for transistors. Development models of several such filters are shown in the photograph.

D-C Return Path

A complicating factor in using these filters as interstage devices between transistors is the lack of a d-c path. For this reason ceramic filters cannot be used as a direct physical replacement for i-f transformers. A d-c return can be provided by a resistor. Although the additional cost of such a resistor is small, there is an attendant loss of sensitivity and power.

An alternative, providing more overall gain, is to use a choke. Some promising work is being done at the Clevite Research Center on circuit arrangements which will permit the optimum use of these filters without performance or cost sacrifices in providing for d-c returns. An i-f amplifier has recently been designed which uses a more recent filter development. The superior characteristics of these filters and, in particular, their low insertion loss, has resulted in a 455 kc i-f amplifier of only two stages with 55 db gain.

Test Results

Electrical performances of some typical piezoelectric ceramic filters

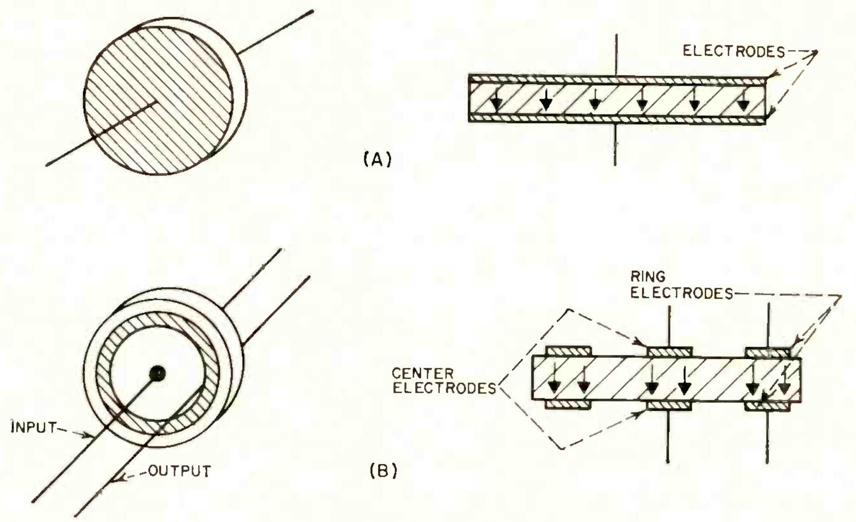
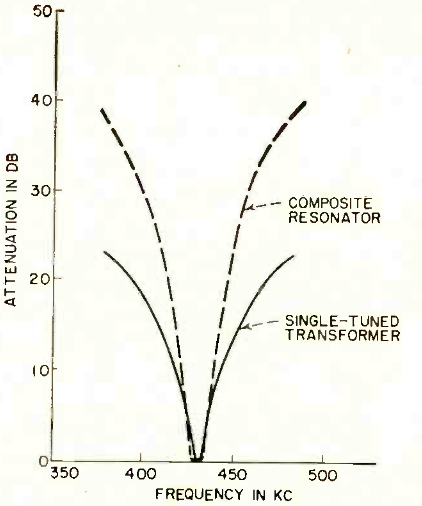


FIG. 1—Two constructions of a barium titanate filter used in tests. In the two-terminal (A) and four-terminal (B) cross sections the arrows indicate direction of polarization



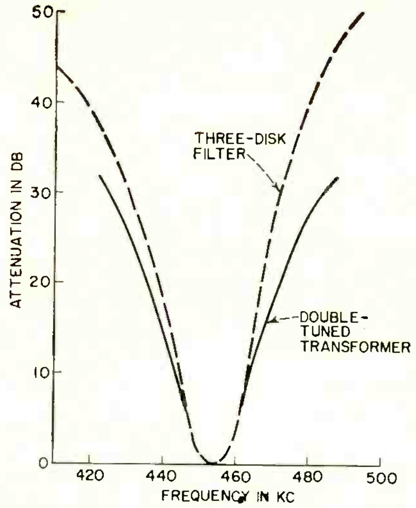


FIG. 2—Selectivity curves for composite resonator compared to single-tuned transformer (A) and three-disk filter compared with double-tuned transformer (B)

are shown in Fig. 2. In Fig. 2A the band-pass characteristic of a composite resonator is compared with a single-tuned i-f transformer. The 6-db bandwidth of both units is 12.5 kc, however, the skirt selectivity of the ceramic filter is superior, 2.7 compared to 5.7 for the transformer. The insertion loss is 1.5 db as compared to 2.5 db for the i-f transformer. Comparative sizes can be seen in the photograph showing a conventional single-tuned i-f transformer, the composite ceramic resonator, and a typical transistor.

Figure 2B compares a three-disk, four-terminal filter using first overtone disks with a conventional double-tuned i-f transformer. Here the 6-db bandwidth is 14 kc for both units with a skirt selectivity of 2 for the ceramic filter compared to 2.5 for the i-f transformer. The insertion loss of both the ceramic and L-C type transformer is in the order of 3 db. Although the use of overtone disks increases the volume of the ceramic filter in these experimental structures, it is still only half that of the double-tuned i-f transformer whose size is $\frac{3}{4}$ in. by $\frac{3}{4}$ in. by 2 in.

Impedance Transforms

The impedance transformations achieved with the varied configurations investigated indicate that they are ideally suited to transistor applications where the filter input impedance must be in the order of 25,000 ohms and the output impedance in the order of 500 ohms. Bandwidths of the designs built to date have been as high as 10 percent of center frequency, using materials having Q's ranging from 50 to 2,000. The power insertion loss of these designs, which is dependent on both Q and bandwidth, ranges from 0.5 to 10 db and, in specific instances, can be made equal to or lower than conventional i-f transformers while having improved skirt selectivity and decreased size.

Limiting Factors

At 455 kc, development has now reached the stage where the temperature and aging properties of the ceramic materials are the limiting factors in their use for military applications. Figure 3 shows the response curve of a two-disk filter at −40 C, +25 C and +85 C. The insertion loss varies about ±0.5 db while frequency shift is about 0.2 percent from +25 C to +85 C and 0.4 percent from +25 C to −40 C. As the work on temperature stability of materials progresses the upper temperature extreme can be increased to 150 C without modification of design criteria. For higher temperatures, say 200 to 250 C, further work may be necessary in high-temperature electrodes and solders.

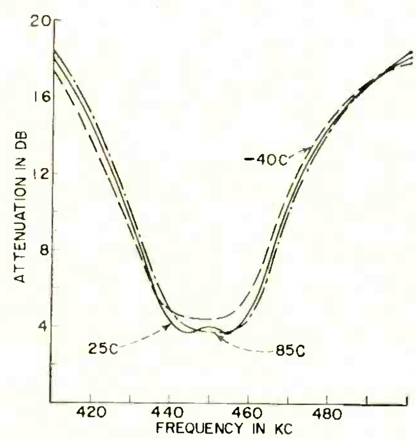


FIG. 3—Frequency selectivity of a two-disk ceramic filter at various temperatures

To gain some idea of the aging properties of one of the better materials used to date, (a lead-zirconate, lead-titinate composition) tests show that after an initial 22 day aging, an additional 14 month aging produces a change of resonant frequency of +0.12 percent. The increase in resonant frequency has been found to be approximately linear with respect to the logarithm of time.

Most effort up to this time has been directed towards establishing design criteria, as a result the development models have been made up more for the convenience of the experimenter than with an eye towards the user. In light of the progress made, some work has been done recently on packaging. Since these filters are fixed tuned, they lend themselves to hermetic sealing. It is now planned to accelerate, somewhat, work on optimum form factor of 455 kc filters while further development is progressing towards the use of the filter at higher frequencies, up to approximately 12 megacycles.

The information presented herein is based, for the most part, on work performed at Clevite Research Center under U. S. Army Signal Engineering Laboratories' direction. In particular much of these results are possible due to the basic and original contribution made by O. Mattiat. Acknowledgment is also made of the more recent contributions of D. Curran and of the circuit design work by A. Longo.

This article is based on material divulged in a paper presented at the 1957 Electronic Components Symposium in Chicago on May 2, 1957.

MILITARY ELECTRONICS—S-band magnetron generates 5 megawatts during 5.5μsec pulse interval. Countermeasures simulator tests system effectiveness on actual radars, simulates flight speeds of aircraft

COMPONENTS—Electroluminescent-ferroelectric screen gives two-dimensional display. Annular-geometry electron gun furnishes inverted beam-control. Two-cavity ammonia-beam maser gives one-way amplification

Highlights of the

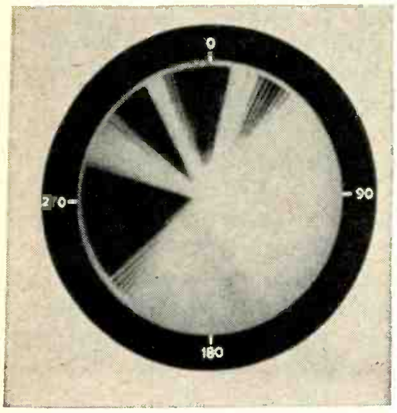


FIG. 1—Condition-IV jamming by white noise obliterates signals

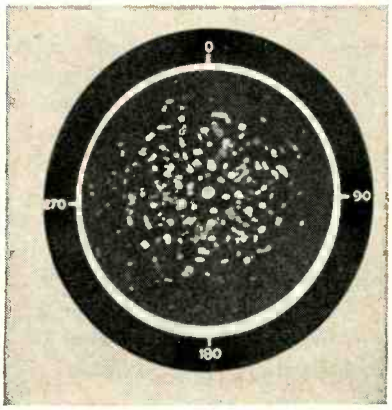


FIG. 2—Condition-V jamming using simulated targets. All are false and moving

HERE ARE typical developments revealed at technical sessions during last month's four-day IRE National Convention:

High-Power Magnetrons

A new magnetron is capable of generating five megawatts of r-f during a 5.5-μsec pulse interval.[1] Mean power output is 5 kw and operating frequency is in the S band. Construction features of the magnetron are an anode block one wavelength long and an output design that is axial. Over 6,000 operating hours have been achieved to date.

An L-band magnetron producing 3 megawatts peak at 6-μsec pulse width and 4-kw mean power output is in production and one capable of generating 5-kw peak at a mean power output of 6 kw is nearing production.

A simulator that tests the effectiveness of various countermeasures on actual radar systems by the simulation of flight speeds for propeller, jet, and rocket driven aircraft was described.[2] Courses are programmable, yet open for minor changes due to weather or tactical situation. A-m, f-m and pulse modulated radiation systems in the 1,100 to 1,400; 2,600 to 3,400 and 8,500 to 10,000-mc bands are available.

The simulator furnishes 30- and 60-mc a-m and f-m sine-wave, square-wave, saw-tooth or super-regenerative noise modulation. It provides simultaneously, two manually controlled single targets which are adjustable in azimuth width and six programmed targets which are capable not only of variation in azimuth width but can also be multiple in range. The unit can transcribe six different courses on the ppi simultaneously or permit individual control. A flight of up to three targets, capable of being multiple in range and of being varied in size, are programmed as a unit or manually operated as such. Random targets which occur during an individual scan, whose average size, maximum range and target density can be adjusted, are also provided.

An operator is said to experience a condition of jamming when through either blank out or complete confusion his equipment and his analysis can not be of strategic or tactical value. During a condition I, a 1 to 90-deg sector of the ppi presentation is jammed out; condition II, a 91 to 180-deg sector; condition III, a 181 to 270-deg sector; condition IV, a 271 to 359-deg (Fig. 1); condition V, a 360 deg, or a sufficient number of random targets to cause equal effect (Fig. 2).

Electroluminescent Display

In one two-dimensional display device, electroluminescence is used as the light source and ferroelectrics provide control and storage of the output image.[3]

An electroluminescent phosphor layer is applied to a transparent conducting base. An array of metal electrodes is vacuum evaporated on the phosphor. Each of these electrodes defines an element of the display screen. Next a ferroelectric capacitor is associated with each of the electrodes and finally a set of bus bars carry power to each line of screen elements. See Fig. 3.

MEDICAL ELECTRONICS—Subminiature transducer measures pressures inside human heart. Analog circuits help record foetal heart rate during labor. Electronically corrected Nipkow disk scans biological specimens

COMPUTERS—Russian-English automatic translator stores 500,000-word lexicon on photoscopic disk. Character recognition system proves useful in mail-sorting tests

IRE Convention

The a-c light-power voltage divides in accordance with the relative capacitances of the ferroelectric and electroluminescent components. The capacitance of the ferroelectric is a function of the applied d-c bias; therefore, the excitation to the electroluminescent capacitor, and hence the brightness of the element, depend on the amplitude of the control voltage of charge. Figure 4 gives the equivalent circuit.

Contrast ratios of 200 to 1 or more can be achieved with several hundred volts. Associated with the problems of control and storage in an electroluminescent display is the problem of distribution of the signal information. Figure 5 illustrates one possible approach.

Annular Geometry Gun

The cathode emitting area of the annular-geometry gun is the internal surface of an annular ring.[4] The physical layout is as in Fig. 6.

As the control grid voltage is raised above cutoff, the beam current at first rises slowly with increasing cathode current. A region of rapid beam current rise follows the slow build up. Suddenly the beam current peaks and then drops sharply to zero with increasing control grid voltage. See Fig. 7.

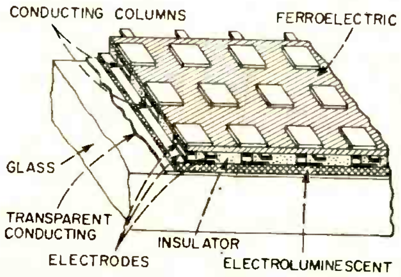


FIG. 3—Cross section of ELF screen

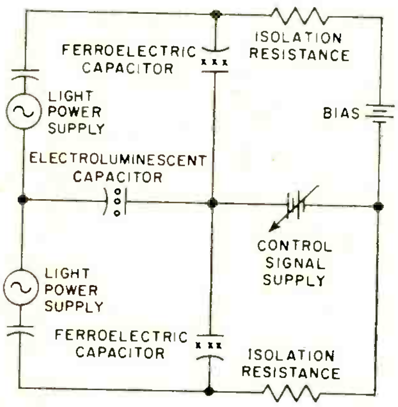


FIG. 4—Equivalent circuit of electroluminescent-ferroelectric screen

The inverted control characteristic extends over a region of about 7 volts. The peak beam current is reached with about −12 volts applied to the control electrodes and beam cutoff occurs at about −5 v.

If the gun is operated in the inverted region, white noise inversion may be achieved. Space charge in the beam appears to have little effect on either spot size or optimum focus condition. Resolution in excess of 750 lines has been attained with peak beam currents greater than 500μa.

Two-Cavity Maser

Unilateral amplification can be obtained by a maser with two isolated resonant cavities[5]. One experimental, ammonia-beam device is a 23.87-kmc fixed-frequency amplifier with a bandwidth of 1,000 cps. (Solid-state masers offer tunable frequencies and broad bandwidths.)

As shown in Fig. 8, separate terminals are provided for input and output functions. In passing through the cavities, the ammonia beam has its normal populations disturbed. More molecules become available for emission rather than absorption resulting in amplification.

Of the two equivalent circuits shown in Fig. 9 the upper one is for the first cavity. Negative quantities represent the beam elements passing through the cavity; I_b is current resulting from stimulation of the beam by the applied field; and other elements represent the cavity itself.

The lower equivalent circuit is for transfer from the first cavity to the second. Parameter l_1 is length of the first cavity; l_2, length

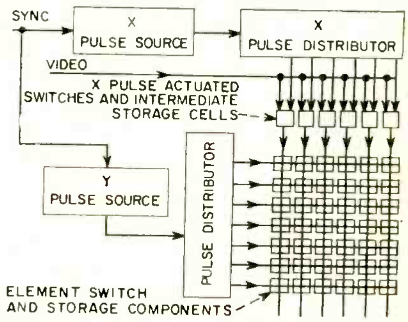


FIG. 5—Switching system for ELF screen

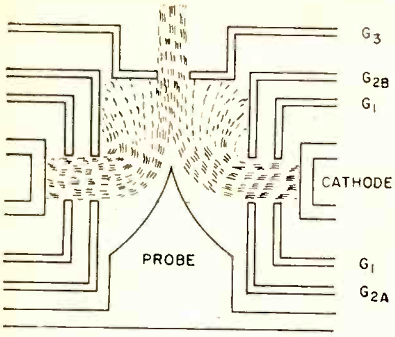


FIG. 6—Cross section of annular-geometry electron gun shows beam path

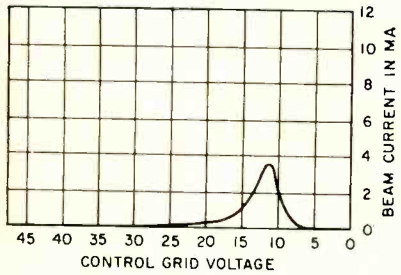


FIG. 7—Control grid voltage against beam current for annular-geometry crt

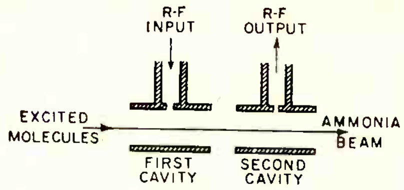


FIG. 8—Cross section of dual-cavity maser shows operating method

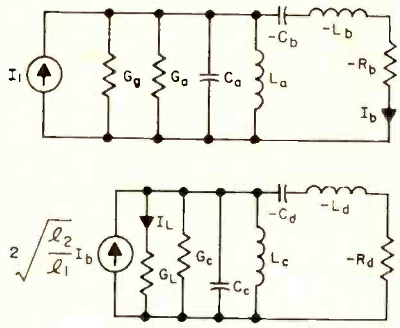


FIG. 9—Equivalent circuit of first cavity (upper) and equivalent circuit for transfer from first cavity to second

of the second. Negative quantities C_d, L_d, and R_d, represent values of the beam as it appears within the second cavity. Other parameters are for the second cavity itself.

For an improvement in gain, the first cavity should be lengthened with respect to the second. This change also results in noise-figure improvement.

For the experimental amplifier with matched cavities described gain was 20 db. Minimum indicated noise figure was 5.6 + 0.9 db; saturation power—10^{-10} w.

Transducer Probes Human Heart

A new intracardiac pressure measuring system makes possible removal of blood samples from within a beating heart while extremely accurate measurements of in-heart blood pressure are recorded.[6] The pressure transducer is thinner than a match stick and only a half inch long. A low-level d-c transistor preamplifier is used to raise the transducer output voltage of 3 microvolts per mm Hg pressure for 9 v bridge excitation to a level suitable for typical hospital recording equipment. Cardiac pressures can be measured in the range of −20 to +300 mm Hg.

Within the device a miniature bellows is activated by cardiac pressure. The bellows presses against a coil of wire that encircles it. While the coil is stretched its resistance increases, causing a voltage change.

Recording Foetal Heart Rate

The recording system provides for digital and analog presentation of data, storage on magnetic tape and semiautomatic data reduction. By determining instantaneous foetal heart rate objectively, an evaluation of the relationship, if any, between foetal heart rate and possible foetal distress can be provided.[7]

In the system, the foetal electrocardiogram is used as a trigger source for a cardiotachometer and display systems. Since both maternal and foetal electrocardiograms are present as vectors, it is necessary to separate the foetal signal so that it is available for counting. This is done by picking up a maternal electrocardiogram alone, matching it in amplitude and configuration with the one from the abdominal wall and subtracting it electronically from the combined maternal-foetal electrocardiograms.

Disk Scanning System

A mechanical scanner, using a rotating Nipkow disk, has found application in microphotometric measurements of cells in cytological smears. The construction of a Nipkow disk presents an exacting design problem because inaccuracies in the angular position, transmission, and size of the holes in the disk result in measurement errors.

The disk errors are eliminated electronically by a circuit that uses a constant light level as a reference source to correct the timing and amplitude of the video signal.[8] This reference light level is a narrow slit introduced along the edge of the scan field by a separate optical train that is not affected by cells in the object plane of the microscope. The slit is positioned so that each hole in the scan disk crosses the slit just prior to scanning the image field of the microscope, and this produces a reference signal in photodetector (Fig. 10).

Automatic Translator

Translation starts by manually converting Russian text into punched codes in paper tape. Input

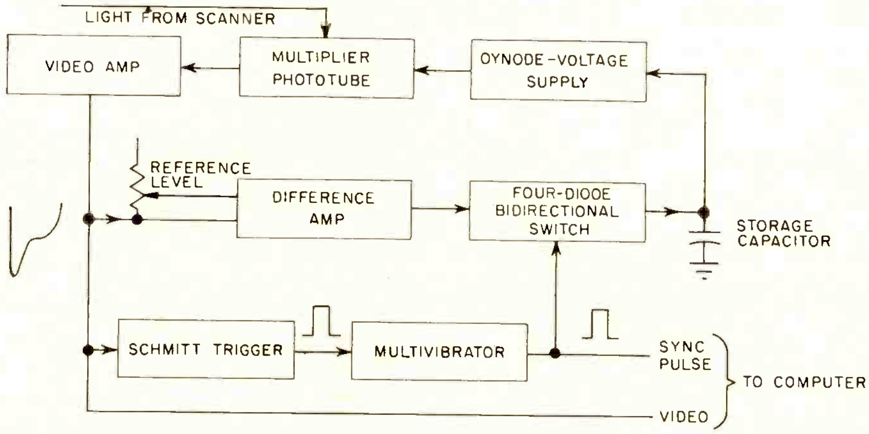


FIG. 10—Nipkow-disk scanning circuit for cytological measurements

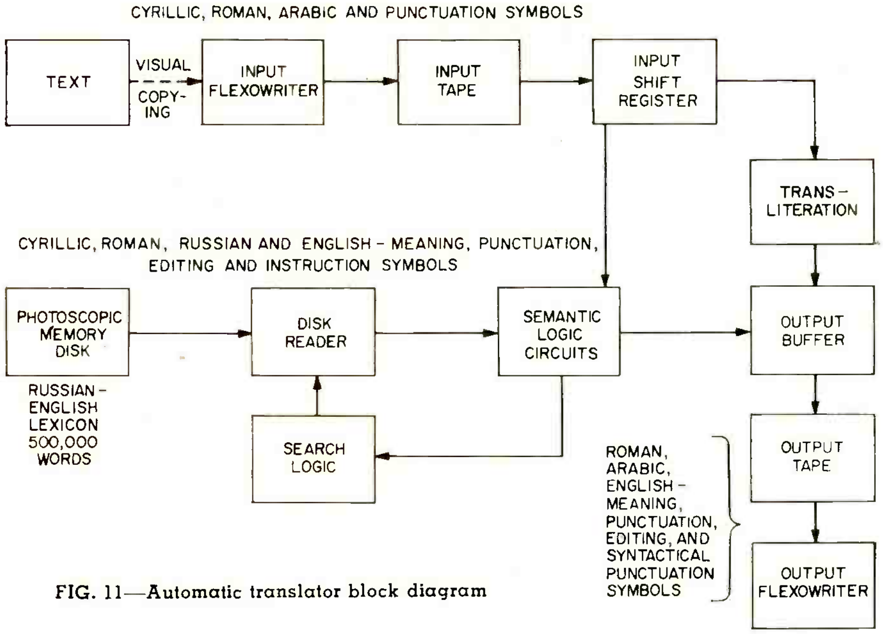


FIG. 11—Automatic translator block diagram

item is then compared with items contained in a 500,000-word Russian-English lexicon and the English translation of the matched item printed out.[9] Figure 11 is the block diagrm.

A transliteration circuit is provided to spell out in Roman characters all Russian words not found in the dictionary and to print out the result in red.

Required memory capacity was obtained by development of a binary lexicon to serve as a dictionary and refinement of technique of photoscopic storage. Film-to-disk unit reduces photographic image 60 times and transfers the linear pattern to circular tracks on the photoscopic disk.

Planned substitution of a sapphire disk for the glass disk will permit higher rotational speeds with corresponding reduction of search access time. Present read rate is 20 words per sec using 10-character average per scientific word.

Asynchronous, 2-mc computational circuits are used which permit simultaneous reading, searching, and comparing. Special symbols are used in search logic circuits to pick up at a likely starting point. The search system can determine position of word and converge on it within one disk revolution. Overall error is one bit in one billion.

Non-Russian inputs such as numerals or bibliographies in English are sent directly to the printer. Sentence format is retained throughout and punctuation inserted automatically. Structure of the dictionary and design of search logic permit translation of Russian semantic units larger than one word and of idiomatic word sequences.

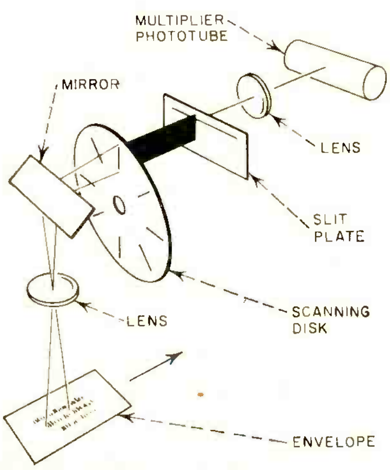


FIG. 12—Automatic mail sorter scanner

Mail Sorter

Studies directed toward automatically sorting mail addressed by typewriters or printing devices are underway and have proved successful on small sample mail runs.[10] One sorter is designed to sense or read words rather than discrete characters, as is done with other devices. This technique would permit rapid sorting of mail because city and state names have distinct and predeterminable letter structures and are recurrent.

A high resolution mechanical scanner is used which is arranged physically as shown in Fig. 12. Documents fly by at 30 in. per sec while the scanner reads typed addresses at 360 words per second. Twenty-five scans per character, on the average, are made to get required resolutions.

Clipped and gated scan signals generated by the scanner are representative of black areas on the document. Sensed signals are fed into a special purpose computer called an integrator. This unit distinguishes character strokes and consists of a primer, an inverter and a measuring unit. The primer remembers preset criteria and stores it until reset, the inverter inverts the input signal, and the measu[...] unit determines length and l[...] of scanned stroke.

The scanner must register [...] city-state line on an envelope w[...] a vertical intelligence zone of [...] to 1½ in. A locator unit is used to obtain and hold proper registration.

Since too great a variation in stroke length cannot be tolerated, the height of the initial character in a word is used as a measure of the height of the remaining characters. A comparator circuit is used to introduce a proportional scale factor which normalizes the type faces. Individual sorting problem of post offices in different geographical areas would be solved by plugboard programming—W.E.B., J.M.C., R.K.J., J.M.K., E.A.S.

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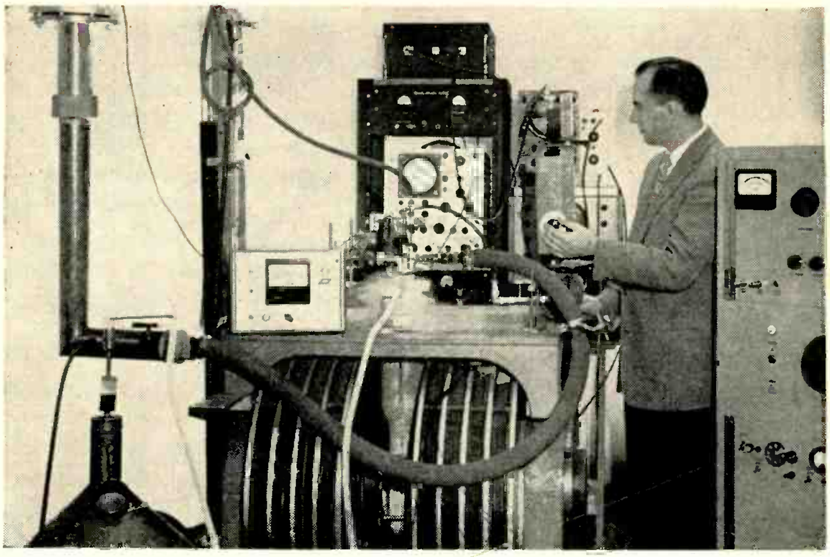

Experimental setup shows maser cavity (center) surrounded by high-voltage field coils

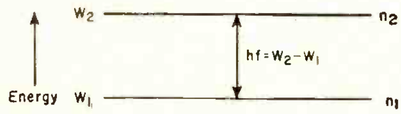

FIG. 1—Energy level diagram for a two-level maser of molecular type

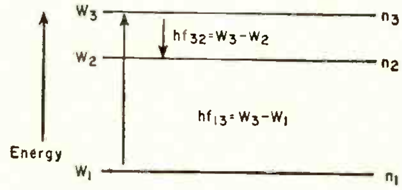

FIG. 2—Energy level diagram for a three-level maser of solid-state type

The Solid-State Maser—

Every so often, a development in our field stands apart because of its basically different approach to a problem. Such is the case with the maser. History, system philosophy, and performance described here include discussions of the following: two-level molecular maser, three-level solid-state maser, current experiments, amplifier and oscillator characteristics, noise measurement, applications and future directions

By **J. W. MEYER,** Staff Member, Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Mass.

DEVELOPMENT of the solid-state maser represents a major breakthrough in the field of low-noise amplification at microwave frequencies. This super-cooled amplifier enables an engineer to construct a receiver with no more self-generated noise than that produced by the antenna and transmission line connected to it.

Masers (*M*icrowave *A*mplification by *S*timulated *E*mission of *R*adiation) are byproducts of basic solid-state research on microwave resonance absorption in paramagnetic materials at temperatures near absolute zero. Successful operation of a solid-state maser was first achieved at Bell Telephone Laboratories where it was made to oscillate at X-band or 9,000 mc.

Experimental amplifiers operated by Lincoln Laboratory research teams in the S-band (2,800 mc), L-band (1,400 mc), and uhf (300 mc) regions have incredibly low self-generated noise. By actual measurement, noise figure of one of these amplifiers is just a fraction over one. Expressed in db, this value is near the ultimate of zero db. The implication of such a low noise figure to the fields of radio astronomy, radiometry, communications, and radar is evident.

Like all amplifiers, the maser depends upon control and conversion of energy. But unlike the vacuum tube, the maser converts the energy stored in a molecular or atomic system by a microwave power supply into useful output. Emission of this stored energy is stimulated by the input signal.

Two-Level Molecular Maser

Earliest investigations of phenomena related to the molecular maser were made at the University of Michigan in the 1930's. Researchers were trying to extend spectographic measurements from the far infrared to what is now called the submillimeter range. Upon applying microwave energy to a bag of ammonia gas, they found that a strong absorption occurred at 24,000 mc.

In terms of quantum physics, a description of this effect is as fol-

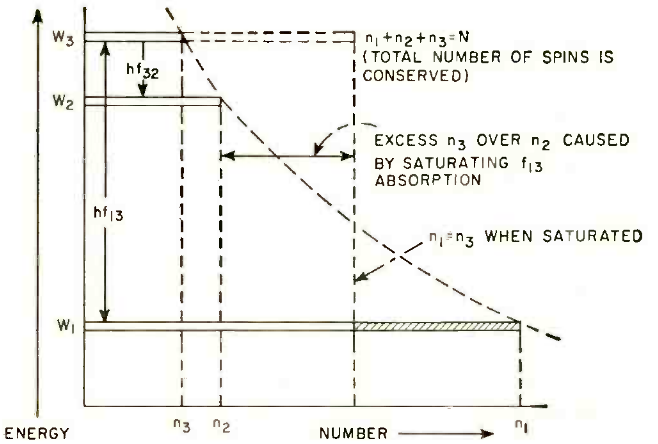

FIG. 3—Spin distribution over three energy levels

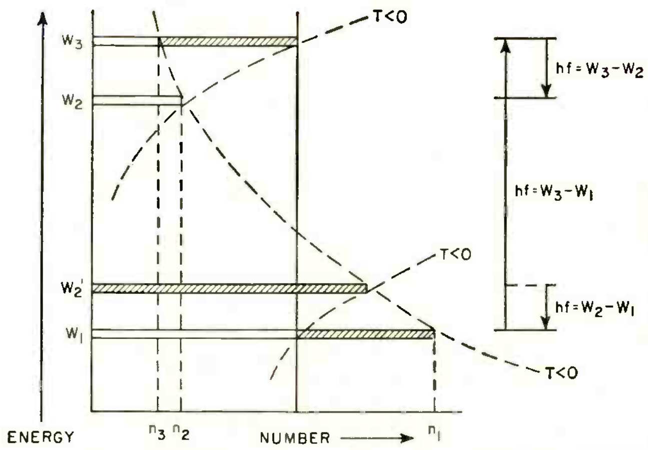

FIG. 4—Spin distribution showing two modes of maser operation

A Supercooled Amplifier

lows: Among all possible modes of motion for the ammonia molecule there are two modes or energy levels separated by an amount hf where h is Planck's constant and f is frequency of absorbed radiation. This can be represented in an energy level diagram as shown in Fig. 1. The horizontal lines represent energy levels with energy increasing in the vertical direction. Assume the number of ammonia molecules in lower energy level W_1 is n_1 and the number of ammonia molecules in upper energy level W_2 is n_2. Then, upon applying the appropriate quantum of radiation to this system, there occurs an absorption of energy. The effect is the transfer of the molecules from mode W_1 to mode W_2 at a frequency so that $hf = W_2 - W_1$.

Structure of the ammonia molecule resembles a pyramid with the nitrogen atom located at its apex. It is possible for the nitrogen to occupy either the apex of the pyramid or its mirror image through the base formed by the hydrogen atoms. Splitting, or energy separation of modes W_1 and W_2, is a result of the difficulty that the nitrogen atom has in tunneling through the base.

Boltzmann's law applies to distribution of molecules over these two energy levels. Ratio of the number in the upper energy state to that in the lower energy state is given by $e^{-hf/kT}$, where k is Boltzmann's constant and T is absolute temperature. At microwave frequencies and room temperature, magnitude of the exponent of e is about 1/200. As a result, the difference between the population of the upper energy level and the lower energy level is extremely small. Yet it is different and, because it is different, there can be a net absorption of energy. To absorb energy in the system, it is essential that the population in the lower level be greater.

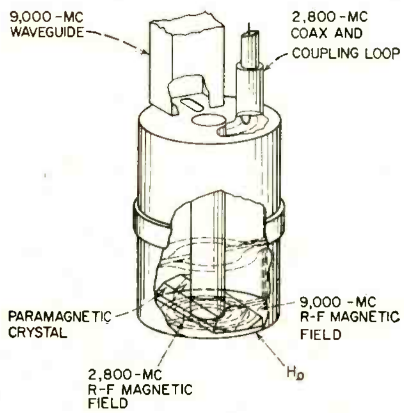

FIG. 5—Dual-frequency maser cavity with magnetic field distribution

Molecules are brought back to the lower level by a phenomenon known as scattering or relaxation. It characterizes the transfer of the increased molecular energy to the surroundings. In a solid-state device, it is usually an interaction between atomic magnets and vibrational energy of the crystal lattice.

Energy that has been put into the system, represented by an increased occupancy of the upper level, has to be transferred back to the surrounding medium. In doing so, it releases energy to this surrounding medium. Equilibrium is maintained by the relaxation mechanisms which bring molecules from the top level back to the lower one. To have a net stimulated emission there must be an excess population in the upper level. Because incident radiation of the correct frequency will stimulate both absorption and emission of radiation, there can be a net emission over absorption only when n_2 exceeds n_1.

Another form of emission in a maser is known as spontaneous emission. It results from the ammonia molecule fluctuating from

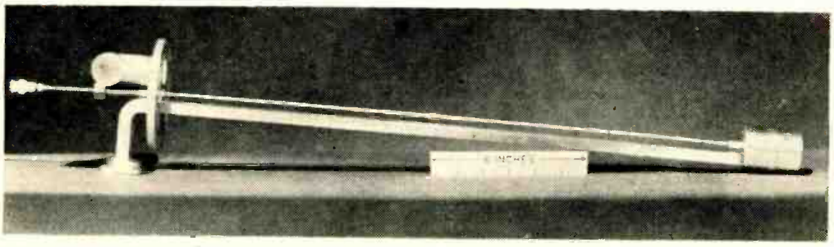

FIG. 6—S-band low-temperature head used for maser amplifier

one state to the other in a random fashion. Spontaneous emission is the basic source of noise, akin to Johnson noise, and can be reduced by cooling.

In the first two-level maser operated at Columbia University, the molecules were separated by a strong inhomogeneous electric field. The focusing system used confined molecules in the upper level to the axis of symmetry of the electric field. Molecules in the lower level were forced away from the axis. Defocusing of molecules in the lower level effectively discarded them. Molecules in the upper level, however, were guided into a microwave cavity resonant to the ammonia absorption frequency. They saw an unoccupied lower level. The correct frequency in the thermal noise distribution in the cavity walls stimulated emission. Once started, oscillations built up and continued as long as ammonia molecules, properly oriented and separated, were fed into the cavity. Resulting output was somewhat feeble but oscillations were continuous at 24,000 mc.

Because ammonia absorption is strictly defined, the oscillator just described is stable and has a fixed frequency. It makes a good frequency standard or molecular clock. But two desirable features in an amplifier are missing—ease of tuning and broad-band coverage. One version of the amplifier had a measured 3.6-db noise figure.

Three-Level Solid-State Maser

Ammonia masers just described use radiation from moleculer electric dipoles. The solid-state maser uses magnetic dipole radiation. In the solid-state device, the two energy levels result from the effect of a magnetic field on the spinning electron—in itself, a small magnet. The magnetic field produces a degree of alignment or order of the electron spins in the direction of the field. This action opposes the disordering effect of the thermal vibrations in the solid. Alignment is never quite perfect except for infinite magnetic field strength on one hand or absolute zero in temperature on the other.

Degree of alignment can be expressed in terms of the projection of the electron-spin magnetic moment vector onto the direction of the applied magnetic field. Imperfect alignment implies that some of these projections lie opposite to the direction of the field. The lower energy level represents alignment with the field: the upper, against it. Again Boltzmann's law holds true. Separation of energy levels amounts to approximately 2.8 mc for every oersted of magnetic field that is applied to the sample. This is the beginning of a tunable device.

Because two electrons are missing in part of its structure, the paramagnetic nickel ion has three rather than two energy levels. This feature of a paramagnetic material was incorporated by Prof. Bloembergen of Harvard University into his suggestion for a three-level solid-state maser. Appropriate separation of the energy levels can be achieved by adjusting the applied magnetic field's strength and direction. For fixed magnetic field strength and direction, the energy-level diagram would appear as shown in Fig. 2. The three levels W_1, W_2, and W_3 are occupied by spins numbering n_1, n_2, and n_3, respectively. Because $n_1 > n_2 > n_3$, incident microwave radiation can cause transitions from W_1 to W_3. Splitting of W_3 and W_2 is fixed at the frequency separation corresponding to the desired operating point. As an example, X-band can be used for the $W_1 \rightarrow W_3$ transition and S-band for the $W_3 \rightarrow W_2$ transition. Frequencies are 9,000 and 3,000 mc.

At equilibrium, occupation of the three levels follows Boltzmann's

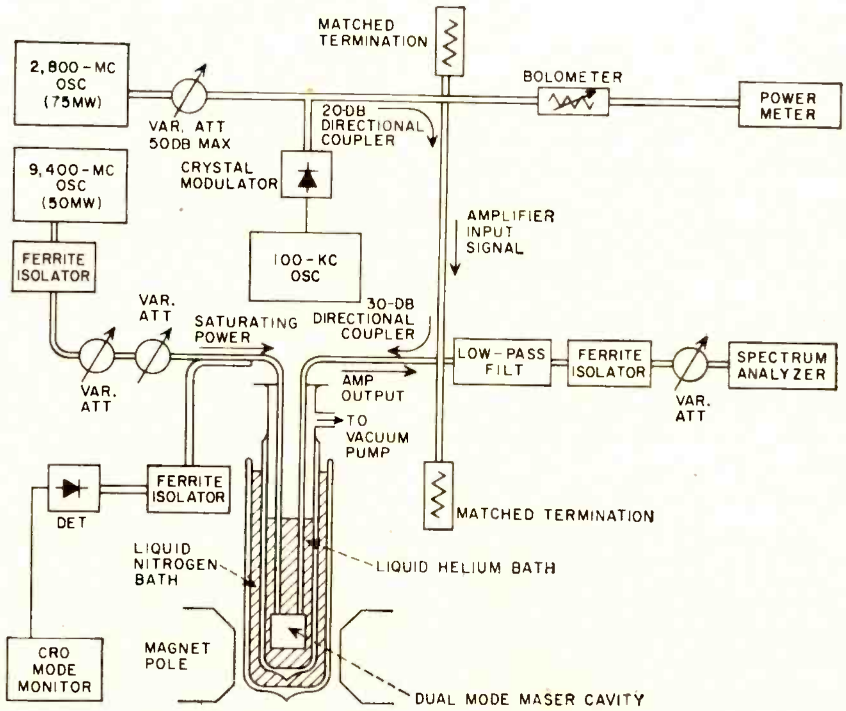

FIG. 7—Experimental arrangement for maser amplifier measurements

law. In Fig. 3, the length of a bar is proportional to the occupation number as a function of energy. Again, the lowest energy state lies near the bottom. At equilibrium, there are more spins in W_1 than in W_2 than in W_3; i. e. for the higher levels, the occupation number is smaller. Application of sufficient

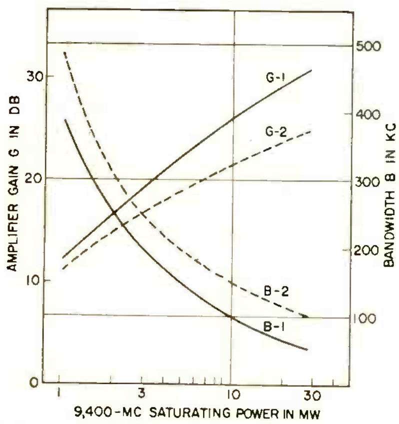

FIG. 8—Solid-state maser amplifier gain-bandwidth characteristics

power at the X-band frequency to exceed the effect of the competing relaxation mechanism and to maintain equilibrium makes the population of W_3 equal that of W_1 at the expense of W_1's population. This is illustrated by the dotted line. Using this saturation of the resonance absorption, an approximately equal population of the lower and upper energy levels results. Because population n_3 now exceeds n_2, energy applied at the frequency of $(W_3 - W_2)/h$ stimulates emission. This action is the basis of the working laboratory model.

The solid-state maser must be operated at extremely low temperatures. It is only at low temperatures that the relaxation mechanism is weak enough to permit saturation of the resonance absorption with reasonable amounts of X-band power. And only at low temperatures can adequate differences in the populations of relatively closely spaced energy levels be obtained and low noise achieved.

Experimental Design

A single paramagnetic salt, $K_3Co(CN)_6$ containing 0.5-percent Cr has been found satisfactory for all three masers. The salt is particularly suitable because of its unusually long spin-lattice relaxation time—time for transfer of energy acquired by resonance absorption from the spin system to the crystal lattice and low temperature bath. Power required to staurate the resonance, therefore, is low at the operating temperature of 1.25 K.

Only three of the four energy levels of the paramagnetic Cr^{+++} ion were used. Energy level spacing was adjusted by the magnitude of the d-c magnetic field and its orientation with respect to the crystalline electric field of the material. Spin-state populations were inverted by saturating the resonance absorption at 9,000 mc for the S- and L-band masers and at 5,300 mc for the uhf maser. While stimulated emission occurred between the upper two levels in the S-band maser, it occurred between the lower two levels in the other two masers. Figure 4 shows that if the middle level lies close to the lower level, rather than the upper, the negative-temperature condition will be created between the lower two levels.

The regenerative-type amplifier has much narrower bandwidth than one would expect at first. To achieve large bandwidths inherent in the width of the paramagnetic resonance line, at no sacrifice in gain, a low Q or slow-wave structure with a larger volume of the salt would have been necessary. In spite of the bandwidth limitation, these masers operate in reasonable agreement with theoretical predictions.

Microwave Apparatus

The maser requires resonant structures capable of supporting two modes—saturating frequency and operating frequency. The r-f magnetic fields at both frequencies must be concentrated in the paramagnetic salt itself. If any parts of the salt in the signal field are not at a negative temperature, they will cause signal loss rather than amplification.

The first S-band amplifier used a coaxial cavity which operated in the TEM mode at S-band and a higher order mode at X-band. This design was not optimum but gave results permitting measurement of gain, bandwidth, and noise. Magnetic field distribution in the early S-band design is shown in Fig. 5.

The L-band amplifier used a reentrant form of cavity. It behaved roughly as a coaxial cavity at X-band and a capacitance-loaded reentrant cavity at L-band. The capacitance loading created a greater concentration of microwave magnetic field in the sample located in the bottom of the cavity.

A single loop of wire plated with superconducting lead terminated in a small variable capacitor formed the resonant circuit for the uhf signal frequency. The saturating field was applied to the salt located in the wire loop by a surrounding microwave cavity operating in the TE_{112} mode.

Power is coupled in an out of the cavities by stainless-steel coaxial lines or waveguides. They are silver-plated to reduce microwave

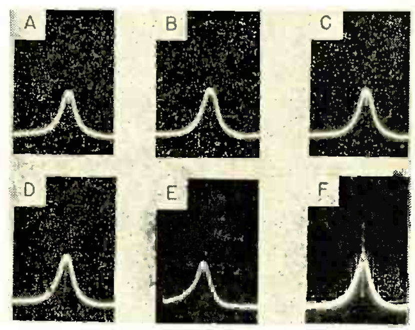

FIG. 9—Power reflected from the cavity under various conditions. Detailed explanation appears in text

losses while maintaining the low heat losses characteristic of stainless steel. Distance from the cavity at 1.25 K to the Dewar flask cover plate at about 300 K is about two feet. This arrangement offers sufficient thermal insulation to permit several hours operation with one or two liters of liquid helium. An S-band low-temperature head is shown in Fig. 6.

Single crystals were grown from an aqueous solution of cobalt and chromium potassium cyanide. Crystals were prepared with chromium concentrations of from 0.1 to 2 percent. Standard crystal-growing techniques produced crystals of more than one sq cm in cross-section by three to five cm long.

Operation of the first S-band

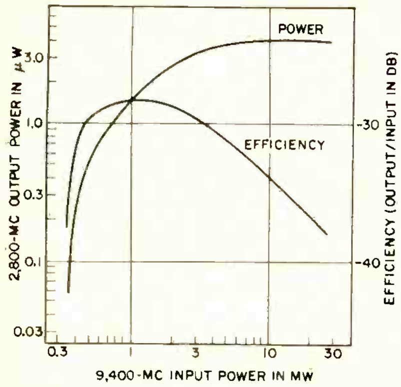

FIG. 10—Maser oscillator characteristics

amplifier was investigated by applying the input power to the cavity through a directional coupler as shown in Fig. 7. This technique permitted gain-bandwidth measurements on the reflection-cavity type amplifier through its single coaxial coupling line without a circulator. Gain was determined by the amount of attenuation needed in the maser output line to maintain constant signal amplitude at the spectrum analyzer. This additional attenuation in the output line, together with the ferrite isolator, served also to keep any power reflected from the spectrum analyzer from reaching the maser and being reamplified.

Bandwidth was taken as the total frequency deviation required to reduce amplifier power output to one-half its midband value. Bandwidths were measured on the spectrum analyzer after its frequency axis was calibrated with the modulating scheme shown in Fig. 7.

Results of the gain-bandwidth measurements are shown in Fig. 8. Parametric curves of both gain and bandwidth are plotted as a function of 9,400-mc power for two different values of 2,800-mc external Q. These values were obtained by adjusting the degree of coupling. With still higher external Q it was possible to achieve gains of 30 db or more with only one mw of saturating power. The maser then oscillated at the larger saturating powers. Stable gains of 37 db with 25-kc bandwidth were also possible. In all cases, bandwidths were limited by the Q of the associated circuits and not by the intrinsic bandwidth of the paramagnetic resonance which was in the 30- to 50-mc region.

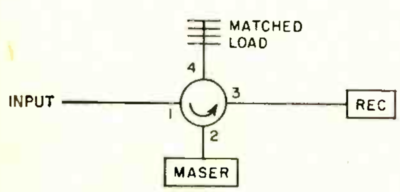

FIG. 11—Circulator provides necessary input and output terminals for reflection-cavity maser described in text.

Observations of gain as a function of input 2,800-mc power revealed the expected decreased gain as the difference in population was affected by the signal power. There was no change in gain when signal power was increased from 10^{-11} to 10^{-10} watt but thereafter the gain diminished and the bandwidth increased.

Oscillator Characteristics

Initial investigation of the maser as an oscillator was made using a frequency modulated probing signal applied to the coaxial coupling line. Frequency of the probing oscillator is swept by the time base of the oscilloscope. Power reflected from the cavity is displayed on the Y-axis as a function of frequency.

Waveform *A* in Fig. 9 shows absorption resulting from the 2,800-mc microwave resonance centered in the klystron mode pattern. With the magnetic field adjusted for paramagnetic resonance, the power reflected from the undercoupled cavity increases as shown in Fig. 9B. Application of 9,400-mc power, Fig. 9C, shows how the negative resistance produced by maser action improves the Q of the cavity. This, in turn, improves the coupling although no changes were made in the coupling-loop adjustments. Further increase of saturating power enhances this effect, Fig. 9D, and in Fig. 9E the maser is beginning to produce power at 2,800 mc. In Fig. 9F, the beat signal between the output of the oscillating maser and the f-m probe signal is seen with the video detector system.

Output of the oscillating maser was observed also on a spectrum analyzer in the absence of an input, 2,800-mc signal. Maser power out, as a function of saturating input power, is shown in Fig. 10. Efficiency (P_o at 2,800 mc/P_i at 9,400 mc) is also given. Maximum efficiency obtained as operated was −28.5 db or 0.14. Because its stability is not exceptional and its output is low, this type of maser has little to offer as a microwave source. Its forte is low-noise amplification. This experimental amplifier is by no means an ultimate device. An improvement in gain-bandwidth product of a factor of ten should be achieved by careful microwave cavity design. This redesign is now being carried out.

Maser Amplifier System

Although extensive laboratory measurements can be made on the maser using the directional coupler, the sacrifice in gain is not practical in an actual application. The circulator comes to the rescue here and provides the necessary input and output terminals for the reflection cavity maser.

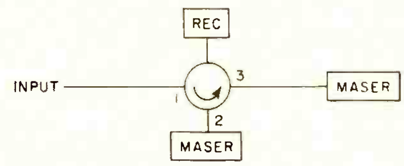

FIG. 12—Maser amplifiers can be cascaded by use of circulator

FIG. 13—System representation for a circulator-maser combination

The circulator, Fig. 11, is a four-terminal-pair device with a nonreciprocal property indicated by its symbol. Power in at arm 1 is sent out at arm 2; power in at 2 is sent out at 3; and so on around the circle.

Insertion loss of circulators is usually a fraction of a db while reverse isolation is in the order of tens of dbs. A circulator or equivalent device is an essential part of the reflection-cavity maser system. It also provides a convenient way of cascading maser amplifiers as shown in Fig. 12.

The circulator-maser combination provides an amplifier system with input and output ports. The system can be represented by a box, Fig. 13, considered to be a network with input and output terminal pairs. Noise produced by this network in excess of the input noise is just kT_nB, where T_n is the noise temperature, B the bandwidth, and k is Boltzmann's constant.

FIG. 14—Experimental arrangement for noise-figure measurement

System Noise Measurement

A crucial test of the system is experimental measurement of its noise figure to verify that it does live up to theoretical expectations. Noise measurements on a circulator-maser system shows that it has an effective input noise temperature of 25 K. In terms of system noise figure, this is 1.08 or about 0.3 db.

Because of its low noise temperature (compare with a 10-db noise figure for which $T_n \approx 2{,}700$ K), the conventional noise-figure measurement is accomplished using unconventional noise sources. One is a 300 K source in the form of a matched load at room temperature; the other, a 77 K source obtained by refrigerating a matched load in liquid nitrogen. The experimental arrangement is shown in Fig. 14.

Noise figure is determined normally by measuring the ratio of noise outputs with a precision attenuator for the 300 K and 77 K noise inputs. By this means, noise temperature of the maser system operating with a 30-db gain and 50-kc bandwidth was found to be less than 25 K. Most of this noise is accounted for by losses in the circulator and the microwave plumbing components. For example, a microwave transmission line having 0.5-db loss ($\approx$ 10-percent power loss) has an effective noise temperature of about 30 K. Because most of the noise contributing to the 25 K noise temperature can be accounted for as described, the maser alone must be operating near its theoretical noise temperature of about 2 K.

A microwave amplifier with a noise temperature of tens of degrees rather than thousands, highlights problems heretofore unimportant. The noise temperature scale shown in Fig. 15 illustrates the importance of keeping transmission-line losses low to avoid producing noise greatly in excess of amplifier noise. Also, an antenna may provide comparable noise through side lobes in the direction of the sun. (A five-foot dish pointed at the sun will have a noise temperature of about 200 K at 3,000 mc). Even antenna side lobes and back lobes looking at the ground degrade its effective temperature by contributing noise. In light of this, a system noise of 25 K is quite compatible with what might be expected from associated microwave components.

The Future

Attractiveness of larger gain-bandwidth products leads to traveling-wave masers where the bandwidth would be limited by the paramagnetic material. In the case of the paramagnetic materials used in the cavity masers, this limitation would be from 30 to 50 mc.

Because microwave magnetic fields are not concentrated in waveguides or slow-wave structures to the degree they are in high-Q cavities, gain per unit length in the traveling-wave maser is small. Consequently, long effective lengths of waveguide would be required to achieve reasonable gains. These problems are not new to vacuum-tube engineers where gain-bandwidth products for various tubes are compared as figures of merit.

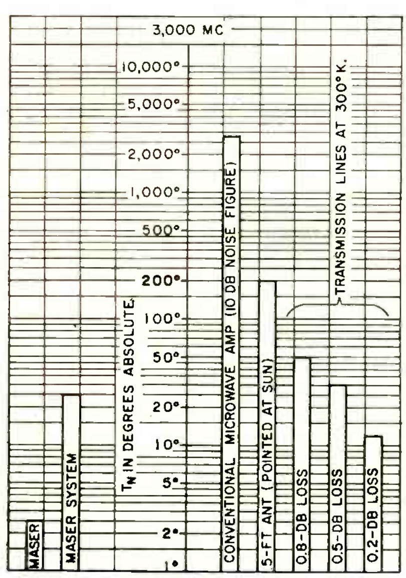

FIG. 15—Noise-temperature scale. Noise power = kT_nB

This same concept is equally applicable to masers. Expansion of maser bandwidth is receiving attention at a number of laboratories.

A question that always arises is whether it is a necessity to operate at such low temperatures. For the present, the answer is yes. Although it has been shown that the maser environment is likely to produce more noise than the maser itself does, present materials give a gain-bandwidth product inversely proportional to operating temperature. Even if an amplifier could be operated at 77 K (liquid nitrogen temperature), its gain-bandwidth product could be improved by a factor of 50 by operating at 1.5 K.

There is much work to be done both in basic and applied research. Basic research, both theoretical and experimental, in paramagnetic resonance and relaxation phenomena should provide needed data on new and different materials.

This article has described, in part, work carried out by S. H. Autler, R. H. Kingston, N. McAvoy, A. L. McWhorter, the author, and all of the staff of Lincoln Laboratory. The research reported was supported jointly by the Army, Navy and Air Force under contract with MIT.

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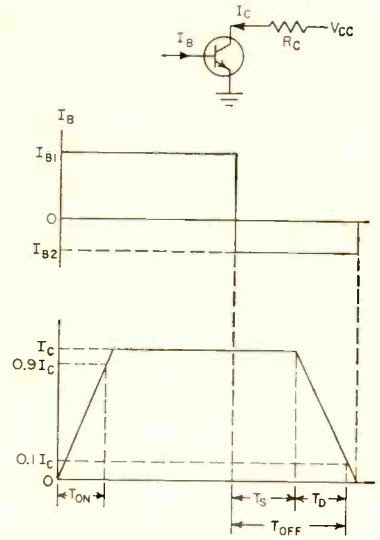

FIG. 1—Common-emitter switching circuit and waveform parameters

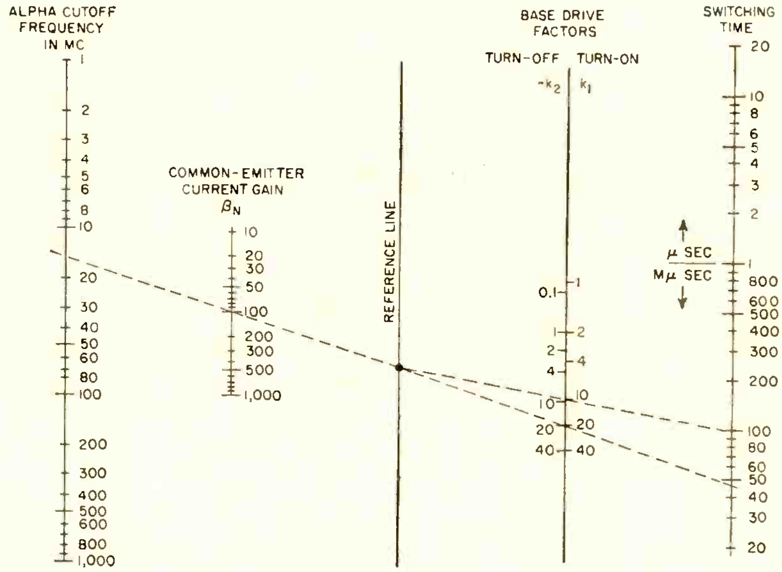

FIG. 2—Both rise and decay times are shown on nomograph scale at far right. Dashed lines show examples described

Switch-Time Nomograph

When common-emitter transistors are used as electronic switches, rise and decay times at turn-on and turn-off can be readily determined through use of the nomograph. Formula for calculation of storage time is also presented

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TRANSISTORS in the common-emitter configuration are used in many circuits as switching elements. Switching times have been calculated in terms of basic transistor parameters and circuit conditions.[1] The results are of the general form $T = A$ (ln B), where A is a function of the transistor and B is a function of both circuit conditions and transistor parameters.

The circuit and switching waveforms are shown in Fig. 1. Turn-off time T_{off} comprises the storage time T_s and the decay time T_d. The turn-on time simplifies to:

$$T_{on} = \left\{ 1/[(1-\alpha_n)\omega_n] \right\} \ln[k_1/(k_1-0.9)],$$

where α_n is the common-base short circuit current gain in the normal direction, ω_n the angular cutoff frequency of α_n and k_1 the ratio of base current I_{b1} used to turn on a transistor in a particular application to that base current I_c/β_n just necessary to saturate the transistor. Quantity I_c is the limiting value of collector current V_{cc}/R_c, and β_n is the common-emitter short circuit current gain in the direction $\alpha_n/(1 - \alpha_n)$.

Decay time is:

$$T_d = \left\{ 1/[(1-\alpha_n)\omega_n] \right\} \ln [(k_2 - 1)/(k_2 - 0.1)], \text{ where } k_2 = I_{b2}/(I_c/\beta_n).$$

Parameter k_2 is negative since the turn-off base current must be opposite to the collector current.

The nomograph of Fig. 2 provides the turn-on and decay times. As an example, assume a transistor and circuit with f_{ab} = 16 mc, $\omega_n = 2\pi f_{ab} = 100 \times 10^6$, $\alpha_n = 0.99$, $(1 - \alpha_n) = 0.01$, β_n = 99 and I_c = 1,000 μa. Also assume a turn-on base current I_{b1} of 100 μa and a turn-off base current I_{b2} of −200 microamperes.

Calculating $k_1 = 9.9$ and $k_2 = -19.8$, on the nomograph draw a straight line through f_{ab} = 16 mc and β_n = 99 to locate a point on the reference line. From this point draw another straight line through $k_1 = 9.9$ or $k_2 = -19.8$ to obtain the corresponding switching time. In this case the turn-on time is 100 mμsec and the decay time is 47 mμsec.

Storage time T_s is more involved and cannot be computed by a single nomograph. It is

$$T_s = \left\{ (\omega_n + \omega_i)/[\omega_n\omega_i (1 - \alpha_n\alpha_i)] \right\} \times \ln [(k_1 - k_2)/(1 - k_2)],$$

where the parameters with the i subscripts are measured with the emitter and collector connections interchanged.

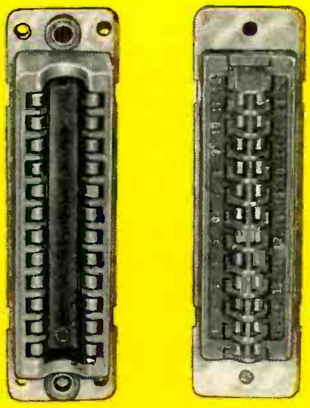
REFERENCE

(1) J. J. Ebers and J. L. Moll, Large-Signal Behaviour of Junction Transistors, *Proc IRE*, p 1761, Dec. 1954.

BLUE RIBBON CONNECTORS by CINCH

VISUAL ALIGNMENT UNNECESSARY... RIBBON SPRING CONTACTS... FLOATING BUSHINGS...

The Wedge principle with the strong spring action of the contacts holds the connector in positive contact, and provides ease of insertion and withdrawal. The protective barriers between ribbon contacts insure uniform spacing. The entire length of the contacts are supported by quality dielectric. Multiple mounting makes it possible to make or break any number of circuits simultaneously. Molded-in mounting plates are of corrosion resistant passivated stainless steel.



24 CONTACT
PLUG AND SOCKET

IMPROVED TYPE

The above illustrates the improved design of plug and socket casting which eliminates any possible breakage.

Commercial plating and contact material. Black Mica body Type MFE per Mil.-M-14E.

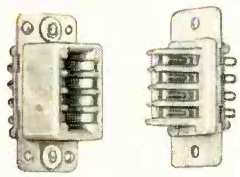
36 - 4100 - 8P (355)
36 - 4200 - 8S (355)
36 - 4100 - 16P (355)
36 - 4200 - 16S (355)
36 - 4100 - 24P (355)
36 - 4200 - 24S (355)
36 - 4100 - 32P (355)
36 - 4200 - 32S (355)

Military plating and contact material. Nylon filled Diallyl body Type MDG per Mil.-M-14E.

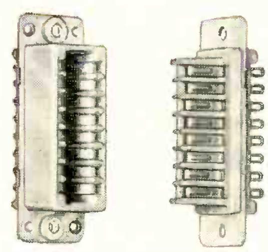
36 - 4100 - 8P (340)
36 - 4200 - 8S (340)
36 - 4100 - 16P (340)
36 - 4200 - 16S (340)
36 - 4100 - 24P (340)
36 - 4200 - 24S (340)
36 - 4100 - 32P (340)
36 4200 - 32S (340)

Commercial plating and contact material. Nylon filled Diallyl body Type MDG per Mil.-M-14E.

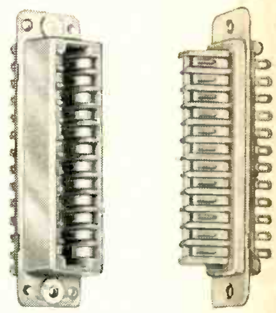
36 - 4100 - 8P (365)
36 - 4200 - 8S (365)
36 - 4100 - 16P (365)
36 - 4200 - 16S (365)
36 - 4100 - 24P (365)
36 - 4200 - 24S (365)
36 - 4100 - 32P (365)
36 - 4200 - 32S (365)



8 CONTACT
PLUG AND SOCKET

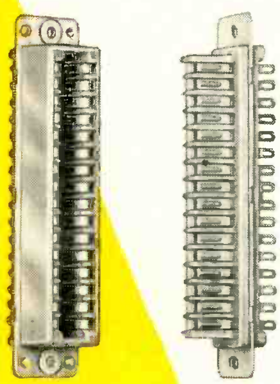


16 CONTACT
PLUG AND SOCKET



24 CONTACT
PLUG AND SOCKET

REGULAR TYPE:



32 CONTACT
PLUG AND SOCKET

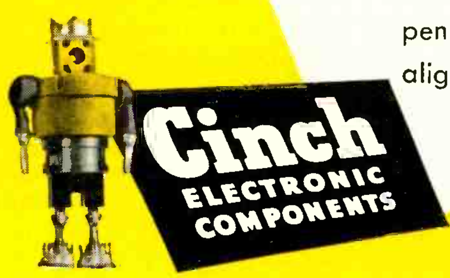
Commercial plating and contact material. Nylon filled Diallyl body Type MDG per Mil.-M-14E.

36 - 4100 - 8P
36 - 4200 - 8S
36 - 4100 - 16P
36 - 4200 - 16S
36 - 4100 - 24P
36 - 4200 - 24S
36 - 4100 - 32P
36 - 4200 - 32S

Military plating and contact material. Nylon filled Diallyl body Type MDG per Mil.-M-14E.

36 - 4100 - 8P (334)
36 - 4200 - 8S (335)
36 - 4100 - 16P (334)
36 - 4200 - 16S (335)
36 - 4100 - 24P (334)
36 - 4200 - 24S (335)
36 - 4100 - 32P (334)
36 - 4200 - 32S (335)

The ribbon contact principle, with dielectric guide and support eliminates the possibilities of damaged or bent contacts and prevents difficulties of plug-in. No dependence on contact arrangement or visual alignment is necessary.



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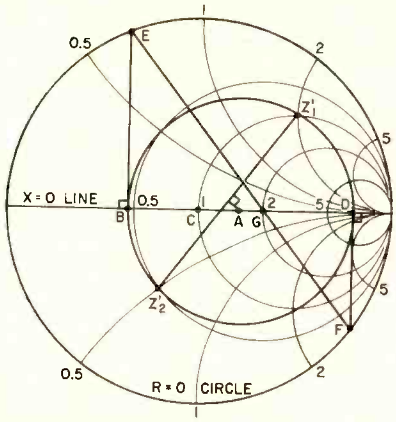


FIG. 1—Characteristic impedance is determined from diagram shown

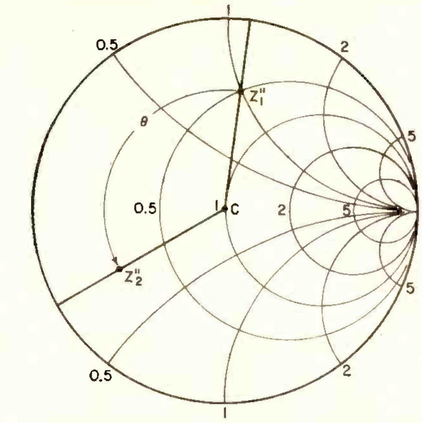


FIG. 2—Propagation constant is found as a function of ϕ from circular chart

Simplified Calculations For Transmission Lines

Characteristic impedance Z_o and propagation constant β of lossless transmission line terminated in lossy load are determined from Smith-type circular transmission-line chart using graphical techniques

By **H. F. MATHIS** Goodyear Aircraft Corporation, Akron, Ohio

IF A LOSSLESS TRANSMISSION LINE is terminated in a lossy load, the characteristic impedance and propagation constant of the line can be determined by the following method.

The input impedance Z_1 is measured for any convenient length of the transmission line terminated in any convenient lossy load. A length d is removed from the line and the input impedance Z_2 is measured using the same or an equivalent lossy termination.

Example

As an example, suppose $Z_1 = 50 + j100$, $Z_2 = 25 - j25$ and $d = 3$ in. The normalized impedances $Z_1' = Z_1/R_o$ and $Z_2' = Z_2/R_o$, where R_o is any convenient value, are plotted on a circular transmission-line chart as shown in Fig. 1. For the example, $R_o = 50$. Point A is located on the zero reactance axis so that the distance from A to Z_1' and from A to Z_2' are equal. Point A is the intersection of the perpendicular bisector of the line Z_1' Z_2' and the zero reactance axis. A circle whose origin is at A passes through the points Z_1' and Z_2'.

Points B and D are the intersections of the circle and the zero reactance axis. Lines BE and DF are drawn through B and D perpendicular to the zero reactance axis. Points E and F are the points of intersection of lines BE and DF with the zero resistance circle.

Point G is the intersection of the line EF and the zero reactance axis. The impedance Z_G is read at point G. Finally, the characteristic impedance Z_o of the line is $Z_o = R_o Z'_G$. For the example, $Z_G = 2$, $Z_o = 100$.

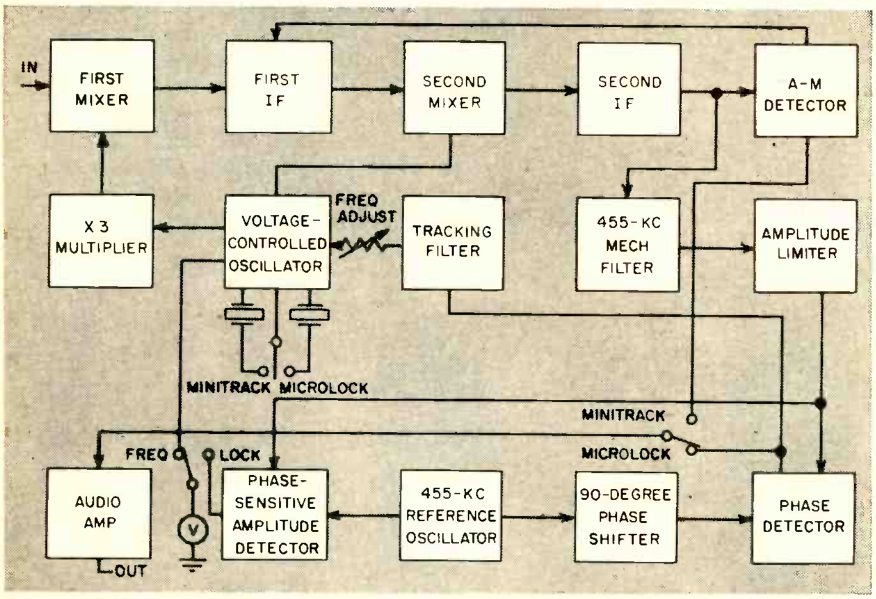
Normalized impedance $Z_1'' = Z_1/Z_o$ and $Z_2'' = Z_2/Z_o$ are plotted on a circular transmission-line chart in Fig. 2. These points are equally equal distant from the center C of the chart. The angle θ is measured. Finally, the propagation constant β is found by solving the equation $\theta = 2\beta d - n\,720$, where $n = 0, 1, 2, \ldots$ If θ is measured in deg and d is measured in in., then β is the phase change in deg/in. For the example, $\theta = 126.7$, $n = 0$, and $\beta = 42.2$ deg/in.

Determining Integers

The value of n must be determined by considering other available information. Often only one value of n gives a value of β which is reasonable. If this is not true, the procedure should be repeated using a smaller value of d.

CIRCLE 48 READERS SERVICE CARD

Portable Receives Satellite Signals



Either 108-mc microlock or 108.03-mc minitrack signals from U. S. satellites can be received and supplied to a tape recorder with this recently announced portable receiver

Minitrack amplitude-modulated or microlock phase-modulated telemetering signals from U. S. satellites can be received on a portable receiver developed by Motorola. Output of the receiver can be recorded on portable recorders and analyzed later.

When the receiver is tuned within automatic lock-in range of a signal, it will automatically acquire and maintain phase-lock to the signal to a level of −145 dbm, although doppler shift may alter the input frequency over a 6.6-kc range. A crystal-selector switch is used to set the receiver to receive either the 108.00-mc microlock signals or the 108.03-mc minitrack signals. A fine-frequency control is used for final adjustment.

Double conversion reduces the 108-mc signals to 455-kc for phase comparison. The resultant 455-kc signal is fed through a 4-kc mechanical filter to a limiter stage. The limiter drives the phase and lock detectors in phase. Reference signals for the detectors are obtained from a 455-kc crystal oscillator. There is a 90-degree phase difference between the two reference signals to obtain maximum positive lock-detector output when phase detector output is zero.

The phase-detector output is fed through a filter that reduces the effective r-f bandwidth to approximately 20 cps. The output of the filter controls the voltage-controlled crystal oscillator and maintains phase lock with the r-f signal. As a result, the receiver will maintain phase-lock to a carrier signal that is more than 20 db below the receiver noise level.

A meter is used for an in-lock indicator and a frequency indicator. When the meter is switched to Lock, it indicates when the receiver is phase-locked to an r-f signal and the relative strength of the signal. In the Frequency position, the meter indicates the relative signal frequency plus doppler shift.

An audio amplifier is used to monitor the beat note between the converted r-f signal and the reference oscillator during acquisition. It is also used to monitor the demodulated a-m tones.

Masks Improve Picture Contrast

By F. L. BURROUGHS and J. T. JANS
Sylvania Electric Products,
Seneca Falls, N. Y.

MOST TV sets have adequate highlight brightness. But a number of light sources, including external illumination, backlighting and the illumination produced by stray and reflected electrons, can reduce contrast by lighting the dark areas.

The effect of external illumination is reduced by a filter safety glass, and aluminized picture tubes eliminate backlighting. However, reflected electrons often present a problem. They often result when the raster overscans the picture-tube screen causing the beam to reflect off the sides and neck. Increasing overscan reduces contrast, as is shown in Fig. 1.

In all rectangular picture tubes, some overscan is necessary because the structure of the bulb prevents the screen from being the rectangular 4:3 aspect ratio that is transmitted. The screen area of a typical tube inside a 4:3 aspect ratio rectangle is shown in Fig. 2.

In addition to the overscan from the bulb shape, most receivers are adjusted at the factory to overscan

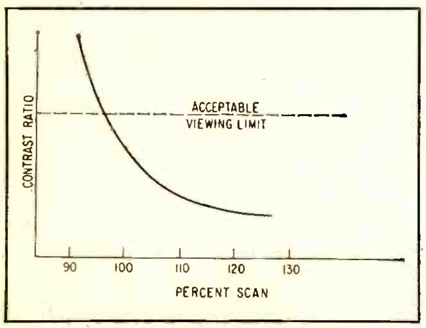


FIG. 1—Contrast ratio plotted against scan indicates loss of contrast with larger raster

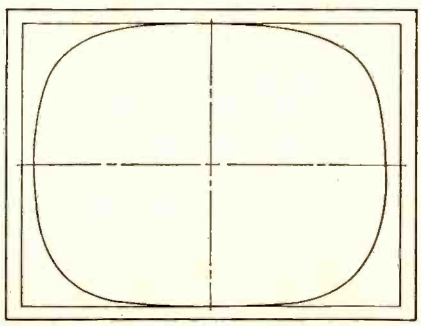
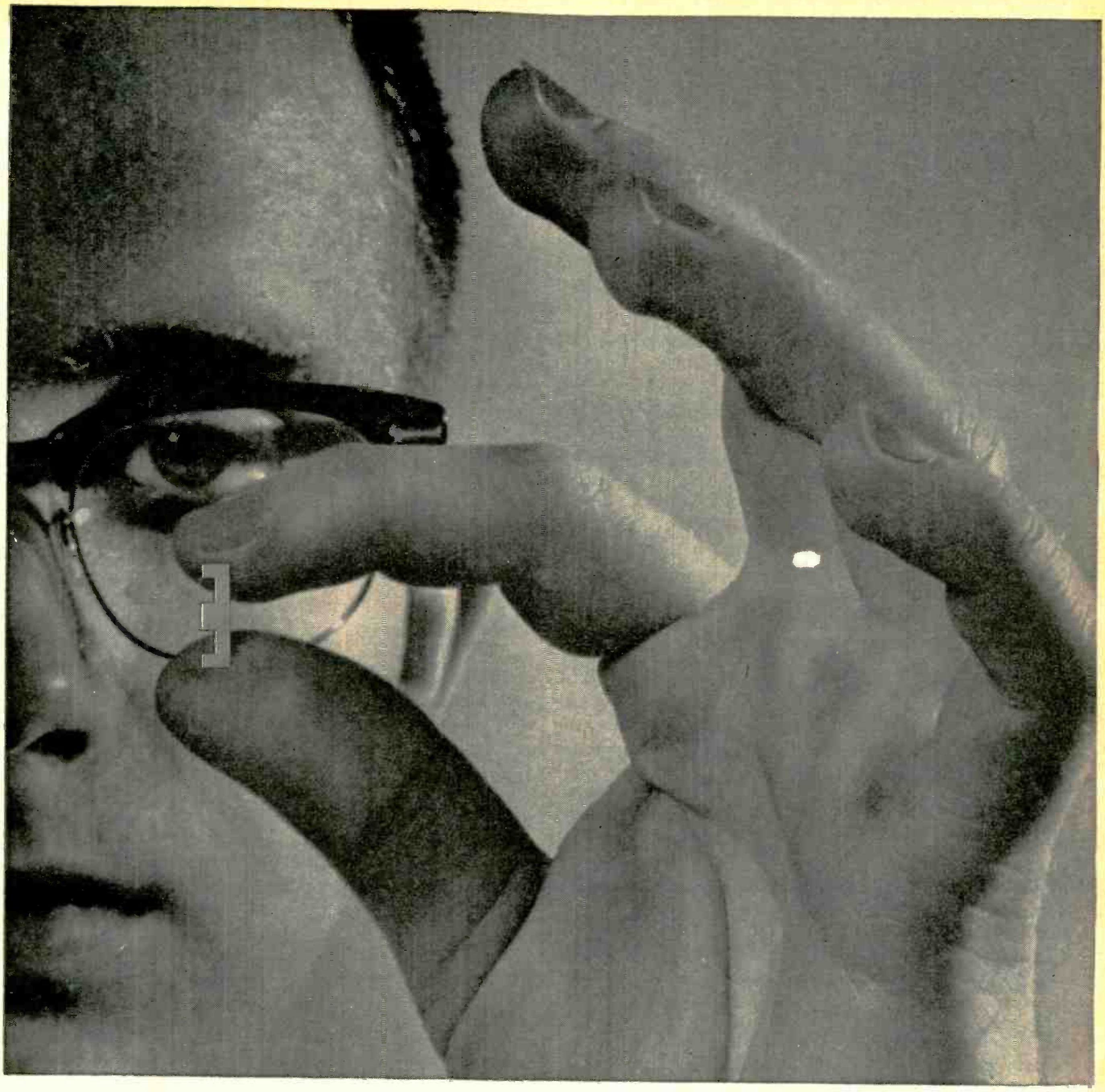


FIG. 2—Screen area of typical tv picture tube shows overlap of 4:3 aspect ratio rectangle



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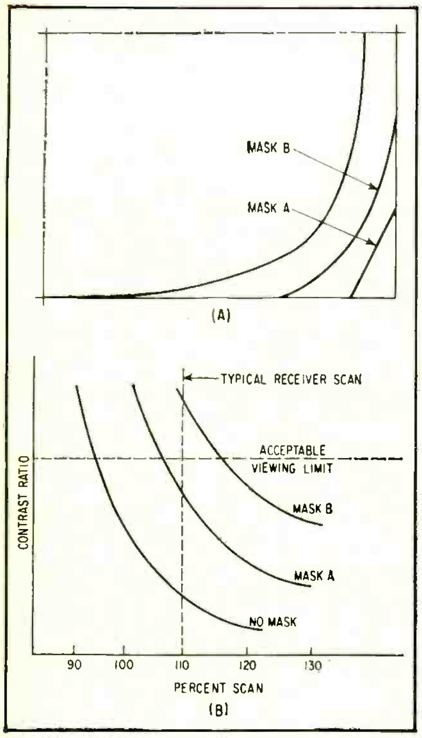


FIG. 3—Two simple masks such as those shown at A improve contrast as shown in plot at B

enough at normal line voltage so they just fill the picture tube screen at low line voltage.

The picture information in the corners is not visible on the screen. This portion of the signal washes out the picture by supplying the reflected electrons that illuminate the dark areas.

If this corner portion of the picture were masked at the camera, the contrast would show a marked improvement. Since the area involved is off the screen, it would not be seen. Two mask shapes are shown in Fig. 3 and the relative contrast ratio improvement for each. The masking would not be visible on any type of picture tube now in use, provided the receiver were correctly adjusted.

A mask could be a very simple one such as A in Fig. 3. Application directly to the camera or flying-spot tube should take but a few minutes.

Contrast improvement is readily apparent on scenes where the background is light extending out to the corners. It may be difficult to standardize masking for broadcast television systems but there is no restriction on using masking in closed-circuit systems.

VU Recorder Has Standard Response

By D. H. McRAE

Transmission & Dev. Dept.
Canadian Broadcasting Corp.
Montreal, Quebec
Canada

PERMANENT records of audio program levels at various points in broadcast systems can be made with a recorder having standard VU response. The recorder can also be used for checking audio network circuits and for speech level measurements.

Because the VU meter is the standard instrument for program level measurement, the recorder should have a response such that it records the levels as indicated by a VU meter. Available level recorders were tested and were found to disagree with the observations of a VU meter.

Faithful VU recordings can be obtained graphically only if they are made by an instrument that has the same rise time, overshoot, frequency response and rectifier characteristics as a standard VU meter. Rather than alter the mechanical constants of a commercially available recorder it was decided that the input of a high-speed recorder should be shaped in an electrical network to secure the correct characteristics.

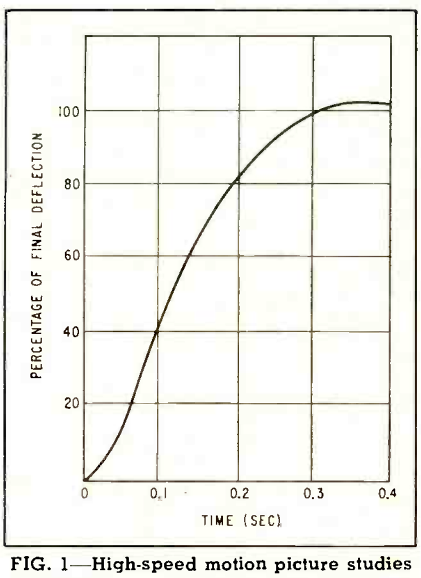


FIG. 1—High-speed motion picture studies indicate response of standard VU meter

The most difficult properties to achieve are the dynamic characteristics of the VU meter. The VU meter movement is actually driven with pulsating direct current from a full wave rectifier. When a step voltage is applied to the meter movement, "the deflection should reach 99 percent of final deflection in 0.3 seconds and should then overswing by 1 to 1½ percent."[1]

The response of a VU meter has been determined by means of high-speed motion picture techniques and is shown in Fig. 1.

The pulsating d-c furnished by the rectifier to the VU meter movement can be considered equivalent to steady d-c for deflection calculations, because the a-c components merely tend to vibrate the pointer and do not contribute to the static deflection. Even vibration is not visible (except at low audio frequencies) due to the sluggishness of the meter movement.

This response has the characteristic shape of the transient response of an underdamped series R, L and C circuit as shown in Fig. 2.

The meter is a simple device mechanically. A very close electrical equivalent of the damping, moment of inertia and rotational compliance, which determine its ballistic response, can be obtained with only three electrical elements. By Hooke's Law, the tension of the spring is directly proportional to the pointer position. Therefore, in the electrical equivalent, the pointer position may be represented by the voltage across capacitor C.

In this circuit, the ratio of the voltage across the capacitor, V_c, to a step voltage, E, applied to the RLC circuit, is at any time, t, equal to:

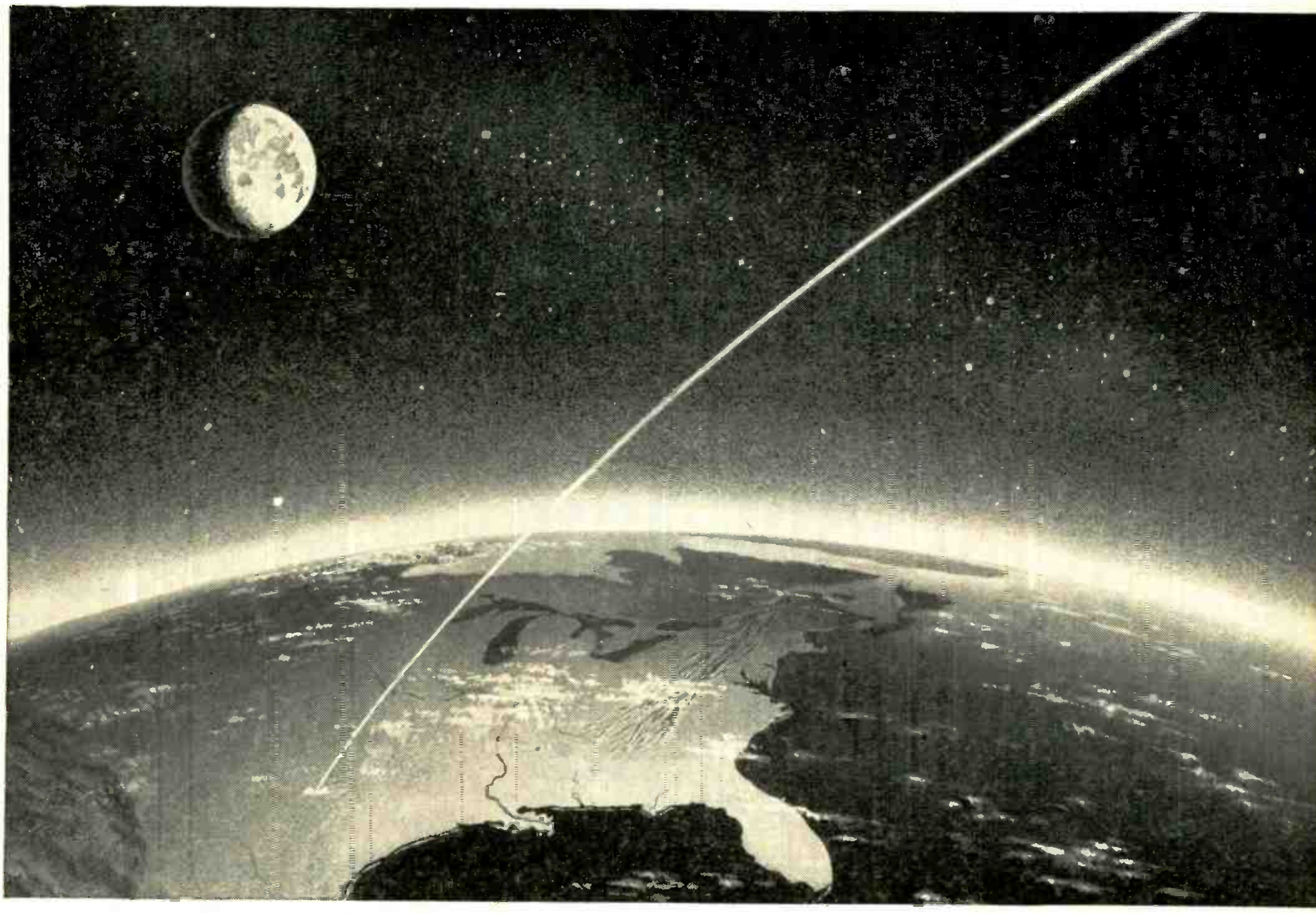
$V_c/E = 1 - e^{at} [(a/\omega \sin \omega t) + \cos (\omega t)$ where $a = R/2L$, $\omega = [1/LC - a^2]^{1/2}$.

If $a = 11.0$ and $\omega = 7.88$, and V_c is expressed as a percentage of E, then $t = 0.05$, 0.1, 0.2, 0.3 and 0.375 sec while $V_c = 15.8$, 43.4, 84.6, 99.02 and 101.2, percent, respectively.

These results plotted in Fig. 1 show good agreement with the standard VU response. If $L = 300$ h, then $R = 600$ ohms and $C = 18.2$ uf.

The circuit used in the recorder

ND FACTS



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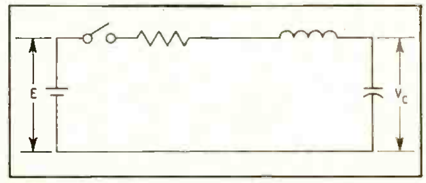


FIG. 2—Underdamped *RLC* circuit has transient response of standard VU meter

is shown in Fig. 3. It is designed so that one volt across the network capacitor corresponds to the zero graduation on the VU meter dial. Because the cathode followers are d-c amplifiers in this case, two are used in push-pull to minimize drift problems. They have an output resistance of about 1,700 ohms. The d-c resistance of the inductor is about 4,500 ohms. Resistor R is about 400 ohms to bring the total to 6,600 ohms looking back into them, a feature that assures similar charge and discharge characteristics for the network.

The four 1N54 diodes loaded with 50,000 ohms gives a rectification characteristic similar to several VU meter rectifiers tested.

The preamplifier that feeds the network has sufficient gain to give the recorder zero deflection with a

Electronics Records Recon Photo Data

Position, altitude and other pertinent data necessary to U.S. Air Force reconnaissance now can be recorded automatically on photos with a device developed by Federal Telecommunication Laboratories. Digital data recording device records all information in coded-dot form from small crt on photograph. During development, a ground-based reader decodes and prints the data beneath the picture

—20 dbm input. Frequency response is flat within 0.2 db from 10 to 50,000 cps.

A d-c amplifier bridges the capacitor with about five megohms and drives a stylus-bearing galvanometer in a graphic recorder. Because of the high input resistance of the d-c amplifier and the high speed of response of the recorder (10 msec rise time), the trace appearing on the moving paper chart is sensibly a plot of the instantaneous voltage across the capacitor as calculated. Thus, graphic recordings of instantaneous positions of a VU meter are made.

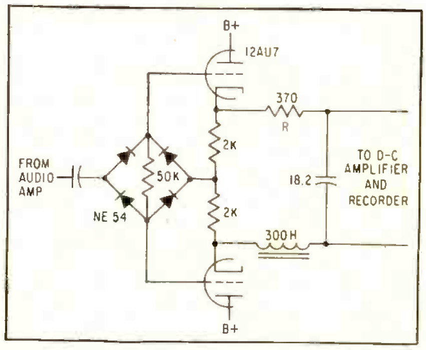


FIG. 3—Circuit used in standard VU recorder includes rectifier said to have characteristics similar to that used in standard VU meters

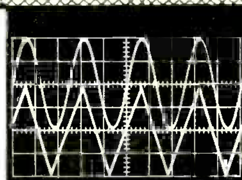
In order to expedite operating the VU recorder, the following facilities are provided: a bridging input for 600-ohm lines, stabilized reference voltage for calibrating overall gain, a step attenuator calibrated in vu's, a paper chart graduated in vu's and a one-minute time marker.

The useable chart width is five cm. The speed is ½ mm per sec. This speed was chosen as the best compromise between definition and economy. The definition is sufficiently good for most purposes and the chart costs only about 18 cents per hour of recording.

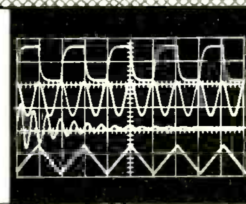
Personnel experienced in using a VU meter find that the complete VU recorder is simple to operate and the chart is easy to interpret.

1. H. A. Chinn, D. K. Gannett and R. M. Morris, A New Standard Volume Indicator and Reference Level, Proceedings of the I. R. E. Jan. 1940.

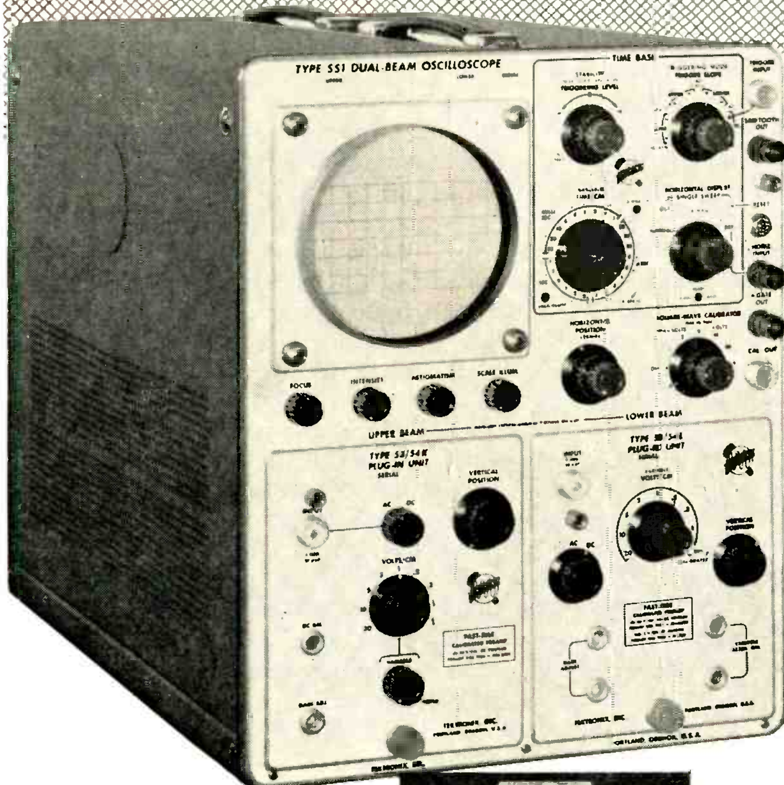
Two Beams



Four Traces



DC-to-25 MC



TYPE 551

When the job requires it, you can double up and display four different waveforms at once with this dual-beam oscilloscope. Type 53/54C Dual-Trace Plug-In Units in both channels make possible the four-trace display.

Less spectacular but more frequent uses of this versatile fast-rise oscilloscope include waveform comparison measurements on a dual-beam display in the dc-to-25 mc range, and all the usual and unusual applications of a high-performance laboratory oscilloscope.

TYPE 551 SPECIAL FEATURES

WIDE-BAND VERTICAL AMPLIFIERS
Main-unit risetimes—12 mμsec.
Passbands and risetimes with Type 53/54K units—dc-to-25 mc, 0.014 μsec.

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0.2 μsec DELAY NETWORKS

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Fully-automatic or amplitude-level selection with preset or manual stability control.

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Brighter display for fast sweeps and low repetition rates.

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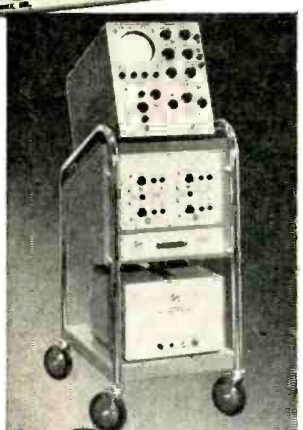
Type 53/54C Dual-Trace Plug-In Preamplifiers, each . . . **$275**
Prices f.o.b. factory.



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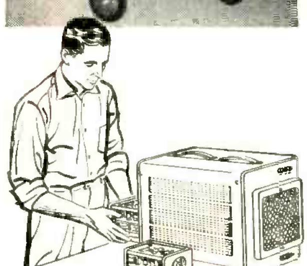

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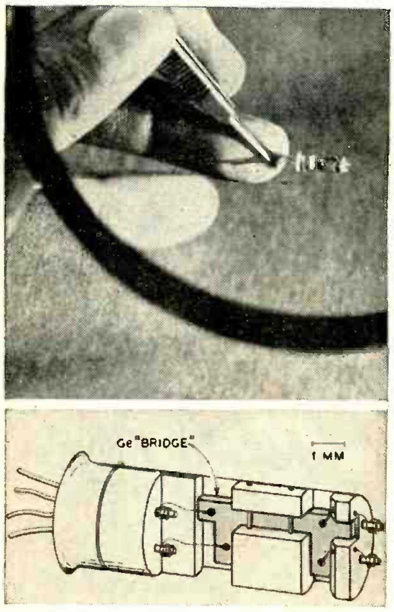
Temperature Measurements at Absolute Zero



"Germanium Bridge" thermometer is accurate to a few ten-thousandths of a degree in the absolute temperature range

A GERMANIUM resistance thermometer with high sensitivity and stability in the absolute-zero temperature range has been developed by J. E. Kunzler, T. H. Geballe and G. W. Hull of Bell Telephone Laboratories. Temperature measurement accuracy is better than a few ten thousandths of a degree at the boiling point of helium (4.2K) even after repeated cycling from room temperature.

Continued low-temperature research has highlighted the need for a thermometer which would indicate low temperatures accurately and reliably, and yet not need continued recalibration. Engineers and scientists who must measure such quantities as the calories necessary to produce a particular reaction or temperatures in outer space should find this invention ideal.

Crystal Bridge

A very small "bridge" cut from a single crystal of arsenic-doped germanium, is the basic element of the thermometer. Actual size of this bridge is about 0.025 in x 0.020 in x 0.210 in. It is strain-free supported in a platinum-glass enclosure containing a small amount of helium gas to aid in thermal conduction. Resistance is determined by measuring the potential drop when a 10 microampere current is passed through the bridge.

Germanium can be doped with arsenic to produce a high and fairly constant temperature coefficient of resistance of about one ohm at room temperature, 14 ohms at 10 deg K and 216 ohms at 2 deg K. Both the temperature coefficient and the actual resistance vary widely with minute changes in the amount of doping. This makes it possible to fabricate a thermometer having any of a wide range of characteristics.

Temperature Cycle

Despite repeated cycling from 300 deg K to 1 deg K, the thermometer will retain its calibration accuracy.

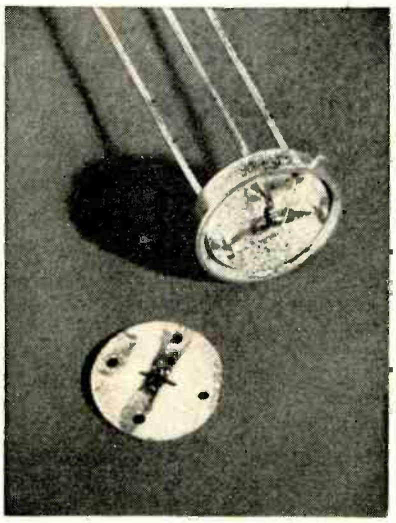
To avoid excessive heating, resistance of the thermometer should be kept as large as possible. However, for simplicity in measurements, a low resistance is desirable. A minor dilemma results, but with the outstanding characteristics obtainable, resolving it is almost a pleasure. A compromise can be reached by controlling the doping of the germanium crystal.

The thermometers are not available from Bell Telephone Laboratories, but a number of them are being turned over to the Calorimetry Conference for testing. If this Conference finds that they have wide usefulness, Bell Labs will atempt to find a qualified manufacturer to produce them commercially.

Transistor Fabrication Defies Testing

A SHOTGUN test was resorted to by GE engineers after conventional means of testing the mechanical stability of a new transistor proved inadequate. Transistors, with the semiconductor bar mounted on a flat ceramic wafer—instead of suspending it between two upright posts—were shot from a 12-guage shotgun into a telephone book. No estimate of the velocity or G-force was given, but a GE representative said the only failure was the telephone book.

The newly-developed technique mounts the germanium or silicon bar on a flat, circular ceramic wafer. The ceramic wafer in turn rests solidly on the "floor" of the transistor housing.



The semiconductor bar is mounted on the wafer and then the wafer is connected to the transistor leads

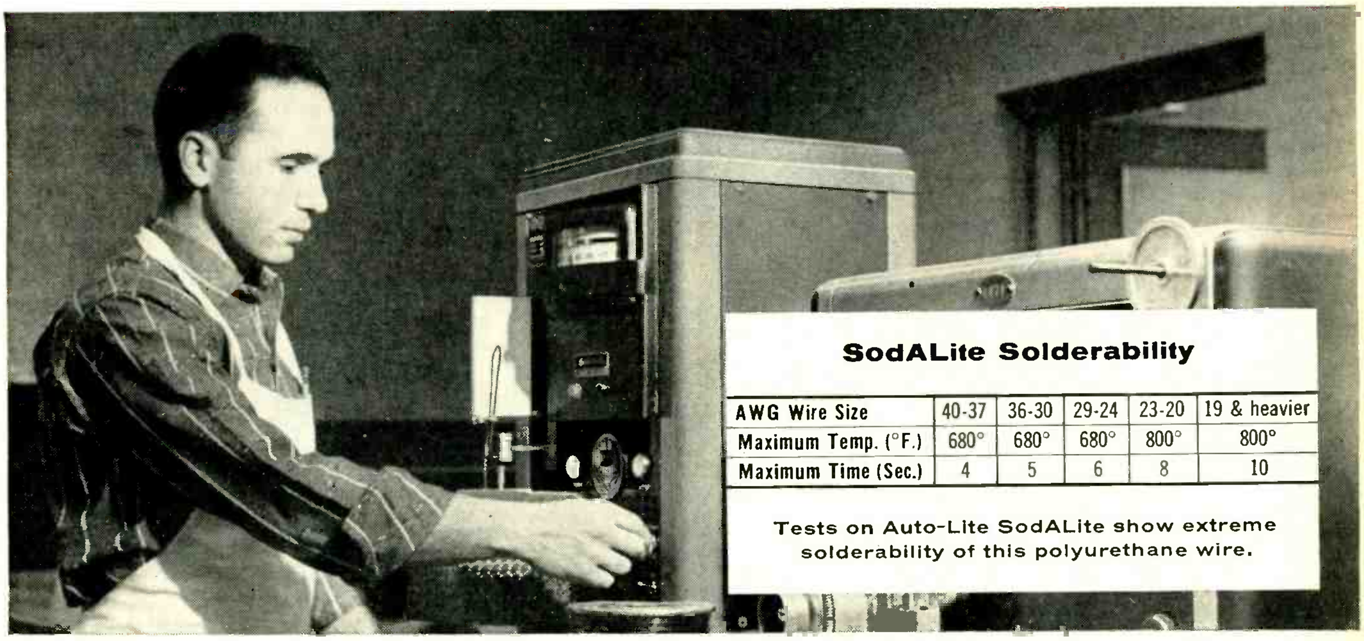
Fixed-bed mounting provides protection against the three major causes of transistor failure—Expansion and contraction of metal parts caused by hot and cold temperature; direct impact, and vibration which tends to separate transistor parts.

Military Test Specs

The structure far exceeds mechanical stability requirements for military transistors set by the Air Force, GE engineers say.

General Electric is now building unijunction transistors with the fixed-bed mounting and plans to extend its use to other industrial and military transistors in the near future. P.S. Since they claim that

SodALite means Solderability!



SodALite Solderability

AWG Wire Size	40-37	36-30	29-24	23-20	19 & heavier
Maximum Temp. (°F.)	680°	680°	680°	800°	800°
Maximum Time (Sec.)	4	5	6	8	10

Tests on Auto-Lite SodALite show extreme solderability of this polyurethane wire.

Here's a polyurethane base magnet wire insulation that's self-fluxing, outstandingly easy to solder!

Fine sizes of SodALite magnet wire can be soldered at 680° F. in approximately 5 seconds. Heavy wire sizes can be soldered at 800° F. in approximately 10 seconds.

Conventional dip, iron, torch or gun methods will produce excellent connections. There is no need for brushing or chemical stripping because SodALite vaporizes to produce a clean, solderable surface. Although SodALite is self-fluxing, some operations may require a non-corrosive flux for best results. Excessively high temperatures will delay soldering and may cause poor connections.

SodALite has higher dielectric strength values when compared with other standard films. Tests indicate only a small drop in dielectric strength after immersion in water at room temperature. High frequency characteristics and corona resistance, even in humid conditions, exceed nylon insulations. SodALite is compatible with a variety of phenolic alkyd, silicone and polyester impregnating varnishes. Field reports show it equal to other popular wires in abrasion resistance and handling characteristics.

SodALite has excellent physical characteristics and electrical properties in addition to good resistance to solvents, moisture, acids, and bases. SodALite has unusual thermal properties and, when tested to method of AIEE #57, has 10-15° C. higher thermal rating than other widely used Class A insulations.

SodALite is offered as a 105° C. magnet wire, or better. Higher temperature usage should be considered only after testing to the specific applications, because polyurethanes such as SodALite cannot withstand excessive overload conditions. For moderate overload conditions SodALite may be considered for use up to 120° C.

Availability: Single, heavy, triple and quadruple films in round AWG #8 through #40.

QUICK DELIVERY FROM THESE PLANTS AND WAREHOUSES

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Wire and Cable DIVISION

THE ELECTRIC AUTO-LITE COMPANY

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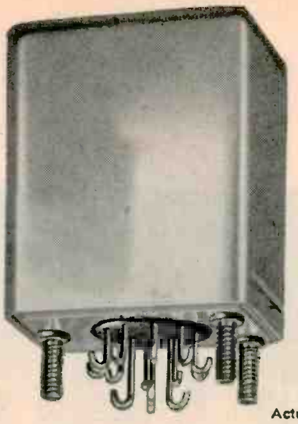
NEW

RBM

BHSM and BHSM HT TYPES



Actual Size

Miniature Hermetically Sealed Relays

The reliability of this relay under severe conditions of vibration and shock has been field-proven in many applications. It is another example of how R-B-M's production maturity and complete facilities can eliminate many of your engineering problems.

Consult your local RBM Product Application Engineer or write for Bulletin BHSM-1.

RBM Division

ESSEX WIRE CORPORATION, LOGANSPORT, INDIANA

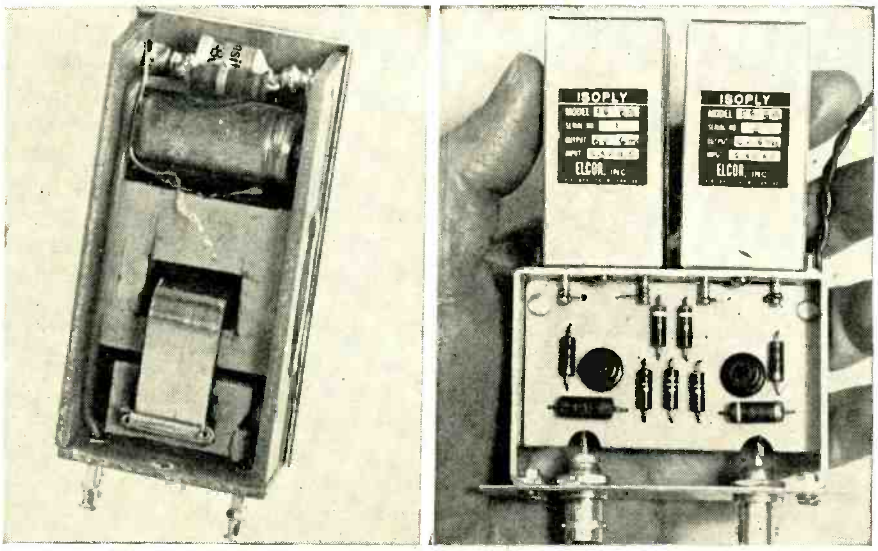
CIRCLE 56 READERS SERVICE CARD

the transistor will withstand the toughest "torture" test possible

General Electric is also building new test equipment.

Subminiature Power Module

A REGULATED, filtered d-c power supply weighing less than 3 ounces and measuring only $\frac{7}{8}$ in. x $1\frac{1}{8}$ in. x $2\frac{1}{2}$ in. has been announced by Elcor, Inc., McLean, Va. The supply furnishes enough power for the collector circuit of a transistor or the bias for a vacuum tube. It has a shunt capacitance from output to ground of 20 $\mu\mu$f making the supply useful as a means of direct coupling in high-speed circuits, and in many bridge circuits in which a signal voltage appears between the power supply output and ground.


Interior (left) of miniature isolated power supply. Transformer construction gives high degree of isolation. Modular d-c discriminator (right) with two subminiature power supplies operates entirely on a-c power. Discriminator converts input waveform into a rectangular wave or pulse

Modular Power

The subminiature supplies are also well suited as power supplies for individual modules or sub-assemblies of a composite system. An advantage in this type of modular construction is the unusual ease with which modules can be interconnected to synthesize a system. Since each module is complete with its own d-c power supply, there is no possibility of interaction between modules through a common d-c power supply. Untold hours of time are saved by avoiding such problems as wiring power plugs, de-coupling and by-passing d-c power leads, and trouble-shooting interaction between circuits.

Reliability and Cost

Use of subminiature power supplies in modular design is also economical. A common fallacy is the tendency to think that a huge saving of cost is always obtained by use of one or two large power supplies in preference to many small ones. Although this is sometimes true, a close study of many typical situations reveals that there are factors that are often overlooked. One is that the cost of a power supply, especially a regulated power supply, increases substantially with the current that it must supply. Another factor is the relatively large cost that accrues in system development as a result of troubles arising from interaction of various circuits because of the use of a common power supply. A third factor is the additional cost resulting from the added complexity needed to make circuits operate from d-c power sources that are referenced to ground. If these factors are considered, circuits employing modular power supplies will compare favorably with conventional circuitry in cost.

Reliability

In applications where consequences of equipment failure are so severe that design emphasis should be placed entirely on reliability and performance, initial cost plays an almost insignificant role compared with advantages of modular construction. The inherent simplicity and stability of subminiature power supply circuits, compared to conventional circuitry, means that a higher potential reliability exists.

Coupling Advantages

A special power supply inserted as a direct-coupling element between the plate of the tube and the load resistor has several advantages. It simplifies circuitry, improves circuit stability and reliability and facilitates interconnecting units which employ this method of direct-coupling. The miniature isolated power supplies, Models A105-15A and A150-10A Isoplys, were developed primarily for vacuum-tube circuits. They are generally too large and powerful for transistor circuits which require the very much smaller subminiature Isoplys.

Input-Output Power

Various models of the Zener diode regulated Isoplys are available with input for 60-400 cycle a-c, and with d-c output voltages ranging from 4 v to 26 v and current ratings ranging from 9 ma at 4 v to 1½ ma at 26 v.

Spin Testing Electronic Components

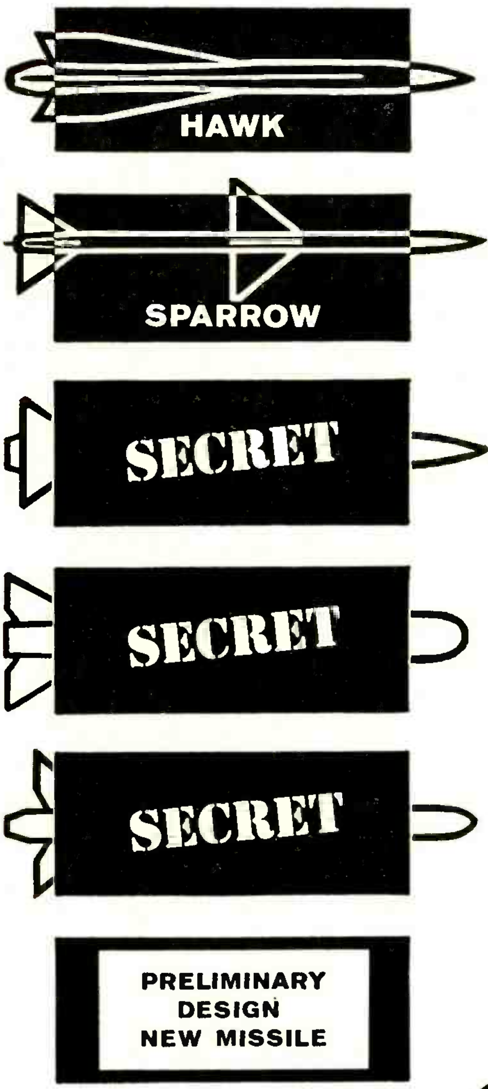
A CENTRIFUGE, designed to subject special-purpose electronic components to radial accelerations as high as 50,000 G's, has been developed by the Alexandria Division of American Machine & Foundry Company. It is a precision, environmental test apparatus.

A direct-reading G-force meter operates through a selector switch set to the specimen mounting radius. An electronic counter indi-

WORK IN RAYTHEON'S

EXPANDING

Missile Program



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- Excellent advancement opportunity.
- Modern facilities.
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For interview at our suburban laboratory in Bedford, Mass., write, wire, or telephone collect to CRestview 4-7100. Ask for J. Clive Enos.

RAYTHEON *MISSILE SYSTEMS DIVISION*

RAYTHEON MANUFACTURING COMPANY, Bedford, Mass.

cates the exact speed of rotation. Slipring assemblies, which make it possible to performance-test spinning components, can be added as optional equipment.

Safety Interlocks

Control and operating sequences are governed by a carefully engineered system of electrical interlocks which permit safe operation of the centrifuge in production testing with relatively unskilled labor.

Failure-prone components are weeded-out by centrifuge tests up to 50,000 G's

The centrifuge will test gravitational forces to meet government specifications for such items as transistors, small magnetrons, semiconductors, and electron tubes. Simple modification of the machine enables it to centrifugally encapsulate components in plastic.

Operation

For test, components are positioned in a plastic liner which fits inside an aluminum centrifuge bowl. In automatic runs, the ultimate speed (from 1,000 to 21,000 rpm) required to produce a specified force level and the duration of rotation at that speed are preset at a control console. A push button closes a sliding door in the armored test chamber and accelerates the bowl to the preset speed for a preset time.

The machine automatically brakes to a stop and the access door opens for removal of test specimens. The entire automatic cycle, including loading and unloading, takes about five minutes.

Composite Circuit Layout Guides Satellite Assembly

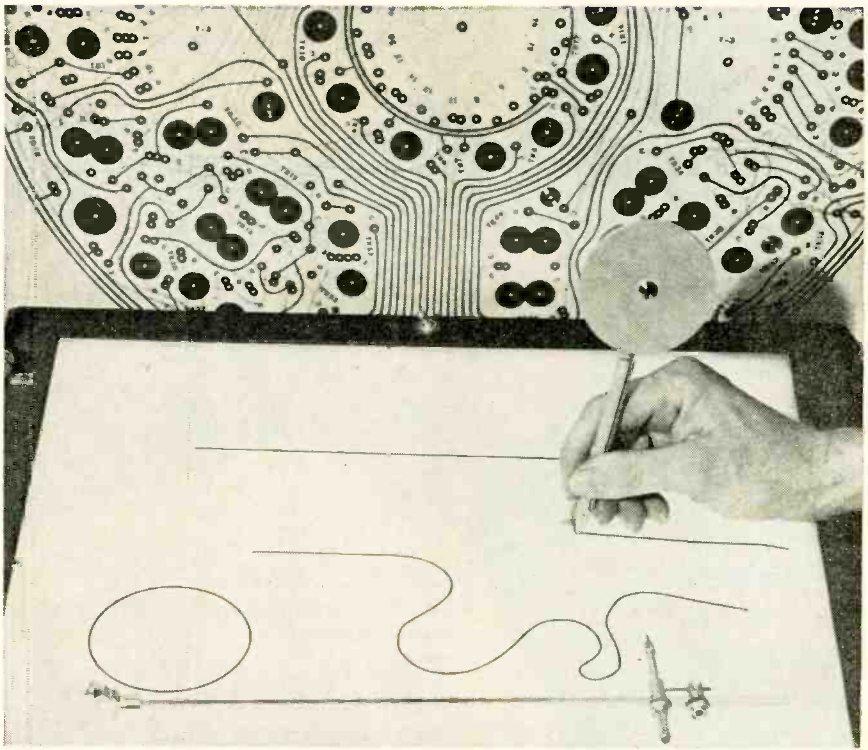
By J. H. PERRY
U. S. Naval Research Laboratory, Washington, D. C.

SEVERAL unusual and time-saving methods are employed to make the printed wiring cards used in the earth satellite developed at NRL (ELECTRONICS, Feb. 28). A composite layout is used as an assembly guide.

The cards—3 are used in the module discussed—are circular in shape, which simplifies layout. Inputs and outputs are separated by placing them on opposite sides of the terminals. The ground, minus and plus voltages, and bias voltages run around the outer edge of the cards making it easy to tap onto for the various circuits.

The masters are laid out on 0.003 inch transparent plastic sheets, each 4 times as large as the card. This sharpens detail upon photographic reduction.

Three layouts are made for each card. The first and second show the wiring on the top and bottom of the card, respectively, with black photographic tape, which can easily be rerouted. The tape is applied with a special tool, described below. These layouts are later processed in the usual manner to make the etched circuits.

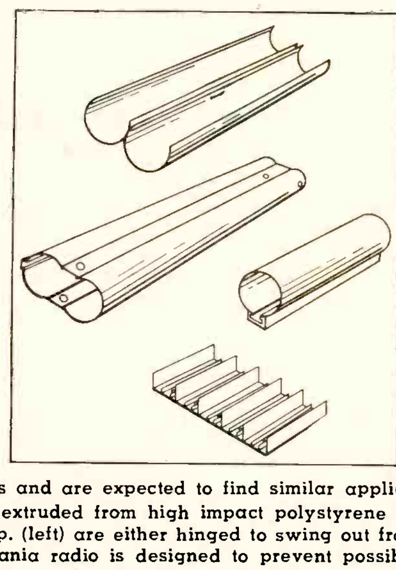


Writing with photographic tape applicator is demonstrated in front of composite layout used as guide in assembling satellite instrumentation printed circuit cards

The third layout contains symbols for all components, values, names and notes for special attention, written on the plastic with a red wax pencil.

All three layouts are taped together at one side in book fashion in the process used to make the assembly diagrams. Each sheet is laid in turn on single sheet of photosensitive paper. The paper is exposed for 5 to 10 minutes under a 275 watt sunlamp. A shaded overlay effect is obtained: the bottom

DESIGN TRENDS: Extruded Plastic Battery Cases



Battery cases facilitate correct replacement of small cells used in portable transistor radios and are expected to find similar applications in transistorized instruments and military equipment. Illustrated are some of types extruded from high impact polystyrene by Anchor Plastics Co., Long Island City, N. Y. Two open types used by Roland Radio Corp. (left) are either hinged to swing out from radio case or riveted to case flap. Closed double tube (center) which fits inside a Sylvania radio is designed to prevent possible short circuits. Tube is keyed on one side to assure correct polarity of contacts

PANEL INSTRUMENT VALUE...

ON A *Grand Scale*

LONG-SCALE READABILITY

UNEQUALLED NATURAL ILLUMINATION

CORMAG® ACCURACY AND SHIELDING

Plus **prices that'll surprise you**

WESTON'S NEW, MAGNETICALLY-SHIELDED MODELS 1371 AND 1375 FEATURE 7.2-INCH SCALES

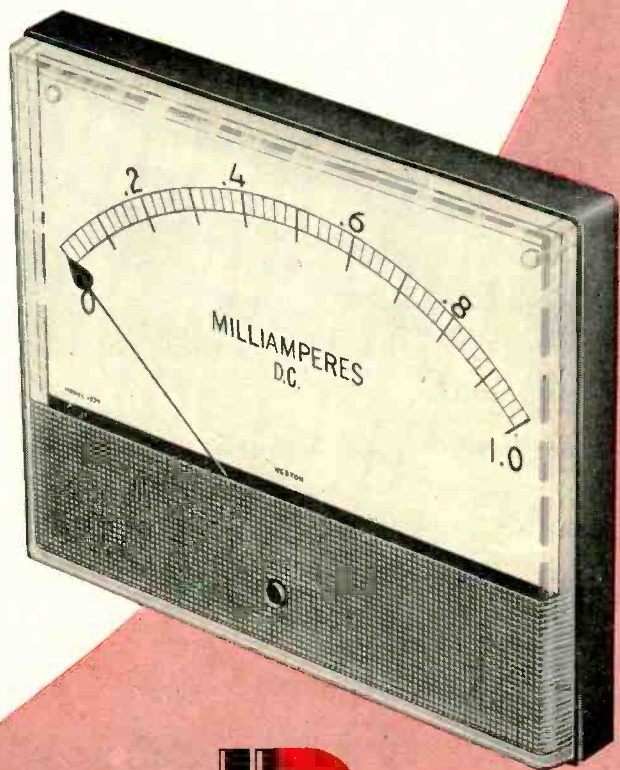
Here's a new series of panel instruments offering Weston's traditional craftsmanship with a bonus in readability . . . and at low cost, too! Look at these features:

CORMAG MECHANISM: means you can mount these rectangulars on magnetic or non-magnetic panels . . . in close proximity to other instruments . . . without special adjustments. They're immune to the effects of stray magnetic fields.

EXCEPTIONAL READABILITY: all-plastio fronts, with clear top and sides, provide excellent natural illumination of the oversize scales—without annoying shadows. Normally supplied with lance pointers, for distance reading, these instruments can be supplied with large pointer tips and heavy scale markings as illustrated . . . or with mirror scales and knife-edge pointers for more precise readings.

HIGH ACCURACIES: available in most d-c ranges with accuracies from ½% to 2% . . . a-c rectifier types, 3%.

For more details, call your local Weston representative . . . or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

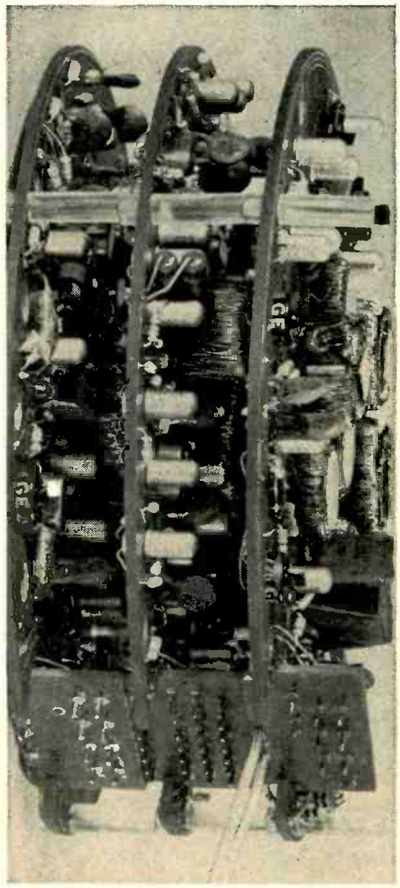


WESTON *Instruments*

A DAYSTROM UNIT

circuit is dim, the top circuit is dark and the components show lightest of all.

The three printed circuit assemblies illustrated are each 5½ inches in diameter and ¾ inch high. They are potted to form a module.

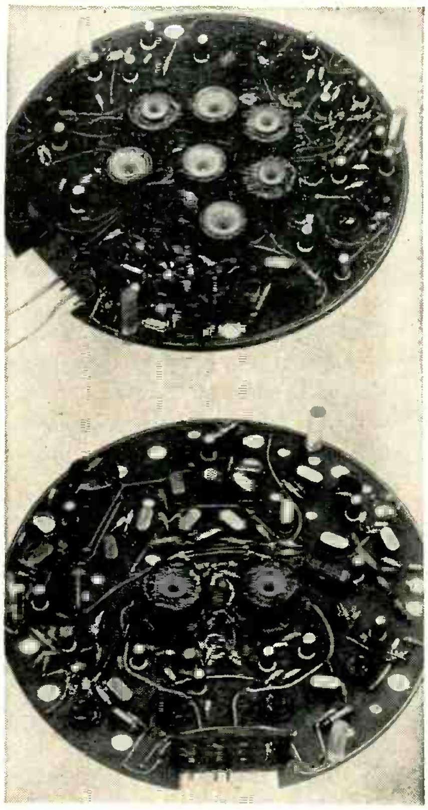


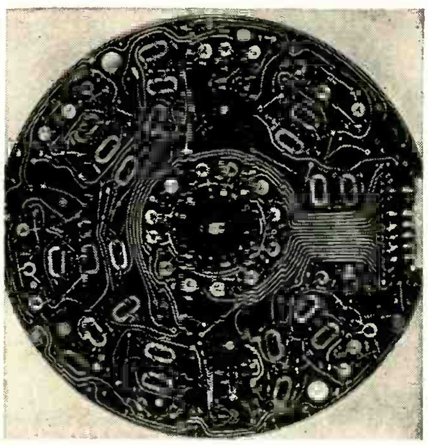
Peak reader, telemetering and counter cards before potting

A 48-channel telemetry encoder system card has 193 parts and 525 soldered connections. Included are 55 transistors and 5 toroidal magnetic cores. Two cores are stacked together for instantaneous Lyman-alpha information, 2 for solar aspect information and another for telemeter timing. The card weighs 3.8 ounces unpotted.

A peak reader and solar switch card has 156 parts and 419 soldered connections. It has 31 transistors, 2 peak current memory cores and a solar switch and weighs 2.5 ounces.

A micrometeorite counter card has 132 parts and 456 connections. It has 32 transistors and a 6-stage amplifier feeding collision signals to a 3-digit decimal counter with 7


Peak reader and solar switch (top) and counter

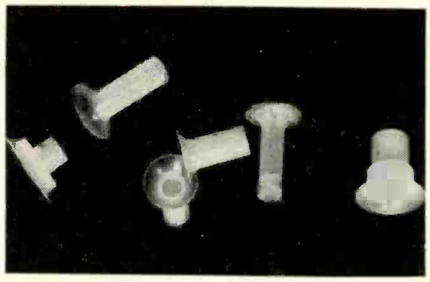

Underside of telemetering card

cores. Weight is 3.1 ounces.

Magnetic cores are fastened to the cards with cones of nylon. Cone flanges are machined to 0.010 inch thickness. When wires cross under these pliable flanges, the flanges will bend and not crush the wires in the core. The cones are anchored by aluminum rivets.

Transistors are hand-mounted by friction fit in drilled holes. Pigtail leads are bent short, cut off and soldered to the printed wiring, providing a firm mounting for testing and adding strength after potting.

Connections are hand-soldered be-

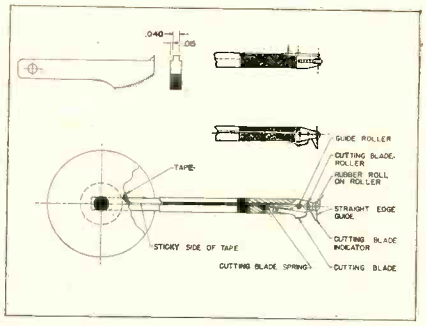


Nylon cones which hold magnetic cores

cause dip-soldering would damage transistors mounted on the undersides of the boards. After the cards are fitted together, they are potted with a foam compound, using an aluminum mold.

Handy Applicator for Photo Layout Taping

LAYOUT work for the earth satellite is speeded up by a photographic tape applicator devised at NRL. Used like a pencil, it unreels the $\frac{1}{16}$ inch tape in zig-zag or straight course. A blade cuts the tape at the end of each run.



Photographic tape applicator is as long as a wooden pencil

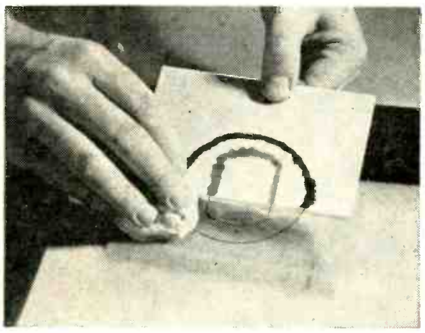
The applicator is threaded from an 18-yard spool of black tape. The tape goes through a slot (not touching either side) to a series of rollers at the applicator's lower end.

The first small roller (see diagram) is the only place the sticky side of the tape touches. The cutting blade perforates the tape against the next roller. The last roller, made of rubber, presses the tape to the plastic sheet surface.

The straight edge guide also indicates when to cut or perforate the tape at the end of each line. When the end of this guide reaches the end of a line, the cutting blade is firmly pressed, perforating the tape. The blade is released, but when the perforation reaches the end of the line, slight pressure on the cutting blade drags on the tape, breaking it at the perforation. Meanwhile, enough tape has run out to start the next line.

The applicator may be attached to the end of a beam compass to make a circle. Minimum drag on the tape allows turns to be made without the tape slipping.

Plastic Gaging Charts



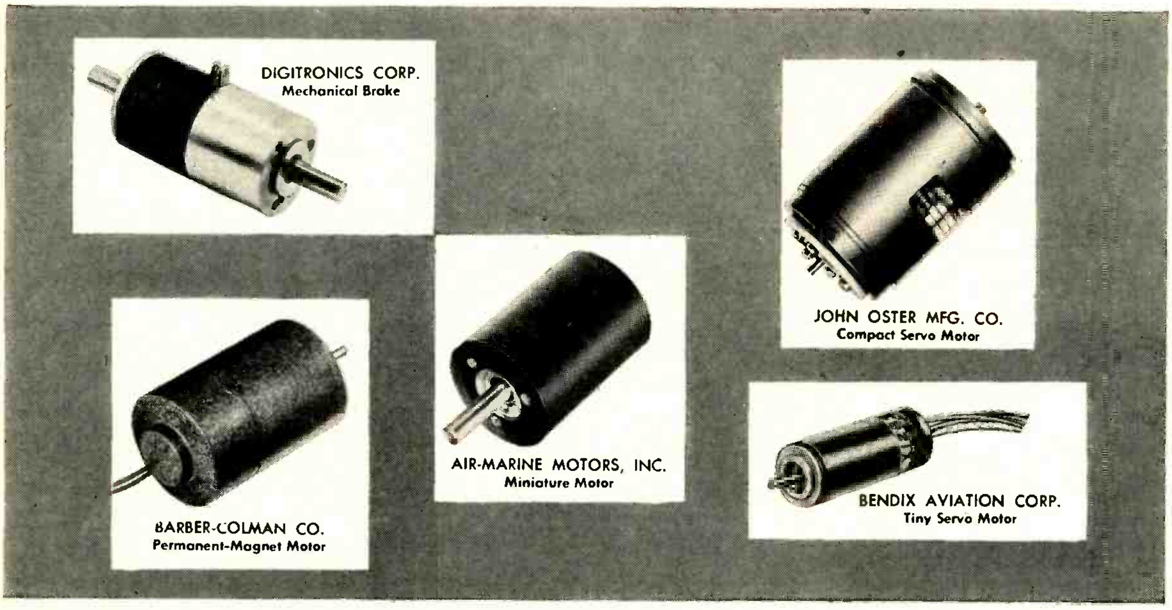
Excess dye is washed from scribed chart

OPTICAL comparator gaging charts can be made with ordinary layout or scribing tools on coated plastic plates supplied by Optical Gaging Products, Inc., New York City. Scribed lines are brushed with a dye-like fluid which impregnates plastic uncovered by scribing. Chart is ready for use after being washed and dried. Plastic plates 0.050 inch thick are said to be next to glass as a chart layout material.

Oil Cleans Contacts

ELECTRICAL CONTACTS of any type may be cleaned without abrasive and kept bright with an oil supplied by Caig Laboratories, New Hyde Park, N. Y. The firm states the oil is a combination cleaner, anti-corrosive, preservative and lubricant. It is a neutral mineral oil containing an organic reagent and other additives. It softens metal oxides and sulfides on contact surfaces without affecting clean metal. The oxides are removed by wiping or working the contact. A film of oil will adhere to the cleaned surface. Electrical resistance of the oil is low enough for contact efficiency and high enough to prevent short circuits.

Unveil New Servo Devices



Miniaturization Featured

ELECTROMECHANICAL equipment plays a big role in the electronics industry. Motors are filling the bill for compact-package requirements in such applications as driving cooling fans and servo systems.

Barber-Colman Co., Rockford, Ill., (300), offers a $1\frac{1}{4}$ in. diameter p-m d-c motor designed to MIL-M-8609 specs. Capable of operating in ambient temperatures from -65 to $+200$ F, a typical FYLM motor, rated 15 millihorsepower at 9,700 rpm requires 0.6 ampere and weighs 0.33 lb.

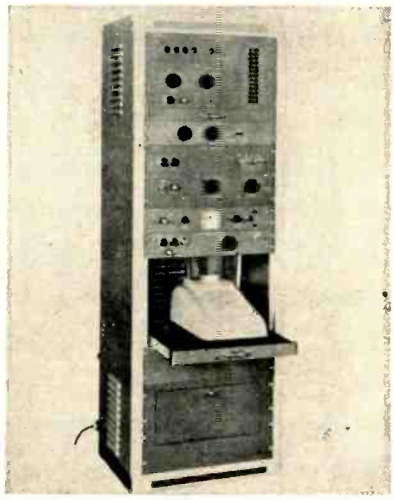
Now in production at **Air-Marine Motors, Inc.**, Amityville, N. Y., (301), is a line of 1 in. diameter motors. They are intended for use in high temperature ambients. In one application, as a centrifugal blower driving a $1\frac{1}{2}$ in. wheel, it delivers 11.6 cfm at 0 in. s-p and 0 cpm at 1.05 in. s-p.

John Oster Mfg. Co., 1 Main St., Racine, Wisc., (302), has available a servo motor which develops 5 oz in. stall torque yet measures only 2.44 in. long and weighs only 21 oz. The motor is designed to replace two standard size 18 units in applications where space and weight are factors.

A tiny 400-cycle motor announced by **Bendix Aviation Corp.**, Teterboro, N. J., (303), is designed for use in servo systems where instant response to input signals is mandatory. It measures $\frac{1}{2}$ in. in diameter by $1\frac{19}{64}$ in. long. It consists of a squirrel cage rotor mounted on precision ballbearings, a two phase stator and a stainless steel housing.

Digitronics Corp., Albertson Ave., Albertson, L. I., N. Y., (304), manufactures the A-500 mechanical brake. It has a high braking action of 10 in. lb, a low control force of 0.06 in. lb, and a response time of 0.001 sec. The unit features integral construction with built-in controls in a complete envelope with sealed ball bearings.

For more information use READER SERVICE CARD



System Analyzer add-a-unit design

TECHNICAL ELECTRONICS CORP., 4060 Ince Blvd., Culver City, Calif. Automation testing of continuity, leakage, resistance, capacitance, inductance and voltage for electronic circuitry and cables is performed by a new system analyzer. Add-a-unit concept makes it adaptable to a few up to several hundred pairs of circuits, and to simple or involved tests.

Capabilities include: (1) single or combined comparison of resistance, capacitance and inductance;

It takes a lot of doing to produce the exact same thing over and over again hundreds of thousands of times—without slipping up on a thousandth of an inch, watt, or milligram. This insistence on *uniformity* has helped build our reputation as the world's most Consistently Dependable producer of CAPACITORS. Continuously uniform production is a science —one that we've painstakingly pursued since 1910.

Typical of the "countless" C-D electrolytics used by major equipment manufacturers the world over are:

"EC" MINIATURIZED CERAMIC CASED TUBULARS For cramped-space applications in hearing aids, transistorized devices, and remote control assemblies. Less than ¼" D., only ¾" L.

"NL" ULTRA-SMALL Hermetically sealed aluminum cased electrolytics, built for compactness, ruggedness, low leakage, long shelf and in-use life.

TANTALUM 3 tubular types, all with low power-factor, moisture-impervious hermetic seal, long service and especially long shelf life. "TX" with sintered anode; "TAN" miniature foil type; sub-miniature, low-voltage wire anode type "NT".

TYPE "UP" Made in the smallest tubular aluminum cans possible for any given capacity and voltage combination. In single, dual, triple and quadruple capacity combinations.

Write for catalog to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

CONSISTENT HI-DEPENDABILITY
CORNELL-DUBILIER CAPACITORS

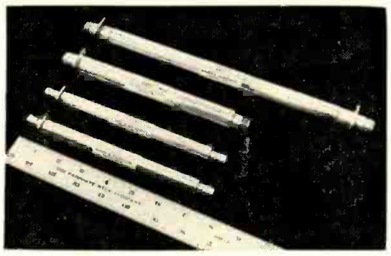
SOUTH PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER & CAMBRIDGE, MASS.; PROVIDENCE & HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD, FUQUAY SPRINGS & VARINA, N. C.; VENICE, CALIF.; & SUB.: THE RADIART CORP., CLEVELAND, OHIO; CORNELL-DUBILIER ELECTRIC INTERNATIONAL, N. Y.

CIRCLE 67 READERS SERVICE CARD

(2) adjustable hi-pot and leakage testing—includes search feature for fault points; (3) indiscriminate testing of voltage percentage regardless of voltage, frequency and polarity; (4) visual digital read-out or tape print-out; (5) remote control; (6) plug-in construction. **Circle 305 on Reader Service Card.**

Low Pass Filters compact, rugged

MAURY & ASSOCIATES, 10373 Mills Ave., Pomona, Calif., has developed two new lines of low pass filters for laboratory purposes. They can be obtained to meet any cutoff frequency between 65 and 1,000 mc, and can be made to meet extreme environmental specifications. They are designated as series A with type BNC connectors, and series C, with type N connectors. Six standard models are available with cutoff frequencies of 125, 250, 500, 750, 875 and 1,000 mc. Specifications for both series A and C are: insertion loss, 1.5 to 2.5 db ripple in the

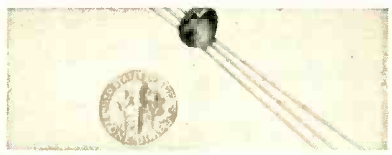


pass band; rejection slope, 40 db minimum at 1.25 times cutoff frequency; vswr, 2.5 maximum in pass band; second harmonic attenuation, 60 db minimum; spurious responses, greater than 40 db above 2 times the cutoff frequency. Power handling for the series A is 15 w, and for the series C, 50 w. Series A is $\frac{9}{16}$ in. in diameter, and series C, $\frac{13}{16}$ in. They range in length from 6 in. to a maximum of 1 in. (including connectors). **Circle 306 on Reader Service Card.**

Pulse Transformer subminiaturized

PULSE ENGINEERING, 2657 Spring St., Redwood City, Calif. The ES3 subminiature pulse transformer is particularly useful in transistor blocking oscillator circuits. Body dimensions for the epoxy resin encapsulated pulse transformers are $\frac{3}{8}$ in. maximum. It is available in two and three winding styles with wire leads of No. 24 Awg tinned copper. Coil inductances to 3 mh are available.

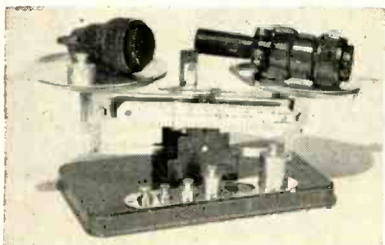
Power rating of the units is 1 w average power and 50 w peak pulse power. **Circle 307 on Reader Service Card.**



Connector shorter, lighter

CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles 31, Calif. To meet the demands for a shorter, lighter MS-E type connector, the company has introduced the MS-E (series CT) which meets all requirements of specification MIL-C-5015 and is approved for use on military equipment.

Featuring an improved end bell

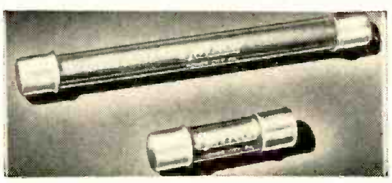


design, the new series CT offers 5-15 percent reduction in weight and up to 25 percent reduction in length as compared with earlier MS-E designs.

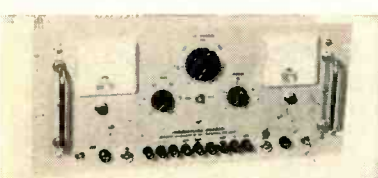
Contacts and wires within the new connector are continuously supported by resilient insulators thus eliminating voids in which moisture could accumulate. **Circle 308 on Reader Service Card.**

Rectifier Stacks up to 21,000 piv

SYNTRON CO., 241 Lexington Ave., Homer City, Pa., announces a new line of h-v selenium rectifier cartridge stacks—up to 21,000 volts peak inverse. This high voltage is made possible by two improvements in selenium rectifiers. First a high voltage cell, and second a completely new process permitting the use of extra thin base plates on which the selenium is deposited.

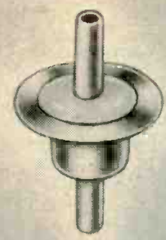


These new voltages are available in three current ratings: 5, 10, and 17 ma (capacitor loads). The containers (either glass tube and ferrule, or phenolic tube) are hermetically sealed, adapting them to continuous operation in salt fog and other adverse atmospheric conditions. **Circle 309 on Reader Service Card.**



Power Packs programmable

ELECTRONIC MEASUREMENTS CO., INC., Eatontown, N. J. Model 235A regulated power pack has a programmable output capable of furnishing 500 ma at any voltage between 0 and 600. Model 236A (illustrated) is rated at 0 to 600 v d-c at a maximum current of 200 ma. Model 236A also has a 0-150



18 Years of Progress at E-I

1940
... specialists in glass to metal seals for over 18 years. Research, development and manufacture devoted exclusively to the production of sealed terminations.

1951
... pioneered the production of compression type glass-to-metal seals. E-I developed and made a practical reality of the first compression seal, now the standard of the industry.

1957
... expanded research paces industry's varied needs. Universal acceptance of super-durable E-I hermetic seals made necessary expansion of research, engineering and production facilities.

—and offering designers in 1958 industry's most complete standard line!

GLASS-TO-METAL SEALS*

E-I glass-to-metal seals are available in hundreds of economical types of standardized designs. The complete line ranges from single lead terminals to miniature closures and color coded terminals. Specify E-I super-rugged compression type seals for critical military and commercial applications. Save time and eliminate custom sealing costs by using application-proven, standardized seals that meet practically every hermetic sealing requirement. Complete engineering data on the E-I Standard Line is contained in one helpful handbook. Write for your copy now.

Select your seals from the complete E-I Standard Line...

ELECTRICAL INDUSTRIES
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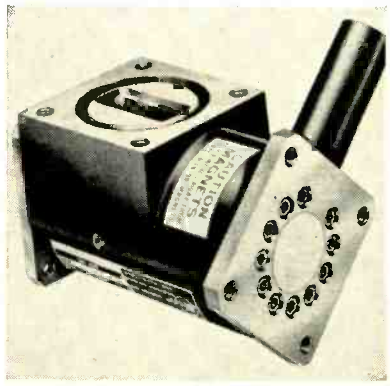
*MANUFACTURED UNDER CANADIAN PATENT 523,390, UNITED KINGDOM PATENT 734,583 AND LICENSED UNDER U.S. PATENT 2561520

CIRCLE 68 READERS SERVICE CARD

v d-c, 5 ma bias supply and a 6.3 v a-c CT, 10 ampere filament supply.

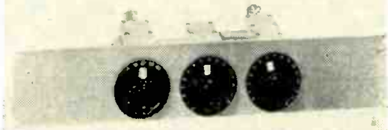
The h-v output in each case may be programmed from a remote location by means of an ordinary resistor, pot or rheostat. For each 500 ohms shunted across the programming line the power pack furnishes one volt. Resistance may be varied continuously or in steps. **Circle 310 on Reader Service Card.**



Ferrite Duplexer rotation type

KEARFOTT Co., 14844 Oxnard St., Van Nuys, Calif. Extremely compact, the model W163-1C-1 Faraday rotation duplexer weighs only 7 oz. yet it offers a frequency range of 9.2 to 9.4 kmc with isolation at 20 db minimum and insertion loss of 0.5 db maximum. It incorporates a unique coaxial termination to permit both transmission and reception.

Other features include: vswr of 1.25 maximum; maximum power absorbed in load at 12 w and peak power at 10 kw. Size of the new unit is $2\frac{3}{4}$ in. long by 3.037 in. high (including termination) by $2\frac{3}{4}$ in. wide. **Circle 311 on Reader Service Card.**



R-F Attenuators single or multiple

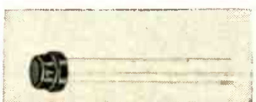
ORTHO FILTER CORP., Paterson, N. J. The series VA accurate variable r-f attenuators operate from d-c to above 250 mc. Standing wave ratio at 100 mc is less than 1.01.

Single rotating units are available at 0.1, 1 or 10 db per step. Multiple unit assemblies are available in various combinations and are supplied mounted on a standard $3\frac{1}{2}$ in. by 19 in. panel with front or rear access connections. The maximum change in loss from 0 to 100 mc is 0.1 db. **Circle 312 on Reader Service Card.**

Tape Programmer modular design

INDUSTRIAL TIMER CORP., 1407 McCarter Highway, Newark 4, N. J., has available a new punched tape programmer that will control as many as 85 individual circuits through an almost unlimited number of steps or functions. The tape reader uses a vinyl tape which makes available 85 individual load circuits. For each foot length of tape there are 64 possible steps.

Available with the unit are memory load relays. These are actuated by a pulse transmitted through the punched hole in the tape. This circuit remains energized until a second pulse is transmitted through a subsequent hole in the same channel in the tape. **Circle 313 on Reader Service Card.**



Transistors three silicon types

TRANSITRON ELECTRONIC CORP., Wakefield, Mass., has available three new silicon transistors, 2N471A, 2N474A and 2N479A. They have been fully specified in MIL-T-19500A format for life, environmental and mechanical tests.

Manufactured by diffusion, these transistors have very low I_{co} up to their maximum voltage (30 v) and temperature (175 C) ratings. They are hermetically sealed in the industry standard JETEC 30 package. These types are electrically interchangeable with the 2N117, 2N118 and 2N119, and can replace these types wherever the JETEC 30 package is preferred. **Circle 314 on Reader Service Card.**

Servo Tester high speed unit

Industrial Control Co., 805 Albin Ave., Lindenhurst, N. Y. Model 105-AR is a stable sine wave generator designed for the automatic frequency response measurements of servo systems and associated components. It features remote control of data frequency, quadrature outputs, and is built to fit into a 19-in. rack with a panel height of 8¾ in.

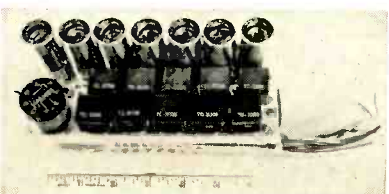
The instrument covers a data frequency range from 0.3 to 30 cps, with different ranges available on special order. **Circle 315 on Reader Service Card.**

Power Supply transistorized

Hyperion, Inc., 1447 Washington St., West Newton, Mass. Model HY A1-32-10 transistorized a-c to d-c power supply is designed for 4-32 v d-c and 10 ampere loads. Components are protected against overloads and short circuits. Output impedance is less than 0.01 ohm from d-c to 100 kc. Regulation is 0.5 percent from 0 to full load and 0.5 percent for 105-125 v a-c line variations. Ripple, including noise and hum, is less than 3.0 mv. **Circle 316 on Reader Service Card.**

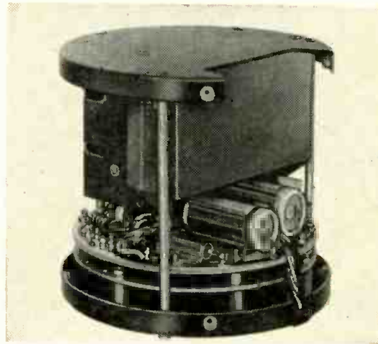
Indicator shows temperature

DYNAMIC DEVELOPMENT CO., 59 New York Ave., Westbury, N. Y., announces the TB102 low-cost direct-reading temperature indicator for general laboratory use. It is especially adaptable to temperature measurement at points in the interior of large electronic equipment, for example, to discover thermal gradients and the effects of cooling. Ambient temperatures and temperatures at different points in environment test chambers are conveniently measured. **Circle 317 on Reader Service Card.**



Binary Counter uses plug-in core

TELECHROME MFG. CORP., 28 Ranick Drive, Amityville, N. Y. Model 301-D binary counter is designed for use with tv synchronizing generators and other binary counter applications. The miniaturized counter is an ultrastable circuit, built as a subchassis which may be mounted in conjunction with additional circuitry. Measuring only 7¾ in. by 3¼ in. by 3⅞ in., Telechrome has made available the newest portable synchronizing generator measuring only 19 in. by 12½ in. high including power supply. A special feature of the model 301-D binary counter is the plug-in type magnetic cores which, although highly dependable, may be replaced easily in the field. Circle 318 on Reader Service Card.



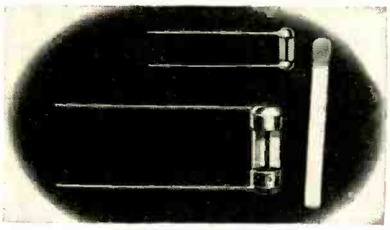
Power Converter for small missiles

Power Sources, Inc., Burlington, Mass. Models PS1008 and PS1009 transistorized telemetering power converters are designed specifically for installation in small missiles. Only 5.5 in. in diameter and 4¾ in. long, these converters provide 270 v at 22 ma, 150 v at 10 ma, and 30 v at 15 ma, all with 75 mv or better ripple, from inputs of 16 v d-c for the PS1008 and 7 v d-c for the PS1009. Weight is 2 lb 8 oz. Units are capable of operation at temperatures up to 85 C and are fully ruggedized to meet all missile shock and vibration specifications. Circle 319 on Reader Service Card.

Capacitors computer grade

General Electric Co., Schenectady, N. Y., offers a new line of d-c Alumalytic capacitors for extremely high microfarad applications such as the bulk capacitance requirements of computer power supplies. Units are rated from 30,000 μf at 10 v d-c to 1,000 μf at 450 v d-c and will operate from -20 C to $+65$ C.

The capacitors are manufactured with diameters of 1 in., $1\frac{3}{8}$ in., 2 in. and 3 in., and with a length of $4\frac{1}{8}$ in. The 1 in. and $1\frac{3}{8}$ in. diameter units are available in case lengths of 2 in., $2\frac{1}{2}$ in., 3 in. and $3\frac{1}{2}$ in. **Circle 320 on Reader Service Card.**

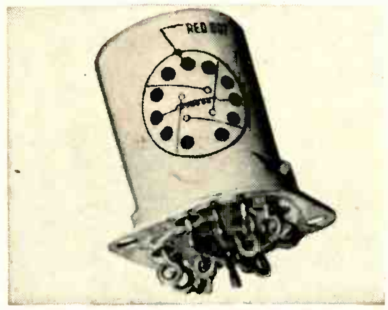


Sealed Fuses subminiaturized

McGraw-Edison Co., Bussman Mfg. Div., University at Jefferson, St. Louis 7, Mo. Fuses of minute size are available for use with miniaturized circuits, controls, electronic devices, and electrical equipment. Made of hermetically sealed glass tubes with lead-ins, these fuses meet requirements for potting and encapsulating. The hermetic seal prevents potting material from seeping into the fuse case and interfering with dependable operation of the fuse. The fuses are designed to withstand heavy shocks and vibrations. **Circle 321 on Reader Service Card.**

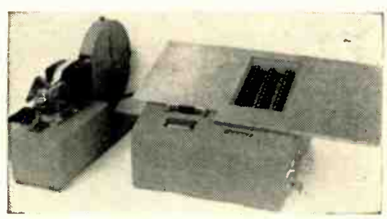
A-C Preamplifier variable gain

Burr-Brown Research Corp., Box 6444, Tucson, Ariz. Model 110 amplifier is completely transistorized and self-powered from ordinary C size flashlight cells. It features an input impedance of over 1 megohm continuously adjustable gain to 50 db, response from 10 cps to 500,000 cps, 0.5 percent maximum distortion, and 750 hours battery life. The unit is housed in a deep-drawn aluminum case measuring 4 in. by 8 in. by 4 in. The unit can be supplied with either continuous gain control or in stepped gain control. **Circle 322 on Reader Service Card.**



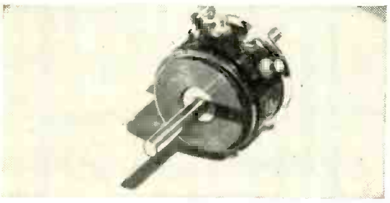
Relay balanced armature

Hi-G, Inc., Bradley Field, Windsor Locks, Conn., announces the new HG-4SL series relay whose size and mounting dimensions meet proposed MS drawings and MIL-R-25018 relay specifications. Rated for dry circuit operation through 10 ampere contacts, it is available in 1, 2, 3 and 4 pole form A, B or C contact arrangements. It can be operated from voltage sources from 4 v through 250 v. It meets MIL-S-901B shock specifications and is available on a short delivery basis. The relay has the rugged, rotary, balanced armature design of other Hi-G types. **Circle 323 on Reader Service Card.**



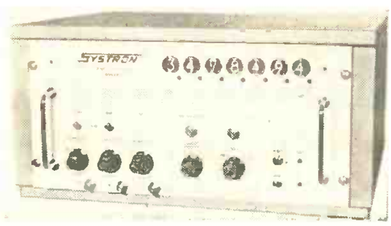
Data Processor produces punched tape

Taller & Cooper., 75 Front Street, Brooklyn, N. Y. introduces a data processor that translates information into punched tape form for computer use. Steady state data is punched on a permanent file card. Cards can be coded in more than 30,000 combinations with a conductor's punch. Variables are added by a typewriter-like keyboard. The sum of a steady state data and newly-added information is fed to a tape punching device, and the card is then returned to file. The system is currently in use by a music company, for tabulating composer royalty payments. **Circle 324 on Reader Service Card.**



Precision Pots high reliability

CARTER MFG. CORP., 23 Washington St., Hudson, Mass. Combining high temperature operation with long load life, these high reliability precision potentiometers have been lab and field tested for nearly two years. All eight standard resistance values (100 to 25,000 ohms) are manufactured with 20 ppm resistance wire and can dissipate more than ½ w at 125 C for more than 2,000 hours. **Circle 325 on Reader Service Card.**

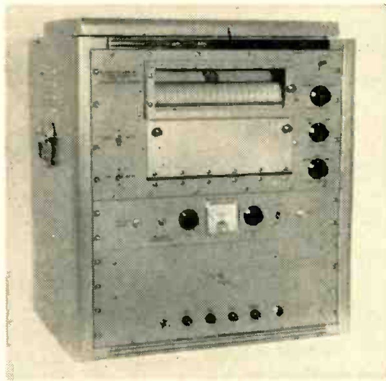


Counter-Timer in-line readout

SYSTRON CORP., 2055 Concord Blvd., Concord, Calif. Model 1031 is a single package in-line megacycle-microsecond counter-timer. Providing flexibility and reliability for laboratory applications it measures: frequency to 1 mc, time and period in 1 μsec increments, phase angles in 0.1 deg increments, events to 7 digits, ratio of 2 frequencies and acts as a secondary frequency standard.

Principal feature is the in-line

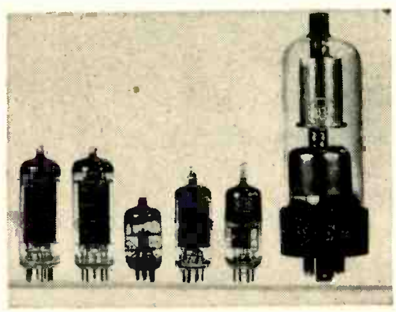
display of information. The well illuminated one-inch high numerals are clearly readable at distances up to 30 or 40 ft. Also featured is modular construction for all amplifiers and control circuitry. **Circle 326 on Reader Service Card.**



Recorders
antenna pattern

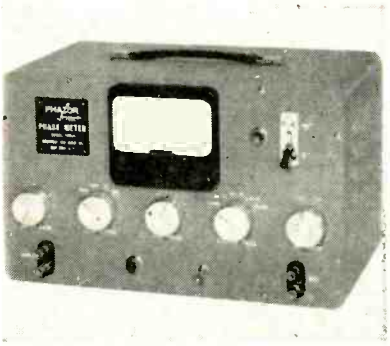
SCIENTIFIC-ATLANTA, INC., 2162 Piedmont Road, N. E., Atlanta 9, Georgia, announces a new series of rectangular antenna pattern recorders. Model 121B recorders offer greater accuracy, faster pen and chart response speeds, and the new plug-in balance potentiometers for selecting linear, logarithmic or square root pen responses.

The companion series 122B polar antenna pattern recorders incorporating all the improvements of the new series is also announced. Both recorders use the improved bolometer-crystal amplifier. **Circle 327 on Reader Service Card.**



Receiving Tubes
six new types

CBS-HYTRON, a division of Columbia Broadcasting System, Inc., Danvers, Mass. Two hybrid auto radio tubes, two series-string tubes, a vhf tuner tube and a color tv h-v rectifier are announced. Circle 328 on Reader Service Card.



Phase Meter high sensitivity

The Industrial Test Equipment Co., 55 E. 11 St., New York 3, N. Y. Phase meter model 200AB features high sensitivity, and high input impedance for the reference input as well as for the signal input. As with the other Phazor instruments, model 200AB measures phase angles by a unique multiplying principle which permits measurements to be made accurately in the presence of noise and harmonic voltages.

The instrument can be used to measure in-phase and quadrature components of voltage, and by the use of simple circuit techniques may be used to measure phase angles in the order of 0.01 deg. Circle 329 on Reader Service Card.

Silicon Rectifiers high voltage type

Pacific Semiconductors, Inc., 10451 West Jefferson Blvd., Culver City, Calif., announces a new line of very high voltage cartridge silicon rectifiers. Voltage range is from

1,500 to 16,000 v, at temperatures to 150 C.

The eighteen types in the new line meet or exceed EIA specification in the IN 1133 to IN 1149 series. The units are highly ruggedized with all connections between component diodes firmly bonded within a high impact sealed sleeve. They can be mounted into a standard 30 ampere fuse clip. Body lengths range from 1 13/16 in. to 6 1/16 in. **Circle 330 on Reader Service Card.**

Load Isolator for X-band radars

Litton Industries, 5873 Rodeo Road, Los Angeles 16, Calif. Model X103/S165 ferrite load isolator is designed for use in X-band radars where insertion loss must be held to a minimum.

Operating at 100 kw power, it is guaranteed to give a minimum of 8 db isolation with a maximum of 0.3 db insertion loss between 8,500 and 9,600 mc. Units produced actually showed only 0.2 db insertion loss over the bandwidth.

With choke flanges, length is 2.07 in. With cover flanges, length is only 1.6 in. Weight is less than 1 lb. **Circle 331 on Reader Service Card.**

Frequency Meter and counter

Westport Electric, 149 Lomita St., El Segundo, Calif. Model WE-120 portable, light weight,

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electronics' READER SERVICE

it's free–it's easy–it's for your convenience

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Circle No.	Product	*

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five-decade frequency or events per unit of time meter and electronic counter uses decade glow transfer tubes for both digital presentation and digital division of the time base frequency. The simplified circuitry of the glow transfer tubes provides a high degree of reliability (counter tube expectancy in excess of 10,000 hours), and low power consumption.

Frequency range of 10 to 100,000 cps, and stability of 0.001 percent, ± 1 count, make the unit useful as a laboratory instrument as well as for production testing. Circle 332 on Reader Service Card.

Thermostat
snap-action device

JAMES KNIGHTS Co., Sandwich, Ill. A positive snap action bi-metal thermostat for highly reliable, long life operation is a principal feature of the new JKO9S series of ovens.

This newly-designed disk type thermostat, combined with the unique thermal-filtering design of the oven proper, retains close temperature control while eliminating the fallibility of previously-used creep-action thermostats.

Ideal for housing quartz crystals, diodes, resistors and capacitors, the new JKO9S series of ovens meets military environmental specifications. Circle 333 on Reader Service Card.

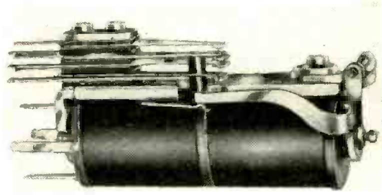
Radiation Counter
rapid response

STANLEY AVIATION CORP., 2500 Dallas St., Denver 8, Colo., has developed a rapid response gamma radiation counter which has a response rate of the order of 10 milli-

CIRCLE 82 READERS SERVICE CARD

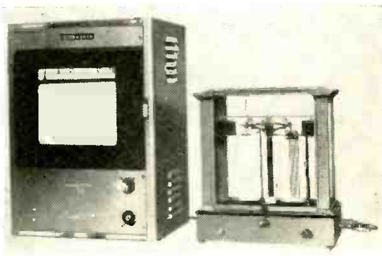
sec or better. Basically the device consists of a scintillation type detector plus associated electronic circuitry which essentially integrates the number of counts over a specified time period to produce a periodic d-c signal whose amplitude is proportional to the radiation intensity.

The precision of the device is strictly a function of the statistical variation in gamma radiation and of the sampling interval. Consequently the accuracy can be improved either by lengthening the sampling interval or by increasing the detector size, thus increasing the sensitivity of the instrument. Circle 334 on Reader Service Card.



Telephone Relay highly sensitive

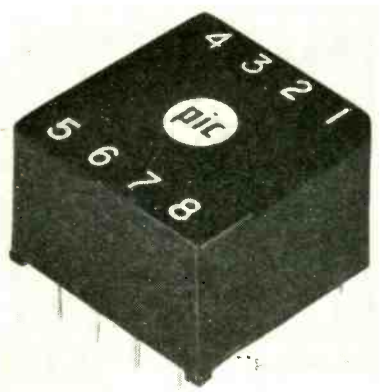
KURMAN ELECTRIC CO., Division of Norbute Corp., 191 Newel St., Brooklyn, N. Y., has available a new, highly sensitive telephone relay called series AS. Features include two microswitches, resistances up to 75,000 ohms and d-c operation. A maximum of 100 milliseconds release delay is available. Circle 335 on Reader Service Card.



Analytical Balance for research uses

WM. AINSWORTH & SONS, INC., 2151 Lawrence, Denver 5, Colorado. An automatic, recording, analytical balance shows instantaneous weight and rate of weight change. Probable applications for the new lab tool are in thermogravimetric analysis, and in investigation of evaporation, absorption, corrosion, oxidation, decomposition and other reactions in which weight-vs-time or weight-vs-temperature (or other factor) is significant. Samples can be placed on the balance pan or suspended in a controlled environment, above or below the balance.

This balance combines the range and accuracy of the analytical balance with a continuous record and automatic operation. Circle 336 on Reader Service Card.



Component Package for printed circuits

Polyphase Instrument Co., East Fourth St., Bridgeport, Pa. Type BA pulse transformer is designed to include all features required for printed circuit applications keeping low cost in mind. Plug-in terminals are arranged on the 0.1 in. multiple grid printed circuit board spacing. The units are keyed for easy insertion with automatic machinery. Four feet provide board clearance and eliminate condensation problems. Epoxy encapsulated PIC standard pulse transformers and toroids in the plastic BA case meet applicable sections of MIL-T-27A and 21038. Overall dimensions are 1 5/8 in. square, 1/2 in. high, 1/4 in. pins. Circle 337 on Reader Service Card.

Precision Pot hermetically sealed

Technology Instrument Corp., 531 Main St., Acton, Mass. The rotary Metlfilm precision potentiometer is hermetically sealed and features super-tested reliability, infinite resolution, very high accuracy, operation at a temperature up to

145 C, low torque and long life exceeding 1,000,000 cycles. The encapsulated deposited metal on film resistance element with a compression contact permits hermetic sealing and the capacity to withstand extreme environmental conditions. Identified as type MFR the pot is available in 1⅝ in. and 2 in. diameter housings. The MFR-1 offers a resistance range of 1K to 25K ohms; and the MFR-2, a range of 1K to 50K ohms. **Circle 338 on Reader Service Card.**

Desk Computer priced at $15,000

Clary Corp., San Gabriel, Calif. Simplicity of operation while performing many of the functions of the giant computers is offered by this new electronic computation system (ECS). Built into a standard desk so that it takes no extra space, the completely transistorized ECS fills the void between the electronic brains and the mechanical calculators. It uses electronic means to perform all basic types of computations.

Figures are entered into the system through the special keyboard the girl is shown working and the computations are performed by an electronic unit stored in the drawer section of the desk. Results are printed automatically on the adding machine-type print unit. **Circle 339 on Reader Service Card.**

Power Supply all-semiconductor

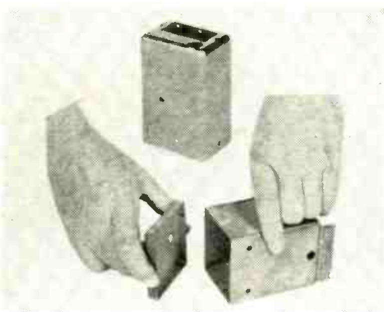
Deltron Inc., P.O. Box 192, Glenside, Pa. Model H3615 transistor power supply is now available. It supplies voltage from 0-36 v d-c at currents from 0-15 amperes at any voltage setting. The all-transistor circuit gives rapid transient response with recovery times less than 100 μsec. Combined line and load regulation is less than ½ percent for changes of load from 0-15 amperes and for line changes from 105-125 v. Output ripple is 3 mv over most of the range, making the unit an ideal replacement for storage batteries and other low ripple d-c sources.

The instrument is 8¾ in. high by 19 in. wide by 14 in. deep, and weighs approximately 50 lb. Circle 340 on Reader Service Card.

Connector for high current

The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif. A 4-pin arrangement in a 19-pin shell is a feature of the company's new DM 9700-194 and DM 9601-194 miniature electrical connector. The four No. 12 size contacts are miniaturized, and each is capable of carrying 40 amperes, continuously with 50-ampere surge.

The connector was designed for use in high current circuits and has a D rating. Envelope drawings are available. Circle 341 on Reader Service Card.

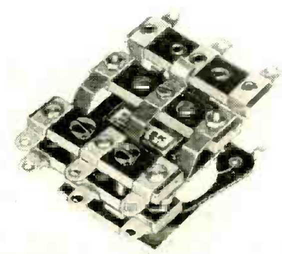


Magnetic Shielding simplifies filtering

Magnetic Shield Div., Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill. A new Netic magnetic shield designed for greater effectiveness in isolating the substantially increased transformer radiation in transistorized power supplies has been announced. Such radiation is more severe in transistorized power supplies because of the considerably higher switching rate than can be accomplished by vibrators.

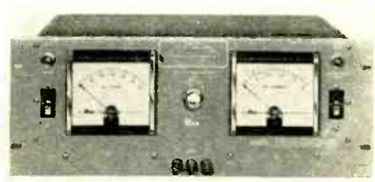
The shield simplifies filtering problems associated with this type of supply, is not retentive, not shock sensitive and does not require periodic annealing.

Shields are available as fabricated cases with covers without tool charge in all sizes. Drawn cases are available with nominal tool charges. Circle 342 on Reader Service Card.



Power Relay 5pdt contacts

KURMAN ELECTRIC Co., Division of Norbute Corp., 191 Newel St., Brooklyn, N. Y. Series 26 power relay is designed for 400 cycle operation. Features include 5 pdt contacts, 125 C operation, high voltage breakdown. The relays are available in both open and hermetically sealed versions. A complete catalog of all types of relays is available from the manufacturer. Circle 343 on Reader Service Card.

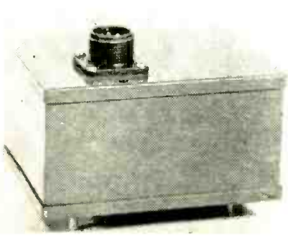


Power Supply transistorized

HARRISON LABORATORIES, INC., 45 Industrial Road, Berkeley Heights, N. J., announces a new rack-mounted, continuously variable power supply delivering from 0 to 60 v at 0 to 7.5 amperes. Model 810-A measures 19 in. wide by 7 in. high by 14½ in. deep, is fully transistorized, and provides the high regulation at any output voltage of less than 0.05 v output change from no load to the full 7.5 amperes. A low d-c internal impedance of less than 0.007 ohm suits the new unit particularly to uses in today's complex circuit problems. It has a ripple of 7 mv rms. Overload and short circuit protection are provided by magnetically-operated circuit breakers. Price of the unit is $895. Circle 344 on Reader Service Card.

Radiator for transistors

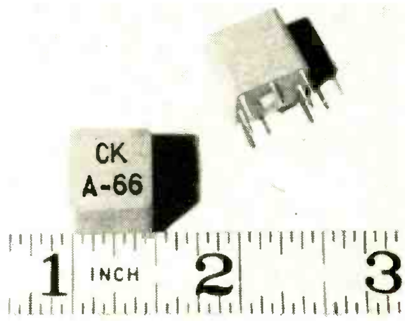
The Birtcher Corp., 4371 Valley Blvd., Los Angeles 32, Calif. A new radiator to fit the JETEC-30 package has been put into production. Material of the finned jacket is black anodized aluminum alloy and is so designed as to press fit over the transistor case without interfering with operation or servicing. Designated heat radiator 3AL-635, the radiator maintains a dissipation coefficient 0.28C/mw. Circle 345 on Reader Service Card.



Frequency Detectors compact package

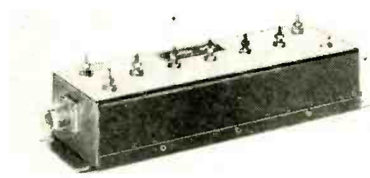
Waugh Engineering Co., 7842 Burnet Ave., Van Nuys, Calif. The FD-100 series frequency detectors provide instantaneous cut-off when the speed of rotating devices exceeds a preselected value. Input signal to the unit is obtained from an a-c tachometer generator or magnetic pick-off coil. The detectors may also be used with turbine flow sensors to provide an alarm or cut-off at preselected flow rates.

Response time within 10 millisec, as well as high reliability, is achieved through the use of transistor switching to control the output current. **Circle 346 on Reader Service Card.**



Shift Register
extremely small

CK Components, Inc., 101 Morse St., Newton 58, Mass., has developed a subminiature magnetic shift register only ½ in. cube in size. These A-66 units may now be had in production quantities and are claimed to be the smallest commercially available. The units go from 0 to 95 kc. They have low peak power and wide tolerance on the width and amplitude of the advance pulse. **Circle 347 on Reader Service Card.**



Band-Pass Filter
high discrimination

Benco Television Associates Ltd., 27 Taber Road, Rexdale, Ontario, Canada. Model BPF band-pass filter incorporates a multi-stage Hi-Q filter and two Hi-Q bridged T traps. Total attenuation is in excess of 80 db on the trap frequencies. The unit is capable of providing very high discrimination between wanted and unwanted channels, according to the manufacturer. **Circle 348 on Reader Service Card.**

Literature of

MATERIALS

Plastics For Electronics. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass., has published a four-page short form catalog giving brief descriptions of many of the various materials available in their lines of Eccosorb microwave absorbers, Stycast casting resins, Eccofoam plastic foams, Eccostock plastic rods and sheets, Ecco reflectors and Ecco Luneberg lenses, Eccocoat plastic surface coatings, Eccobond adhesives, cements and sealants, Eccoseal impregnating resins, and Eccomold laminating resins. **Circle 349 on Reader Service Card.**

COMPONENTS

Permanent Magnets. Thomas & Skinner, Inc., 1122 East 23rd St., Indianapolis 7, Ind. Bulletin No. 158, entitled "Permanent Magnet Design," covers such subjects as permanent magnet applications, fundamental properties, design problems, magnet testing, magnetic attraction, mechanical considerations and stabilization and magnetization of finished magnets. The bulletin is illustrated both pictorially and with curves. **Circle 350 on Reader Service Card.**

Rotary Selector Switches. Micro Switch, a Division of Minneapolis Honeywell Regulator Co., Freeport, Ill. Covering the company's complete standard line of rotary selector switches, an expanded four-page data sheet now includes information on the new sealed subminiature assemblies and a V3 version which is available with as many as 20 basic switching units. **Circle 351 on Reader Service Card.**

Waveguide Components. Microwave Associates, Inc., Burlington, Mass. A new 48-page catalog describes in detail more than 300 different types of microwave waveguide components, test equipment and pressure windows. Photographs of each product type are

the Week

included. Circle 352 on Reader Service Card.

EQUIPMENT

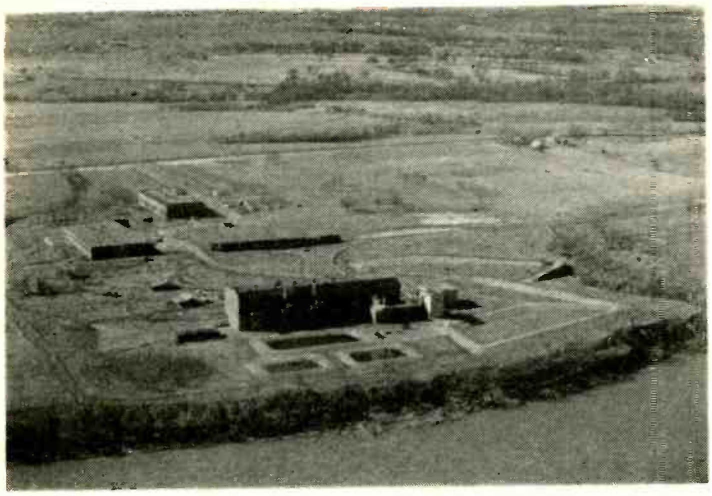
Crest Voltmeter. Sensitive Research Instrument Corp., 310 Main St., New Rochelle, N.Y. A recent issue of *Electrical Measurements* shows "the why and how" of measurement of peak voltages. Specifications and price for the model CRV crest voltmeter are included. Circle 353 on Reader Service Card.

Total Temperature Probe. Rosemount Engineering Co., 9424 Lyndale Ave. So., Minneapolis 20, Minn. A four-page brochure illustrates and describes the 103 total temperature probe which features high accuracy and small size, with capability to Mach 5 at extremely high altitudes. Circle 354 on Reader Service Card.

Tubeless Power Supplies. Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn. A new product data sheet describes three low-cost T-Nobatron tubeless power supplies, recommended for use in the development and testing of transistor circuits or for other applications within their voltage ranges, such as relay testing and computer circuitry development. Circle 355 on Reader Service Card.

FACILITIES

Mass Moment of Inertia. Technology Instrument Corp. of California, 7229 Atoll Ave., N. Hollywood, Calif. Technical bulletin No. 20 provides: (1) a table to supply data pertaining to mass moment of inertia for the company's standard line of precision potentiometers, and (2) description of an experimental method to serve as a guide in the compilation of mass moment of inertia of other related components within a system. Circle 356 on Reader Service Card.



New Tantalum Facility Opens

THE NEW $6,500,000 Fansteel Metallurgical Corp. tantalum-columbium plant near Muskogee, Okla. is now in operation.

The plant (picture) is situated on 113 acres on the west bank of the Arkansas River, comprises four building units with approximately 95,000 sq ft of floor space, and a group of outdoor tanks for storage of liquid reagent chemicals.

Cost of the plant and equipment was financed through the sale of $3,000,000 in convertible subordinated debentures. Financing was entirely private.

"Since operations began at Muskogee," says Frank H. Driggs, president, "the delivery of tantalum has been improving almost daily. Tantalum in most mill forms will soon be available in stock."

Glen Ramsey, vice president and general manager of the firm's rectifier-capacitor div, says there is sufficient tantalum available for 11 times as many capacitors as were produced in the United States in 1957.

Tantalum and columbium ingots from the Muskogee plant are added to those produced at North Chicago and are processed into sheet, foil, rod, wire, tubing and a large variety of fabricated parts and products for industry. This includes acid proof tantalum process equipment for the chemical industry.

Columbium is being used in some types of nuclear reactors. Experimental work is being done on columbian alloys for resistance to corrosion and high temperature.

A feature of the new operation is the control center, where steps in the processes are operated and observed by push-button switches, indicator lamps, control and recording instruments.

Although its melting point is approximately 5400 F, tantalum is malleable and ductile. All rolling, stamping, forming and deep drawing are done cold.

Kalbfell Named Cubic Consultant

CUBIC CORP., San Diego, Calif., appoints David C. Kalbfell (picture) as staff consultant in connection with the company's expansion into airborne telemetry systems. He has been a consultant for Lockheed Missile Division, Convair Astronautics Division, Ampex Corp., and several other companies.

Kalbfell is now president of Kalbfell Electronix and was the founder of Kalbfell Laboratories, Inc. (now called Kin Tel).

Duncan Takes New Post at GE

APPOINTMENT of M. R. Duncan (picture) as manager of product service and marketing administration in GE's technical products department at Syracuse, N. Y., is announced. He had been manager of service engineering.

In his new position, Duncan will be responsible for market research and administration, inventory control, product scheduling, commercial service and headquarters and field service engineering.

Motorola Ups MacDonald

NEW director of engineering at Motorola's Chicago Military Electronics Center and the company's Communications and Industrial Electronics Division is Angus MacDonald. The move is one to implement engineering liaison between the two groups.

MacDonald has been with Motorola since 1953, starting as an

GOOD-ALL
CAPACITORS

...KNOWN AND RESPECTED THROUGHOUT THE INDUSTRY

Three HEADLINERS from a broad line of fine quality capacitors

GOOD-ALL Type 600-UE
Mylar* Dielectric...Molded In Epoxy

A general-purpose tubular of extraordinary performance. Priced in the same range as molded paper designs, but a stand-out in stability and resistance to humidity.

SPECIFICATIONS

Dielectric	Mylar Film	**Temp. Range**	−55 to +125°C
Case	Epoxy	**IR at 25°C**	100,000 Meg. x Mfd.
Voltage Range	100–1600	**Power Factor**	0.6% Max.

GOOD-ALL Types 616-G and 617-G
Sub-Miniature Metal Enclosed Mylar* Designs

Designed to provide EXTENDED LIFE at high temperatures. Rugged, military construction throughout. These lines include a 50-volt series for transistor applications.

SPECIFICATIONS			
Dielectric	Mylar Film	**Temp. Range**	Full rating to 125°C, 50% derrating at 150°C
Case	Hermetically Sealed	**D.C. Voltage Rating**	50, 100, 400 and 600
Winding	Extended Foil		

*DuPont's trademark for polyester film.

Good-All EPOXY Coated Ceramic DISCS

Something really new! The tough, durable Epoxy coating provides excellent moisture resistance and high voltage breakdown strength. The lead entries are tightly sealed.

TYPES AVAILABLE			
Temperature Compensating	Type A	**AC Line By-Pass**	Type D
By-Pass	Type B	**Highly Stable**	Types E & EE
Dual Shielded	Type C	**High Voltage**	Type G
		Transistor	Type H

Immediate Delivery on Standard Items.

Return inquiry card in back of magazine, and detailed brochures on the above capacitor types will be mailed to you promptly.

Soon in stock at your local distributor.

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engineering staff assistant. He has also served as chief engineer for two-way and mobile equipment. Before his association with Motorola, he was with the Westinghouse Electric Corp. as a section manager, commercial communications.

IBM Executive Heads Up FIER

CUTHBERT C. HURD (picture), director of automation research for IBM Corp., has been elected president of the board of trustees of the Foundation for Instrumentation Education and Research. FIER is a non-profit organization for stimulating, guiding and supporting programs of education and fundamental research in the field of instrumentation and automatic control. Hurd is also chairman of the foundation's development and policy committee.

MM&M Division Moves

THE Industrial Controls Division of Manning, Maxwell & Moore, Inc., manufacturer of electronic instruments for measurement, transmission and control of process variables, has moved its offices and manufacturing facilities from the company's Stratford, Conn., plant to a new plant (pictured on p 126) in Danbury, Conn.

The new plant makes available over 50,000 sq ft of space on a 13-acre site. A one-story design and arranged for straight-line production, the building permits for future expansion.

The company plans to use the space vacated in the Stratford plant by the Industrial Controls Division for its Nuclear Components Department which manufactures products for the nuclear energy field.

Erie Resistor Names Shioleno

In Erie, Pa., Lewis J. Shioleno (picture) is appointed general manager of the electronics division of Erie Resistor Corp. Prior to his appointment, Shioleno was superintendent of manufacturing for the electro-mechanical division. His new duties-encompass all responsibility for sales, engineering and production for the electronics division.

Bayle Takes New Position

Appointment of Andrew C. Bayle as director of engineering of the Waltham Precision Instrument Co. (formerly the Waltham Watch Co.), Waltham, Mass., is announced. In his new position, he will be in complete charge of engineering, and also head up the research and development activities of Waltham.

Prior to his present affiliation, Bayle was assistant to the president of Vectron, Inc., and on its board of directors. Earlier he was chief engineer of the Doelcam Corp. During the war, he served as a research engineer at MIT.

Executive Moves

H. J. Hannon, an executive of Sterling Precision Corp., Flushing, N. Y., for over two years, is appointed general sales and contract manager of Sterling Precision Instrument Division.

Walter E. Sutter, district microwave sales manager, General Electric, Redwood City, Calif., is named national microwave sales manager for GE's communication products department, with headquarters in Syracuse, N. Y.

News of Reps

MECHATROL Division of Servomechanisms, Inc., Westbury, L. I., N. Y., will have its electromechanical components sales handled by **W. A. Brown and Associates**, Indian River City, Florida.

Hermetic Seal Corp., Newark, N. J., appoints **Pacific Electro-Sales** as rep for Hermetic-Pacific Corp., Rosemead, Calif., its west coast division. **Fred Falk** of Pacific Electro-Sales will service the San Diego area.

Bendix Pacific Division's Electro-Span digital supervisory control systems will be sold by **The Ray Welch Co.** in northern Illinois and Indiana; by **J. A. Halpine & Son**, in the Oklahoma, Kansas and Missouri area.

Hunter & Salsbury Inc. are appointed reps for Dial Products Co., Bayonne, N. J. They are covering the Metropolitan New York-New Jersey territory for Dial's line of magnetic clutches and brakes and also flexible couplers.

NEW BOOKS

Engineering Electronics

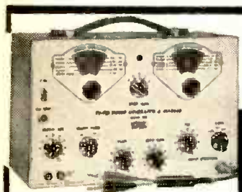
By J. D. Ryder
McGraw-Hill Book Co., Inc.,
New York, 1957, 655 p, $9.50.

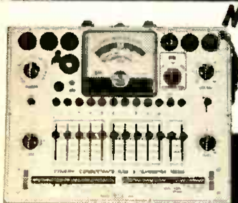
The field of applied electronics has engendered an impressive series of omnibus books which have dealt with these applications as each author viewed them. This latest member of the series, which is probably more highly concentrated than any of its predecessors, covers a somewhat special selection of topics reflecting the trends in modern practice. In more relaxed times, when books of this kind had a much smaller field to cover, it was feasible to treat the various topics to a reasonable depth. Consequently, they were written primarily as textbooks for required undergraduate courses in electrical engineering.

As the tempo of our times has accelerated, books presenting applications of electronic circuits have, through necessity, had to deal more and more tersely with each separate area, and to rely less upon convincing analytical developments and more on unsupported statements beginning familiarly, "It can be shown. . . ." For these reasons a greater measure of responsibility rests upon the author in the selection of appropriate material, its sequential arrangement, and the presentation of his facts with impeccable truth.

Source-Book—Although the jacket flap suggests that the book is written for a senior-level college course, it is difficult to visualize the kind of course that would develop around so highly-distilled and encyclopedic a digest. With educators turning strongly toward the treatment of basic ideas in depth to the neglect of particular applications, this kind of book seems destined to play the role of a reference work. As such it is a rich source-book of today's practice which should prove not only to be valuable, but interesting as well, to students and practicing engineers alike.

Topical Coverage—The main theme of the book is electron-tube circuits; the emphasis is on the field of control, with applications to the communications field de-





liberately played down. After a short introductory chapter, six rather conventional chapters cover physical phenomena in electron tubes, vacuum-tubes as circuit elements, small-signal and low-pass vacuum-tube power amplifiers and finally, feedback amplifiers.

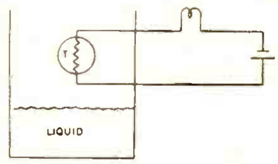
The next two chapters are both interesting and timely. The first surveys modern direct-coupled amplifier practice, including such matters as chopper stabilization; with this background, the discussion goes on to various aspects of analog simulation and computation. Also included in this chapter is an unexpected section devoted to Lagrange's formulation. The second chapter of this group develops wave forming circuits and leads logically into digital computation ideas. Many fine photographs of oscilloscope traces appear throughout the book and are employed to excellent advantage in this particular chapter.

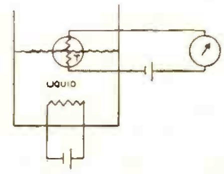
Industrial Applications—The remaining chapters reflect a greater emphasis on industrial applications. A chapter on conventional vacuum-tube power supplies and filters (a good part of which might have been omitted) is followed by a meaty chapter on r-f tuned amplifiers and oscillators and their application to high-frequency heating. A second unexpected inclusion is the theoretical background of skin effect and its relation to induction-heating design, based upon Maxwell's electromagnetic field equations.

Chapter 12, which is entitled "Semiconductors; Transistors" starts out with an outline of semiconductor physics as preparation for the formulation of models of transistors. A sketch of the network formulations of two-port networks introduces circuit models and their analysis. The chapter concludes with a varied selection of transistor circuits.

Chapters 13 through 18 are concerned principally with various aspects of control and control devices. The topics include photoelectric devices, power rectification, control and inversion, relays, timers, welding and motor controls and finally, servomechanisms.

General Comment—The book is





well organized and is easy to read. The material has been skillfully digested and for the most part, the relevant and important matters have been separated successfully from the chaff. Although there are some sections that appear to be rehashes, the greater part of the work represents new writing that is crisp and reflects an up-to-date viewpoint.

There are some weaknesses in subject matter and in presentation. Of the former, the most important is the heavy emphasis on electron tubes in an era in which the transistor has already preempted the field. The latter point is conspicuous in the important area of feedback. An early and undistinguished chapter presents the conventional material on feedback amplifiers.

In the final chapter on servomechanisms, there is a noticeable lack of correlation in the analyses of these closely-related systems. The material on control-system stability, which seems to wander somewhat aimlessly might have been brought into sharp focus with the benefit of root-locus techniques.

Despite these weaknesses, which are perhaps inevitable in such an ambitious survey, the book creates a favorable impression of presenting, with a good deal of realism, a cross-section of the role of electronics in the more progressive areas of the present state of the art.—W. A. LYNCH, *Prof. of Elec. Eng., Polytechnic Institute of Brooklyn, Brooklyn, N. Y.*

THUMBNAIL REVIEWS

Auto Radio Removal—1956. Howard W. Sams & Co., Inc., Indianapolis, Ind., 1957, 104 p, $2.95. Step-by-step instructions for the removal of radios, power supplies and speakers from 1956 automobiles.

Atomic Power—An Appraisal. Edited by Corbin Allardice, Pergamon Press, New York, 1957, 151 p, $3.50. Collection of remarks by panelists of Eleventh Annual Meeting of the Board of Governors of the International Bank for Reconstruction and Development.

Tape Recorder Manual, Vol. 1. Howard W. Sams & Co., Inc., Indianapolis, Inc., 1958, 148 p, $2.95. Complete servicing information on seven basic tape recorder chassis and two tape players produced in 1956 and 1957.

COMMENT

Eye Movement

I write to you about . . . "Detector Plots Eye Movement" (Jan. 31, p 36) . . .

I must . . . ask you to print a short note . . . to cover the matter of the title, the address and the possible imputation to us of scientific inaccuracy and misrepresentation in reporting our work.

B. SHACKEL
EMI ELECTRONICS LTD.
PSYCHOLOGICAL RESEARCH LABORATORY
HAYES, MIDDLESEX, ENGLAND

Author Shackel's article was originally submitted with the title "An Eye-Movement Measuring Apparatus". The authors' address is as shown above. The potential difference between front and back of eyeball was given in the summary as 10 to 40 μv instead of 5 to 10 mv; Fig. 1 when redrawn was not made precisely to follow the original pen trace; in Table I, what should have been the value "1 mv" appeared in four places as "1μv"; in Fig. 3, the second input lead is shown running to ground instead of to the input socket.

Speaking of Gravity

An atomic or aerodynamic model of the fundamental particles and the ether throws an interesting light on the high-velocity radiation of light by electrons in a synchrotron. We might say that the electrons create a "Mach I sonic shock-wave" in the ether fluid which shows up as a viscosity turbulence-drag increase in mass and results in the generation of a light shock-wave.

The astronomical red shift may be a simple lowering of frequency in feeble electromagnetic waves traveling over vast distances through the ether fluid. The gravitational bending of starlight passing close to the sun may be a simple diffraction effect in this medium. Apparent gradual small changes in the measured velocity of light may be changes in ether density.

Schrodinger's wave-mechanics atom model may be Bohr's particle model modified by an ether turbulence and standing-wave effect produced by the spinning particles. The Michelson-Morley light-velocity experiment might have been nullified by a planetary "ether-drag" effect. The duality of light's nature may be due to the interaction of atomic structure particles and a subcorpuscular ether.

Such an ether and particle model may point to a better understanding of magnetism and gravity, and to a possible escape from the mathematical conjectures of the Einsteinian relativistic maze.

TED POWELL

GREAT NECK, N. Y.

Reader Powell's conjectures are fascinating. However, Michelson and Morley made their experiment for the precise reason that they wished to determine whether or not the velocity of light underwent any change as a result of possible "ether drag" of the type mentioned in the letter above. Their results—with an admitted possibility of error due to imprecise instrumentation—said there was no such drag.

We understand that there will soon be an experiment to check the Michelson-Morley experiment. This one will be capable of measurements about an order of magnitude more precise than M&M's. Perhaps then we'll see.

Air Plan

The article ("Air Plan Means More Business," Jan. 17, p 8) describes a contract for data processing and display which the Airways Modernization Board plans to let to a team of contractors headed by General Precision Labs. The fourth paragraph of this article concludes with the sentence "Subcontractors associated with GPL are Link Aviation and Librascope . . . and Pasker Instrument." The correct name for our company is Tasker Instruments Corporation.

Our company will share with General Precision Lab the responsibility of developing a data processing and display system. GPL will work with the enroute portion of the problem while Tasker Instruments will handle the terminal area portion.

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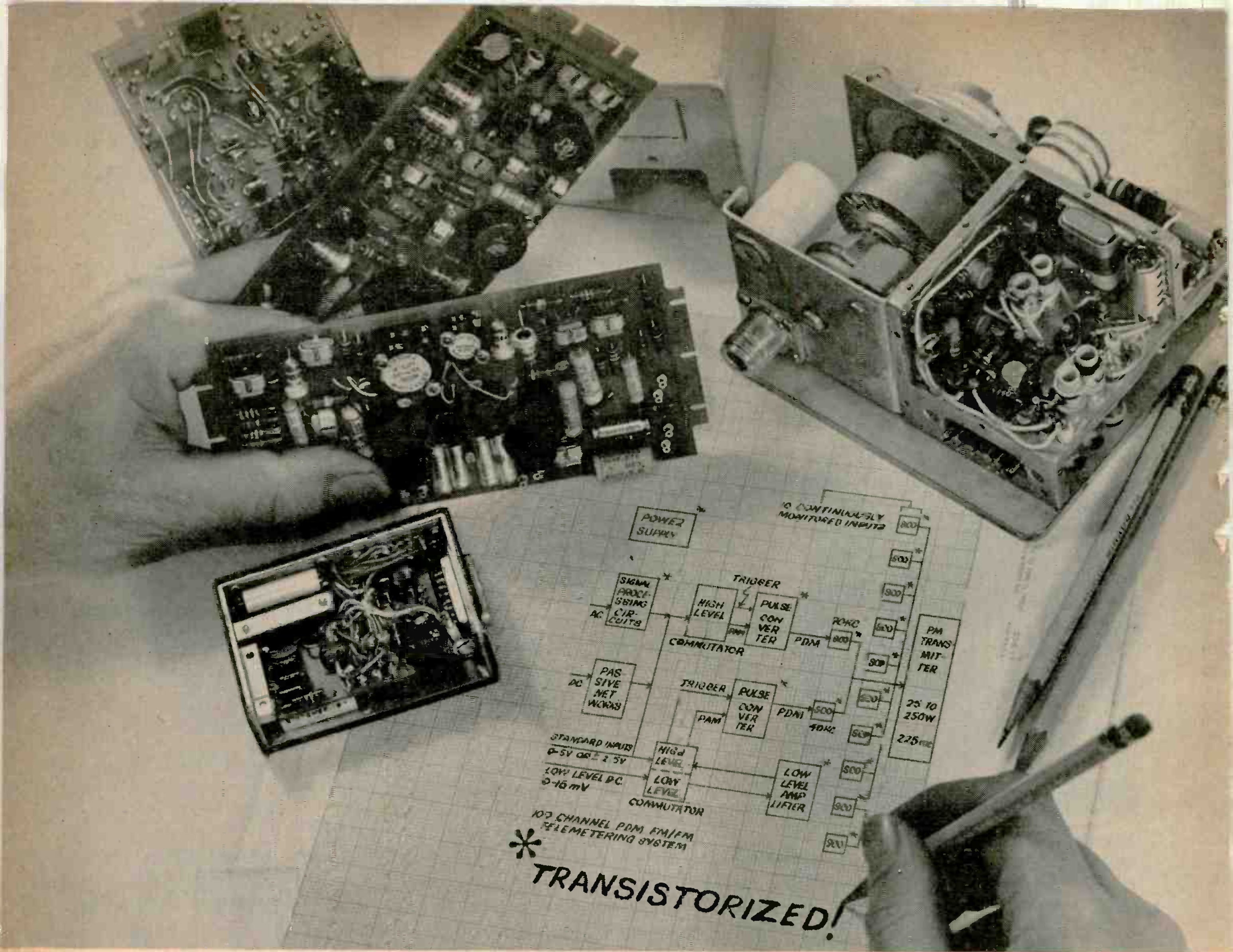

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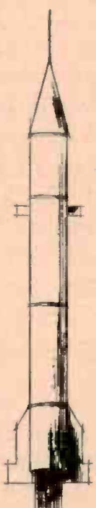

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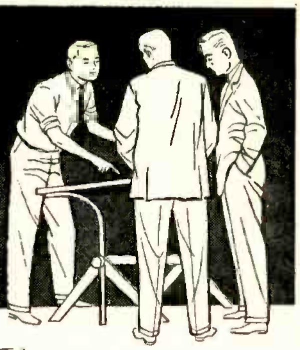

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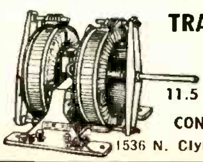

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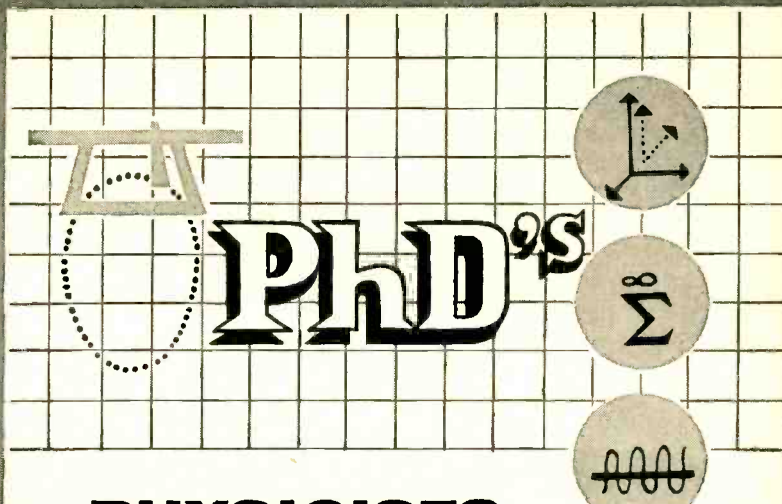

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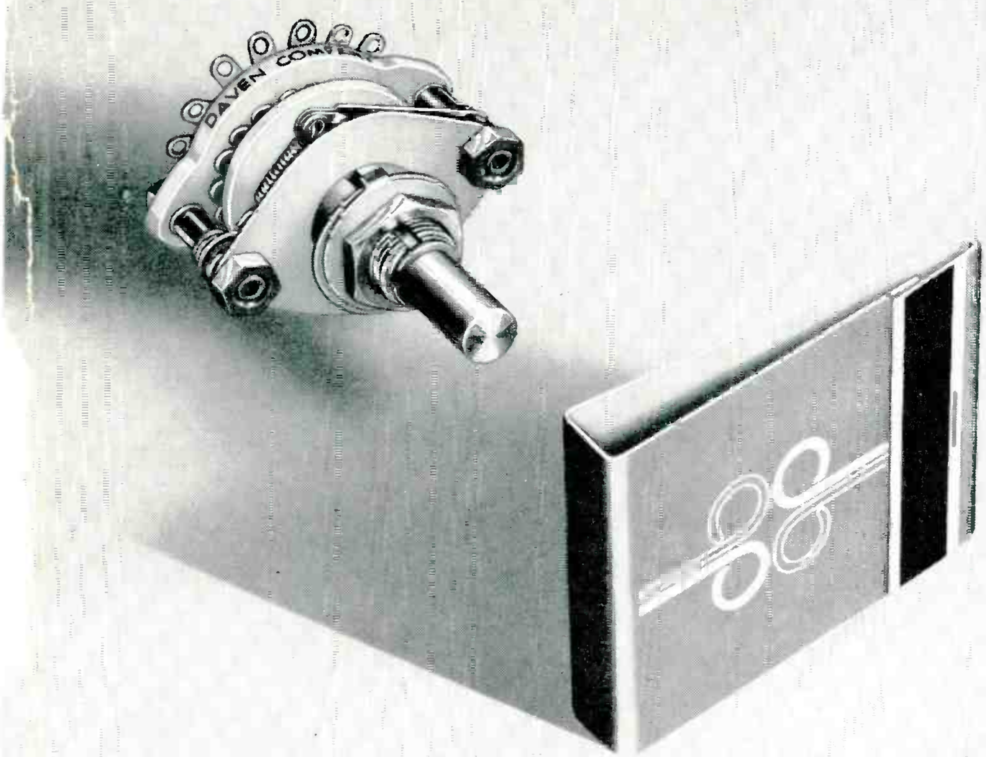

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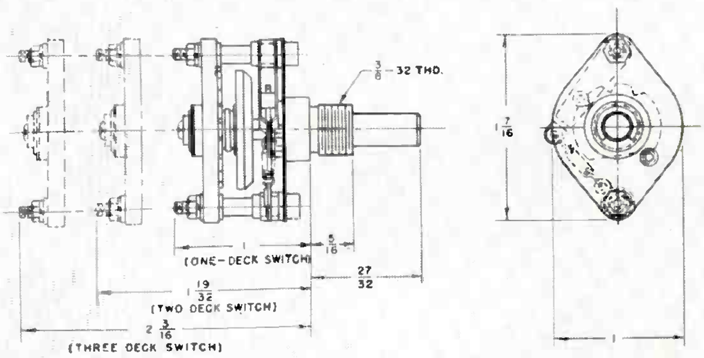

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