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MARCH 14, 1958

electronics

engineering edition

Etched Amplifier for Color Tv

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IRE Program and Show Guide

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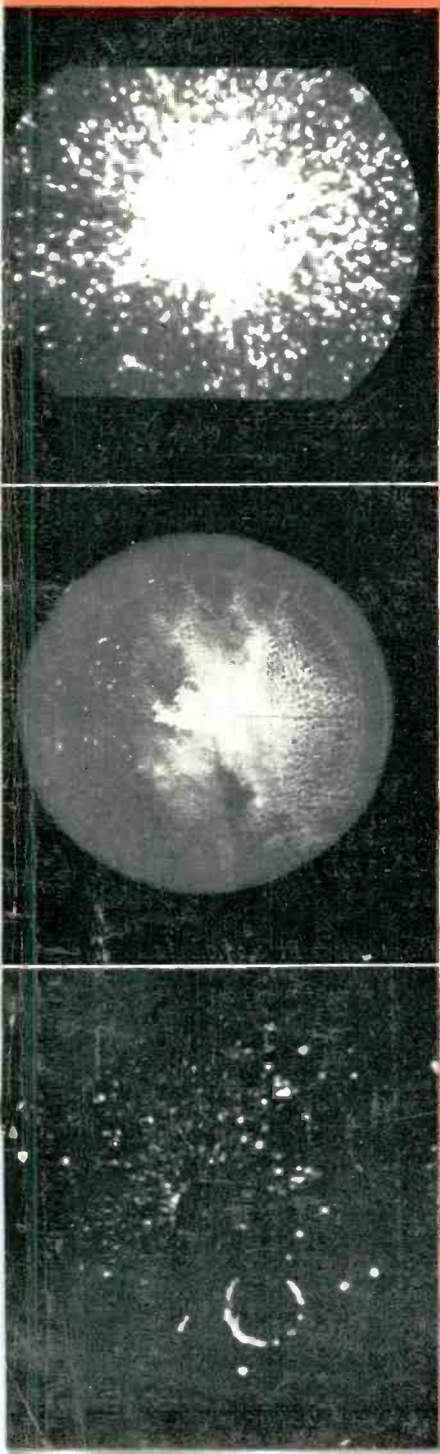

Hunting Radar "Angels" . . . p 140

electronics engineering edition

A McGRAW-HILL PUBLICATION • VOL. 31, NO. 11 • MAR. 14, 1958

ISSUE AT A GLANCE

Hunting Radar "Angels". Scientists at Air Force Cambridge Research Center look for anomalous returns on radar ppi. Examples at left show several kinds of so-called radar angels that have been received and identified .... COVER

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electronics

March 14, 1958 Vol. 31, No. 11

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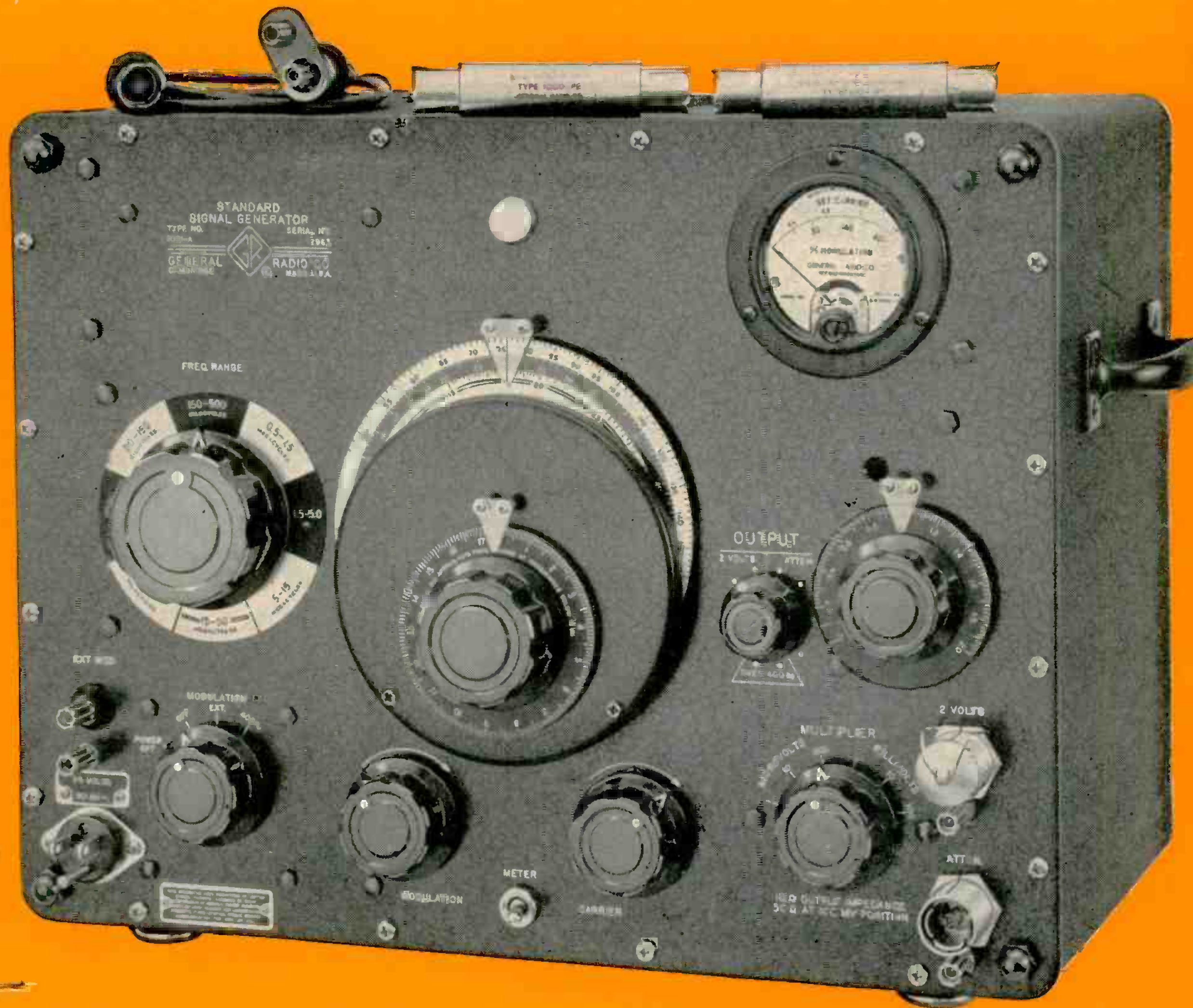

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Output Impedance: Attenuator Jack: 10 Ω except for highest attenuator position where impedance is 50 Ω; 50 Ω when 40 Ω Series Unit is used. 25 Ω at end of Terminated Cable.
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Output Voltage Accuracy: Below 10 Mc: ±(6% + 0.1 μv) with output dial near full scale.
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At 2-VOLTS Jack: ±3% to 15 Mc.

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Incidental Frequency Modulation: No more than 30 to 300 ppm over most of range at 80% a-m; proportionately less at lower modulation percentages.

Carrier Noise Level: Corresponds to about 0.1% modulation.

Leakage: Stray fields at 1 Mc are less than 1 μv per meter, two feet from generator.

Servicing Feature: Oscillator section plugs into shielded compartment and is easily removed for operation outside the cabinet, making servicing particularly easy.

Accessories Supplied: Double-shielded coaxial cable with G-R 874 Connectors, 50 Ω Termination Unit, 40 Ω Series Unit, 874 Adaptor to banana plug, extra cable and panel connectors, spare fuses, and power cord.

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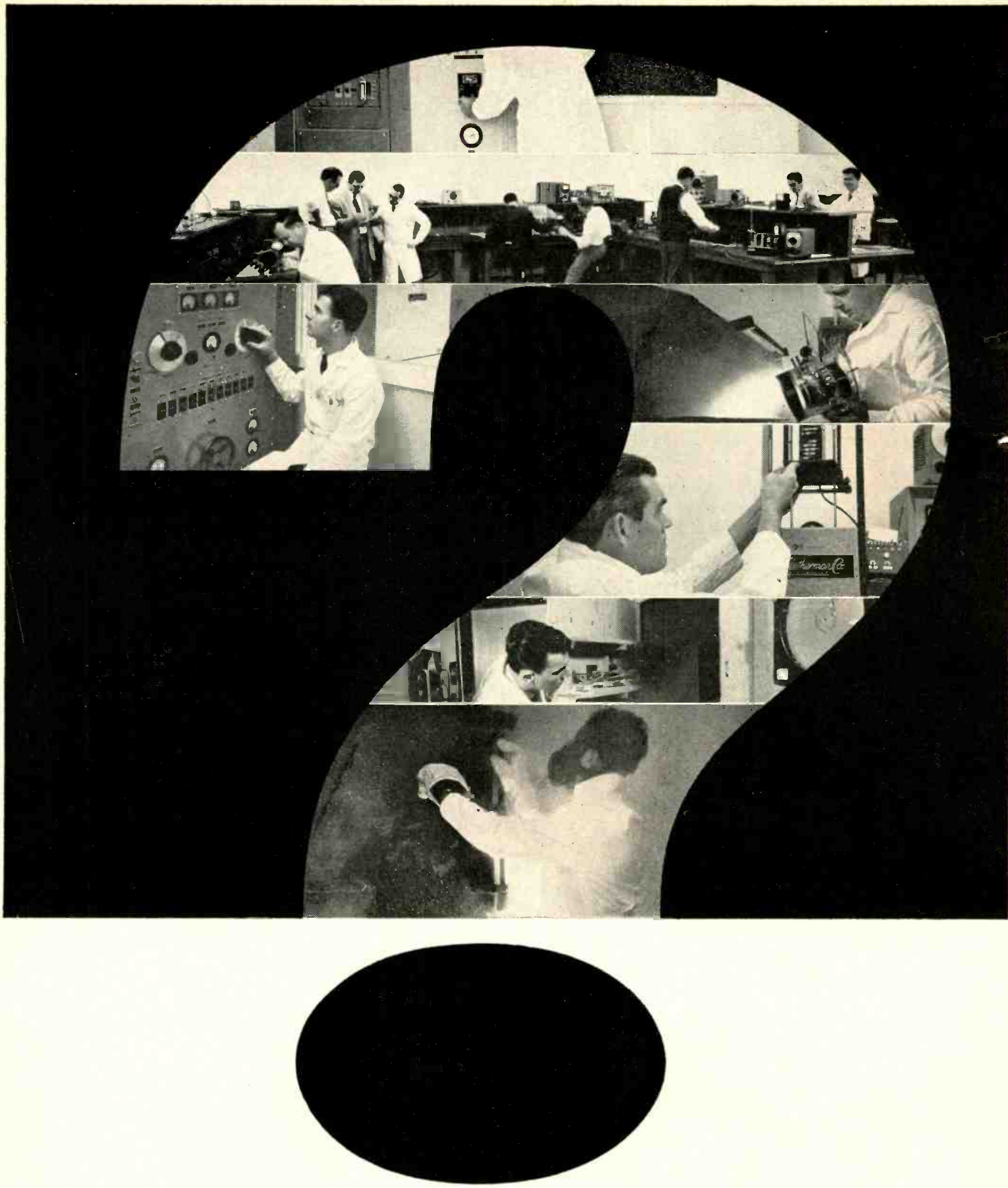

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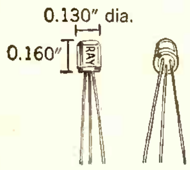

These new Raytheon Submin Transistors have one-fourteenth the volume of the JETEC-30 package.

COMPUTER TRANSISTORS
Temperature Range −65°C to +85°C

SUBMIN Type	JETEC-30 Electrical Equivalent	V_{CE} max. volts	$f_{\alpha b}$ ave. Mc	H_{FE_1} ave. $I_B = 1$ ma $V_{CE} = -0.25V$	H_{FE_2} ave. $I_B = 10$ ma $V_{CE} = -0.35V$	Rise Time* max. μsec
CK25	2N425	−20	4	30	18	1.0
CK26	2N426	−18	6	40	24	0.55
CK27	2N427	−15	11	55	30	0.44
CK28	2N428	−12	17	80	40	0.33

*I_C — 50 ma; I_{B_1} = 5 ma; R_L = 200 Ω; I_{B_2} = 5 ma; Grounded Emitter Circuit

GENERAL PURPOSE AUDIO TRANSISTORS
Temperature Range −65°C to +85°C

SUBMIN Type	JETEC-30 Electrical Equivalent	V_{CE} max. volts	Beta ave. small signal	Power Gain Class A ave. db	I_{co} ave. μa	Noise Factor ave. db
CK22	2N422	−20	90	40	6	6 max.
CK64	2N464	−40	22	40	6	12
CK65	2N465	−30	45	42	6	12
CK66	2N466	−20	90	44	6	12
CK67	2N467	−15	180	45	6	12

GENERAL PURPOSE RADIO FREQUENCY TRANSISTORS
Temperature Range −65°C to +85°C

SUBMIN Type	JETEC-30 Electrical Equivalent	V_{CE} max. volts	$f_{\alpha b}$ ave. Mc	Beta ave.	C_{ob} ave. $\mu\mu f$	r_b'' ave. ohms
CK13	2N413	−18	2.5	25	12	70
CK14	2N414	−15	6	40	12	80
CK16	2N416	−12	10	60	12	90
CK17	2N417	−10	20	80	12	100

Dissipation Coefficients for all submin types: in air, 0.75°C/mW; infinite sink, 0.35°C/mW

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ELECTRONICS NEWSLETTER

SUPPLEMENTARY DEFENSE APPROPRIATION to be requested by the Pentagon for the 1959 fiscal year may add up to more than $2 billion. Assistants working on the new request say it may go higher than the $1.3 to $1.7 billion range estimated recently by Secretary McElroy before the Senate preparedness subcommittee. McElroy indicated the total military appropriation would amount to at least $40.9 billion, and possibly to $41.4 billion.

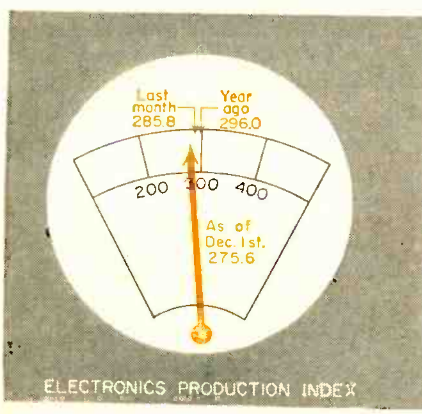
Generally, the additional money will go for ballistic missiles like the Polaris, space projects and continuation of B-52 production into 1960.

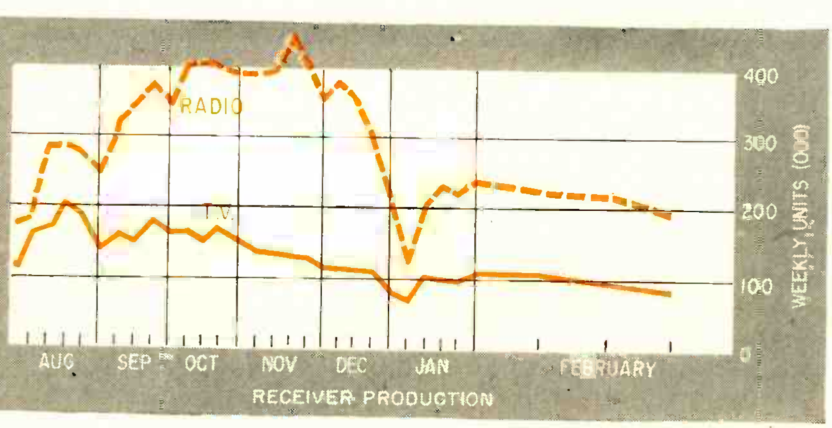
ELECTRON BEAM FURNACE for a new melting and metal casting process has been proved on a pilot scale by Stauffer Chemical Co., Mallory-Sharon Metals Corp. and Temescal Metallurgical Corp., the firms that developed it (ELECTRONICS, Jan. 10, p 22). Bombardment by electrons in a high vacuum melts chemically active materials with high melting points. A dozen special metals have already been melted, purified and cast in water-cooled crucibles without contamination.

Economics of electron bombardment melting look favorable at present, says Stauffer, because high voltage d-c electrons are relatively cheap, power efficiencies high. Purification of columbian requires about 3-4 kwh per pound, tantalum about 6-8 kwh per pound. This compares with 500 kwh per pound used in the solid state sintering of tantalum.

ELECTRICIANS' UNION PUSHES ELECTRONICS TRAINING for members. California State Association of Electrical Workers recommends that apprenticeship of an electrician be extended from four to five years to train him in installation of electronic equipment. Union says electronics work has jumped 20 percent in the last three years, and more is expected in both commercial and residential construction. A check of one New York City local reveals that a "preliminary program to get members interested in electronics" has been underway for four months, and that optional evening sessions are so popular the program may be expanded.

NEW USAF SOLID FUEL BALLISTIC MISSILE of 500-5,500 mi range has been approved for development in 4-5 years by Guided Missiles Director Holaday. Missile is part of Minute Man project which envisages underground launching facilities. Improved ICBM nose cone may mean on-target delivery of large warheads will be possible at faster than present planning of 10-15,000 mph.





FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	Feb. 21, '58	Feb. 14, '58	Feb. 22, '57
Television sets, total	86,903	98,841	117,891
Radio sets, total	192,460	211,545	344,507
Auto sets	70,792	68,874	131,108

STOCK PRICE AVERAGES

(Source: Standard & Poor's)	Feb. 26, '58	Feb. 19, '58	Feb. 27, '57
Radio-tv & electronics	45.34	46.49	46.25
Radio broadcasters	55.37	57.40	62.05

FIGURES OF THE YEAR

Totals for year

	1957	1956	Percent Change
Receiving tube sales	456,424,000	464,186,000	− 1.7
Transistor production	28,738,000	12,840,000	+123.8
Cathode-ray tube sales	9,721,008	10,987,021	− 11.5
Television set production	6,399,345	7,387,029	− 13.4
Radio set production	15,427,738	13,981,800	+ 10.3
TV set sales	6,560,220	6,804,756	− 3.6
Radio set sales (excl. auto)	9,721,285	8,332,077	+ 16.7

LATEST MONTHLY FIGURES NEXT PAGE

In New York's Coliseum 20,000 items will be exhibited four days for electronics industry members as . . .

IRE Show Probes Future

More than 50,000 engineers due at New York City convention week from Monday. Three new sessions, industry optimism among highlights

A LOOK INTO THE FUTURE, three new sessions, and electronics industry optimism despite recession talk will be highlights of the 1958 IRE National Convention and Radio Engineering Show starting a week from Monday in New York City.

Among the forward looking sessions will be those on thermonuclear power, electronics in space, automation systems and the impact of electronics on industry.

The world's greatest assembly of technical ideas and products unfolds March 24-27 in the Coliseum. Three sessions will be held for the first time. They will be on radio frequency interference, education, and engineering writing and speech, reflecting recent establishment of IRE groups in these fields.

Overall attendance is expected to be a few thousand over last year's record attendance. Some 850 firms will exhibit 20,000 items worth about $12 million. Exhibitors will represent about 80 percent of the electronics industry's total production capacity.

ELECTRONICS checked and found some exhibitors were running right to the wire on prototype production and testing of new products. Others were awaiting permission to show prestige-building military gear.

From coast to coast electronic engineers and salespeople are now entering two of the year's busiest weeks.

Component, materials, subsystem and production equipment firms are turning out en masse for the show, but there will be fewer big systems shown this year. The emphasis is on products that can be sold in the trade.

Exhibitors report their commercial business has been picking up nicely, the heat generated by the Sputniks has warmed up military business.

The theme of the show—"That New Idea"—is being carried over from last year. The show management feels that it will be more effective as a promotion idea in its second year. New products will be identified by a show sticker and booth staffs will be wearing "New Idea" buttons.

The Radio Engineering Show will again occupy all four floors of the Coliseum: systems on the first floor; components, second and third floors; instruments, third floor; and production gear, fourth.

The technical program, 275 papers in 55 sessions at the Coliseum and Waldorf-Astoria, is the same length as last year. That's just about all that can be squeezed into four days. (See complete program, exhibitor list and booth numbers on p 270).

Presentations were organized by representatives of the IRE's 27 professional groups. Emphasis is still on theory, circuits, systems and parts needed to build markets now developing.

In addition to brisk trading on the floor, manufacturers hope to influence engineers who will make buying decisions back home.

Von Braun Says '5 More Firings'

THE ARMY Ballistic Missile Agency has been given the green light and "financial support for five firings involving satellites or other space projects," says Wernher von Braun, Army's chief of development operations for missiles.

Von Braun would not reveal how much money was approved for the projects, nor would he give a date for the next satellite launching try.

He said the next satellite under

LATEST MONTHLY FIGURES

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Dec. '57	Nov. '57	Dec. '56
Prod. workers, comm. equip.	380,400	398,000	407,800
Av. wkly. earnings, comm.	$78.40	$77.22	$79.15
Av. wkly. earnings, radio	$76.64	$75.08	$75.95
Av. wkly. hours, comm. ..	39.2	39.0	40.8
Av. wkly. hours, radio ...	39.1	38.9	40.4

TRANSISTOR AND TUBE SALES

(Source: EIA)	Dec. '57	Nov. '57	Dec. '56
Unit sales	2,773,000	3,578,700	1,608,000
Value	$6,619,000	$6,989,000	$4,691,000
Receiving tubes, units	27,736,000	39,950,000	34,340,000
Receiving tubes, value	$24,881,000	$33,166,000	$29,111,000
Picture tubes, units	644,026	772,801	795,476
Picture tubes, value	$12,971,487	$15,138,438	$13,423,157

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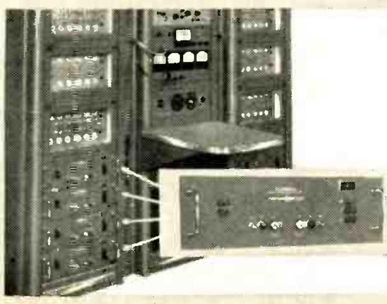

Lambda Com-Pak supplies, with front panel modifications, used by Western Electric to power United States continental air defense system tests.

Standard Lambda power supplies specified by Stromberg-Carlson for multi-million dollar Air Force Digital Computer Intervention and Display System.

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Now Lambda gives you the strongest proof of consistent trouble-free power supply performance ever offered.

The unprecedented five-year guarantee is based on the excellent experience owners of Lambda power supplies have had with their equipment under the most grueling, heavy-duty service.

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They will be on display in Booths 2436 and 2438. You'll also want a close-up view of Lambda's Com-Pak series, for all needs up to 1.5 amperes. The Com-Pak models are real space savers. They need only 5¼″ to 8¾″ of front panel height, depending on the model.

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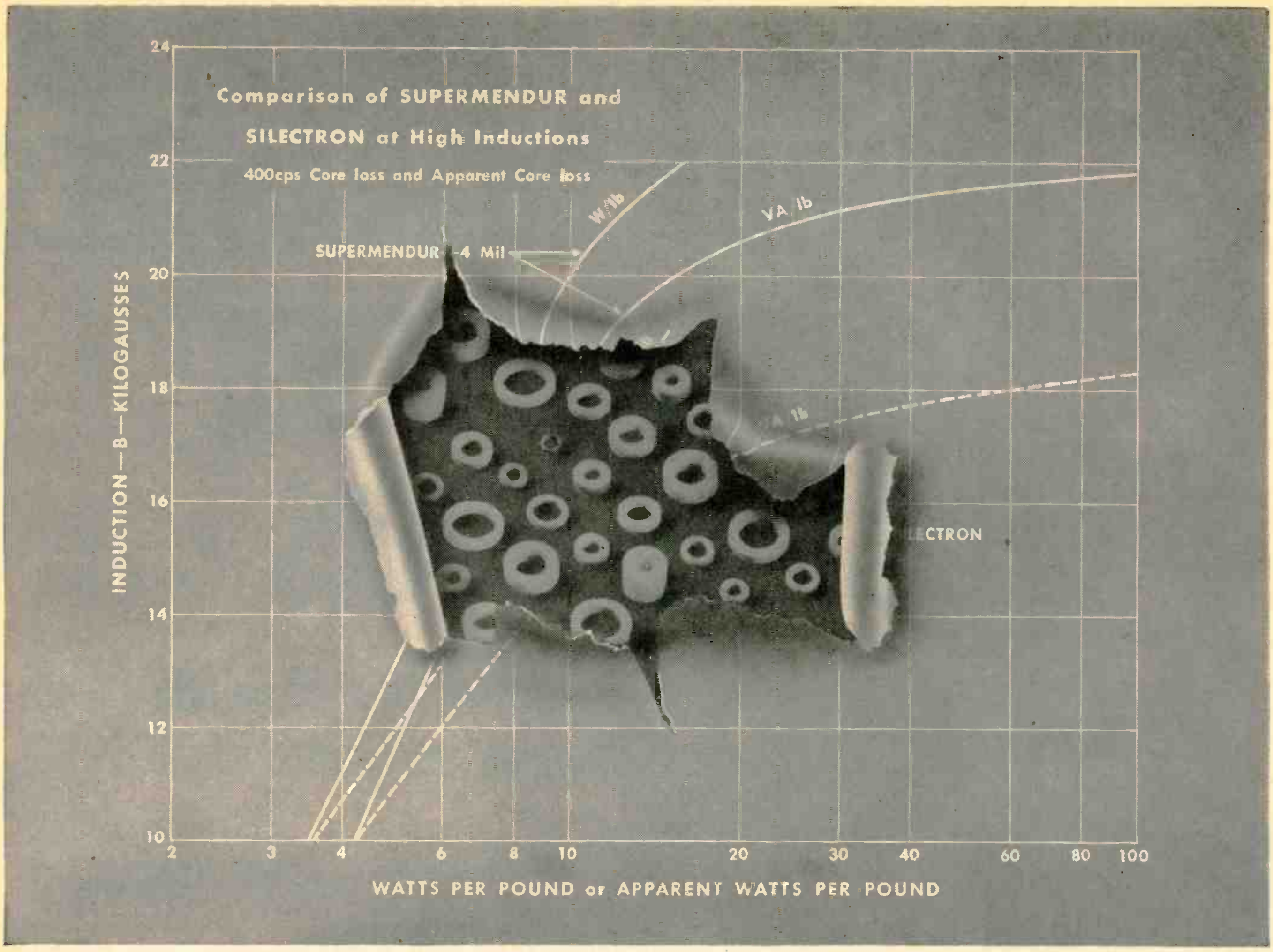

SUPERMENDUR TAPE WOUND CORES
. . . A Real Breakthrough in Miniaturization

The successful development of tape wound cores of Supermendur represents a giant step in the field of circuit miniaturization and simplification. The unique characteristics of this new rectangular-loop core material in the range of induction from 16 to 22 kilogausses permit significant weight and size reduction of toroidal transformers and magnetic amplifiers.

Supermendur, an oriented cobalt-iron-vanadium alloy, combines the high saturation flux density of the cobalt-iron alloys with the desired hysteresis loop rectangularity of the oriented 50% nickel-irons.

Coercive forces substantially lower than those of previously available cobalt-iron alloys are obtained. The lower core losses and excitation properties of Supermendur show a decided improvement in high density characteristics compared with oriented silicon steel, as illustrated by the curves partially shown above. ***Complete curves are available in a new Supermendur Bulletin TC-113, available on request.***

Specific advantages of Supermendur cores in toroidal transformers are: high operating induction, low core loss, low exciting current and high permeability at high induction. In magnetic amplifiers or saturable reactors, they include: rectangular hysteresis loop, high saturation induction and moderate excitation at high induction. Advantages in all uses are: thin tape, small size and low weight.

Supermendur is an ideal material for high temperature core components, because of its high Curie temperature.

● Supermendur is manufactured by Arnold under license arrangement with the Western Electric Company. We'll be glad to send you additional information or furnish you engineering assistance on any of your tape core applications if you'll just drop us a line.

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his control will be in the same bullet shape as Explorer I.

Von Braun said the program "does not imply we'll hit the moon."

The next satellite, he said, will utilize a built-in miniaturized tape recorder and receiver with a "little electro-motor to wind up the spring for the tape.

"A signal from the ground will trigger the recorder when it is passing over our western hemisphere, and give us the recorded data gathered by instruments on the other side of the world," Von Braun said.

Space Age Needs Manned Aircraft

WASHINGTON—Producers of electronic equipment for manned aircraft will share, along with makers of missiles, in the stepped up U. S. spending for military hardware.

This was the belief of those attending the recent Air Force Association's Jet Age Conference here.

By far the most predominant single issue brought out was the continuing need for manned bombers, regardless of progress in ballistic missiles.

This recurring theme was stressed by all Air Force speakers. Lt. Gen. Francis H. Griswold, Vice Commander-in-Chief, Strategic Air Command: "For the foreseeable future, missiles will supplement and complement rather than replace the manned bomber."

Maj. Gen. James Ferguson, Director of Requirements, Deputy Chief of Staff, USAF said: "Since there are signs that significant elements in the country would stampede us into outer space, leaving little else behind, I am happy to help put into proper perspective the continuing operational need for manned aircraft."

Ferguson added: "The attribute of wide discretion is one we cannot build into a machine. It becomes apparent, then, that we must preserve and refine our manned systems, if for no other reason, for this discretionary capability alone. With all their capability the destructive power of the missile is not equal to that of the manned bomber."

WASHINGTON OUTLOOK

NAVY's super secret project ASROC, antisubmarine rocket, reportedly is a large-scale version of its recently announced antisubmarine weapon RAT, a rocket-thrown weapons system. Minneapolis-Honeywell is the prime contractor, with Librascope handling the electronics end of the project.

Basically, the system searches out submarines, then launches rockets for undersea kills. It is said to use electronic digital fire-control computers for the first time on surface ships.

Navy has touted its RAT project as the hottest thing yet in antisubmarine warfare. Presumably this is a small scale test of the coming ASROC project. Minneapolis-Honeywell doesn't admit the project exists, but it is known that the project is being handled from a West Coast plant. Librascope's subcontract amounts to $17-million.

- A new entry in the sweepstakes to develop new missiles is the Air Force's Minute Man, a solid propellant ICBM. The Pentagon has authorized the Air Force to push ahead on research and development. None of the project contractors has been officially revealed. But it's believed that Aerojet-General, Thoikol, Phillips Petroleum and Grand Central Rocket are competing for a production contract on the missile's engine.

  Presumably, the propulsion subsystem is being pushed the most right now, with the belief that advanced models of the GE-Burroughs guidance system for the liquid-propellant Atlas ICBM or the Arma-Bell Lbs system for the liquid-propellant Titan ICBM could be incorporated at a later date in Minute Man.

- The trend toward stronger military unification—and more centralized Pentagon control over weapon development and production—could be sidetracked by a bill introduced by Rep. Carl Vinson (D., Ga.), the powerful chairman of the House Armed Services Committee and Rep. Leslie C. Arends (R., Ill.), the committee's ranking Republican and House whip for his party.

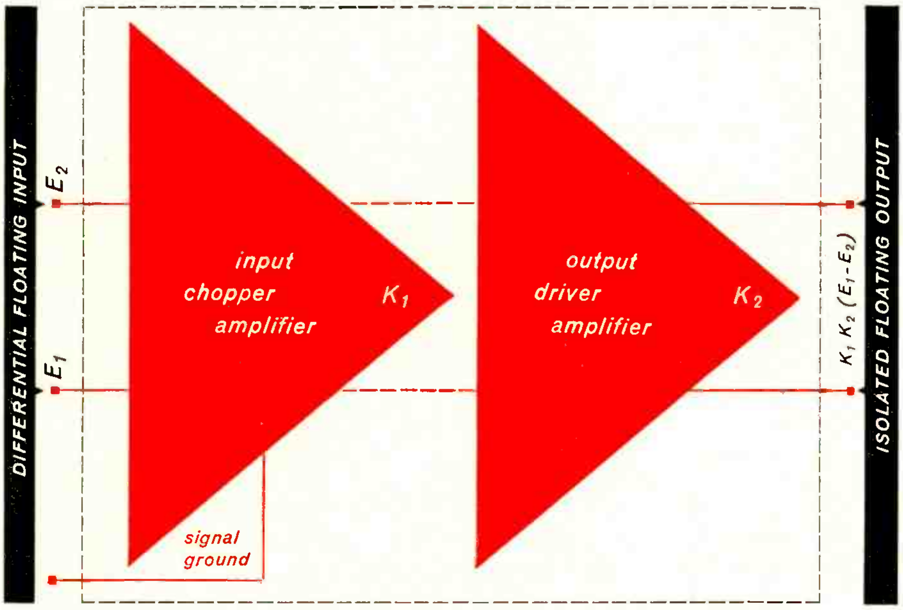
  The bill would cut the Secy. of Defense's office from 2,400 persons to 600, eliminate 14 of the Pentagon's roster of 29 under secretaries and assistant secretaries, substantially restrict the authority of the Defense Comptroller and elevate the civilian secretaries to membership in the National Security Council.

  In effect, the bill seriously reduces the Defense Secy.'s central powers, creates greater authority for the individual services. This is in direct conflict with the proposals, now being considered by the administration, to reorganize the Defense Dept. with stress on unifying military organization and policy.

  Some Pentagon sources consider the Vinson-Arends bill an effort to temper the Administration reorganization plans now being worked up for Congressional consideration. Both Vinson and Arends are conservatives on the organization issue, strongly oppose the creation of a single chief of staff, greater authorities for Defense Secy., and all other trends toward greater unification.

- Government officials say reliability of electronic parts in rockets and missiles has reached the stage where the prime missile makers themselves—Convair for one—are pumping as much as 75 percent of their development funds into searching for better electronic materials and components.

New! KIN TEL's true differential DC amplifier...

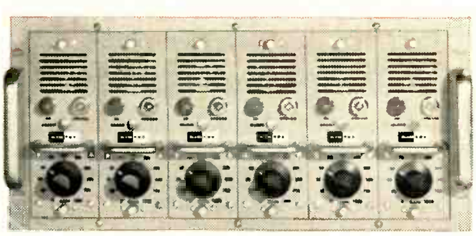


completely isolates input from output!

AMPLIFY MICROVOLT-LEVEL DATA SIGNALS New transistorized differential DC amplifiers provide extremely high common-mode rejection, very low drift, high output capability, and excellent stability and linearity... all unaffected by load or gain changes. Ideal for thermocouple amplification, they eliminate ground loop problems; allow the use of a common transducer power supply; permit longer cable runs; drive grounded, ungrounded or balanced loads, and can be used inverting or non-inverting. The 114A is the *perfect instrumentation amplifier*.

BRIEF SPECIFICATIONS – 114A DIFFERENTIAL DC AMPLIFIER

- 120 db common-mode rejection from DC to 60 cps.
- Gain of 10 to 1000 in 5 steps, continuous variation between steps.
- Gain accuracy 1.0% DC 10 cps, 3% to 30 cps, 3 db down at 120 cps.
- DC gain stability and linearity 0.1%.
- <5 μv noise; <5 μv drift at gain of 100 or above.
- Maximum output capability 10V at 10 MA.
- 100 K ohm input, <1 ohm output Z (min. load res. 20 ohms, max. load cap. 1.0 μf).



Six KIN TEL amplifiers in compact 19″ rack mountable module.

STANDARD WIDEBAND DC AMPLIFIERS can be used single-ended or for floating input applications. An operational version permits the user to employ his own feedback networks to limit bandwidth, generate transfer functions, obtain specific gains and perform integrations. Specifications for the 111 series, Wideband DC Amplifiers include: <2 μv drift; <5 μv noise. ±35 V, ±40 MA output. 100 K ohm input, 1 ohm output Z; 1.0 μf allowable output cable capacity. 0 to 1000 gain in ten steps, with continuous 1 to 2 times variation of each step. Gain accuracy (freq. response) ±1.0% DC to 2 KC, <3 db down at 40 KC.

ALL KIN TEL DC AMPLIFIERS feature integral power supplies, convenient plug-in mounting and KIN TEL's proven chopper feedback amplifier circuitry for unsurpassed stability, accuracy and reliability. They have accumulated over 500 years of operating time, and in one installation alone have logged over a million hours of trouble-free operation. Records like this are the result of stringent quality controls, thorough testing and calibration, and years of experience in the design and manufacture of thousands of chopper stabilized DC amplifiers.

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and probably more than we envision now, man will fly the equipment. Man's judgment and skills will always be needed to achieve the greatest effectiveness."

George E. Valley, Jr., USAF's Chief Scientist: "Missiles are indeed new weapons, but they are additions to our armament: their properties are complementary to those of the manned aircraft."

Gen. C. S. Irvine, Deputy Chief of Staff, Materiel: "Missiles and manned aircraft are getting more alike as to design. But missiles are going through a trial period. When judgment is required and when the reliability is assured, then man will be put into missiles."

Previously, ELECTRONICS (Feb. 7, p 13) quoted Major Alexander de Seversky's statement before the Senate Preparedness Subcommittee: "For any predictable time, the hypersonic, manned vehicle will be the decisive weapon in any future war. In general, robots are too logical. Their reaction is predictable; they are easier to intercept."

Tv Multiplex Shows Progress

PRESENT STATUS of development in a tv multiplex system was recently demonstrated in Newark, N. J., to leaders in government and industry. Originally announced last fall (ELECTRONICS, Oct. 10, '57), system which then was in drawing-board stage has since developed into the form of experimental hardware.

Developers of the Bi-Tran system assert that more refinement is necessary before it can be offered to the industry as a commercial possibility.

One problem is to get perfect phase cancellation between the two video signals. At present there is interlineation and video crosstalk in both channel A and B reproduction.

In addition to possibility of using B channel for subscription tv, promoters also envision uses of existing networks and stations for hitchhike by military, educational, medical, civil defense and other emergency services.

MILITARY ELECTRONICS

• **Projects USAF** and/or the Department of Defense are studying include: sending a 3,000-lb reconnaissance satellite into orbit via an ICBM Atlas; accelerating R&D work on ICBM Titan; developing a solid-fueled ICBM not as "awkward" as liquid-fueled Atlas and Titan; extending production of the B-52; and reexamining Army's IRBM Jupiter in comparison with USAF's Thor.

• **Airborne Bendix-Decca pictorial navigation** equipment for helicopters is being evaluated in the New York area by the Airways Modernization Board. Objective: to what extent will a hyperbolic system expedite helicopter operations in a high-density terminal area?

Four organizations are associated in the program: Pacific div. of Bendix will furnish, install and maintain the equipment; Bell Helicopter will modify a helicopter, installing advanced types of instrumentation developed by Bell and Bendix; New York Airways will fly the units; and Airborne Instruments Labs will provide engineering aid to AMB during the program, and will measure the technical performance of the system.

• **Airways Modernization Board** has awarded a $4,272,484 contract to General Precision Labs for design, development and fabrication of enroute portion of AMB experimental semiautomatic traffic control data processing system for civil and military air traffic control.

The AMB also started negotiations with GPL for the development of the high-density terminal portion of the automatic data processing and display element.

• **Combination data processing** and closed circuit tv to be used for testing Navy's IRBM Polaris was developed by Siegler's Hallamore Electronics div. under a $1-million R&D contract with the Naval Ordnance Test Station, Pasadena. The system's data reduction equipment contains electronic devices for calibrating all equipment prior to testing or firing the missile.

• **Range** and accuracy **of infrared** homing missiles will be increased due to the development of a hyperpure monocrystalline silicon disk lens with a 4-in. plus diameter, according to developer Friedrich Schwarz, U. S. Semiconductor Products, Inc., located in Phoenix, Ariz.

Schwarz declares that the new lens makes it possible to detect and home in on an enemy missile from 1,000 mi.

New Weapon

MB-1 Genie, air-to-air rocket, is shown in front of its launcher, the McDonnell F-101B Voodoo. Hughes' electronic fire control system locates target and fires armament. Genie, built by Douglas, is part of CONAD's arsenal

Space Challenge To Electronics

CHICAGO—THE PROBLEM of "instrument display and controls in a space ship offers considerable challenges to the present state of the electronic art," says Brig. Gen. Don Flickinger, director of Human Factors and surgeon at the Baltimore Headquarters of the U. S. Air Research and Development Command.

The pilot and medical scientist told ELECTRONICS that "in the next four to five years I can see the possibility of putting in space a man who is contributing something to the instrumentation system, and

recovering him after a five day period."

Gen. Flickinger added: "Extremely small energy requirements will carry out necessary communication functions between the space man and the ground staff. We do not have a space communication system now, but we do have components of a system we know will work in a vacuum chamber."

The Air Force scientist said some electrochemical techniques of dealing with gases and rearranging them for the space man's safety at relatively small watt cost and energy "show promise."

"In the next couple of years we can come up with an electrochemical process to extend the time base from five days to probably five weeks or two months.

"We are doing this now with special battery powered units operating at about ¾ of a kilowatt. It provides power for 24 hours. The total unit for one man oxygen day weighs 75 lbs."

The X-15 airplane will be tried out in 1959, he said. "Certain instruments in the vehicle will have to be displayed in a manner so a man can quickly make a decision and instigate action on this judgment."

FINANCIAL ROUNDUP

• **Consolidated Electrodynamics**, Pasadena, Calif., and **Cenco Instruments** of Chicago give up on plans to merge the two firms. The proposed merger reportedly bogged down because of difficulties of merging people of the two organizations. Employment contracts of key Cenco personnel did not conform with CEC policies.

• **Sylvania Electric** offers two long term debenture issues totaling $40 million. The double issue comprises $20 million of senior debentures due in 1980 and $20 million of convertible subordinated debentures due in 1983. Receipts from the senior issue are being used to pay off three year bank loans due in 1960. Convertible receipts are going for additional working capital required for expanded operations and new defense projects. Paine, Webber, Jackson & Curtis and Halsey Stuart & Co. head the underwriting group.

• **Barry Controls**, Watertown, Mass., purchases physical assets and products of **Vlier Engineering** of Los Angeles. Payment was in cash and five year notes, but amount was not disclosed. Vlier will operate as a Barry subsidiary. It makes tooling accessories for dies, jigs and fixtures used in the metal working industry. Barry's principal business is the design and manufacture of mounting systems and components to protect electronic and other equipment from shock and vibration. Acquisition gives parent company additional diversification outside the military field.

• **Digitronics Corp.**, Albertson, Long Island, N.Y., plans to issue 140,000 shares of class B capital stock at $1.50 per share. Proceeds are to be used for corporate purposes. Cortland Investing Corp. of N.Y.C. will underwrite the issue.

• **Ling Electronics** of Los Angeles and **Ling Industries** of Dallas, Texas, consummate merger plans as stockholders approve proposal. Ling Electronics, the surviving corporation, will maintain executive offices in Dallas. Principal product of Ling Electronics is vibration testing equipment used in the missile and jet-aircraft industry.

• **Marchant Calculators**, Oakland, Calif., reduces quarterly common divident to 15 cents per share. It had previously paid 32½ cents. Step was to conserve cash needed for corporate purposes and for move into new building.

• **Sanders Associates**, Nashua, N. H., pays semiannual dividend of 4 cents per share on common today. It had paid quarterly dividends of 2 cents per share.

• **General Precision Equipment** declares a dividend of 60 cents on common shares payable tomorrow. Regular quarterly dividends, payable at the same time, were also declared on $4.75 cumulative preferred stock, the $1.60 convertible preference stock and the $3 cumulative convertible preference stock.

Selling Seats By Wire Line

Braniff airline hostess queries equipment about seat availability on her flights by using key-set machine

RECENTLY, Braniff International Airways unveiled its new electronic reservation system in Dallas, Texas.

The equipment, constructed by Teleregister, uses teleprinter equipment. Teleprinters feed reservation requests and seat information directly into the electronic equipment. Space can be sold or canceled in a few seconds.

With the new equipment, reservation clerks in remote cities can now query a central electronically controlled inventory of seats in a distant city directly by teleprinter. Agents in 140 branch offices of the airways are connected into the reservation system by 18,000 miles of land line.

F-M Triplecasts Seen Profitable

REPORTS of recent success in broadcasting three programs simultaneously are gaining the attention of f-m broadcasters and receiver manufacturers alike.

Trial triple broadcasts are being made by WGHF (f-m), Brookfield, Conn. with FCC approval. Programming consists of stereo-

 CIRCLE 115 READERS SERVICE CARD

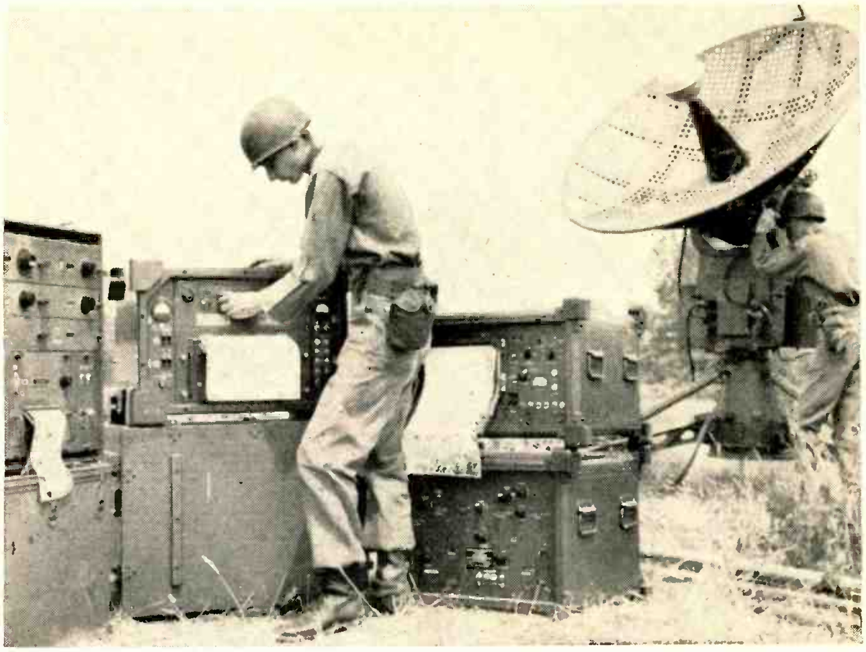
phonic hi-fi music and commercial background services.

Financial prospects for this type of operation look good according to WGHF's owner, A. J. Detzer. He says hi-fi stereo music will have considerable appeal in his Westchester and Fairfield County areas, while commercial background servicing will find ready customers.

If FCC approves, the station plans to have f-m stereocasts on regular schedule as soon as adapters for home receivers become generally available.

Several manufacturers are reportedly interested in this new potential market. Prices for the multiplex adapters are expected to run somewhat under $100.

Broadcasts are made by using the main channel and one subchannel for hi-fi stereocasts, and the other channel for background service. Reports say no interference problems arise from this multiplexing.



Meteorology Computers

Computer packaged in battlefield console automatically issues high-altitude weather reports. An antenna tracks the balloon, other basic information is radioed from instruments on the balloon. System, developed by Army Signal Engineering Laboratories, provides vital pressure, humidity, temperature and wind readings

MEETINGS AHEAD

MARCH						
S	M	T	W	T	F	S
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2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23/30	24/31	25	26	27	28	29

APRIL						
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MAY						
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25	26	27	28	29	30	31

Mar. 17-21: 1958 Nuclear Congress, Engineers Joint Council, AICE and Atomfair, Atomic Industrial Forum, International Amphitheatre, Chicago.

Mar. 18-19: Conf. on Extremely High Temperatures, Air Force Cambridge Research Center, New England Mutual Hall, Boston, Mass.

Mar. 24-27: IRE National Convention, All Prof. Groups, Waldorf-Astoria Hotel and N. Y. Coliseum, N. Y. C.

Mar. 31-Apr. 2: Instruments & Regulators Conf., PGAC, ASME, AICHE, ISA, Univ. of Delaware, Newark, Del.

Mar. 31-Apr. 2: Southwest District Meeting of AIEE, Mayo Hotel, Tulsa, Oklahoma.

Apr. 2-4: Conf. on Automatic Optimization, PGAC, ASME, AICHE, ISA, Univ. of Delaware, Newark, Del.

Apr. 8-10: Sixth National Conf. on Electromagnetic Relays, Oklahoma State Univ., Stillwater, Okla.

Apr. 8-10: Symposium on Electronic Waveguides, Microwave Research Institute of Brooklyn Polytechnic Inst., head at Engineering Societies Bldg., N. Y. C.

Apr. 10-12: Tenth Southwestern IRE Conference and Electronics Show, St. Anthony Hotel and Municipal Auditorium, San Antonio, Texas.

Apr. 14-16: Conf. on Automatic Techniques, IRE, ASME, Statler Hotel, Detroit, Mich.

Apr. 15: Closing date for registration, Intensive course in Automatic Control scheduled for June 16-25 at Univ. of Mich., Coll. of Engineering.

Apr. 17-18: Second Annual Tech. Meeting, Institute of Environmental Engineers, Hotel New Yorker, N. Y. C.

Apr. 18-19: Twelfth Annual Spring Tech. Conf. on Television and Transistors, Engineering Society of Cincinnati Bldg., Cincinnati.

Apr. 20-24: Scientific Apparatus Makers, 40th Annual Meeting, El Mirador Hotel, Palm Springs, California.

Apr. 21-25: Society of Motion Picture and Television Engineers, 83rd Convention, Ambassador Hotel, Los Angeles.

Apr. 22-24: 1958 Electronic Components Conf., IRE, AIEE, Theme: "Reliable Application of Component Parts," Ambassador Hotel, Los Angeles.

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

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

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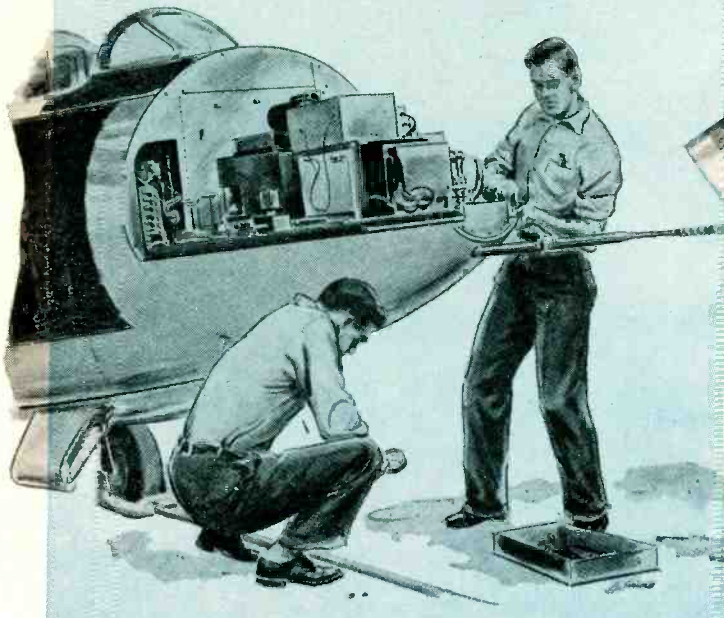

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	Input Voltage (Volts)	Input Current (Amps.)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/deg.)	IMPEDANCE		Phase Shift (deg.)	Remarks
						Input	Output		
Transmitter—Control Transformer	26	.111	.74	22.5	393	58+j226	626+j233	19	High impedance load on CT
Transmitter—Control Transformer	26	.111	.75	21.6	377	58+j226		19	50' load on CT
Transmitter—Control Transformer	26	.110	.83	19.2	335	64+j221		17	5' load on CT
Transmitter—Differential—CT	26	.134	1.78	19.5	340		748+j364	40	Output to High impedance
Electrical Resolver—Electrical Resolver	11.8	.115		7	120			52	Input to stator
Electrical Resolver—Electrical Resolver	26			15	260			53	Input to rotor

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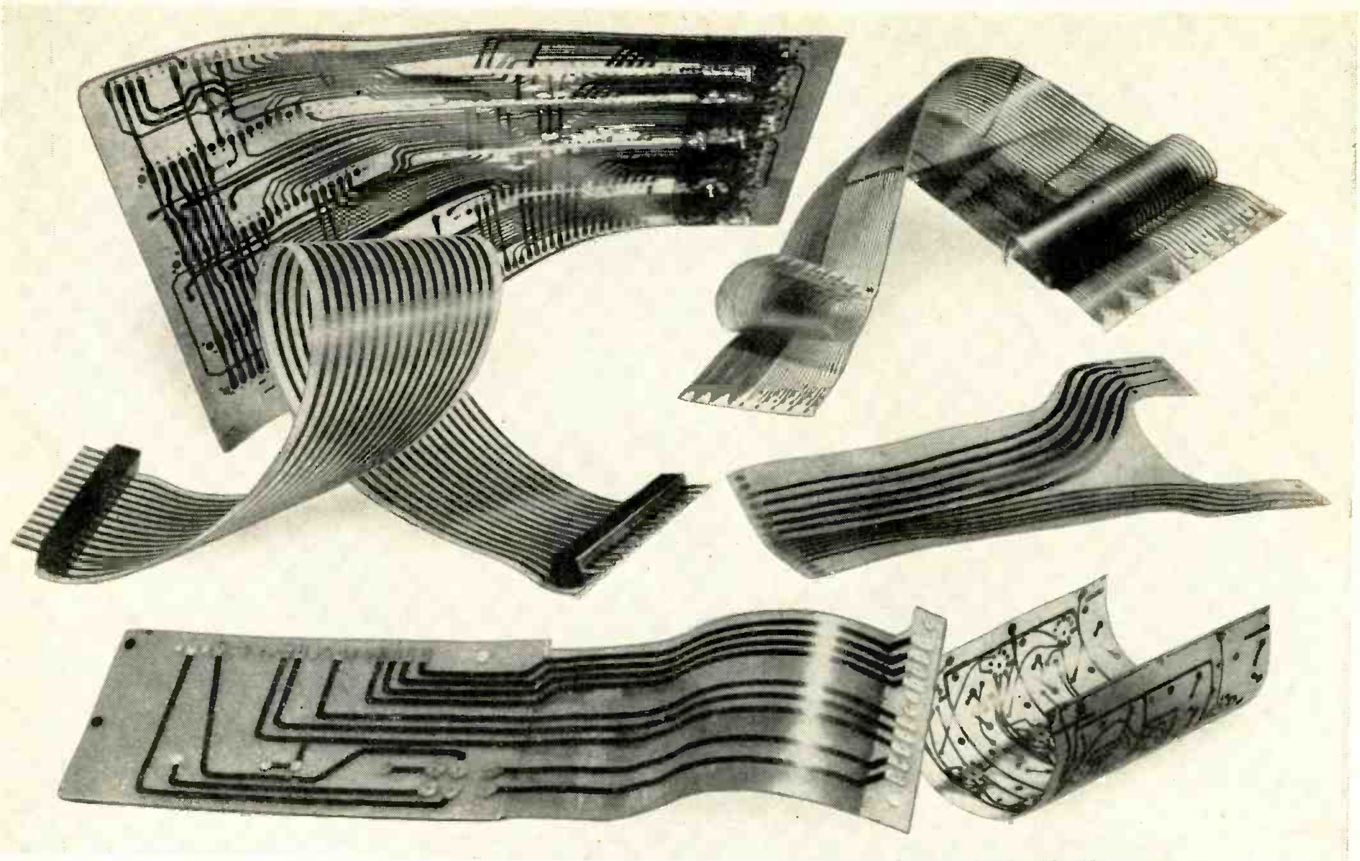

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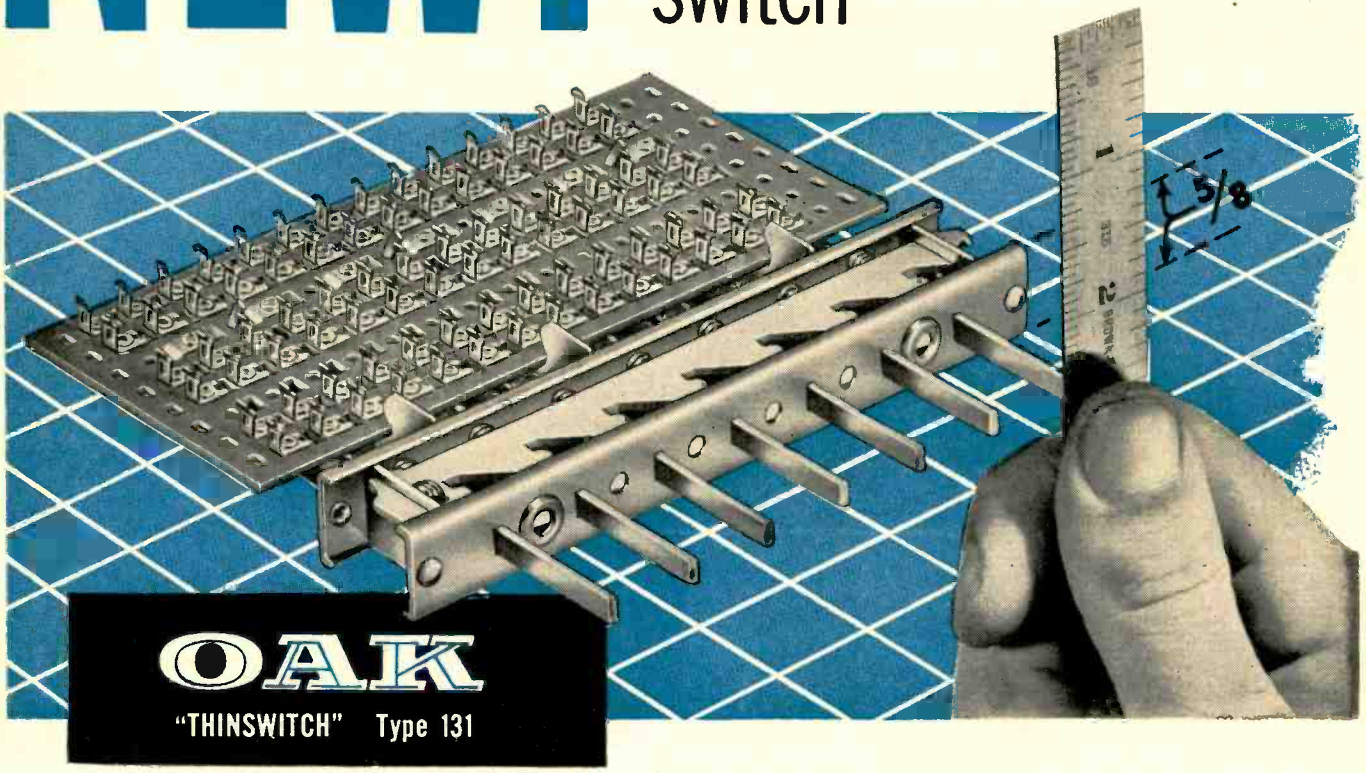

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- Famous Oak double-wiping contacts.
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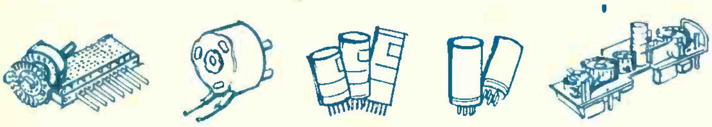

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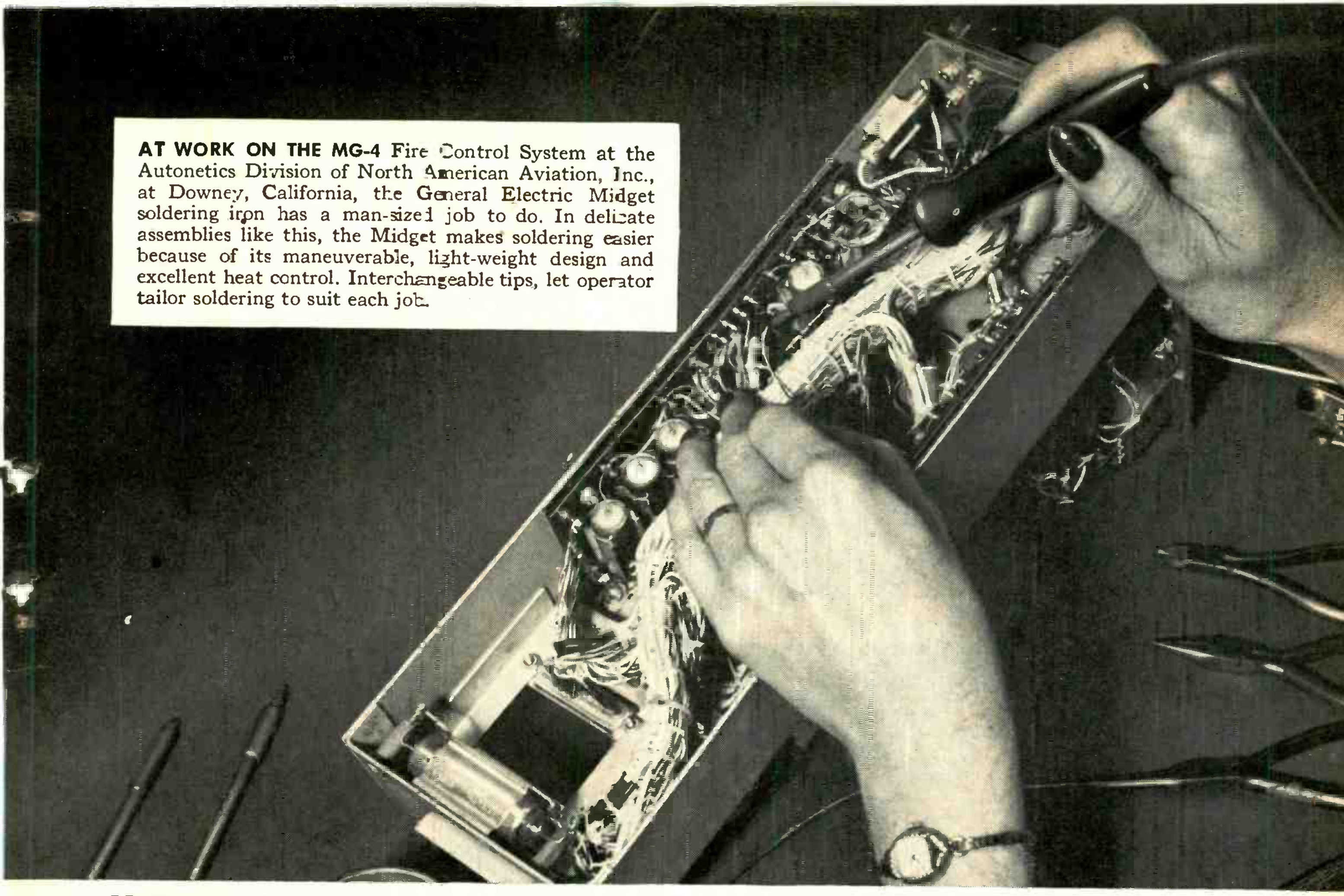
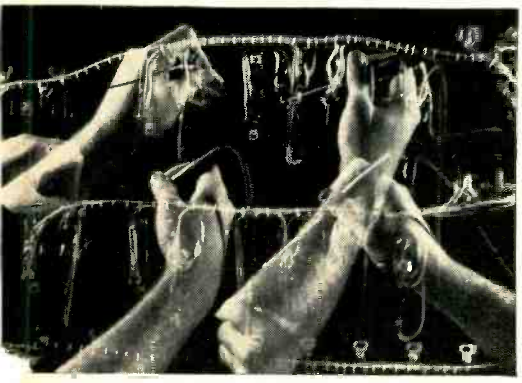


AT WORK ON THE MG-4 Fire Control System at the Autonetics Division of North American Aviation, Inc., at Downey, California, the General Electric Midget soldering iron has a man-sized job to do. In delicate assemblies like this, the Midget makes soldering easier because of its maneuverable, light-weight design and excellent heat control. Interchangeable tips, let operator tailor soldering to suit each job.

DEPENDABLE G-E MIDGET IRON cuts costs of producing MG-4 Fire Control Systems by reaching through maze of resistors, small wires, and tiny tubes quickly, easily, efficiently. . .reducing risk of damage to adjacent parts. Finished assembly, above, is one of the MG-4 System components used on North American F-86K Sabre Jets. It helps the pilot find aggressor aircraft.

Autonetics Cuts Sabre Jet Costs With General Electric Midget Soldering Irons



FASTER HEAT RECOVERY and lower maintenance of G-E soldering irons have been proved by many manufacturers under their own production conditions—along with competitive soldering irons. If you would like to compare General Electric irons with the irons you are now using, call your G-E distributor.

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SAVINGS ACHIEVED by several users and information about the construction features of General Electric soldering irons are included in a new bulletin, "Save While You Solder," GED-3553. For a copy, call your G-E distributor or write Section 724-7, General Electric Company, Schenectady 5, New York.

GENERAL ELECTRIC

CIRCLE 120 READERS SERVICE CARD

Hewlett-Packard 684 series Sweep Oscillators are new measuring tools deliberately designed to give you simpler, faster microwave measurements. Four models are provided, covering the G band (3.95 to 5.85 KMC), J band (5.30 to 8.20 KMC), X band (8.20 to 12.40 KMC) and P band (12.40 to 18.00 KMC).

These new instruments make possible microwave investigations and evaluations with a convenience previously associated only with lower frequency measurements. The 684 series oscillators provide a wide range of sweep speeds so that measurements of reflection, attenuation, gain etc., can be displayed on an oscilloscope or recorded in permanent form on X-Y or strip-chart recorders.

Electronic Sweeping

Specifically, the new oscillators provide either a CW or swept rf output throughout their individual bands. The instruments employ new backward wave oscillator tubes whose frequency is shifted by varying an applied potential. Thus, troublesome mechanical stops and tuning plungers are eliminated. Sweep range is continuously adjustable and independently variable; sweep rate is selected separately, and either can be changed without interrupting operation. The full band width can be covered in time segments ranging from 140 seconds (very slow for mechanical recorder operation) to 0.014 seconds (high speed for clear, non-flickering oscilloscope presentation).

Linear Frequency Change

The swept rf output from the 684 series oscillator is linear with time, and a linear sawtooth voltage is provided concurrent with each rf sweep to supply a linear time base for an oscilloscope or recorder. In addition, for convenience in recording and other operations, rf sweeps can be triggered electrically externally and single sweeps can be triggered by a front panel push button. The rf output can also be internally AM'd from 400 to 1,200 cps and externally AM'd or FM'd over a wide range of frequencies.

Rapid Visual Presentation

The variety of sweep rates and band widths available from the new oscillators insures convenience and accuracy for reflection and transmission coefficient measurements and many other production line and laboratory tests. For maximum speed, an oscilloscope such as *-hp-* 130A/B may be used as indicated in the diagram on opposite page. For maximum information and a permanent record, an X-Y or strip chart recorder may be used.

Complete details of a rapid visual method using an oscilloscope or a maximum-data, permanent record method using a recorder may be obtained from your *-hp-* field engineer. Detailed discussions of these methods are also contained in the *-hp-* Journal, Vol. 8, No. 6, and Vol. 9, No. 1-2, available on request.

TYPICAL SPECIFICATIONS

Below are specifications for *-hp-* 686A Sweep Oscillator, 8.2 to 12.4 KMC. Specifications for *-hp-* 684A (G band), 685A (J band), and 687A (P band) are similar except for frequency range.

Types of Outputs: Swept Frequency, CW, FM, AM.

Single Frequency Operation

Frequency: Continuously adjustable 8.2 to 12.4 KMC.

Power Output: At least 10 milliwatts into matched waveguide load. Continuously adjustable to zero.

Swept Frequency Operation

Sweep: Recurrent; externally triggered; also manually triggered single sweep. Rf sweep linear with time.

Power Output: At least 10 MW into matched waveguide load. Output variations less than 3 db over any 250 MC range; less than 6 db over entire 8.2-12.4 KMC range.

Sweep Range: Adjustable in 7 steps 4.4 MC to 4.4 KMC.

Sweep Rate-of-Change: Decade steps from 32 MC/sec. to 320 KMC/sec.

Sweep Time: Determined by sweep range and rate; from 0.014 to 140 seconds over full-band.

Sweep Output: +20 to +30-volt-peak sawtooth provided at a front-panel connector concurrent with each rf sweep.

Modulation

Internal Amplitude: Square wave modulation continuously adjustable from 400 to 1200 cps; peak rf output power equals cw level.

External Amplitude: Direct coupled to 300 KC; 20 volt swing reduces rf output level from rated cw output to zero.

External Pulse: +10 volts or more, 5 millisecond maximum duration.

External Frequency: FM and external sweep voltages.

General

Input Connectors, Impedances: BNC; above 10,000 ohms.

Output Connector: Waveguide cover flange; SWR less than 2:1.

Power Requirements: 115/230 volts 50/60 cps ac; approximately 475 watts.

Price: *-hp-* 684A (3.95-5.85 KMC) $2,265.00
-hp- 685A (5.30-8.20 KMC) $2,265.00
-hp- 686A (8.20-12.40 KMC) $2,615.00
-hp- 687A (12.40-18.00 KMC) $3,115.00
(Prices above are f.o.b. factory for cabinet models. Rack mount instruments $15.00 less.)

Data subject to change without notice.

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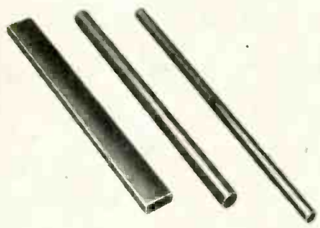
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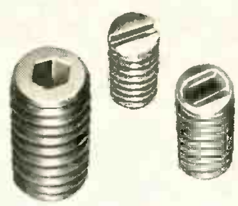
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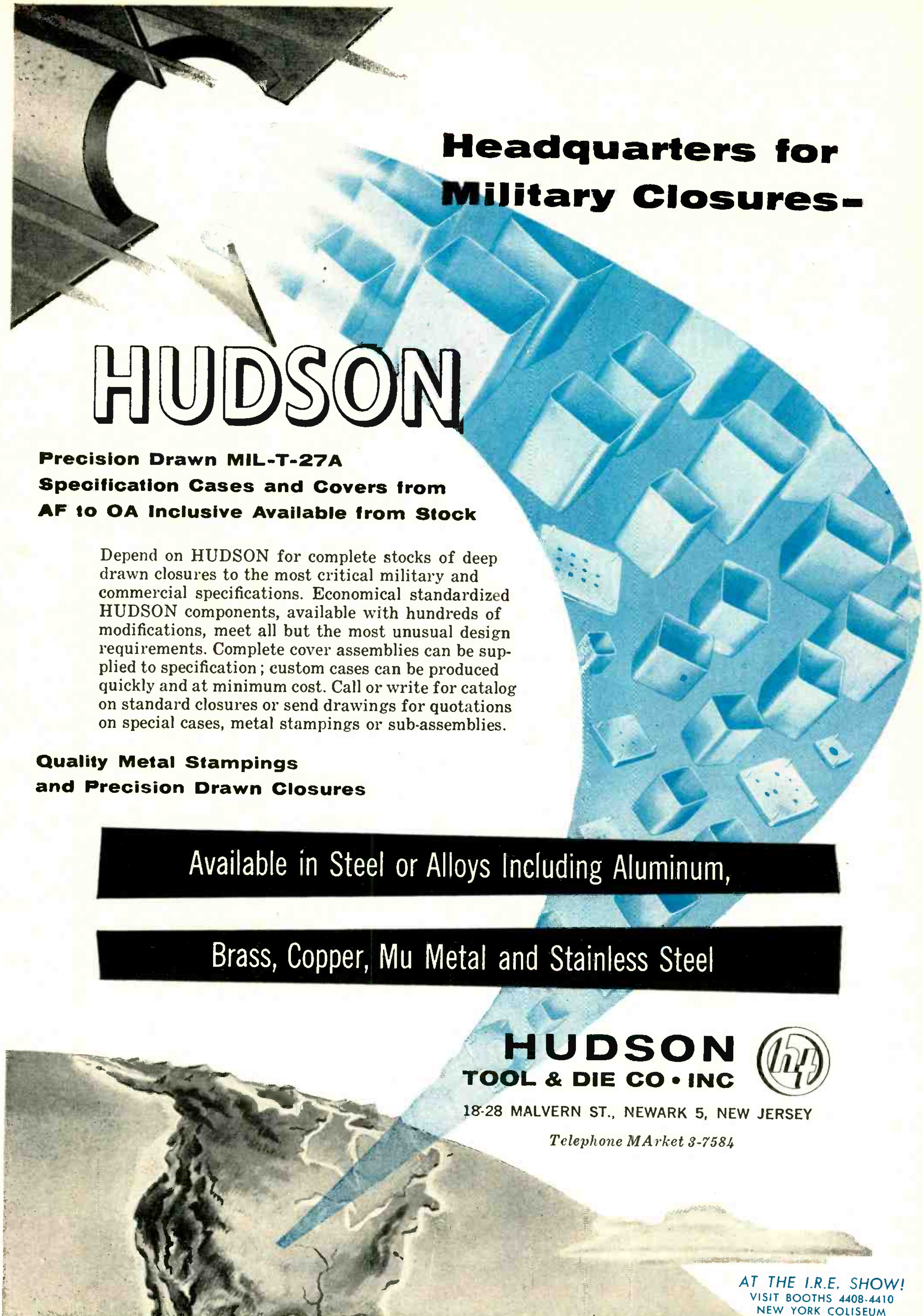

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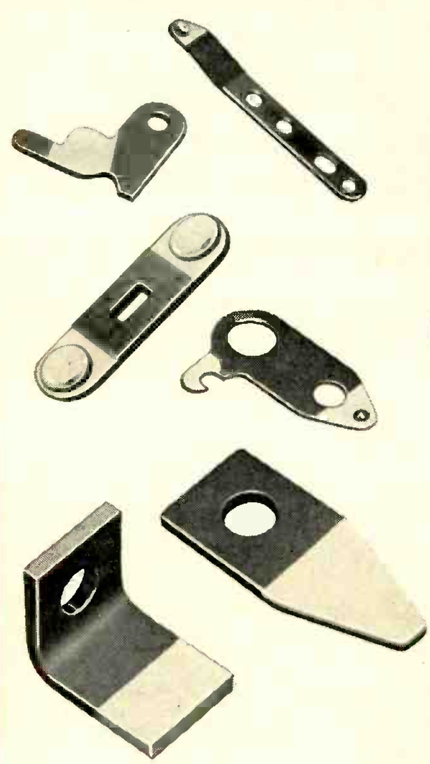
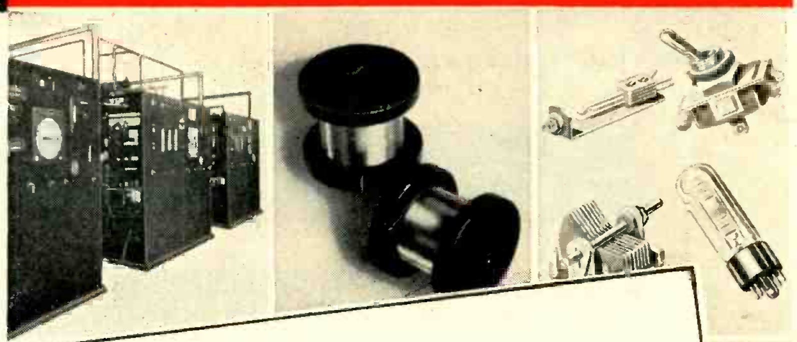
One of the most widely used materials for electrical contacts, SILVER provides high resistance to atmospheric corrosion. Silver Alloys—which contain base metals to achieve specific properties—provide other modified characteristics, such as increased resistance to arc erosion, sticking and metal transfer.

PLATINUM AND PLATINUM ALLOYS

Offering a higher resistance to tarnish and corrosion than any other contact material, the contact resistance of platinum can be maintained at a low value throughout its operating life. Platinum alloys provide higher melting points and hardness, greater resistance to deformation, longer life and increased resistance to sticking and metal transfer.

Write for complete catalog material and details.





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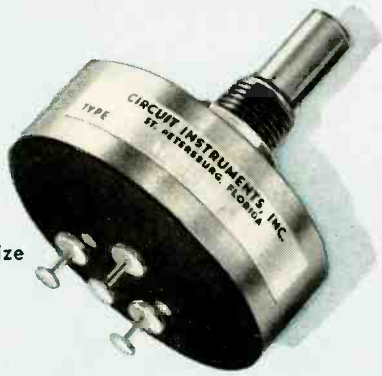

Actual Size

TYPE H-151

Single turn
Net weight: 2 oz.
Rotation: 350° + 4° —0°
Rating: 3 watts
Resistance: 15 to 100,000 ohms
Linearity: Std. ± 0.5%; Special to ± 0.2%
Terminals: Turret type

Actual Size

TYPE H-751

Single turn
Net weight: 1 oz.
Rotation: 345° ± 5° std. (others available)
Rating: 1 watt
Resistance: 50 to 25,000 ohms
Linearity: Std. ± 1%; Special to ± 0.5%
Terminals: Turret type

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Economy without compromise of quality, precision and ruggedness . . . that's the *real difference* in CIRCUIT single turn potentiometers.

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NOW FOR BT RESISTORS. Grip Strip packaging is available for IRC Type BT Resistors at no extra charge. There is a small charge for Grip Reel. Bulk packaging is still supplied for manual assembly.

EXACT POSITIONING. Resistors are equally spaced and held securely at right angles to the strip.

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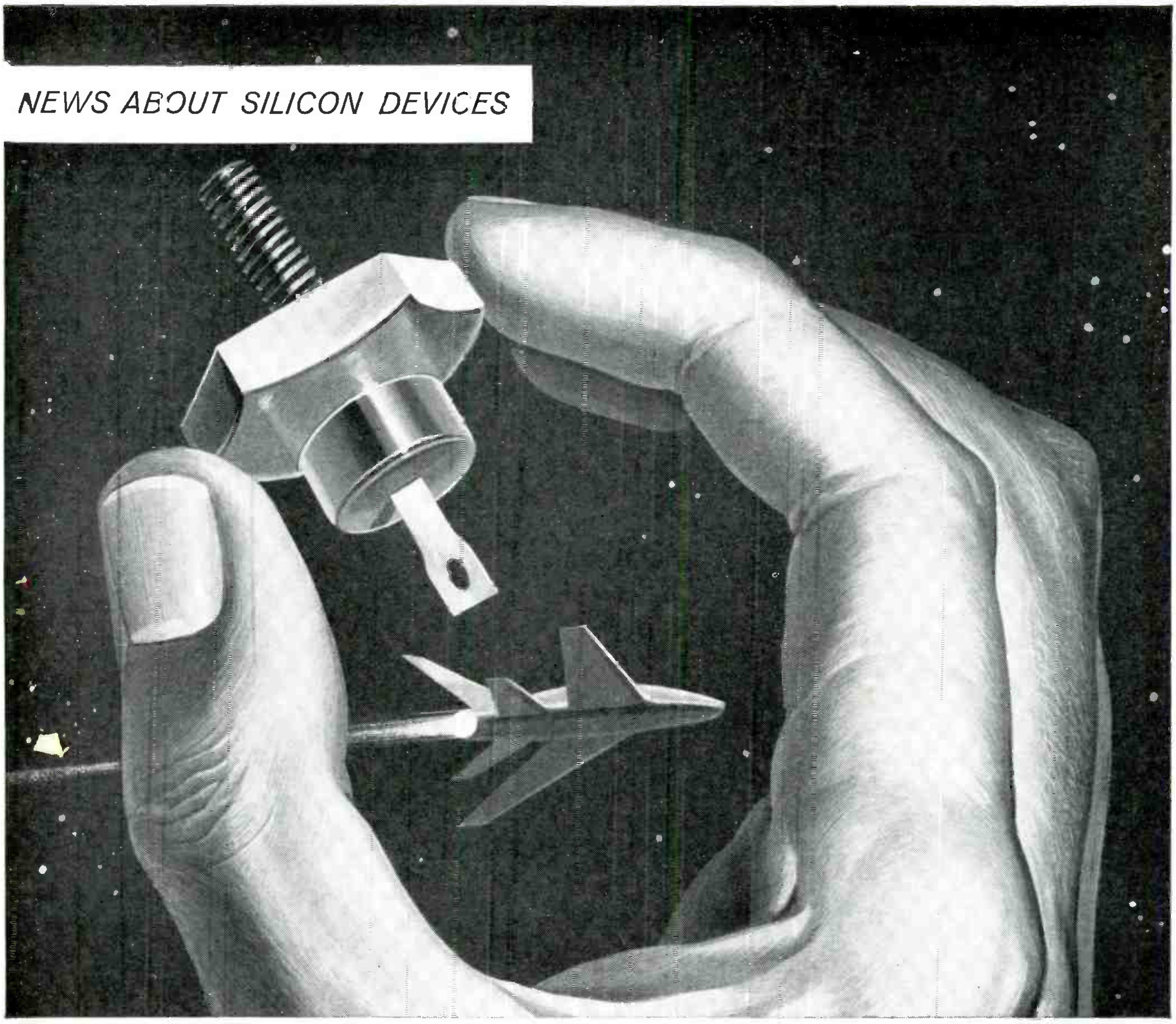

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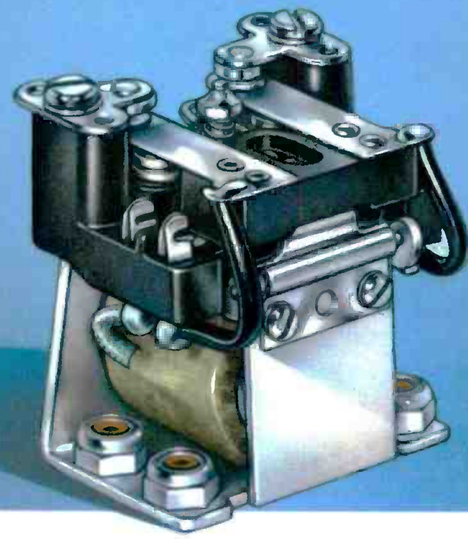

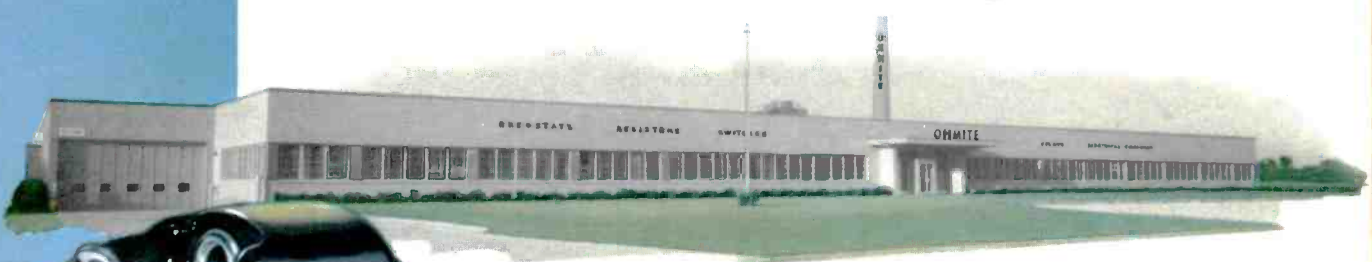

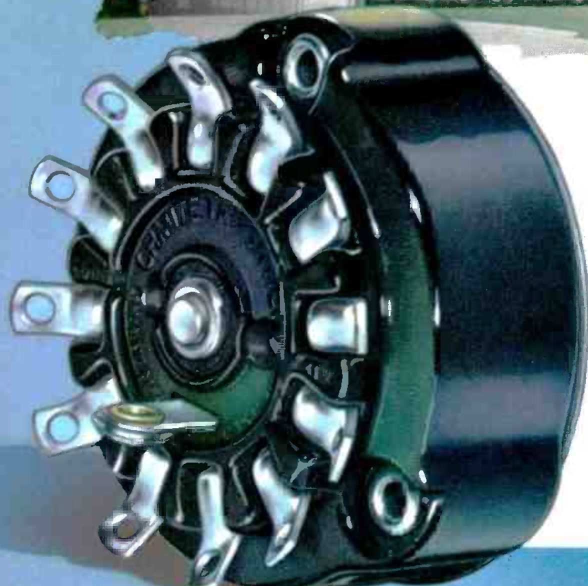

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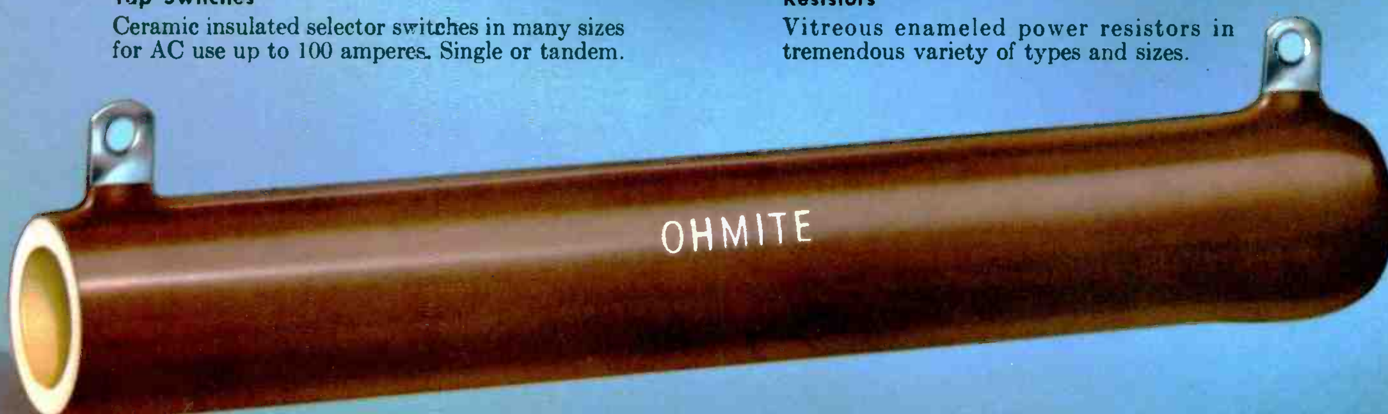

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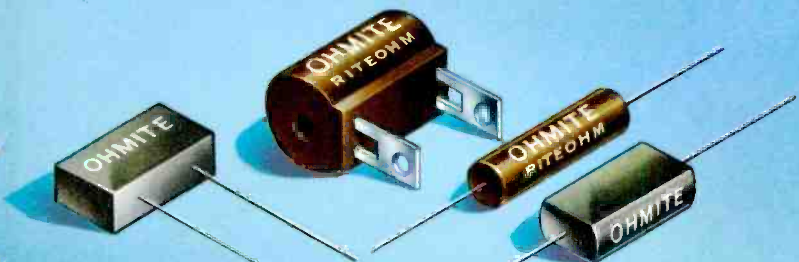

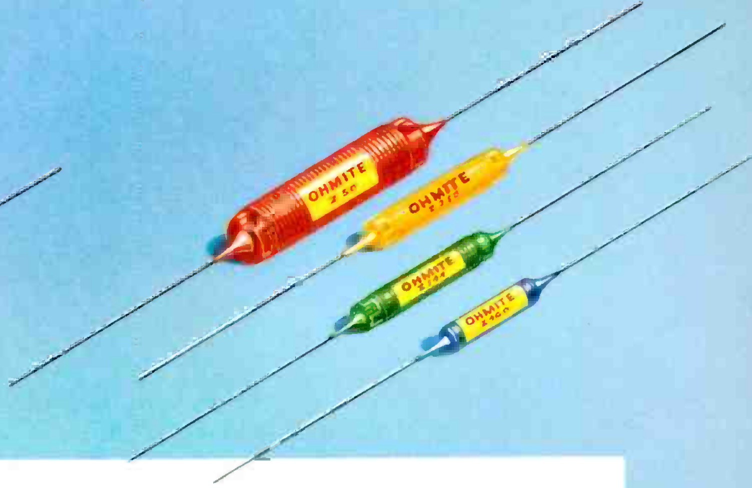

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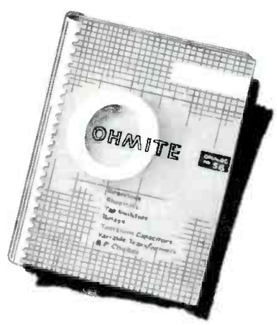

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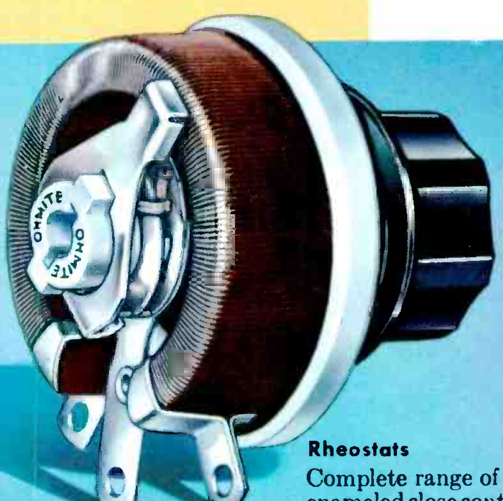

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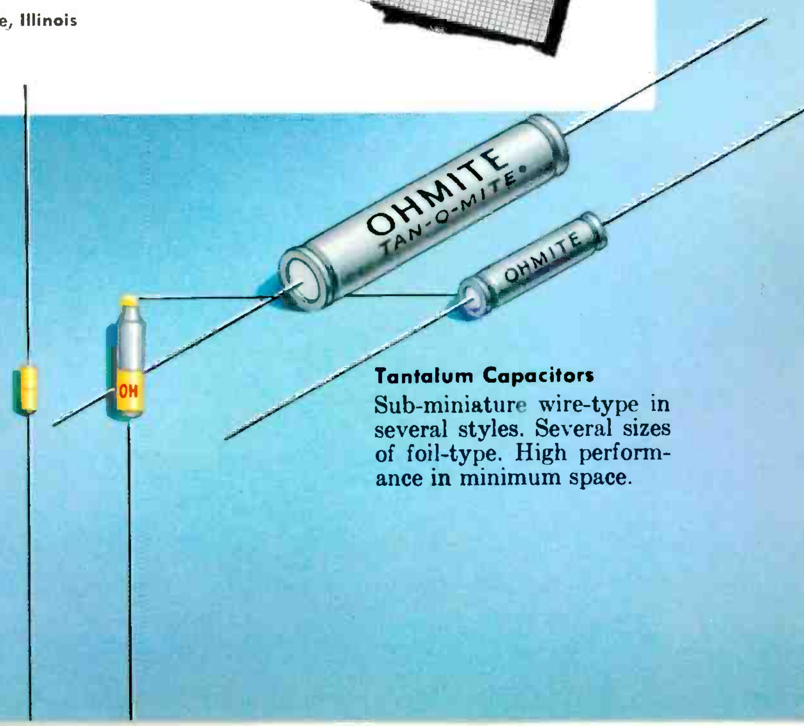

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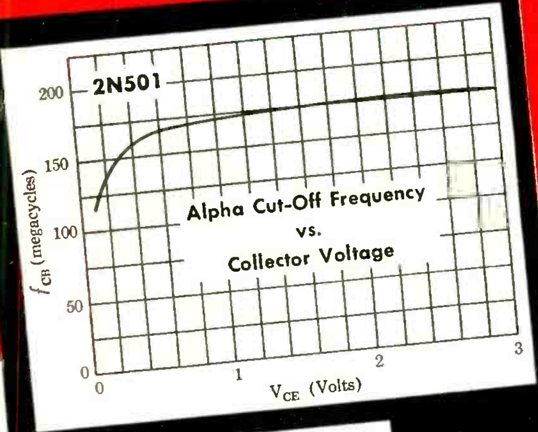

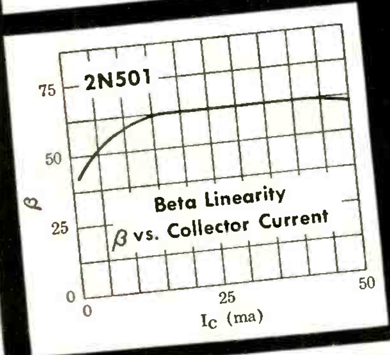

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MADT FAMILY APPLICATIONS DATA

TYPE*	fmax	Power Gain	Oscillator Efficiency	Class of Use
2N499	250 mcs (min)	10 db at 100 mcs	25% at 100 mcs (min) 25% at 200 mcs (min)	oscillator and amplifier to 100 mcs oscillator to 400 mcs
2N500				
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 35V and dissipation ratings to 100 mw.
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Make Philco your prime source of information for high frequency transistor applications.

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10	115	400	1	10,000	.05	.035	4.0	0.112 oz. in. at 6000 rpm	2.0 Oz.	....	10-A 8104-02
10	115	400	1	11,000	None (Shaded Pole)	.085	7.5	.096 oz. in. at 7000 rpm	3.5 Oz.	....	10-A 8101-01
11	115	400	1	12,000 Synch	0.1	.070	8.0	.08 oz. in. at 12,000 rpm	4.0 Oz.	....	11-A 8110-01
11	115	300-1800	1	10,000 (400 CPS)	0.5 (In Parallel)	.060 (400 CPS)	8.0 (400 CPS)	0.10 oz. in. at 9000 rpm (400 CPS)	5.0 Oz.	....	11-A 8223-01
11	115	400	1	60 Synch	0.1	.070	8.0	12 oz. in. at 60 rpm	7.75 Oz.	200:1	11-R 9003-02
11	26	400	1	30 Synch	2.0	0.35	8.0	14.5 oz. in. at 30 rpm	5.5 Oz.	195:1	11-R 9052-01
15	115	400	1	6,000 Synch	0.3	0.138	15.6	0.14 oz. in. at 6,000 rpm	8 Oz.	....	15-A 8120-01
18	115	400	1	12,000 Synch	0.35	0.148	14.7	0.41 oz. in. at 12,000 rpm	8 Oz.	....	18-A 8125-01
18	115	400	1	7600	0.6	0.45	4.5	2.45 oz. in. at 6800 rpm	24 Oz.	....	18-A 8126-01
18	115	60	1	8.5	1.0	0.175	17.5	30 oz. in. at 8 rpm	20 Oz.	405:1	18-R 9302-01
18	115	60	1	6.0	1.0	0.177	17.8	40 oz. in. at 5.75 rpm	20 Oz.	565:1	18-R 9302-02
21	115	400	1	22,000	1.0	0.75	80.0	1 oz. in. at 20,000 rpm	18.5 Oz.	....	21-A 8142-01
24	115	400	1	11,800	1.5	0.85	130.0	6.17 oz. in. at 10,800 rpm	29 Oz.	....	24-A 8161-01
24	115	60	1	20,000	None Required	1.2	175	8.9 oz. in. at 7,500 rpm	28 Oz.	....	24-U 8826-02
24	115	400	1	78	4.0	1.65	175	1530 oz. in. at 72 rpm	3 Lbs.	1528:1	24-R 9452-02
34	115	60	1	14,000	None Required	1.5	125	15 oz. in. at 4500 rpm	3-3/4 Lbs.	....	34-U 8901-02
34	115	60	1	1,780	3.75	0.45	50	12 oz. in. at 1700 rpm	4-3/4 Lbs.	....	34-A 8044-01

- All motors are continuous duty except Type 24-U-8826-02.
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- All motors can be modified to meet your precise specification.
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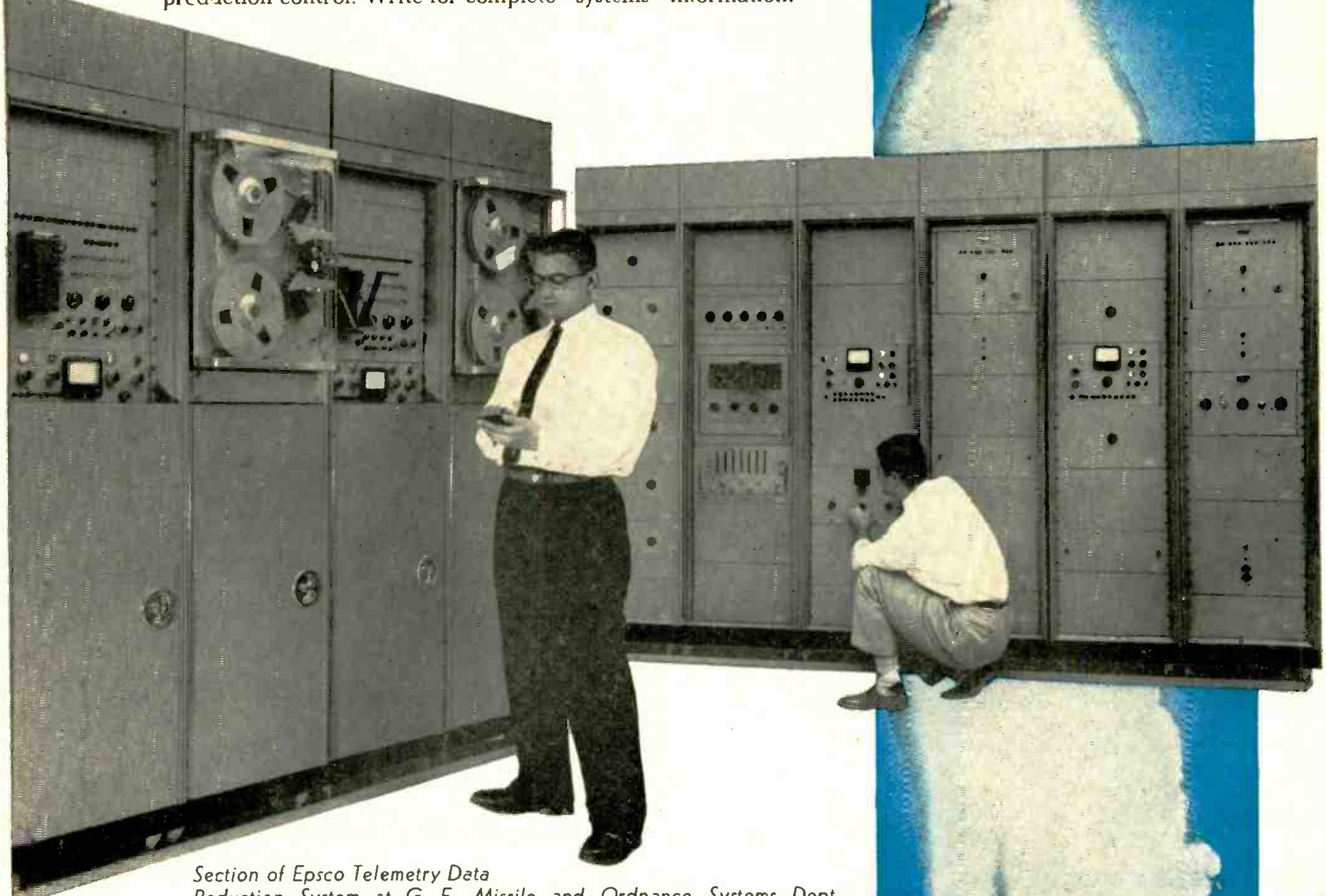

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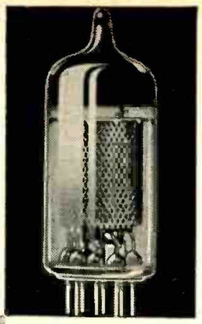

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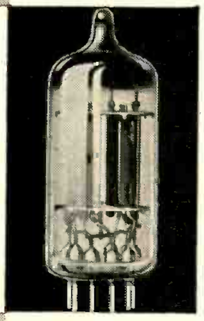

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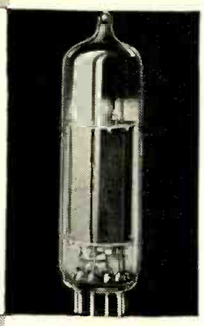

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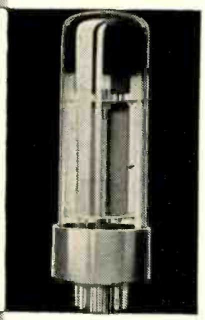

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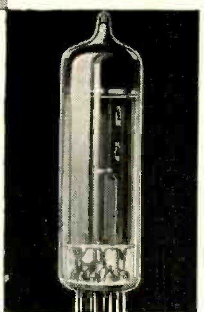

GZ34 *5AR4*

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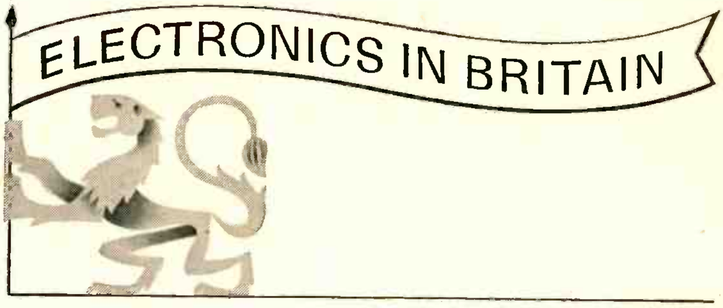

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CIRCLE 5 READERS SERVICE CARD

CIRCLE 6 READERS SERVICE CARD→

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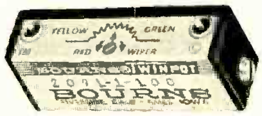

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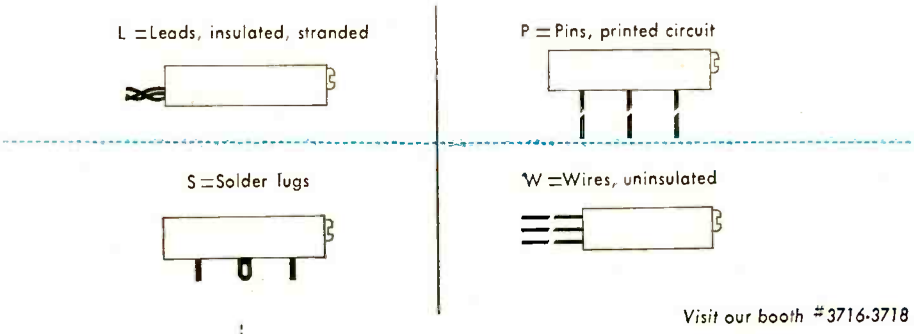

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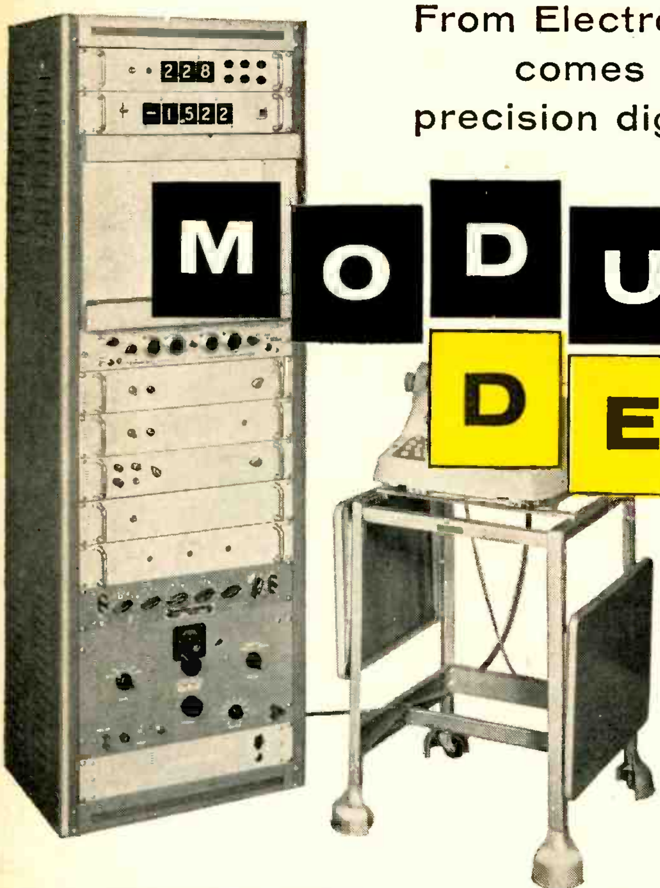

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Range	.0001-999.9 volts	0.0001-999.99 volts
Accuracy	±1 digit	±(0.01% and 1 digit)
Automatic Features	Polarity, ranging	Polarity, ranging
Controls	Digits gain, manual and automatic ranging, power on-off-standby	Digits gain, manual and automatic ranging, power on-off-standby

Write for Bulletins 180.1 and 180.2

AC-DC DIGITAL VOLTMETERS

Specifications	Model DVA-410	Model DVA-510
DC	Same as DVA-400	Same as DVA-500
AC		
Accuracy	0.1% or 2 digits	0.1% or 2 digits
Frequency Response	30-10,000 cycles	30-10,000 cycles
Range	.0001-999.9 volts	0.0001-999.99 volts
Controls	Same as DVA-400, AC-DC	Same as DVA-500, AC-DC

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Automatic Features	Ranging	Ranging
Controls	Digits gain, manual and automatic ranging, power on-off-standby	Digits gain, manual and automatic ranging, power on-off-standby

For accuracy specifications see Bulletin 180.3

Write for Bulletins 180.1, 180.3

AC RATIOMETERS

Specifications	Model DRA-480	Model DRA-490
Display	5 digits	5 digits
Ratio Range	0.0000-1.0999	0.0000-1.0999
Accuracy*	±2 digits	±2 digits
Controls	Digits gain, power on-off-standby	Digits gain, power on-off-standby, reference selector
External Reference	1 volt rms	Choice of 3

*Calibration at 400 cycles; 60 cycle models also available.

Write for Bulletin 180.9

DC RATIOMETERS

Specifications	Model DRC-400	Model DRC-500	Model DVC-400†
Display	4 digits	5 digits	4 digits, polarity
Ratio Range*	.0000-.9999	.00000-.99999	00.01-99.99 volts
Accuracy	±1 digit	±(0.01% and 1 digit)	±1 digit
Controls	Digits gain, power on-off-standby	Digits gain, power on-off-standby	Digits gain, power on-off-standby
External Reference**	1 to 10 volts	10 to 100 volts	±100 volts

*Models DRA-400L and DRA-500L, 10% overscale read out. For higher ratio ranges, see Bulletin 180.7.

†Recommended for computer applications.

**Internal reference supply optional; specify DRA in place of DRC.

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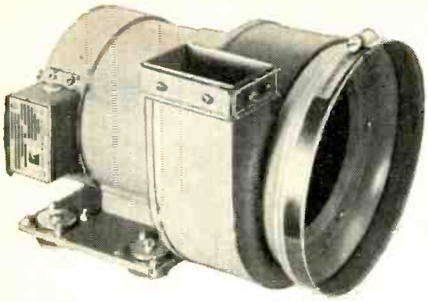

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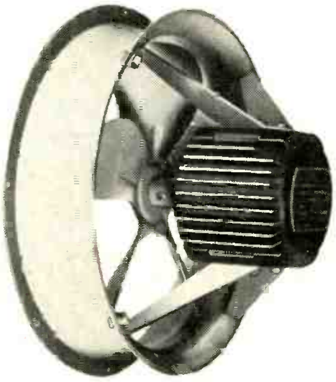

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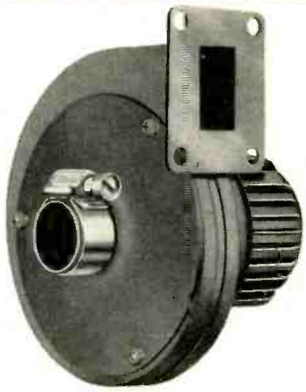

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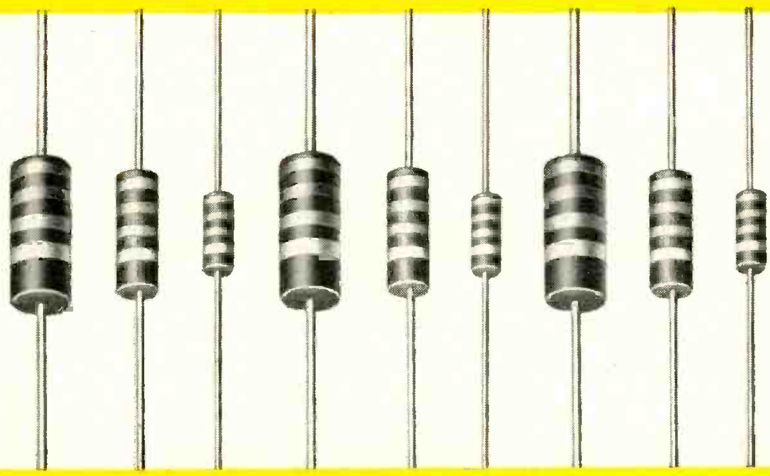

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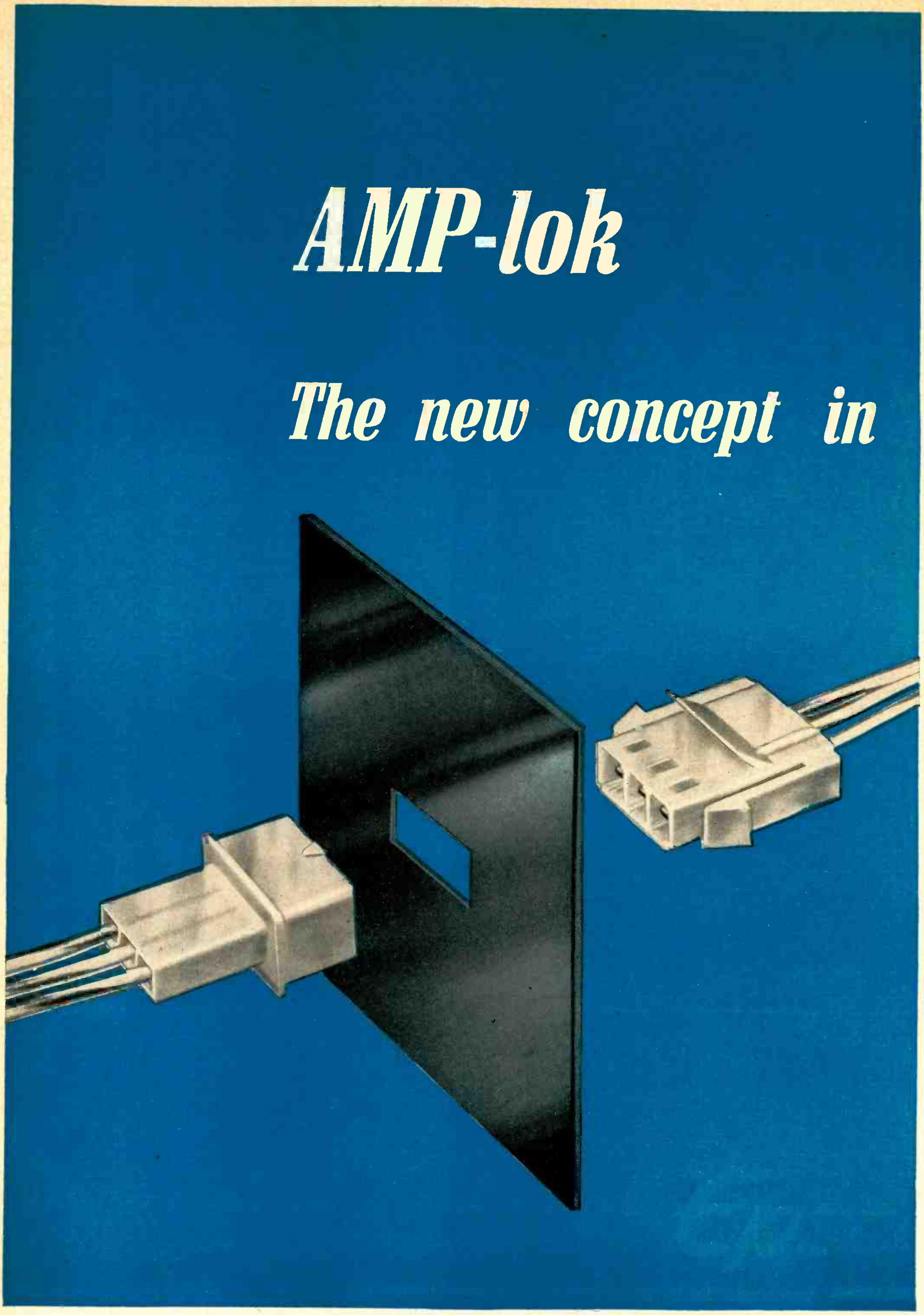
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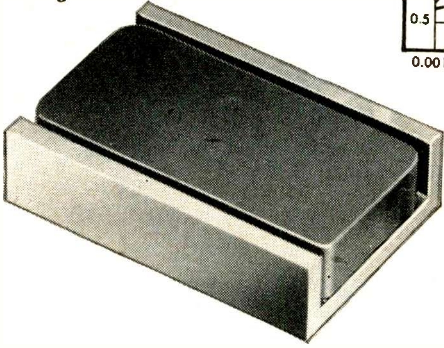
Design Shortcut for Holding Magnets

Richard A. Scholten, Senior Design Engineer, The Indiana Steel Products Company, describes a fast design method that eliminates complex math. Magnet dimensions are obtained by a simple, three-step procedure using basic performance data.



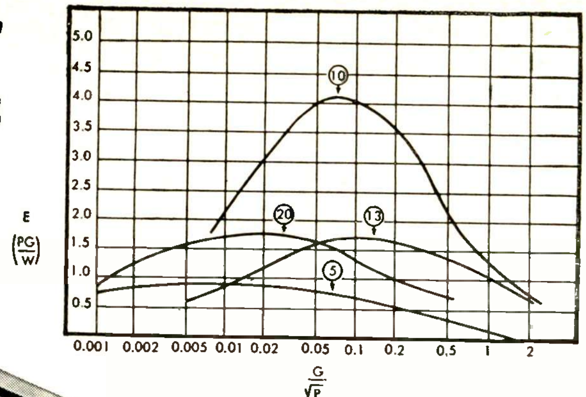


FIG. 2. EFFECTIVENESS CURVES

Indox I (non-oriented) — Design 5
Indox V (oriented) — Design 10
Alnico V (cast) — Designs 13 and 20

In this unique method for designing holding magnets, all the hard work is done with graphs. It requires mathematics no more difficult than cubing a number, then taking its square root.

A comparison of configurations is the key to the method. In most cases any magnet design can be used to predict the performance of any other magnet of the same material and geometric shape—regardless of size.

Only three factors are needed for design: desired pull, air gap and geometric shape. If air gap and each magnet dimension are multiplied by the same factor K, the new system will be geometrically similar and the pull force will vary directly as the area of the magnet pole face.

Material to be used must be considered first. For a discussion of magnet material selection, see *Applied Magnetics*, October-December, 1957. Information on four of the 24 designs analyzed is shown here: Design 5, using an Indox I ceramic magnet; Design 10, using Indox V; and Designs 13 and 20, using cast Alnico V magnets. The four designs are illustrated in Fig. 1.

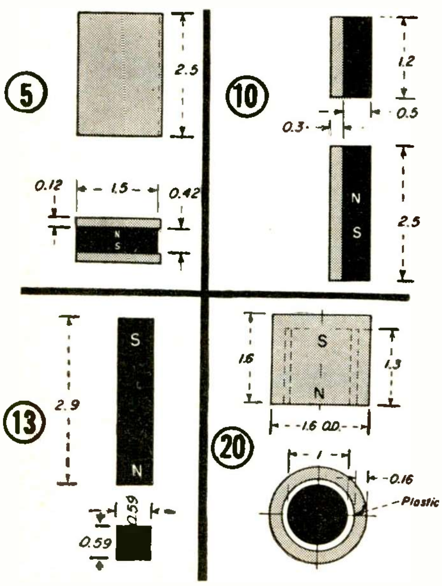


FIG. 1. Four of the basic designs for holding magnets. From these designs other holding magnets, geometrically similar but with any desired pull force, can be derived. Magnetic material is in black, steel in gray; all dimensions are in inches. Design numbers correspond to those on effectiveness curves and in Performance Table II.

Effectiveness curves, Fig. 2, are plotted in terms of pull effectiveness E vs reach factor $G/\sqrt{P}$ (Table I). A magnet with high pull effectiveness has high pull for low magnetic material weight W.

Pull effectiveness E (=PG/W) remains constant between any two geometrically similar magnetic systems because P is proportional to the ratio factor K^2 (face area), G is proportional to factor K (length of magnet) and PG is proportional to volume or weight. This is significant because P and G are known or specified for a new design, and a calculation of W can be made from PG/W.

Reach factor $G/\sqrt{P}$ measures G for a specified pull. P is proportional to area; therefore, $\sqrt{P}$, like G, is proportional to linear dimensions. Result is a constant reach-factor value for all geometrically similar magnets. Thus, the same curves — effectiveness vs reach factor — can be used for any magnets similar to the four design examples, regardless of size.

Zero-gap effectiveness E_o has a different value than for a magnet with an air gap, because in this case G is zero.

TABLE I — Nomenclature

G Air gap, measured from closest point of magnet assembly to armature, in.

P Pull, lb.

W Weight of magnetic material in basic design, lb.

HOW TO USE THE METHOD

EXAMPLE: A holding magnet, air-gap type, is required to produce a 10-lb pull at 0.05-in. gap. Reach factor $G/\sqrt{P}$ is $0.05/\sqrt{10}=0.0158$. In the effectiveness curves shown, Design 10 has the highest effectiveness at this reach factor. From the curve, E = 2.7. If this shape is adaptable to the application, the weight of magnet material required is PG/2.7 = 10 x 0.05/2.7 = 0.185 lb. Design 10 in Performance Table uses 0.27 lb of material, so each linear dimension of Design 10 is multiplied by $K = \sqrt[3]{0.185/0.27} = 0.88$ to establish new magnet dimensions.

TABLE II — Performance of Four Basic Holding-Magnet Designs

		Indox I	Indox V	Alnico V	
Magnetic Material		Indox I	Indox V	Alnico V	
Design Number		5	10	13	20
Weight, lb. — Magnetic Material	Actual Wt.	0.27	0.27	0.27	0.27
Weight, lb. — Magnetic Material	Practical Min.	0.01	0.15	0.01	0.002
Weight, lb. — Magnet Assy. Wt.		0.55	0.53	—	0.72
Pull for Air Gaps Shown, lb.	0.00	77	20	19	60
	0.002	46	—	—	—
	0.005	39	—	—	41
	0.010	25	—	12.0	32
	0.02	12.0	17.6	9.7	22
	0.04	6.0	14.5	7.2	12.0
	0.08	2.0	11.0	5.2	6.0
	0.15	—	7.5	3.1	2.4
	0.3	—	3.2	1.3	0.8
	0.6	—	0.8	0.4	—

A complete reprint of "Short Cut for Holding-Magnet Design" appears in the October-December, 1957, Applied Magnetics. The article covers the 24 basic designs of holding magnets in all magnetic materials, and discusses material selection considerations in detail. Write for your free copy . . . Dept. A-3.

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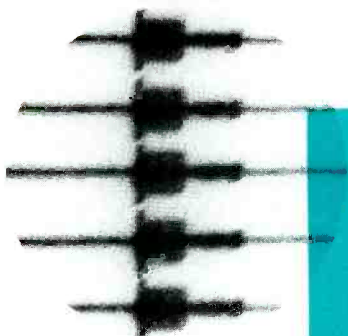

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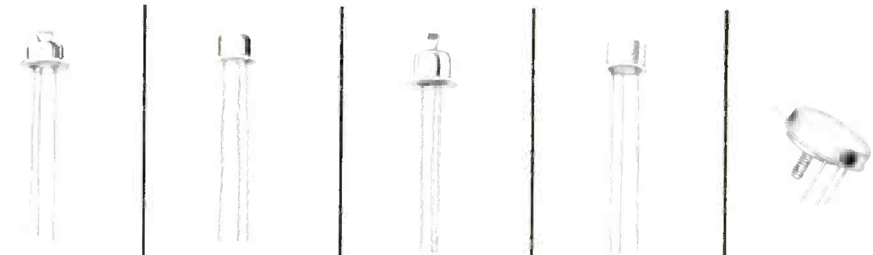

Line	Material	Application	INLINE LEAD PNP	TRIANGULAR LEAD PNP	INLINE LEAD NPN	TRIANGULAR LEAD NPN	POWER NPN
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		UNIJUNCTION				2N489* 2N490* 2N491* 2N492* 2N493* 2N494* *A PN Device	
		POWER					2N451 2N452 2N453 2N454
	GERMANIUM	AUDIO PNP	2N43 2N43A 2N44 2N44A	2N525			
		COMPUTER PNP	2N123	2N394 2N395 2N396 2N397 2N450 2N518			
		COMPUTER NPN			2N78 2N167		
		HIGH FREQ. AMPLIFIER NPN			2N78		
		TETRODE NPN				4JD3B1	
ENTERTAINMENT	GERMANIUM	IF NPN			2N168A 2N169 2N169A 2N292 2N293		
		AUDIO PNP	2N186 2N186A 2N187 2N187A 2N188 2N188A 2N189 2N190 2N191 2N192 2N241 2N241A 2N265	2N319 2N320 2N321 2N322 2N323 2N324 2N508			

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General Electric Company
4927 Oakton Street
Skokie, Illinois
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GENERAL ELECTRIC

ECG-280 2-58

PRINTED IN U.S.A.

RECTIFIERS for your ev

SILICON / GERMANIUM | G-E Semico

GREATER POWER – HIGHER TEMPERATURE RATINGS | the largest se

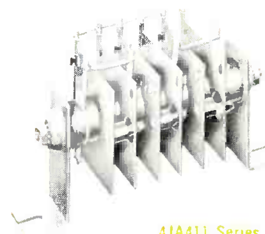
1N1115 Series
1N253 Series

1N1115 Series: For direct chassis mtd., or on fins, permitting forward currents up to 1.5 amps, temperature up to 170° C with derating. Extremely low reverse current at max. junction temperature. **1N253 Series** offers specifications designed for applications requiring forward current up to 1.0 amp, temperature up to 150° C, such as power supplies and magnetic amplifiers.

SILICON LOW CURRENT

1N536 Series 1N1095 96
1N440 440B Series 1N1487 Series

1N536 Series: 1N1095-96: Designed for maximum forward conductance at high operating temperatures. The **1N440-440B Series** is similar to the 1N536 Series but with extremely low reverse current. The **1N1487 Series** provides less expensive units for lower temperature requirements. No heat sink required. Ratings up to 160° C ambient.



4JA411 Series

4JA411 Stacks: Combine high temperature operation (up to 150° C) with increased ratings (up to 18 amps d-c). Hundreds of stack combinations to meet a variety of circuit conditions. High efficiency plus excellent regulation.

4JA60
4JA61
4JA62
4JA63
Series

SILICON HIGH CURRENT

Large a
puts as
6211 u
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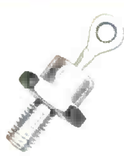


1N1301 Series

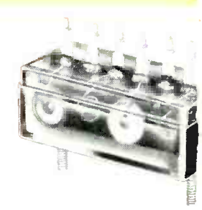
Designed for individual cell applications in the 2 to 20 amp. range. High junction temperature ratings, extremely low forward voltage drop and thermal resistance. May be mounted directly or electrically insulated from heat sink with mica-washer mounting kit provided with each unit.

SILICON MEDIUM CURRENT

4JA3511 Series

Stacks provide a broad range of power applications with d-c outputs up to 100 amps.

Mounted in standard eigh
and 4JA420 Series) or rec
lug connections (4JA221
able in a large number of
to six cells may be potted
vidual cell specifications de
from free air ratings is not n
utilize 1N91-93 cells; 4JA42
540, 1N1095-96 cells. (See B



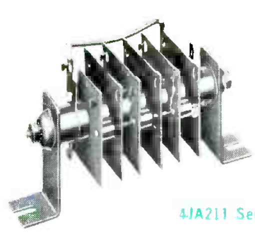
4JA221 Series (Germanium
4JA421 Series (Silicon)

USAF1N315, 1N315; 1N368
1N91 Series

USAF1N315: 1N315: Designed for high operating temp. (up to 85° C) and low reverse current. USAF1N315 meets Air Force Specification MIL-E-1/1088. The **1N368** type features a very low reverse current at a high d-c reverse voltage.

1N91 Series: Alloyed junction type combining very low forward resistance with high back resistance to give almost 100% efficiency. **1N93** is the commercial version of the G-E U.S. Navy approved USN 1N93 rectifier. **1N151 Series** and **1N158** are single and double-fin units, respectively.

GERMANIUM LOW CURRENT



4JA211 Series

4JA211 Stacks: The industry's most widely used semiconductor rectifier. Hundreds of of thousands in use. May be arranged in stacks up to 12 fins to produce over 160 different circuit configurations. Small size, light weight, excellent regulation.

Single Fin Mount

GERMAN MEDI CURRE

For
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effici
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85° C

G-E rectifiers are designed to meet rigid military mechanical and environmental specifications.

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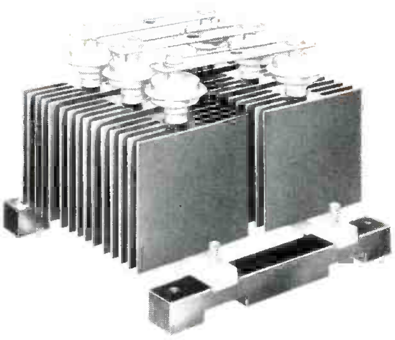
nductor Rectifiers are lling in the industry!



4JA6011 6211 Series

rea junction type. Operating temperature to 200° C. D-C out- high as 85 amps per rectifying element. Lower cost 4JA62 and its are for applications which do not require the full current of 4JA60 line. Reverse polarities provided in 4JA61 and 4JA63 tack combinations offer d-c outputs up to 915 amps.

t-pin tube base (4JA220 ngular design with solder high as 4JA421 Series). Avail- ircuit configurations. One in a single circuit. Indi- termine ratings. Derating ecessary. 4JA220-21 Series)-21 Series utilizes 1N536- ASIC RATING CHART)

4JA220 Series (Germanium)
4JA420 Series (Silicon)

POTTED RECTIFIER CIRCUITS

IUM
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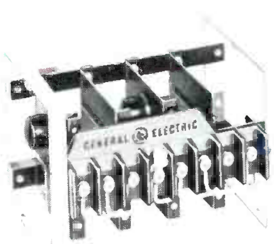
NT



4JA3011 Series

general purpose power supplies, control devices, blocking cir- and many other applications. Extremely low power dissipa- and forward voltage drop provide excellent regulation and ncy. Available in stacks up to 12 fins providing ratings in ands of watts, depending on circuit design, with operation to . Transient PIV's up to 600 volts per cell.

BASIC RATING CHART

Choose the performance range required for your particular needs from one of the most comprehensive line of rectifiers in the industry. Complete specifications are available through your distributor or G-E Semiconductor Products Dept. District Sales Office. Order by JETEC or G-E Type No.

RECTIFIER CELLS

JETEC or G-E Type No.	PIV	Max. I_{DC} at T°C	Max. 1 Cycle (60 cps) Surge	Max. Storage Temp. °C
1N91	100	150ma at 55° amb.	25A	85°
1N92	200	100ma at 55° amb.	25A	85°
1N93	300	75ma at 55° amb.	25A	85°
USN1N93	300	75ma at 55° amb.	25A	85°
1N151	100	500ma at 55° amb.	25A	85°
1N152	200	500ma at 55° amb.	25A	85°
1N153	300	500ma at 55° amb.	25A	85°
1N158	380	500ma at 55° amb.	25A	85°
1N253	95	1000ma at 135° stud	4A	150°
1N254	190	400ma at 135° stud	1.5A	150°
1N255	380	400ma at 135° stud	1.5A	150°
1N256	570	200ma at 135° stud	1.5A	150°
1N315	100	100ma at 85° amb.	5A	95°
USAF1N315	100	100ma at 85° amb.	5A	100°
1N368	200	100ma at 85° amb.	10A	85°
1N440	100	300ma at 100° amb.	15A	175°
1N440B	100	500ma at 100° amb.	15A	175°
1N441	200	300ma at 100° amb.	15A	175°
1N441B	200	500ma at 100° amb.	15A	175°
1N442	300	300ma at 100° amb.	15A	175°
1N442B	300	500ma at 100° amb.	15A	175°
1N443	400	300ma at 100° amb.	15A	175°
1N443B	400	500ma at 100° amb.	15A	175°
1N444	500	300ma at 100° amb.	15A	175°
1N444B	500	425ma at 100° amb.	15A	175°
1N445	600	300ma at 100° amb.	15A	175°
1N445B	600	350ma at 100° amb.	15A	175°
1N536	50	500ma at 100° amb.	15A	175°
1N537	100	500ma at 100° amb.	15A	175°
1N538	200	500ma at 100° amb.	15A	175°
1N539	300	500ma at 100° amb.	15A	175°
1N540	400	500ma at 100° amb.	15A	175°
1N1095	500	425ma at 100° amb.	15A	175°
1N1096	600	350ma at 100° amb.	15A	175°
1N1115	100	1.5A at 85° stud	15A	175°
1N1116	200	1.5A at 85° stud	15A	175°
1N1117	300	1.5A at 85° stud	15A	175°
1N1118	400	1.5A at 85° stud	15A	175°
1N1119	500	1.5A at 85° stud	15A	175°
1N1120	600	1.5A at 85° stud	15A	175°
1N1301	50	1.5A at 85° stud	300A	200°
1N1302	100	15A at 160° stud	300A	200°
1N1304	200	15A at 160° stud	300A	200°
1N1306	300	15A at 160° stud	300A	200°
1N1487	100	250ma at 125° amb.	15A	175°
1N1488	200	250ma at 125° amb.	15A	175°
1N1489	300	250ma at 125° amb.	15A	175°
1N1490	400	250ma at 125° amb.	15A	175°
1N1491	500	250ma at 110° amb.	15A	175°
1N1492	600	250ma at 95° amb.	15A	175°
4JA60A	100	70A at 120° stud	900A	200°
4JA60B	200	70A at 120° stud	900A	200°
4JA60C	300	70A at 120° stud	900A	200°
4JA60F	50	70A at 120° stud	900A	200°
4JA60G	150	70A at 120° stud	900A	200°
4JA60H	250	70A at 120° stud	900A	200°
4JA61A	same as 4JA60A, except reverse polarity			
4JA61B	same as 4JA60B, except reverse polarity			
4JA61C	same as 4JA60C, except reverse polarity			
4JA61F	same as 4JA60F, except reverse polarity			
4JA61G	same as 4JA60G, except reverse polarity			
4JA61H	same as 4JA60H, except reverse polarity			
4JA62A	100	40A at 120° stud	900A	200°
4JA62B	200	40A at 120° stud	900A	200°
4JA62C	300	40A at 120° stud	900A	200°
4JA62D	400	40A at 120° stud	900A	200°
4JA62F	50	40A at 120° stud	900A	200°
4JA62G	150	40A at 120° stud	900A	200°
4JA62H	250	40A at 120° stud	900A	200°
4JA62J	350	40A at 120° stud	900A	200°
4JA63A	same as 4JA62A, except reverse polarity			
4JA63B	same as 4JA62B, except reverse polarity			
4JA63C	same as 4JA62C, except reverse polarity			
4JA63D	same as 4JA62D, except reverse polarity			
4JA63F	same as 4JA62F, except reverse polarity			
4JA63G	same as 4JA62G, except reverse polarity			
4JA63H	same as 4JA62H, except reverse polarity			
4JA63J	same as 4JA62J, except reverse polarity			

RECTIFIER STACKS

G-E Type	PIV (up to)	Max. I_{DC} at T°C (up to)
4JA211	630 V	6 amps. at 55° amb.
4JA411	3360 V	18 amps. at 25° amb.
4JA3011	630 V	48 amps. at 55° amb.
4JA3511	630 V	100 amps. at 55° amb.
4JA6011	810 V	573 amps. at 35° amb.
4JA6211	840 V	430 amps. at 35° amb.

SILICON / GERMANIUM ADVANCEMENTS

MEAN GREATER STABILITY – FASTER SWITCHING – MORE POWER

General Electric's new streamlined line of transistors offers you both standard reliable transistors that you have used successfully for years, and exciting new devices that are extending the range of applications suitable for transistorization.

For multivibrators, pulse generators, flip-flops, etc., the Unijunction Transistor enables you to simplify circuitry, and in many cases reduce the number of transistors used by as much as half.

For servo amplifiers, switches, DC to DC (or AC) converters, etc., G.E.'s Silicon Power Transistor's power handling ability allows you to design equipment never before practical.

For high frequency switching applications, the 2N394-2N397's extreme stability of h_{FE} and I_{CO}-I_{EO} simplify your design problems and contribute to high equipment reliability.

Whatever your application is, be sure to check your G-E Semiconductor Products District Sales Manager first.

MAXIMUM RATINGS				TYPICAL VALUES						
MAXIMUM COLLECTOR DISSIPATION @ 25° C (mw) P_C	BREAKDOWN VOLTAGE (VOLTS) BV_{CB}	COLLECTOR CURRENT (ma) I_C	MAXIMUM STORAGE TEMP. (°C) T_{STG}	D-C CURRENT GAIN h_{FE}	ALPHA CUTOFF FREQ. (mc) f_{ab}	POWER GAIN (db) G_e	SATURATION VOLTAGE (VOLTS) V_{CE} (SAT)	COLLECTOR CAPACITY ($\mu\mu f$) C_{ob}	COLLECTOR TO BASE CURRENT (μa) MAX I_{CO}	@ V_{CB}
150	45	25	200	15	30.0	35	.4	7	4	30
150	45	25	200	35	33.0	39	.4	7	4	30
150	45	25	200	50	38.0	42	.4	7	4	30
P_{AV}	BV_{BB}	I_E		η	f_{MAX}	R_{BBO}	V_E (SAT)	I_{B2} (MOD)	I_{EO} @ V_{EB}	
350	45	50	200	0.56	0.9	5.6	2.2	12	1	60
350	55	50	200	0.56	0.7	7.5	2.4	12	1	60
350	45	50	200	0.62	0.8	5.6	2.6	12	1	60
350	55	50	200	0.62	0.7	7.5	2.8	12	1	60
350	45	50	200	0.68	0.7	5.6	3.0	12	1	60
350	55	50	200	0.68	0.65	7.5	3.2	12	1	60
P_C	BV_{CE}	I_C		h_{FE}	f_{ae}	R_{SE} (MAX) Ohms			I_{CO}(ma) @ V_{CB}	
85w	65	5A	150	16	400kc	4			20	65
85w	65	5A	150	12	400kc	2.5			50	65
85w	30	2A	150	30	400kc	6			20	30
85w	65	2A	150	15	400kc	10			20	65
					f_{ab}	G_e	Freq of G_e	C_{ob}	(μa)	
240	−30	−300	100	53	1.3			40	−16	−45
155*	−25*		100	53	1.3			40	−16	−45
240	−30	−300	100	31	1.0			40	−16	−45
155*	−25*		100	31	1.0			40	−16	−45
240	−30	−300	100	52	2.5			25	−10	−45
*Ratings based on military test requirements										
150	−15	−125	85	30 Min.	8.0			15	−6	−20
150	−10	−200	100	20 Min.	5.5			12	−6	−10
150	−15	−200	100	25 Min.	7.0			12	−6	−15
150	−20	−200	100	30 Min.	7.0			12	−6	−20
150	−10	−250	100	30 Min.	10.0			12	−6	−10
150	−12	−125	85	30 Min.	6.0			12	−6	− 6
150	−12	−125	85	60 Min.	11.0			12	−6	−12
65	15	20	85	70	9.0			3	5	15
75	30	75	85	30	9.0			2.5	1.5	15
65	15	20	85	70	9.0	28	500kc	3	5	15
50	10	20	85		100.0	14	60mc	1.8	25	7
65	15	20	85	40	8.0	30	455kc	2.4	5	15
65	15	20	85	72	9.0	24	455kc	2.4	5	15
65	25	20	85	72	9.0	24	455kc	2.4	5	15
65	15	20	85	25	6.0	24	455kc	2.4	5	15
65	15	20	85	25	7.0	30	455kc	2.4	5	15
							P_o			
100	−25	−200	85	24	0.8	28	300	40	−16	−25
200	−25	−200	85	24	0.8	30	750	40	−16	−25
100	−25	−200	85	36	1.0	30	300	40	−16	−25
200	−25	−200	85	36	1.0	30	750	40	−16	−25
100	−25	−200	85	54	1.2	32	300	40	−16	−25
200	−25	−200	85	54	1.2	32	750	40	−16	−25
75	−25	− 50	85	24	0.8	37		40	−16	−25
75	−25	− 50	85	36	1.0	39		40	−16	−25
75	−25	− 50	85	54	1.2	41		40	−16	−25
75	−25	− 50	85	75	1.5	43		40	−16	−25
100	−25	−200	85	73	1.3	35	300	40	−16	−25
200	−25	−200	85	73	1.3	35	750	40	−16	−25
75	−25	− 50	85	110	1.5	45		40	−16	−25
240	−20	−200	85	33	2.0	30	750	25	−16	−25
240	−20	−200	85	48	2.5	32	750	25	−16	−25
240	−20	−200	85	48	3.0	35	750	25	−16	−25
140	−16	−100	85	70	2.0	39		25	−16	−16
140	−16	−100	85	90	2.5	41		25	−16	−16
140	−16	−100	85	80	3.0	43		25	−16	−16
140	−16	−100	85	125	3.5	45		25	−16	−16

1 NEW

AMPHENOL

actual size

STUB E

Smallest, Lightest MS "E" Connectors

STUB E connectors are the shortest, smallest, lightest MS "E" connectors available. Fully conforming to MIL-C-5015C environmental resistance requirements, ***STUB E'S*** are available in MS3100E, MS3101E, MS3102E and MS3106E shell types; 50 standard MS insert configurations will be available.

An outstanding feature of ***STUB E*** connectors, aside from the significant space-saving, weight-saving design, is the fully *unitized* rear sealing grommet assembly which provides easy—fast assembly. Solder pockets of the silver-plated contacts are pre-filled for instant, low cost soldering.

2 NEW

High Temperature MS "E"-type Connectors

Real ***"E"*** connectors—environmentally resistant MS "E"-type construction with an operating temperature range from −103°F. to +400°F. and limited operation to +500°F. Smaller even than AMPHENOL Stub E connectors, ***REALE'S*** feature unique Poke Home contacts with braze- or crimp-type terminations that are wired *outside* the connector body and poked home for assembly. By the use of resilient silicone rubber inserts, full *unitized* rear grommet and cable clamp, face seals and shell peripheral seals, an optimum "E" construction is achieved.

Ideal for high altitude applications under temperature cycling, ***REALE*** connectors have exceptional current conductivity efficiency: 80% at 78°F. and 64% at 500°F.

REALE'S can be truthfully described as the finest MS-type connectors now available.

½ actual size

AMPHENOL

Real E

IRE 1958

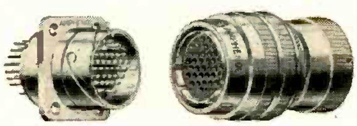
See us in Booths 2321-2327

3 NEW

First True Miniature "E"

MINNIE'S are the first miniature connectors to meet fully the "E" performance requirements of MIL-C-5015C. Available as 4 shell types in 4 constructions in 5 shell sizes, ***MINNIE'S*** have a test voltage rating of 1500 volts RMS when sealed with no derating at elevated altitudes. Operating temperature limits are −67°F. to +257°F.

MINNIE connectors have spring-loaded coupling rings to provide a positive locking action and a constant compensating force against the effects of any possible face seal compression "set." 5 stainless steel bayonet pins and slots are used. A unitized rear grommet and cable clamp individually seals and protects each wire lead. The face seal gasket has individual isolating contact barriers.



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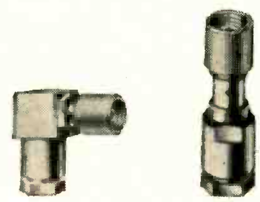
AMPHENOL

MINNIE

4 NEW

AMPHENOL



actual size

SUB*Minax*®

field serviceable

No Special Tools for Assembly!

Field serviceable Subminax connectors, for use with RG-196/U Teflon cable, represent a new concept in subminiature RF components. With all parts kept to an absolute minimum, these new connectors *require no special assembly tools.* By simple wrench-tightening, the improved cable clamp firmly grips the smooth Teflon cable, providing maximum cable retention strength. Two Teflon insulators hold the center contact securely in place, preventing possible axial float. Voltage rating is 500 volts peak.

50 ohm plugs, jacks, bulkhead jacks and right angle plugs are available in screw-on and push-on couplings; they mate with the 50 ohm types in the standard Subminax line.

1958 IRE

AMPHENOL ELECTRONICS CORPORATION • CHICAGO 50, ILLINOIS

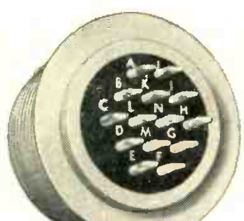
7 NEW

Contact Letters on Glass!

AMPHENOL production engineers have achieved a remarkable *first*. Hermetically sealed MS-type receptacles with *contact identification on the glass insert* are now available—and available only from AMPHENOL. White lettering is provided on both the front and back of the brown glass insert—all letters are sharply cut and legible.

AMPHENOL's *Idento*seals thus combine the advantages of a single *compression-sealed* glass insert with quick and easy identification of each contact —they are labor-saving to use, both in initial assembly and in circuit checkouts.

*Idento*seals mate with standard MS plugs with female inserts. They are available with round or square flange, or in a flangeless shell.

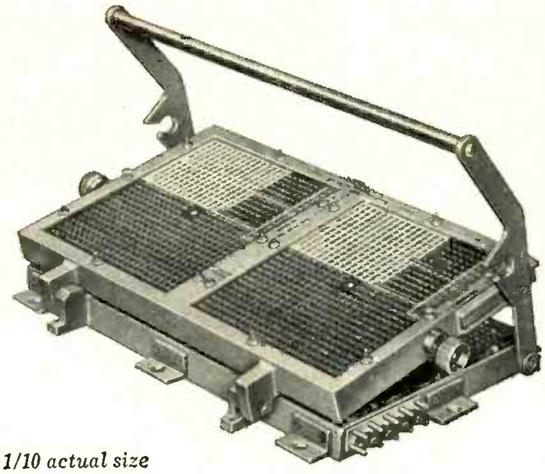


½ *actual size*

AMPHENOL

Idento SEALS

AMPHENOL



1/10 actual size

CUSTOM ENGINEERING

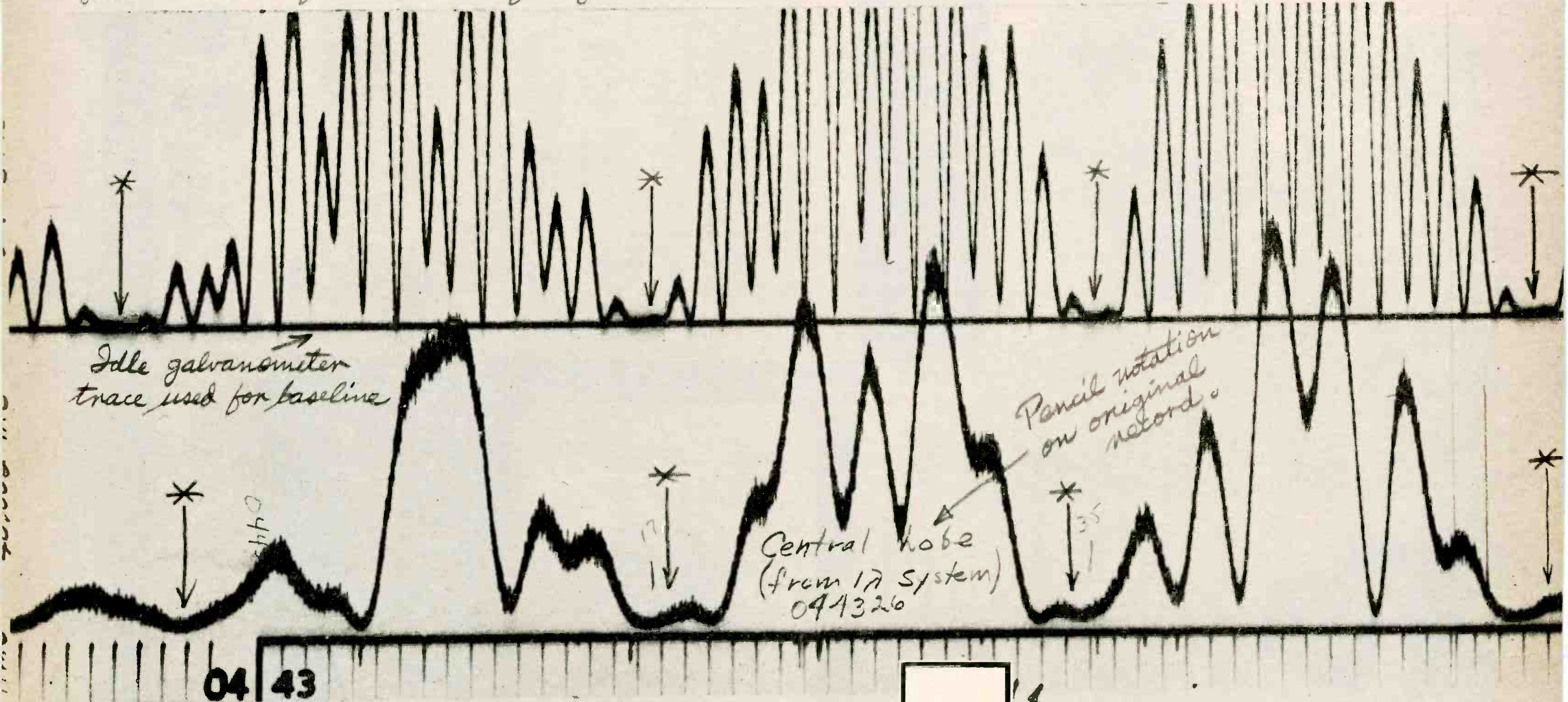
AMPHENOL Custom Engineering adapts standard components or designs new components to special performance and application requirements. By working closely with customer engineering personnel, AMPHENOL can tailor electrical and mechanical characteristics of a new design to an exact application, with resulting tailor-made reliability.

The 1280 contact Programming Board illustrated is an impressive example of AMPHENOL Custom Engineering. The performance requirements in resistance to both shock and vibration were so stringent that no conventional programming board could be used. Example: This Programming Board withstands a shock of 30 G's applied three times along three perpendicular axes. Its outstanding design is typical of the results to be expected from AMPHENOL Custom Engineering.

1958 IRE

AMPHENOL ELECTRONICS CORPORATION • CHICAGO 50, ILLINOIS

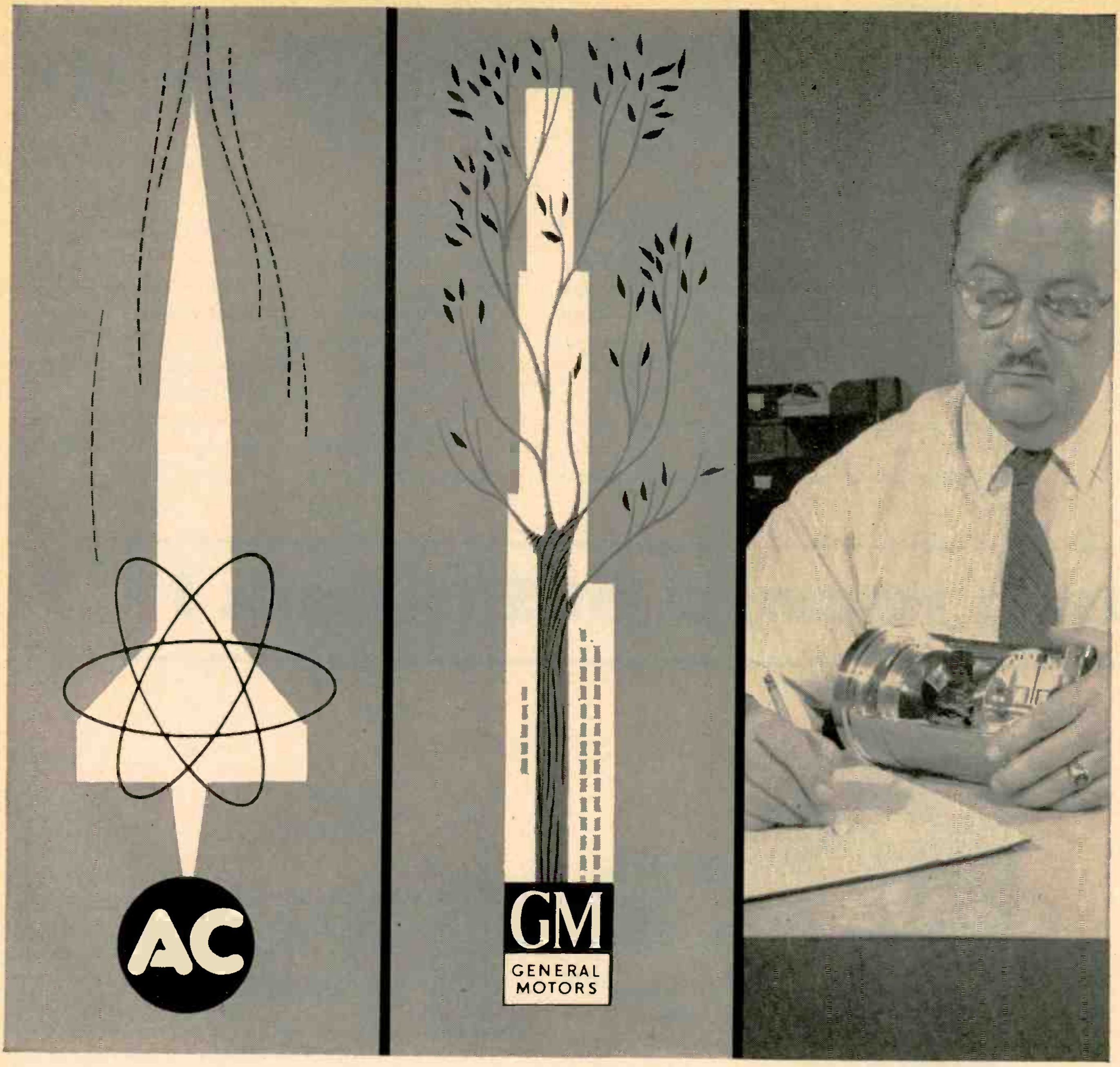
#2 This picture shows slightly less than one minute of a record perhaps 10 minutes long. It is a good interferometer record, though not quite as "pretty as #1. It has a very good record of WWV timing signals.



Timing "ticks" (seconds) from WW[illegible]

* - Nulls in pattern of interferometer antenna [illegible]. The other lobes & nulls (fine structure) are signal fading.

this



THIS IS A CHALLENGE . . . AC, today, is counted among the leaders in the electronics industry, working full speed to meet vital commitments for our armed forces . . . and for industry, too.

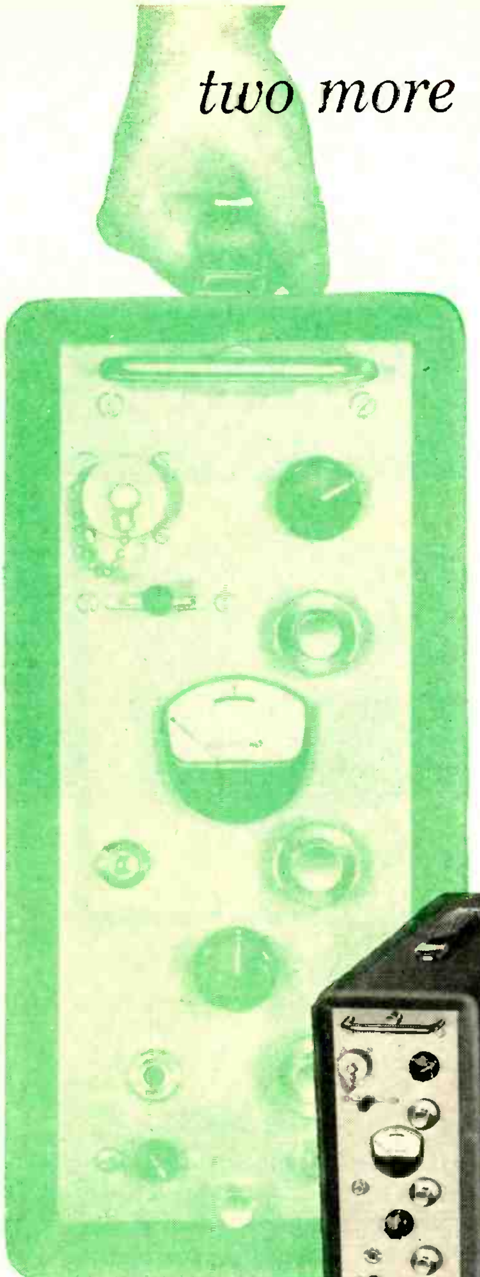
THIS IS A SOUND FUTURE . . . AC, like all General Motors, is soundly based and increasing in size each year. Here is security and an opportunity to grow with a growing organization.

THIS MAY BE FOR YOU . . . Read over the product list below. There are opportunities today with the engineering groups working on each one of these items.

AC is now looking for experienced men who hold degrees in mechanical or electrical engineering. If you have from 3 to 10 years' technical experience in one of these fields, and the idea of working with AC's Milwaukee group appeals to you, write Mr. Cecil Sundeen, Supervisor of Technical Employment, Dept. A, in care of AC . . . the Electronics Division of General Motors, 1925 E. Kenilworth, Milwaukee 1, Wisconsin.

. . . THE ELECTRONICS DIVISION OF GENERAL MOTORS
Milwaukee 1, Wisconsin

Afterburner Fuel Controls • Bombing Navigational Computers • Emergency Fuel Controls • Gun-Bomb-Rocket Sights • Gyro-Accelerometers • Gyroscopes Inertial Guidance Systems • Manifold Air Pressure Regulators • Speed Sensitive Switches • Speed Sensors • Three-Way Selector Valves • Torquemeters



two more UNIT PREAMPLIFIERS

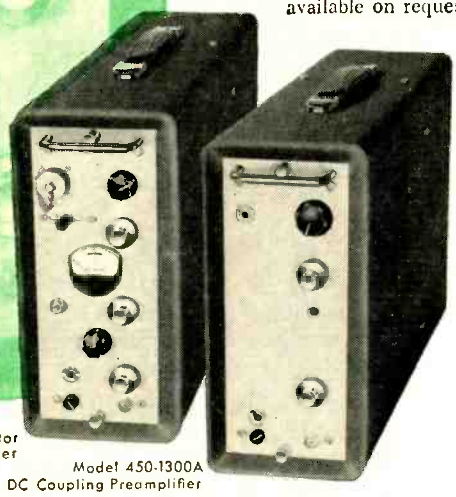
in the new

SANBORN "450" SERIES

Here are the newest of the recently introduced Sanborn "450" Series Unit Preamplifiers—compact, lightweight, self-contained instruments for use with optical and tape recorders, wide band 'scopes, panel meters, computers, etc. (For use with high speed optical galvanometers at frequencies above 500 cps, requiring larger current swings, a transistor output amplifier is built into the 450-1800A True Differential DC type and available as optional equipment on other 450's.) As with all 450 Unit Preamplifiers, the new Servo Monitor and DC Coupling models mount in either individual portable cases or in the four-unit 19" module frame (#354-1100-C2) shown. The *450* designation refers to *unit packaging* of Sanborn 350 Preamplifiers and Power Supplies in individual 450 cases. Loosening two front panel thumbscrews allows quick, simple interchangeability. Since *all* "450" Preamps use the 350-500 Power Supply (which remains in place at the rear of the frame or case), new requirements necessitate only additional *Preamplifier* units, permitting sizable savings in equipment investment.

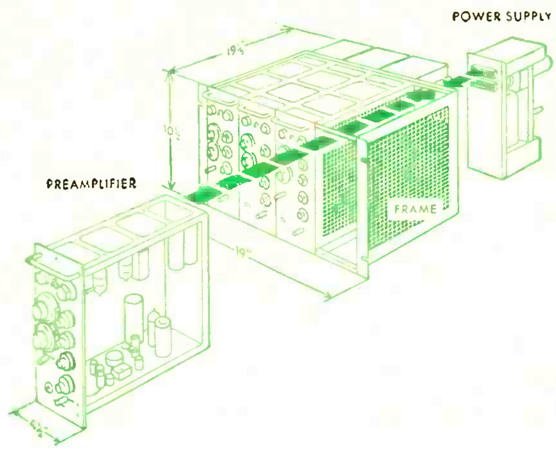
The Model 450-1200 is a phase-sensitive demodulator, whose DC output voltage is proportional to the in-phase (or 180° out-of-phase) component of an AC signal with respect to a reference. Precision measurement is realized by such characteristics as negligible quadrature signal error, provision for floating signal and reference inputs, front panel VTVM for accurate calibration signals. The 450-1200 accepts the outputs of resolvers, synchros, differential transformers and other transducers. The 450-1300A is a moderate gain, balanced input—balanced output DC amplifier. Its input circuit performs equally well with single-ended or balanced signals.

The "450" Series Unit Preamplifiers presently include the Model 450-1100 Carrier, 450-1200 Servo Monitor, 450-1300A DC Coupling and 450-1800A True Differential DC types. Following these will be "450" Series Logarithmic and Low Level types. Further data and application information on present models is available on request.



Model 450-1200 Servo Monitor (Demodulator) Preamplifier

Model 450-1300A DC Coupling Preamplifier



MAJOR SPECIFICATIONS

MODEL 450-1200 SERVO MONITOR PREAMPLIFIER

Sensitivity: 5 mv (in phase) produces 1 volt at output jack under maximum output load conditions
Input Impedance: Signal 100k
Reference 12.5k for 15 volts, 55k for 120 volts
Frequency Response: 3db down at 20% of carrier frequency filter position
Carrier Frequency Filter: Selected by a switch (three positions)
Low 60 cycles
Med 400 cycles
Hi 1000 cycles (5000 cycles optional)
Reference Voltage: Internal selection accepts voltages from 15 to 120 volts
Quadrature Rejection: Ratio better than 100:1
Maximum permissible quadrature before overload indicator lights is twice full scale (in phase)
Calibrate Voltage: 10 millivolts internal (set by meter on panel)
Drift: Less than 0.1% of full scale per hour
Preamplifier Output Jack: ±3 volts available into 2.2k minimum load resistance. Output appears across two cathodes at approximately ground potential
Rear inputs and overload indicator lights are included
Output Impedance: 1k
Overall Linearity: ±¼%
Power Requirements: 115 volts, 50-400 cycles, approximately 35 watts

MODEL 450-1300A DC COUPLING PREAMPLIFIER

Sensitivity: 50 mv produces 1 volt at output jack under maximum output load conditions

Input Impedance: 5 megohms each input side to ground

Input: Single-ended or push-pull

Preamplifier Output Jack: ±3 volts into 2.2k minimum load resistance. Output is balanced and appears across 2 cathodes at approx. ground potential

Output Impedance: 1k

Drift: Referred to input 2 mv/hr. line voltages change less than 10%

Frequency Response: 0-20kc

Calibration: 100 millivolts internal

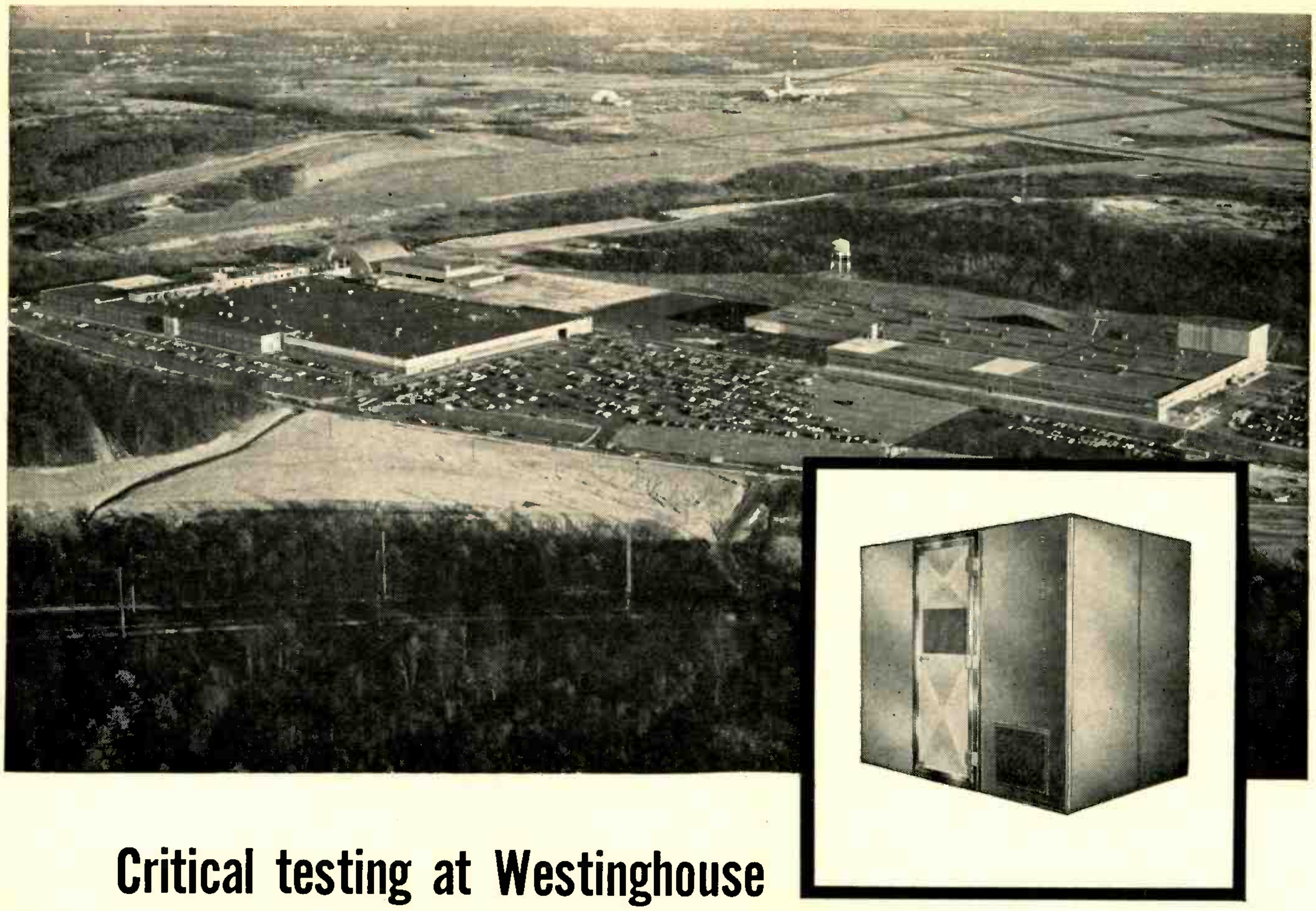
Linearity: ±¼%

Rear inputs included

See the new "450's" and other Sanborn equipment at Booth 3601-3603 I. R. E. Show

SANBORN COMPANY
INDUSTRIAL DIVISION
175 WYMAN STREET, WALTHAM 54, MASS.

CIRCLE 23 READERS SERVICE CARD



Critical testing at Westinghouse conducted in 49 Ace shielded enclosures

The Westinghouse Electronics and Air Arm Divisions, Friendship Airport, Baltimore, Md. plants, have almost unbelievably high r-f interference ambient caused by radar transmitters, missiles, military planes, spot welders, motors, powerful transmitters, and other types of electric/electronic equipment. Testing critical electronic equipment under these adverse interference conditions is extremely difficult. The slightest outside interference would distort readings.

Westinghouse takes no chances. The flight control fighter armament systems, missile guidance systems, radar, and ship-board transmitters under design and development at the plant are completely shielded from outside interference and from each other by 49 Ace shielded enclosures.

See us at the IRE Show—Booth 1728.

The Ace patented RFI and Cell-Type Designs* provide the high attenuation required for satisfactory results at all frequencies. All enclosures are designed and constructed to insure permanent r-f leak-proof performance. Size-flexibility is another feature. The modular construction of the panels and doors permits rapid alteration of the size of the enclosure. Small rooms can be joined to make larger units or large enclosures can be converted into smaller ones.

If you have a shielding problem—big or small—in your plant, you'll want to talk to an Ace Engineer about an effective yet economical solution. Be sure to write for free catalog on standard Ace enclosures.

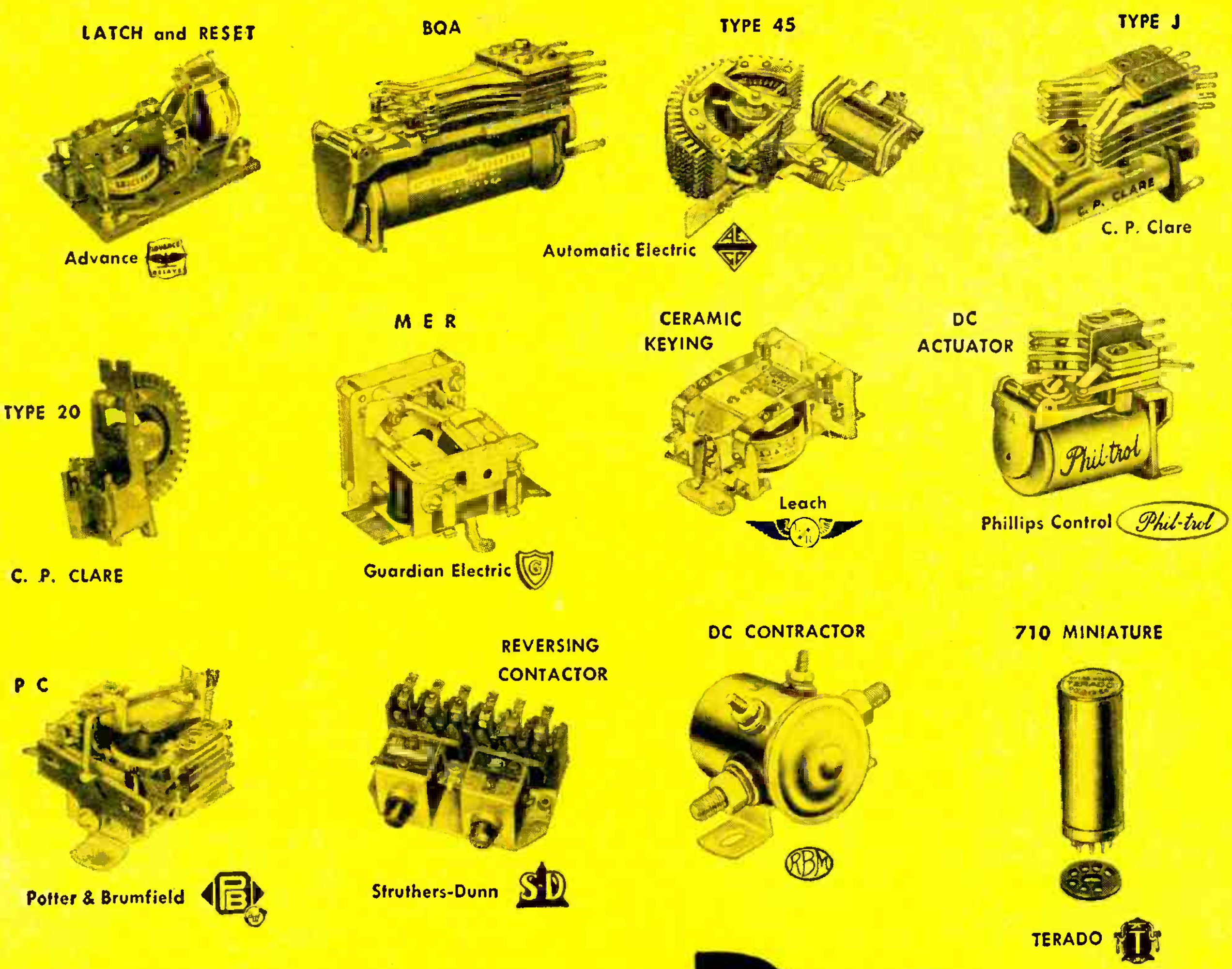
*Lindsay Structure

First and Finest in Shielded Enclosures

ACE ENGINEERING AND MACHINE CO., INC.

Tomlinson Road • Huntingdon Valley • Pennsylvania

12 POPULAR MODELS FROM OUR STOCK OF OVER A MILLION RELAYS



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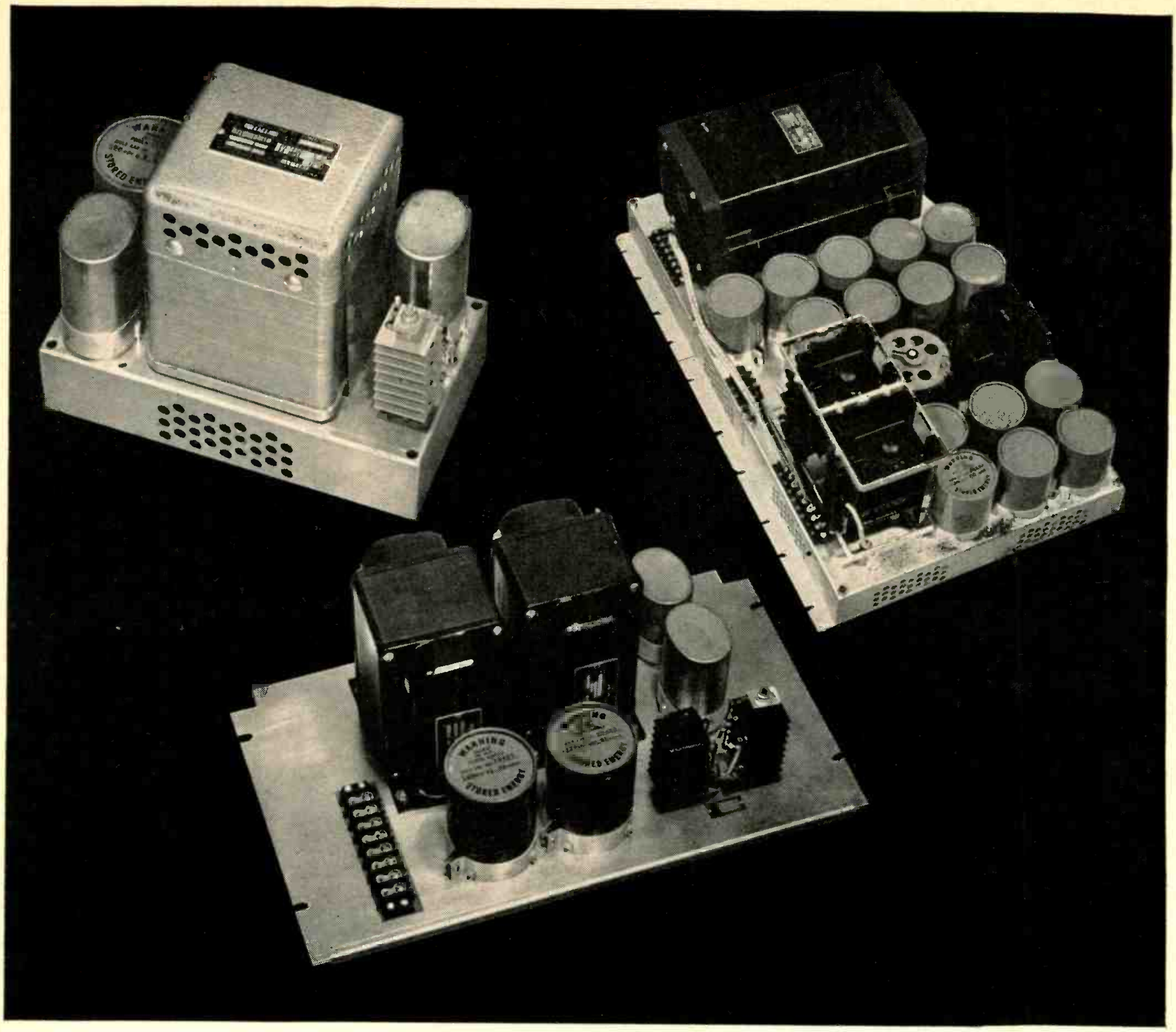
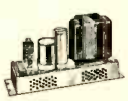
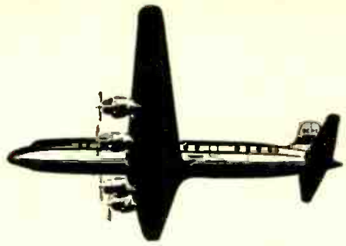




CIRCLE 27 READERS SERVICE CARD

AEROCOM'S 1046 H. F. TRANSMITTER



POWER + STABILITY

1000 WATTS WITH .003% STABILITY

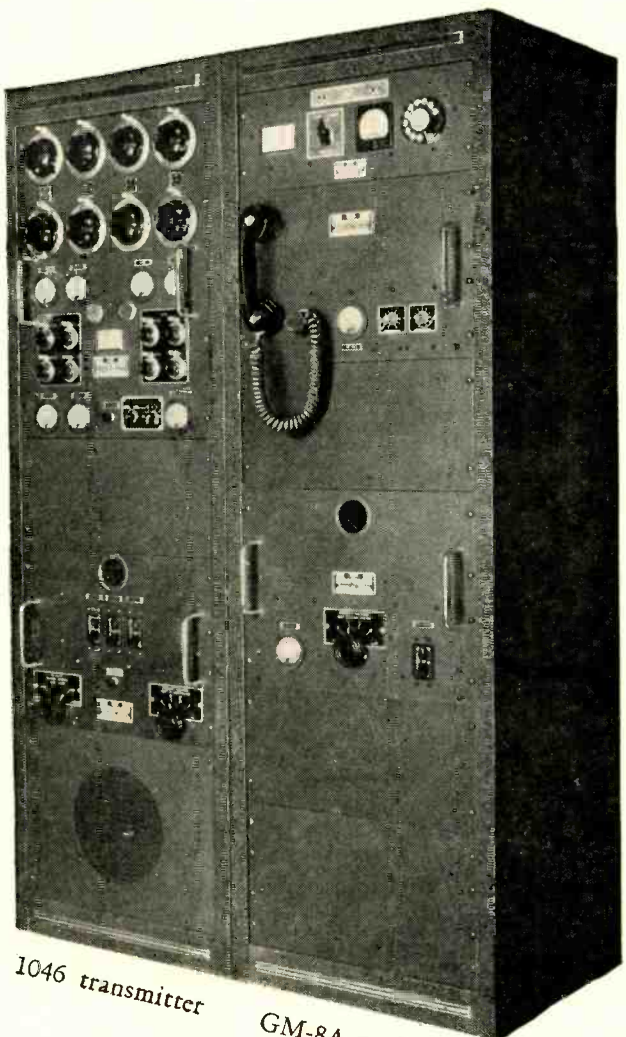
Rugged, versatile general purpose H. F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0° to + 50°C.). Excellent for point-to-point or ground-to-air communications.

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

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

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

Complete technical data on request



1046 transmitter

GM-8A modulator

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

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CIRCLE 28 READERS SERVICE CARD

CIRCLE 29 READERS SERVICE CARD →

Solderless wrapped connections . . . the process proved

Fast, economical, solderless, metal-to-metal connections that resist vibration failure and corrosion. That's the solderless wrapping method—proved superior by billions of connections without a reject.

With a lightweight, fast-acting Keller "Wire-Wrap" tool, you wrap up wiring jobs fast . . . and you get these profit-building benefits:

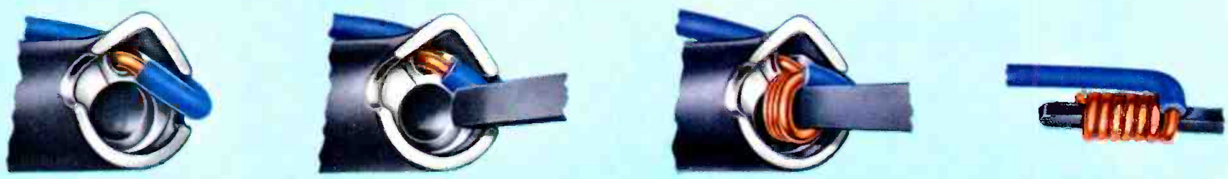
Greater production. You make permanent solderless connections in a hurry. Three seconds total time required per connection. Actual connecting time 1/10 second.

Lower production costs. You eliminate the expense of precise process control required by other methods.

Reduced labor costs. You make more connections per operator, with less fatigue. You eliminate soldering—no faulty connections that require expensive hand repair work.

Higher quality. Mechanically strong connections electrically stable—proved most reliable in industry.

HOW THE KELLER Wire-Wrap® TOOL WORKS



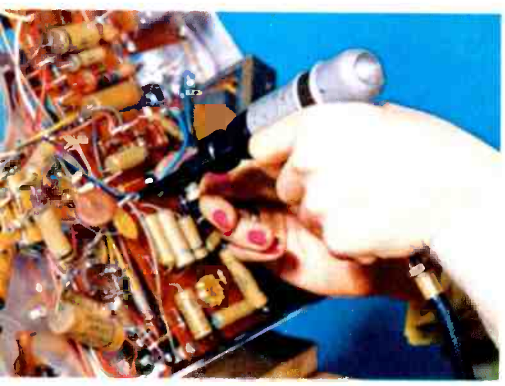
Wire insertion and anchoring

Terminal insertion

Wrapping

Finished connection

KELLER Wire-Wrap® TOOLS—ADAPTABLE TO CIRCUITRY OF EVERY TYPE

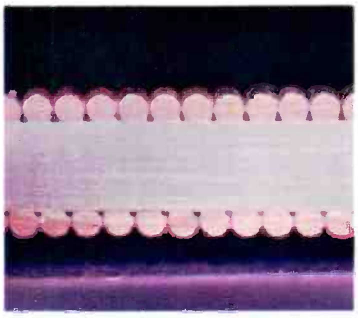


Television chassis wiring with Keller "Wire-Wrap" tools helps cut production costs and simplifies quality control processes. Only a periodic check of the connection produced is required to insure consistent quality.

Relay panels on oil burner stack controls are wired with vertically mounted Keller "Wire-Wrap" air tools faster and at less cost than with soldering methods. Maintenance cost of tools like this is less than that for soldering operations.

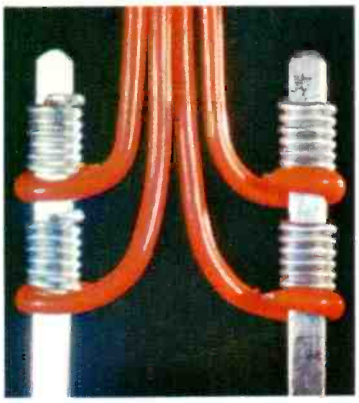
Switchboard panels of telephone dialing system are interconnected with electrical "Wire-Wrap" tool. In manufacture of panel subassemblies, connection of wires to relay terminals is made with air-powered tools.

superior by leaders in communications and electronics



Large, gas-tight contact areas. Just four turns of wire produce a contact area greater than the cross-sectional area of wire. Surface adhesion at contact areas prevents damage from severe temperature changes, humidity, corrosive atmospheres and vibration.

High-pressure, metal-to-metal contact. After wrapping, cold flow of copper causes pressure in center of contact area to drop from 100,000 psi. to about 29,000 psi. The metal then stabilizes . . . pressure remains constant. Keller "Wire-Wrap" tools produce a clean metal-to-metal contact. As connection ages, it becomes mechanically stronger due to solid state diffusion.



No embrittlement or stress concentrations. Embrittlement caused by change in metallic structure is impossible. No heat is used in making solderless wrapped connections. Elimination of stress concentration where wire joins terminal results in superior vibration life.

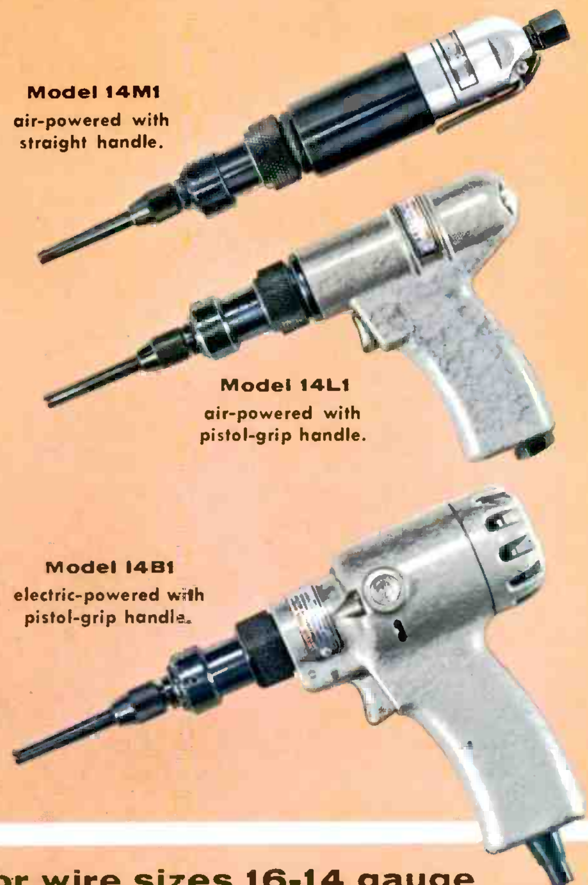
Close terminal spacing. Today's trend toward compact electrical assemblies naturally demands close spacing of terminals. The small diameter of the Keller "Wire-Wrap" tool tip permits close terminal spacing. In addition, a number of wires can be connected to the same terminal.

REQUEST FREE BULLETIN 14-1

Here are 16 pages packed with valuable data. The bulletin is completely illustrated with diagrams and pictures. It includes a comprehensive explanation of the solderless wrapping method, plus full details on terminal requirements, and specifications on Keller "Wire-Wrap" tools.

SELECT FROM THESE STANDARD MODELS

for wire sizes 26-18 gauge



Model 14M1
air-powered with straight handle.

Model 14L1
air-powered with pistol-grip handle.

Model 14B1
electric-powered with pistol-grip handle.

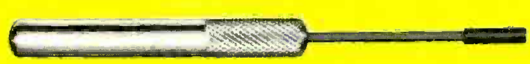
for wire sizes 16-14 gauge

Model 14A-2S
air-powered with straight handle.

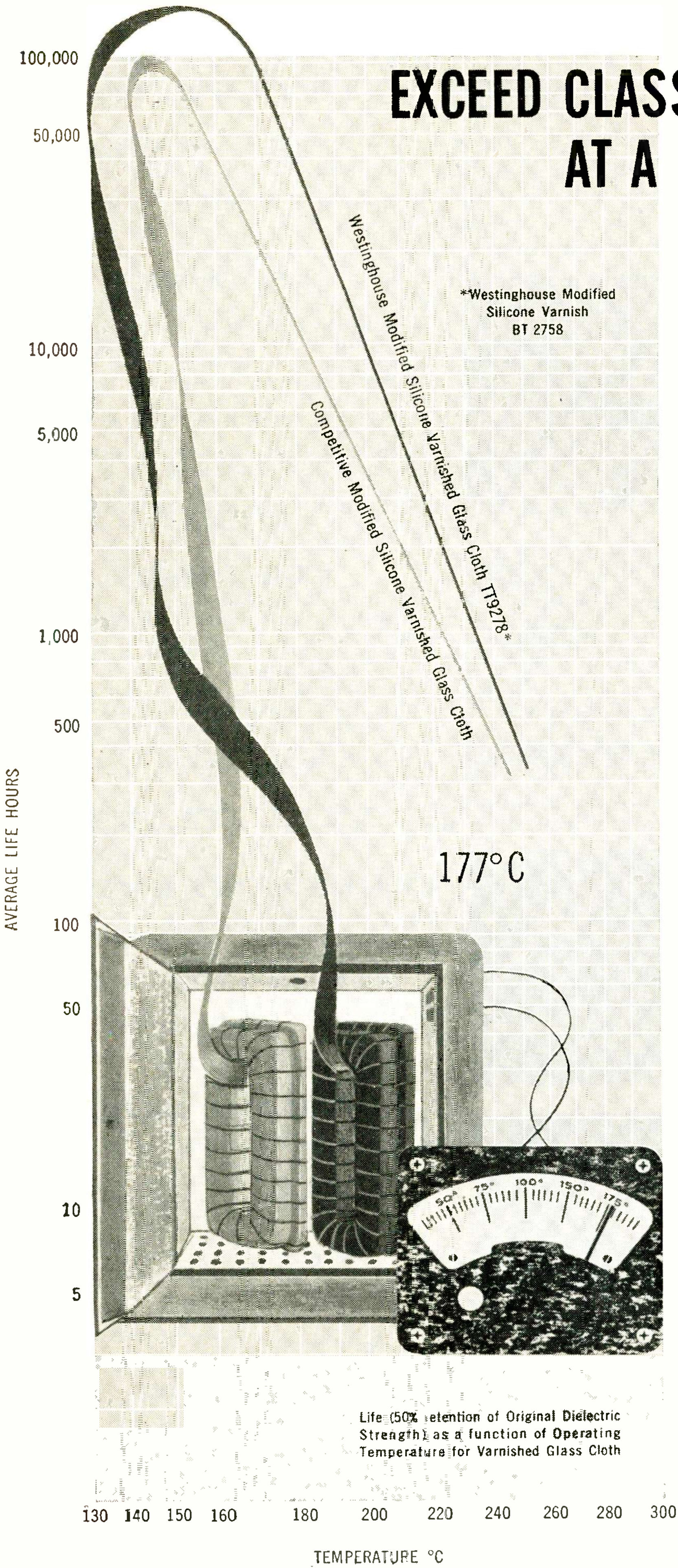
Model 14A-2
air powered with pistol-grip handle.

MANUAL TOOLS FOR SERVICEMEN

Unwrapping tool for removing connections. Either right- or left-hand rotation available.



Wrapping tool for use where power is not available.



EXCEED CLASS "F"† PERFORMANCE AT A CLASS "B" PRICE

with

Westinghouse Modified Silicone Varnished Glass Cloth and Tape!

Like to *upgrade your product at no extra cost?*

You can! Your equipment will operate *better, longer* with an amazing new Westinghouse insulation—Modified Silicone-Resin-Treated Varnished Glass Cloth and Tape, Grade TT-9278! "9278" withstands temperatures up to 177°C for ten years! It'll hold up even under conditions of continuous overload!

That's not all—Westinghouse TT-9278's *oil and solvent resistance* far surpasses that of conventional Class "H" materials. Heated in oil or immersed in toluene for 48 hours, there's no evidence of disintegration. This new Westinghouse insulation approaches Class "H" Performance . . . at a Class "B" price.

"TT-9278" is only one of a Leadership Line of some 100 different Westinghouse tape and sheet insulation materials, designed to meet every Class "A," "B," "F" or "H" electrical insulating need.

There's a companion line of Benolite varnishes, finishes and enamels, too—for example, Modified Silicone Varnish BT-2758, used in producing "9278." Why not write for your free copy of the 8-page Westinghouse *Leadership Line Catalog?* Just fill out and mail the coupon below . . . we'll do the rest.

J-06636

†New AIEE classification established June 21st, 1957, with a hotspot limit of 155°C.

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Westinghouse

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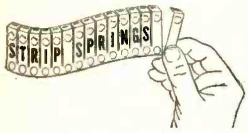
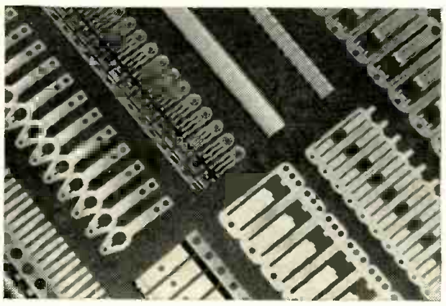
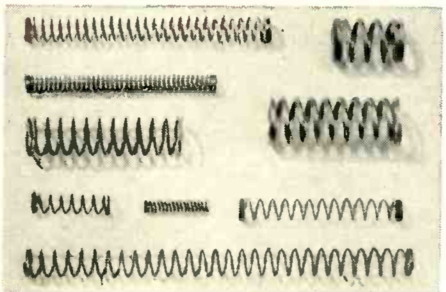


FOR HIGH PRODUCTION



STRIP SPRINGS

Fabricated from beryllium copper.
Easily handled, readily broken apart by hand or used in automatic or semi-automatic assembling devices and contact riveting machines.
Individual pieces may be broken off without trace of burr.
Eliminate sorting, untangling and handling of loose pieces.
Springs may be produced in strips to various shapes; formed angles may be held within plus or minus one degree.
Heat treated in multiple fixtures to insure uniformity, close tolerances and elimination of variations in spring-back.



COIL SPRINGS

Made from laboratory tested beryllium copper wire.
Special coiling and heat treating equipment insures 100% uniformity.
Guaranteed rigid tolerances held on diameter and load tests at specified deflection.
These factors combine to assure increased service life through higher endurance strength – make products perform more consistently by eliminating drift, set or fatigue. Furthermore, they eliminate expensive hand adjustment and reduce inspection costs of finished product.

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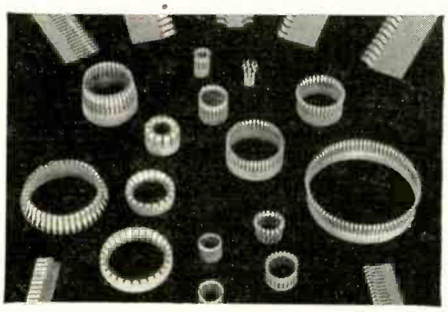

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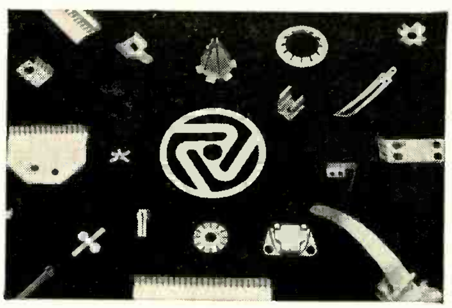
We are equipped to supply standard mating parts for use with 2C-39, 2C-40, 2C-43 and 3C-37 tubes, or custom made parts in related fields.
Grounding strips and contact fingers can be supplied in standard or special contours.
"Flea" contacts for co-planer type subminiature tubes and transistors.



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For those who need quick delivery of parts in pilot quantities or require a low-cost proving ground for spring designs. I-S methods eliminate expensive tooling. Laboratory controlled, precision produced – yet at lower cost than is possible with permanent, high-activity tools.
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JAN TYPES

1N253

1N254

1N255

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The reliability demanded by the rigid electrical, mechanical and environmental specifications of MIL-E-1 is now assured with **Automatic's** JAN TYPE silicon rectifiers . . . offered in production quantities at prices reflecting volume output.

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1N253	100	1000	0.1	Stud-Mount	1024
1N254	200	400	0.1	Stud-Mount	989A
1N255	400	400	0.15	Stud-Mount	990A
1N256	600	200	0.25	Stud-Mount	991A

*CASE TEMPERATURE 135°C.

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Covering the spectrum with reliable ceramic tubes

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2CL40A	4CX250B	X635
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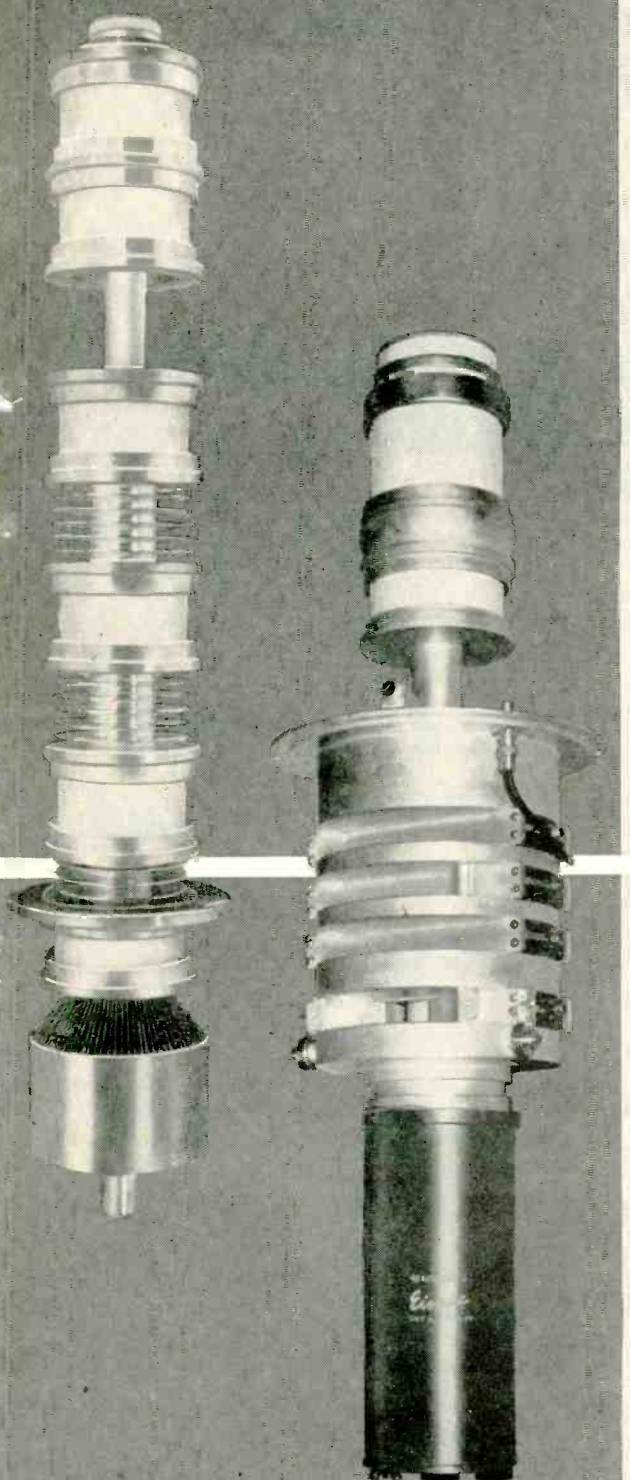
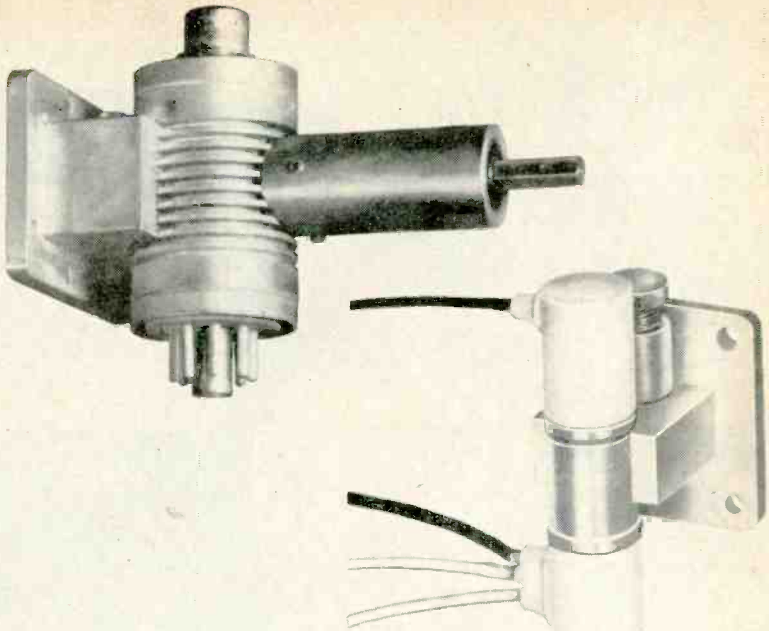
2C39WA	4CX250M	X685C
3CX100A5	4CX1000A	X693
3CPN10A5	4CX5000A	X694
4CX300A	X629	

UHF Ceramic Tubes

2C39B	3K3000LQ
2C39WA	3K50,000LA
3CX100A5	3K50,000LF
3CPN10A5	3K50,000LQ
3K2500LX	3KM2500LT
3K2500SG	3KM3000LA
	3KM50,000PA





From audio into super high frequencies, Eimac covers the RF spectrum with modern ceramic tubes. This incomparable ceramic electron tube family — more than one-third of the Eimac line — includes reflex and amplifier klystrons, negative grid tubes, rectifiers, pulse modulators, and receiving tubes. The tubes illustrated are typical of more than 40 Eimac ceramic tube types that are being selected by leading equipment manufacturers for use in all types of applications — from tropo-scatter to industrial heating, from single sideband to pulse.

The advantages of reliable Eimac ceramic tubes include: resistance to damage by impact, vibration, and heat; smaller size; and better processing techniques.

Do it yourself — subject an operating Eimac ceramic tube to impact at our unique display, booths 2409-2412, during the New York IRE Show, March 24-27.

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EITEL-McCULLOUGH, INC.

SAN BRUNO CALIFORNIA

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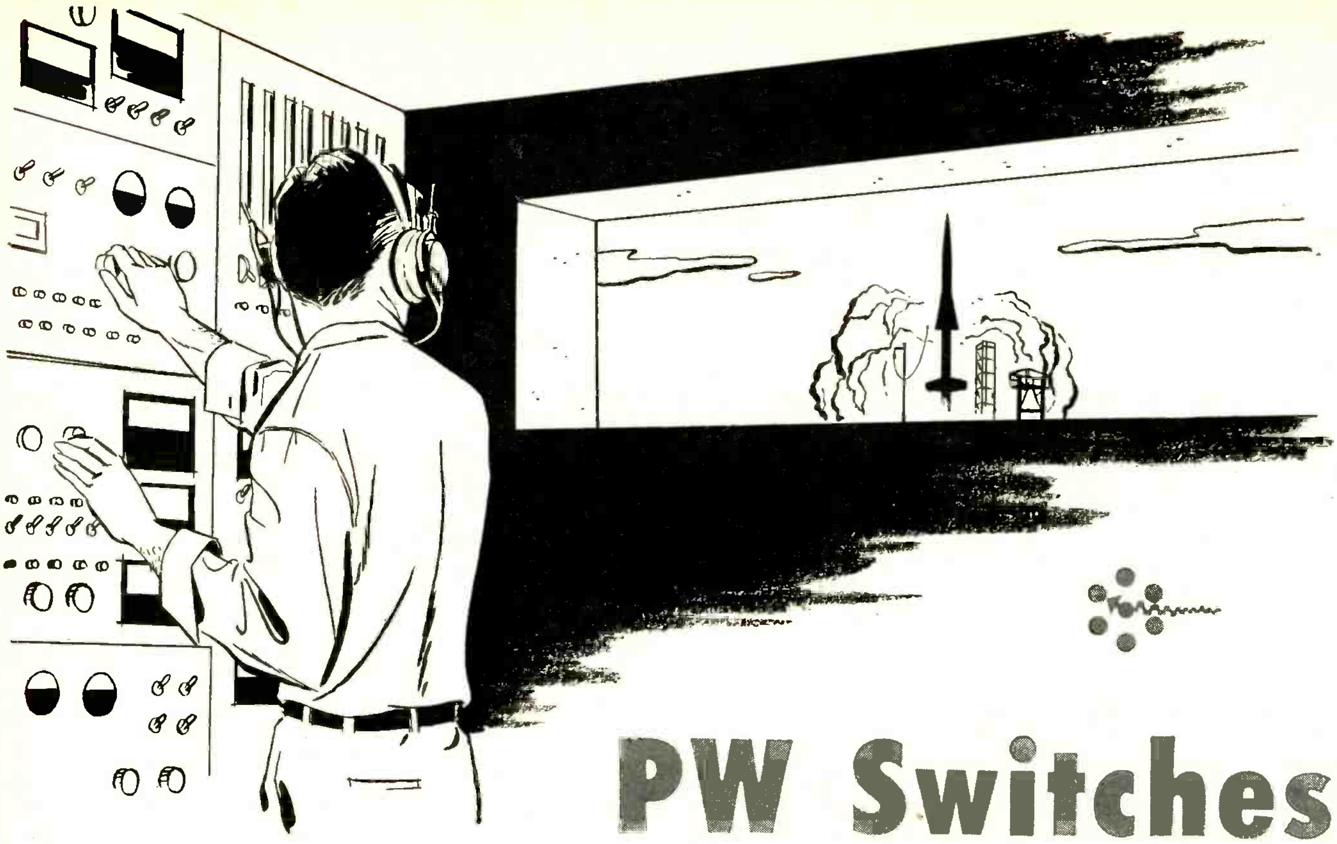
4CX250K
4CX250M
4K50,000LQ
4KM50,000SG
4KM170,000LA

6K50,000LQ
X576
X597
X626
X685C
X693

SHF
Ceramic Tubes

1K125CA
1K125CB
1K20XS
1K20XK
1K20XD

1K20KA
X563
X639
X686



PW Switches

For Your Pulse Width Systems

Available Directly From The

ASCOP

ELECTRO-MECHANICAL DIVISION

FORMERLY SWITCH DIVISION

DSM-180

High Level 90 channel x 10 sweeps per second, 900 samples per second, IRIG Standard, 28 volt DC drive motor, governor controlled (other units of this series available at 45 x 20 and with 400 cycle, 115 volt drive motors).

FSS-2

High Level 30 channel x 30 sweeps per second, 900 samples per second, IRIG Standard, 28 volt DC drive motor, governor controlled..

Only at ASCOP can you order multiplexing switches with the high levels of precision and reliability so important to the accuracy of your pulse width systems.

When you order from ASCOP, you are buying from the largest producer of PW Multiplexers. ASCOP has over 10 years of experience in building high-speed sampling instruments that have been tested and field-proven in thousands of the most advanced military and industrial applications.

In ASCOP's extensive facilities all switches undergo the most severe environmental tests to assure long service-free life and the widest margins of dependable operation. ASCOP has a large line of standard switches and also will build components to your individual specifications. Order directly from the ASCOP Electro-Mechanical Division or write for literature.

ASCOP also designs and builds complete Pulse Width Systems

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The new ultra-modern Chester Cable Corporation plant is now in full production on super-rugged extra-pliable Plasticote and Plasticord wires and cables. These longer-lasting Chester conductors, plus nylon coated and teflon wrapped wires are available in standard types to meet every wiring requirement. When specifications indicate the use of custom constructions, they can be produced to your special design. The Chester engineering staff, and research facilities, are available to help solve unusual wiring problems.
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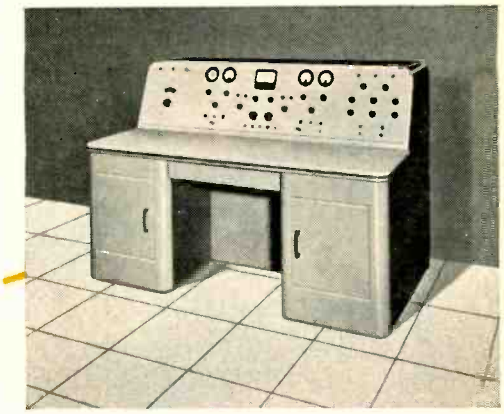
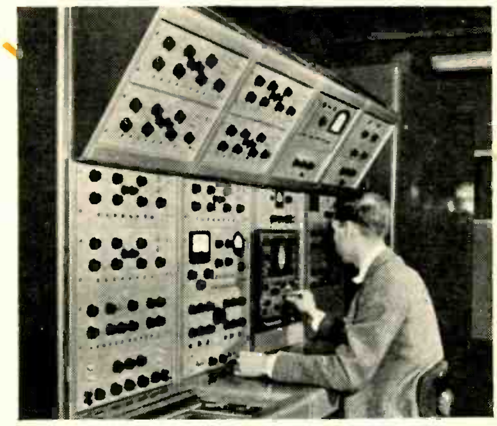
vibration test systems

MB MODEL C10VB EXCITER rated for frequencies up to 6000 cps. Works in environmental test chambers, combining vibration with altitude and temperature testing.



MODEL TEMC CONTROL CONSOLE offers optimum control reliability. It is the only true servomechanism in the vibration testing field that integrates the error and reduces it essentially to zero.



MODEL T88 COMPLEX MOTION CONSOLE equips system for duplicating "noise" or random motion. Uniquely, it contains peak notch equalizer . . . which is an analog computer for giving exact inverse of the resonant response from specimen on the exciter.

VIBRATION testing grows more discriminating. First, sinusoidal testing; and now random and complex motions. Whatever *your* program, look to MB to keep you ahead. As the world's largest producer in its field, MB provides complete systems for advanced techniques.

Basically, *what you're really buying is the motion at the shaker table.* And nobody knows the requirements of the shaker better than its maker. MB builds equipment around the operational needs, thereby assuring optimum performance from system as whole, and from shaker specifically.

MANY AMPLIFIERS IN SERVICE

MB has built over 850 electronic amplifiers for vibration test systems since 1945. More than 275 are 3 KW and larger. In advancing the science of complex motion testing, MB builds the required electronic gear with similar advanced thinking . . . to make it easier to use, and fit for future needs.

SOME FEATURES

MB amplifiers feature automatic operation. Push a button to start. No need to fuss with filament and plate voltages. Amplifier can be remotely located to cut down noise and heat and save floor space at test location. Control console facilitates automatic or manual sine wave testing. The compensation console equips system for rapid setup and high fidelity complex motion work.

The largest field service organization of vibration specialists are on call nationwide to users of MB test systems. They provide technically qualified service on the *whole system.*

TYPICAL PERFORMANCE OF SYSTEMS

Amplifier Model	Exciter Model	Sine Force pounds	Random Force pounds
T444	C10VB	1750 peak	850 rms
T666	C25H	3500 peak	2500 rms
T888	C25HB	5000 peak	3500 rms

SEND FOR COMPLETE DATA

Be sure to visit the MB booth, spaces 17-23 and 17-25 at the IRE Show in the New York Coliseum

MB manufacturing company

A DIVISION OF TEXTRON INC.

1075 STATE STREET
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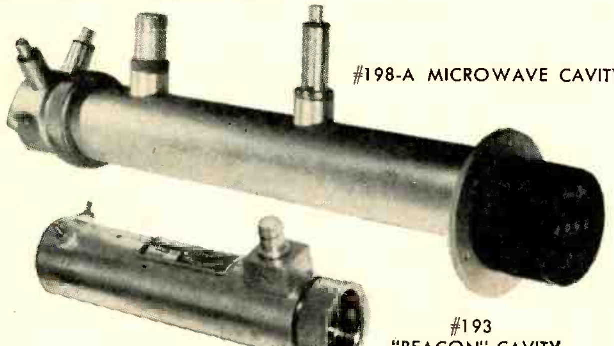
AMERAC'S PRECISION MICROWAVE PRODUCTS

MICROWAVE CAVITIES

Amerac, Incorporated manufactures a comprehensive line of co-axial line cavities, utilizing various standard tubes, for numerous microwave applications including aircraft, guided missile and beacon work.

FEATURES

These cavities have such features as — single control tuning, fixed feedback, rugged anti-backlash tuning mechanism, accurate Root counter (optional), adjustable type "N" or "BNC" 50-ohm inductive loop coupling, convenient tube receptacle for quick replacement, long-duration R.F. output stability, operates on inexpensive power supply.



#198-A MICROWAVE CAVITY

#193 "BEACON" CAVITY

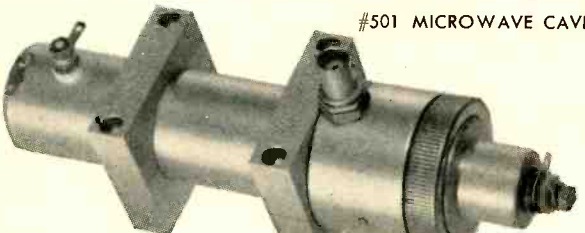
SPECIFICATIONS

Model	Frequency Range	Type	Cavity Mode	Tube Type
192-A	2400—4000 MC	Pulse	¾	2C36
192-AB	750—2000 MC	Pulse	¼	2C36
192-B	750—2000 MC	CW	¼	2C36
193-A	2400—4000 MC	Pulse	¾	2C36
194	2300—3300 MC	CW	¾	2C39B
194-A	2300—3300 MC	Pulse	¾	2C39B
195	2000—3100 MC	CW	¾	6442
195-A	2000—3100 MC	Pulse	¾	6442
191-A	2400—3400 MC	Pulse	¾	Pencil Triode
198-A	800—2050 MC	CW	¼	6BM6
198-A	2050—4200 MC	CW	¾	6BL6
198-A	800—2050 MC	Pulse	¼	5837
198-A	2050—4200 MC	Pulse	¾	5836

FOR EXTREME ENVIRONMENTAL CONDITIONS

Engineered to operate under extreme conditions of shock, vibration, temperature and humidity, these cavities have been designed to withstand 2000 cycles at 15 G. 200 MC tuning range.

#501 MICROWAVE CAVITY



SPECIFICATIONS

Model	Frequency Range	Type	Cavity Mode	Tube Type
#500	2000—3100 MC	CW	¾	GL-6442
#501	2000—3100 MC	Pulse	¾	GL-6442
#502	3100—3550 MC	CW	¾	GL-6442
#503	3100—3550 MC	Pulse	¾	GL-6442
#508	3800—4500 MC	CW	¾	Z-1910
#509	3800—4500 MC	Pulse	¾	GL-6442

CO-AXIAL LINE WAVEMETERS

#229 "S" BAND WAVEMETER

FOR LABORATORY USE, Amerac, Incorporated manufactures a precision wavemeter that is handsomely finished with golden anodized aluminum panel and hand-rubbed walnut cabinet. The panel is sloped for easy observation.

These models feature high accuracy of measurement (±.02%), high frequency stability (10°C to 40°C), extreme mechanical stability, ease of operation, rugged components and tri-plated surfaces.

GENERAL SPECIFICATIONS

Type "N" constant impedance input connector. BNC or UHF co-axial fitting for external video connection. Power handling capability: absorption — .5mw to 1 watt; transmission — 1mw to 1 watt. Peak power: up to 25 watts (transmission).

INDIVIDUAL SPECIFICATIONS

Model	Frequency Range	Loaded Q	Width	Depth	Height	Net Weight
#228*	900—2400 MC	1000	15″	9¾″	7¾″	13½ lbs.
#229	2300—4500 MC	1500	8″	6½″	5″	4¾ lbs.
#230	3500—6000 MC	1500	8″	6½″	5″	4¾ lbs.

*Model 228 has a direct-reading frequency control dial.

FOR FIELD USE, Amerac, Incorporated manufactures two co-axial line wavemeters covering the "S" band, the Model 131 (Amerac's version of the popular military model TS-117) and the inexpensive, C&D Wavemeter Model 232.

Both models feature a rugged metal case, finished in gray, baked enamel; highly sensitive indication of resonance; rugged components; precision cavity assembly and anti-backlash device, for high accuracy.

#232 "C & D" WAVEMETER

GENERAL SPECIFICATIONS

Input connections are two type "N" jacks. R.F. detector is a type 1N21B silicon diode. They have a ruggedized 50 microampere indicating instrument for abusive field work and all silver-plated parts are Rhodium flashed to minimize corrosion.

INDIVIDUAL SPECIFICATIONS

Model	Frequency Range	Loaded Q	Length	Depth	Width	Net Weight
#131	2400—3400 MC	1000	6″	3¼″	5½″	3½ lbs.
#232	1800—3800 MC	1000	8″	2¼″	7¾″	2½ lbs.

Amer-Dial

For multi-turn devices. Direct reading to 1/100th of a turn. Accurate to 1 part in 10,000. Readings up to 9999 with up to 100 turns. Unobstructed knurled dial. Regular and illuminated.

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Amerac, INCORPORATED

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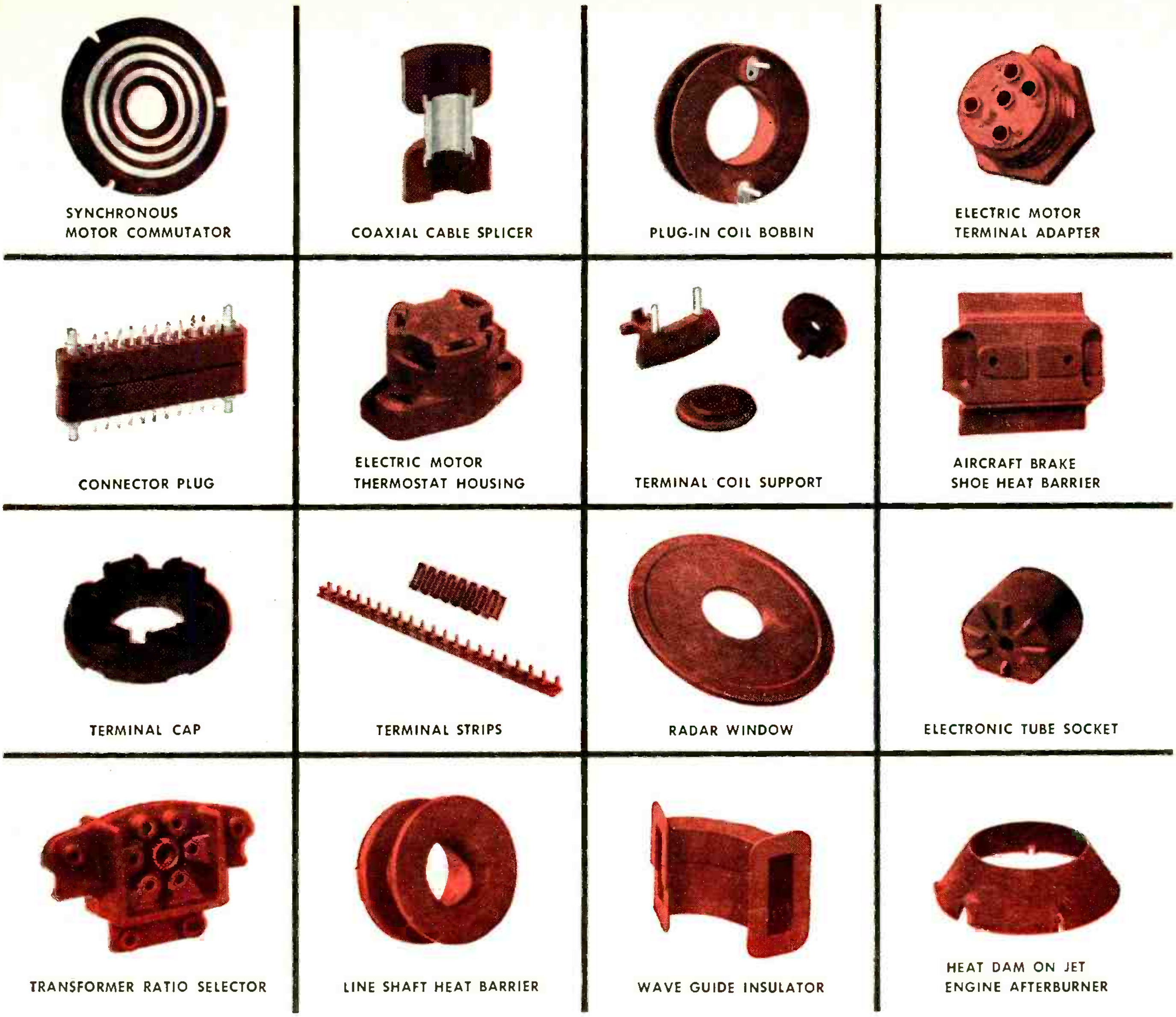
BOOTH 3022 — I. R. E. SHOW



Thermal or Electrical Insulation at 800 F . . . with

DOW CORNING SILICONE MOLDING COMPOUNDS

Parts made from Dow Corning silicone molding compounds are light, strong, and heat-resistant. They have excellent dielectric properties and low heat conductivity . . . will reduce transferred temperatures from 1500 F to lower than 500 F in less than one inch of wall thickness. Dow Corning silicone molding compounds withstand continuous operation at 600 F and even short exposure to 1500 F. They are readily molded on conventional equipment.

Typical Properties of a Dow Corning Silicone Molding Compound*

Dielectric constant		
@ 1 megacycle	dry 3.2	wet 3.6
Dissipation factor		
@ 1 megacycle	dry 0.005	wet 0.05
Flexural strength, psi		12,000
Tensile strength, psi		4,500
Impact strength, ft-lb/in		15

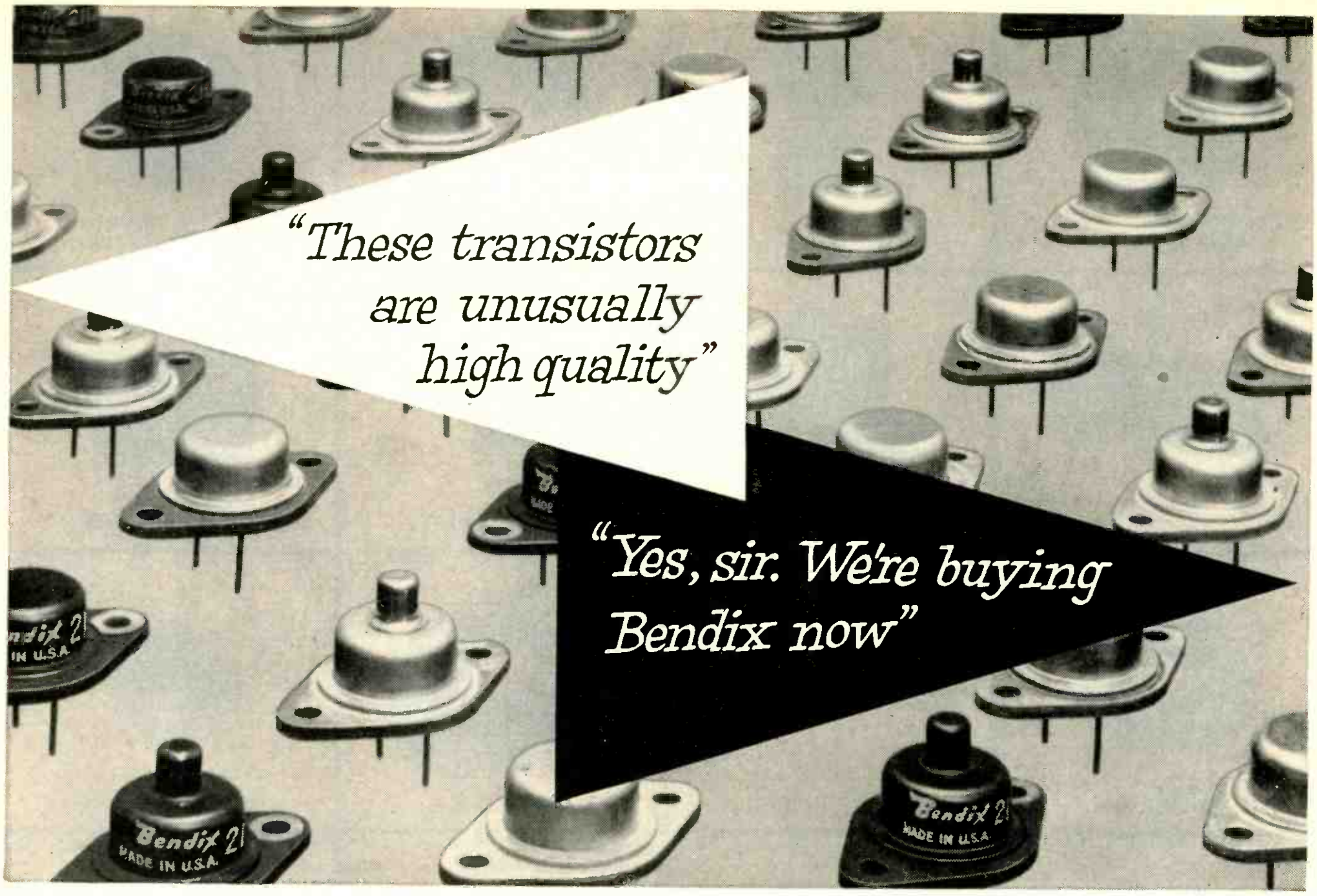
*Cured 2 hours at 390 F. For operation at 1500 F, an additional afterbake at 800 F is recommended.

Send for new brochure, Address Dept. *483.*

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

CIRCLE 40 READERS SERVICE CARD



For better transistors at low cost . . .

TRY BENDIX HIGH GAIN POWER TRANSISTORS

If you are in design, project, or research and development, Bendix Transistors can mean much to you and your job. The enthusiastic endorsements of other engineers show that Bendix Transistors help in these six ways: (1) High power and current gain; (2) Low leakage; (3) Life stability; (4) High breakdown voltage; (5) Low thermal resistance; (6) Linear temperature variation.

The extra quality at no extra cost stems from our transistor program. Here, the simplified design *increases dependability* and also *cuts costs*. The component parts and materials—all exceeding specification requirements by a sizeable margin—*provide extra performance capability*. Our close quality control uses Bendix-developed methods and instruments to assure uniformly dependable quality. And improved manufacturing techniques at high-volume level make for *better transistors at low cost*.

Write us now for complete details or for help with your circuitry problems. SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.

LARGE SELECTION OF POWER TRANSISTORS FOR MANY DIFFERENT APPLICATIONS

Type Number	Primary Application	Max. Collector Voltage	Max. Collector Current	Thermal Resistance	Collector Dissipation		Current Gain B at Ic		Power Gain at Max. Power Out	Max. Undistorted Power Out
		Vdc	Adc	°C/W	W[a]	at °C[b]	—	Adc	db	W
2N234 2N234A	Audio Amp.	30 Vce	3	1.5	7.5	75	25	0.5	30	2
2N235 2N235A	Audio Amp.	40 Vce	3	1.5	7.5	75	50	0.5	36	2
2N236 2N236A	Audio Amp.	40 Vce	3	1.5	10	80	40	0.75	35	4
2N285 2N285A	Audio Amp.	40 Vce	3	1.5	5	85	150	0.5	39	2
2N399[d]	Push Pull Amp.	40 Vce	3	1.5	7.5	75	40	0.75	33	8[c]
2N400	Audio Amp.	40 Vce	3	1.5	18	60	80	1.3	35	6
2N401[d]	Push Pull Amp.	40 Vce	3	1.5	7.5	75	40	0.5	30	5[c]
2N420 2N421[e]	High Current Switch	40 Vce	5	1.5	10	80	50	4.0	—	—

a—Each transistor
b—Mounting-base temperature
c—Output power using two transistors in push-pull
d—Supplied in matched pairs
e—Missile transistor with collector solder lug

VOLUME PRODUCTION ASSURES IMMEDIATE DELIVERY

Red Bank Division

Bendix AVIATION CORPORATION

CIRCLE 41 READERS SERVICE CARD

Take a good look

These test results mean what they say. Iron Fireman's micro-miniature relays conform to and exceed the requirements of MIL-R 5757C; and the data, shown in the illustration above, were obtained under the strict requirements set forth in the military specifications.

These brand new Iron Fireman dual-coil, balanced armature relays are designed for applications demanding either voltage or current sensitive relays with high reliability and performance in small, hermetically sealed enclosures.

These latest additions to the line of dependable Iron Fireman relays are tooled for high production.

WRITE TODAY for *Bulletins 600 and 680:* Iron Fireman Electronics, 2810 S.E. Ninth Ave., Portland 2, Ore.

IRON FIREMAN® *Electronics* DIVISION

Manufacturers of high speed relays, sensitive relays, micro-miniature relays, vertical gyros, slip rings and brushes.

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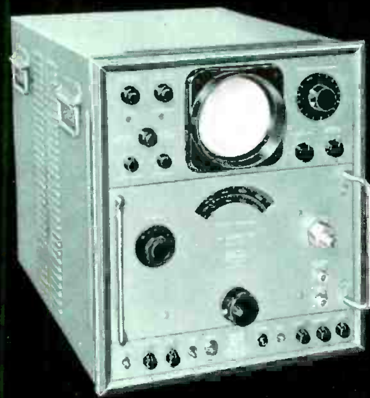
NEW MICROWAVE ANALYZERS

10 to 44,000 mc

SAVE ENGINEERING MANHOURS



Model TSA

A complete line of spectrum analyzers with full frequency coverage — up to Q Band

POLARAD
PROVEN RELIABILITY

TO TEST:

MISSILES
RADARS
MICROWAVE COMPONENTS
TELEMETERING
MULTI-PULSE TRANSMISSIONS

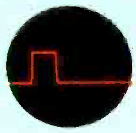
FEATURES:

- Direct reading, UNI-DIAL control
- High accuracy, resolution and sensitivity
- Stable and accurate frequency marker
- Five interchangeable plug-in units

NEW APPLICATIONS

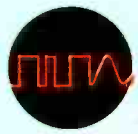
Model TSA-S

TSA-S COMBINATION SYNCHROSCOPE SPECTRUM ANALYZER



Pulsed signal as seen in synchroscope operation.

Spectrum of same pulsed signal displayed in spectrum analyzer operation.



Time display of complex video signal

MEASUREMENT OF PULSE MODULATION IN FREQUENCY AND TIME

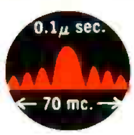
This single instrument (Model TSA-S) Synchroscope-Spectrum Analyzer provides a direct method of observing a pulsed signal and its frequency spectrum. As a **sensitive synchroscope receiver**, it displays a wide range of pulse widths and repetition rates. **As a spectrum analyzer**, it shows complete frequency spectrum. Selector switch determines function instantly.

ANALYSIS OF COMPLEX SIGNALS

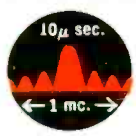
Displays the envelope of complex pulsed signals, such as used in radar systems and some telemetry applications.

Model TSA-W

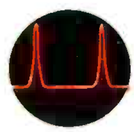
TSA-W VERY WIDE DISPERSION SPECTRUM ANALYZER



0.1 microsecond pulse using 70 mc dispersion.



10 microsecond pulse using 1 mc dispersion.



Two cw signals 60 mc apart using 70 mc dispersion.

NARROW PULSE ANALYSIS

Model TSA-W, by virtue of its wide frequency dispersion (up to 70 mc), will display the spectrum of very narrow pulses.

WIDE PULSE ANALYSIS

By changing selector switch to a narrower bandwidth, spectra of wide pulses can be displayed accurately on the TSA-W because of its high resolution (7 kc narrow bandwidth, 50 kc wide bandwidth).

SIGNAL COMPARISON

Two or more signals may be compared against a standard or each other as to frequency spacing. Wide dispersion provides simultaneous observation of signals separated by large frequency differences.

Additional applications for spectrum analyzers are available on request. Write for free handbook on spectrum analyzer techniques.

Interchangeable Plug-in Tuning Units

Tuning Unit	Frequency Range
STU-1	10 — 1,000 mc
STU-2	910 — 4,560 mc
STU-3	4,370 — 22,000 mc
STU-4	21,000 — 33,000 mc
STU-5	33,000 — 44,000 mc

POLARAD ELECTRONICS CORPORATION

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Representatives in principal cities. See your Yellow Pages.

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Engineers: Tear out for your notebook

MULTI-BAND MICROWAVE RECEIVER

400-46,700 mc

A sensitive microwave receiver is a basic tool in microwave testing operations. A few of the many and diverse applications of this versatile instrument are illustrated below, using a Polarad Model R Receiver, 400 to 46,700 mc. Operation is simplified by UNI-DIAL control and direct reading frequency dial.

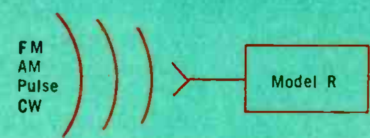
POLARAD PROVEN RELIABILITY

Model R

Frequency Range

Tuning Unit Model RR-T	400 — 1,000 mc
Tuning Unit Model RL-T	950 — 2,040 mc
Tuning Unit Model RS-T	1,900 — 4,340 mc
Tuning Unit Model RM-T	4,200 — 7,740 mc
Tuning Unit Model RX-T	7,300 — 11,260 mc
Tuning Unit Model RKS-T	9,500 — 15,600 mc
Tuning Unit Model RKU-T	14,700 — 22,000 mc
Tuning Unit Model RQ-T	20,300 — 46,700 mc

RECEPTION of MICROWAVE ENERGY



A multi-purpose broadband microwave receiver is indispensable for quantitative analysis of microwave signals and monitoring of all types of radio and radar communications. With a test antenna connected to the r-f input, power and frequency comparisons of virtually any type of signal encountered in microwave work (AM, FM, cw and pulse) may be read directly on the front panel meter. Trigger output reproduces pulse width and repetition rate, at the same time eliminating noise that may be present.

SOME TYPICAL APPLICATIONS:

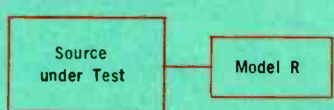
ANTENNA PATTERN MEASUREMENTS

Connect a synchronized antenna drive and pattern recorder (Polarad Models AD-1 and PR-1 or equivalent) into microwave system as shown in block diagram. As receiver antenna is rotated, pattern variations may be observed directly in db, or as a proportional voltage function on the receiver meter, and are recorded on the moving chart of the recorder. Besides permitting complete investigation of minor lobes the high sensitivity of the Model R receiver allows ample separation of transmission and receiver antennas to avoid phase errors, without high powered source. Tuned, narrow band preselector eliminates spurious and interfering signals which might cause error. Dynamic range permits establishing nulls as much as 60 db down from energy in the direction of maximum directivity.

LEAKAGE and INTERFERENCE MEASUREMENTS

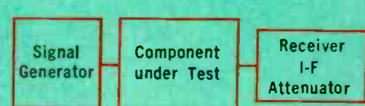
Use a dipole or horn antenna, connected to receiver input, to search around connectors, screw joints or any other suspected source of leakage. Any r-f energy present is indicated on the front panel meter. By calibrating the microwave receiver, absolute leakage level may be accurately determined. The Polarad Model R receiver is ideally suited to leakage detection because of its extremely high sensitivity, its broad frequency coverage and its use of a preselector below 11,000 mc to eliminate spurious responses.

MEASUREMENT of RELATIVE POWER of HARMONICS



With the receiver tuned to the harmonic in question, set an arbitrary gain level on the meter. Then, normalize the receiver gain with the receiver tuned to the fundamental and repeat the measurement. Subtract the db power level of the harmonic from the db level of the fundamental to determine the relative power level between the signals. Important receiver requirements for this measurement are broadband coverage and wide dynamic range as featured in Polarad Model R.

CALIBRATION of COMPONENT ATTENUATION



With the component under test placed between the signal source and the receiver, set an arbitrary gain level on the receiver meter. Then remove the component and connect the source directly to the receiver. Increase the attenuation of the calibrated i-f attenuator on the front panel of the receiver until the same reference meter reading is reached. Attenuation of the component under test is then equal to the amount by which the i-f attenuator was increased.

OTHER APPLICATIONS:

- Measurement of bandwidth of microwave cavities
- Frequency meter
- Field intensity meter
- Pulse, pulse time or pulse position demodulator
- Sensitive microwave power meter
- General communications

Complete specifications and prices on request.

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- Antimony Trioxide
- Barium Acetate
- Barium Carbonate
- Barium Fluoride
- Barium Nitrate
- Benzene
- Boric Acid
- Cadmium Chloride
- Cadmium Nitrate
- Cadmium Sulfate
- Calcium Carbonate
- Calcium Chloride
- Calcium Fluoride
- Calcium Nitrate
- Calcium Phosphate
- Carbon Tetrachloride
- Cobalt Carbonate
- Ether, Anhydrous
- Ether, Petroleum
- Hydrochloric Acid
- Hydrofluoric Acid
- Hydrogen Peroxide
- Lithium Carbonate
- Lithium Chloride
- Lithium Nitrate
- Lithium Sulfate
- Magnesium Carbonate
- Magnesium Chloride
- Magnesium Oxide
- Manganese Dioxide
- Manganous Carbonate
- Methanol
- Nickelous Chloride
- Nickelous Nitrate
- Nickelous Sulfate
- Nitric Acid
- Potassium Dichromate
- Potassium Hydroxide
- iso-Propyl Alcohol
- Radio Mixtures
- Silicic Acid
- Sodium Carbonate
- Sodium Chloride
- Sodium Hydroxide
- Sodium Phosphate Dibasic
- Strontium Nitrate
- Sulfuric Acid
- Toluene
- Triple Carbonate
- Xylene
- Zinc Chloride
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- Zinc Oxide

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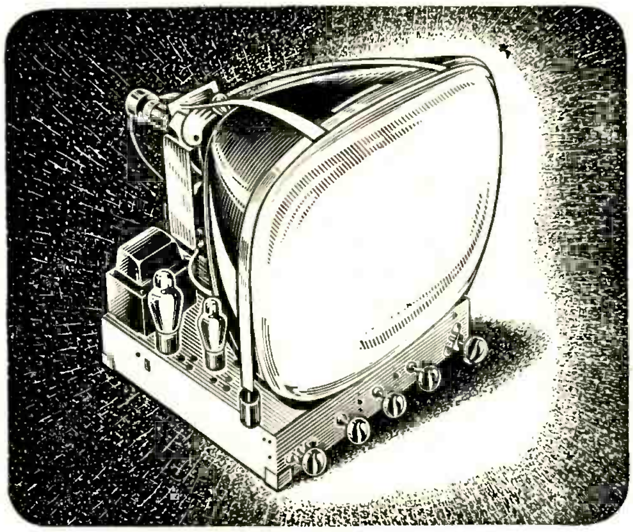
High Purity

Baker ELECTRONIC CHEMICALS

For your electronic tubes and screens—



BARIUM ACETATE, C.P. for Electronics

One of many high purity Baker production chemicals for the electronic industry. For use in screen settling, it will pay you to investigate Baker Barium Acetate, C.P. for Electronics. You get double-protection—purity is assured by the high assay and by control of several impurities that are critical.

In the specifications shown below, note that the assay is 99% minimum. Heavy metals, chlorides and insolubles are particularly low. And thorough blending insures that purity is uniform within each lot.

With your need for quick solubility in mind, this material is produced as a fine crystalline powder. Close control of chemical and physical specifications help achieve uniform operating characteristics in your process.

Today, the increasing demands of the electronic industry for closer tolerances present ever-new challenges for higher chemical purity. Baker works closely with chemists and electronic engineers to aid in meeting these challenges. Look over the list of Baker electronic chemicals on this page — write for prices and samples of those which interest you.

BARIUM ACETATE, C.P. For Electronics, Crystal

$Ba(C_2H_3O_2)_2$	F.W. 255.452
Assay ($Ba(C_2H_3O_2)_2$)	99.0 %
Insoluble Matter	0.010 %
pH of 5% Solution at 25°C	7.0-8.5
Chloride (Cl)	0.003 %
Oxidizing Substances (as NO_3)	0.005 %
Substances not Precipitated by H_2SO_4	0.10 %
Calcium and Strontium Salts (as SO_4)	0.50 %
Heavy Metals as (Pb)	0.0005 %
Iron (Fe)	0.001 %

J. T. Baker Chemical Co.

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Phillipsburg, New Jersey

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Freq. Range KMC	Band	Wave-guide Number	Bendix Type Number	RETMA Type No.	Mount Type	Recommended Mode of Operation (Note 2)	Anode Current Ma (Note 1)	Tube Drop Volts (Note 1)	Tube Excess Noise Ratio DB (Note 3)
1.12-1.70	L	RG-69/U	RXB103085		10°E	D.C.	250	130	15.2
			TD-21	6881	90°H	D.C.	250	65	15.2
			TD-29	7101	90°H	A.C. and D.C.	250	130	18.0
			TD-33		90°H	A.C. and D.C.	250	75	15.2
2.6-3.95	S	RG-48/U	TD-12	6358	10°E	D.C.	250	80	15.2
			TD-22	6782	90°H	A.C and D.C.	250	45	15.2
			TD-31		10°E	A.C. and D.C.	250	85	15.2
			TD-32		10°E	A.C. and D.C.	250	140	18.0
			TD-34		10°E	D.C.	250	155	18.0
			TD-35		90°H	A.C. and D.C.	250	80	18.0
			TD-38		10°E	PULSE*	(250)	(90)	15.2
3.30-4.90	S	WR-229	TD-24	6852	10°E	A.C. and D.C.	250	65	15.2
			TD-30		10°E	A.C. and D.C.	250	110	18.0
3.95-5.85	C	RG-49/U	TD-10	6356	10°E	D.C.	250	70	15.2
			TD-39		10°E	PULSE*	(250)	(80)	15.2
			RXB103422		10°E	D.C.	250	(110)	18.0
5.85-8.20	X	RG-50/U	TD-10	6356	10°E	D.C.	250	70	15.2
			TD-39		10°E	PULSE*	(250)	(80)	15.2
			RXB103422		10°E	D.C.	250	(110)	18.0
8.20-12.40	X	RG-52/U	TD-11	6357	10°E	D.C.	200	75	15.2
			TD-23	6882	10°E	D.C.	200	115	18.0
			TD-40		10°E	PULSE*	(200)	(85)	15.2
			RXB103093		90°H	D.C.	200	(35)	15.2
			RXB103394		90°H	A.C. and D.C.	(100)	(50)	15.2
12.4-18.00	K	RG-91/U	TD-18	6684	10°E	D.C.	200	70	15.2
			RXB103399		10°E	D.C.	200	(110)	18.0
			RXB103409		10°E	A.C. and D.C.	(100)	(65)	15.2
			TD-41		10°E	PULSE*	200	(80)	15.2
			RXB103411		90°H	A.C. and D.C.	(100)	(50)	15.2
			RXB103254		90°H	D.C.	200	(40)	15.2
18.0-26.5	K	RG-53/U	TD-13	6359	10°E	D.C.	200	65	15.2
			RXB103423		10°E	D.C.	200	(100)	18.0
			TD-42		10°E	PULSE*	(200)	(75)	15.2
			RXB103411		90°H	A.C. and D.C.	(100)	(50)	15.2
26.5-40.0	K	RG-96/U	RXB103251		10°E	D.C.	(150)	(120)	15.2

NOTE 1: Anode current and tube drop are D.C. values. Values in parentheses are tentative.

NOTE 2: D.C. operation—Cathode at one end only.
A.C. and D.C. operation—Cathodes at both ends.
Pulse operation—Cathode at one end specially designed for pulse operation.

NOTE 3: The Excess Noise Ratio in DB is 10 log $\left(\frac{T\ eff}{290} - 1\right)$

*If the anode current during the "on time" of a square pulse (of greater than 100 micro sec. duration) is nominally the same as the rated D.C. anode current, the tube drop during this period will be approximately the same as the rated D.C. tube drop.

26

NEW TYPES ADDED TO BENDIX NOISE SOURCE TUBE LINE!

Expanding its line from 9 types to 35 types, Bendix Red Bank now offers a great variety of noise source tubes.

But great variety is only one advantage. Noise source tubes that are free from ambient temperature corrections are the result of making tubes so that no correction in noise figures is necessary from —55°C. to +85°C. What's more, long life and unusual stability result from precise quality control—far beyond the usually accepted tolerances for such products.

Whatever your applications, whether for 10° or 90° angle mounting, check with our specialists for the most efficient solution. Write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

West Coast Sales & Service: 117 E. Providencia Ave., Burbank, Calif.
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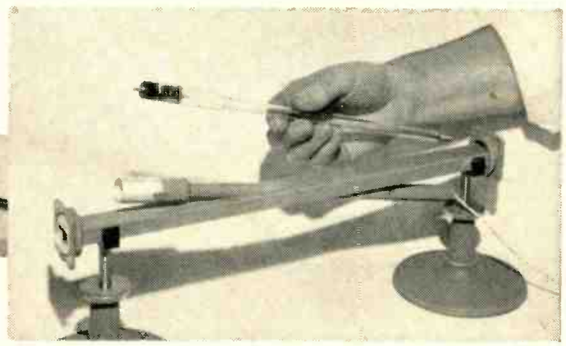
Canadian Distributor: Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ontario

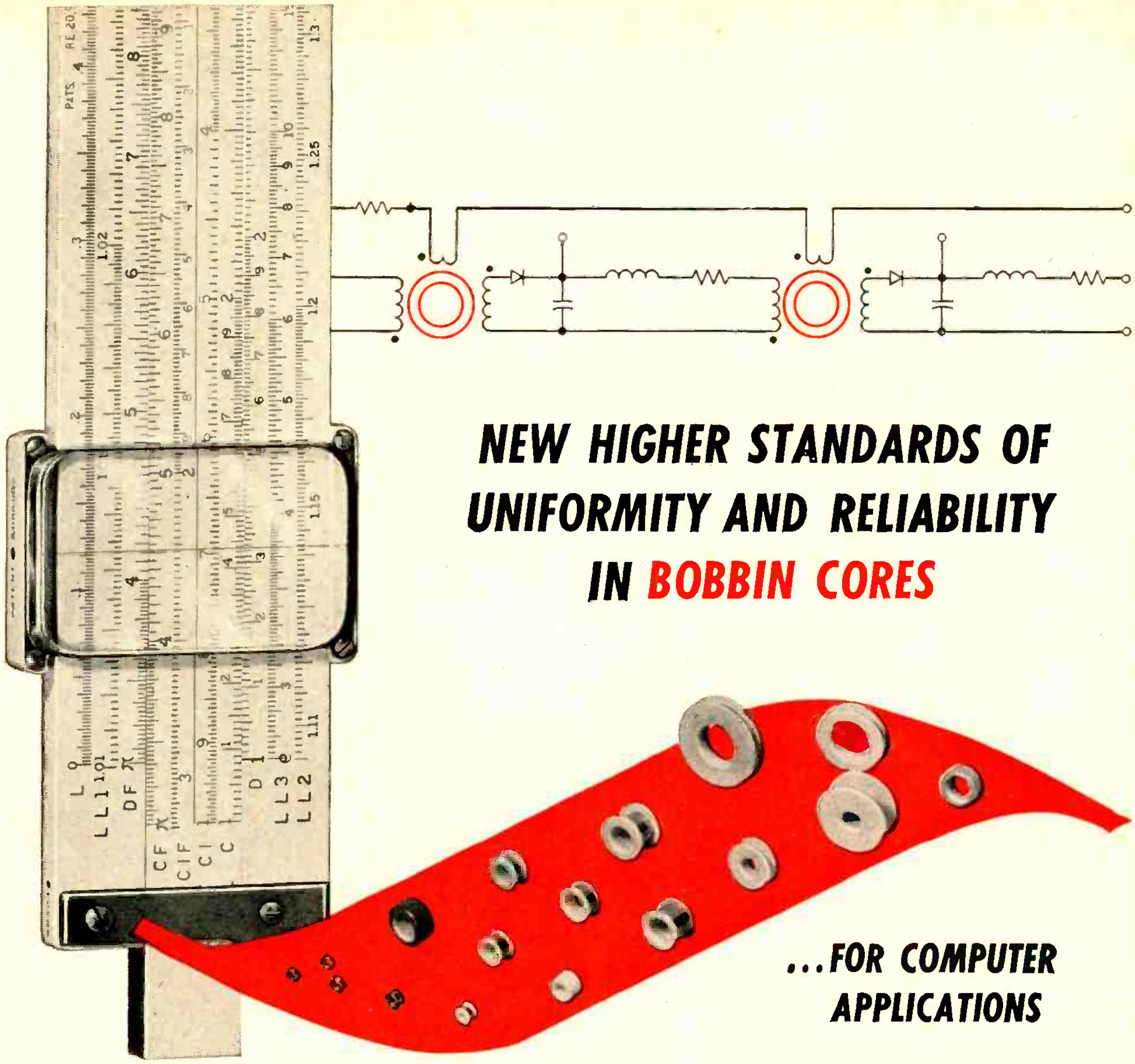
Microwave test equipment used in calibrating all Bendix noise source tubes.



Red Bank Division

Bendix
AVIATION CORPORATION

CIRCLE 49 READERS SERVICE CARD

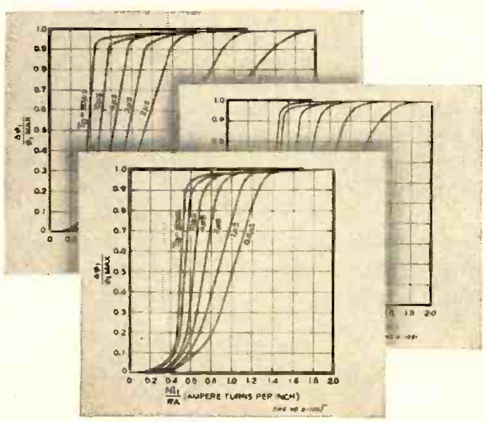


NEW HIGHER STANDARDS OF UNIFORMITY AND RELIABILITY IN BOBBIN CORES

...FOR COMPUTER APPLICATIONS

CHECK THESE FEATURES:

Rigidly controlled 4-79 Molybdenum Permalloy Tape • Ceramic or Stainless Steel Bobbins • Hydrogen atmosphere annealing • Polyester Tape, Polyethlyene or Nylon Protective Jackets • 100% Tested to Customer Performance Specifications • Maximum Uniformity in Production Quantities • Reliable Reproduction of uniform cores to rigid performance specifications — on order after order — over long periods of time!



DYNACOR Bobbin Cores using ultra-thin tape offer greater uniformity and reliability than ever before available. The new high performance standards will be interesting to designers using magnetic core logic for computer, counter and control circuits. DYNACOR Bobbin Cores find ideal application in critical magnetic shift register, switching transformer and other logic circuits which require the utmost uniformity in switching time and signal to noise ratio. ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

COMPLETE PERFORMANCE DATA • SEND FOR BULLETINS

Write for Bulletin DN-1000 and Engineering Data Sheets DN-1001 and DN-1002 for complete performance data covering the wide range of DYNACOR Bobbin Core sizes. Address your letter to Technical Literature Section, Dynacor, Inc., 10431 Metropolitan Avenue, Kensington, Md. ★ ★ ★ ★ ★ ★ ★ ★ ★

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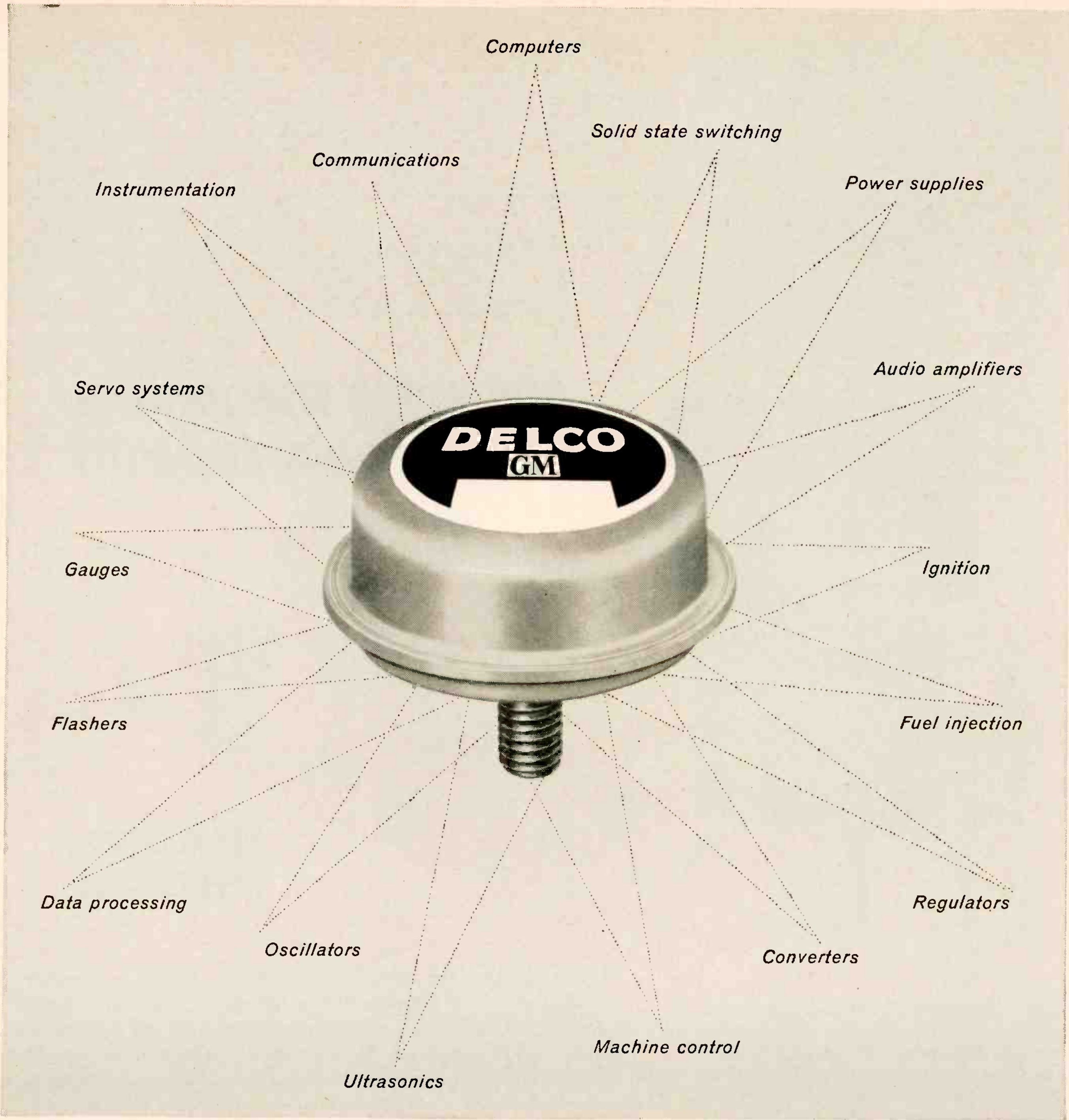


Wherever you require high power, consider

DELCO HIGH POWER TRANSISTORS

Thousands of Delco high power germanium transistors are produced daily as engineers find new applications for them. In switching, regulation, or power supplies—in almost any circuit that requires high power—Delco transistors are adding new meaning to compactness, long life and reliability.

All Delco transistors are 13-ampere types and, as a family, they offer a collector voltage range from 40 to 100 volts. Each is characterized by uniformly low saturation resistance and high gain at high current levels. Normalizing insures their fine performance and uniformity regardless of age. Also important—all Delco transistors are in volume production and readily available at moderate cost.

For complete data contact us at Kokomo, Indiana or at one of our conveniently located offices in Newark, New Jersey or Santa Monica, California. Engineering and application assistance is yours for the asking.

DELCO RADIO DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA

BOOTH 1619 AT THE I.R.E. SHOW

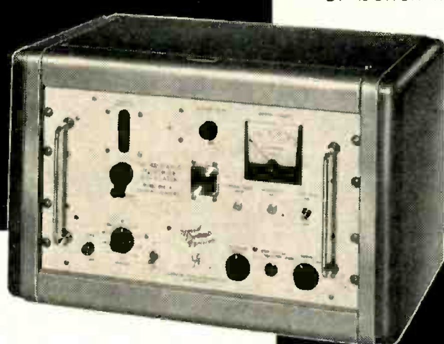
CIRCLE 51 READERS SERVICE CARD

HIGH POWER-ULTRA-STABLE-TUNABLE MICROWAVE OSCILLATORS

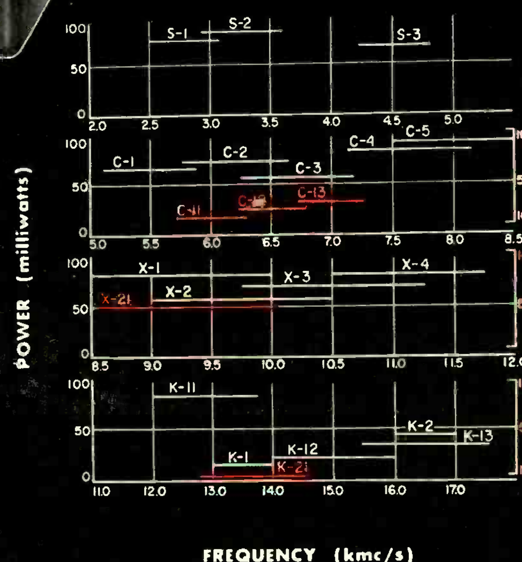
The first complete line of stabilized oscillators to cover the microwave spectrum.

Series 814, with 23 models, has as main components a klystron oscillator and stabilizing feedback loop consisting of a tunable reference dual-mode cavity and low-noise d-c amplifier. The direct reading dial and freedom from oscillator pulling makes measurements in all applications easy and accurate, even for semi-skilled personnel.

HIGH POWER . . . 20 milliwatts to 1.5 watts output, dependent on klystron. **ULTRA-STABLE** . . . short term frequency stability approximately five parts in 10^8, long term frequency stability one part in 10^6. **TUNABLE** . . . direct reading tuning dial accurate to 0.1 percent of reading. **BUILT-IN STABILITY CIRCUIT** . . . klystron output locked to reference cavity frequency by built-in stability circuit, including automatic stability indicator — an exclusive feature. **SPECTRUM COVERAGE** . . . complete line covers microwave spectrum — 2500 to 17,500 mc. **DESIGN** . . . clean, rugged construction, rack or bench mounted for test or system installation.



Every stable source is warranted by the only microwave stability tester on the market today -- the LFE 5004.



Specifications

FREQUENCY COVERAGE . . .
2500 to 17,500 mc/s

DIAL CALIBRATION . . .
1 mc per division on main dial, vernier dial included for tuning ease and interpolation

FREQUENCY STABILITY . . .
5 parts in 10^8 average short term stability, 1 part in 10^6 average long term stability, (under normal environmental conditions)

AMPLITUDE MODULATION . . .
Up to 15% amplitude modulation by internal 1000 cps modulator. Front panel jack for connection to external audio oscillator

FREQUENCY MODULATION . . .
Total deviation up to 0.01% of frequency

POWER . . .
200 watts average, 117 volts, 50-60 cps

DIMENSIONS . . .
Overall with dust cover: 21 1/16" wide, 14 9/16" high, 16 5/16" deep. May be rack mounted. Panel only: 19" by 10 1/2"

WEIGHT . . .
100 lb

L/E

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LABORATORY FOR ELECTRONICS, INC.

75 PITTS STREET BOSTON, MASS.

GENERAL INSTRUMENT
SEMICONDUCTORS

Radio Receptor silicon diodes

IN ANY COMBINATION OF CHARACTERISTICS INCLUDING...

high speed • high conductance • high temperature
high voltage • high back resistance

General Instrument semiconductor engineering has made possible these new silicon diodes with a range of characteristics never before available to the industry. **Particularly outstanding is the all-purpose type 1N658 which offers uniform excellence in all parameters.** The RRco. diodes shown here are just a small sampling of the line — the complete list will be sent you upon request to Section EL-3

Code No.	Max. Fwd. Voltage Drop @ Indicated DC Current	Max. Rev. DC Cur. @ Test V. 25° C.	Max. Rev. DC Cur. @ Test V. 150° C.	Test Voltage	Min. Break-down Voltage*	Reverse Recovery
1N658	**1 @ 100 mA**	**.05 μA**	**25 μA**	**50V**	**120V**	**80KΩ in 0.3 μsec†**
1N457	1 @ 20 mA	.025 μA	5 μA	60V	70V	
1N458	1 @ 7 mA	.025 μA	5 μA	125V	150V	
1N459	1 @ 3 mA	.025 μA	5 μA	175V	200V	
DR668	1 @ 200 mA	.025 μA	5 μA	60V	80V	
DR669	1 @ 200 mA	.025 μA	5 μA	125V	150V	
DR670	1 @ 200 mA	.025 μA	5 μA	175V	200V	
			100° C.			
1N625	1.5 @ 4 mA	1 μA	—	10V	30V	15KΩ in 0.15 μsec‡
	—	10 μA	50 μA	20V	—	————
1N627	1.5 @ 4 mA	20 μA	100 μA	75V	100V	400KΩ in 1.0 μsec†
1N629	1.5 @ 4 mA	20 μA	100 μA	175V	200V	400KΩ in 1.0 μsec†
DR677	1 @ 100 mA	0.5 μA	25 μA	20V	30V	15KΩ in 0.15 μsec‡
DR673	1 @ 100 mA	0.5 μA	10 μA	75V	100V	400KΩ in 1.0 μsec†
DR675	1 @ 100 mA	0.5 μA	10 μA	175V	200V	400KΩ in 1.0 μsec†

*Reverse voltage at which a reverse current of 100 μA flows.
†When switching from 5 mA to −40V.
‡When switching from 5 mA to −20V.

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Selenium Rectifiers • Communications, Radar and Navigation Equipment

Concerned with microwave test equipment?

Only NARDA offers you these exclusive features!

TURRET ATTENUATORS

Only Narda offers you a UHF-only attenuator. This represents a considerable savings in cost for applications in this frequency range. Each of three models offers the Designer or Development Engineer 12 steps of attenuation from d.c. to 1,500 mc with a VSWR of 1.25. Designed for bench use or mounting into test equipment packages.

One unit can give a maximum of 30 db attenuation; two units can be used in series to provide a wide range of control in small steps.

Model 705—0, 3, 6, 9, 12, 15, 20, 25, 30 db
Model 706—0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20 db
Model 707—0, 3, 6, 9, 12, 15, 18, 21 INF db

ALL MODELS . . . **$275** each

COAXIAL DIRECTIONAL COUPLERS

10, 20 and 30 DB . . . 225 to 4,000 mc.

Only Narda offers coaxial directional couplers in 10 and 30 db values, as well as 20 db. In addition, all models offer such advantages as these:

1. Flat Coupling—values with 1 db of nominal over a full octave frequency range, with calibration provided to ± 0.2 db accuracy.
2. Machined from solid blocks of aluminum—hence, more rugged.
3. Directivity exceeding 20 db.
4. Frequency Ranges: 225-460, 460-950, 950-2000, 2000-4000 mc.

Write for complete specifications.

$100 to **$225**

S to X BAND FREQUENCY METER

Narda offers the only single instrument covering this complete band of frequencies—2,350 to 10,500 mc. In addition, no combination of other meters can cover these frequencies at a comparable price!

An easy to read nomograph type calibration chart, mounted in the lid, converts digital counter readings to frequency in megacycles—to the rated accuracy of 0.2%. No calculations or interpolations are needed.

The unit is completely self contained, with built-in detector and indicating meter. A sensitivity control allows use with strong signals; for signals below 5 mw., the external meter jack may be connected to an amplifier or oscilloscope.

Model 802B . . . $785

UHF FREQUENCY METER DETECTORS . . . Direct Reading

The only direct reading frequency meter detectors available for the UHF range—and they're from Narda, of course! Absorption type meters, with 0.2 db insertion loss, each includes a resonant cavity, coaxial switch, crystal detector, current meter, sensitivity control and type N terminals.

SPECIFICATIONS

Frequency (mc)	Accuracy	Loaded Q	VSWR	Sensitivity for full scale deflection	NARDA Model	Price
200-500	0.5 mc	500	1.15	0.2 mw	804	$375
500-1500	1 mc	700	1.15	0.2 mw	805	375
1500-2400	2 mc	500	1.25	0.5 mw	806	375

Complete Coaxial and Waveguide Instrumentation for Microwaves and UHF — including:

DIRECTIONAL COUPLERS	TUNERS	ATTENUATORS
TERMINATIONS	ECHO BOXES	STANDARD REFLECTIONS
FREQUENCY METERS	SLOTTED LINES	BOLOMETERS
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High Resolution Magnetic Heads
WITH GAPS AS NARROW AS **20** MICROINCHES

Clevite "Brush" high resolution magnetic heads permit major improvements in tape recording systems:

Greater packing density and/or higher frequency recording at your present tape or drum velocity. *Less volume of tape required.*

Up to 10 to 1 reduction in tape or drum velocity at your present frequencies or pulse repetition rate. *More recording time on the same length of tape.*

Reduced playback pulse width, allowing extended pulse width modulation (pwm) recording; for example, 10 microsecond pulse width at 120 inches per second tape velocity.

Special high resolution heads were developed by Clevite to meet specific customer applications. They are now commercially available in 2 to 32 channel form in a variety of mechanical configurations. These heads, slightly modified, may fit your present design requirements. One of our specialists will be pleased to discuss your application by detailed correspondence or personal visit. Write: Product Manager, Magnetic Heads, Clevite Electronic Components, 3311 Perkins Avenue, Cleveland 14, Ohio.

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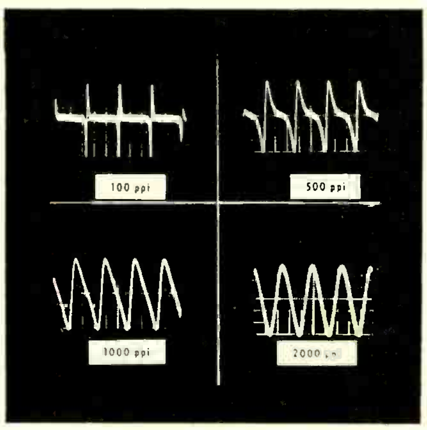
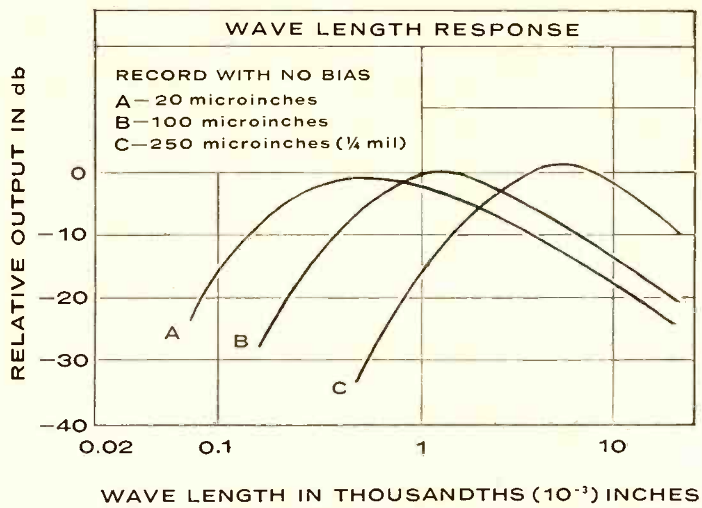
Typical Clevite narrow gap multi-channel head records more data on an equal length of tape.



Oscilloscope photos of pulse recordings on Clevite high resolution head. Pulse duration, 1 microsecond; tape speed, 60 inches/sec.



Clevite 'Brush' High Resolution Heads for radar recording • high density tape recording • high density drum recording • video recording • VHF instrumentation for missile telemetering

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DIVISION OF CLEVITE CORPORATION

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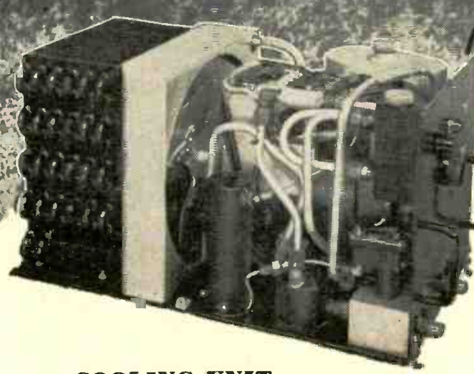
CIRCLE 56 READERS SERVICE CARD→

cooling avionic systems

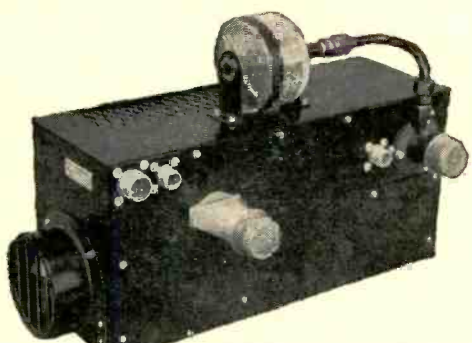
During World War II, Eastern Industries pioneered cooling systems for aircraft electronic systems. Now, thousands of installations later, and as the leader in this challenging field, Eastern is still pioneering.

Experience has been a springboard to new developments . . . compactness, simplification, refrigeration cycles. Research and development continue to play their vital parts in perfecting systems to overcome the new problems as expanded aircraft performance produces fantastic rises in temperatures.

If you have a challenging problem, come to the leader in the field for complete and creative engineering help.



COOLING UNIT



REFRIGERATION-TYPE

ELECTRONIC TUBE COOLING UNITS

Custom-made units, with or without refrigeration cycles, provide a method of maintaining safe operating temperature limits in electronic equipment. Standard sub-assemblies and components normally are used to create a custom-made design to fit your exact needs. Costs are minimized for these completely self-contained units by combining heat exchangers, fans or blowers, liquid pumps, reservoirs, flow switch, thermostat, and other common components.

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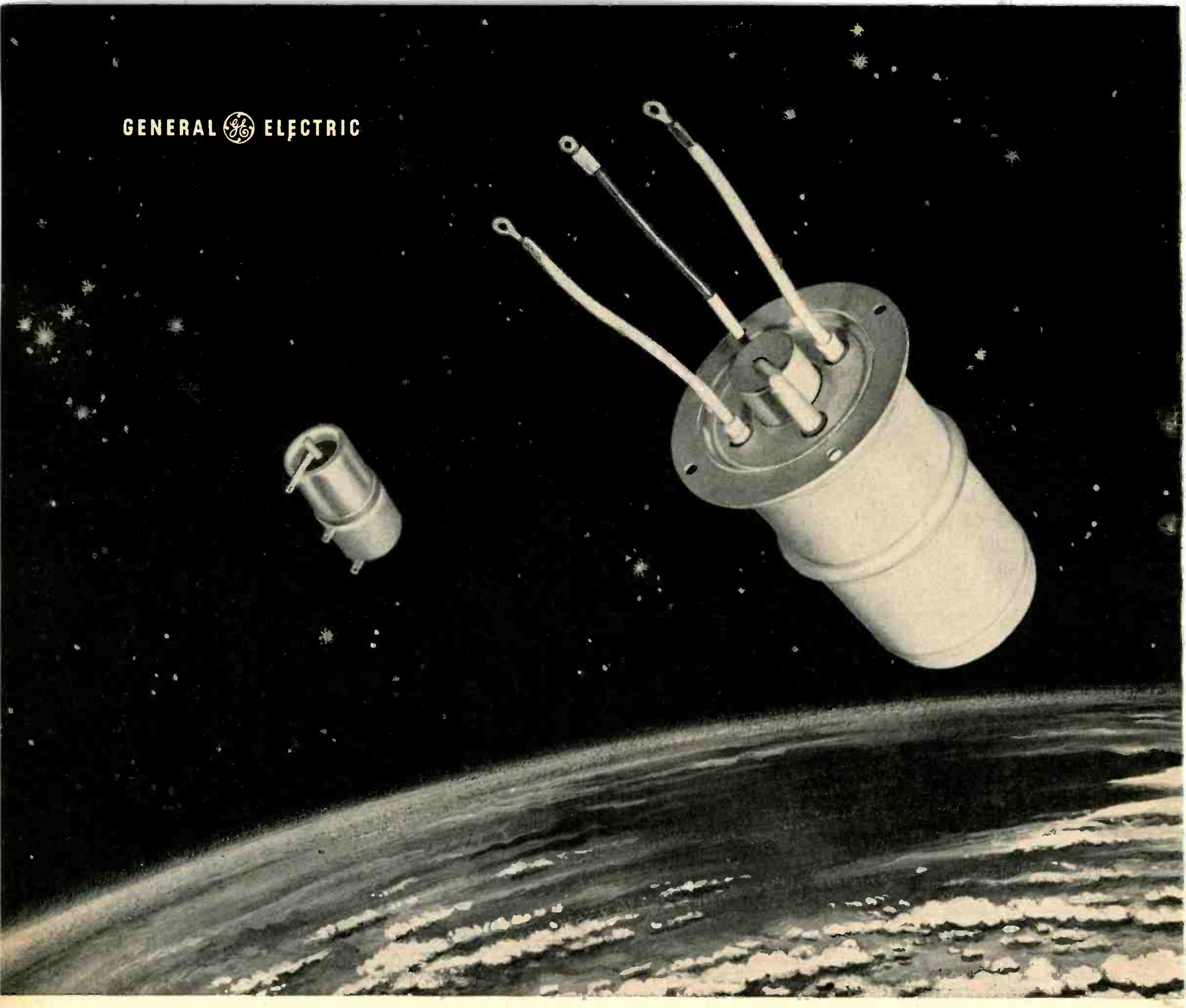
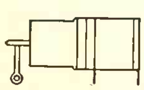


New General Electric Hydrogen Thyratrons

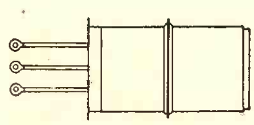


A RUGGED, CERAMIC HYDROGEN THYRATRON DESIGNED FOR USE IN GUIDED MISSILES

This new General Electric ceramic hydrogen thyratron is designed to withstand up to 21G vibration, at 20 to 2,000 cycles per second. Among a number of construction features contributing to the unusual strength of this tube is a special cathode assembly newly developed by G-E engineers. This assembly is rigidly fastened to the tube's envelope in a single, continuous, vibration-free structure.

CHARACTERISTICS:

Peak Anode Voltage—7 KV
Average Anode Current—25 milliamperes
Peak Anode Current—75 amperes
Anode Dissipation Factor—0.5 x 109



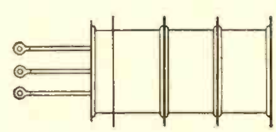
A HYDROGEN THYRATRON ESPECIALLY DESIGNED FOR HIGH-POWER RADAR PULSE MODULATORS

Below are shown the approximate envelope sizes and power outputs of two thyratrons now in use in high-power radar, as compared to the new G-E developmental tube.

TYPE 1257	TYPE 5948	NEW G-E DEVELOPMENT
8 ½"x20"	5"x16"	6"x11"
Avg. Power 33 KW Peak Power 33 MW	Avg. Power 12.5 KW Peak Power 12.5 MW	Avg. Power 66 KW Peak Power 33 MW

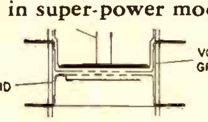
CHARACTERISTICS:

Peak Anode Voltage—33 KV
Average Anode Current—4 amperes
Peak Anode Current—2,000 amperes
Anode Dissipation Factor—40 x 109



A HIGHER-VOLTAGE DESIGN FOR SUPER-POWER RADAR PULSE MODULATORS

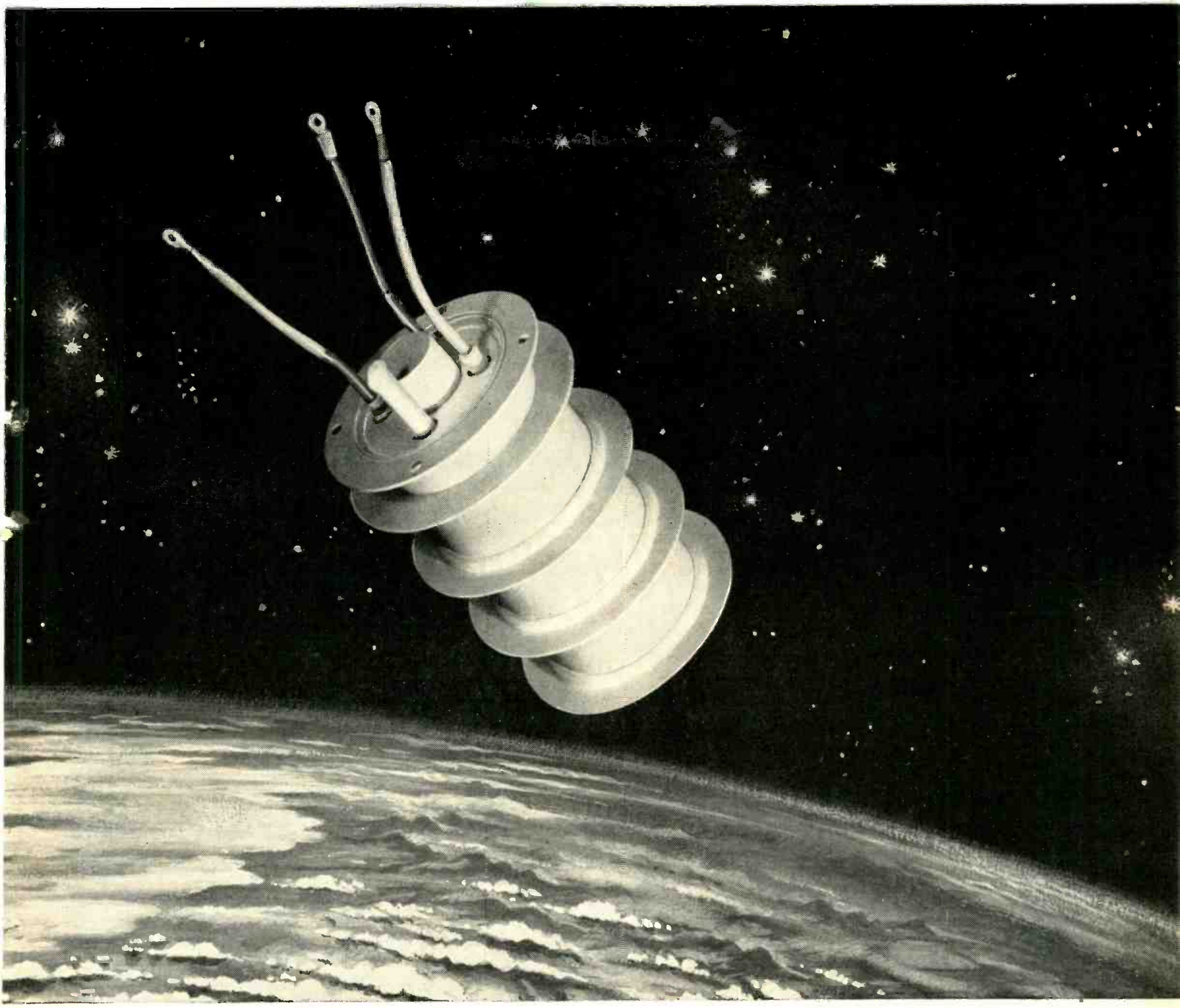
The use of a voltage gradient grid in this hydrogen thyratron permits the tube to operate at a higher anode voltage and to deliver a higher peak power. One tube can now do the work of two or more thyratrons usually required in super-power modulators.



CHARACTERISTICS:

Peak Anode Voltage—40 KV
Average Anode Current—2.2 amperes
Peak Anode Current—2,400 amperes
Anode Dissipation Factor—45 x 109

CIRCLE 57 READERS SERVICE CARD



Speed Design of Super-Power Radar

When tube designers and equipment manufacturers work together on advanced projects early in the planning stages, vital time is saved. Also, future availability of new tubes in desired quantities is assured.

The three developmental General Electric hydrogen thyratrons shown above are examples. New design and manufacturing techniques—and new applications of materials—were conceived by G-E designers to meet the specific needs of advanced super-power radar equipments now being developed. The result, months saved in the development of both new tubes and the equipment in which they will be used.

Call any of the General Electric Power Tube offices listed at the bottom of this page now if you are planning or developing advanced electronic equipment—and take advantage of General Electric's comprehensive facilities and experience. *Power Tube Department, General Electric Company, Schenectady, New York.*

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Inspect these three new hydrogen thyratrons in the General Electric exhibit at the IRE Show.

Progress Is Our Most Important Product

GENERAL ELECTRIC

9545-8481-11

CIRCLE 58 READERS SERVICE CARD

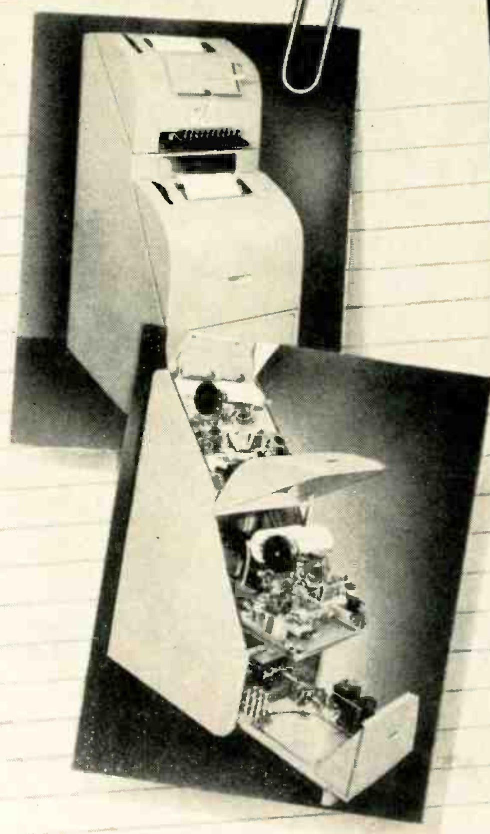
PROBLEM:

Reduction of repair and replacement time for vital message switching center

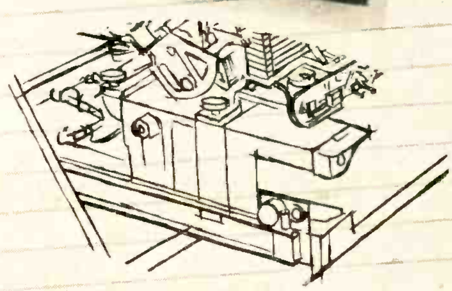
SOLUTION:

Grant stock slides appreciably decrease servicing time, increase overall efficiency

Western Union has developed a fully automatic switching center which assists in unifying and improving the efficiency of the United States Air Force's domestic and global communications system. With this system, a message typed only once is automatically flashed to a desired air base, in any part of the world, in seconds. It checks out human, equipment and line failure and even determines the priority of a message. After the initial typing of the message, the entire process is automatic. Units such as these, with their precise and sensitive components, must undergo inspections, adjustments and maintenance and moments lost in dismantling might mean the delay of a vital message. The important operating sections of this equipment are mounted on Grant No. 306 slides. These afford instantaneous accessibility, permitting faster, more convenient and most efficient maintenance.



Grant No. 306 Slides (one of a great variety of stock slides) recommended for loads up to 50 lbs./pair



Courtesy The Western Union Telegraph Company, N.Y.C.

Write for complete data on this slide and the wide range of heavy duty, 3 section slides.

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INDUSTRIAL SLIDES

If the question is Accessibility... the answer is Grant.

Grant Pulley and Hardware Corporation

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Transitron

SILICON RECTIFIERS

HIGH VOLTAGE • 600 volts

HIGH CURRENT • 400 ma

combined with subminiature size

Type	Peak Recurrent Inverse Operating Voltage (volts)	Maximum Average Forward Current @ 150°C (ma)	Maximum Average Forward Current @ 25°C (ma)	Maximum Inverse Current @ 150°C Full Load (ma)
1N689(TG62)	600	150	400	.2
1N686(TG52)	500	150	400	.2
1N684(TG42)	400	150	400	.2
1N682(TG32)	300	150	400	.2
1N679(TG22)	200	150	400	.2
1N677(TG12)	100	150	400	.2

High ratings of 600 volts and 400 ma (150 ma at 150°C) are now yours in a tiny glass envelope only .1 inch by .3 inch in size. This versatile package is ideal for printed circuits, subminiature power supplies, D.C. blocking, high voltage series strings, and other applications where space is at a premium.

Rugged and reliable at temperatures to 175°C, these hermetically sealed rectifiers have been thoroughly tested under the most severe operating conditions. They offer the same high degree of dependability that characterizes Transitron silicon diodes and stud type rectifiers.

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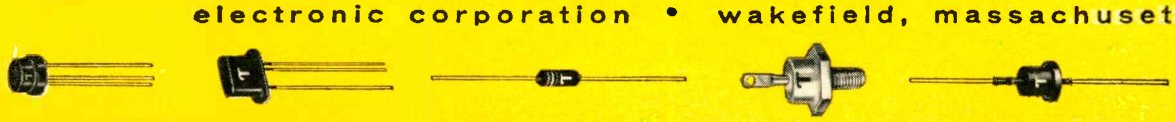
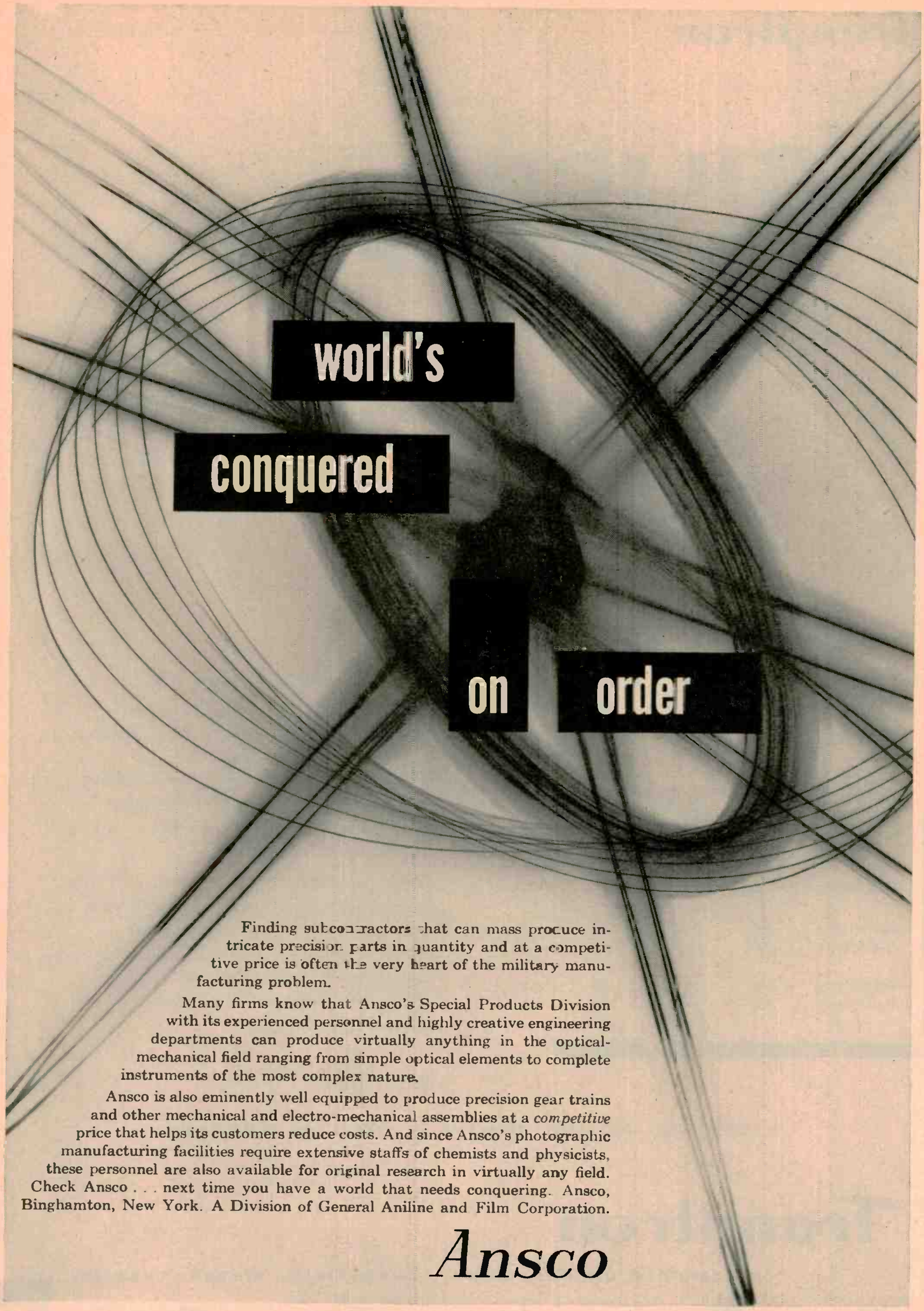


Transistors Diodes Regulators Rectifiers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Finding subcontractors that can mass produce intricate precision parts in quantity and at a competitive price is often the very heart of the military manufacturing problem.
Many firms know that Ansco's Special Products Division with its experienced personnel and highly creative engineering departments can produce virtually anything in the optical-mechanical field ranging from simple optical elements to complete instruments of the most complex nature.
Ansco is also eminently well equipped to produce precision gear trains and other mechanical and electro-mechanical assemblies at a *competitive* price that helps its customers reduce costs. And since Ansco's photographic manufacturing facilities require extensive staffs of chemists and physicists, these personnel are also available for original research in virtually any field. Check Ansco . . . next time you have a world that needs conquering. Ansco, Binghamton, New York. A Division of General Aniline and Film Corporation.
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SILICON TRANSISTORS

Now... The widest POWER RANGE in the industry!

Two new high power transistors have just been added to the Transitron line, increasing power ratings to 80 watts. Now, whatever the application, you can choose from the broadest power range in the industry . . . with Transitron reliability built into every transistor.

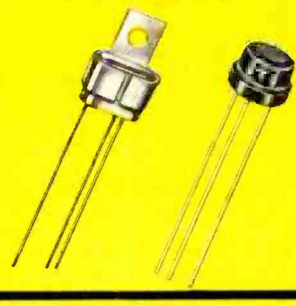
HIGH POWER

- Ratings to 80 watts
- Operation to 5 amps
- Low Rcs, 1.5 ohms typical
- Voltage Ratings to 60V

Type	Maximum Power Dissipation at 25° C case (watts)	Minimum D.C. Common Emitter Current Gain B	Typical Collector Saturation Resistance (ohms)	Maximum Collector Voltage Vc (volts)
ST400	80	15@5 amps	1.5@5 amps	60
2N389	37.5	10@2 amps	3@1 amp	60

MEDIUM POWER

- Operation to 500 ma
- Ratings to 5 watts
- Low Rcs, 6 ohms typical
- Voltage Ratings to 100V

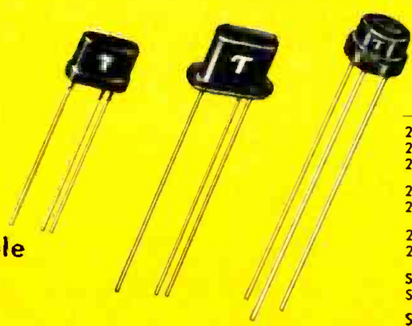


Type	Maximum Power Dissipation at 25° C case (watts)	Maximum Collector Voltage VcMax (volts)	Minimum D.C. Common Emitter Current Gain B	Typical Collector Saturation Voltage (volts)
2N545*	5	60	15@500 ma	3V@500 ma
2N547	5	60	20@500 ma	3V@500 ma
2N498	4	100	12@200 ma	4V@200 ma
2N497	4	60	12@200 ma	4V@200 ma
2N551	5	60	20@ 50 ma	1V@ 50 ma
2N243	.75	60	9@ 5 ma	3.5V@20 ma
2N244	.75	60	28@ 5 ma	3.5V@20 ma

*Fast Switching Type

SMALL SIGNAL

- Operation to 175°C
- Low Ico at Rated Vc max.
- High Current Gain
- Three package sizes available



Type	Minimum Common Emitter Current Gain, β	Maximum Collector Voltage Vcc Peak (Volts)	Typical Cut-off Frequency (MC)	Maximum Collector Cut-off Current at 25°C at Vc MAX (μa)
2N543	80	45	15	.5
2N480	40	45	11	.5
2N475	20	45	10	.5
2N336	78	45	13	50
2N334	18	45	11	50
2N118	18	30	4	10
2N119	36	30	4	10
ST904	18	30	4	10
ST905	36	30	4	10

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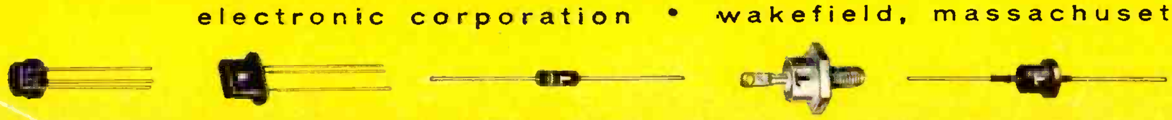
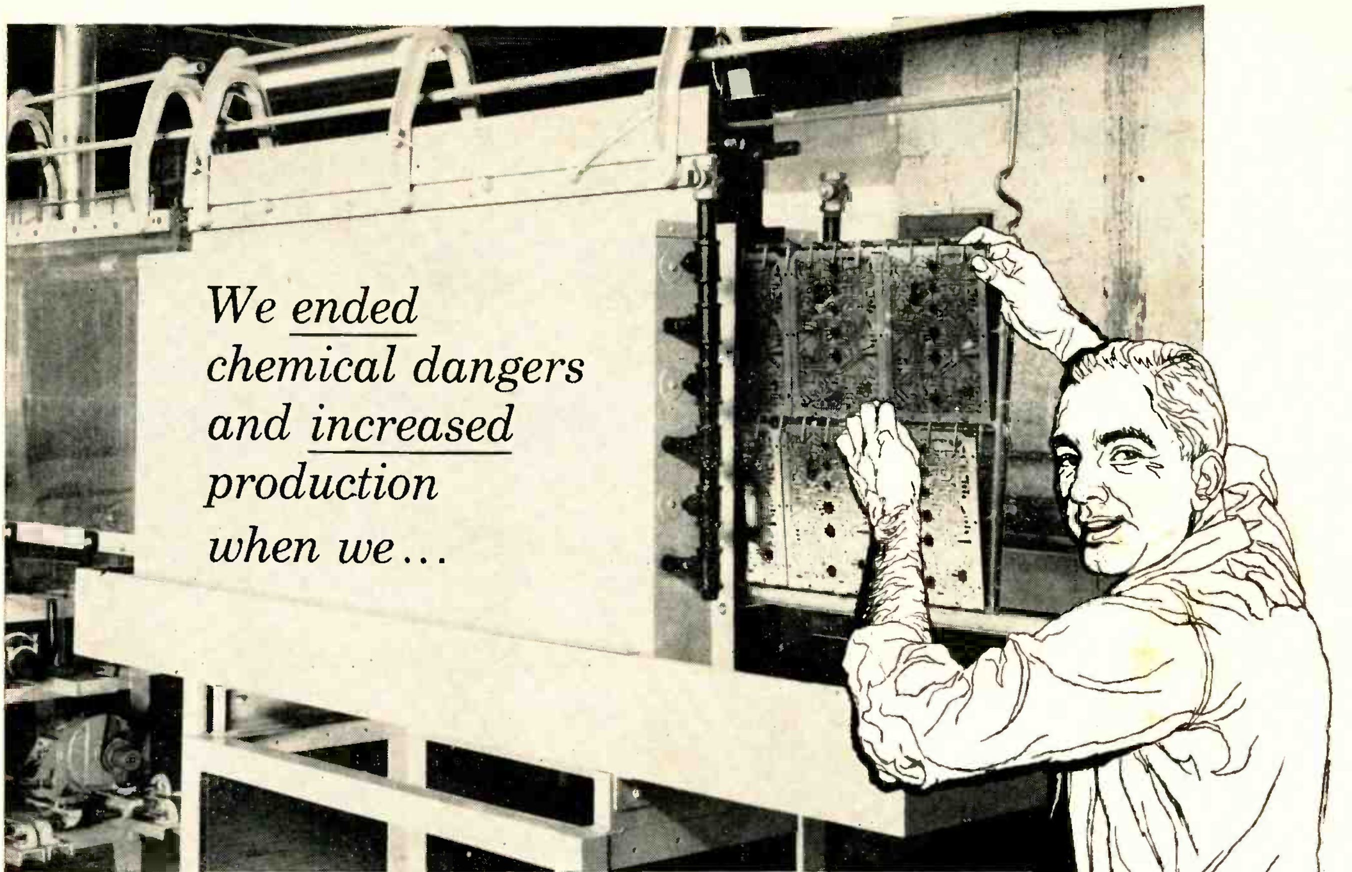
electronic corporation • wakefield, massachusetts



Transistors Diodes Regulators Rectifiers



STOPPED *making our own etchant* STARTED *using* HUNT S.C.E.

"We used to make our own etchant for solder plated circuit boards until we heard of HUNT S.C.E. Solution.

"To mix our own etchant we used to stock large quantities of chromic and sulphuric acid. It took time to make up the solutions which filled the air with noxious fumes and was always dangerous to handle. Besides the time it took to make up the solutions we ended up with variations from batch to batch. And in order to get the solution working right, we had to heat it up to 140° F and over.

"So we did the wise thing... stopped making our own and started to use HUNT S.C.E. which works at room temperature. Now we have no more chemical dangers. We are really saving money — etching time is standardized and we maintain a uniform production rate around the clock."

HUNT S.C.E. (Solder Circuit Etch) is superior to plant mixed etchants because it:

1. Etches rapidly at room temperature.
2. Is a ready, prepared product designed specifically for this one purpose.
3. Has a high capacity for copper.
4. Never attacks the solder plated circuit.
5. Has guaranteed uniformity and is the highest quality because of rigid laboratory control.
6. Gives fast, odorless etching of the copper.
7. Produces boards that pass all corrosion and stability tests.

For detailed information about HUNT S.C.E. and valuable production handling information, write for Technical Bulletin No. 3 — *"The Etching of Solder Plated Circuit Boards by Hunt S.C.E. Solution."* Hunt S.C.E. Solution is available in 125 pound (12 gallon) carboys and 530 pound (55 gallon) drums.

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DATA SHEET

PHILLIPS

REMOVE AND FILE FOR REFERENCE

SERIES 34 & 36 SUB-MINIATURE RELAYS

UNIQUE NON-RESONANT ARMATURE RETURN SPRING

In Series 34 and 36 sub-miniatures, the armature return spring is enclosed within the pole piece and is adjusted to extremely close limits. Because of its novel design, it is effectively dampened to prevent natural resonance. The movable springs are of a "safety pin" type. While providing adequate current capacity to carry the military requirement of four times rated load for overload test, they have very small mass and a high natural resonant frequency.

DC-34 & DC-36 ASSEMBLY FEATURES

The entire structure of these sub-miniatures is designed to provide long life with a high degree of reliability.

All units are hermetically-sealed. Materials used in their construction are of high temperature types. All insulation materials are inorganic, assuring non-gassing to minimum temperatures of 400° F.

These relays will not malfunction under extremes of vibration and shock, meeting military environmental requirements. Further, they conform exactly to military standards for dimensions and mountings, thus insuring interchangeability with contemporary types.

Standard coil and contact rating, listed on the reverse side, are conservative. Additional ratings are available for special requirements.

Adequate insulation is provided to insure an insulation resistance of 1000 megohms minimum when measured at 500 volts DC and a dielectric breakdown of 1000 volts rms between all terminals and case and between adjacent contact sections.

Special contact materials are available for switching in the low level or "dry circuit" range. Excellent reliability can be obtained in this application.

DC-34 & DC-36 DESIGN FEATURES

The motor assembly features a very tightly closed magnetic circuit, which results in low magnetic leakage and high magnetic efficiency since the entire field is concentrated in the useful area. Properly annealed armco is used to provide high permeability and freedom from residual magnetism.

A special coil design, with minimum amount of inorganic insulating material and no impregnating varnish, permits an unusually high number of ampere turns in the magnetic field.

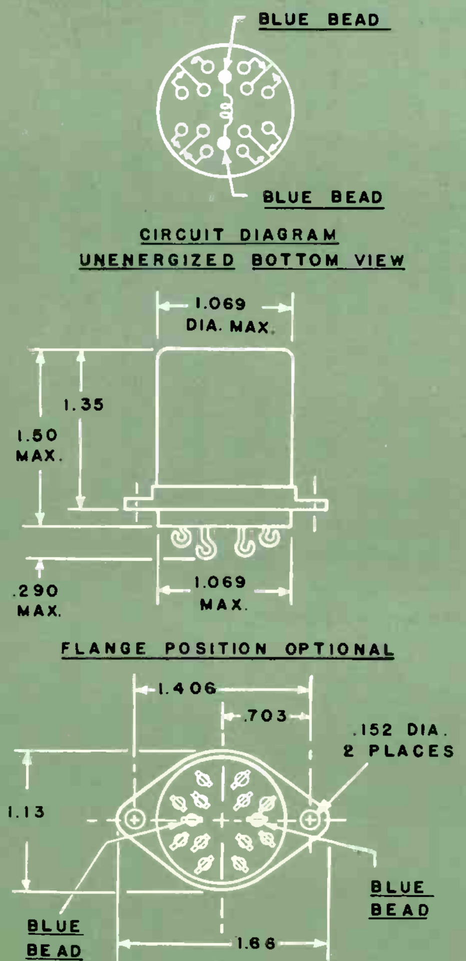
A special modified solenoid type armature is extremely lightweight — the entire armature and actuator assembly weighs only 2.2 grams. This armature is capable of operating the heavy spring load and furnishes a favorable weight to spring ratio for better resistance to external forces.

Movable contact is a spherical bead permanently coined on the contact spring. Stationary contacts are fabricated from beryllium copper overlaid with silver. All contact assemblies are heavily gold-plated to prevent oxidation prior to hermetic sealing.

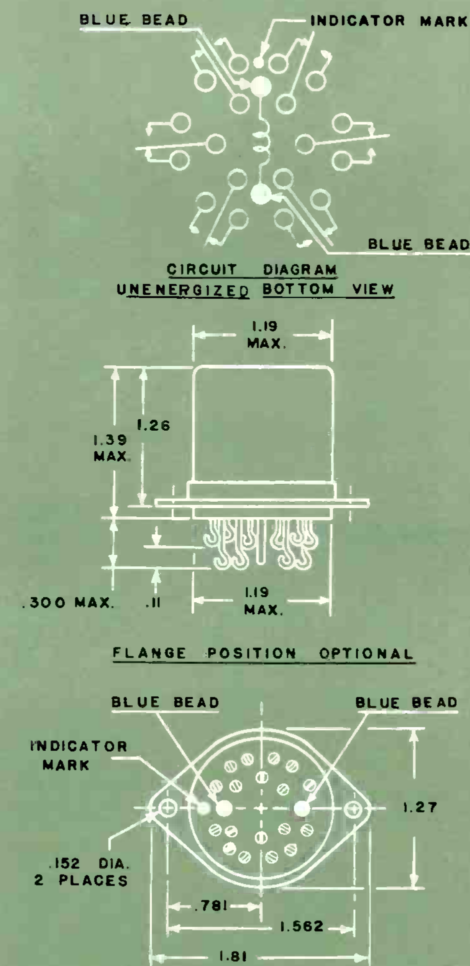
In adjustment of the contact groups, adequate pre-travel and over-travel are provided to compensate for wear and erosion of contact surfaces, assuring high contact pressure throughout a long and useful life.

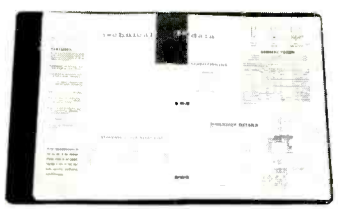
SERIES 34 & 36 SUB-MINIATURE RELAY AND SUB-ASSEMBLIES

Perforated for easy tear-out. Remove and file for reference.



DC-34	CHARACTERISTICS	DC-36
4PDT-(4 Form C)	**Contact Form**	6PDT-(6 Form C)
up to 300v. D.C.	**Coil Voltage**	up to 300v. D.C.
up to 22,500 ohms.	**Coil Resistance**	up to 27,500 ohms.
50G, 11ms.	**Shock (operating)**	50G, 11ms.
30G to 500c.p.s. 20G to 2,000c.p.s.	**Vibration (operating)**	30G to 500c.p.s. 20G to 2,000c.p.s.
−65 °C to 125 °C	**Temperature Range**	−65 °C to 125 °C
3.25 oz.	**Weight**	4 oz.
MIL-R-25018	**Specifications**	MIL-R-25018
Solder or Plug-in	**Terminals**	Solder or Plug-in
	DETAIL SPECIFICATIONS	
32	**Max. Operating Voltage**	32
26.5	**Nominal Coil Voltage**	26.5
18v. Max.	**Pick-up Voltage @125 °C**	18v .Max.
13v. Max.	**Drop-out Voltage @125 °C**	13v. Max.
240 ohms. Min.	**Coil Resistance @25 °C**	200 ohms. Min.
Silver	**Contact Material**	Silver
2 amps.	**Contact Rating, Resistive**	2 amps.
100,000	**Minimum Operating Life**	100,000
Continuous	**Rated Duty**	Continuous
9ms.	**Operate Time**	9ms.
3ms.	**Release Time**	3ms.
.05 ohms Max.	**Contact Resistance**	.05 ohms Max.
1,000 Meg. Min.	**Insulation Resistance**	1,000 Meg. Min.
1,000 RMS	**Voltage Insulation**	1,000 RMS





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PUBLICATION LIST . . . 8-page folder that lists and describes all the current publications offered by Allegheny Ludlum: 9 general publications, 14 on stainless, 10 on stainless applications in specific industries, 16 technical data sheets on stainless, 40 on tool steels, 20 on Carmet carbide materials, 5 on forgings and castings, 12 on electrical steels. There is a handy order form to use in getting the data you need.

As *the* major producer of special alloy steels for industry, Allegheny Ludlum naturally offers much more than steel. Ten strategically located plants provide prompt mill deliveries and stock shipments are made from warehouses in all industrial centers. Staff specialists from the mills working with the sales engineers from the sales office provide assistance when requested. Whenever you have a problem involving stainless, high-temperature, electrical, magnetic or tool steels or sintered carbides, let us help. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pennsylvania.***

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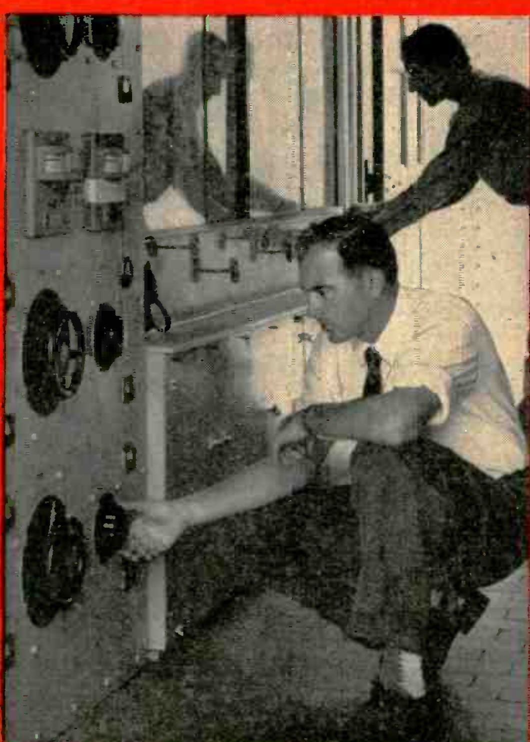
PIONEERING on the Horizons of Steel

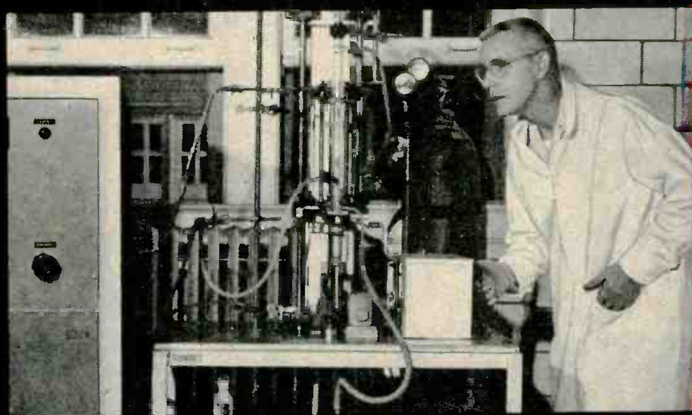


All phases of process are carefully checked and reviewed prior to a run.

Leading manufacturer of fine chemicals offers single-crystal and polycrystalline silicon.

Base boron content below one atom of boron per six billion silicon atoms.

CIRCLE 67 READERS SERVICE CARD



The checking of silicon refining via the floating zone technic is but one of the many process checks made in the manufacture of polycrystalline silicon.

Critical quality control and rigid specification standards are maintained through regular testing. Here a Merck technician pulls a silicon crystal prior to test that will assure uniform product purity, quality, and dependability.

CON

The critical specification of silicon materials is their purity—purity that will not limit the performance of present and future semiconductor devices. Merck is now manufacturing the purest grade of silicon available.

Long-established and world-renowned for its manufacture of products that must be pure—products that demand the ultimate in quality control—Merck is eminently suited to launch its program of products for the electronics industry.

SINGLE-CRYSTAL FORM

Single crystals are currently available in the following form:

Resistivity Min.	1000 ohm cm. p type
Lifetime Min.	200 microseconds

In the near future, single crystals will be available also in a variety of resistivities from the highest purity 1000 ohm cm. p or n type minority carrier to any intermediate resistivity up to 80 ohm cm. ± 20% over entire crystal.

All single crystals are prepared from extremely pure Merck silicon. The crystals are grown without contact with quartz or any other crucible material. Thus, they possess extremely low oxygen concentration and should exhibit very little heat treating.

POLYCRYSTALLINE FORM

In addition to the single crystals described above, Merck silicon polycrystalline is available in the form of billets of high density material. The billets are under one inch in diameter and are in suitable lengths so that two or three billets, without additional cutting or etching, will fit into the average crucible for crystal pulling. Other lengths will be available in the future for floating zone refining (vertical crystal growing). Merck polycrystalline billets have not previously been melted in quartz so that no contamination from this source is possible. Billets are shipped in double-walled polyethylene bags for protection.

At present, the polycrystalline material contains a small concentration of a Group V element which segregates rapidly in zone refining. No other elements, such as tantalum, gold, zinc, iron, manganese, molybdenum, potassium, sodium, bismuth, and cobalt, appear to be present even when tested by the most sensitive analytical technics such as activation analysis.

SPECIAL TECHNICAL SERVICE

A completely equipped and staffed laboratory is being maintained at the Electronic Chemicals Division to aid customers in the use and applications of Merck ultra-pure silicon.

For additional information on specific applications and processes, write Merck & Co., Inc., Electronic Chemicals Division, Department ES-1, Rahway, New Jersey.

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395 Page Mill Road
Palo Alto, California

Extends a cordial invitation
to visit

BOOTHS 3017-3018

at the 1958 national IRE convention,
March 24th - 27th, New York

where the latest types of multi-purpose

DIGITAL INSTRUMENTATION EQUIPMENT

will be displayed and demonstrated.

Included in the Dynac, Inc. exhibit will be

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. . . **Voltage-to-Frequency Converter**
. . . . **Computing Digital Indicator**
. . . . . **Digital Comparators and Associated Go/No-Go Test Equipment**

Experienced instrumentation engineers will demonstrate the new digital equipment and will be available for consultation on your instrumentation requirements.

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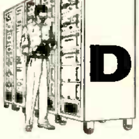
Dynac, Inc. is a leading supplier of custom-engineered radar simulators and related microwave equipment for guidance system development and testing. Dynac engineers will be at the IRE Show to discuss your interest and requirements in this important new field.

Application engineers nation-wide. Write direct for detailed information and name of representative in your area.



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Custom instrumentation systems of the highest performance, efficiency and dependability.

model 602 Direct Recording OSCILLOGRAPH

MI

D/R

DIRECT READOUT • NO POWDERS • NO CHEMICALS

SPECIFICATIONS

MAXIMUM CHANNELS: 50 Channels

RECORD WIDTH: 12 inches

MAGAZINE CAPACITY: 200 feet

RECORD SPEED RANGE: .0865 to 138.5 per second

WRITING SPEED: Above 30,000" per second

OPTICAL ARM: 11 inches

POWER REQUIREMENTS: 115V 60 cps

TIMING LINES: 0.01 with 0.10 second (accentuated intervals)

SIZE: $11\frac{1}{16}$" x $16\frac{13}{16}$" x $24\frac{1}{2}$"

WEIGHT: 130 pounds

Swift readout of the completed records as they flow from the 602 D/R Direct Recorder, places this advanced instrument on the top priority list with test engineers and laboratory researchers who prefer INCREASED ACCURACY + TIME SAVED.

Outstanding features include: full width timing lines — record numbering and identification — wide range of recording speeds — use of standard MI Galvanometers, all exclusive to the MI model 602 Direct Recorder OSCILLOGRAPH.

Midwestern Instruments manufactures several models of oscillographs — a model for practically any application.

MI

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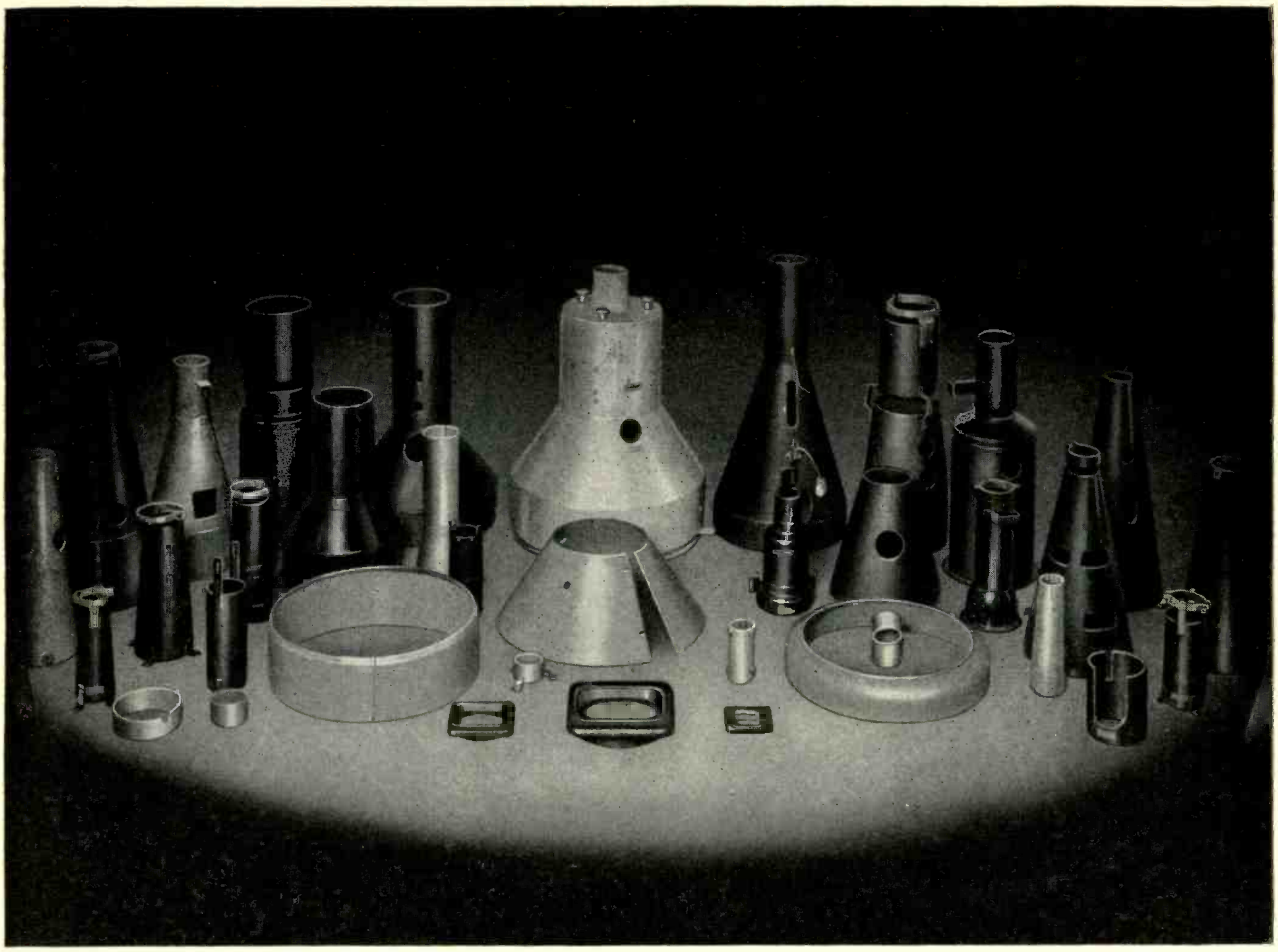

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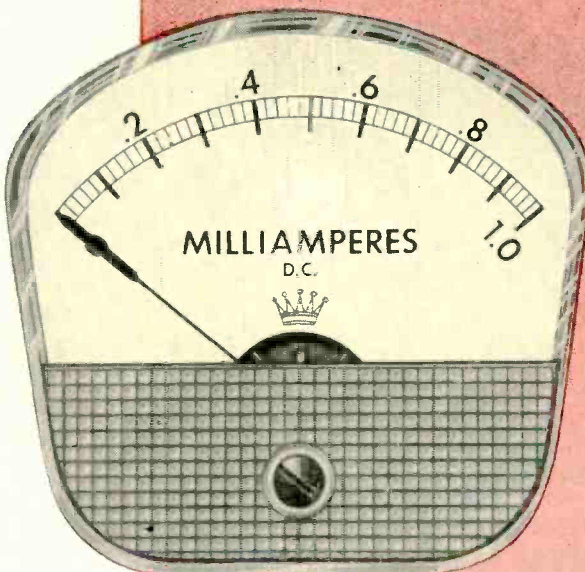
an exciting new series of panel instruments

New **LOW COST!**

New **HIGH STYLE!**

Weston traditional **QUALITY!**



Weston presents a new look in panel instruments! You'll see the difference at first glance. The price will delight you . . . the performance will confirm that Weston's unequalled craftsmanship has scored again!

ULTRA-MODERN STYLING! Crown Instruments, with their handsome contours and sparkling prismatic cases, will enhance your most advanced panels and equipment. They're available in a variety of custom-colors, too.

EXTRA-LONG SCALES! Crown's 2.5-inch, 100° scales are longer than those of most 3½-inch diameter panel instruments. Clear plastic top, front and sides provide exceptional natural scale illumination.

CORMAG® PROTECTION! Weston's famous Cormag mechanism permits close grouping of instruments on magnetic or non-magnetic panels. No special adjustments need be made. There's no danger of magnetic intereffects.

WESTON ACCURACY! Crown D-C Instruments are accurate within ±2% of their full scale values; rectifier-type A-C models within ±3%.

INTERCHANGEABILITY! All Crown models can be mounted interchangeably with any 2.5-inch JAN or MIL spec instruments.

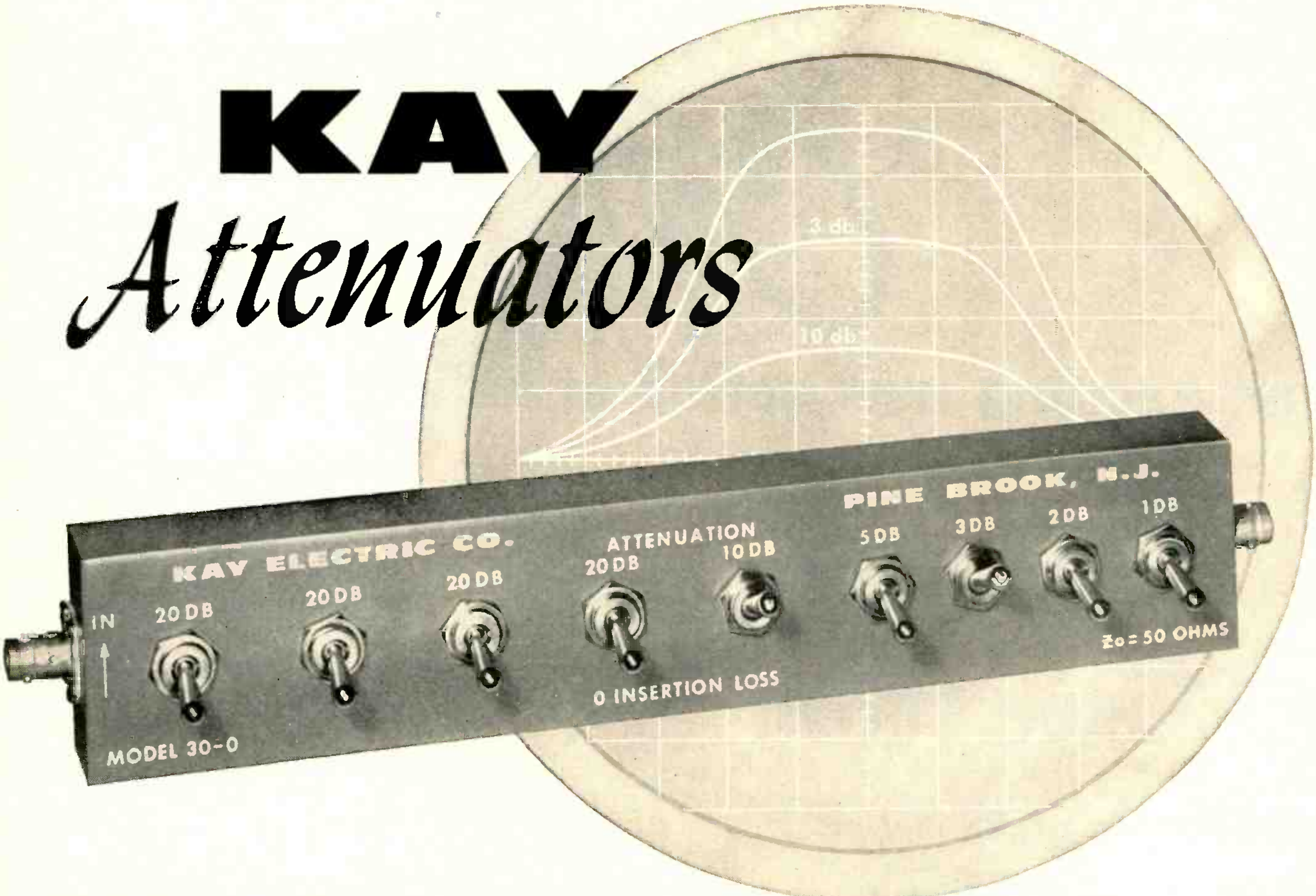
For accuracy, appearance, readability and cost, your best buy is CROWN. Your local Weston representative will be glad to quote on your requirements and arrange prompt delivery of prototypes. Contact him for full information, or write to Weston Instruments, Division of Daystrom Inc., Newark 12, N. J. *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

Truly Flexible High Frequency Attenuators at 50, 70, or 90 Ohm Impedances

KAY *Attenuators*



- Fast Switching to Check Points (½ Power, etc.) at Any Pre-Set Reference Level
- 0-101 db in 1 db Steps from Single Unit
- Ruggedized High Frequency Switches — Solid Silver Contacts in Teflon — for Low Insertion Loss
- 1% Tolerance Carbon Film Resistors for Highest Accuracy and Stability

Kay *Attenuators* are a series of nine high-frequency attenuators in three groups. The first provides a fixed insertion loss of 10 db; the two remaining offer a zero insertion loss. Each group offers a choice of 50 ohm, 70 ohm, or 90 ohm input and output impedance.

The first and second groups provide 0-41 db attenuation in 1 db steps; the third provides 0-101 db attenuation in 1 db steps.

SPECIFICATIONS

Model	20	21	22	20-0	21-0	22-0	30-0	31-0	32-0
Cat. No.	430-A	440-A	450-A	431-A	441-A	451-A	432-B	442-B	452-B
Zin Zout	50 ohms. nom.	70 ohms. nom.	90 ohms. nom.	50 ohms. nom.	70 ohms. nom.	90 ohms. nom.	50 ohms. nom.	70 ohms. nom.	90 ohms. nom.
Max. Power	½ watt								
Insertion Loss	10 db			zero db at low freq. approx. 0.3 db at 200 mc			zero db at low freq. approx. 0.5 db at 200 mc		
DB Switched	41 db in 6 steps						101 db in 9 steps		
Steps	20 db, 10 db, 5 db, 3 db, 2 db, 1 db						20 db, 20 db, 20 db, 20 db, 10 db, 5 db, 3 db, 2 db, 1 db		
Frequency Range	DC to 500 mc *								
Accuracy of Attenuation	Within 0.1 db/db to 500 mc Better accuracy at lower frequencies								
Connectors	BNC type UG-185/U								
Dimensions	2¼" x 8¼" x 2⅛"						2¼" x 11½" x 2⅛"		
Weight	2½ lbs.						4 lbs.		
Price	$65			$60			$95		

* useful to 1000 mc

All prices f.o.b. factory.

NOTE: Kay *Attenuators* can be made on special order in 0.5 db steps, and to customer's choice of insertion loss, attenuation range, and impedance rating.

See Kay Attenuators and other Kay precision electronic instruments at the IRE Show — Booths 2608-09-10.

Write for 1958 Kay Catalog

KAY ELECTRIC COMPANY

DEPT. E-3 MAPLE AVE. PINE BROOK, N. J. CAldwell 6-4000

CIRCLE 73 READERS SERVICE CARD

CIRCLE 74 READERS SERVICE CARD →

ALLIED'S CH RELAY

Miniature 10 Amp 4 PDT

Designed for Resistance to:

Shock—100 gravity units

Vibration—5 to 55 cps at 0.5 inch double amplitude 55 to 2000 cps at 30 gravity units

Temperature—from −65°C to +125°C

Other Specifications:

Contact Rating: 10 amperes resistive, 8 amperes inductive, at 29 volts d-c or 115 volts a-c 400 cps

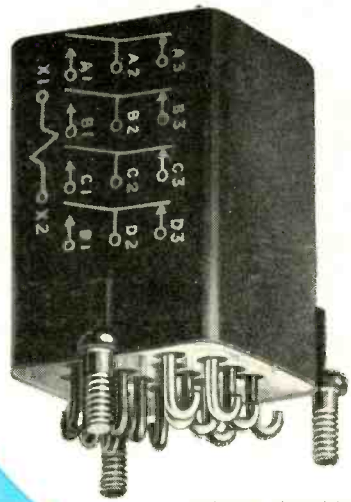
Weight: 5.3 ounces

Dielectric: 1500 volts rms at sea level

Contact Resistance: 0.10 ohm max. initial

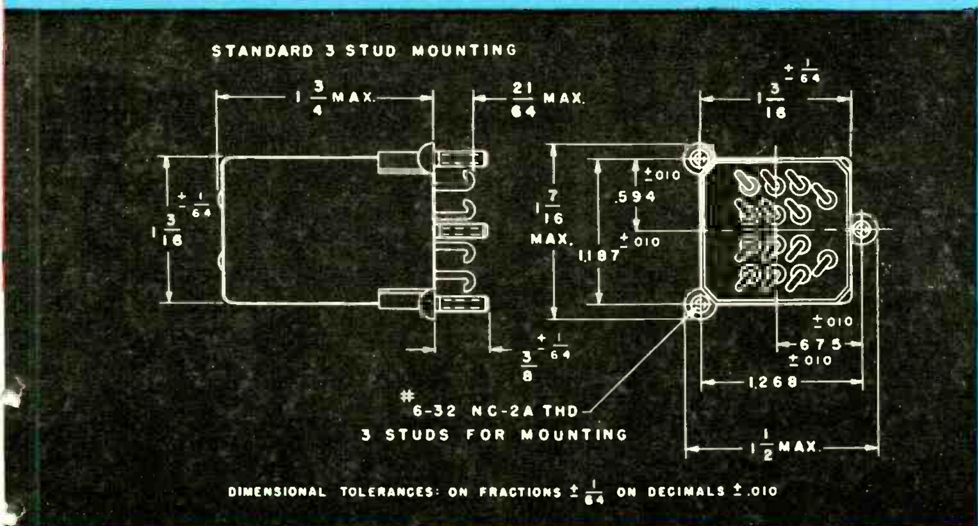
Contact Arrangement: Four Pole Double Throw

Now with Stabilized Construction*



TYPE CH-12D
ACTUAL SIZE

* Includes materials and processing necessary to minimize contact resistance variations and dielectric deterioration during life due to contact contamination, mechanical wear and shift of adjustments with temperature.

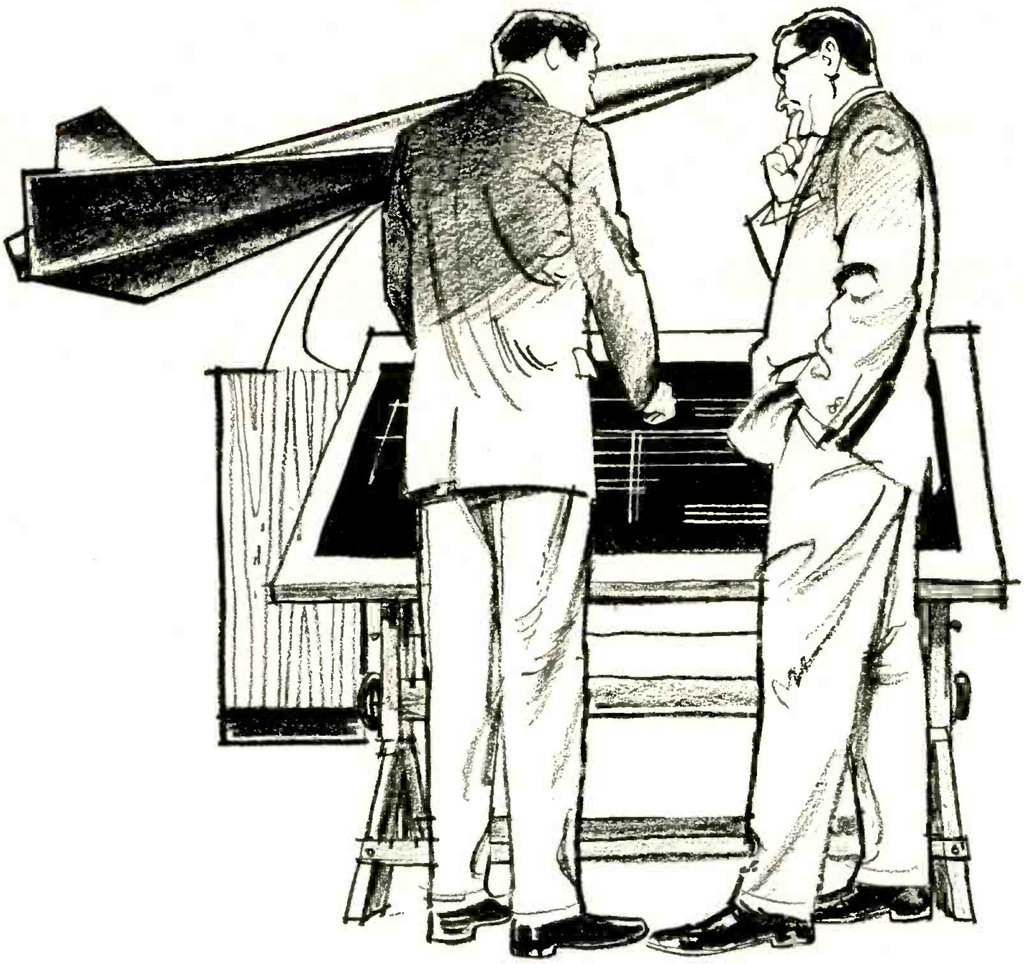


The Allied CH-12D Relay was developed to meet the more rigid requirements of vibration, shock, temperature, rupture and overload conditions of the latest MIL spec. This relay is constructed with the latest improved materials and processes available. This relay is available with other mounting arrangements, such as 4 mounting studs, 2 mounting studs or holes with Allied MHY-12D mounting dimensions. For additional information write for Bulletin CH.

ALLIED CONTROL

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N. Y.

AL-185



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

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

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Silver-Copper Alloys . .	Bulletin A-2
Silver-Magnesium-Nickel	Bulletin A-3
Silver Conductive Coatings	Bulletin A-4

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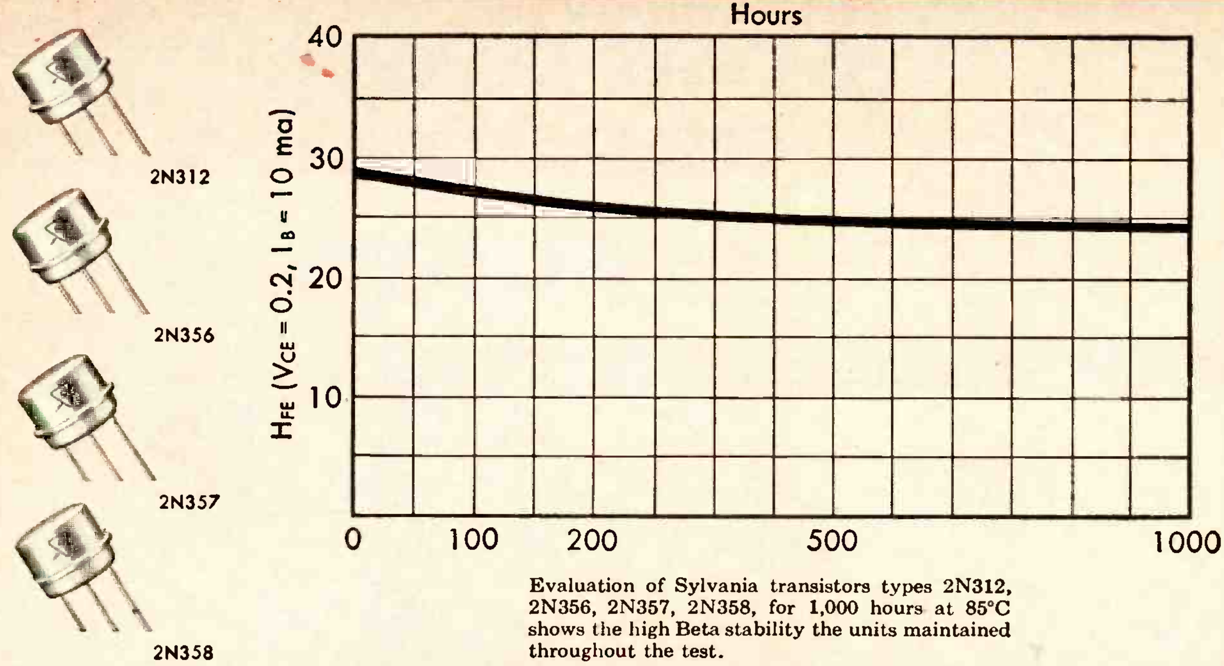

Evaluation of Sylvania transistors types 2N312, 2N356, 2N357, 2N358, for 1,000 hours at 85°C shows the high Beta stability the units maintained throughout the test.

Four more **Computer Transistors**

-from Sylvania

Sylvania widens its product line of high stability types designed especially for computer applications

Design engineers are now provided with an expanded line of computer transistors from Sylvania, basic source for high Beta units. The new additions, types 2N312, 2N356, 2N357 and 2N358, are NPN germanium alloy junction transistors. They exhibit the stable Beta characteristics and fast switching times that have made Sylvania types 2N377, 2N385 and 2N388 so popular. The new transistors are "base-off-the-can" types designed specifically for those applications where all transistor elements must be insulated from the metal case.

As with Sylvania original computer transistors, the types 2N312, 2N356, 2N357 and 2N358 meet EIA size group 30 dimensions. They also meet environmental tests typical of those required in military applications. Tests include temperature cycle, moisture resistance, centrifuge, and lead fatigue.

In addition to stable Betas at changing current levels, the four types have good leakage stability. Total dissipation for each unit is conservatively rated at 100 mw with ambient temperature at 25° C.

Typical Characteristics (25° C):	**2N312**	**2N356**	**2N357**	**2N358**
Collector Cutoff Current, I_{CBO}				
V_{CB} = 20, emitter open	—	20	20	20 ua
V_{CB} = 15, emitter open	10 ua	—	—	—
V_{CB} = 5, emitter open	—	3	3	3 ua
V_{CB} = 1, emitter open	2 ua	—	—	—
Emitter Cutoff Current, I_{EBO}				
V_{EB} = 20, collector open	—	20	20	20 ua
V_{EB} = 15, collector open	10 ua	—	—	—
V_{EB} = 5, collector open	—	3	3	3 ua
V_{EB} = 1, collector open	2 ua	—	—	—
Emitter Punch Thru, I_E				
V_{EB} = 0	—	20 (V_{CB} = 20)	20 (V_{CB} = 18)	20 ua (V_{CB} = 15)
Collector Punch Thru, I_C				
I_B = −25 ua (reverse bias)	—	500 (V_{CE} = 20)	500 (V_{CE} = 18)	500 ua (V_{CE} = 15)
R_{BE} = 10K	400 ua (V_{CE} = 15)	—	—	—
Current Gain, h_{FE}				
V_{CE} = 0.25, I_C = 100 ma	—	30	—	—
V_{CE} = 0.25, I_C = 200 ma	—	—	30	—
V_{CE} = 0.25, I_C = 300 ma	—	—	—	30
V_{CE} = 1.0, I_C = 10 ma	45	—	—	—
Saturation Voltage, V_{CE} (max.)				
I_C = 100 ma, I_B = 10 ma	—	0.2	—	—
I_C = 200 ma, I_B = 20 ma	—	—	0.2	—
I_C = 300 ma, I_B = 30 ma	—	—	—	0.2
I_C = 10 ma, I_B = 1 ma	0.075	—	—	—
Input Voltage, V_{BE} (max.)				
V_{CE} = 0.25, I_C = 100 ma	—	0.8	—	—
V_{CE} = 0.25, I_C = 200 ma	—	—	0.8	—
V_{CE} = 0.25, I_C = 300 ma	—	—	—	0.8
Rise Time	1.0	1.0	.6	.4
Storage Time	1.5	0.3	.3	.5
Fall Time	0.8	1.0	.6	.6

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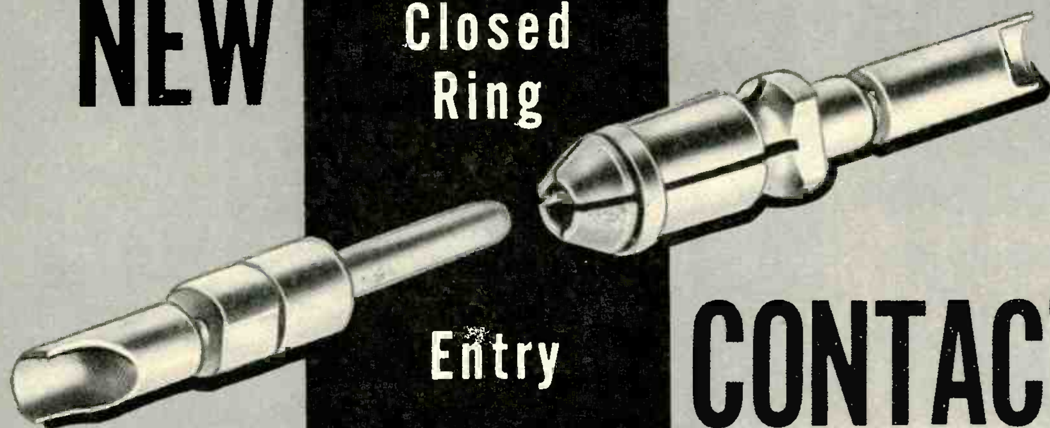
Continental Connector announces...

NEW Closed Ring Entry CONTACT*



3½ TIMES ACTUAL SIZE

CLOSED ENTRY DESIGN . . . FOR 100% MORE RELIABILITY

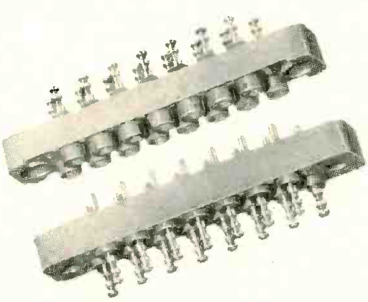
A solid ring limits socket contact expansion to maximum tolerance of pin diameter. This prevents over-stress of the individual socket contact leaves and possibility of any contact distortion. Also, an oversized probe cannot enter the socket contact. Even "rocking" and "prying" actions will not distort the contact.

Constant and uniform insertion pressure is guaranteed while a consistently low millivolt drop is maintained. The new contact was developed for use in intercontinental ballistic missiles and other applications requiring high reliability. It is another example of Continental Connector's constant research into improved design.

Technical brochures on various Continental Connectors are available free on request. Specify your requirements to Electronic Sales Division, DeJur-Amsco Corporation, 45-01 Northern Boulevard, Long Island City 1, N. Y.

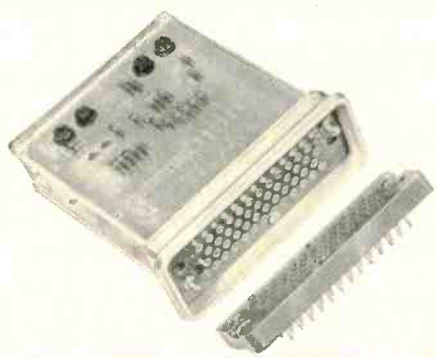
- ★ Solid Construction—Cannot be Forced Out of Shape
- ★ Extremely High Reliability—Indestructible in Normal Maintenance
- ★ Maintains Low Millivolt Drop Under Constant and Uniform Insertion Pressure
- ★ Terminations Include Solder Cup, Turret, or Solderless Taper Pin (Solder Cups can be hot pre-filled, if desired.)

AVAILABLE IN ALL STANDARD CONTINENTAL CONNECTORS



15 Contact Plug and Receptacle with New Closed Entry Contacts and Turret Terminals.

*PAT. PENDING



Continental Connector and New Closed Entry Contacts Used with Printed Circuit Application for Classified Intercontinental Ballistic Missile.

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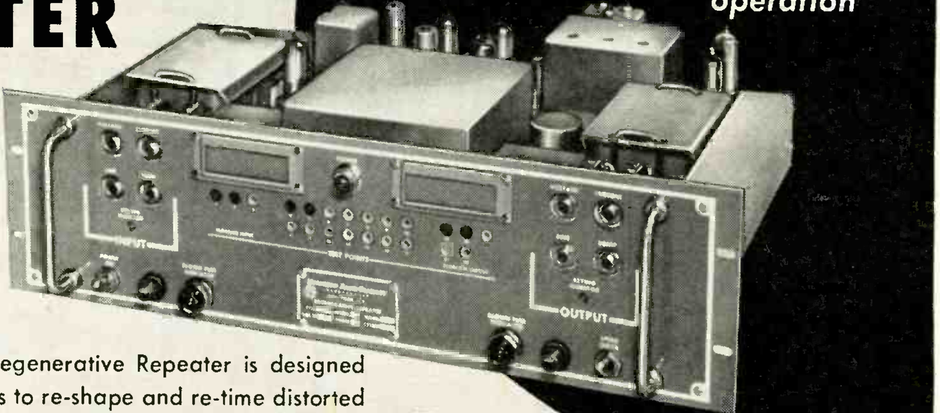
NEW NORTHERN RADIO REGENERATIVE REPEATER

for teleprinter, half duplex and synchronous binary operation



Type 207 Model 1

the most advanced in the industry!

The new Northern Radio Regenerative Repeater is designed for use in telecommunication circuits to re-shape and re-time distorted signals for local use or retransmission. Special provision has also been made for use of this unit on half duplex circuits — where it will not only regenerate the ordinary teleprinter signals but also faithfully reproduce such special signals as "break" signals and "mark restoration" information.

Further provision has been made for use of this Regenerator with synchronous binary signals on either single channel circuits or multi-channel time division multiplex systems. Provision is made to synchronize this unit from an external source.

- **Maximum Acceptable Signal Distortion:** new circuitry accepts up to 47% mark or space distortion.
- **"Floating" Input & Output Circuits:** completely electronic output, no relays.
- **Greater Timing Circuit Stability:** time base derived from highly stabilized L-C oscillator.
- **Switch Selection of Speeds:** 60, 75, 100 words per minute.
- **Adaptable to Any Speed:** low-pass filter & frequency-determining elements are plug-in units.
- **Completely Self-contained:** includes power supply and line battery.
- **OTHER OUTSTANDING FEATURES:**
  - faithfully reproduces "break" signals
  - transmits "break" signal in case of line failure
  - protected against "space lock-out"
  - output can be open-circuited with no excessive rise in line voltage & no harm to the Repeater
  - 22 front panel test points for equipment function and 8 jacks for input & output line, equipment, current and voltage measurements

Input Keying Signal Requirements:	(1) Neutral keying, positive or negative sense (a) on-off 60 ma pulses (b) on-off voltage pulses 10-100V into 100K ohms (2) Polar keying (3) Dry contact keying
Frequency Stability of Time Base Generator:	Less than 1 point range loss for ± 10% line voltage variation or ± 20° C ambient change from 25° C
Sampling Time:	Approximately 50 microseconds
Output:	Electronic tube outputs: (a) neutral 65 ma max. into 2K ohms (b) polar 33 ma (max.) into 2K ohms
Output Distortion:	(a) Signal bias distortion less than 0.5% (b) Signal element random jitter less than 1% (c) Signal history (duty cycle) distortion less than 0.5% (d) Total distortion less than 2%
Power Requirement:	125 watts approx: 110/220V, 50/60 cps
Mounting:	Standard 19" rack mounting, 5¼" panel

Write for free 67-page catalog. See us at Booth 1423, IRE SHOW

Pace-Setters in Quality Communication Equipment

NORTHERN RADIO COMPANY, inc.

147 WEST 22nd ST., NEW YORK 11, NEW YORK

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CIRCLE 80 READERS SERVICE CARD

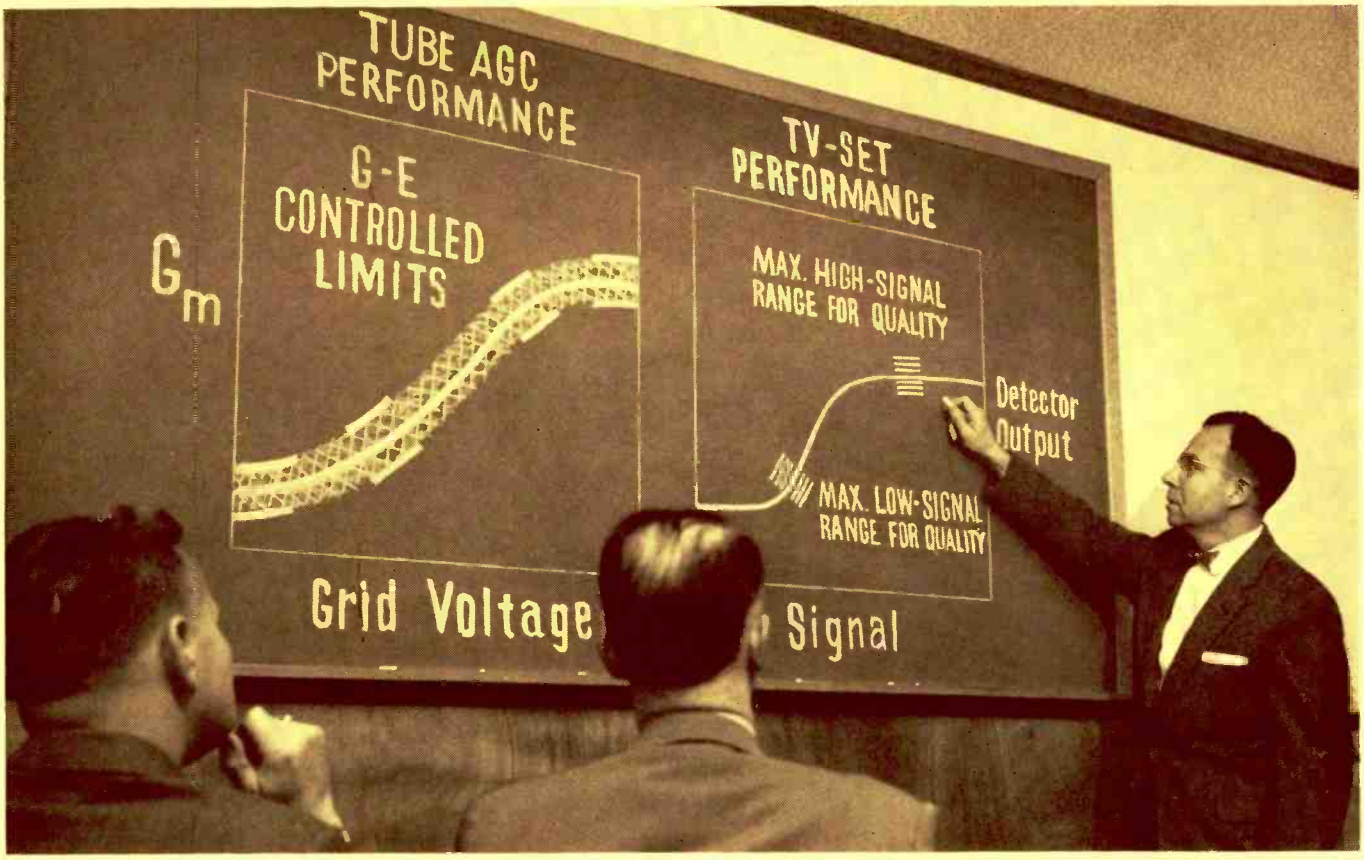
CIRCLE 81 READERS SERVICE CARD →

GENERAL ELECTRIC

TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY

General Electric Improves TV Reception Through New, Close Controls of Tube AGC Performance!



How General Electric's close control of tube AGC characteristics stabilizes TV-set performance! R. E. Moe, Manager of Engineering, General Electric Receiving Tube Department, shows the relationship that exists between tightly-controlled characteristics of an IF-amplifier type, and television-receiver performance that is held to quality levels at important points such as the high-signal and low-signal reception areas.

More and tighter controls than the industry has used before, are being applied by General Electric to critical IF-amplifier tubes for sockets with AGC. Television manufacturers and owners benefit in improved reception, whether in low, intermediate, or strong-signal areas.

In the past, the practice has been to hold quality controls to the high and low ends of the AGC voltage range, which led to variations—often wide—in the shape of the actual tube performance curve. Now, by doubling the number of control points, General Electric helps stabilize the performance of IF-amplifier types at all signal levels.

In addition: through median, or "lot-center" control methods, a heavy preponderance of General Electric tubes manufactured and shipped follow the center line of the optimum performance curve (see chart at left, above). The percentage of tubes which approach the outside control limits is exceedingly small.

Because tubes for fringe-area TV must amplify extremely weak signals, high tube gain is fundamental—and, from the standpoint of a receiver manufacturer, must be uniform and predictable in every lot of tubes he installs. Strong-signal reception, on the other hand, calls for equally uniform and predictable grid cut-off characteristics.

By promoting consistent tube AGC performance at all voltages, General Electric's new, close control methods help make it possible for television builders to offer the public sets that are economical in circuitry and transform signals of any strength into pictures with superior quality.

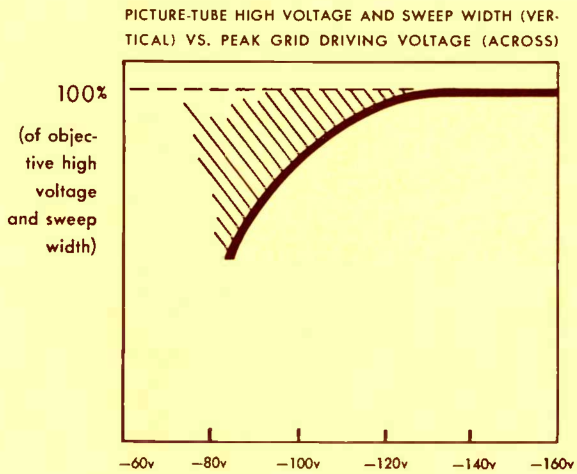
Tear off and keep this sheet for reference. It contains useful tube-application data.

WITH TV SWEEP TUBES, INADEQUATE GRID DRIVE CAN CAUSE . . .

. . . Loss of sweep width—giving a narrowed and distorted picture.

. . . Reduction in the picture-tube voltage —less brightness and contrast.

RIGHT: curve shows how sweep width and high voltage both are reduced by grid voltage that is insufficient. The shaded area indicates less-than-desired picture performance. Designers, by providing for ample grid drive in the sweep circuit, can contribute importantly to superior TV.

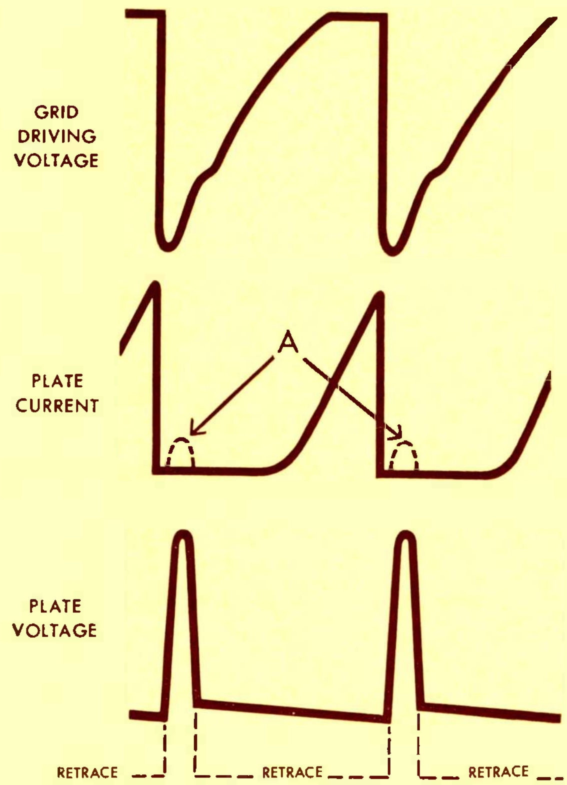


Low Grid Drive Will Fail to Hold Tubes at Cut-Off. Circuit Energy Suffers.

In the center curve at right, "A" indicates the undesirable plate-current flow that can occur when grid drive is insufficient to hold a horizontal-amplifier tube at cut-off. This flow acts as a shunt on the stored energy of the circuit. The result is a loss of high voltage and sweep width of as high as 50%.

TV designers must guard against two contingencies. One is insufficient grid voltage provided for in the sweep circuit itself. After the circuit has been checked with this in mind, the designer should assure himself that the sweep tubes he selects will meet those standards of performance required for high picture-tube voltage and full sweep width at all times.

Here General Electric assists by carefully controlling, through high-voltage testing, the cut-off and other characteristics of 6DQ6-A's and other sweep tubes *before* they reach the set manufacturer's hands. More dependable TV quality results.



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

EASTERN REGION	CENTRAL REGION	WESTERN REGION
200 Main Avenue, Clifton, New Jersey	3800 North Milwaukee Avenue	11840 West Olympic Boulevard
Phones: (Clifton) GRegory 3-6387	Chicago 41, Illinois	Los Angeles 64, California
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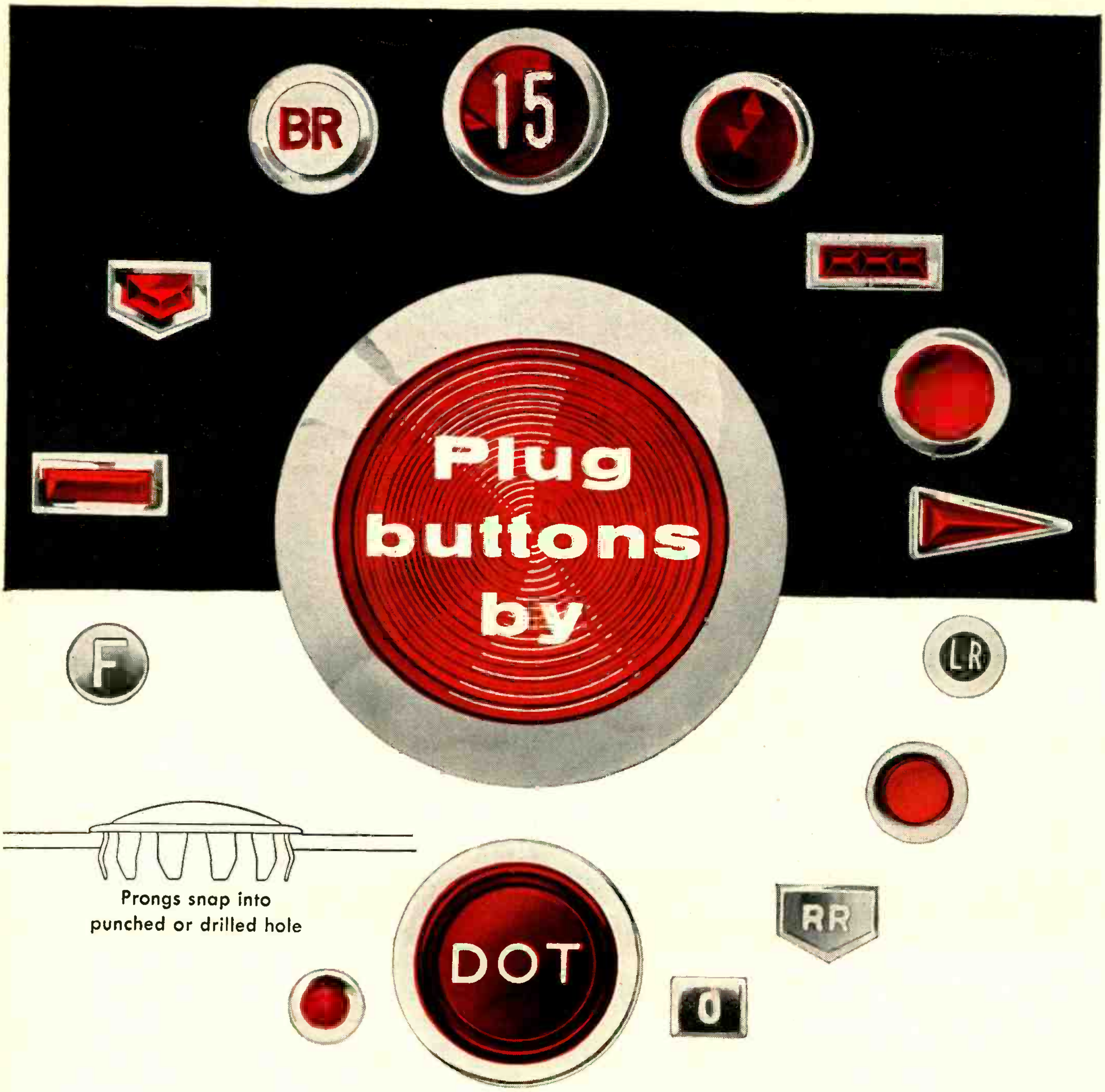

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Dot plug buttons were originally used in automobiles to fill spaces on standard models which, on de luxe models would be occupied by such extras as cigarette lighters, radio controls and so on. They are now also widely used as lenses for indicator lights and as identification buttons on instrument and control panels of all kinds.

Available in clear or colored plastics . . . brass or steel in all standard finishes . . . embossed and enamel-filled or molded to show company insignia or other identification symbols . . . Dot plug buttons snap into place and stay where they're put even under conditions of extreme vibration. Yet they can be removed and replaced repeatedly without damage.

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MAKERS OF DOT FASTENERS

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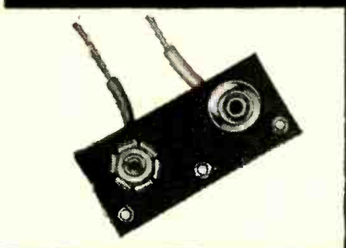
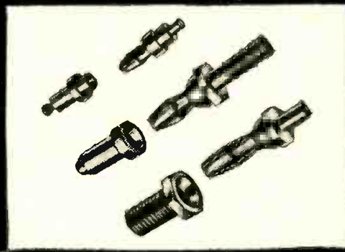
Ucinite Electrical Assemblies



BATTERY CONNECTORS

Wired snap-on units for use with batteries equipped with United-Carr electrical snap fasteners. Wiring to customer's specifications.

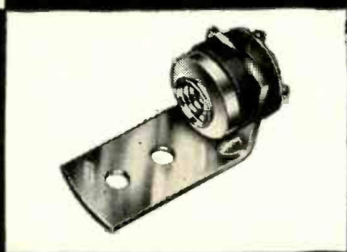


BANANA PINS

Four sizes of plugs with one-piece beryllium copper springs. Adaptable mounting ends in threaded, staking, or solder lug types. Similar Mating Jacks also available.

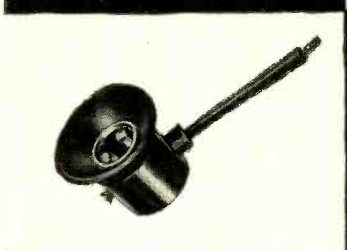
SHOCK MOUNTS

Offered in several sizes—brackets and durometer of rubber bushings can be varied. With threaded Teenuts or plain bushings. Insulated versions if needed.



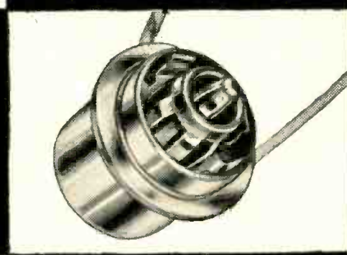
ANODE CONNECTORS

Plug button contacts for positive firm connections. Corona resistant neoprene or silicon shields in straight or right angle types. Wiring to customers specifications.



TUBE CAPS

Positive gripping, heat treated steel springs in corona resistant metal housing. Insulated or non-insulated. Wired to specifications. Type shown has silicon shield for special application.

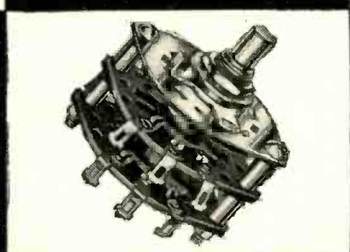


MAGNETRON CONNECTORS

For heater and heater cathode terminals of magnetrons. Available in many variations to answer specific needs.

SWITCHES

Oak type switches manufactured as a licensee. Variety of rotary and push-button assemblies to specifications.

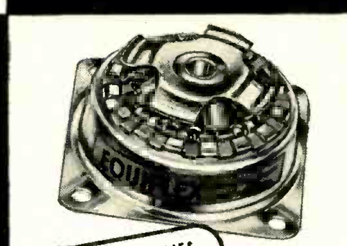


SNAP SWITCHES

Precision, momentary contact push-button switches. Small and dependable. Several circuit arrangements. Water tight version shown.

TEST JACK

Ucinite's quality jack for .080 probes. Beryllium copper contacts. Nylon insulation in colors. Metal shell for firm dependable mounting.



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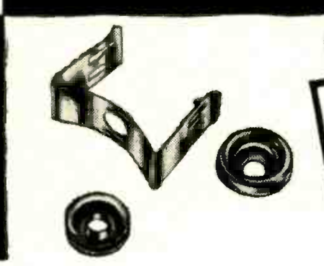
Equiflex (1 to 1 ratio) metal mounts ensure long life, fit small spaces, can be used in any direction. Three sizes, cup or plate mountings.

METAL STAMPINGS

Volume production in Metal stampings. Years of engineering and tooling skill available to solve your particular problem.



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With years of specialized experience in the electronics field and complete facilities for the volume production of small metal stampings as well as the assembly of metal to plastic and ceramic components, Ucinite is fully equipped to supply you with special electrical parts and assemblies... designed, assembled, wired and marked to your specifications. For complete design, engineering and production service, call your nearest Ucinite field engineer.

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DIVISION OF UNITED-CARR FASTENER CORP.

Newtonville 60, Massachusetts

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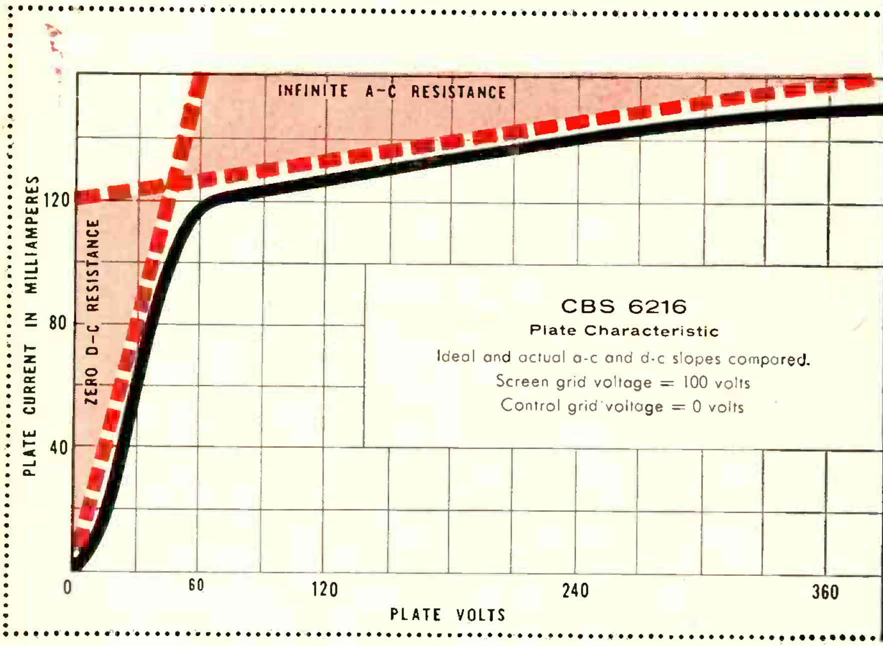
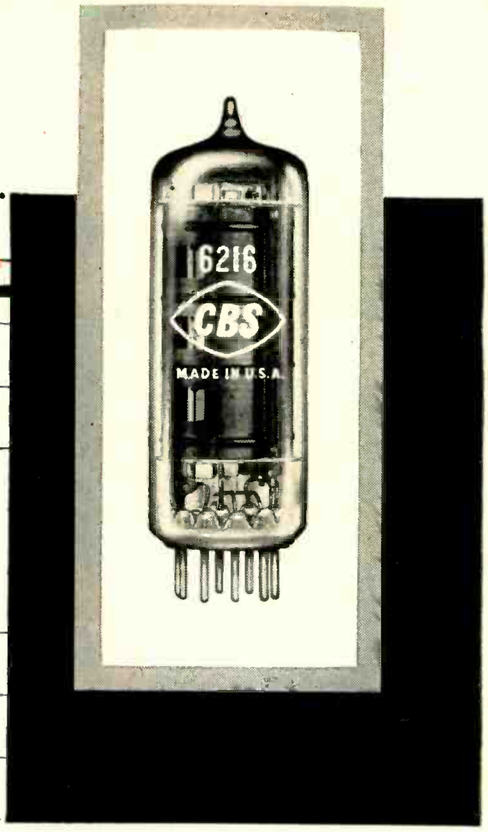
RUGGED...RELIABLE...VERSATILE

6216 Pass Tube combines...

LOW D-C RESISTANCE

HIGH A-C RESISTANCE





The ideal pass tube would have zero d-c and infinite a-c resistance. Note how closely the 6216's plate characteristic approaches this. Its low plate voltage knee is unique . . . results in minimized internal tube drop.

Another feature is the tube's resistance to cathode interface formation which keeps the rise time high on a steep wavefront in switching applications. The 6216 is suitable for many circuits: pass . . . switching . . . control . . . cathode follower . . . power amplifier (Class A, B, C) . . . and filter reactor, for example.

This efficient 9-pin miniature beam pentode is mounted in a compact T-6½ bulb. Yet the CBS 6216 has maximum ratings of 10 watts plate dissipation, 110 ma. cathode current. Reliabilized and ruggedized (650 g), the tube is designed for use in airborne and vehicular equipment.

Can you use this versatile tube? Write for complete Bulletin E-199A — or order the CBS 6216 today.

Reliable tubes through Advanced-Engineering

CBS tubes ®

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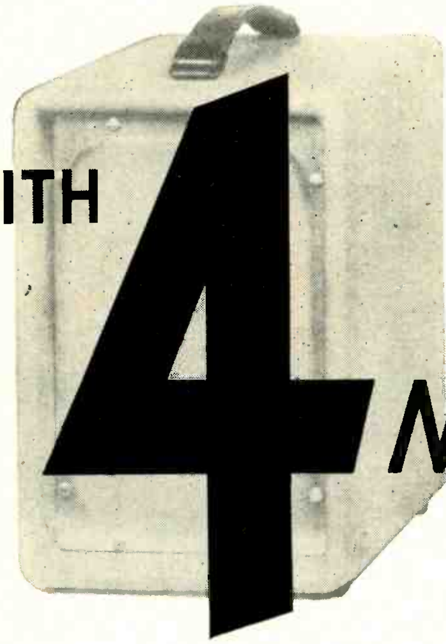
Danvers, Mass.
A Division of
Columbia Broadcasting System, Inc.

GREATER ACCURACY
PERMANENT STABILITY



WITH 4 *NEW* MILLIVAC INSTRUMENTS

Designed for exacting electronic measurements, each of these products establishes a new quality standard in its field.

¼% DC VTVM

½% real RMS VTVM

DC differential VTVM

DC precision milli-VTVM, MV-57A
An unusual VTVM with better than ¼% accuracy, designed especially for those who find an ordinary 2 or 3% VTVM not accurate enough. Permanent accuracy due to built-in standard cell and precision wire-wound resistors.

Precision, high impedance RMS milli-voltmeter, MV-32A
This is not one of the "true" RMS voltmeters which use synthetic RMS circuitry. It is a *real* RMS voltmeter, incorporating a vacuum thermo-couple. Accuracy ½%.

DC differential milli-VTVM, MV-37A
This instrument meets the demands of many industrial and research engineers for a good differential DC-millivoltmeter. 1 mV — 1 KV F.S., 3%.

Video-power-post-amplifier, VS-102A
It puts a "punch" into weak signal generators and sweep generators. Max. output 28 V peak-to-peak, 20 cps — 10 MC.

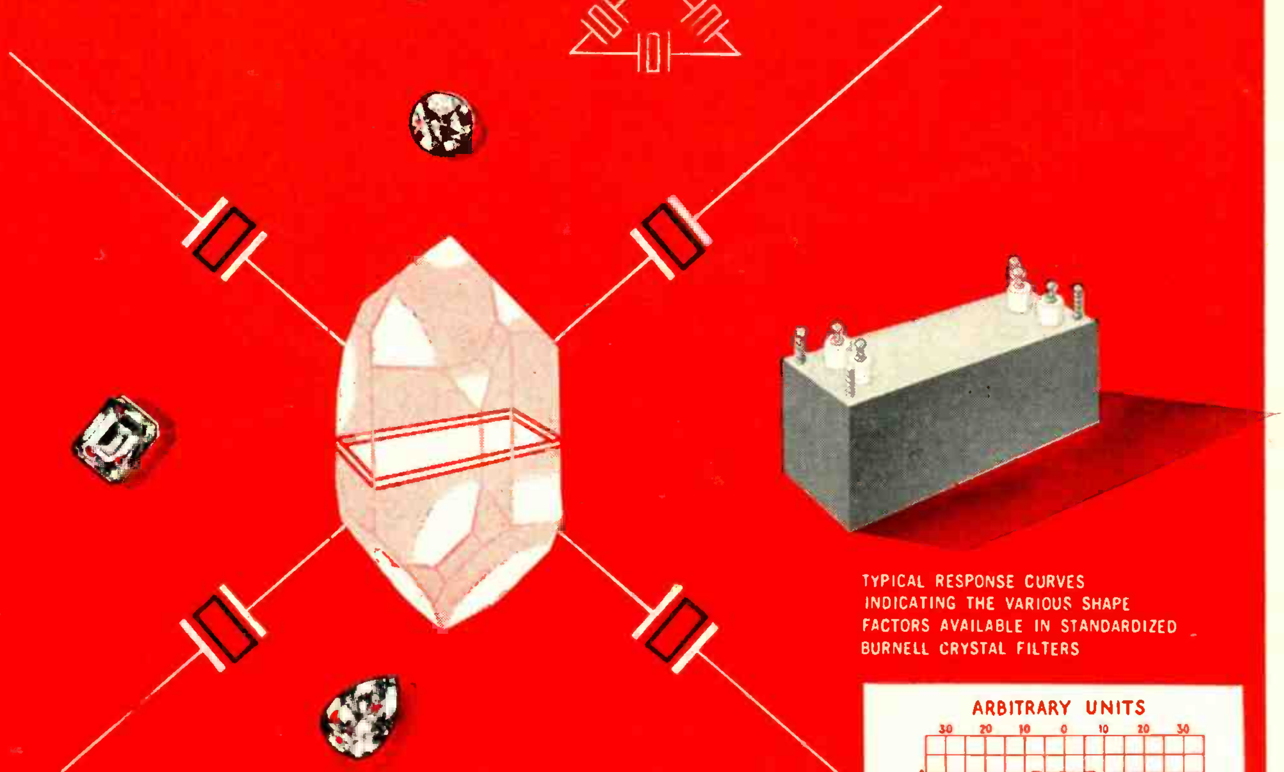
We invite you to evaluate these and other new instruments at IRE — New York, Booths 3204-3206.

MILLIVAC INSTRUMENTS
Division of Cohu Electronics, Inc.
BOX 997 SCHENECTADY, N. Y.

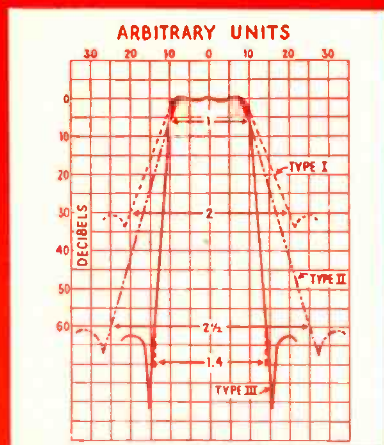
TOMORROW IS OUR YESTERDAY

Crystal filters

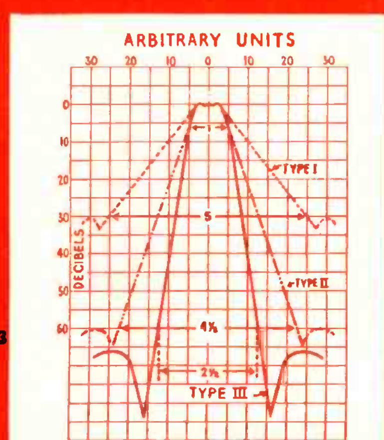
by BURNELL & CO., INC.



TYPICAL RESPONSE CURVES INDICATING THE VARIOUS SHAPE FACTORS AVAILABLE IN STANDARDIZED BURNELL CRYSTAL FILTERS



WIDE BAND CRYSTAL FILTER



NARROW BAND CRYSTAL FILTER

Burnell & Company is pleased to announce that it has expanded, in its new plant, the facilities of its *crystal division* for the production of crystal filters.

Like fine jewels, crystal filters are synonymous with stability, permanence and reliability. With the development of advanced production techniques and circuitry by Burnell & Co., they offer vast potential in electronic communications, telemetry, and remote control applications.

Depending on band width and frequency, they may be composed entirely of crystals, or in complex networks, combine quartz crystal elements with stabilized toroidal coils to produce the desired band width and shape factor. Frequency has been extended from low range to the megacycle spectrum so that Burnell Crystal Filters now provide the solution to myriad problems formerly insoluble with even the best of toroidal components.

Economical, standardized complex designs of lattice networks and their three terminal network derivatives preclude high developmental costs. Packaging encompasses a wide range in standard, miniature and sub-miniature sizes with considerable latitude in permissive impedance range from required transistor usage to pentode operation. Whether your crystal filter is of standard design or calls for custom specifications, our facilities are at your disposal. Write for new Burnell Crystal Filter Bulletin, XT-455.

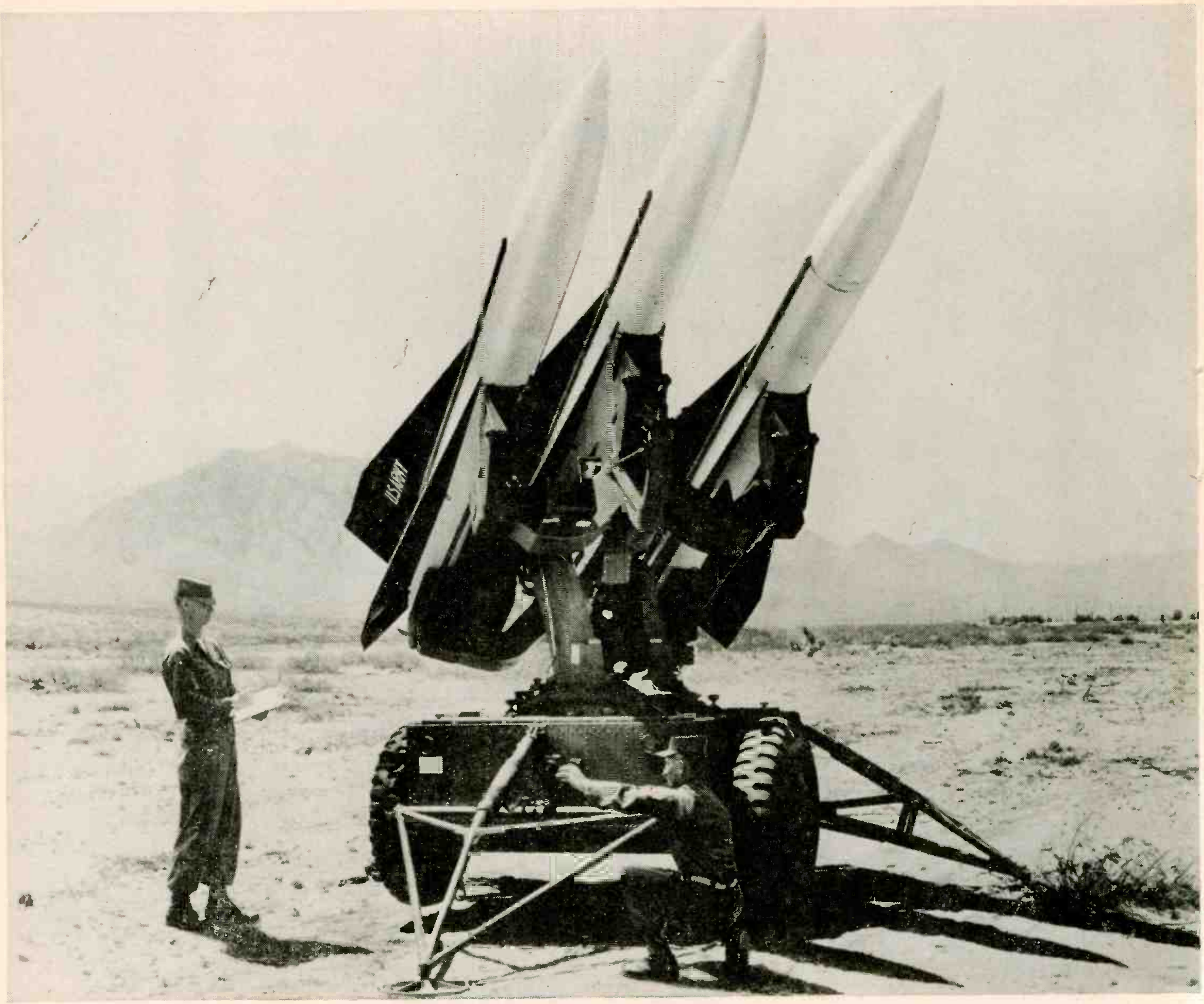
Burnell & Co., Inc.

first in toroids, filters and related networks

SEE OUR DISPLAY IN BOOTH 2909 AT THE I.R.E. SHOW

EASTERN DIVISION Dept. E-3
10 PELHAM PARKWAY
PELHAM MANOR, N.Y.
PELHAM 8-5000

PACIFIC DIVISION
720 MISSION ST.
SOUTH PASADENA, CAL.
RYAN 1-2841

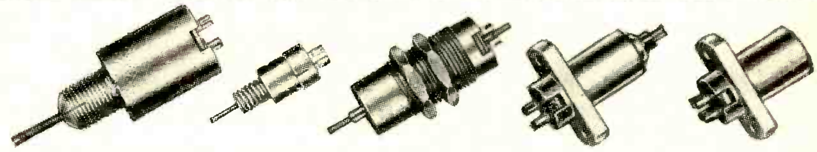


RAYTHEON HAWK MISSILE. PHOTO COURTESY U. S. ARMY.

Ten families of Cambion quality components — guaranteed unconditionally in any quantity

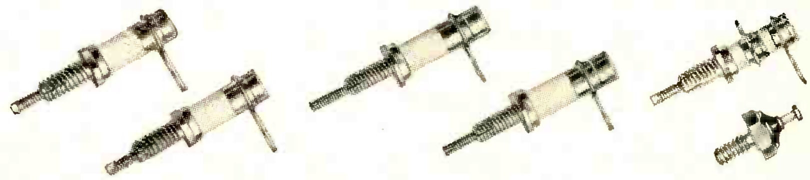
CAMBION QUALITY SHIELDED COIL FORMS

Miniaturized. Highly shock resistant. Mechanically enclosed, completely shielded for maximum reliability.



CAMBION QUALITY CAPACITORS

Miniaturized Variable Ceramic Capacitors that outperform much bigger capacitors. (*Extreme right*): Stand-Off Capacitors with ceramic dielectric. Rugged R-F by-pass capacitors for high quality equipment. Shock-, vibration-, humidity-resistant.

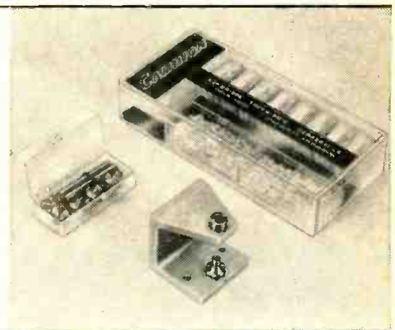


CAMBION QUALITY WOUND COILS IN STANDARD VALUES

Precision-wound on slug-tuned ceramic coil forms, with silicone Fibreglas collars and mounting hardware. Available in bulk or in kit form (illustrated).

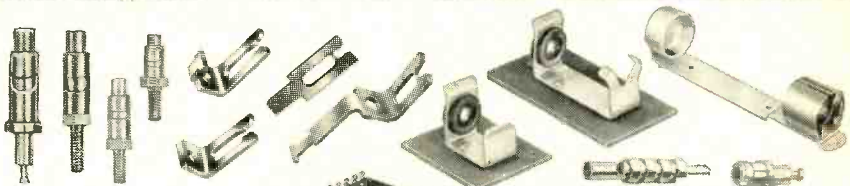
CAMBION QUALITY KITS

Design your electronic equipment around standard components, using four convenient CAMBION kits: Coil Form Kit, Coil Kit, Choke Kit, Solder Terminal Kit (illustrated).



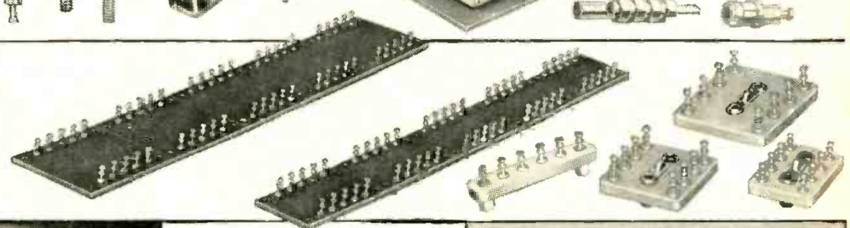
CAMBION QUALITY DIODE CLIPS

Seven different types, including rivet and spring-loaded units primarily for holding fragile pigtail leads from .005″ to .085″ in diameter. Also, one-, three-, and five-cell battery clips and miniature plugs and jacks.



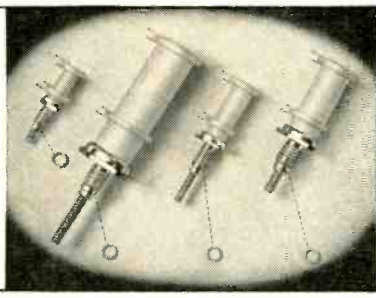
CAMBION QUALITY TERMINAL BOARDS

Custom-made, standard all-sets, standard ceramics. Variety of materials available — paper, cloth, nylon, glass laminates — phenolic, melamine, epoxy, silicone resins. Moisture- and fungus-proofed.



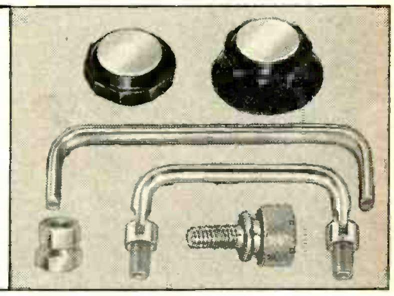
CAMBION QUALITY PERMA-TORQ® COIL FORMS

Constant - tensioning devices for tuning cores of standard CAMBION ceramic coil forms. Keeps coils tuned as set despite shock, vibration.



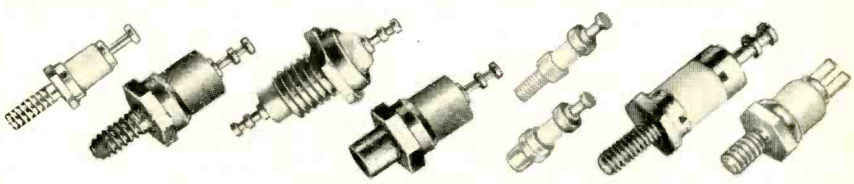
CAMBION QUALITY KNOBS AND PANEL HARDWARE

Selected materials, carefully processed and finished. Metal parts polished before plating. Hard-wearing surfaces, lasting lusters.



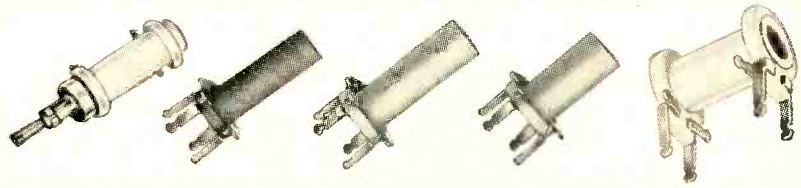
CAMBION QUALITY INSULATED TERMINALS

Wide variety of stand-off and feed-through models in Teflon and ceramic. Extremely resistant to shock, vibration, moisture and temperature. Solder terminals hold even after prolonged soldering operations.



CAMBION QUALITY PRINTED CIRCUIT COIL FORMS

Phenolic and ceramic types. Can be soldered after mounting. Available as forms alone or wound as specified. Two- to six-terminal models.



CIRCLE 91 READERS SERVICE CARD

You're precisely correct

when you use

Fenwal Thermistor Temperature Controllers

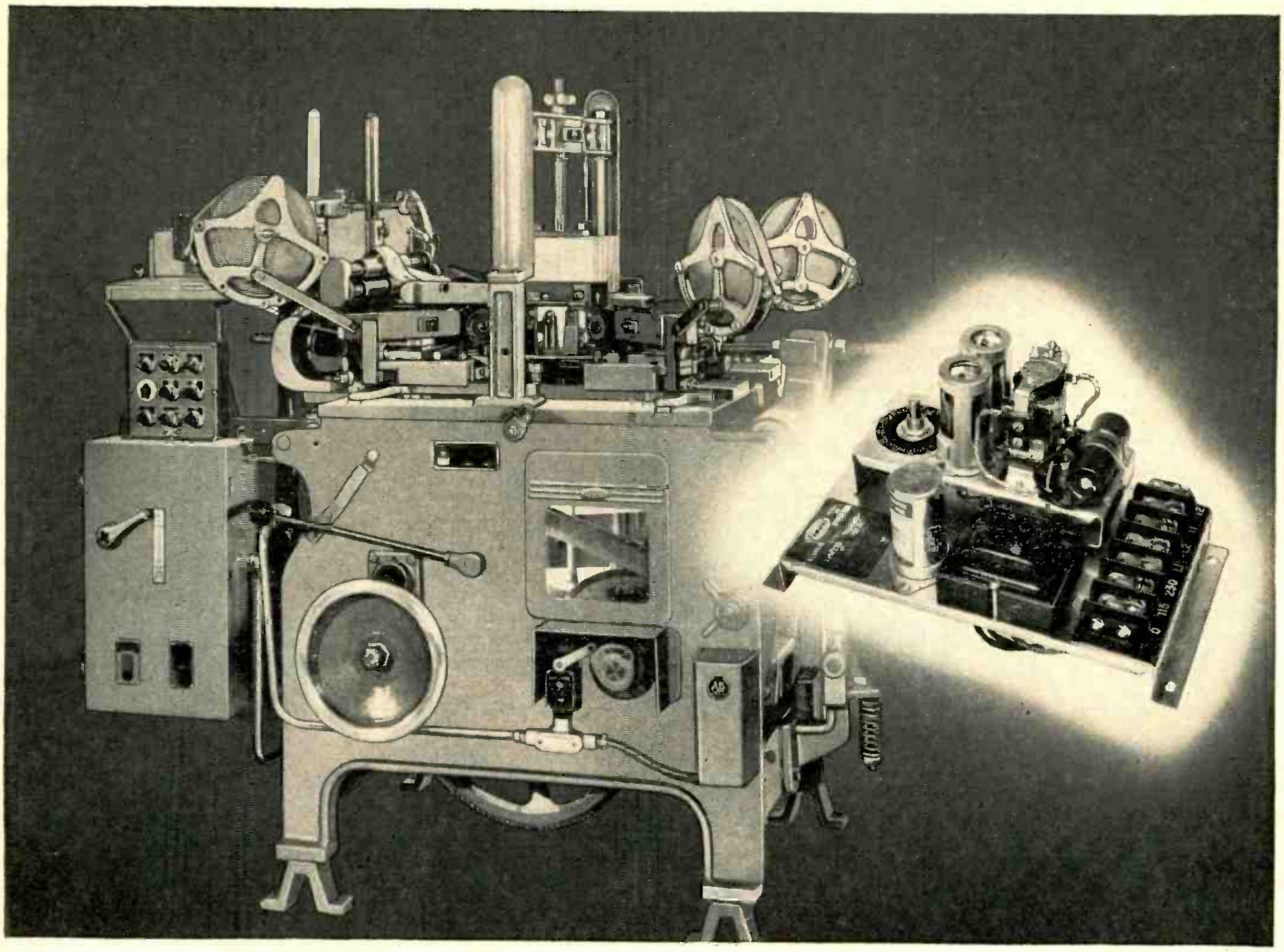
When we say "precisely" we mean control within .25% of range! Here's why — when temperature goes up, the resistance of the thermistor sensing element goes down — a unique property that makes very small temperature changes into large resistance changes. That means *quick, extremely precise temperature control!*

Small probes respond fast — can be installed nearly anywhere. Unbalanced bridge circuit design assures sensitivity and reliability. These are among reasons why one Thermistor Controller customer can report 0.08°F control. Why another reports over two years service with *no drift or set point variation!*

You can have remote control — as much as 200 feet — without ambient or lead length compensation problems. You can control 1 or 100 points, with or without indication. Versatile Fenwal Thermistor Controllers are adaptable to all kinds of applications. No matter what your need, you get *dependable precision with amazing stability.*

You'll want to have complete details on the new advance in precision temperature control at your fingertips, and we'll get it in your hands soon if you'll write us at Fenwal Incorporated 203 Pleasant Street, Ashland, Massachusetts.

Here's a Thermistor Controller (Model 530) in a package forming machine. One Fenwal Thermistor probe in one corner plunger controls temperature at all four corners. A potentiometer on the control panel permits infinitely variable temperature range from 200 to 600 degrees. It eliminates a thermostat in each of the corner plungers, simplifies operation and maintenance — and assures uniformly high quality output. There are four standard temperature ranges for you to choose from: −100°F to 50°F; 0°F to 150°F; 100°F to 300°F; and 200°F to 600°F. Special ranges can, of course, be supplied in most cases.

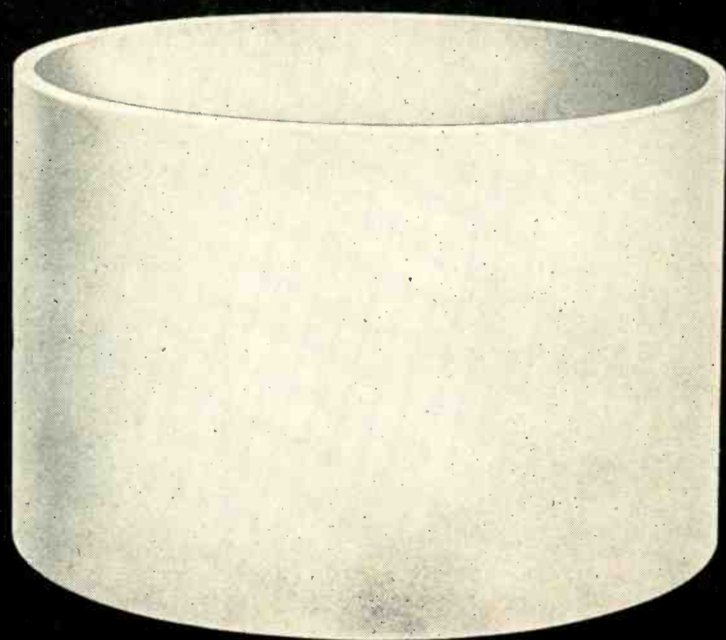


Fenwal CONTROLS TEMPERATURE . . . PRECISELY

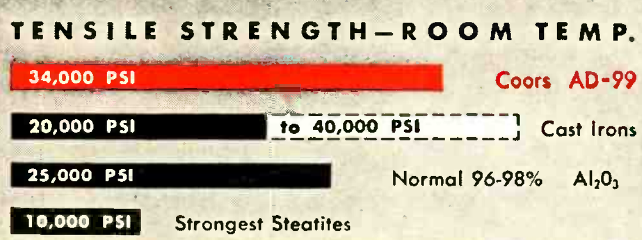
CIRCLE 92 READERS SERVICE CARD

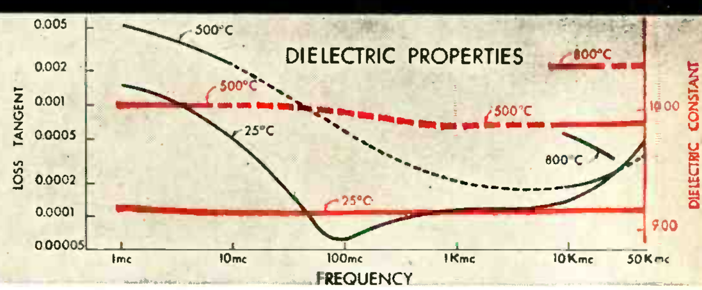
CIRCLE 93 READERS SERVICE CARD →

Coors NEW AD-99 ALUMINA CERAMIC



AD-99 Ceramic
Tube Envelope
10" dia. x 8½"





SUPER DIELECTRIC — STRONG AS IRON
75% OF TENSILE STRENGTH AT 2000° F

Coors new AD-99 ceramic is non-porous 99.0% Al_2O_3 with the amazing tensile strength of 34,000 psi — as strong as cast iron. It has 30% greater strength than the best commercial high aluminas of 96% to 98% Al_2O_3. It is particularly superior to any ordinary metals in strength at high temperatures —retaining 75% of its tensile strength or 20,000 psi at 2000°F (1100°C).

Coors AD-99 is a superior dielectric material. At modern micro-wave frequencies, loss tangents are lower than those of plastics and all but one or two special ceramic materials—as reported by the Laboratory for Insulation Research, Massachusetts Institute of Technology. At room temperature, the loss tangent is 0.00006 ±0.00002 at 100 mc, less than 0.0001 at 300 mc, and 0.00052 at 50 Kmc.

These properties, combined with the excellent hardness and wear resistance of the alumina family, make this the most superior ceramic now available for commercial use. In addition, Coors AD-99 has complete, unequaled homogeneity made possible only through the use of the Coors isostatic process.*

Originally developed in Coors own laboratory especially for radome work, Coors AD-99 is now available on a commercial production basis for critical electronic and mechanical applications. We can make test parts for your developmental work at nominal costs. Production quantities can be supplied at prices only slightly higher than ordinary alumina ceramics.

Coors Porcelain Company operates under license for this patented process from Champion Sparkplug Company, Toledo, Ohio.

COORS PORCELAIN COMPANY

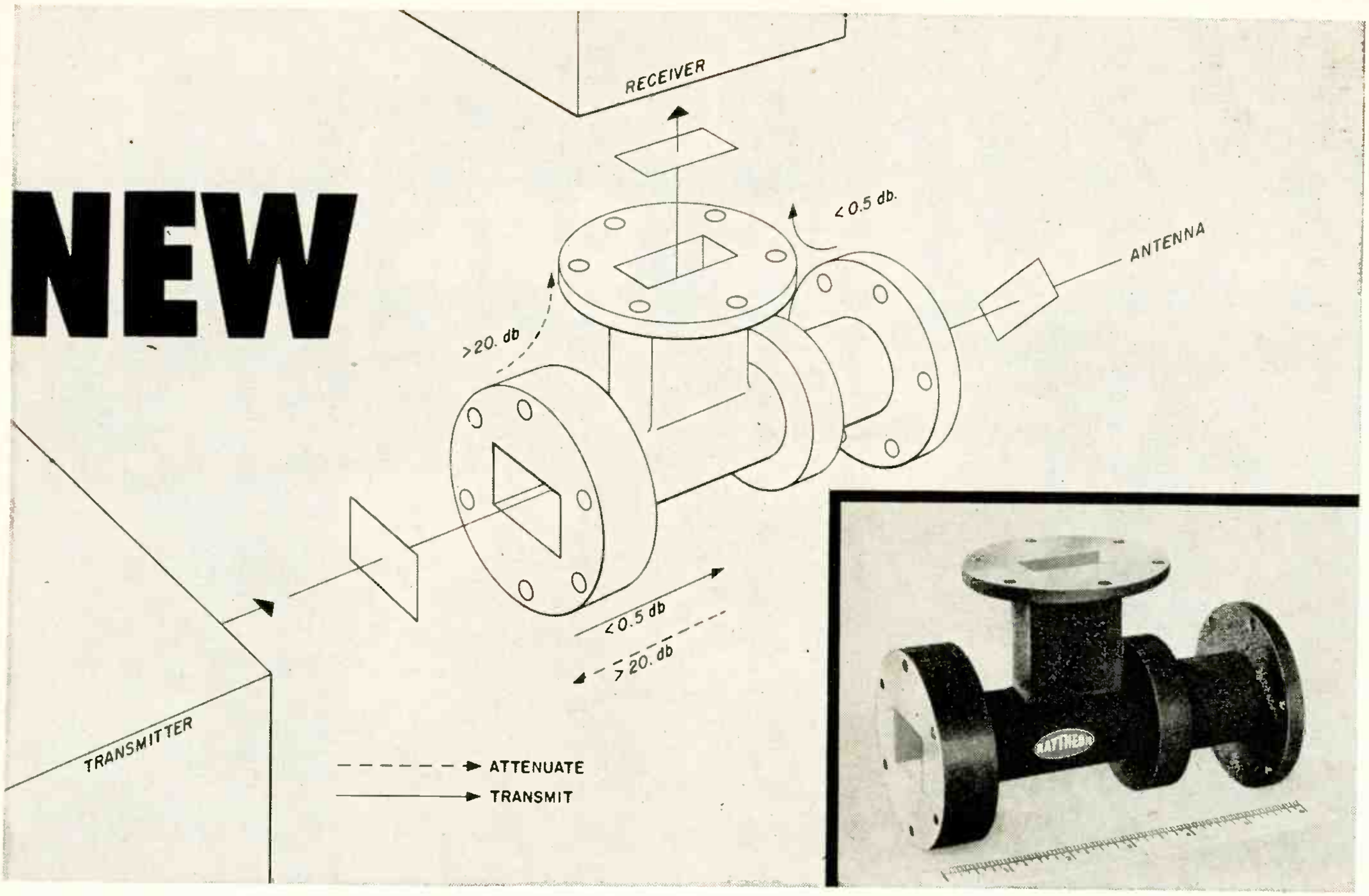
Manufacturers of High Strength Alumina Ceramics

GOLDEN, COLORADO

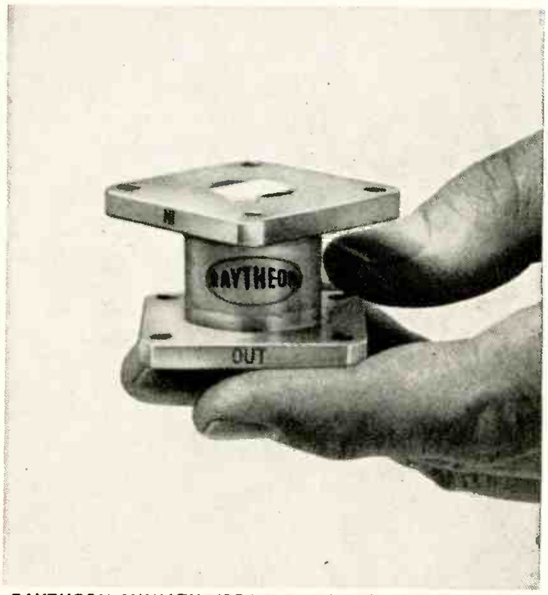
COORS PORCELAIN CO., 612 9th St., Golden, Colo.
Please send me detailed bulletin on new Coors AD-99 Ceramic.
Name.......................... Title..........
Company..........................
Address..........................
City.......................... State..........

See our 12-page catalog in Sweet's Product Design File

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.

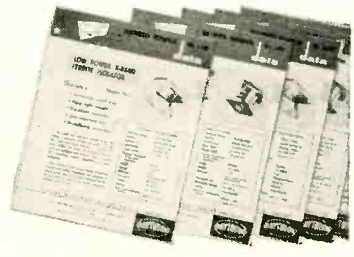
Compact C-band unit replaces gas-tube duplexer; needs no external power.

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

SEE OUR EXHIBIT AT THE IRE SHOW

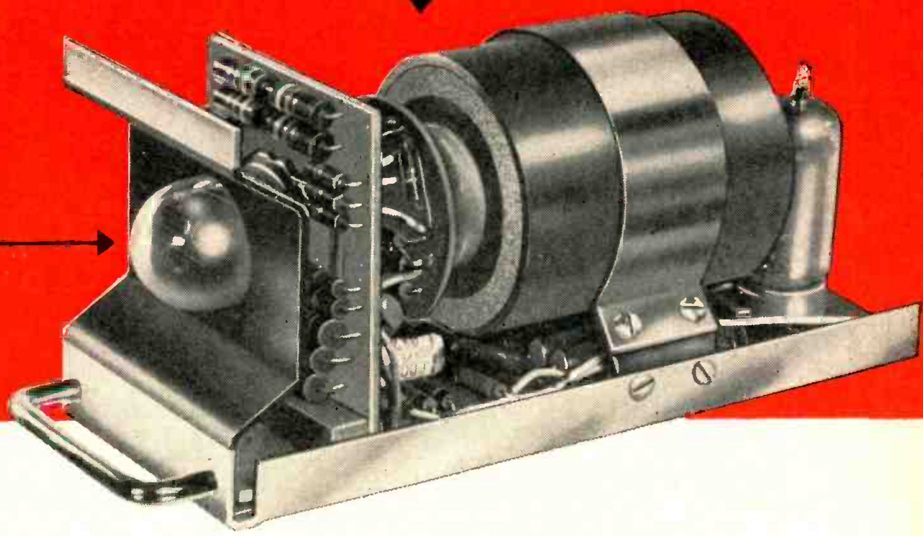
Visual and Electronic

error-free decade counters

*NOW WITH LESS THAN ONE MICROSECOND RESET AND 10 OUTPUTS

BEAM SWITCHING TUBE

NIXIE ALL ELECTRONIC READOUT TUBE



MADE POSSIBLE BY BEAM SWITCHING TUBES

NOTE THESE OUTSTANDING FEATURES

- **NIXIE** READOUT IN-LINE FIGURES VISIBLE 30-40 FT.
- RELIABILITY OF **BEAM SWITCHING TUBE**
- OPERATION WITH FULL TOLERANCE VARIATION OF ALL COMPONENTS
- SMALLEST PANEL HEIGHT (3 3/16")
- MINIMUM HEATER WATTAGE
- PLUG-IN DESIGN
- PROVISION FOR MECHANICAL OR ELECTRONIC ZERO-SET
- UNITS CASCADED DIRECTLY

MODEL	DC-101	DC-102	DC-103	*DC-105
Input	Negative 2.5 μs 125V ½ Sine Wave Or Output of DC-101 DC-102	Negative 50 Volts Less than 1 μsec rise time Duration at least 2 μsec	Negative 110 Volts Less than 0.5 μsec rise time	Negative 110 Volts Less than 0.5 μsec rise time
Output	Drive DC-101	Drive DC-101	Drive DC-102	Drive DC-105 and 10 Individual Outputs
Resolution of Paired Pulses	Less than 10 μsec	Less than 10 μsec	Less than 1 μsec	Less than 1 μsec
Reset to Zero	Manual on Switch Closure or Electronic with Suitable Pulse	Manual on Switch Closure or Electronic with Suitable Pulse	Manual on Switch Closure or Electronic with Suitable Pulse	Manual on Switch Closure or Electronic with Suitable Pulse
Construction	Plug-In-Winchester Type MRE9P For Insertion in Type MRE9S	Plug-In-Winchester Type MRE9P For Insertion in Type MRE9S	Plug-In Winchester Type MRE9P For Insertion in Type MRE9S	Plug-In Printed Circuit Board For Insertion in U. S. Components UPCR93-D10
Maximum Counting Rate	10 KC	100 KC	1 Mc	1 Mc
Count Indication	Nixie "in-line" Numerical Readout — Type 6844A	Nixie "in-line" Numerical Readout — Type 6844A	Nixie "in-line" Numerical Readout — Type 6844A	Nixie "in-line" Numerical Readout — Type 6844A
Power Requirements	300 V — 18 ma DC 6.3 V — 0.3 A AC	300 V — 28 ma DC 6.3 V — 0.6 A AC	300 V — 30 ma DC 6.3 V — 0.9 A AC	300 V — 30 ma DC 6.3 V — 0.9 A AC
Tube Complement	Type BD300 Beam Switching Tube Counter — 6844A Indicator	Type BD300 Beam Switching Tube Counter — 6844A Indicator — Type 6201 Flip-Flop	Type BD300 Beam Switching Tube 6844A Indicator 5670 Flip-Flop 5963 Buffer	Type BD300 Beam Switching Tube 6844A Indicator 5670 Flip-Flop 5963 Buffer

Write for new brochure S1-4 that includes the Burroughs "Beamplexer" high speed 10 position electronic switch.

ANOTHER ELECTRONIC CONTRIBUTION BY

Burroughs Corporation

ELECTRONIC TUBE DIVISION

Plainfield, New Jersey

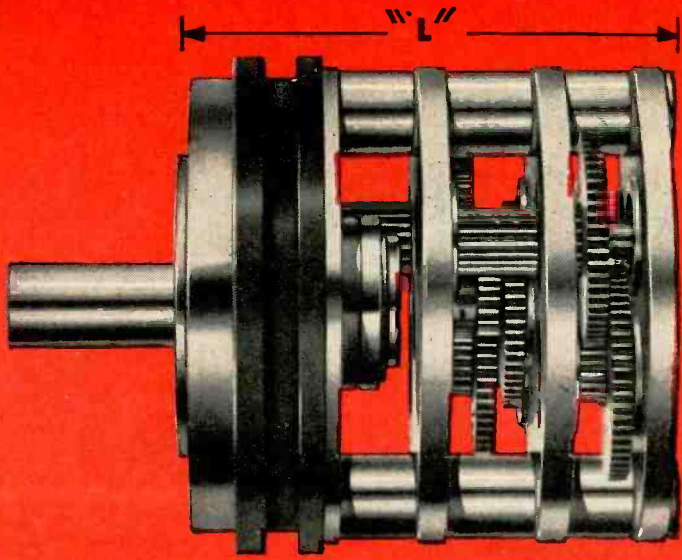
SEE US AT BOOTHS 1718-24 IRE SHOW

CIRCLE 95 READERS SERVICE CARD

EDISON

PRECISION GEAR HEADS

- Sizes 8 through 18 available in any ratio within 1%.
- Mount directly on all Edison and Bureau of Ordnance Motors without adapters.



- Adapters available to mount on any motor.

CHARACTERISTICS	STANDARD EDISON GEAR HEADS				
Size	8	10	11	15	18
Part Number					
Pinion Data: Number of Teeth	12	13	13	15	15
Diametral Pitch	120	120	120	96	96
Pressure Angle	20°	20°	20°	20°	20°
Pitch Diameter	.1050″ +.0 −.0005	.1083″ +.0 −.0005	.1083″ +.0 −.0005	.1562″ +.0 −.0005	.1562″ +.0 −.0005

Gear Ratio to Length "L"	Ratio	"L"	Ratio	"L"	Ratio	Ratio	"L"	Ratio
	17	0.750	31	0.781	36	40	0.812	60
	42	0.812	93	0.954	108	140	1.000	240
	104	1.008	280	1.054	324	490	1.100	960
	253	1.070	840	1.116	972	1715	1.162	3840
	615	1.204	2521	1.266	2916	6000	1.328	15,360
	1494	1.347	7565	1.409	8748	21,000	1.487	61,440
	3629	1.421	22,696	1.500	26,244	73,500	1.600	245,760

CHARACTERISTICS	8	10	11	15	18
Moment of Inertia GM CM^2	.01	.018	.02	.05	.08
Maximum Running Torque in. oz.	15	15	20	25	25
Maximum Stall Torque in. oz.	35	35	40	50	50
Breakdown Torque in. oz.	.01	.01	.012	.015	.018
Backlash maximum	30′	30′	30′	30′	30′

Gear Tolerances: Precision Class 2 AGMA 236.02. *Bearings:* Stainless Steel ABEC Class 5 or better. *Shaft Radial Play:* .002″/inch length max. with 4 ounce gage load. *Shaft End Play:* .002″ max. with 1 pound gage load. Friction Slip Clutch available on request. Designed to meet applicable paragraphs of MIL-E-5272.

Thomas A. Edison Industries
INSTRUMENT DIVISION
54 LAKESIDE AVENUE, WEST ORANGE, N. J.

McGRAW EDISON

DOW CORNING CORPORATION

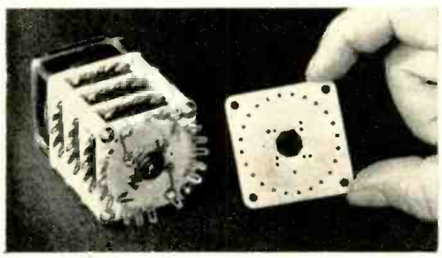
Silicone Dielectrics

ELECTRICAL AND ELECTRONIC NEWS No. 17

Rotary Switches More Reliable With Silicone-Glass Laminates

Combining unique dielectric and physical properties, silicone-glass laminates can be used to improve the performance of electrical and electronic devices involving extreme heat or moisture. An unusually good illustration is provided by Shallcross Manufacturing Company, Collingdale, Pennsylvania.

Shallcross' new line of 24-position electrical rotary switches features decks stamped from glass cloth laminate bonded with a Dow Corning silicone resin. The heat-stable silicone-glass decks keep terminals locked securely in place despite heat of soldering. More important, the silicone-glass construction of these 1500 V, 1 to 6 deck rotary switches assures reliable operation in hot, cold or humid climates where other insulating materials would fail.

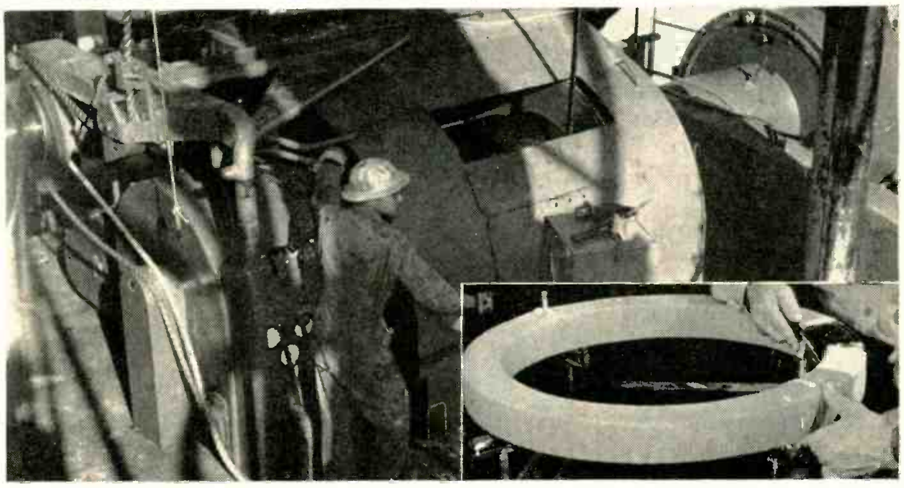


According to Shallcross, silicone-glass laminate was chosen because of these outstanding properties:

1. Low moisture absorption.
2. Thermal stability which not only permits service in varying climates, but prevents terminals loosening during soldering.
3. Good surface resistivity.
4. Low dielectric loss for increased RF efficiency.

The silicone-glass laminate used in these switches is "Phenolite G-7-830," produced and sold by National Vulcanized Fibre Company. National fabricates the plates maintaining a tolerance of ±.005 inch in the punched holes. *No. 66*

Pressure-sensitive silicone tapes— that stick to wet or dry surfaces; form good bonds; have high dielectric strength; repel moisture; are not affected by corrosive chemicals—are described in a new folder designed to help you choose the tape best suited to your application. *No. 67*



REPLACEMENT COSTS SLASHED

Increasing the reliability of magnetic brakes and couplings by insulating them with silicone dielectrics has paid handsome dividends to the Baylor Company, Houston. Result: greater customer satisfaction plus improved maintenance-free performance for their product.

Unconditionally guaranteed for a full year, Baylor Elmagco brakes and couplings are used in oil drilling to dissipate the tremendous energy developed while lowering drill strings. Three years ago Baylor started insulating this equipment with Dow Corning silicone insulation.

The heat-stable silicone insulation so drastically reduced Baylor's replacement costs during the one year warranty period that savings far exceeded the higher initial cost of using silicone insulation. Coil replacements dropped from 30% of total output to a mere 0.55%, only one-fiftieth of the previous rate.

While the brakes are designed to dissipate energy up to 5000 hp, actual rates are frequently much higher. The silicone insulated brakes operate efficiently despite temporary overloads that would quickly burn out any other type of insulation. *No. 65*

LARGE SILICONE EXHIBIT A FEATURE OF 1958 IRE SHOW

For the latest news of silicone dielectrics and to learn how you can profitably apply these new engineering material to your specific designs, be sure to visit the Dow Corning Exhibit, BOOTHS 4106-8, New York Coliseum, March 24 to 27.

See for yourself how silicone rubber stays flexible in extreme cold; how silicone insulated equipment operates at temperatures far above the limits of organic insulation, and how dozens of other electronic products are made better and more reliable with silicones.

And while there, be certain to pick up your copy of the most comprehensive guide to Dow Corning silicone insulating materials ever published for electronic design engineers. Titled "Silicones as Dielectrics", this 12-page booklet will help you select the silicone material offering the best combination of mechanical and dielectric properties for any application. You can also obtain a copy by circling . . *No. 68*

Send Coupon for More Information

DOW CORNING CORPORATION - Dept. 483
Midland, Michigan
Please send me **65 66 67 68**

NAME ______________

TITLE ______________

COMPANY ______________

STREET ______________

CITY ________ ZONE ______ STATE ______

ATLANTA • BOSTON • CHICAGO • CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEW YORK • WASHINGTON, D. C.
Canada: Dow Corning Silicones Ltd., Toronto; **Great Britain:** Midland Silicones Ltd., London; **France:** St. Gobain, Paris

PZT-4 ©

NEW

Piezoelectric* Material

Surpasses barium titanate . . . performs remarkably independent of temperature . . . Curie point above 572°F. . . suggests new fields of application—maybe yours

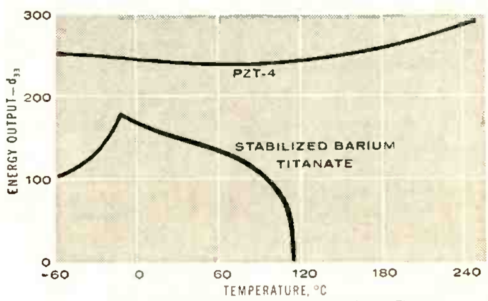
A newly-developed polycrystalline ceramic, Clevite PZT-4, can greatly increase the reliability and operating range of missile devices, sonar transducers, ultrasonic cleaning equipment and other systems now using "grown" crystals or barium titanate elements.

PZT-4's resonant frequency and piezoelectric coefficients are virtually independent of temperature . . . dielectric constant compatible with barium titanate—substitute PZT-4, extending your operating temperature range. PZT-4 substantially increases voltage output and power handling capacity of transducers.

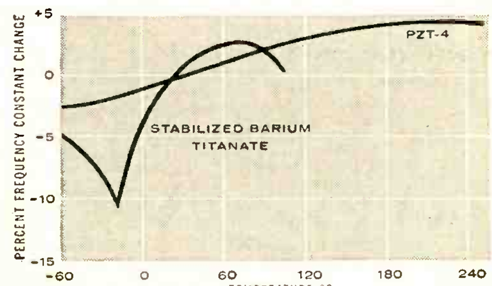
Commercial quantities of PZT-4 are now available in electromechanical specifications to meet your needs. With skilled facilities, knowledge and experience in this highly specialized field, Clevite's Electronic Components Division is also prepared to manufacture complete assemblies — such as transducers — for your needs. Send for PZT-4 technical data, or discuss your application with one of our specialists.

*Piezoelectric—"pressure" electricity. Press or squeeze certain crystalline materials and they generate electricity. Conversely, charge them electrically and they change in width, in length or in thickness.

VISIT BOOTH NO. 2622, IRE SHOW, N.Y.C.—MARCH 24-27.



Energy Output vs. Temperature—PZT-4 and Barium Titanate



Frequency Constant vs. Temperature—PZT-4 and Barium Titanate

CLEVITE ELECTRONIC COMPONENTS

3311 Perkins Avenue, Cleveland 14, Ohio

DIVISION OF CLEVITE CORPORATION

'BRUSH' MAGNETIC HEADS, TRANSDUCERS, PIEZOELECTRIC CRYSTALS AND CERAMICS

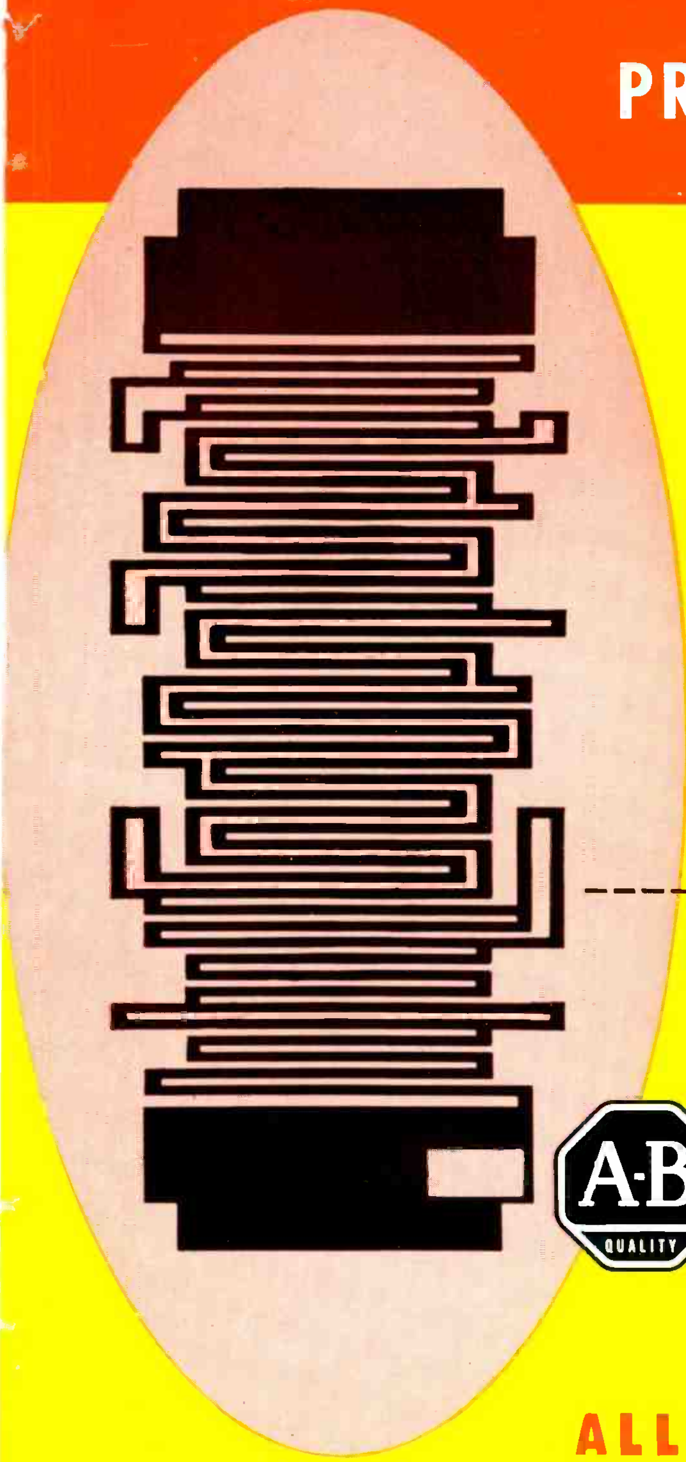
CIRCLE 98 READERS SERVICE CARD

CIRCLE 99 READERS SERVICE CARD→

ALLEN-BRADLEY PRESENTS...

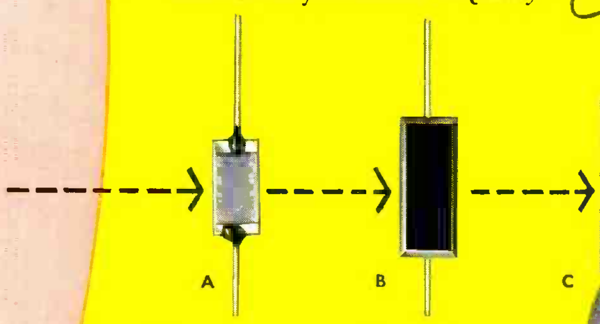
NEW METAL GRID

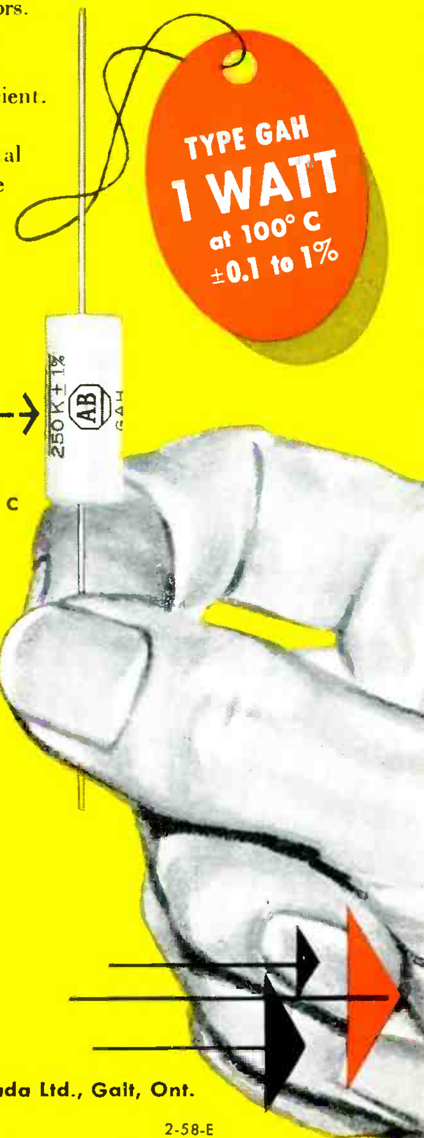
¼, ½, and 1-WATT PRECISION RESISTORS



Far exceed MIL Specs for film and wire-wound resistors

Allen-Bradley's new, truly accurate, metal grid resistors are now available in ¼, ½, and 1-watt ratings, producing test results that are a substantial improvement over the MIL Specs for wire-wound and film type precision resistors. They combine remarkable stability, under load and on the shelf, with an exceptionally low temperature coefficient. Provided with gold plated leads for flawless soldering—these new metal grid resistors justly qualify under the Allen-Bradley trademark of *Quality*.





The construction of the ¼, ½, and 1-watt resistors is identical. At left is an enlarged view of the metal alloy grid, mounted on glass, that forms the resistance element. (A) Actual size of 1-watt element, (B) encapsulating epoxy resin body, (C) finished unit hermetically sealed in ceramic tube.

A-B QUALITY

ALLEN-BRADLEY

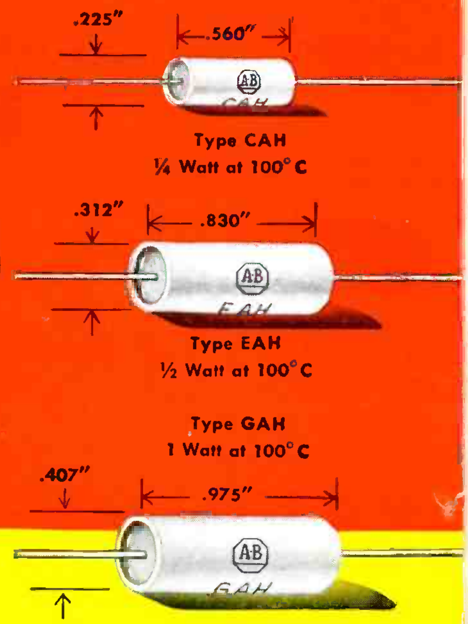
ELECTRONIC COMPONENTS

QUALITY

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

2-58-E

See how ALLEN-BRADLEY'S NEW METAL GRID PRECISION RESISTORS exceed MIL Specs for film and wire-wound resistors!



The specially designed metal alloy grid of these new resistors is noninductive, providing excellent high frequency characteristics. Due to the metal grid, the Type CAH, ¼-watt; Type EAH, ½-watt; and Type GAH, 1-watt resistors have an exceptionally low noise level . . . comparable to that of wire-wound units.

Each Allen-Bradley precision resistor is individually calibrated and marked with the nominal resistance value, the tolerance, and the temperature coefficient. Obviously, the price cannot be low, but there are many critical military and industrial applications where the stability and reliability of these metal grid resistors will more than offset the initial cost.

It will pay you to investigate the use of these *Quality*, hermetically sealed resistors in your really "tough" military and industrial circuits.

COMPARATIVE SPECIFICATIONS

	Allen-Bradley Specification (Metal Grid)	Military MIL-R-93A (Wire-Wound)	Military Proposed Charac. C MIL-R-10509C (Film)	MIL-R-19074A (Ships) (Film)
Rated Ambient	100°C	85°C	100°C	85°C
Maximum Derating	165°C	105°C	165°C	150°C
Tolerance	.1 to 1.0%	.1 to 1.0%	1.0%	—
Temperature Characteristic	±25 PPM ±50 PPM	±30 PPM	±30 PPM	±25 PPM ±50 PPM
Low Temperature Storage	.1% Max.	—	.2%	.5%
Temperature Cycling	.1% Max.	.2%	.2%	.2%
Moisture Resistance—In Cabinet	.2% Max.	1.0%	.5%	—
Short Time Overload	.1% Max.	.5%	.5%	.5%
Load Life—100°C Ambient 1000 Hrs.	.2% Max.	.5%	.5%	.5%
Terminal Strength	No damage	—	No damage	No damage
Solder Test	.1% Max.	—	.1%	.5%
Dielectric Strength	.05%	.05%	.1%	.05%
Insulation Resistance	1000 Meg.	—	1000 Meg.	1000 Meg.

ALLEN-BRADLEY
ELECTRONIC COMPONENTS
QUALITY

A-B QUALITY

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

2-58-E

A Research Project of Dr. Harry Nyquist, Senior Scientist, Stavid Engineering, Inc.

Dr. Nyquist is a pioneer in advanced areas of electronics such as Information Theory and circuit noise, and is credited with nearly 150 patents in the field of communications. He is now contributing his exceptional analytical ability to Stavid's work on a far reaching anti-missile system. Men like Dr. Nyquist are typical of Stavid's outstanding scientists and engineers who are working on advanced concepts . . . years ahead of actual systems development.

In Stavid's objective engineering atmosphere, scientific, development and manufacturing teams are producing a wide range of electronic systems for all branches of the military. Typical of such projects is the REGULUS missile command guidance system, designed, built and maintained in operational status by Stavid.

CURRENT STAVID PROJECTS INCLUDE:

- Airborne Search, Bombing and Terrain Clearance Radar
- Radar-Infrared Airborne Fire Control System
- Missile Beacon Telemetering System
- Missile Guidance Systems
- Anti-Aircraft Subminiature Fire Control System
- High Power Air Search Radar

STAVID Engineering, Inc. Plainfield, New Jersey

Imaginative Electronics . . .

Engineers and Scientists: Join Stavid's Advanced Systems Engineering Team.

NEW..ALL TRANSISTOR

the most versatile...most sensitive direct writing oscillograph ever available

combining all these features!

- ★ stable d-c sensitivity of one microvolt per mm
- ★ true differential input
- ★ high input impedance
- ★ response to beyond 150 cps.
- ★ reluctance, differential transformer, strain gage with a-c or d-c excitation, thermocouples, etc., used with all amplifiers
- ★ deflection time less than 2 milliseconds
- ★ fixed precision calibration
- ★ instant warm-up
- ★ precision source for d-c and 400 cycle excitation, self-contained
- ★ zero suppression, twenty times full scale, both directions

and all in only 33¼ inches of rack space for eight channels!

Using Offner developed transistor circuits which have been time-tested in over two years of service, in hundreds of channels of Offner Dynograph medical equipment, the Offner *Transistor* Dynograph is now first made available to industrial users as a *time* and *service* proved instrument, which we believe superior in practically every important respect to any other direct-writing oscillograph.

The Type R incorporates the following units:

Type 482 Dual Channel Transistor Power Amplifier itself providing sensitivities from 10 MV to 50 volts per cm, with a stability impossible with conventional amplifiers. The high performance of the Type 482 is made possible only by the Offner-developed transistor circuits employed*. Zero suppression and internal self-calibration are incorporated. The Type 482 may be employed without preamplifier when its sensitivity is sufficient, and differential input is not required.

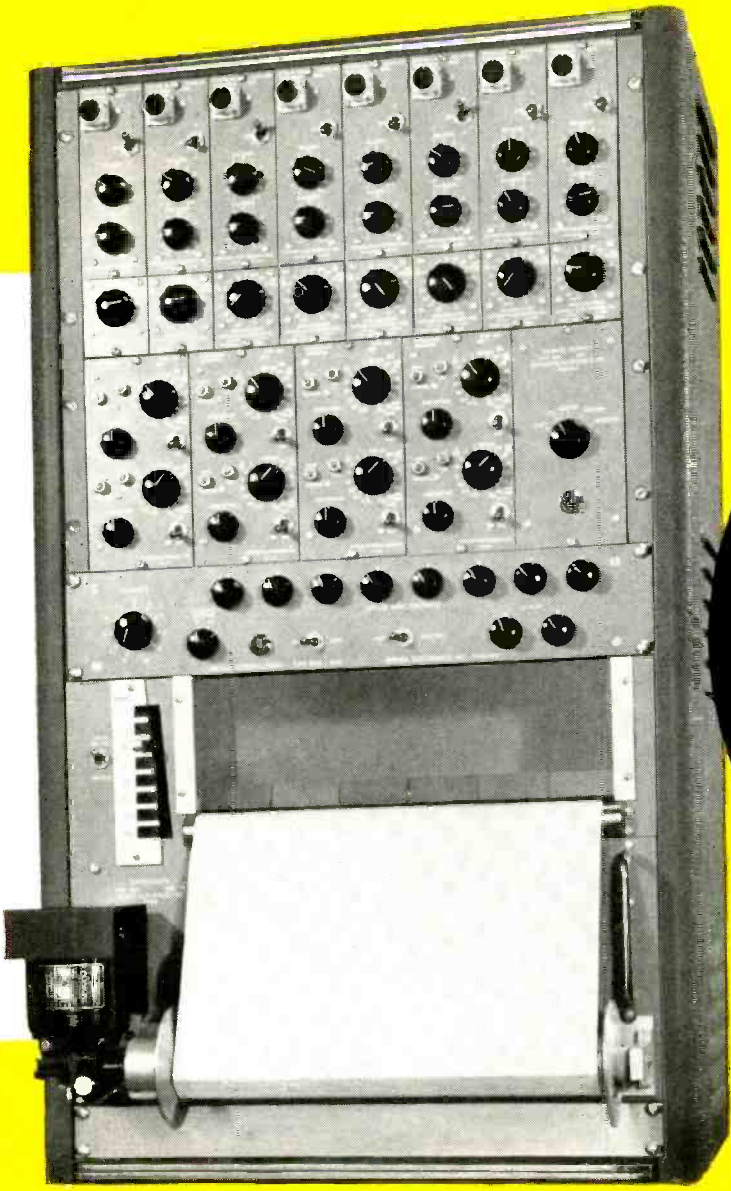
Type 481 Preamplifier, incorporating the circuit principles of the Type 190 Data Amplifier*, provides zero-drift amplification of signals down to the microvolt level, and permits a sensitivity of up to ten microvolts per cm to be realized. The Type 481 provides true differential amplification with infinite rejection of d-c common signals. Gain stability and linearity are so nearly perfect that zero suppression may be employed *after* the preamplifier, permitting considerable simplification of operation in many applications. The Type 481 also serves as a phase sensitive demodulator for reluctance gage and other a-c bridge applications.

**Patents granted and Pending*

see it at the IRE show . . . Booth No. 3051

DYNOGRAPH

see it at the IRE show Booth No. 3051



THE OFFNER TYPE R

TRANSISTOR DYNOGRAPH

Type 9800 Series Input Couplers plug into the Type 481 Preamplifier units, and provide all necessary bridge balancing facilities, etc. A variety of standard panels are available for strain gage, reluctance gage, LVDT, and d-c input applications. Special couplers will be provided for applications not provided by standard couplers.

Type 504/506W Dynograph uses the time-proved rugged and accurate low-resistance, high torque Dynograph element. The uniformity of response of the Dynograph units permits a frequency response substantially flat to beyond 150 cps to be now obtained, using the Type 482 Power Amplifier as driver. The Type 504 Paper Drive employs the exclusive Offner zero-weave drive principle*. Quick-change gear box provides eight speeds, one to 250 mm/sec; electrical speed change to mm/*minute* available as optional feature. Writing media available are curvilinear ink or electric; rectilinear heat or electric. Writing media may be interchanged in a few moments time.

Type 382 Power Supply provides all voltages for all amplifiers, and in addition a highly stable source for d-c excitation of strain gage bridges, and a stable source of 400 cps at 6 volts for operation of reluctance gages, LVDT's, and strain gage bridges when a-c excitation is desired.

OFFNER ELECTRONICS INC.

5320 N. Kedzie Avenue, Chicago 25, Illinois

The Year Advertising Helped

This editorial message was first published by McGraw-Hill two years ago. It describes advertising's dramatic contribution to the American economy during 1954. The theme of the editorial—that advertising can help promote economic stability by stimulating sales at a crucial time—is even more pertinent today.

As our economy grows, it is constantly changing. The conditions business faces today are not the same in every respect as those it faced in 1954. But business again has the opportunity, through advertising and other selling efforts, to help sustain a high level of economic activity. At the same time, it will be building markets for the period of renewed expansion that is sure to follow.

This editorial is reprinted exactly as it appeared in 1956 except for minor editorial changes to bring it up to date. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw
PRESIDENT
McGraw-Hill Publishing Company, Inc.

IN 1954 we had a business recession in the United States. Sales fell about 4% during the year. If management had followed the historic pattern of business ups and downs, advertising volume would have fallen much further.

But in 1954 the volume of advertising did not fall. It increased over 5%, and expenditures in all major advertising media rose. Every effort was made to stimulate sales when sales were needed to sustain prosperity.

This was something entirely new under the sun. It had a powerful influence in making the recession of 1953-54 one of the mildest on record. It helped greatly to speed business on to the record-breaking levels it attained in the years 1955-57.

There are several reasons why America's business management attacked this decline in sales with more advertising. One of them grew out of the greatly strengthened position of the American consuming market. Consumers' income after taxes has been rising an average of over $10 billion a year since 1946, and this rising income is more widely distributed than ever before. Furthermore, consumers had piled up reserves of about $200 billion in cash or its equivalent. These reserves offered a new and powerful inducement to increased selling and advertising effort even in the face of a possible decline in consumer income. (At the end of 1957, consumer reserves were $225 billion.)

Taking the Longer View

However, the principal reason why a sales decline was attacked with increased advertising is management's new-found conviction that good advertising is essentially an investment in the development of a market. Successful development requires sustained investment. The inclination of business management to take this longer view is, of course, motivated

McGraw-Hill PUBLISHING COMPANY,

ABP HEADQUARTERS FOR

Kill a Business Recession

by the fact that the American market, with over 3 million consumers being added annually, is growing at a prodigious rate.

Ten years ago only a handful of companies had plans for investment in new producing facilities extending beyond the current year. Today almost all leading companies have investment programs running some years ahead. And keeping pace with these long-range investment plans has been the development of sales and advertising programs to reach tomorrow's greatly expanded markets.

Advertising's Key Role

This crucial role of advertising in providing driving power for our economy is gaining greater recognition every day. In his book, "People of Plenty," Professor David M. Potter of Yale University remarked: "Advertising is not badly needed in an economy of scarcity, because total demand is usually equal to or in excess of total supply, and every producer can normally sell as much as he produces. It is when potential supply outstrips demand—that is, when abundance prevails—that advertising begins to fulfill a really essential economic function."

Today abundance so completely prevails in the United States that it has been conservatively estimated that as much as a third of everything offered for sale falls in the realm of "optional consumption." That is, consumers can "take it or leave it" without any immediate personal inconvenience. But if they decide to "leave it," a terrific economic depression will not be far behind. In such circumstances, advertising—in which, in all of its forms, we are now investing over $10 billion annually—clearly is of crucial importance to our continued prosperity.

In performing its key role in past years, American advertising never realized its full potential. It successfully promoted sales. But it never was called upon to promote an overall economic stability as a direct outgrowth of increased sales.

By successfully promoting both sales and economic stability, as it did in 1954, advertising surely has added new strength to the American economy. It has also added a great new and constructive dimension to advertising itself.

One of the surest means of expanding your sales volume in today's industrial markets is through dominant advertising in the publications directly serving your major customers and prospects.

McGraw-Hill's business and technical publications can give you quick access to the men who initiate, specify and approve the purchases of industrial products and services. Because all are leaders in their respective fields, you are assured a maximum return on your advertising investment when you *concentrate* in the McGraw-Hill publications serving your most important markets.

INCORPORATED • 330 West 42nd St., New York 36, N. Y.

B U S I N E S S I N F O R M A T I O N

All business is specialized

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

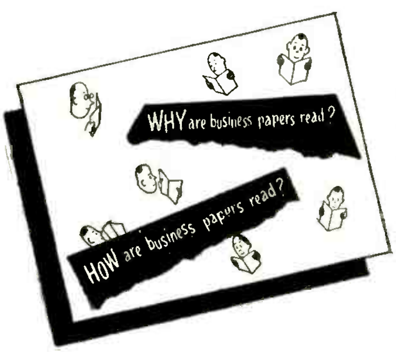
Here's a smart business man. He spends his time where every sitzmark parks a prospect at his feet. It's simple sense: He *specializes* . . . and it *pays*!

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.

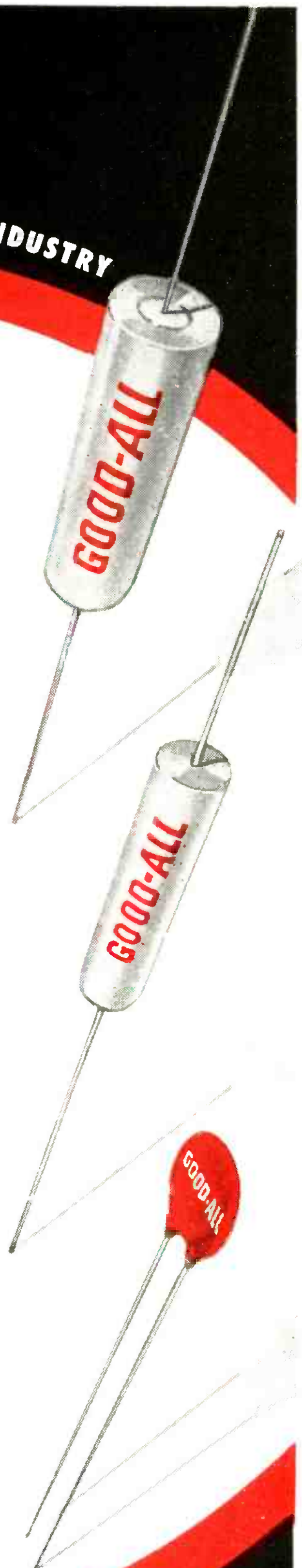
One of a series of advertisements prepared by THE ASSOCIATED BUSINESS PUBLICATIONS

GOOD-ALL
CAPACITORS

THROUGHOUT THE INDUSTRY

...KNOWN AND RESPECTED

Three HEADLINERS from a broad line of fine quality capacitors



METAL ENCLOSED Tubulars per MIL-C-25A

"CP" capacitors are the widely accepted standards of military equipment designers.

Quality of product and dependability of service bring a steady flow of new customers to Good-All Electric for "CP" requirements.

Good-All specializes in Types CP04, CP05, CP08, CP09, CP10 and CP11. Approvals are listed by ASESA in the current issue of the QPL.

Good-All Type 663-UW SPACE-SAVING Sub-Miniatures with a SKIN-TIGHT Case

Type 663 UW is an ideal choice for miniaturized and transistorized products. The space-saving possibilities are amazing.

SPECIFICATIONS			
Dielectric	Mylar Film	**Voltage Range**	100–600 VDC
Case	Plastic Wrap	**Temp. Range**	−55° to +125°C
End Fill	Thermo-Setting Plastic	**IR at 25°C**	100,000 Meg. x Mfd.
		Humidity Resistance	Superior

Available for delivery from Stock.

Mylar, 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.

Write or phone for consultation on specific design problems or to secure detailed specifications on our complete line of Tubular and Ceramic disc capacitors.

Soon in stock at your local distributor.

GOOD-ALL ELECTRIC MFG. CO. • OGALLALA, NEBRASKA

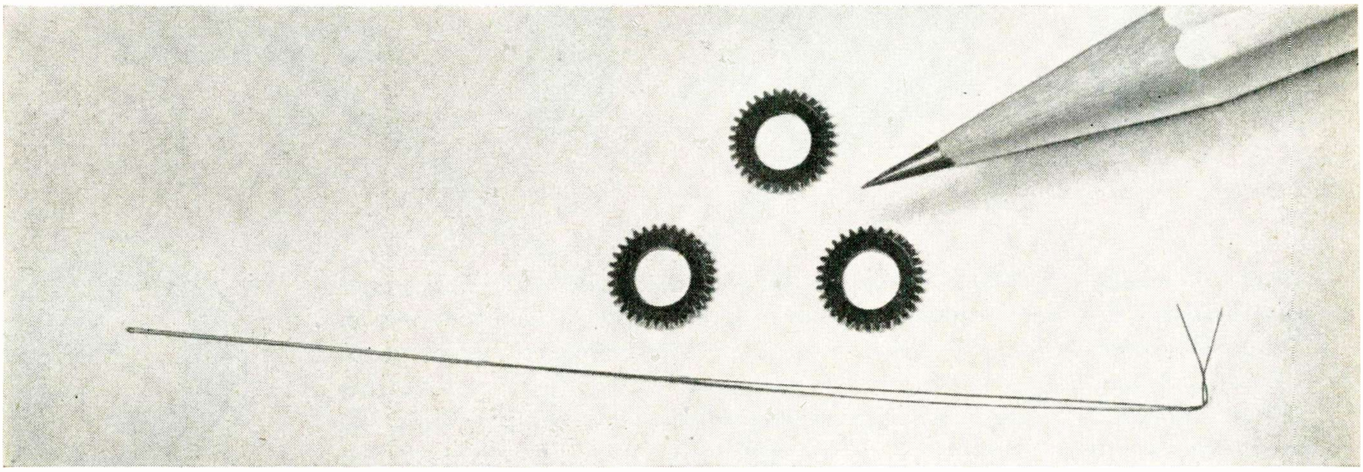
Production Inspection is Faster and Easier with a J&L Optical Comparator

. . . and its extreme versatility enables you to perform inspections that used to be "impossible"!

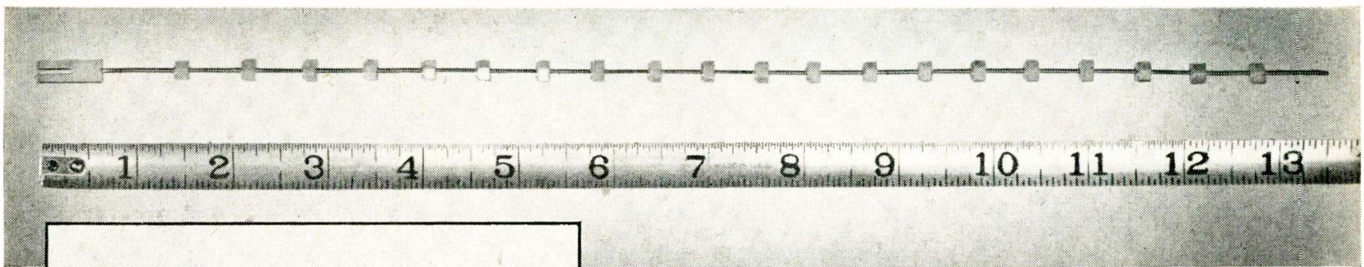
More and more electronics manufacturers throughout the country are using Jones & Lamson Optical Comparators in their quality control operations. Small shops, as well as the giants, have learned that a J&L Comparator pays for itself in very short order.

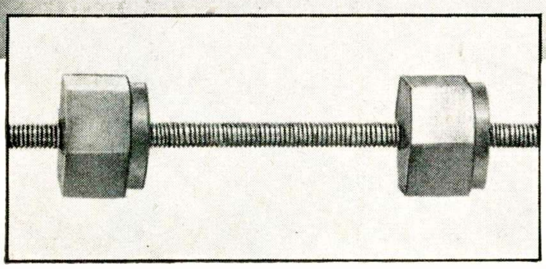
The Comparator's ability to measure and inspect, through shadow magnification, all sorts of parts and objects with extreme precision and speed makes it ideally suited for checking electronics components, especially those which are tiny or intricately contoured.

Investigate how the J&L Comparator can help you make your production operations more efficient . . . and more profitable. Write today for a free copy of our new illustrated catalog No. 5700.

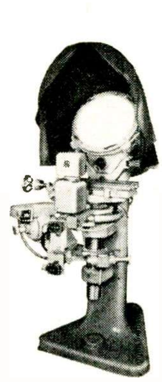


For Instance — A customer writes: "One of our assemblies, containing 32 separate circuits, measures only 5/16" dia. by 1" long. The parts which go into this assembly must have perfect shape and tension, which are impossible to check by mechanical means. Two such parts are these .005" dia. gold wires, and precisely toothed brush spacers. Since using the J&L Optical Comparator in our inspection, assembly failure due to malfunction of either of these two parts has virtually disappeared."





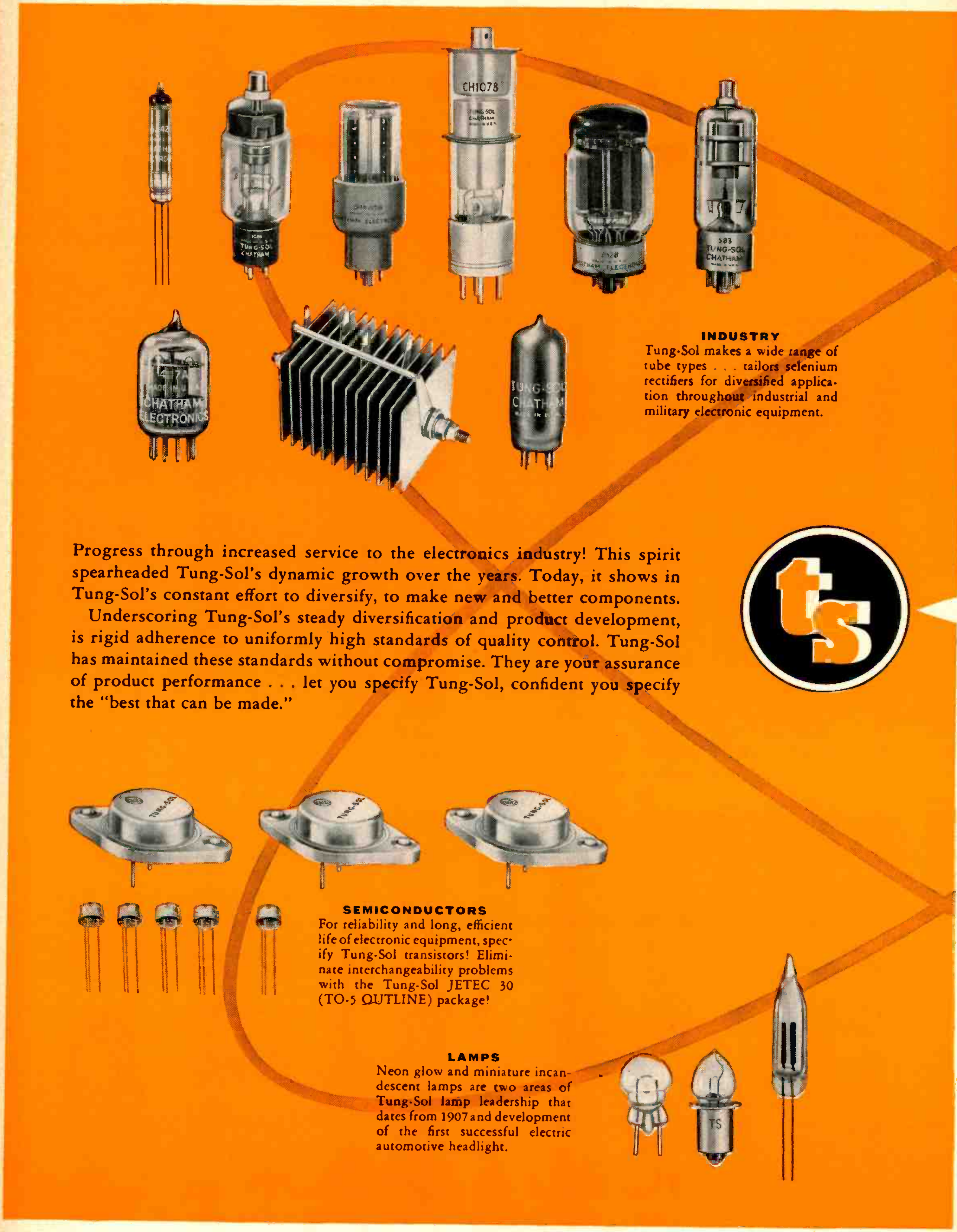
This precisely-threaded rod (used in calculating machines) is of .047" dia. stock, 120 pitch, with continuous threading along its entire 12" length. Threading accuracy and critical dimensions are measured and checked speedily and efficiently with a J&L Comparator.



Model PC-14

JONES & LAMSON

JONES & LAMSON MACHINE COMPANY, Dept. 710, 539 Clinton Street, Springfield, Vermont



CIRCLE 102 READERS SERVICE CARD

CIRCLE 103 READERS SERVICE CARD

Varian Strip Chart Recorders

POTENTIOMETER PERFORMANCE* AT MODERATE COST

Varian G-10 — Portable for laboratory or bench use where chart accessibility is of prime importance. Base price $340.

Varian G-11A — For panel, rack or portable use; designed for OEM, lab or field for long-term monitoring. Base price $450.

* The servo-balance potentiometer method has long been used in expensive recorders to achieve superior stability, sensitivity, ruggedness and high input impedance. Use of servo balancing systems assures full realization of these inherent advantages by providing ample power independent of the source being measured. Now Varian offers you recorders of moderate cost using this time-proven principle.

VARIAN SPECIFICATIONS:

- Spans as low as 10 mv
- Limit of error 1 %
- Maximum source resistance 50K ohms or higher
- Balancing times: 1 second or 2.5 seconds on G-10; 1 second on G-11

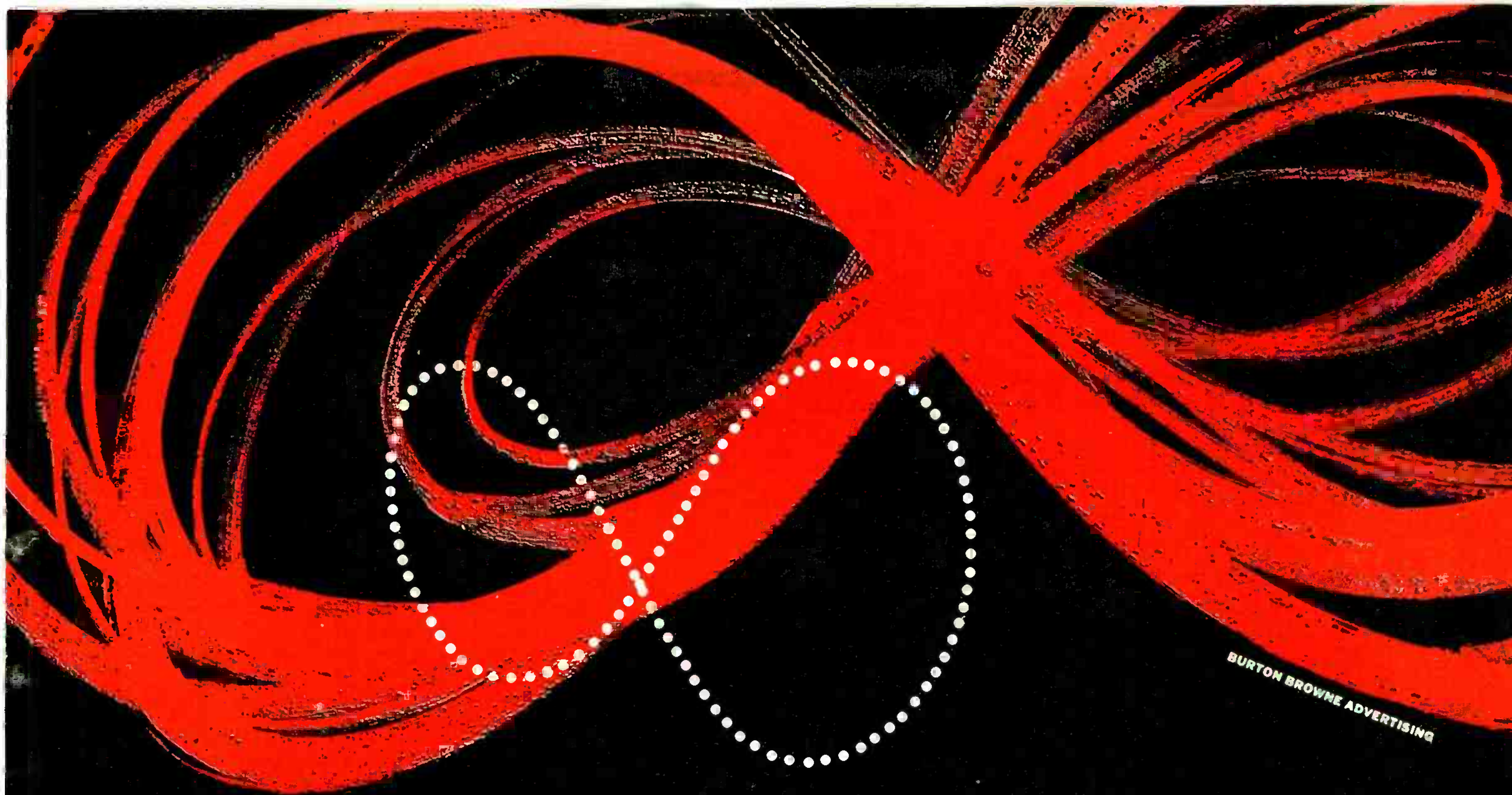
WRITE TODAY FOR COMPLETE SPECIFICATIONS

Varian recorders are sold and serviced throughout the free world by representatives in principal cities.

VARIAN associates
INSTRUMENT DIVISION
PALO ALTO 1, CALIFORNIA

Varian Associates manufactures Klystrons, Traveling Wave Tubes, Backward Wave Oscillators, Linear Accelerators, Microwave System Components, R. F. Spectrometers, Magnets, Magnetometers, Stalos, Power Amplifiers and Graphic Recorders and offers research and development services.

CIRCLE 135 READERS SERVICE CARD



EINSTEIN, INFINITY and the IONOSPHERE

Creative imagination took Einstein into a new widening concept of the nature of the physical universe.

At the National Co. creative imagination is continuing to broaden our mastery of the physical universe through the realization of such means of communication as Ionospheric Scatter systems.

The implications of these new means of communication are manifold and the applications multitudinous.

You, who enjoy such creative challenges to scientific and technical development, should talk to *National.*

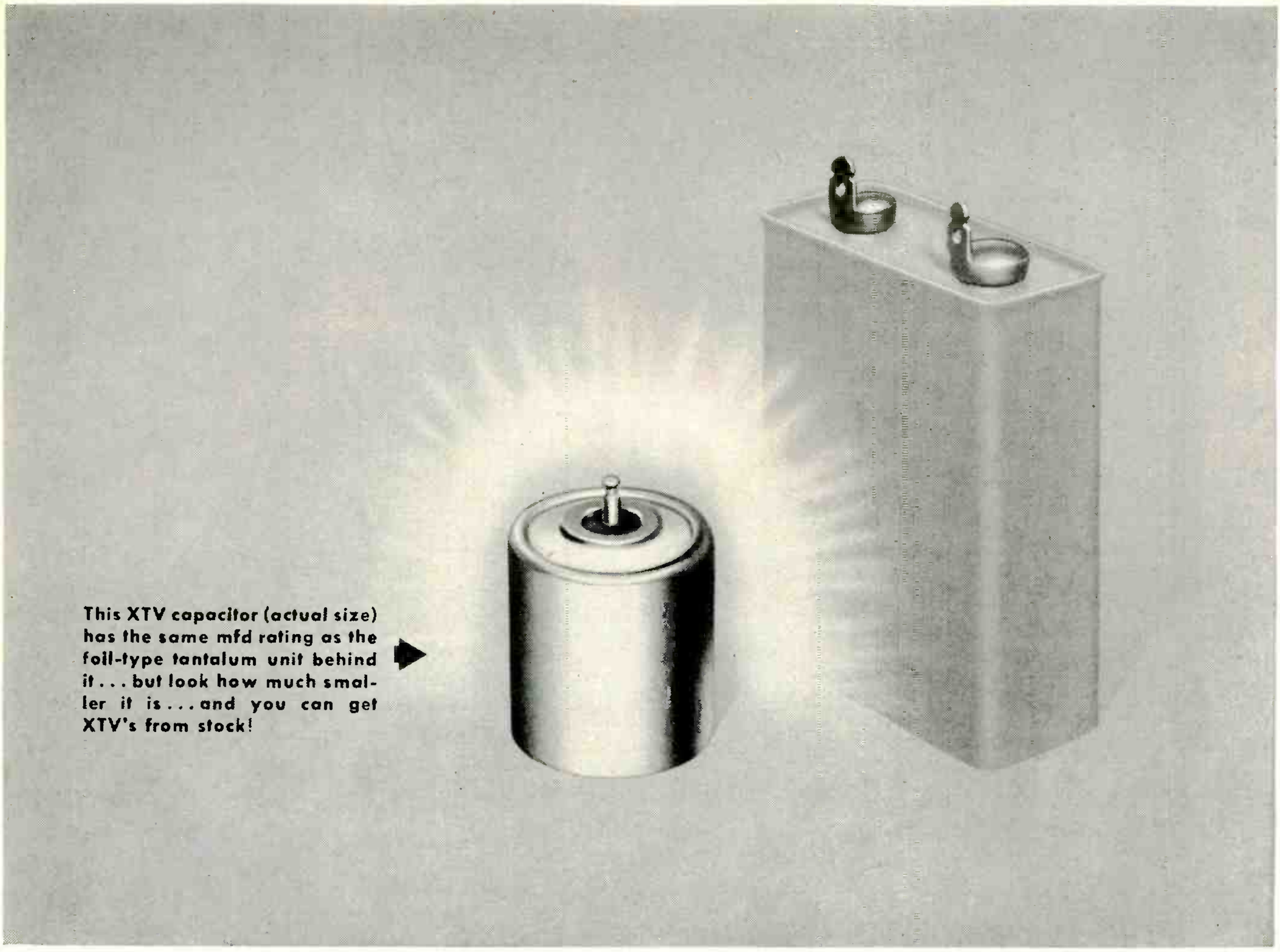
National Co. *right now* affords engineers and physicists the opportunity to grow and establish prestige in such advanced fields as atomic frequency standards, multipath transmission, noise reduction and correlation techniques, Tropospheric scatter systems, Ionospheric scatter systems, molecular beam techniques for signal processing, and long range microwave transmission.

At National Co. in the heart of New England electronics, you can associate with a company in which creativity is required, recognized and rewarded.

Write or phone

tuned to tomorrow **National** ®

National Company, Inc. Malden, Massachusetts



This XTV capacitor (actual size) has the same mfd rating as the foil-type tantalum unit behind it . . . but look how much smaller it is . . . and you can get XTV's from stock!

A *NEW* Mallory Tantalum

High capacity • High temperature • Small size

Here is really big news about a little capacitor —especially interesting to missile and computer design engineers: you can now get up to 1000 mfd. in a case only 1⅛" x 1⅛". It's the new Mallory XTV Tantalum Capacitor, especially suitable for those applications requiring several hundred microfarads of capacity at low voltage. A single, small capacitor will do the job which formerly required the parallel connection of many low-capacity capacitors.

Mallory XTV Tantalum Capacitors are hermetically sealed—are capable of operating at extremely high altitudes without danger. They are ideal for missile guidance systems, aircraft communications equipment, commercial computers, or any energy storage device where limited space and extreme environmental conditions are encountered.

Electrically, Mallory XTV Tantalum Capacitors have low impedance, low series resistance and low leakage current. They will operate over an extreme temperature range (—55° to 175°C), have virtually unlimited shelf life, and greatly extended operating life.

Standard Ratings:

Mfd.	VDC @ 85°C	VDC @ 125°C	VDC @ 175°C
1,000	40	35	26
750	60	50	38

For ratings not listed, and for additional data and application information, write Mallory.

Expect more . . . get more from

P. R. MALLORY & CO. Inc.
MALLORY

P. R. MALLORY & CO. Inc., INDIANAPOLIS 6, INDIANA

Parts distributors in all major cities stock standard Mallory components for your convenience.

Serving Industry with These Products:

Electromechanical — Resistors • Switches • Tuning Devices • Vibrators
Electrochemical—Capacitors • Mercury and Zinc-Carbon Batteries
Metallurgical—Contacts • Special Metals • Welding Materials

CIRCLE 105 READERS SERVICE CARD

electronics
engineering edition
MARCH 14, 1958

Etched I-F Amplifier Pares Color Tv Cost

Vane-tuned inductances and rejection traps, etched on the same board as the wiring of a 41-mc i-f strip for color tv, provide neat and economical design technique. Design requirements and performance data are covered completely for a typical i-f strip and construction details given

By LINUS RUTH* Laboratories RCA Ltd. Zurich, Switzerland

ETCHING INDUCTANCE COILS and traps on the same board as the wiring can save considerable material and labor costs. This is especially true in a 41-mc i-f strip for color tv to be described where the number and complexity of inductances make is possible to fully realize the economies of printed circuitry. The bill of material saving alone compared to conventional three tube color i-f strips is approximately 25 percent.

Requirements

In a wide-band color i-f amplifier there must be sufficient bandwidth at the chrominance detector to handle the 42.17-mc color subcarrier and both sidebands up to 500 kc from the color subcarrier (B-Y, R-Y demodulation).

The bandwidth at the luminance detector should produce resolution in line with good monochrome practice. There should be 26 to 30 db sound attenuation at the sound detector for proper intercarrier operation; approximately 50 db minimum adjacent picture attenuation; approximately 50 db minimum adjacent sound attenuation with no phase degradation in the vicinity of the picture carrier, and approximately 50 db minimum sound attenuation at the luminance detector for elimination of 920-kc sound-color beats. Also, the picture carrier at the chrominance detector should be of greater amplitude than the chroma subcarrier to prevent luminance modulation of the chroma subcarrier.

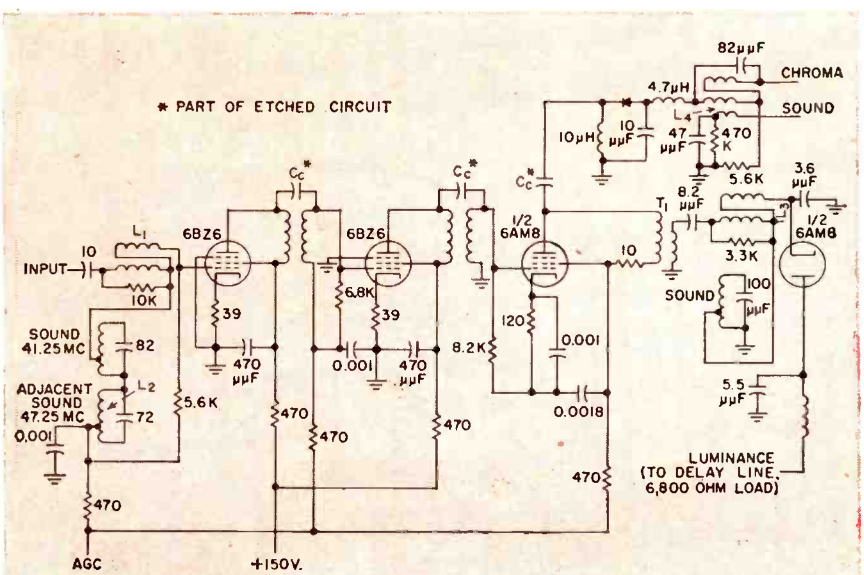
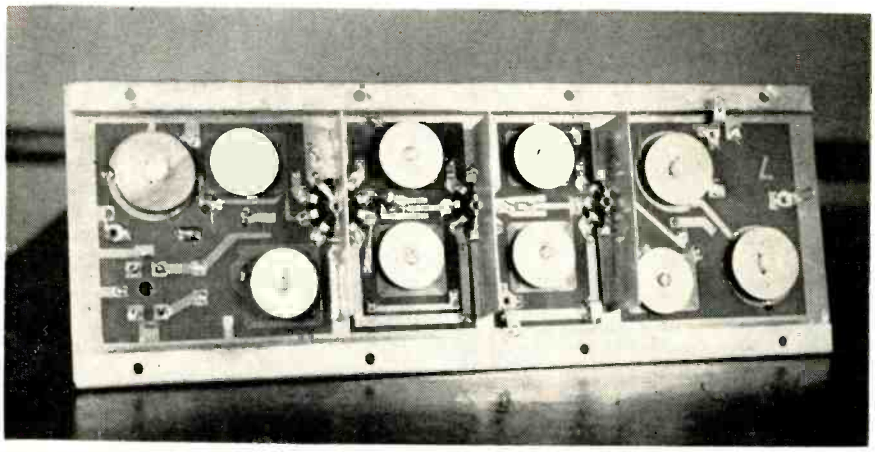


FIG. 1—Schematic diagram of the 41-mc i-f amplifier. Traps are printed on the same board with the wiring and other coils and are vane tuned

Design

The mixer to first grid is overcoupled with low side capacitance

*Formerly associated with Standard Coil Products, Los Angeles, Calif.



Photograph of i-f amplifier showing layout and spacing arrangement between the coils in the center of the strip. This arrangement greatly reduced d-c leakage

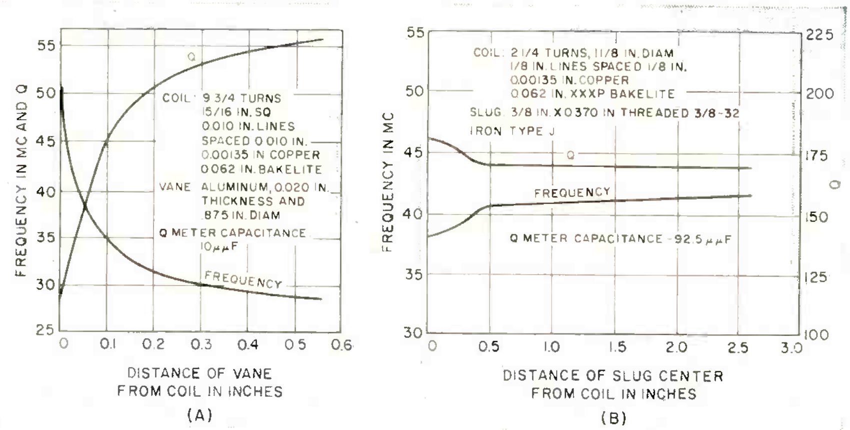


Fig. 2—Frequency and Q plotted against distance from the coil using aluminum vanes on steel screw (A) and powdered iron slug tuning (B)

coupling and two bifilar T traps; one sound and one adjacent sound. See Fig. 1. The next two stages are grid loaded and overcoupled, chosen in preference to a staggered pair because it was felt that the problem of holding the coupling would be alleviated with coils on the same board and provide additional stage gain.

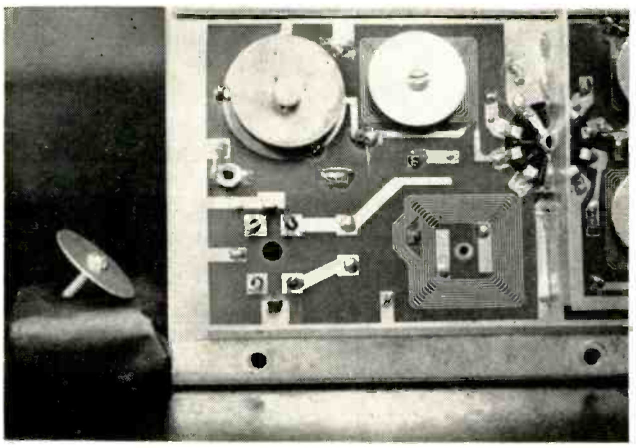
Attenuation of the two bifilar T traps in the grid of the first i-f is adjusted by a tap on the adjacent sound trap L_2 and the balancing resistor across the first half of the cross connected bifilar coil L_1 to give maximum attenuation with minimum low frequency phase disturbance. The sound trap tap is adjusted to give 28 db sound attenuation at the sound and chroma detector. With this adjustment, attenuation of adjacent sound varies from a minimum of 50 db to a maximum of over 70 db with a ± 5 percent variation of the resistor. The sound trap only varies from a minimum of 25 db to a maximum of 30 db.

One of the problems with printed bifilar coils used in a stagger-tuned circuit is that d-c leakage develops between the plate coil and the grid coil. The B+ potential is usually 130-150 v and agc potential is -3.0 v or so, at relatively high impedance. The seriousness of this leakage is greatly reduced by the relatively small area and increased spacing of the coupling capacitor between the coils in the center of the strip.

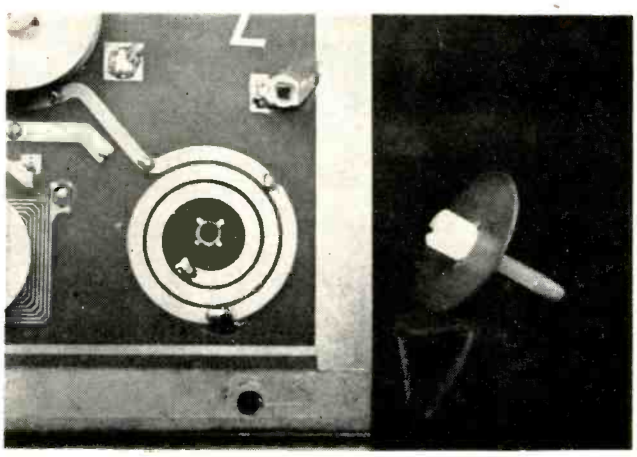
There are three bifilar coils on the strip, used in conjunction with the bifilar traps. Coil L_1, in the grid of the first i-f shown in Fig. 1 and L_3 in the detector circuit have no d-c potential between coils. The d-c potential across T_1 could be avoided by returning the grounded end of the secondary to B+ with a 0.001-μf bypass to ground at that point.

Detectors are overcoupled with a bifilar T sound trap in the luminance detector. A 6,800-ohm delay line is used for the luminance detector load and negative mutual peaking is used in the video amplifier grid circuit.

The chrominance detector is aligned so that the picture carrier



Closeup of i-f amplifier shows the aluminum vanes, mounted on steel screws, used for tuning the coils



View of the bifilar trap with vane removed shows nylon-screw mounting hole. Screw and vane are at right

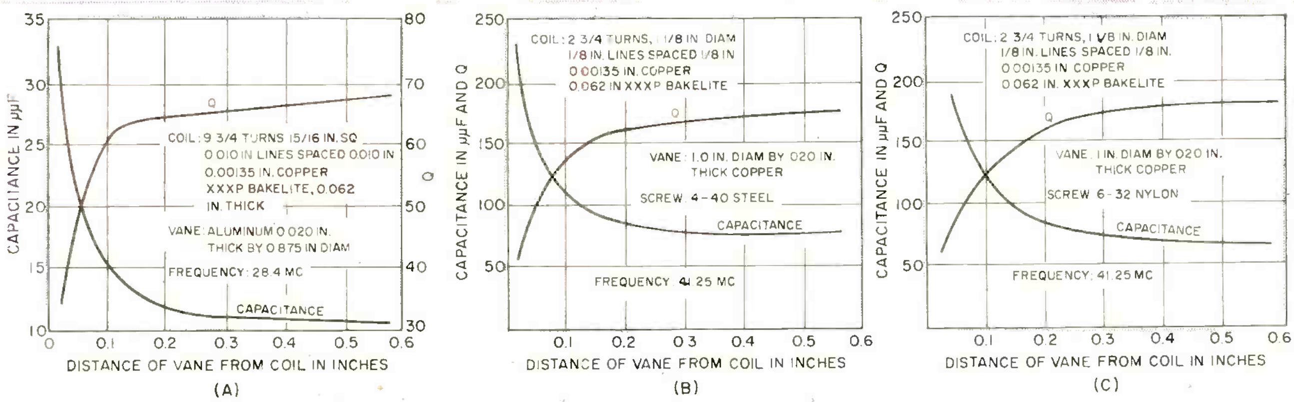
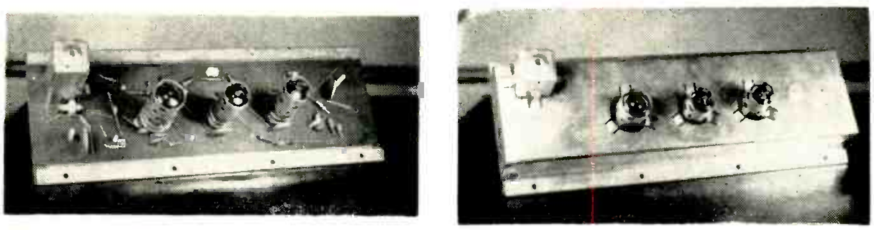


FIG. 3—Capacitance and Q plotted against vane distance from trap coil using aluminum vane (A), copper vane mounted on steel screw (B) and copper vane mounted on a nylon screw (C)



The i-f strip with the top shield removed (left). Shielding for the sound trap in the luminance detector circuit is taken care of by a small copper strip enclosing the trap on sides not adjacent to ground

is several db above the chroma subcarrier.

Coils are vane-tuned with aluminum vanes on steel screws. This tuning method is inexpensive and gives greater tuning range than slug tuning. However, when the vane gets close to the coil, the coil Q deteriorates seriously, as shown in Fig. 2A. Coil inductance is adjusted so that the vane never comes closer than 0.125 in. and the Q variation is kept within ± 10 percent of the nominal value.

Figure 3A shows that a total variation in circuit capacitance of 3.5 $\mu\mu$f may be satisfactorily compensated. Since this is several times the expected capacitance variation, it is safe to exclude from the operating range the 0.125 in. closest to the board.

The traps are also printed on the same board with the wiring and other coils. The original tuning method used with the traps was a powdered iron disk. However, this method resulted in low Q and a restricted tuning range. Later a large threaded slug was used in conjunction with a threaded nylon tube to allow the slug to be withdrawn from the field of the coil. The Q is satisfactory but the tuning range is still restricted, as shown in Fig. 2B.

Trap inductance was increased by extending the winding into the space formerly occupied by the slug, maintaining the same outside diameter and vane tuning with a copper vane mounted on a steel screw was tried. If the Q is maintained above 150, the vane must be kept 0.15 inch from the board and a capacitance variation of ± 10 percent of 83.5 $\mu\mu$f may be compensated, as shown in Fig. 3B.

With the same configuration and a nylon screw mount, the Q may be maintained above 160 for the same capacitance variation, as in Fig. 3C.

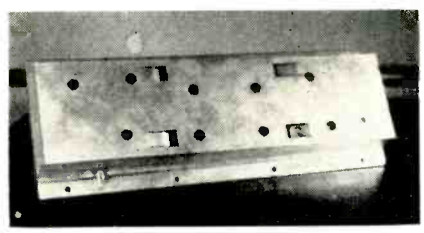
Shielding

Small shields installed across each tube extending to the edge of the strip provide decreased impedance in the ground paths and shield adjacent stages. Further shielding is provided by bottom and top covers. The grounding strip that extends up from the tube socket to ground the tube shield is not of sufficiently low impedance, therefore each tube shield is grounded to the top cover by three springs.

Shielding for the sound trap in the luminance detector circuit is taken care of by a small copper strip enclosing the trap on sides not adjacent to ground. Details of the shielding are shown in the photographs.

Before dip soldering, an epoxy resist is screened over the coils and coupling capacitors so that their values will not be altered during the soldering process.

The entire chroma detector circuit, including the bifilar T 4.5-mc sound trap L_1 with sound take-off coil, is included within a ⅞ by ⅞ in. shield can except for the crystal diode.



Details of shielding for i-f amplifier show punched chassis containing spring surfaces for good shielding contact

A series tuner is used to check the performance characteristics. Sensitivity for 1 v d-c rise at the luminance detector load is 60 μv (i-f) for the mixer grid, 12 μv for channel 3 and 16 μv for channel 10.

Trap rejection of sound at the luminance detector is 63 db, adjacent sound is 58 db and adjacent picture is 40 db.

Adjacent picture attenuation could be increased to greater than 50 db by adding another trap. However, further shielding for this addition did not warrant the cost and the trap was left out as an economic compromise.

Roof-Top-Target Tubes

New pulsating X-ray tube designs and systems for their use are described. The most successful system uses two tubes. Each tube is controlled by applying a relatively low-voltage square wave to a special tube element called a diaphragm. Anode current is maintained constant by alternately switching from one tube to the other. Pulsating frequency can be controlled from 35 to 100,000 cps with an adjustable duty cycle from 10 to 90 percent

By E. F. WELLER Physics-Instrumentation Dept., Research Staff, General Motors Corp., Detroit, Mich.

SYSTEMS for using special X-ray tubes, which can be pulsed over a wide range of frequencies and duty cycles, are described. The tubes are capable of delivering therapeutic dose levels.

Square pulses of X-ray energy can be produced at rapid repetition rates in five basic ways. These are: interruption of the beam with a mechanically controlled shutter; pulsing the anode voltage of the X-ray tube; use of a control tube in the cathode circuit to interrupt the X-ray tube current; deflection of the electron beam, within the tube, to a second target which emits X-rays in a different direction; and interruption of the X-ray tube current by pulsing a control element within the tube. The first three systems limit duty cycle and/or repetition frequency. The remaining two do not.

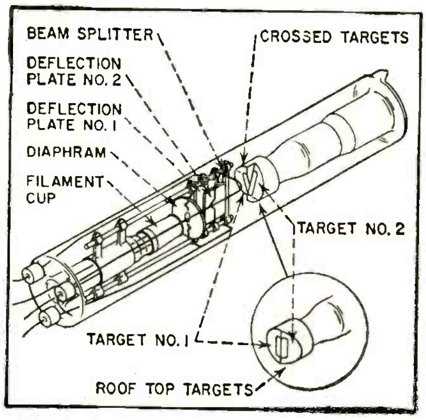


FIG. 1—X-ray tube, type 1, has crossed targets. Type 2 has a roof-top target

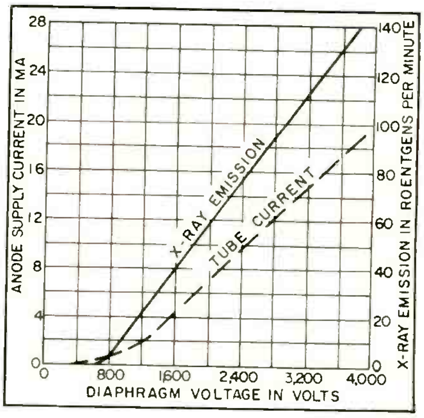


FIG. 2—Cutoff characteristics of the second X-ray tube described in this article

Table I—Typical Characteristics of Pulsating X-Ray Tubes

	Experimental Type 1	Experimental Type 2
Anode voltage (kv)	+80	+80
Anode current (ma)	20	20
Deflection plate voltage (v)	+1,200 − (+50)	+1,250 − (+60)
Beam splitter and diaphragm voltage (v)	+ 1,250	0
Cathode bias (v)	−800	−2,000
Filament voltage (v)	8	8
Filament current (amp)	4	4
Output (r/min at 10 in.)	240	230
Tube dimensions	20¾-in. long	4-in. diameter
Distributed capacitance (μμf)		
Beam splitter and diaphragm	1.15	
Deflection plate	0.95	
Anode	not measurable	

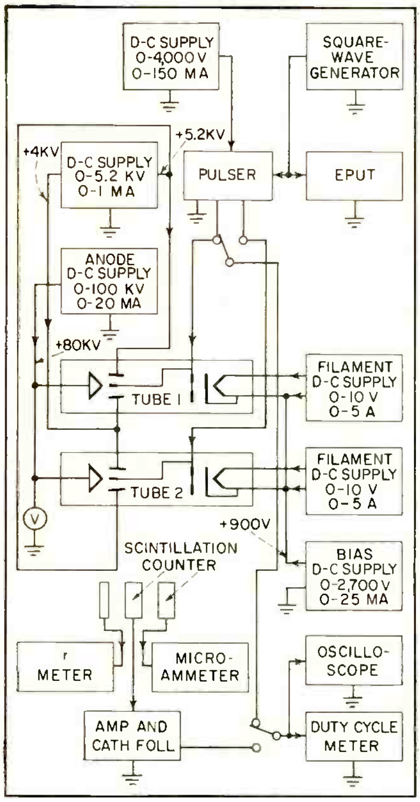
To make possible electron-beam deflection and current-interruption systems, two basic tube types were developed and supplied by Westinghouse Electric Corp. Each tube type shown in Fig. 1, contains a special target shape, electrostatic deflection plates, and a diaphragm or grid. Output from both tubes, as well as operating voltages and currents, are shown in Table I.

Beam-Deflection System

The electron-beam deflection system, using the new tubes, presented one basic problem. The total number of electrons comprising the tube current could not be directed solely to the desired target. Under optimum conditions, a minimum of three percent of the X-rays was emitted from the dead target. This emission was probably caused by stray electrons striking the target.

Experimentation showed that it was possible to cut off the X-ray tube current completely by reduction of potential between diaphragm and cathode. Tests run with fixed deflection-plate voltage and a pulsed diaphragm voltage showed that this type of operation was feasible. Figure 2 shows cutoff characteristics of the second experimental tube type when operating under these conditions. Experience with the tubes indicated that the diaphragm voltage required to cut off the beam current could be reduced by a redesign of the location of the tube elements.

Pulse X-Rays



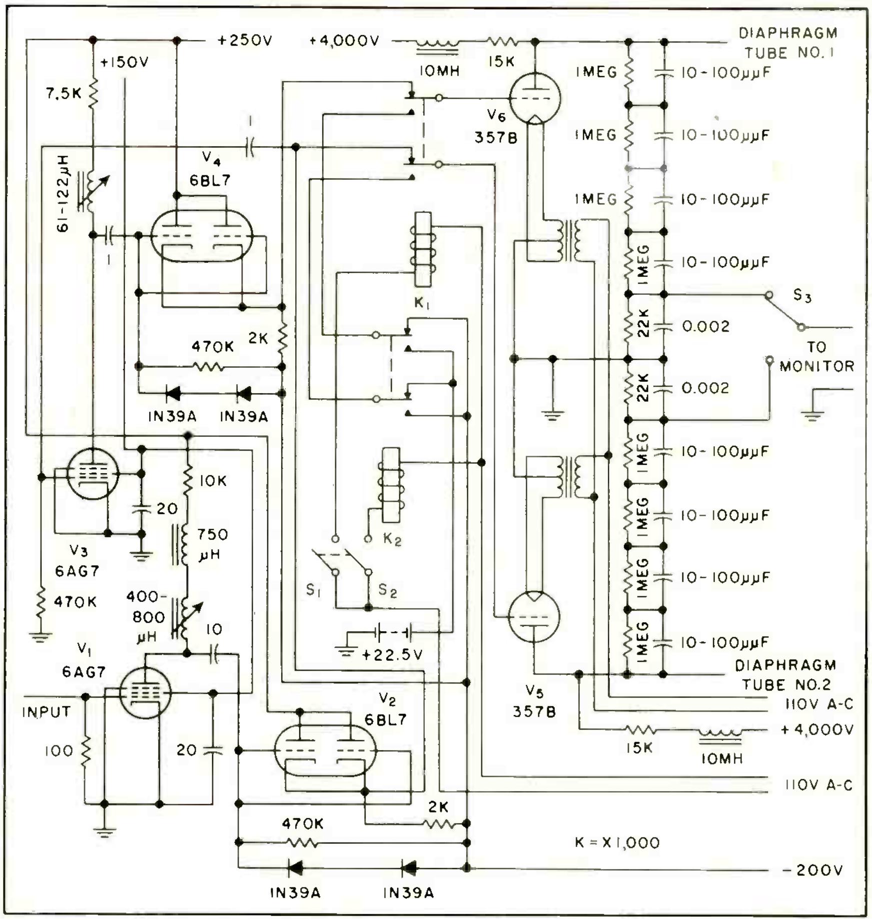


FIG. 3—Ultimate system uses two, type-2 tubes. Principal components are shown

FIG. 4—Diaphragm pulser circuit. High-voltage pulses are generated in this unit

Since average anode current is a function of duty cycle, constant anode voltage is difficult to maintain with commercial X-ray high-voltage supplies. Commercially available power supplies are not capable of holding the instantaneous tube output sufficiently constant. This difficulty was overcome by installing a second X-ray tube. The diaphragms in each tube were pulsed alternately to maintain constant anode voltage and current.

Final Two-Tube System

The overall pulsating X-ray system is shown in Fig. 3. Electrode power-supply voltages were designed to pulse the diaphragms. From a circuit design and construction viewpoint, it is easier to make the pulser and high-voltage supplies operate with their negative voltage sides at ground potential. This factor complicated the anode cooling problem in that the anodes are operated at 80 kv above ground.

The tubes are constructed without an outer protective cover or tube housing primarily so that the tube elements can be observed at all times. As a result, a cooling liquid could not be circulated over the surface of the tube. Cooling is accomplished by circulating water through a spray nozzle screwed into the anode stem behind the target.

The pulser must supply 3,600-v peak-to-peak pulses, swinging from 400 to 4,000 v. It derives its input signal from a square-wave generator modified to give an adjustable duty cycle of 10 to 90 percent from 35 to 100,000 cps.

Pulser Circuit

Circuit diagram for the pulser is shown in Fig. 4. Tube V_1 is a voltage amplifier with the plate peaking inductance adjusted for optimum operation. Output of this stage drives a cathode follower, V_2, which provides sufficient power to drive one of the pulser tubes. A signal from V_2 is also coupled to a phase inverter, V_3. The phase inverter feeds cathode follower V_4 which drives the other pulser.

Grids of V_2 and V_4 are diode-clamped to keep the baseline of the waveform at constant level. Output from stages V_2 and V_4 is fed to relay K_1. This relay permits switching grids of the 357B pulser tubes from the output of the cathode followers to steady direct voltages. The voltages are set so that one tube has +22.5 v applied to its grid while the other has −200 v. Actuating relay K_2 reverses this condition to permit either steady-up or steady-down X-ray beam operation.

Diaphragm drive tubes, V_5 and V_6, are inductively compensated in the plate circuit. The 357B tubes were chosen because they develop high-voltage pulses and their interelectrode capacitances are small.

Spurious indications on a radar screen of an object in space when nothing is visible are commonly called angels. Observations of reflection phenomena have been noted since 1936 and up to recent flying saucer incidents. Known or theorized causes include insects, birds, tropospheric layers, water vapor, storms, convection bubbles, mineral and organic particles, clouds and the ever increasing number of radio signals present in space

By **VERNON G. PLANK** Project Scientist, Air Force Cambridge Research Center, Bedford, Mass.

Atmospheric Angels

RADAR ECHOES that are received from or caused by a sensibly clear atmosphere are commonly called angels. Coincident with expanded use of ultra-high-power radars there has been a marked increase in the number of such echoes. Some of them are readily recognized as products of scattering from precipitation particles or of anomalous propagation, but many of the others tend to defy a simple explanation. They are mostly phenomena of mere casual interest, but they can cause operational problems and are of growing meteorological significance.

Recent observations and accelerated research have contributed appreciably to our understanding of these elusive echoes. Controversy has by no means been eliminated, but certain features have been isolated and general patterns established.

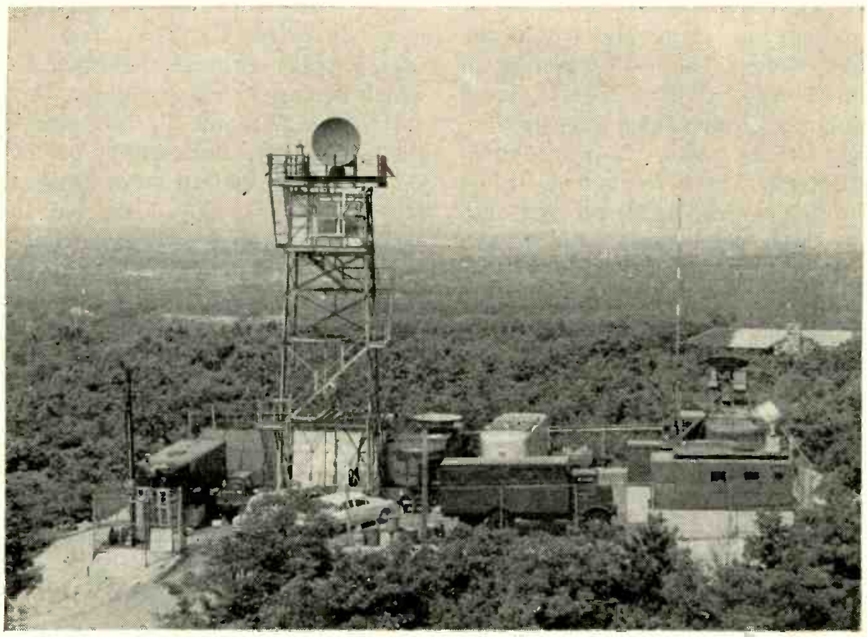
Pre-Radar Observations

The first angel echoes were detected with vertically directed pulsed radio equipment. In 1936 investigators in England, India and the United States independently reported detecting weak echoes at 3 to 300 meters under conditions that suggested low-level atmospheric sources.

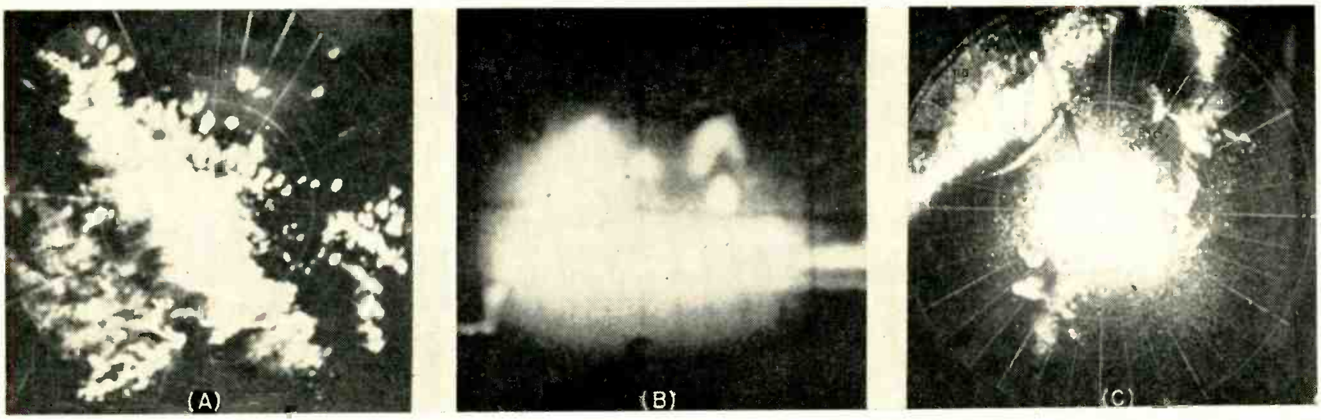
Continuing pulsed radio work prior to the war supported the initial observations. Echoes were detected frequently at altitudes of 1,600 to 50,000 ft during all seasons and at various hours of the day and night. They tended to be especially strong in summer, during the afternoon and near the tropopause below 8,000 ft. The altitude of the sources appeared to vary with air mass and at times echoes that were strong and persistent at 25 and 50 meters were weak and intermittent at 3 meters. Maximum power-reflection coefficients varied from 10^{-6} at long wavelengths to 10^{-10} at the shorter ones.

Considerable controversy existed concerning the source of these echoes. Pulsed radio antennas were at best only slightly directive, and many persons felt the echoes were merely side reflections from ground objects. Others considered the sources to be refractive layers or patches, primarily because of the many correlations between the occurrence and altitudes of the echoes and the meteorology.

Strong echoes, for example, were received from altitudes where radiosonde and aircraft measurements showed the presence of



FRONT COVER—Radar weather station at Milton, Mass. has four radars operating from 0.86 to 3.2 cm. has observed many of the angel echo phenomena



Radar displays of several angel types. Lower left section of (A) is lightning echo. Circular echo under inverted-U mantel echo of (B) was rising at 250 ft/min. Thin diagonal line in upper left region of (C) is echo from clear sky just ahead of squall line

Mimic Radar Echoes

weather fronts, air-clound boundaries and other strata having sharp and extensive lapse rates of relative humidity, the refractive index being highly dependent on humidity. Weak and more diffuse echo types were observed with turbulent zones and thunderstorms. Ion layers were suspected for a time, but measurements disproved this possibility.

Various attempts were made to resolve this controversy but general agreement never was reached. The observations are nevertheless most interesting when viewed in the light of subsequent radar observations of similar phenomena.

Layer Echoes on Radar

Echoes from suspected tropospheric layers or patches were first detected on vertical-pointing radars in 1947. Equipment operated at 10 cm and radiosonde data showed that the echoes derived from altitudes where atmospheric refractive layers existed. Other echoes were observed at 3 cm and 13-17 meters as well.

Subsequently at the Cavendish Laboratories, low-level echoes at 10 cm were detected over Cambridge, England, and a detailed meteorological study showed that they were from an atmospheric subsidence inversion. Evans Signal Corps Engineering Laboratory, using a 0.86-cm vertical-pointing radar, received a semicontinuous echo for a 20-hr period from the clear sky near a sharp subsidence inversion. Air Force Cambridge Research Center detected well-defined signals from a sea-breeze front 800 feet above a 1.25-cm radar and many echoes from invisible layers and thin stratified clouds were observed using S-and L-band equipment.

Although there is little doubt that atmospheric layers can give radar echo, rigorous proof of the point is beyond our present capabilities. The echoes are a product of the microrefractive structure of the stratified or turbulent layers. We can neither measure this structure to the resolution required nor can we obtain from present theory more than a qualitative idea of the scattering or partial reflection to be expected. Present instruments having a resolution capability of a few feet do show many regions and layers where refractive-index gradients are sharp and extensive.

Project Lincoln of Massachusetts Institute of Technology has made various airborne-refractometer measurements and found numerous stratified refracting layers. Some extend over many square miles and possess vertical gradients of as much as $3N$ units per meter. Quantity N is $(n-1) \times 10^6$, where n is the true refractive index.

It has also been shown theoretically that such layers can cause significant partial reflection of meter and centimeter waves, a given layer being more reflective at the longer wavelengths. AFCRC has measured 40 to $70N$ unit changes in tens of feet at the top of a stratus cloud deck and flying through a warm front has revealed it to be a region of considerable index variation.

Some radar echoes may look like atmospheric layers but merely be side-lobe reflections. Site, antenna pattern, type of scan and set sensitivity and power are determining factors. High power radars can be especially subject to such reflections, for although the side lobes are 20 to 30 db below the primary they radiate substantial power.

Wind-Carried Sources

In 1943 a different type of radar echo phenomena was noted by Bell Telephone Laboratories. Invisible and apparently wind-carried sources in the lower troposphere were causing transistory and sharply localized echoes on sensitive X- and S-band equipment. On a plan-position scope the echoes take the form of dots or small areas moving over the face, sometimes in tremendous numbers.

On a range-height indicator or the azimuth-range scope of a fixed-beam radar operating anywhere between horizontal and vertical incidence, the echoes are from a fraction of a second to several seconds duration, and frequently a number of them occur simultaneously at different ranges. Generally the echoes are received from ranges of less than 20 mi and their character is coherent, quite different from the scattered signals from precipitation. Most sources are indicated to be smaller than the resolution capability of the radar.

Many such echoes have since been detected, especially at Q, K and X bands. They are observed in all seasons, both day and night, but they are more likely to occur in summer and at midday. Warm, moist, clear days seem especially favorable. Maximum volume reflectivities at K and X bands range from 10^{-10} to 10^{-12}, which is about 0.4 to 50 sq cm radar cross-section.

The primary source of most of these echoes is believed to be refractive-index inhomogeneities of various types. Convective bubbles, highly refractive portions of atmospheric layers and water-vapor or temperature-anomaly regions are typical examples.

The precise mechanism of energy return from a variable dielectric is not known. But it is suspected that echo is the summation product of partial reflection from all the favorably-oriented refractive-index gradients or other microstructure within the radar pulse volume.

That which appears best to explain daytime activity is the convective bubble. Such invisible bubbles rise from the earth's surface during active solar heating and are important elements in cumulus-cloud development. The sharp refractive gradients in the upper and side-boundary region of the bubble are believed responsible for echoes. Aircraft and other observations verify the bubble's existence and theory forecasts their sharp boundary structure. Decided correlations between convective and angel activity have been noted by various investigators.

Insects are also important contributors. Their ability to cause substantial scatter signal on sensitive high-resolution Q- K- and X-band radars has been proven by theory and observation. Radar crosssections range up to four times geometric size and, since the system compresses a large part of the atmosphere onto a small indicator, surprisingly few insects can cause appreciable scope clutter.

On a 0.86-cm cloud-base-and-top indicator only one detectable-size insect in 10^5 cu ft is required to fill the scope with echo. Normal concentrations of large insects are perhaps ¼ to 1/6 of this, but during the spring and fall they may approach or even exceed it.

Occasionally large mineral or organic particles are carried into the air by winds or thunderstorms. When they are settling, these particles may also cause angel echoes.

Relative importance of the two primary sources depends on location, time of day and wavelength. Evidently inhomogeneities are more important in humid climates, during midday and at the longer wavelengths. Insects predominate in arid climates, toward evening and at the shorter wavelengths. Since insects cause echo by scattering, considerable radiated power is required for their detection. Most operational X-, S- and L-band radars should therefore be free of insect echoes.

Mantel Echoes

Another wind-carried echo source was isolated quite recently. Echoes that defined the general upper and side boundary regions of small cumulus clouds were received on S band at East Hill, England. The clouds were nearby and clearly visible, and a perfect correspondence was established between the echo and cloud positions. On the rhi scope these mantel or cap echoes look like inverted U's and V's. Similar echoes have subsequently been observed on Cape Cod, also at S band. Both observations failed to detect the echoes at X band.

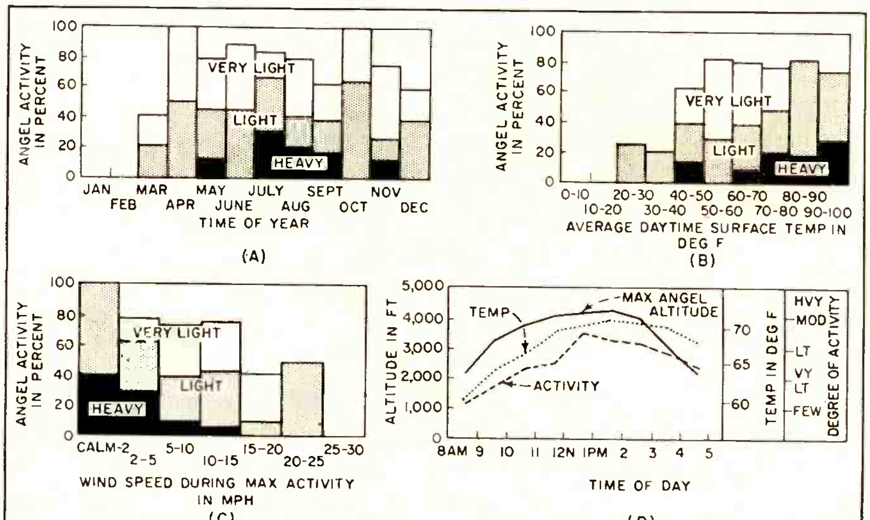
It is believed that mantel echoes are caused by scattering or partial reflection from sharp and extensive refractive-index gradients that airborne refractometer measurements have shown to be in the boundary regions of cumuli. These echoes couldn't have resulted from scattering by water droplets as the clouds were too small.

The East Hill observations also revealed other angel echoes rising into the cumuli from the clear air region below, and sometimes columnar echoes were observed extending from the ground to the mantels. Implications are that the radar was seeing convective bubbles and thermals.

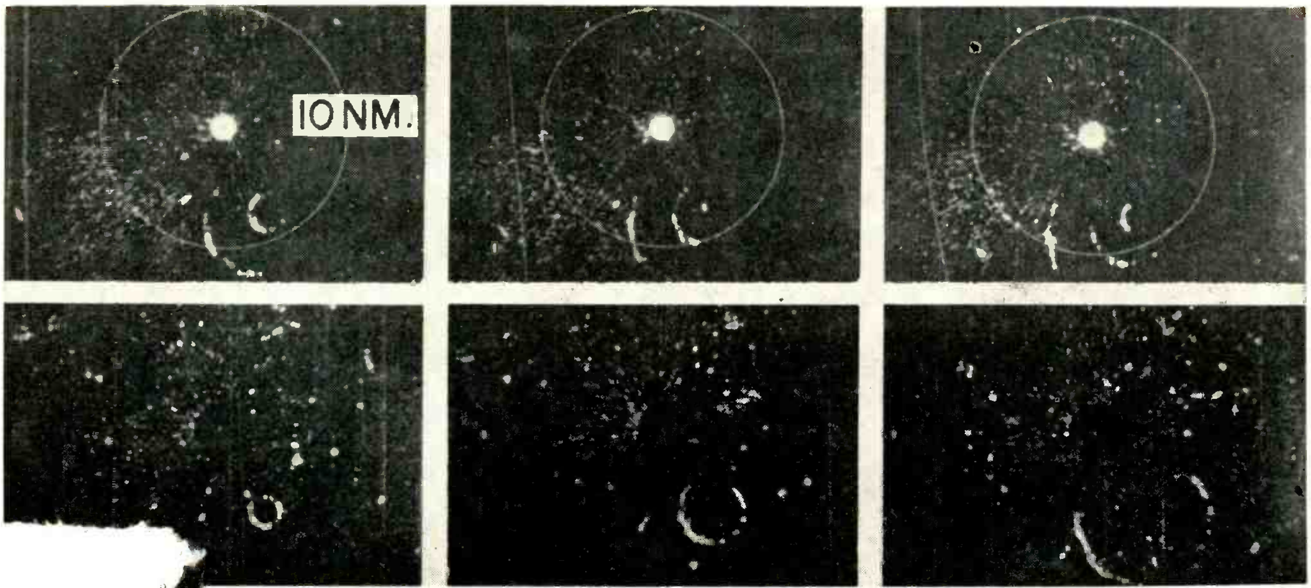
Non-Wind Echoes

There is also a class of localized angel activity similar in scope appearance to that apparently from wind-carried sources except that the echo movement may vary from the wind velocity and direction. Velocities are generally under 50 knots, movements are semiregular and the tracks are smooth curves. Some reports, however, indicate movements in the direction of the wind at twice its velocity. Radar cross-sections of the sources range as large as 700 sq cm at L band.

Such angels have been observed primarily on air-traffic-control ra-



Seasonal variation of angel activity (A), variation with temperature (B), with wind speed (C) and diurnal variation (D)



on two January days at Engineering Research Institute of University of Michigan. Sightings occurred around 4 ... were observed on a 23-cm FPS-3 radar

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mid-latitudes. Echoes in varying number, depending upon day and location, have been observed out to ranges of 20-25 mi. Visual observations have agreed with indicated source positions and the velocities and motions were appropriate to birds. Furthermore the presence and patterns of activity conformed with many of birds' characteristic habits. Reports point out the excellence of bird sources because of their elevation above the surface, and emphasize that as few as eight birds in a sq mi can completely blank the ppi.

Although birds probably predominate as sources of non-wind-correlated angels, they cannot explain echoes with indicated radar cross-sections of several hundred sq cm. There must be other sources. One hypothesis is that they are elevated refractive inhomogeneities which play a different role from those described previously. Here they are visualized to be properly-structured and oriented blobs, or convective bubbles.

Or they may be portions of atmospheric layers which divert incident radar energy to the ground by refractive bending or forward scattering. The illuminated patch of ground, perhaps a particular terrain feature, then scatters energy back to the receiver through the reciprocal path. The situation is really anomalous propagation, but only a few small atmospheric volumes are involved.

There is appreciable evidence to support the hypothesis, and it is easier to explain echoes from inhomogeneities if we assume diversion to ground rather than direct back scatter. That anomalous propagation can result from convective blobs on a clear day is not commonly known, yet this was recently observed and verified on 3 cm at Salina, Kansas.

Other possible explanations for non-wind echoes are side-lobe and second-sweep, automobile reflections, interference between radars, and instrument-produced signals.

Rapid and Erratic Movements

A type of nonaircraft echo suddenly appears, moves for some minutes in a semi-straight line path at 600 to 1,500 mph and then disappears. As yet this is unexplained, but there is speculation that the source might be shock waves, echo being the product of direct backscatter or diversion of energy to ground. Shock waves are thin, on the order of 10^{-5} in. and the refractive index differences across them can range as large as several hundred N units.

Then there are radar flying saucers. One popular explanation invokes extraterrestrial sources, but others can also be conjured. There is good reason to believe that many such echoes are merely the product of scope misinterpretation. The observer assumes that the echo return presented on successive rotations of the antenna is derived from a single moving source when actually the returns are unrelated ones of types previously discussed. The classic saucer incidents over Washington, D. C. in July, 1952, for example, occurred when the atmosphere was exceedingly superrefractive and spotty anomalous propagation was definitely in order.

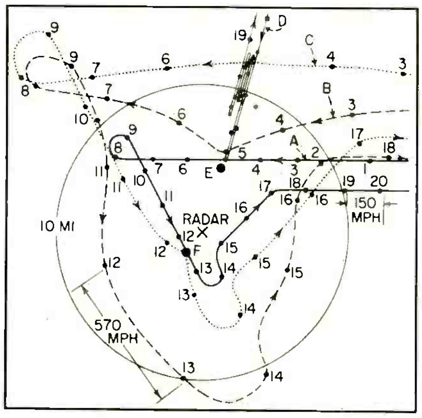
Another saucer mechanism that could explain rapid and erratic echo maneuvers at close range is non-isotropic secondary-scattering of energy from aircraft to ground or the inverse. Phantom echoes that overtake, fly parallel with or collide with valid aircraft echoes can be thus explained.

Other scope patterns reveal phenomena with rather obvious meteorological origins. In the summer of 1953 sea breeze fronts were detected at horizontal and vertical incidence as they moved onshore at Round Hill, Massachusetts. During 1955-56 ring angels were detected at Ann Arbor, Michigan. These appear on the ppi like concentric, expanding waves formed by dropping a stone in water.

The mechanism best explaining the facts is that radar energy was diverted to ground by elevated, point-source gravity waves. Lines or bands of angel echoes have frequently been observed at L and S bands lying in the clear air regions in advance of squall lines or parallel to the edges of shower echoes. Frontal circulations set up by storms or nascent zones of cumulus development are believed responsible. Finally there have been many observations at X, S and L bands of the ionized channels left in the atmosphere by lightning discharges.

Meteorological Angel Study

Our knowledge of the seasonal, diurnal and general meteorological dependence of most angel types is exceedingly sketchy. Certain associations with convection, non-conventional superrefraction and with clouds and fronts have been noted rather frequently. But the specific dependencies have not been established, nor the forecast rules ascertained. We know that small cumulus clouds don't invariably produce mantel echoes and that convection occurs frequently without angels, but we have as yet only identified a few of the peculiarities of the meteorology that are responsible for the differences.



Echo from secondary scattering. Line *A* is aircraft path, line *B* is echo from aircraft to point *E* to aircraft to receiver. Line *C* shows similar scattering involving point *F*. Line *D* shows scattering from *E* to aircraft to *E* to receiver

The angel activity observed on a vertical-pointing radar operating at 1.25 cm, with 0.37 deg conical beam, 0.4-μsec pulse and 10.8-kw output has been studied in some detail and may be typical of the activity of apparently wind-carried sources. Facsimile records of the a/r scope for a 15-month period of daytime operation were analyzed to ascertain the nature of the angel activity and sources. Days both with and without echoes were compared with the meteorology. The radar site was Boston.

The investigations reveal that angels occur primarily on days with high temperature, high humidity and low wind speed. Activity is especially intense during the summer months, at midday and with clear skies. Activity also appears to be favored by opposing conditions of surface and atmospheric moisture. No angels have occurred when the ground is completely covered with snow, when low-level atmospheric temperature inversions exist below the minimum radar range of 500 ft, or when the atmosphere is extremely dry.

In most instances angels occur entirely within the convective mixing region, sometimes showing an obvious intimate correlation with cumulus clouds. On clear days there is a pronounced diurnal trend, echoes beginning early in the morning, increasing to maximum at noon, then decreasing rather sharply during the afternoon. The echo altitude rises throughout the morning, is highest at the time of maximum surface temperature, and drops off thereafter.

Bunched or layer echoes occur in the vicinity of sharp moisture gradients, with or sometimes immediately after a summer rain, or under conditions of extremely high moisture, with greater than 1...
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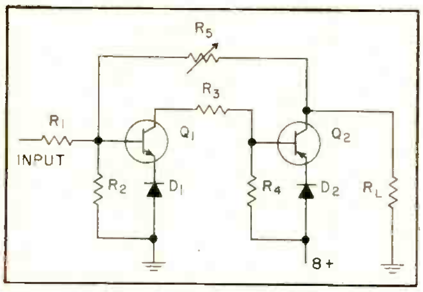


FIG. 1—Basic transistor relay circuit is controlled by Zener diode D_1

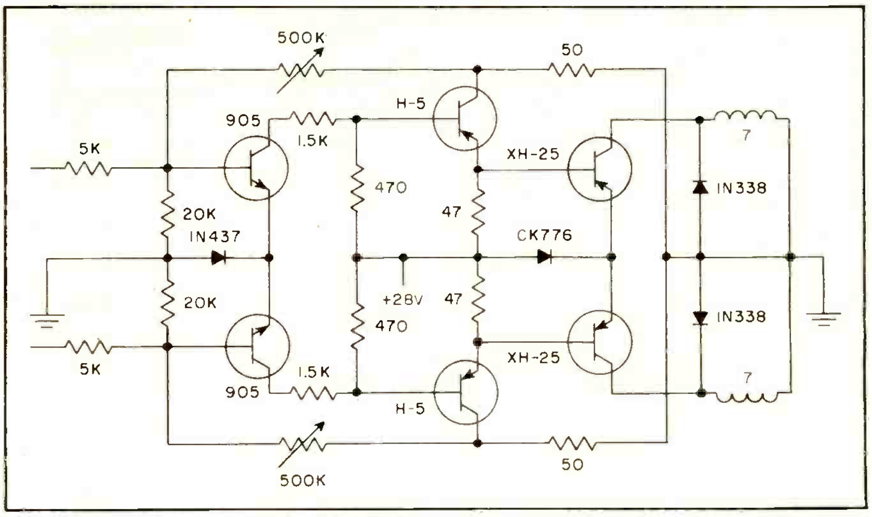


FIG. 2—Push-pull relay capable of handling 10 amperes has high-speed response

Fast Transistor Relay

Push-pull switching unit capable of handling up to 10 amperes has a rise time of 50 μsec. Zener diode control triggering voltage level to eliminate need for step-waveform control voltage to provide equivalent to mechanical relay

By **DORRANCE L. ANDERSON** Development Engineer, Army Ballistic Missile Agency, Huntsville, Alabama

TRANSISTORS prove to have almost ideal switching characteristics. However, to obtain the step function characteristics of a closing relay with transistors a step function is usually necessary at the input of the transistor.

In the circuit described here, a step input is not required yet switching is as rapid as with a relay.

A rising d-c voltage applied to the input produces no output until a predetermined level has been reached. Upon reaching the desired input level, the power-supply voltage is suddenly switched across the load. The circuit remains locked in as long as the input voltage equals or exceeds the level at which the trip action takes place.

The transistor relay circuit is shown in Fig. 1. Key to its operation is controlled positive feedback. The input voltage at which the circuit trips is determined largely by the breakdown voltage of Zener diode D_1. Fall-out voltage is controlled mainly by the breakdown voltage of the diode and the amount of positive feedback.

Circuit Operation

As the input voltage reaches the level where D_1 begins to break, current starts to flow in the input circuit of Q_1. Collector current of Q_1 drives Q_2 into conduction. The collector of Q_2 goes positive and this positive-going voltage is fed back through R_3 to the base of Q_1. This feedback is regenerative and drives the circuit to saturation thereby switching the supply voltage across the load. This action takes place in a matter of microseconds, depending on the rise time of the transistors.

It is important that the Zener diode have a sharp break. Diodes that break at about seven volts are recommended for this application. Resistors R_1 and R_2 form a voltage divider and isolating network for Q_1. Resistor R_3 is a current limiting resistor for the protection of Q_1. Resistor R_4 provides a relatively low impedance from base to B + of Q_2 for stabilizing purposes. Diode D_2 offers high impedance from emitter to ground of Q_2 when Q_2 is not conducting. This protects the transistor against thermal runaway at high ambient temperatures. Once the circuit trips, D_2 becomes a low impedance and offers little inverse feedback.

The circuit shown in Fig. 2 performs as a push-pull relay capable of switching 4 amperes at 28 volts. A single 1N437 silicon Zener diode serves both sides of the circuit producing better balance than if separate diodes were used. The H-5 transistors switch approximately 0.5 ampere to drive the XH-25 transistors to 4 amperes output. The diodes across the output are used with inductive loads to protect the transistors from inductive spikes. The diode common to the emitters of the output transistors is for stabilizing purposes at high ambient temperatures. System rise time is about 50 μsec compared to several millisec delay time for mechanical relays.

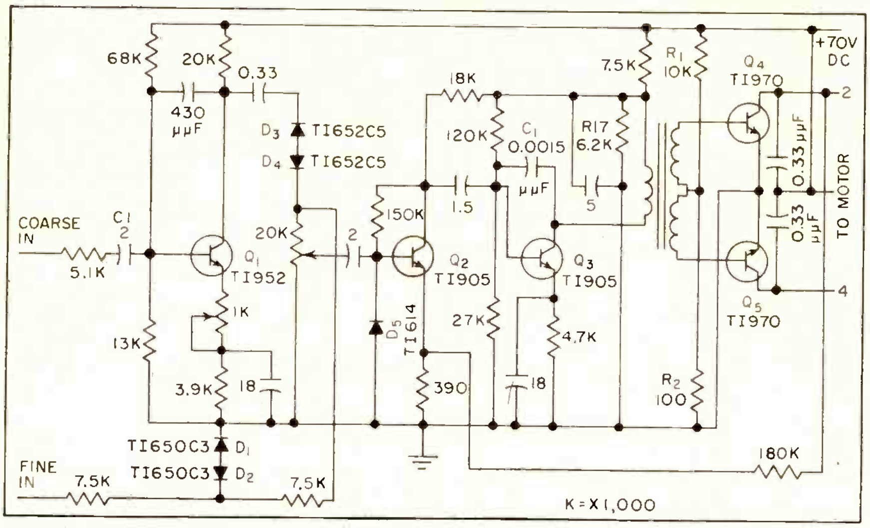
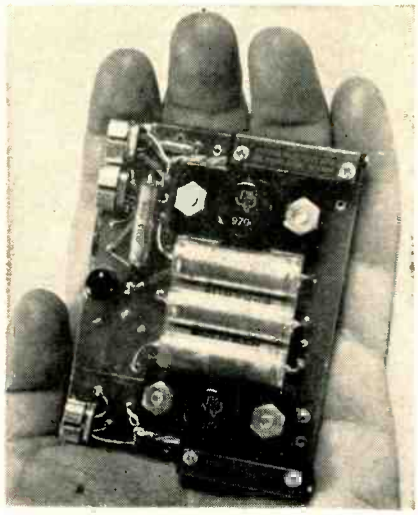


FIG. 1—Silicon transistors and diodes ensure reliable operation in extreme temperatures. Maximum coarse and fine signal input is 26 volts rms at 400 cps. Voltage gain of coarse amplifier Q_1 is about 25 and that of feedback amplifier Q_2, Q_3, Q_4 and Q_5 is 460



Transistorized servo amplifier can be held in palm of hand. Amplifier contains five transistors and four Zener diodes

Direct Drive Amplifier

TWO-SPEED TRANSISTORIZED servo amplifiers are constantly increasing in usage. The system described consists of an input switching circuit, which selects the proper signal with respect to the mechanical error, and a three-stage feedback amplifier capable of directly driving a standard size-11 motor.

Coarse and fine inputs are designed for maximum signals of 26 volts rms at 400 cps and both have an impedance of at least 10,000 ohms. Voltage gain from the fine input is adjustable from 0 to about 460 at 400 cps. The input switching circuits are designed for a gear ratio of 45 to 1 between the coarse and fine synchros. However, redesign for other ratios is possible. A complete servo amplifier circuit is shown in Fig. 1. Gain characteristics are as in Figs. 2 and 3.

Input Switching Amplifier

Figure 4 illustrates the relative phase of the coarse and fine inputs at the time of switching. The two voltages shown are the magnitudes of the 400-cps outputs of two control transformers as the two-speed system approaches a null. Switching must occur to the left of point *A* to prevent a 180-deg ambiguity in the null position.

Ideally, the gain from both coarse and fine inputs should be constant to maintain constant system gain. This is accomplished by inserting an amplifier between the coarse input and the main amplifier, since the fine input is geared up and thus has higher loop gain. Since the fine signal is attenuated to 0.57 of its original value by a resistance divider, gain needed in the coarse amplifier is roughly 0.57 times 45.

Actual switching of signals is accomplished by Zener voltage reference diodes D_3 and D_4 (Fig. 1) connected back-to-back in series with the output of the coarse amplifier.

The inputs should switch when the coarse voltage is about 0.2 volts rms. This represents 5 volts rms at the amplifier output, so the 6-volt

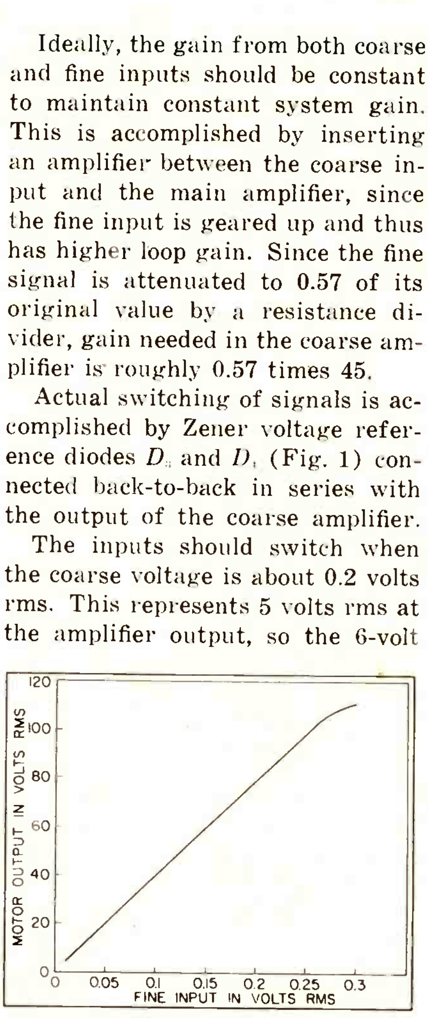


FIG. 2—Two-speed servo amplifier voltage gain characteristics

diodes, TI 652C5, should perform satisfactorily.

After switching to the coarse input, the fine signal must have as little influence as possible. Since transistors operate with relatively low maximum collector voltages, their maximum rms output is severely limited. A TI 952 was chosen as coarse amplifier Q_1 for operation with the +70-v d-c supply to obtain optimum output. Limiting of the fine signal was necessary to reduce mixing effects at the main amplifier.

Two Zener diodes D_1 and D_2 are used as clippers at the fine input, and the limiting voltage is arranged so that the coarse input takes control before limiting of the fine signal begins. This preserves linearity at small error angles.

An unbypassed variable resistance in the Q_1 emitter circuit provides gain adjustment.

Feedback Amplifier

Forward voltage gain of the three-stage amplifier is about 5,000 and feedback from the output to Q_2 emitter reduces this to 460. Large amount of feedback used makes the gain quite stable over a wide range of temperatures and with wide variations in transistor

Five-transistor servo amplifier directly drives standard size-11 motor, eliminating need for an output transformer. Used in two-speed systems, amplifier contains a switching circuit and three-stage feedback network. Switching between fine and coarse signals is accomplished by Zener diodes. Large amount of feedback stabilizes voltage gain over wide temperature range and broad transistor parameter variation

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For Two-Speed Servos

parameters. Figure 5 shows gain variation over the range of −20 to +100 C, with a nominal gain of 400 at room temperature. Electrolytic capacitors used in the prototype are designed for an upper limit of 85 C. Consequently, the portion of the gain curve above that temperature represents only what would happen if the amplifier were subjected to high temperatures accidentally.

Sufficient voltage derating of the capacitors allows the extreme temperature to exist for several hours

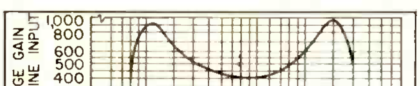

FIG. 3—Two-speed servo amplifier voltage gain-frequency characteristics.

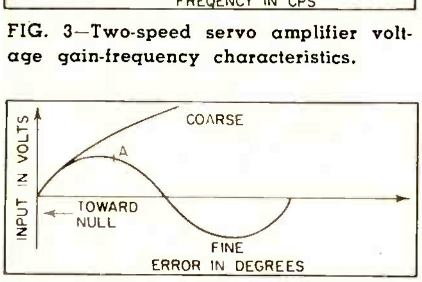

FIG. 4—Phase error voltage relationship between coarse and fine signals in the two-speed servo system. Switching between two signals should occur to the left of point *A*

if necessary without impairing the voltage gain of the amplifier. Higher-temperature electrolytics now becoming available promise a substantial increase in the maximum temperature rating. Dissipation of all transistors in the circuit is sufficiently low to allow operation at up to 100 C.

The two voltage amplifier stages Q_2 and Q_3 are conventional. Diode D_5 at the base of Q_2 is necessary to prevent the base voltage from reversing at high input signal levels. High-frequency oscillations are eliminated by capacitor C_1 from collector to base of Q_3. Collector supply for Q_2 and Q_3 is obtained from a voltage-divider network that supplies about 25 v d-c.

Maximum rms voltage developed at the motor is limited by the 120-v peak collector voltage rating of the 970. For the push-pull amplifier, the peak-to-peak load voltage is 200 to 230 v, or 78 to 82 v rms. This value is exceeded somewhat in the actual amplifier because of motor-load tuning. An actual rms voltage of 100 to 110 v is normally developed at the motor under no-load conditions. Choice of collector supply voltage was also based on the 970 peak voltage rating since each collector swings above and be-

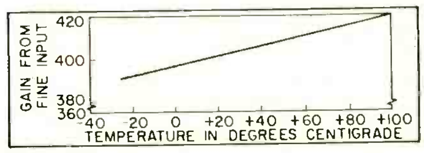

FIG. 5—Two-speed servo amplifier voltage gain-temperature characteristics. Gain at room temperature is about 400

low the supply voltage by an equal amount due to the balanced load.

A nominal supply of 70 v d-c prevents large excursions of the collector-to-base voltage into the Zener region where the dissipation per cycle would be high. Resistors R_1 and R_2 furnish a small positive bias of about 0.7 v d-c for the base circuit of the 970. This bias prevents crossover distortion in the class-B amplifier and considerably increases voltage gain over the zero-bias condition. Type 970 transistors used should have beta values within ±20 percent of each other, measured at 20 ma collector current, for proper circuit operation.

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F-M Exciter for Sight or Scatter Systems

Capable of operation in either a tropospheric scatter system or standard uhf line-of-sight communication systems, exciter accepts multichannel output of the telephone terminal equipment as a modulating signal and produces an output power of 15 w from 700 to 1,200 mc and 8 w from 1,700 to 2,400 mc. Unit handles 132 voice channels in addition to order-wire system

By A. E. ANDERSON and H. D. HERN Research and Development, Collins Radio Co., Cedar Rapids, Iowa

INCREASING DEMAND for high quality, long distance communication systems has necessitated the development of reliable, high-performance radio equipment. From the standpoint of system simplicity, flexibility and economy, uhf radio equipment applicable to both line-of-sight and scatter systems is highly advantageous. Interchangeability has special significance in satisfying the ever increasing logistic demands of the military organizations.

The uhf exciter to be described is applicable in either line-of-sight or scatter systems and has a minimum power output of 15 w from 700 to 1,200 mc or 8 w from 1,700 to 2,400 mc. It can be used either to provide excitation for a scatter-system power amplifier, or as a line-of-sight transmitter.

Frequency stability, noise and distortion level, frequency response, channel capacity, frequency coverage and power output are necessary considerations of the system in which the equipment is to be used. Since requirements vary from system to system, it is necessary to design for the most stringent anticipated conditions. In addition, reliability and service life, stability of tuning adjustments, ease of maintenance and simplicity of operation are desired.

Exciter Description

A general block diagram of the exciter is shown in Fig. 1. Functionally, it consists of four main units in addition to power supplies, switch panels and other accessory items.

The modulating input signal is separated into order-wire and multiplex spectra. The multiplex spec-

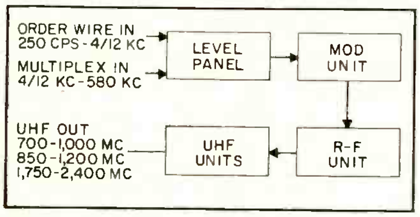
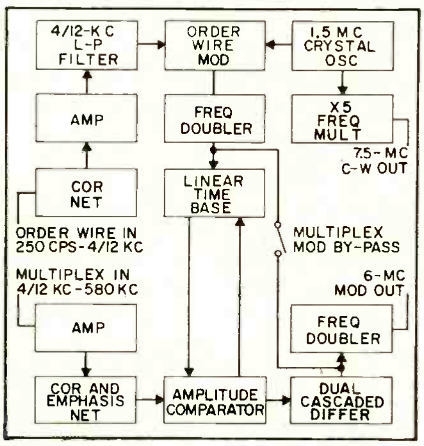
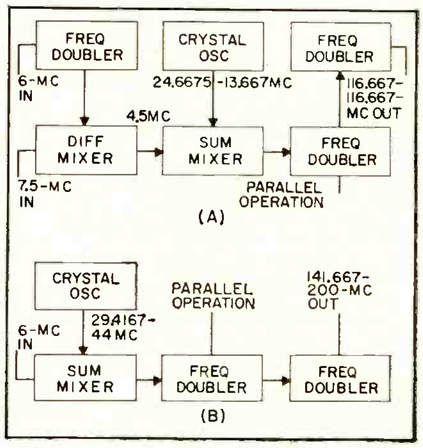


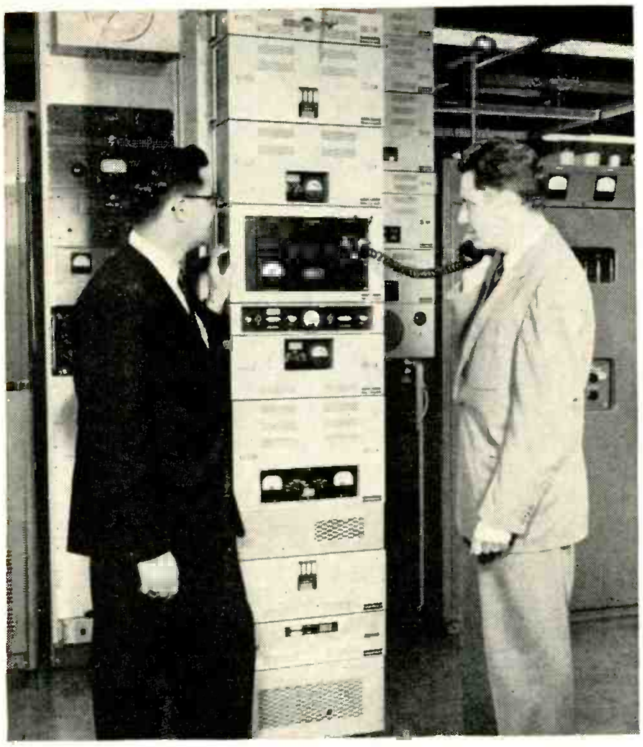
FIG. 1—Exciter consists of four blocks plus power supplies, switching panels and accessories

FIG. 2—Frequency-doubled carrier controls a linear time base in the modulator

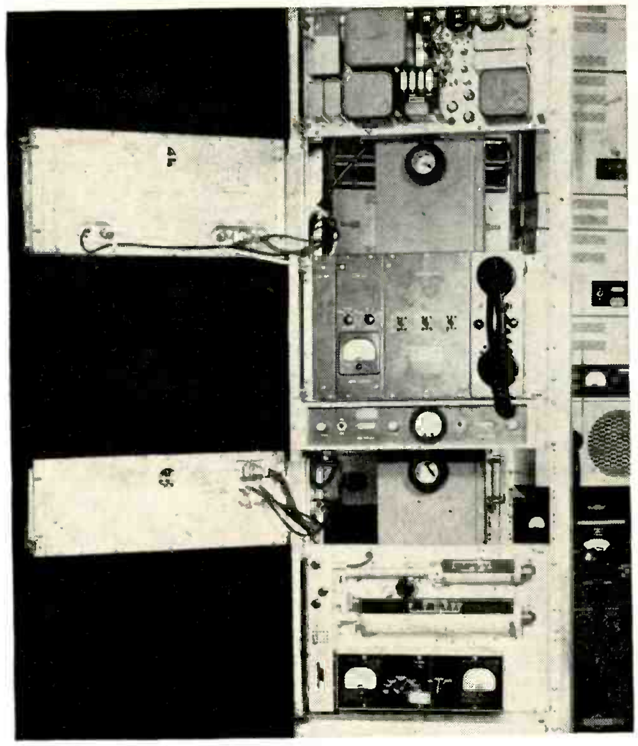
FIG. 3—Modulator outputs feed r-f units which cover 700-1,000-mc band (A) and 850-1,200-mc and 1,700-2,400-mc bands (B)







Authors operate f-m exciter in laboratory test to determine just how it fulfills design expectations



Dust covers are removed from exciter and two chassis are hinged out to show cabling and air connections

trum, consisting of the combined multichannel output of the telephone terminal equipment, starts as low as 4 kc and extends to an upper limit determined by the voice-channel capacity. The order wire consists of a voice service channel extending from 250 cps to 4 kc.

When the multiplex band starts at 12 kc or higher, the band from 4 kc to 12 kc is utilized in the order-wire circuit as a telemeter channel for special signaling, teletype or other desired service.

Modulator Unit

To obtain f-m characteristics a correcting network whose output is inversely proportional to frequency must precede the phase modulator. The voltage level as a function of frequency then decreases at the rate of 6 db/octave at the modulator terminals. Thus, the voltage difference between a 250-cps signal and a 512-kc signal is 66 db.

Since a single-phase modulator capable of handling eleven octaves of corrected modulation signal with extremely low distortion compared to the highest frequency signal level is impractical, the modulating spectrum is separated and two phase modulators are used in cascade. Furthermore a simple order-wire modulator can be used as the distortion requirement on the order-wire circuit is generally much less than on the multiplex.

In most f-m systems some preemphasis is used at the transmitter together with a companion deemphasis network in the receiver. This partially compensates the noise characteristics of an f-m receiver and permits a nearly equal signal-to-noise ratio in each channel. Although the preemphasis reduces the signal-level difference between the high and low modulating frequencies, it is not sufficient to warrant use of a single modulator for high channel capacity systems.

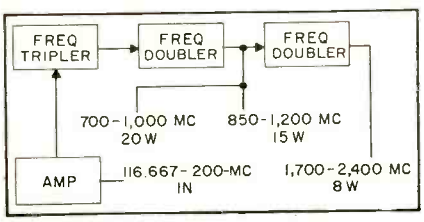


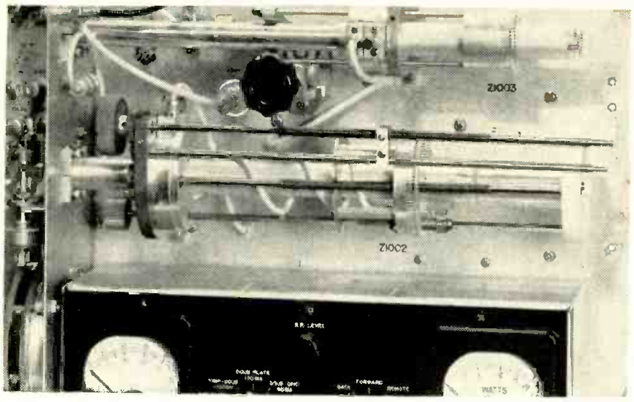
FIG. 4—Additional frequency-doubler circuit in uhf unit handles 1,700-2,400-mc band of the exciter

A 1.5-mc stable carrier is generated in the modulator of Fig. 2 and coupled to the conventional transconductance order-wire modulator and a factor-of-5 frequency multiplier. The phase-modulated output doubles in frequency and controls a linear time-base circuit. A diode instantaneously compares the multiplex signal level to the linear time base. At the instants of equality, the comparator produces an abrupt change in both waveforms.

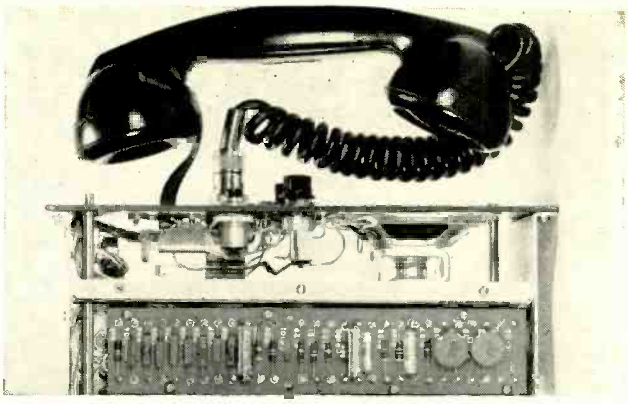
Two cascaded differentiators produce a narrow pulse whose position with time is proportional to the modulating waveform. The pulses control an amplifier whose output circuit selects a 1.2-mc band centered at 6 mc. The bandwidth is

TABLE I — Typical Operating on 700-1,200 MC UHF Unit

Stage	Amplifier	Tripler	Doubler
R-f input power	0.2 w	2 w	2.5 w
R-f output power	2 w	2.5w	15 w
Plate current	25 ma	30 ma	60 ma
Plate voltage	275 v	850 v	850 v
Bandwidth	2 mc	3 mc	6 mc



Closeup of uhf unit shows amplifier, tripler and doubler stages. Cavities are partially disassembled to show inner parts



Service channel portion of level panel with telephone handset indicates simplified modular construction

sufficient since the modulation index is low and the energy in sidebands beyond this range is negligible.

If the modulator fails in an installation having no standby, a section of the modulator unit can be bypassed, maintaining communications on the order-wire circuit.

R-F Units

A block diagram of the r-f units used to cover the 700-1,000, 850-1,200 and 1,700-2,400-mc bands is shown in Fig. 3. In the low-frequency unit of Fig. 3A a 4.5-mc signal is derived by using both outputs from the modulator unit and the 700-1,000-mc band is covered without objectionable spurious signals at the sum mixer output. Crystal frequencies in the r-f units are selected to obtain the desired final carrier frequency, thereby allowing the modulator crystal oscillator to be continuously operated at 1.5 mc. Common modulator and frequency-control circuits are required for obtaining coherent signals at two high-power transmitters. This is accomplished by bridging the two exciters at the parallel operation jacks and removing the oscillator crystal from either of the r-f units.

UHF Units

An amplifier, tripler and first doubler shown in the block diagram of the uhf units of Fig. 4 are used in all frequency bands. A second frequency doubler provides the 1,700-2,400-mc band output. The frequency multiplier stages consist of 2C39B ceramic triodes in coaxial resonators capable of continuously tuning to slightly less than a two to one frequency range.

Final carrier frequency is obtained in the uhf crystal-controlled f-m exciter of Fig. 1 by first heterodyning and then multiplying to the final frequency. The main advantage of this method is that full bandwidth is needed only at the output of the last multiplier.

The first stage of the 700-1,200-mc uhf unit shown in Fig. 5 is a grounded-grid amplifier. The plate is tuned by a one-turn inductor in conjunction with a 3-18.7-$\mu\mu$f variable capacitor. The second stage operates as a common-grid tripler and its plate is tuned with a coaxial resonator operating in the 1/4-wavelength mode. A lumped-constant π section matches the coaxial circuit to the cathode of the doubler stage. The plate circuit of the doubler is tuned by a coaxial structure operating in the 1/4-wavelength mode.

Since air cooling of the doubler and tripler stages is required, and the plate cooling fins extend from the cavity, the plates should be operated at d-c ground potential. The cathodes are at high negative potential.

Typical operating data of the unit is given in Table I.

The output power on all bands is continuously monitored by a resistive-loop directional coupler. A small portion of the output energy, 20 db below main-line power, is coupled out to obtain information for such functions as automatic switchover.

Level Panel

Figure 6 is a simplified block diagram of the level panel. The impedance matching network in the multiplex section provides connec-

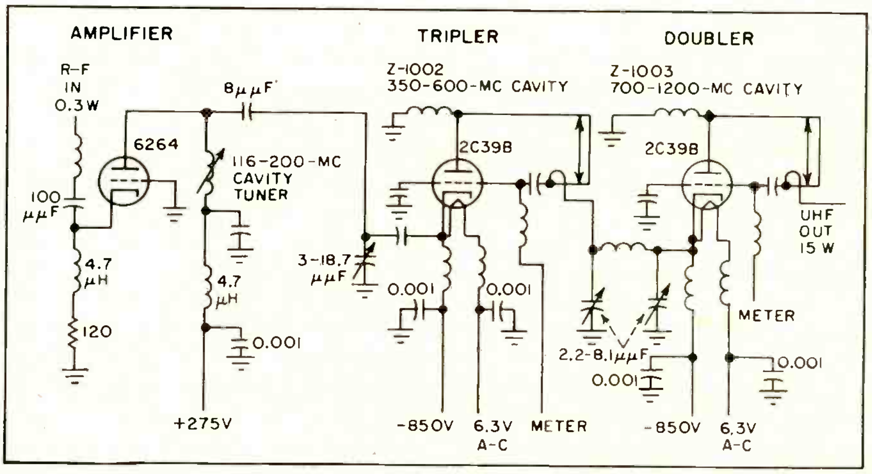


FIG. 5—Common-grid voltage tripler and voltage doubler of uhf unit are tuned with coaxial resonaters. Input coil for r-f has five turns of number 20 wire with 0.25-in. diameter

tion for 135/600 ohms balanced or single ended. The vtvm monitors the multiplex or order-wire circuit over a range of levels from −40 dbm to +10 dbm.

A party line feature on the service channel allows voice exchange from a link station. A 3.2-kc calling oscillator is used for service where external ringing is not desired. A 4-kc crystal-controlled oscillator is included for system continuity testing.

Exciter Performance

Transmission quality of a multichannel voice-communication system is normally expressed as a signal-to-interference ratio measured in each channel. The interference level consists of crosstalk products and noise introduced by the equipment and interfering sources. Such a performance measurement is generally made at a standard signal level and the interference level is expressed in dba units. Eighty-two dba is equal to one mw of noise measured with F1A weighting and referenced to a 0 db transmission level.

Since interference is generated in each portion of the radio equipment, all system components must be considered when designing a communication circuit. When evaluating a single system component, a figure for system quality can be expressed assuming all other components to be theoretically free from contributing to the channel interference level.

The interference level in the voice channel depends on the characteristic of the residual modulation present on the transmitted carrier. For the exciter described here the residual modulation introduces a 2 dba noise level at the −9 db transmission level.

In a single voice channel system a signal distortion level of some 10 percent or more can be tolerated before the intelligibility is greatly impaired. Unfortunately, such order of distortion is intolerable in multichannel systems because the high distortion produces objectionable crosstalk between channels. The crosstalk is at a maximum when the system is operating at the fullest possible capacity.

When the signals of many active voice channels are combined, the composite or multiplexed signal resembles random noise. Thus, if a measurement of distortion is made using random noise as the test signal, then actual multichannel operation is simulated.

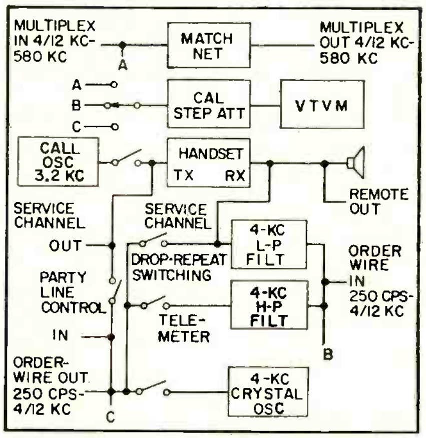


FIG. 6—Party-line feature on service channel in level panel permits voice exchange between link stations

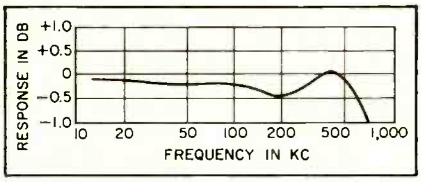


FIG. 7—Measured modulating response in db plotted as a function of frequency

A test which simulates busy conditions consists of loading all but the first and last voice channels with uniform noise at a level which produces peak frequency deviation. Comparing the levels obtained in the first and last channels to any loaded-channel level results in a measure of distortion at the receiver demodulated output which can be expressed in terms of an interference level in the channel with normal voice loading. For the exciter described, this level is 1 dba at the −9 db transmission level for a capacity of 36 4-kc voice channels. Therefore, the total interference level due to exciter noise and distortion is 4.6 dba at the −9-db transmission level.

The maximum channel capacity of the exciter is principally a function of the frequency response shown in Fig. 7. The measured curve indicates that the exciter is capable of handling at least 132 voice channels in addition to the order-wire facilities.

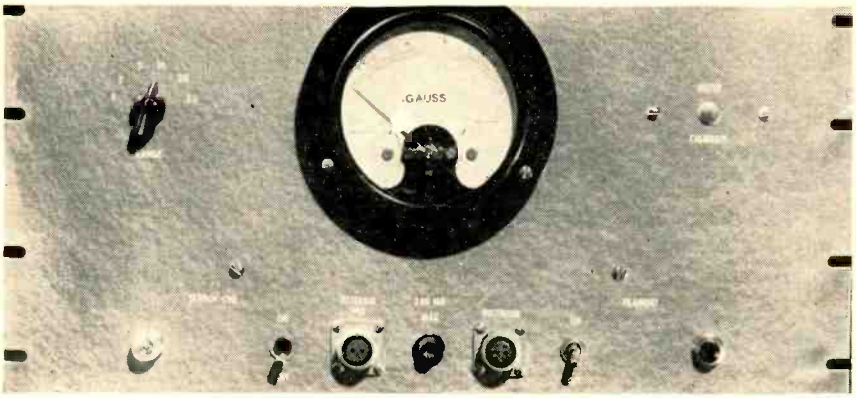
Reliability Considerations

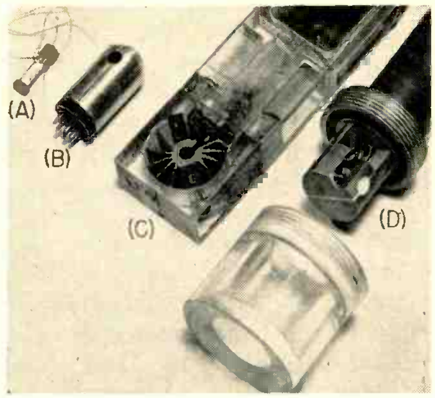
Despite improvements in reliability and performance, tubes are still a primary cause of equipment failure. Since high operating temperature is a major cause of tube failure, any significant reduction in the ambient operating temperature of vacuum tubes appreciably improves equipment reliability. To accomplish this, forced air cooling is provided for all tubes in the exciter. The tubes in the uhf unit have mandatory cooling requirements and are cooled by a separate blower, interlocked for tube protection in case of blower failure. All remaining tubes are cooled by the rack blower and air duct.

Each unit has a plenum chamber that automatically couples to the air duct. Pressure in the plenum chamber then forces air through the special air-cooling tube sockets and out between the tube and tube shield, thereby eliminating the dead air pocket normally existing between tube and shield. In addition, corrugated shield and base liners conduct heat from the tube to the shield, and black shields increase heat radiation.

An indication of the effectiveness of the cooling system is the 145-deg. reduction in bulb hot spot when operating at maximum dissipation with the air socket, radiating shield and liner. To further increase tube reliability, all tubes are operated at less than 70 percent of rated cathode current.

Built-in test equipment facilitates maintenance and operational checks, and permits a complete tuneup on frequency by monitoring plate and grid current of all stages in the uhf unit, r-f power output, d-c power supplies and modulator signal levels. The units are hinged, permitting them to swing out for easy access to the rear of the chassis. An articulated hinge prevents interference with equipment mounted in an adjacent rack.





Front panel includes variable controls, meter and connections for optional devices (left) Sensing probes (right) include basic unmounted element (A). 10-gauss uncooled model (B), 100-gauss convection-cooled version (C) and 300-gauss conduction-cooled unit (D)

Magnetometer Makes

Developed for use in an electron cyclotron, instrument monitors magnetic field strength continuously with accuracy of 0.1 percent. Probe design varies with application, one type employing quadrupole construction for magnetic isolation and a heat sink for cooling. Lower field-strength models delete the heat sink while higher field-strength forms sacrifice the quadrupole configuration. Electronic system is closed-circuit servo loop, with internal r-f excitation to bring magnetic field to knee of B-H curve of probe

By **FERDINAND VOELKER** Radiation Laboratory, University of California, Berkeley, California

MANY MAGNETS are designed for a uniform field over as large an area of the pole pieces as possible. Measuring the magnetic field under these circumstances is relatively easy. Where the gap may be as small as 0.5 in. and where the field must agree both radially and circumferentially with mathematically determined values, as in an electron cyclotron, magnetic measurements can be tedious.

Continuous Measurement

The magnetometer described here is designed for continuous magnetic measurements in such a cyclotron and meets requirements of 0.1-percent accuracy in fields of 10 to 100 gauss, continuous monitoring of the field to follow automatic plotting against the probe position, horizontal-position accuracy of about 0.005 in. and quadrupole probe construction to minimize effects of nearby iron.

The instrument consists of the sensing probe to detect the magnetic field, and its associated electronic chassis. The probe is a small transformer comprising three windings with a high-permeability core, as shown in Fig. 1. The primary comprises two outer layers and four inner layers, while four intermediate layers serve as a secondary. The mean diameter of the inner layers is approximately $1/\sqrt{2}$ of the mean diameter of the two outer layers. Thus the area of the inner winding is about the same as that between the outer and inner windings.

When the two windings are connected so that current in them flows in opposite directions, the primary acts as a magnetic quadrupole, causing the field in the region around the probe to fall off much more rapidly than it would with a single coil. This helps isolate the

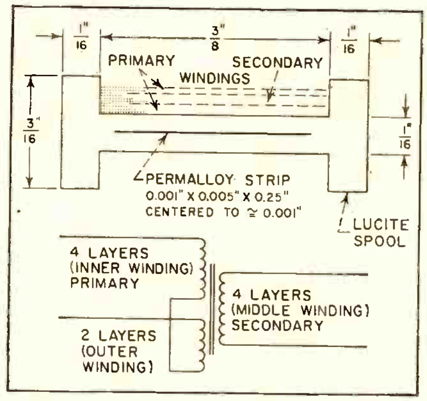
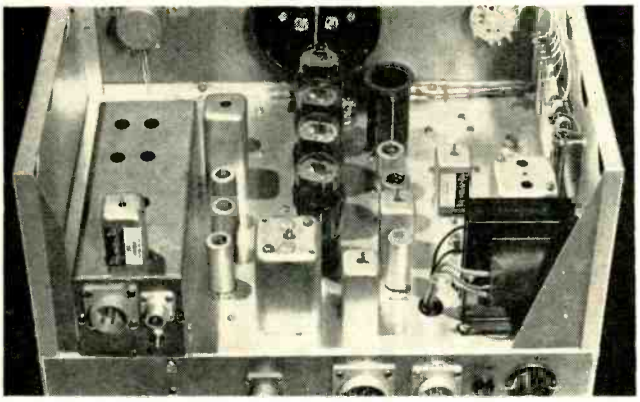
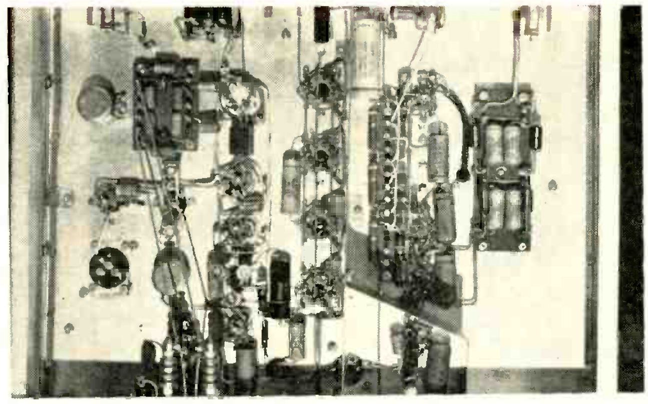


FIG. 1—Mechanical and electrical details of sensing probe construction. The primary acts as a magnetic quadrupole when current flows in opposite directions



Top chassis view shows standard component used in the construction of the magnetometer



Use of common chassis requires shielding between several elements to prevent interaction

Continuous Measurements

probe from nearby magnetic materials, but also reduces the total ampere-turns acting on the core to 0.33 of its value if the windings were connected series-aiding.

Operation

In operation there is a small r-f current and a relatively large amount of d-c flowing in the primary. Since the effective ampere turns of the primary determines the maximum range of the instrument, this figure should be as large as possible.

The relatively small size of the coil imposes an arbitrary limit of 300 ma, with the I^2R loss conducted to a heat sink surrounding the coil. At this current the plastic core approaches softening temperature and the maximum measurable field is about 100 gauss.

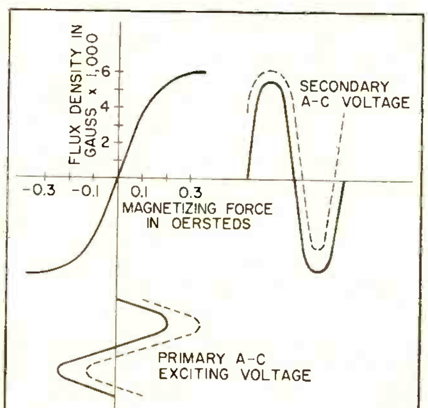


FIG. 2—Excitation level and magnetic characteristics of core cause secondary voltage to be rich in odd harmonics

One form of probe has fins for convection cooling of the heat sink. Another, designed for measurement of the earth's magnetic field, has a maximum rating of 10 gauss or 30 ma and no heat sink is necessary. Still another version of the probe sacrifices the quadrupole construction to obtain a 300-gauss maximum. This probe is used in a vacuum and has a conduction-cooled heat sink.

The magnetization curve of the core is approximately as shown in Fig. 2. The primary winding is excited with an r-f voltage just sufficient to bring the magnetic field to the knee of the curve. The voltage induced in the secondary is rich in harmonics, but because of the symmetry of the curve they are all odd if there is no d-c field. But a d-c field as small as 2 millioersteds generates appreciable amounts of even harmonics.

Probe Response

The even harmonics are used to servo d-c through the primary in a direction that minimizes even-harmonic production and cancels the external d-c field in the region around the core. The probe response is therefore quite linear, with d-c in the primary proportional to the external field. Because of the large length-to-cross-section ratio of the core, the probe responds to the component of the magnetic field that is parallel to the core.

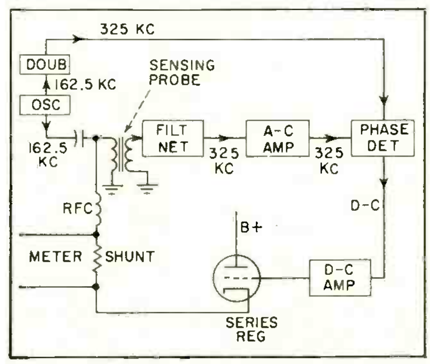


FIG. 3—Functions of magnetometer elements

A functional diagram of the magnetometer is shown in Fig. 3. The number of components in the feedback loop make it a difficult one to close. The filter network and a-c amplifier are designed to have a phase shift of less than 90 deg from 225 to 425 kc. Since there are large amounts of odd harmonics and only a feeble second harmonic at the secondary of the sensing probe, the problem is to amplify only the second harmonic without excessive phase shaft. Bridged-T filters are used, as shown in Fig. 4, to accomplish this.

The amplifier shown in Fig. 5 is designed to amplify the second-harmonic signal while rejecting higher harmonics and low-fre-

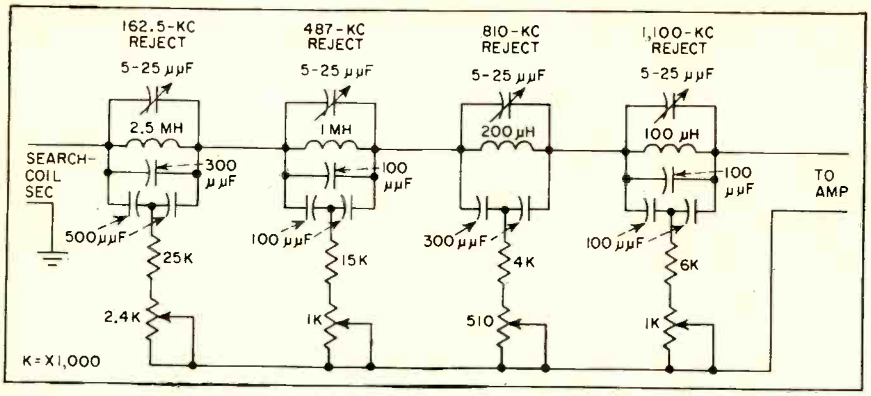


FIG. 4—Multisection bridged-T filter is used to reduce sensing probe output to second harmonic alone without encountering excessive phase shift

quency noise. This is accomplished by a circuit tuned to the second harmonic, with the Q restricted to about ten to avoid excessive phase shift.

The fourth stage is used as a phase detector as well as a d-c amplifier. Its plate voltage consists of a sinusoidal signal at twice the oscillator frequency with 300 v peak amplitude. This voltage can be adjusted in or out of phase with the second-harmonic signal coming from the sensing probe.

The tube acts as a shunt rectifier and develops a negative d-c plate voltage which is dependent on the second-harmonic grid signal. The cathode bias is adjusted so that −35 v is developed at the plate with no grid signal. With the grid signal in phase the tube conducts more heavily and the rectified plate voltage becomes less negative. Conversely, with an out-of-phase signal the plate voltage becomes more negative.

Regulator Tubes

The rectified plate voltage is applied to the grids of four 6L6 tubes in parallel, which serve as a series regulator to control bias current in the search coil. A bridged-T filter tuned to the second-harmonic is necessary at this point to attenuate the a-c signal applied to the amplifier plate. A shunt capacitor together with the source impedance of the rectifier serves both as filter and as the time constant on which the servo loop is closed. It provides a phase shift of 6 db/octave to 100 kc, under circumstances where the loop gain is less than unity.

The total range of voltage on the 6L6 grids can vary from 0 to 100 v, which allows them to control bias current from 300 down to a few ma. As these tubes approach cutoff their transconductance becomes less and less.

Maintaining Gain

Normally the loop gain of the magnetometer would also become lower, until at some current the accuracy would be less than required. To avoid this the cathodes are biased to a negative supply so that 10 ma of current is diverted around the search coil at all times. Thus with no current in the bias winding, corresponding to zero field, the tubes still have considerable gain.

Three shunts are provided to monitor the current through the bias winding. One is for a 1-percent front-panel meter and the other two have 0.1-percent accuracy for use with an external pen-type recorder.

The magnetometer has proved quite reliable and, when carefully adjusted, is capable of giving accuracies within a few millioersteds throughout its range. Even when it is not carefully adjusted, the instrument measures accurately to 0.1 percent on the 100-gauss range, which is satisfactory for many applications.

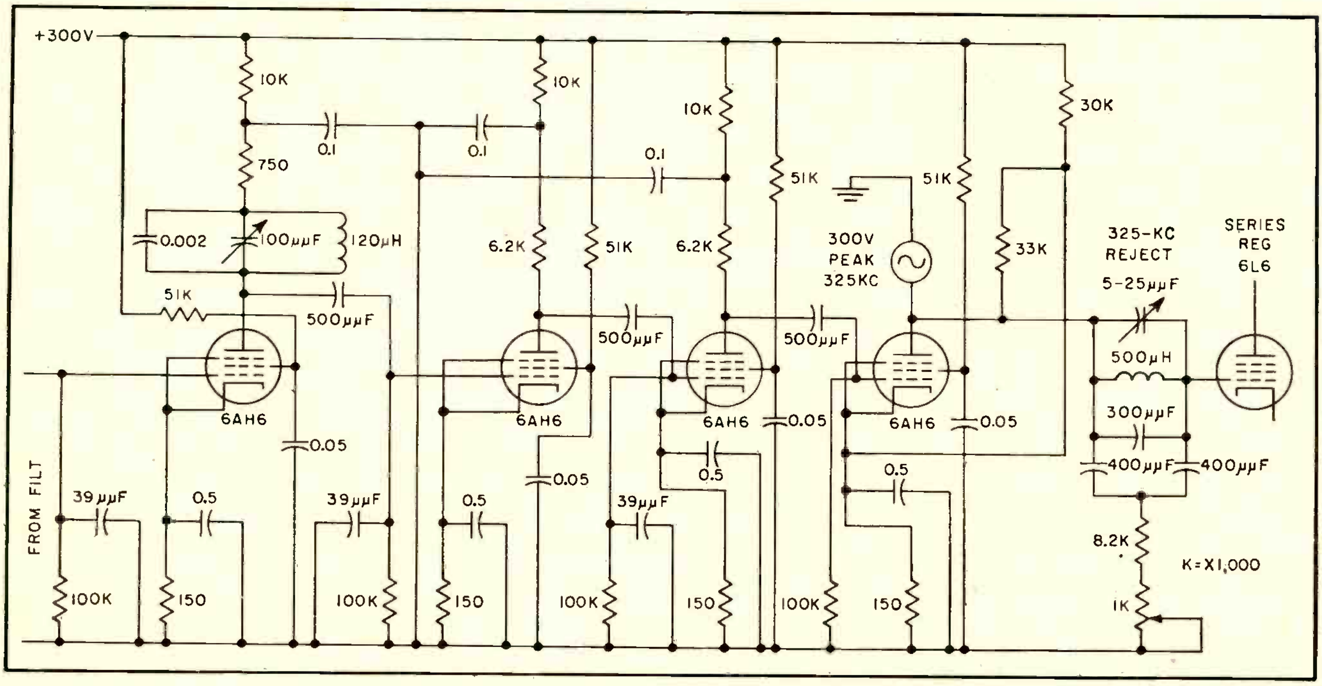


FIG. 5—Circuit details of the a-c amplifier, phase detector and d-c amplifier elements of the magnetometer system

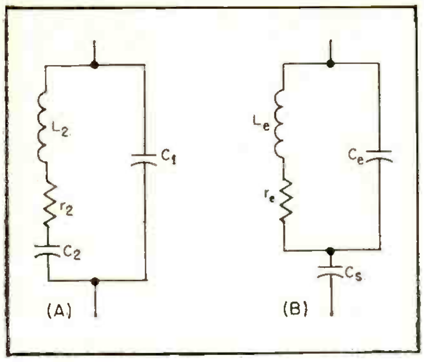


FIG. 1—Equivalent circuits for piezoelectric crystal. E-R version formulas for (A) to (B) are given in article

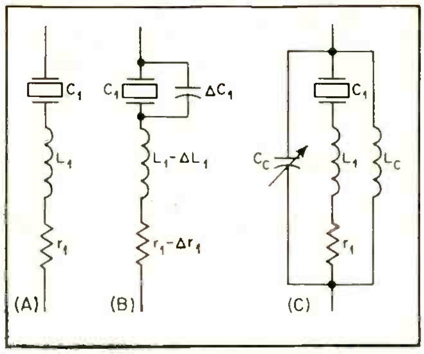


FIG. 2—Basic crystal circuit (A), lower impedance version (B) and its use with tuned circuit

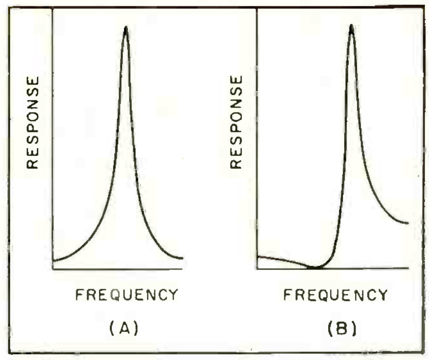


FIG. 3—Crystal circuit response when paralled by resistor (A) and with L_1 or C_1 misadjusted

Stable Crystal Filter Is Parallel Resonant

High-Q, unbalanced crystal circuit has properties similar to low L/C-ratio parallel-tuned circuit over appreciable frequency range. Ease of circuit design and adjustment makes it readily adaptable for use in f-m oscillators, signal generators, i-f amplifiers and variable-bandwidth filters

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ELECTRONIC Q-MULTIPLIER circuits for improving the Q of parallel-tuned circuits have been described in the literature[1, 2, 3] for frequencies of 0.5 mc or less. Cascading of such circuits is impractical because Q-multiplication does not improve the frequency stability. Crystal circuits, which have both Q and stability, have the disadvantages that they are usually balanced, are tedious to design and are not readily adapted to variable bandwidth.

The crystal circuit described here is stable, unbalanced and easy to design and adjust. It was devised to improve the selectivity of radio receivers used in radio propagation studies using rockets.

Signals approaching the millivolt level would sometimes be present within 2 or 3 kc of the weak signal received from the rocket. Although the permissible bandwidth of the system was only 0.5 kc, more than one stage of selectivity was required to eliminate such competition. In addition, as considerable testing was necessary before the rocket firing, it was desirable to have the bandwidth variable, as signal generators can drift out of a 0.5-kc band when operating near 10 mc.

The circuit was incorporated into the receiver's local oscillator where a stable frequency, which could be varied over a narrow range of frequencies, was desired.

Crystal Circuit Theory

Figure 1A shows the conventional equivalent electrical circuit for a piezoelectric crystal.

Figure 1B shows another equivalent circuit which makes the behavior somewhat easier to visualize. Although it is not rigorously correct to do so, L_2, C_2 and r_2 can be assumed to be constants in practical design problems. The conversion formulas for Fig. 1B are

$$C_s = C_1 + C_2 \cong C_1 \qquad (1a)$$

$$L_e = L_2\left(\frac{C_2}{C_1 + C_2}\right)^2 \cong L_2\left(\frac{C_2}{C_1}\right)^2 \qquad (1b)$$

$$C_e = \frac{C_1(C_1 + C_2)}{C_2} \cong \frac{C_1^2}{C_2} \qquad (1c)$$

$$r_e = \left(\frac{C_2}{C_1 + C_2}\right)^2 r_2 \cong \left(\frac{C_2}{C_1}\right)^2 r_2 \qquad (1d)$$

Fig. 1B can be converted into a parallel-resonant circuit at one frequency by adding a coil L_1 in series with the crystal, of such a magnitude that it will series resonate with C_1, the capacitance of the crystal in its holder and socket. This capacitance can be measured easily by using a Q meter or bridge at a frequency at which the crystal does not vibrate.

The parallel-resonant crystal circuit is shown in Fig. 2A. This circuit will be referred to hereafter as the crystal circuit. The impedance of the circuit may be reduced by adding an additional capacitor ΔC_1 as shown in Fig. 2B.

At a frequency f near the parallel-resonant frequency f_p the impedance is approximately

$$Z = r_1 + j4\pi f_p L_1 \delta + \frac{L_e/C_e}{r_e + j4\pi f_p L_e \delta} \qquad (2)$$

where $\delta = f/f_p - 1$ is the percentage of frequency deviation from resonance and r_1 is the resistance of coil L_1.

For small values of δ, the first two terms of Eq. 2 are of small significance and the response is essentially that of a parallel-tuned circuit. For frequencies far from resonance, the response is that of a series-resonant circuit.

Minimum Z is obtained when the reactance is zero; this occurs at a value

$$\delta_m \cong \pm \tfrac{1}{2}\sqrt{C_2/C_1} \qquad (3)$$

Circuit Response

There is a minimum resistance of r_1 at a frequency difference of $\delta_m f_p$ cycles each side of resonance. The response of the circuit follows the universal resonance curve closely until the impedance has decreased to a value comparable with r_1. This usually occurs at a value of not less than 90 percent of δ_m. For larger values of δ the impedance increases slowly.

Ratio C_2/C_1 is important as it is nearly equal to the square of the coefficient of electromechanical coupling. For a wire-mounted plated AT-cut crystal, the best ratio that can be obtained is not larger than 1/180.[4] Where the capacitance of the holder and socket must be included, the ratio runs about 1/230; thus $\delta_m = \pm 3.3$ percent as a maximum for AT-cut crystals, which compares favorably with values obtainable with magnetostriction resonators. The equivalent circuit is the same, except that inductors and capacitors are interchanged. For BT-cut crystals, δ_m is about ± 2 percent.

The basic circuit can be paralleled by a resistor R or a tuned L-C circuit, as shown in Fig. 2C, to give a lower resultant Q given by

$$Q_R = Q_2 \frac{R}{(R + R_p)} \qquad (4)$$

where Q_2 is the crystal Q and R_p is the maximum resistance of the crystal circuit.

Paralleling a tuned L-C circuit with the crystal circuit improves the Q of the L-C circuit and reduces its temperature coefficient materially because the crystal's C_e is large and has an effective temperature coefficient of the order of only a few parts per million per deg C. The combination will have a low reactance at all frequencies not near f_p except for two symmetrical responses at $f_p \pm \delta_r f_p$.

The deviation of these side responses can be found from the relation

$$\delta_r = \pm \sqrt{\frac{L_c}{4L_1} + \delta_m^2} = \pm \sqrt{\frac{C_1}{4C_c} + \delta_m^2} \qquad (5)$$

where L_c and C_c are the values used in the tuned circuit. These side responses are not particularly serious in general, as they can usually be removed by a following amplifier stage having only the usual L-C tuned circuit, tuned to f_p. Another method is to use different values for L_c in successive stages.

The resultant bandwidth BW can be found by appropriate substitutions into Eq. 4 to obtain

$$BW = 1\Big/\left[2\pi R C_1\left(\frac{C_1}{C_2}\right)\left(1 - \frac{Q_R}{Q_2}\right)\right] \qquad (6)$$

As Q_2 is 10^5 or more, it is usually possible to ignore the ratio Q_R/Q_2. If a crystal is to be used whose ratio C_1/C_2 is not known, it may be calculated from

$$C_1/C_2 = f_p/[2(f_p - f_s)] \qquad (7)$$

if f_p and the series resonant frequency f_s are measured.

If a narrower bandwidth, BW', is desired, compute C_2 from Eq. 7 and then from Eq. 6 obtain the total capacitance C_1' required. Add enough capacitance in parallel with the crystal to give this required capacitance. If the resultant frequency f'_p is not quite equal to the final center frequency desired, a parallel reactive component may be added across the crystal circuit to tune it to the correct frequency.

Table I shows the comparison of the measured values of Q_R compared with those calculated from Eq. 4 using various resistors, R, in parallel with a crystal circuit similar to that of Fig. 2A. The crystal used was an air-gap type transmitting crystal with a C_1/C_2 ratio of 2,350 ($\delta_m = \pm 1$ percent). The crystal circuit parameters were $f_p = 848.4$ kc, $L_1 = 1.86$ mh, $L_e = 0.79$ μh, $Q_2 = 129{,}000$, $L_2 = 4.4$ h, $C_e = 44{,}600$ $\mu\mu$f, $R_p = 544{,}000$ ohms, $C_1 = 19$ $\mu\mu$f, $r_e = 0.00005$ ohm.

Figure 3A shows the response of the above crystal circuit paralleled by a resistor; Fig. 3B shows the effect of a misadjustment of either L_1 or C_1. At the expense of a poorer

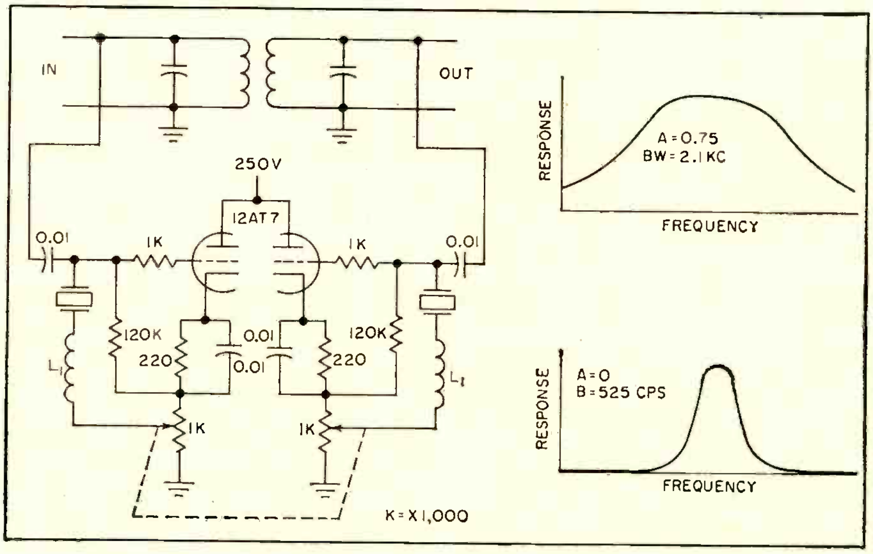

FIG. 4—Variable bandwidth circuit and responses at 848.54-kc center frequency

response on one side, the response can be made quite steep on the other side.

Use in I-F Amplifiers

The crystal circuit may be applied to i-f amplifiers already built, but which are not sufficiently selective, by connecting it in parallel with one or more of the L-C circuits in the amplifier. At least one L-C circuit should not be so paralleled, to remove the effects of the side responses.

It is possible to retain the center-frequency gain within a few percent if the plate circuit impedances are not too large. Standard 456-kc i-f amplifiers have high plate impedances, so that it may be necessary to tap down on the inductances. However, to obtain the fullest benefit from this crystal circuit, the i-f amplifier should operate at a higher frequency to obtain good image rejection and to make the needed component values easier to obtain. Five mc has been found to be a convenient frequency at which to operate.

If a flat-topped response characteristic is desired, stagger-tuning may be employed, but the overall gain is reduced. If the receiver has double-tuned transformers, one crystal circuit may be placed across the primary and one across the secondary.

If the impedance of the transformer at resonance is much smaller than that of the crystal circuit at resonance, the critical coupling coefficient and the center-frequency gain is not appreciably altered; the bandwidth is reduced with the shape of the response curve the same as before.

This method was tried on two amplifier stages with critically coupled transformers in an 845-kc amplifier with a bandwidth of 12 kc. The shape of the response curve was the same, but the new bandwidth was 0.5 kc. The maximum gain was reduced a few percent.

Similar bandwidth reductions were obtained with a 5.1-mc amplifier where the bandwidth was reduced from 50 kc to 5 kc.

Bandwidth may be decreased in steps by incorporating a switch that increases the capacitance in parallel with each crystal and at the same time reduces L_1 correspondingly. The coefficient of coupling of the transformers need not be altered. This method will cause a slight change in the center frequency.

Figure 4 shows an arrangement for securing a continuously variable bandwidth over a 4 to 1 range with no change in the shape of the response curve. It has the desirable features that the gain in the pass band is essentially unaltered and the center frequency of the pass band is constant.

The crystal circuit was placed in the input circuit of a cathode follower, so that the input impedance was $Z_i = Z/(1 - A)$ where Z is the crystal circuit impedance and A is the cathode follower gain. The input to the cathode follower was connected across the primary of an ordinary double-tuned transformer. Another similar circuit was placed across the secondary. Gains were kept approximately equal by the ganged potentiometers. The responses shown were obtained for $A = 0$ and $A = 0.75$ at a center frequency of 848.4 kc.

Table I—Measured and Calculated Q for Various Values of Parallel Resistors

R (Ohms)	Q (Meas.)	Q (Cal.)	Percent (Diff.)
75,000	15,400	15,700	2
27,200	6,050	6,140	1.5
14,500	3,265	3,360	3
7,300	1,740	1,710	1.7

Use in Oscillators

The crystal circuit was connected across one tank circuit of a regenerative amplifier type of oscillator to provide a stable oscillator that could be easily set to a new frequency by a variable capacitor.

Figure 5 shows the frequency variation obtained with a 100-$\mu\mu$f capacitor using a 3.87-mc crystal. The dotted lines show the variation obtained if the capacitor across the crystal (part of C_1) is either too large or too small, thus introducing asymmetry in the crystal circuit response. The total variation in C_1 was 10 $\mu\mu$f. The voltage amplitude for the symmetrical case is also shown plotted in percent of maximum amplitude. An oscillator was constructed for field use at 7.75 mc which covered a frequency deviation range of 0.3 percent.

Paralleling the crystal circuit with a capacitor results in r_1 reducing the Q and consequently the maximum impedance of the circuit. If X_{C_a} is the reactance of the added

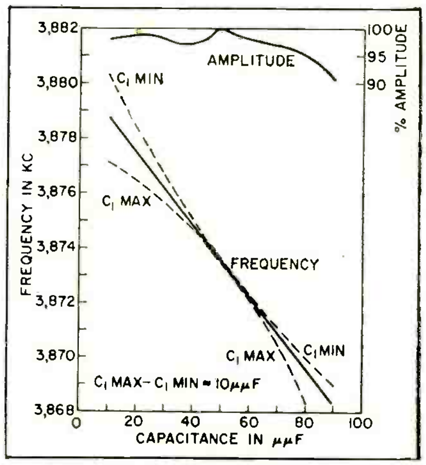

FIG. 5—Performance of variable-frequency crystal oscillator

parallel capacitor, the maximum impedance of the circuit is in general reduced by the same amount as though a resistor of approximately $X_{C_a}^2/r_1$ ohms were added in parallel with the circuit. Thus there is a limit to how far the circuit can be detuned without serious loss of Q. Also, the temperature coefficient increases as the frequency is tuned away from f_p.

The high selectivity obtained with this circuit is useful in spectrum analyzers. The circuit was also used in a standard type of frequency discriminator circuit.[5]

The author acknowledges helpful discussions with J. E. Jackson. G. H. Spaid supplied almost all of the data on the applications.

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Waveforms of magnetic inverter are checked on oscilloscope and effects of bias variations determined

Magnetic Inverter Uses

Collector and emitter-coil windings of the on transistor of multivibrator are differentially connected across input voltage so that turns in drive winding partially determine frequency of oscillation. Common-base resistor extends operating range by limiting base-to-emitter drive without waveform deterioration. Reliable operation is obtained without current bias. Alternate electron-tube circuit description is also given along with characteristics

By C. H. R. CAMPLING Associate Professor, Department of Electrical Engineering, Queen's University, Kingston, Canada

TRANSISTOR-MAGNETIC INVERTERS are finding increasing applications in signal and power conversion. For signal conversion, they give results similar to those given by electromechanical vibrator converters and for power conversion they produce high voltage from a low-voltage d-c power source. Frequency as well as output amplitude is directly proportional to the input voltage.

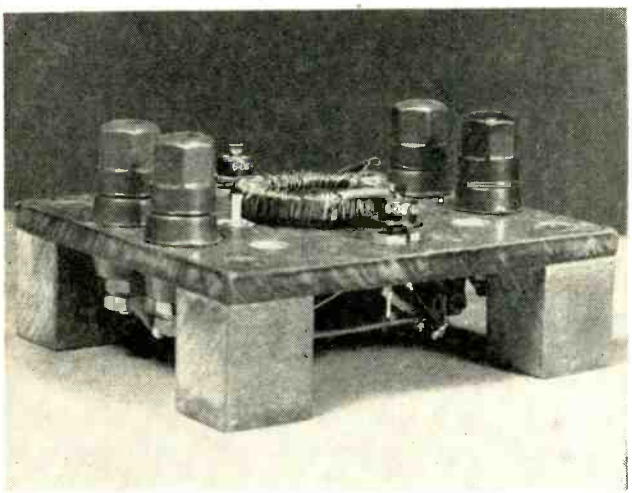
For power conversion, the magnetic inverter can substitute for the dynamotor type of rotating machine used in aircraft electrical systems and in military electronic equipment. Chief advantage of the magnetic inverter is that it is entirely a static device in which the switching action is accomplished by transistors or electron tubes.

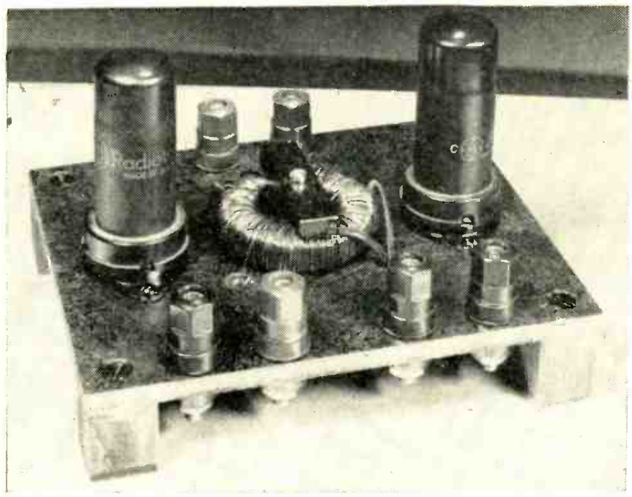
This article describes a differential multivibrator inverter circuit.[1] Its basic operation is similar to the more common type of inverter.

Basic Theory

An improved version of the non-differential multivibrator described by Royer[2] is shown in Fig. 1. The circuit is analogous to its free-running capacitor-coupled counterpart. In the latter, the time interval during which either switching element conducts or is cut off depends upon capacitor charge time. In the magnetic-coupled multivibrator the corresponding interval is determined by the time required for the flux in a magnetic core to change its level. The core flux change extends from positive to negative saturation or vice versa, although in other circuit modifications one flux level can be preset and controlled.[3]

In Fig. 1 consider transistor Q_1 to be conducting. Since the drop across the emitter to collector terminals is small, nearly the entire supply voltage V_{in} is applied across the collector winding of N_2 turns. Polarity of other induced voltages is indicated by winding dots. The voltage developed by the base windings N_1 keeps transistor Q_1 conducting. The current-bias source (E_B and 68,000-ohm combination) limits the base-drive current and prevents overheating. When transistor Q_1 is conducting the voltage





Component layout indicates physical relationship and relative size for transistorized inverter (left) and tube inverter (right)

Tubes or Transistors

developed across the collector windings N_2 tends to cause transistor Q_2 to conduct. In fact, the collector-to-emitter voltage for transistor Q_2 is twice the input voltage V_{in}. But the voltage appearing across base windings N_1 keeps Q_2 cut off.

During this quasisteady state, the core flux is changing over the steep unsaturated portion of its magnetization characteristic and the core and windings can momentarily be regarded as an ideal transformer. The winding voltages are steady because the voltage sustaining the flux change in the core is V_{in}.

Core Saturation

Transistor Q_1 conducts until the core saturates. Time of saturation is a function of N_2 and V_{in} in accordance with Faraday's law that $d\phi/dt = V_{in}/N_2$. When the core saturates, the core and windings are no longer regarded as an ideal transformer. The winding voltages collapse and the bias source forces conduction of one transistor. Furthermore, the energy stored in the core can only be released by a decrease in the flux from its saturation level. Therefore, transistor Q_2 conducts. The transistors exchange roles rapidly and during the next half cycle transistor Q_1 is cutoff. Evidently, both the frequency and the amplitude of the output square wave depend directly upon V_{in}. The frequency is given by $f = V_{in}/4N_2\phi_m$ where ϕ_m is the saturation flux. The linear dependence of f upon V_{in} makes the circuit applicable for telemetering. For loads of appreciable magnitude, there is efficient conversion of d-c source power to square-wave load power. Consequently, inverters can substitute for rotating electromechanical converters.

Clipping Diodes

Diodes D_1 and D_2 in Fig. 1 clip leading-edge spikes of the square wave when a transistor switches from on to off. The output waveforms for the circuit with and without the diodes are shown in Fig. 2A and 2B. The spikes should not be eliminated by shorting the bias source as E_B ensures reliable circuit oscillations and limits the on transistor base current to a minimum heating value.

For the saturated on transistor, the product of base current and base-to-emitter voltage can exceed the product of collector current and collector-to-emitter voltage.[4]

The spikes in Fig. 2B occur because the bias source cannot function properly as a current source

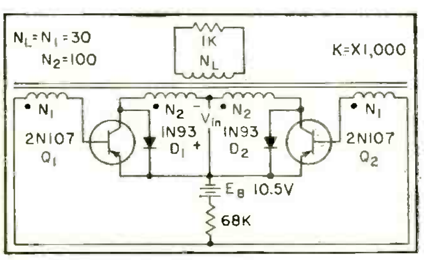


FIG. 1—Inverter is analogous to free-running cathode-coupled multivibrator

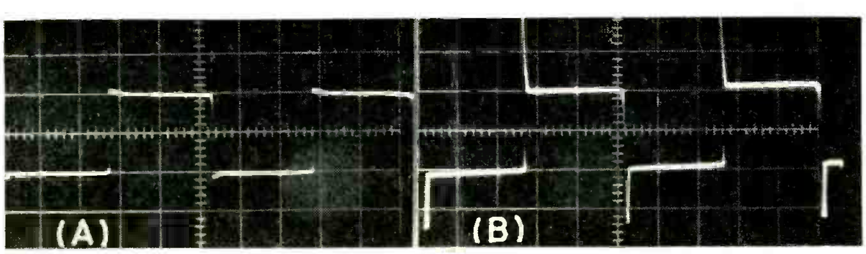


FIG. 2—Diodes of modified inverter clip spikes of output (A) while original inverter spikes appear (B). Scales are 1 v per amplitude division and 0.5 millisec per time division

unless one transistor is fully conducting. During the transition interval, the resistance of the bias path is momentarily too high. The use of the diodes is the most effective way to eliminate transients at all frequencies.

The multivibrator of Fig. 1 has one serious disadvantage. To increase the frequency V_{in} must be increased, and as V_{in} increases all winding voltages including the base voltage of the on transistor increase. Excessive base drive causes the transistors to overheat.

Neither reducing the number of turns in the base windings nor adding resistance in series with these windings can effectively avert overheating. If the base-winding turns are reduced, the circuit is likely to cease oscillation at low input voltages. On the other hand, the addition of series resistance in the base circuit causes the flat portions of the output waveform to be replaced by decay transients.

Differential Multivibrator

Most of the disadvantages inherent in the simple transistor-magnetic inverter are eliminated in the differential circuit of Fig. 3. This circuit oscillates reliably without the use of current bias. Since any spikes appearing in the output waveform are less than 1/2 μsec in duration, the clipping diodes are omitted. If the spikes are objectionable, they can be eliminated by connecting small capacitors between collector and emitter of each transistor. Furthermore, the common-base resistor R_B limits the base-to-emitter drive without impairing the circuit waveforms.

With the circuit in oscillation, one transistor is cut off and the other is fully conducting. If transistor Q_1 is conducting, the voltage V_{in} appears across N_2 turns in series with N_1 turns, neglecting the small collector-to-emitter drop. The series differential connection of collector and emitter windings provides an emitter-to-base drive of the correct polarity to sustain conduction. Similarly, the transformer voltage across the N_1 emitter windings of Q_2 is of the correct polarity to keep transistor Q_2 cut off despite its high collector voltage. Because of conduction in transistor Q_1, the rate of change of flux in the core is $d\phi/dt = V_{in}/(N_2 - N_1)$. Core-flux excursion from negative to positive saturation occurs more quickly than in the inverter of Fig. 1. When the excursion is complete, the winding voltages collapse. Transistor Q_1 is then cut off, transistor Q_2 conducts for the next half-cycle and the process is repeated.

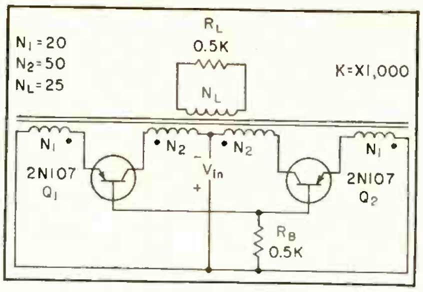


FIG. 3—Magnetic inverter with differentially connected windings oscillates without current bias

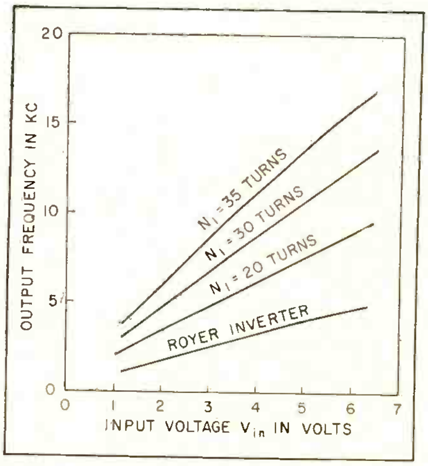


FIG. 4—Frequency characteristics of modified circuit (lowest curve) has components of Fig. 3. Remaining curves for differential inverter with N_1 as parameter

While the turns in the emitter drive windings influence the oscillation frequency, it is possible to prevent transistor overheating caused by excessive drive. Even high turns ratio values, compared with those required for the circuit of Fig. 1, are offset by the insertion of resistor R_B which limits the base current of the on transistor. The limiting action does not interfere with the load components of current in the core windings. Resistor R_B does not carry these currents. Furthermore, R_B does not cause deterioration of the clean rectangular output waveform. Finally, its limiting action is effective over a wide range of the input voltage V_{in}.

Oscillation Frequency

The circuit is called a differential multivibrator or inverter because of the differential action of the collector and emitter windings. Since the rate of change of core flux is affected by the differential connection, the frequency of oscillation is too. The frequency is given by $f = V_{in}/[4(N_2 - N_1)\phi_m]$. The differential circuit produces, for the same set of components and the same input voltage, a higher output frequency than does the circuit arrangement of Fig. 1.

Comparative Characteristics

The family of characteristics shown in Fig. 4 indicates the effect of varying the number of turns N_1 in the feedback or emitter windings of the circuit in Fig. 3. The lowest curve is obtained with the same components indicated in the circuit of Fig. 3, but with the circuit arrangement of Fig. 1. For this set of components, in which the com-

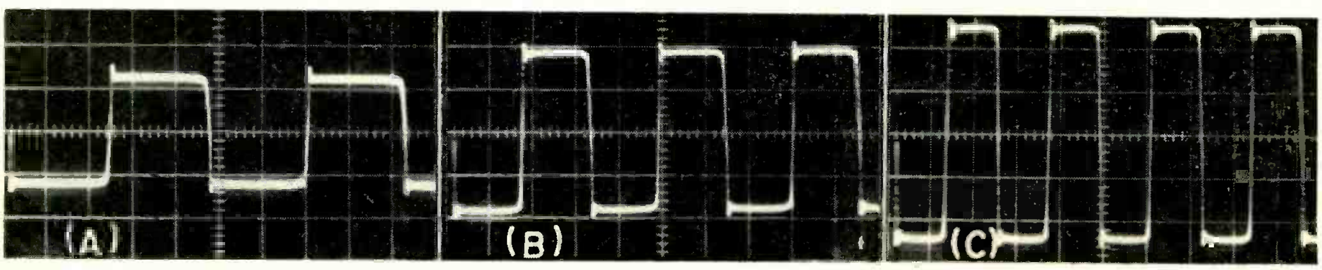


FIG. 5—Output waveform of differential inverter of Fig. 3 with 0.01 μf capacitor connected between collector and emitter of each transistor to clip pip. Input voltage V_{in} = 3 v (A), 4.5 v (B) and 6 v (C). Each waveform amplitude is 2 v per large division and time scale is 50 sec per large division

mon base resistor R_B is optimized by trial, little further advantage occurs from the increase in slope obtained with an increase in N_1 as ultimately the waveform deteriorates. However, the insertion of resistors of the same magnitude as R_B in series with the bases of the transistors in a circuit like that shown in Fig. 1 completely alters the output waveform at all frequencies. Thus, the differential circuit permits the use of this simple self-adjusting protective feature which operates effectively over a wide range of voltage, frequency and the parameter N_1.

Thermal instability at the 6-v level on the lowest curve in Fig. 4 emphasizes the importance of the base resistor in extending the operating range. The upper curves, obtained using the differential circuit with the limiting resistor, represent stable operation at the 6-v level without noticeable heating of the transistors.

Output waveforms for the differential circuit of Fig. 3 are shown in Fig. 5. The emitter windings consisted of 20 turns each. The three waveforms correspond to V_{in} equal to 3, 4.5 and 6 v respectively.

A comparison of several of the voltage levels in the differential circuit are given in Table I for both the circuit of Fig. 1 and the differential circuit of Fig. 3. While the differential connection increases the individual winding voltages, it does not increase the peak collector-to-emitter voltage for the off transistor.

Table 1—Voltages of Differential and Nondifferential Circuit

Voltage	Nondifferential Inverter of Fig. 1	Differential Inverter of Fig. 3
Peak a-c voltage across collector windings N_2	V_{in}	$V_{in} \frac{N_2}{N_2 - N_1}$
Peak a-c voltage across drive windings N_1	$V_{in} \frac{N_1}{N_2}$	$V_{in} \frac{N_1}{N_2 - N_1}$
Peak collector-to-emitter voltage for off transistor	$2\,V_{in}$	$2\,V_{in}$
Peak a-c load voltage	$V_{in} \frac{N_L}{N_2}$	$V_{in} \frac{N_L}{N_2 - N_1}$

Transistor-Tube Comparison

Electron tubes can also be used as the switching elements although they are less efficient than transistors in this application. The drop across an on tube and the relatively large current drawn by its grid are the main reason for lower efficiency. Nevertheless, tubes at present may be better in some applications because of availability with a suitable combination of voltage rating, current rating and capacity for switching at high speed.

Electron-Tube Circuit

A differential inverter using electron tubes as the switching elements is shown in Fig. 6. Best results are obtained with separate grid resistors. The extension of the permissible upper limit for V_{in} is noteworthy because the large grid currents associated with the nondifferential circuit limit its usefulness. Two separate tubes must be used because the common cathode of the double triode 6N7 precludes the use of its two halves as the two switching elements in the differential circuit. At low values of the input voltage, in the same order of magnitude as the voltage drop across the on tube, the output frequency rises as the voltage is lowered. This behavior is associated with a flux excursion in the magnetic core over a minor but symmetrical hysteresis loop. The switching process occurs before the flux in the core reaches the saturation level. The low-voltage region is of limited utility for ordinary purposes because the output waveform deteriorates from its clean rectangular shape, and the frequency becomes dependent upon the load.

With transistors, the drop across the on switching element is small and as the input voltage decreases to tiny values the circuit ceases oscillation before a region of increasing frequency is reached.

Typical frequency characteristics for the circuit of Fig. 6 are shown in Fig. 7. Frequency characteristic *B* is that of a nondifferential circuit using the same components without protective resistors. In each case the maximum frequency shown is the highest obtained without rapid deterioration of the circuit operation due to overheating. Overheating is caused, particularly in the nondifferential circuit, by excessive grid current. The characteristics emphasize the extended range of operation which can be obtained with the differential circuit.

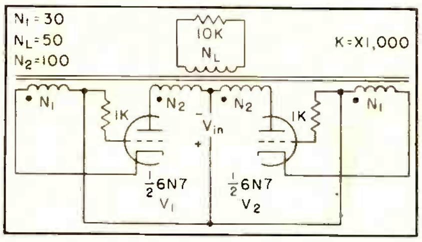


FIG. 6—Differential electron tube inverter gives best results when separate grid resistors are used

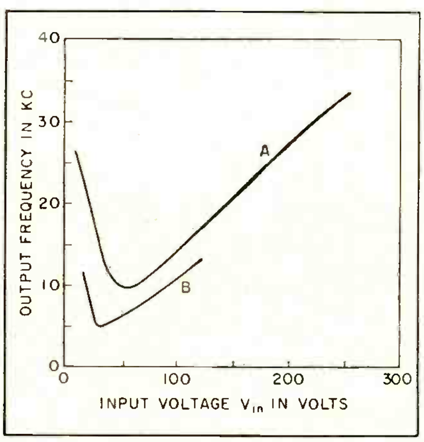


FIG. 7—Frequency characteristics for electron-tube inverter using separate half-tubes *A* and a single common cathode without grid resistors *B*

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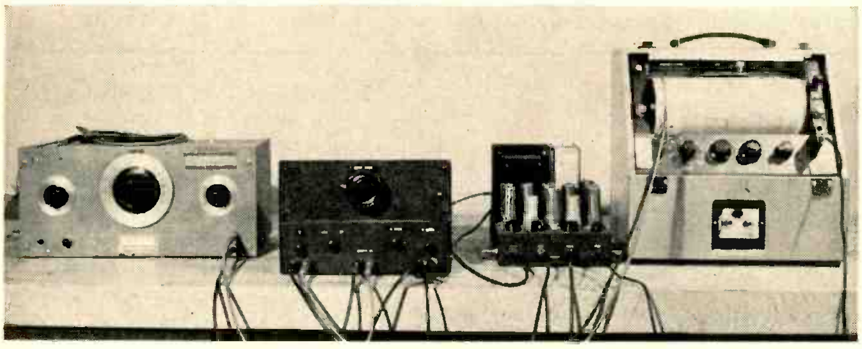

Amplitude distribution analyzer with associated equipment for determining distribution of various noise waveforms obtained from missile radar systems

Front view of analyzer. Knob is used to control bias placed on input wave

Simple Plotter Analyzes

TO EVALUATE NOISE and vibration, signal data on both power against frequency and amplitude-distribution density against amplitude must be available. Several versions of spectrum analyzers can provide the power-frequency characteristics automatically. However, the amplitude-distribution density has not been easily obtained.

The method most widely used to determine the amplitude-distribution function involves a slow and costly data reduction process. Recorded on either paper or film, the wave amplitude is measured and tabulated at regular intervals of time and the results are then reduced numerically to provide a histogram on the amplitude-distribution density of the signal.

Automatic Method

The amplitude-distribution analyzer, described in this article and developed for analyzing radar noise at the Naval Air Missile Test Center, provides a simple and rapid method for obtaining the amplitude-distribution density of noise signals in the audio frequency range. It produces an automatic plot of the amplitude-distribution density with an accuracy of about 5 percent with coarse resolution. Distribution density can be plotted almost as fast as the analyzer is operated.

Signals to be analyzed have a frequency range from 0 cps (d-c) to 1,000 cps. The present system performs well from 1 cps to 10,000 cps, but with redesign the lower limit can be extended down to essentially d-c. The plotter is similar to one developed by the Naval Research Laboratory[1] but is much less complex.

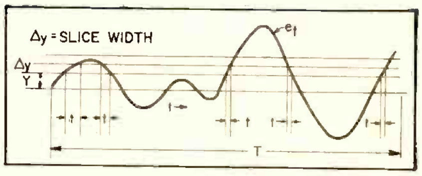

FIG. 1—System is based on the principle that the amplitude distribution density plot is the ratio of Σ_t to T

Theory of Operation

A typical signal to be analyzed is shown in Fig. 1. The system is based on the following principle. As a function of time the amplitude-distribution density of an electrical signal is the relative probability that the signal amplitude lies within an interval of amplitude Δy, which is between the level Y and $Y + \Delta y$. The amplitude-distribution density plot is the ratio of Σt, the time the waveform spends between Y and $Y + \Delta y$, to T, the total time of measurement at level Y. This relationship can be expressed:

$$\int_{Y}^{Y + \Delta y} P\,(e_t)\, de_t = \frac{\Sigma_t}{T} \qquad (1)$$

where $P(e_t)$ is the probability distribution of the waveform, e_t; t is the time that waveform e_t lies between Y and $Y + \Delta y$; and T is the total time that the interval Δy is positioned at Y. This amplitude-distribution analyzer presents an output voltage E that is proportional to $\Sigma t/T$. Therefore, from Eq. 1

$$E = K\Sigma_t/T = K \int_{Y}^{Y + \Delta y} P\,(e_t)\, de_t$$

Circuit Description

Figure 2 contains the block diagram of the analyzer. The schematic is shown in Fig. 3. The waveform to be analyzed e_t is amplitude gated or sliced, that is, a small amplitude interval or slice

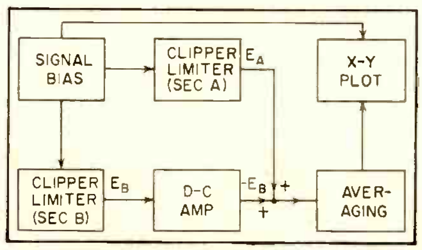

FIG. 2—Block diagram of amplitude-distribution analyzer. Analyzer effectively inspects only small amplitude interval of input wave. Input wave to be analyzed is biased and then amplitude gated by two clipper limiters, one samples positive slice and the other samples negative. Output is average voltage E of gated portion

Device plots amplitude-distribution density required for complete analysis of noise and vibration signals within 1 to 10,000 cps with an accuracy of 5 percent of maximum amplitude. Circuit illustrates principle that amplitude-distribution density of an electrical signal is a function of time wave spends between two adjacent amplitude levels

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Radar Noise Rapidly

of the signal is allowed to pass through the system for inspection. The voltage output from the slice is an average voltage E.

The input signal level is made to vary in d-c potential by adding a bias voltage to the input. As the bias is varied, different amplitude levels of the input waveform are sampled by the slice. If E is plotted as a function of the bias voltage, an approximation to the probability distribution of e_t, $[P\ (e_t)]$, will be plotted. If the slice width approaches zero, or infinite resolution, the plot approaches $P(e_t)$.

Basically, the device consists of two clipper limiters or slicers that maintain a narrow interval between the clipping and limiting levels. The two clipper limiters, sections A and B, are used to amplitude gate the signal and form E.

Section A samples the d-c biased input signal, e_t + bias, between zero and $+\frac{1}{2}$ slice width. The output of section A is shown in Fig. 4. Because of a relatively narrow slice, the output of section A is essentially a negative square wave with amplitude equal to $-\frac{1}{2}$ slice width. The average value of this waveform is E_A.

Section B inspects the biased input signal between zero and $-\frac{1}{2}$ slice width. The output of section B is inverted and biased to $+\frac{1}{2}$ a slice width by a d-c amplifier so that essentially a positive square wave is produced. The average value of this output waveform is E_B.

The output of sections A and B is summed through the output of the d-c amplifier. The average of the combined waveform E is now plotted by an X-Y recorder to display the amplitude-distribution of the waveform. Thus, a plot of E against d-c bias is a first approximation to the amplitude-distribution function of the input waveform.

For audio signals, the X-Y will average E, but for subaudio signals the filter R_5, C_4 must be used.

The requirements for the d-c amplifier used in this analyzer are low d-c drift rate and a frequency response to 1,000 cps.

Operation

Operating controls for the distribution analyzer are two slice level potentiometers, the bias scan potentiometer, an X-axis scale factor control, and an on-off switch. The first step in operation of the analyzer is to balance the d-c amplifier and to adjust the two slice level potentiometers until both diode sections are producing the same magnitude. Proper scales are then selected on a two-axis plotting board, Y-Y recorder, and finally

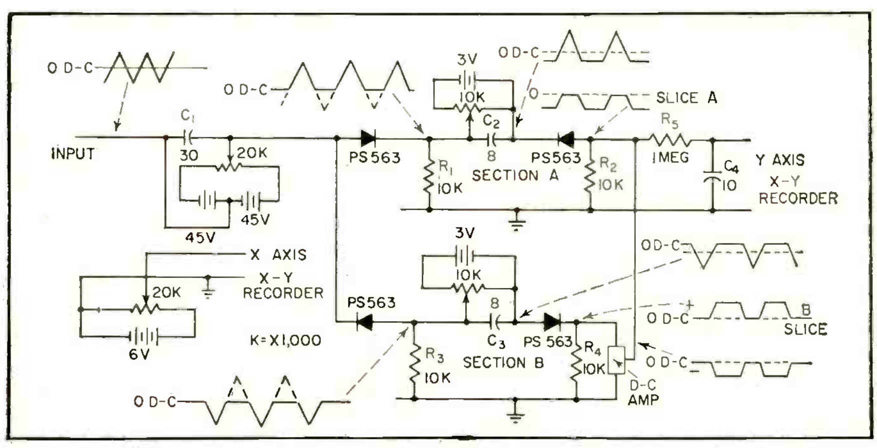

FIG. 3—Schematic of amplitude-distribution analyzer. Clipper limiter A samples d-c biased input signal between zero and positive half of slice width. Clipper limiter B samples d-c biased input signal between zero and negative half of slice width. Output of B is inverted and biased to produce positive square wave by a d-c amplifier. Recorder plots average wave E of combined A and B output

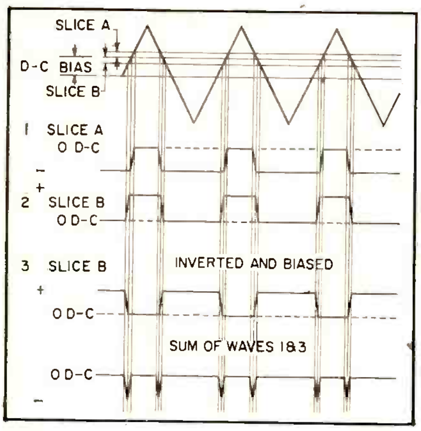

FIG. 4—Circuit waveforms of the analyzer for an input triangular wave

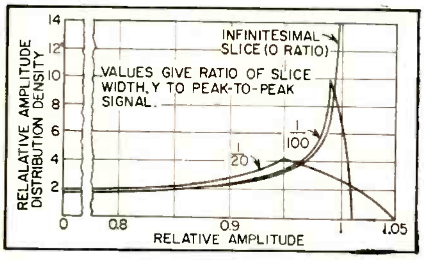

FIG. 5—Theoretical amplitude-distribution of a sine wave for different ratios of slice width to peak-to-peak sine-wave amplitude as used in technique described

the bias scan potentiometer is used to slowly sweep the amplitude of the input signal producing the distribution density versus amplitude on the X-Y recorder.

Input signals for the present model must be less than 90 v peak-to-peak, the full swing of the d-c bias, so that a full amplitude sweep may be obtained. The peak-to-peak value of the signal should be as near as possible to 90 v to obtain maximum resolution.

The approximations made in this description have been that the wave has constant slopes inside the slice and that the action of the diodes is perfect.

Accuracy

Errors in the present system are caused by resolution limitations of the circuits and errors of circuit components. Resolution is the ability of the analyzer to define the structure of the true amplitude-distribution of the input waveform. Resolution is directly related to slice width, which must approach zero if E is to be exactly proportional to $P\ (e_i)$. Experimentally, the slice width is several percent of the peak-to-peak input signal amplitude because of equipment limitations. Component errors are caused primarily by the silicon diodes and the d-c inverting amplifier. Silicon-diode error increases at high frequencies. At frequencies below 1,000 cps the error is quite small.

Drift Error

Direct-coupled amplifier error is caused by amplifier drift. This drift causes an output error that is inversely proportional to the amplitude of the output signal. Therefore, the output signal must be made as large as possible to minimize this error.

The analyzer output signal E is proportional in magnitude to the slice width and should be larger than the expected drift of the d-c amplifier. Thus, the amplifier drift error must be balanced against resolution error.

Slice width to peak-to-peak signal amplitude ratio is defined as the resolution ratio. Resolution ratio is limited to 1:20 because of amplifier drift. However, if a stabilized d-c amplifier is used, the drift error is negligible and a resolution ratio of 1:100 is possible. In this case, the silicon diodes are the primary cause of system error.

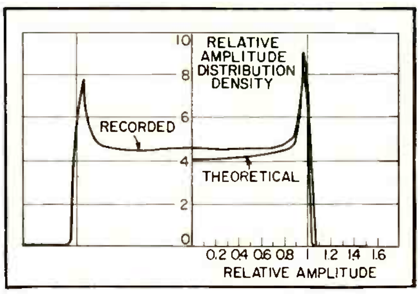

FIG. 6—Theoretical and recorded distribution density for a sine wave. Slice width Δy to peak-to-peak input ratio at 1/20

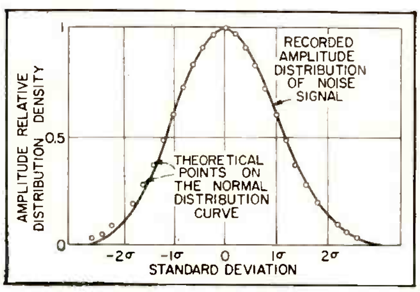

FIG. 7—Recorded amplitude distribution of the output of a random noise generator

Error in the equipment is defined as the percentage deviation of the analyzed distribution from the theoretical distribution with respect to the maximum value of the plotted distribution. This is similar to percent of full scale used for many meters. The present equipment will plot the distribution of noise inputs with an error of 5 percent or less.

If a stabilized amplifier and a resolution ratio of 1:100 are used, the analyzer error is reduced to less than 2 per cent for frequencies below 1,000 cps.

Sine Wave Inputs

For sine wave inputs, maximum error will exceed 5 percent because of the large error caused by resolution limitations. Figure 5 is a plot of a part of the amplitude-distribution of a sine wave. The effect of different resolution ratios is illustrated.

Figures 6 and 7 are plots of distribution densities for a sine wave and for random noise. Theoretical distribution for a sine wave is infinitely discontinuous at maximum signal amplitude. The analyzer cannot reproduce this part of the distribution accurately as is shown in Fig. 5.

Figure 7 shows the plotted and theoretical distribution density of a normal random noise signal. The analyzer results compare quite favorably. Good results can be expected for any distribution that is continuous.

Conclusions

From the results obtained from the use of this analyzer, it is evident that this device will produce an amplitude-distribution analysis with an error of not more than 5 percent of the maximum amplitude of the distribution for any noise signal between the frequencies, 1 cps to 10,000 cps. With improved design and components outlined in this article, the analyzer may have better resolution, 1:100 vs 1:20, an error of less than 2 percent, and a frequency range extending to zero.

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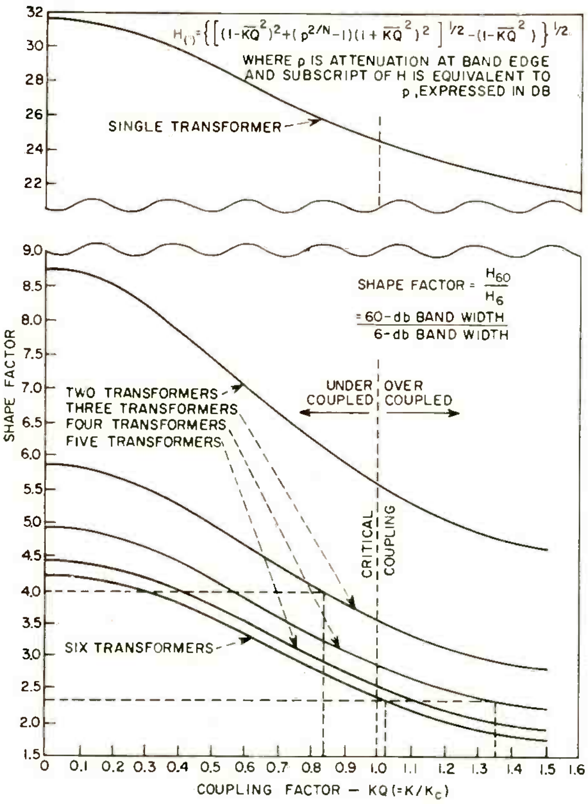

FIG. 1—Shape factors for single and cascaded double-tuned transformers vs coupling factor. Curves are solutions of the equation shown which also applies to Fig. 2 and 3

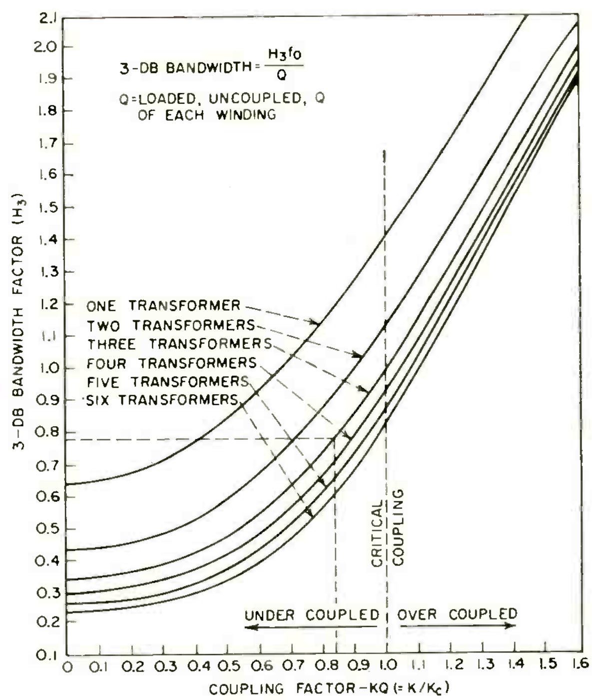

FIG. 2—Three-db bandwidth factor for transformers with two identical coupled circuits

H-F Amplifier Design

Any narrow-band h-f tuned amplifier can be designed from the accompanying curves and a minimum of additional information. The step-by-step method is directed to the bread-and-butter circuits of communications system design—narrow-band i-f amplifiers, r-f stages, and audio filter circuits. It relies only on provision of a set of design specifications

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TYPICAL DESIGN specifications for a narrow-band h-f tuned amplifier give the amount of gain required from a completed unit, the bandwidth at either the 3-db or 6-db points, and the 60-db bandwidth. The problem is to determine the number of amplifier stages and transformers required; the transistor (or tube) types to be used; and the specifications for the i-f or r-f transformers to be used.

A simplifying assumption is made that $Q_{pri} = Q_{sec}$ in each case. In narrow-band amplifiers it is seldom necessary to use transformers having unequal primary and secondary Q.

A quantity bandwidth factor (H) is introduced to normalize the design charts about any specified center frequency. This factor is defined as follows: H_3 = 3-db bandwidth $\times Q/f_o$ and H_6 = 6-db bandwidth $\times Q/f_o$, where H_3 and H_6 are the 3- and 6-db bandwidth factors, respectively; f_o is the center frequency of the pass band; and Q is the loaded uncoupled Q of each transformer winding ($Q_{pri} = Q_{sec}$).

The term coupling factor is applied to the quantity KQ, where K is the coupling coefficient and Q is as defined previously. This expression is identical with K/K_c, K_c is critical coupling.

Use of the Tools

Assume that the following performance characteristics are specified for an amplifier: shape factor, overall gain, 3-db band-

* Now with Ampex Corp.

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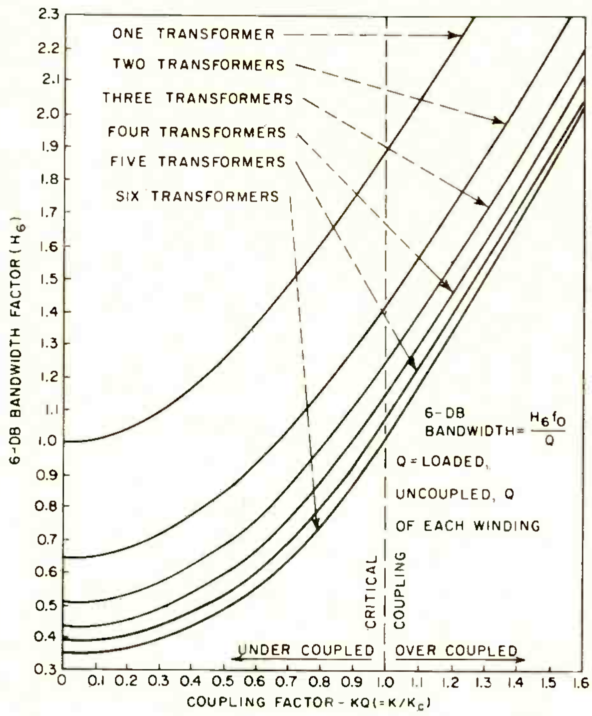
Amplifier Design (continued from page 165)



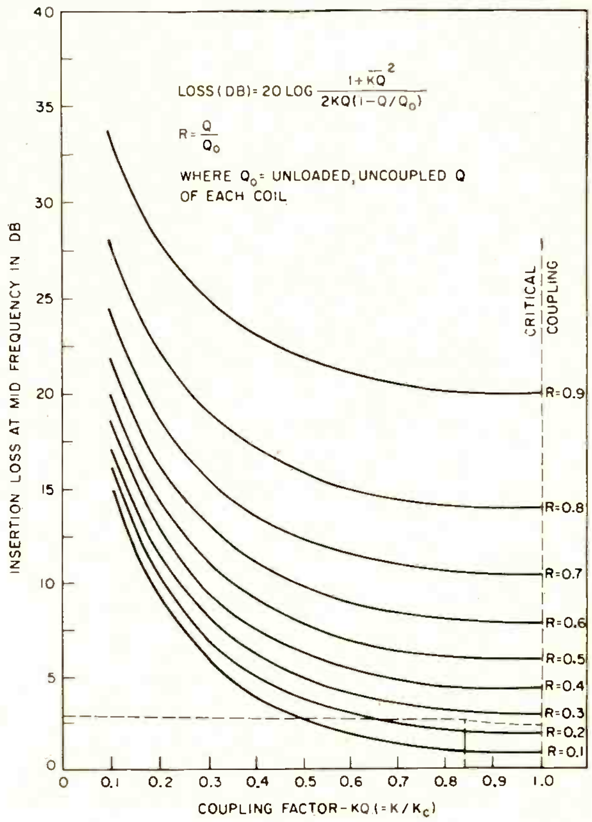


FIG. 3—Six-db bandwidth factor for transformers with two identical coupled circuits

FIG. 4—Insertion loss of a single transformer at its midfrequency for varying values of the Q/Q_0 ratio

width, and center frequency. The design procedure is as follows:

(1) Enter Fig. 1 with the specified shape factor. Determine the minimum number of stages required and their coupling factor.

(2) Verify that suitable transistors are available to provide the specified gain with the number of stages determined in step 1. If not, select a higher number of stages, and lower KQ.

(3) Determine the 3-db bandwidth factor, H_6, by entering Fig. 2 with the number of stages and the coupling factor determined in steps 1 and 2.

(4) Compute the required loaded, uncoupled Q of the transformer windings from $Q = H_3 \times f_o/$ overall amplifier bandwidth. (Note: If the 6-db bandwidth rather than the 3-db bandwidth is specified, Fig. 3 should be used in place of Fig. 2, and H_6 should be used in place of H_3 in step 4.)

(5) Determine the insertion loss of each transformer from Fig. 4. Use a value of R based on the value of Q found in step 4 and the expected value of unloaded, uncoupled Q attainable within the limitations of the problem.

(6) Determine total gain of the amplifier by subtracting the total insertion loss of the several transformers from the gain attainable with the transistors used. This step constitutes a check on the estimate made in step 2. If the total computed gain is less than that called for in the specifications, solutions of step 2 are avilable for a recomputation.

Example

A typical set of design specifications are: gain, 60 db min; frequency (f_o), 455 kc; 3-db bandwidth (BW), 8 kc; and shape factor (S), 4.

(1) Enter Fig. 1 with the specification that $S = 4.0$. The curves show that a minimum of three i-f transformers are needed. Three transformers with their coupling adjusted to $KQ = 0.84$ will provide the exact shape factor specified.

(2) From Fig. 2, follow the $KQ = 0.84$ line to its intersection with the three-transformers line. The 3-db bandwidth factor (H_3) can then be read as 0.78.

Since $BW = H_3 f_o/Q$, the required loaded, uncoupled Q of each transformer winding may be computed:

$Q = H_{3o}/BW = 0.78 \times 455/8 = 44$

Thus far, a requirment for three i-f stages incorporating three transformers, each having primary and secondary loaded Q of 44, with coupling factor adjusted to 0.84, has been found.

To predict insertion loss of each transformer, estimate the ratio of loaded to unloaded Q of the transformer windings. Previous experience shows that an unloaded Q of 175 is easily attainable at 455 kc with proper core and winding material. This magnitude gives a ratio of loaded to unloaded Q of about 0.25. Enter Fig. 4 with $R = 0.25$ and $KQ = 0.84$. Estimate insertion loss per transformer at 2.8 db for a total insertion loss (three

(continued on page 168)

Amplifier Designing (continued from page 166)

Table I—Max KQ for Max Permissible Double-Humping

Permissible peak-to-valley ratio (db)	Number of transformers					
	1	2	3	4	5	6
1	1.6	1.4	1.3	1.27	1.25	1.2
2	2	1.6	1.45	1.4	1.35	1.3
3	2.3	1.8	1.6	1.5	1.45	1.4

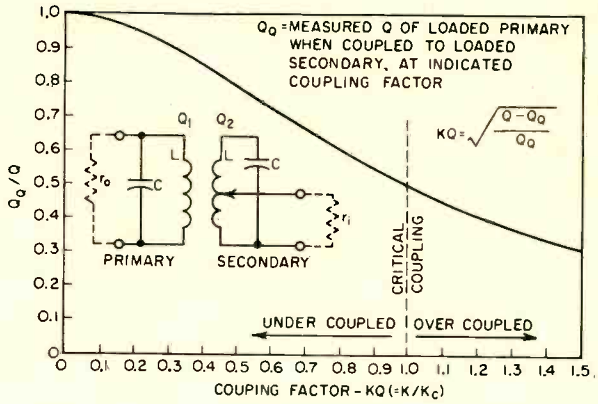


FIG. 5—Curve used for setting of coupling factor with a Q-meter as well as circuit of typical coupling transformer

transformers) of 3 × 2.8 or 8.4 db. To attain specified net gain of 60 db from the amplifier, 60 + 8.4 or 68.4 db of gain must be provided by the three transistors used. Fortunately, many transistors are available with sufficient gain to do the job.

The minimum number of stages may depend either on overall gain requirements, a maximum shape factor specification, or both. If, in the previous example, a shape factor of 2.4 was called for instead of 4, Fig. 1 reveals that four transformers at $KQ = 1.35$, five transformers at $KQ = 1.1$, or six transformers at $KQ = 1.02$ could meet the requirements.

Slight overcoupling may often save the complication and expense of an additional stage. Table I shows how far overcoupling may be carried without exceeding a specified maximum peak-to-valley ratio.

Transformer Design

Double-tuned transformers may now be specified if the output impedance of each driving stage and the input impedance of each driven stage are known. The transformer supplier may not be able to deviate from classical winding-machine settings. In this event, the following procedure, using previously computed data, will produce a proper transformer.

The untapped primary and tapped secondary arrangement shown in Fig. 5 is generally satisfactory for a coupling transformer. Primary and secondary coil inductance may be computed as follows:

$$L = \frac{r_o\,(Q_u/Q - 1)}{2 f_o Q_u} \qquad (1)$$

where r_o is output resistance of driving stage; f_o is midband frequency; Q is loaded, uncoupled Q from step 4; and Q_u is unloaded, uncoupled Q of each winding. Trial windings will be necessary to determine the value of Q_u.

Capacitance C (Fig. 5) should be selected to resonate with L at the desired center frequency. Reactive components of the transistor input and output impedances my be taken care of by providing trimming controls on L, C, or both. Alternatively, reactance may be allowed for by modification of C.

Position of the secondary tap may be computed as follows:

$$N_T/N = (r_i/r_o)^{1/2} \qquad (2)$$

where N_T is the number of turns between tap and cold end of the secondary, N is the number of turns in each full winding, and r_i is the input resistance of driven stage.

With the aid of Fig. 5, coupling between the windings may be set on a Q meter to the desired value of KQ. First, terminate the windings with resistors to simulate the expected r_o and r_i. Then, adjust the coupling until the measured value of primary Q drops to the value (Q_Q/Q) specified on the ordinate for the desired coupling factor.

As an example, design a transformer using Raytheon 2N112 transistors and meet the following requirements and conditions: r_i, 600 ohms; r_o, 25,000 ohms; $KQ = 0.84$; f_o, 455 kc; Q, 44; and Q_u, 175.

Compute inductance with Eq. 1

$$L = \frac{25 \times 10^3\,(175/44 - 1)}{2 \times 455 \times 10^3 \times 175} = 150\ \mu\text{Hy}$$

From a reactance/frequency table, C is 810 $\mu\mu$f.

Position of the secondary tap may be computed with Eq. 2.

$$N_T/N = (600/25{,}000)^{1/2} = 0.155$$

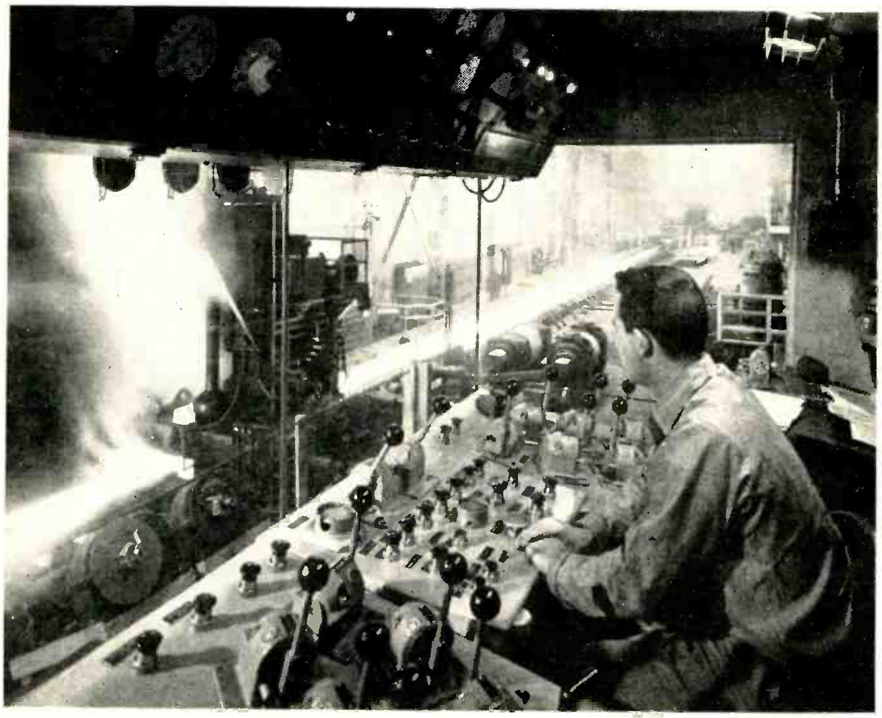
or the secondary tap should be about 15 percent above the cold end of the secondary coil.

The coupling is adjusted to the required $KQ = 0.84$ (Fig. 5) as follows: (1) Connect a 25,000-ohm resistor across the primary terminals. (2) Connect a 600-ohm resistor between the secondary tap and the cold end of the secondary. (3) Connect the primary to a Q meter and resonate both primary and secondary with the slightest possible coupling. (4) Read primary Q. (5) Increase coupling until the measured Q drops to 58 percent of the value measured in step 4. The coupling factor is now at the required value of 0.84.

Since the 2N112 transistor has a published gain capability of better than 30 db per stage, 60 db in three stages is easily attainable.

Thanks are due B. D. Ramsey for the basis for Figs. 1 to 3.

Punched Cards Control Steel Production



Digital and analog techniques are combined to control the operation of reverse roughing mill in new steel plant

CARD-PROGRAMMED system called Prodac will direct the operation of a 6,000-horsepower universal reversing roughing mill. The system was designed by Westinghouse for the new $36-million Aliquippa Works of the Jones and Laughlin Steel Corp.

With the system, the mill operator can press a single button to initiate the complete rolling sequence for a given slab. Information in punched-card form governs the setting of edger opening, edger speed, mill opening and mill speed.

When a stack of cards is inserted in an IBM card reader, the mill operator can begin to roll a sequence of schedules. To roll the first schedule, the operator presses a schedule advance button that causes the first punched card to be read by the card reader and its information to be stored.

A pass advance button causes information applying to the first pass to be used to set the separation and speeds of horizontal and vertical rolls. The slab then enters the edger and the mill.

When the slab has passed beyond a slowdown hot-metal detector, the mill decelerates to limit slab travel after it clears the rolls. When the slab has passed beyond the rolls, the load detector initiates a signal that stops the mill.

Simultaneously, information for the next pass is used to reset the edger and main roll separations and to establish speeds and direction of rotation for the next pass. The mill is then automatically accelerated, and the slab reenters the mill. Similar operations are repeated for each pass.

If several slabs are to be processed identically, the operator needs only to press the pass advance button and fully automatic operation results. If the second schedule is to be different, pressing the schedule advance button will cause information from the second card in the reader to be extracted. The new schedule will be executed automatically when the pass advance button is pressed.

To illustrate the signal sequence incorporated in Prodac, the subsystem for automatically controlling separation between upper and lower rolls will be described. Information applying to screwdown is transferred from punched card into storage by the IBM card reader. An analog signal representing actual roll separation is transmitted from the mill to an analog-to-digital converter for conversion into digital form.

When the operator presses the pass advance button to initiate rolling operations, digital reference information for the desired roll separation is extracted from storage and supplied to a digital difference detector. At the same time, the signal corresponding to actual roll separation is passed to the digital difference detector. The detector performs a subtraction that yields a resultant signal representing the difference between the actual and desired roll separation.

This signal applied through the digital-to-analog converter yields an analog signal for input to a magnetic amplifier. When output of the magnetic amplifier is supplied to a rotating regulator, an adjustable voltage drive adjusts the screws until roll separation is equal to that originally specified by the punched card.

Similar processes are used to control mill speed, edger speed and edger opening.

Neon Triode Gives Low-Speed Gate

By RONALD L. IVES
Palo Alto, Calif.

GATING CIRCUITS a generation ago usually employed electromagnetic relays, which were seldom useful at speeds above 1,000 operations per second. They were most dependable at the lower operating speeds.

Since World War II, most gating circuits employ vacuum-tube multivibrators and their near relatives, which have useful operating speeds ranging from several operations per week up to quite a few million operations per second. These are *first in Performance Reliability and Quality*

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- Terminations on front and rear of unit.
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SC-32-1	0-32	0-1	0.01	0.1	19″	3½″	13″
SC-32-1.5	0-32	0-1.5	0.01	0.1	19″	3½″	13″
2SC-32-1.5 DUAL OUTPUT	0-32 0-32	0-1.5 0-1.5	0.01 0.01	0.1 0.1	19″	7″	13″
SC-32-2.5	0-32	0-2.5	0.01	0.1	19″	3½″	13″
SC-32-5	0-32	0-5	0.005	0.05	19″	5¼″	13″
SC-32-10	0-32	0-10	0.001	0.01	19″	8¾″	13″
SC-32-15	0-32	0-15	0.001	0.01	19″	10½″	13″
2SC-100-0.2 DUAL OUTPUT	0-100 0-100	0-0.2 0-0.2	0.1 0.1	1.0 1.0	19″	5¼″	13″
SC-150-1	0-150	0-1	0.05	0.5	19″	5¼″	13″
SC-300-1	0-300	0-1	0.1	1.0	19″	8¾″	13″

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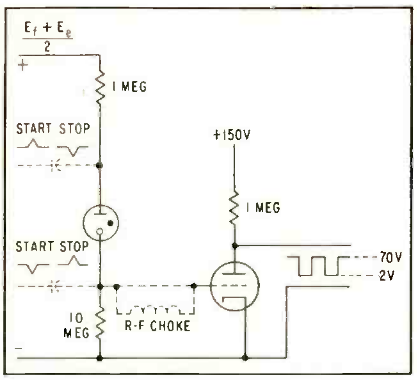

FIG. 1—Gating circuit may use 6AV6, ½12AX7 or other triode types to produce low repetition rate pulses

gratifyingly dependable at all speeds below the few million operations per second. However, component requirements (particularly for capacitors) become inordinate at very slow operating speeds. The ratio of standby power to controlled power also becomes quite high at these slower speeds.

Experiments with neon tubes and triodes, to replace the dual triodes used in most multivibrator circuits, indicate that a number of slow-speed gating problems can be solved by such circuits. These circuits provide a great saving in standby power.

Two specific circuits will be described with operating constants. A number of rather obvious alternate and derivative circuits are possible, and most of those tested work satisfactorily.

Upper limit of operating frequency of these circuits is in the vicinity of 5,000 operations per second, because of the slow deionization time of commercial neon tubes. Dependability of operation is enhanced if the neon tubes are constantly illuminated at almost any level above zero. Several spontaneous operations per month may be expected in exposed installations (probably caused by cosmic rays). However, the number of these operations is reduced to a very low figure (but probably not zero per year) by enclosure in a metal cabinet.

Off-On Gate

The circuit of an off-on gate is shown in Fig. 1. The supply voltage is set midway between the firing voltage (E_f) of the neon tube and its extinction voltage (E_e). The neon tube does not conduct unless triggered by a momentary increase in voltage. Once conducting, it will continue until the supply voltage is momentarily lowered below the extinction voltage.

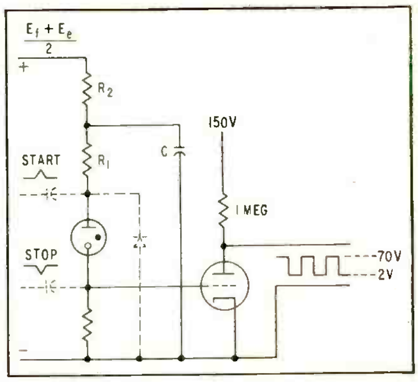

FIG. 2—If R_2 is much greater than R_1 and the reciprocal of time on is much less than prf, time on = 2.303 $R_1C \log_{10} (E_f + E_e)/2E_e$, while dead time = 2.303 $R_2C \log_{10} (E_f + E_e)/2E_e$

The neon tube is coupled to the triode by means of the triode grid resistor. The high value of this resistor biases the triode to low conduction. When the neon tube is conducting, the grid and cathode of the triode act as a diode, having negligible resistance. This action effectively short-circuits the triode grid resistor, so that the triode grid is very close to cathode potential when the neon tube is conducting. The triode therefore draws heavy plate current.

Triggering of this gate may be through a small capacitor in the anode circuit of the neon tube. With this arrangement, a small positive pulse momentarily increases the anode voltage of the neon tube, causing it to fire. This discharge, once started, continues as long as adequate supply voltage is present. A negative pulse applied through the same trigger input will momentarily lower the anode voltage of the neon tube below extinction level, and conduction will cease.

A similar triggering action can be made to take place through the cathode circuit of the neon tube. Here a negative pulse is required to start conduction. A positive shutoff pulse applied to the cathode of the neon tube will stop conduction. The triggering pulses are kept out of the triode grid-cathode circuit by means of a small r-f choke, indicated in Fig. 1.

Amplitude of the start pulse must always exceed the difference between the supply voltage and the firing voltage (E_f) of the neon tube. A small correction for contact po-

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tential in the cathode circuit of the neon tube may be found desirable. The shutoff pulse amplitude must always exceed the difference between the supply voltage and the extinction voltage (E_e) of the neon tube. Optimum shape for the triggering pulses is like that of a ripsaw tooth, with a sharp rise and a gradual decline.

Constant Duration Gate

Circuit of a neon-triode gate that gives an output pulse of constant duration through a wide range of input pulse-repetition frequencies is shown in Fig. 2. A relatively large capacitor is tapped along the anode resistor of the neon tube. When the tube fires, the capacitor discharges through the neon tube and resistor R_1 until the charge is dissipated. At that time, the neon tube goes out.

If anode triggering with a positive pulse is used and the pulse shape is not ripsaw toothed, operation can be improved by addition of a high back resistance diode, as shown in Fig. 2.

When the neon tube is not conducting, the capacitor recharges

Discharge Path Forms Tree

Mullard in England made this tree-like pattern with one of their linear accelerators. Electronics from the accelerator penetrated the polished surface of the plastic block causing a charge to accumulate inside the block. The charge was released by inserting a sharp pin in the bottom, resulting in the tree effect which shows the discharge path

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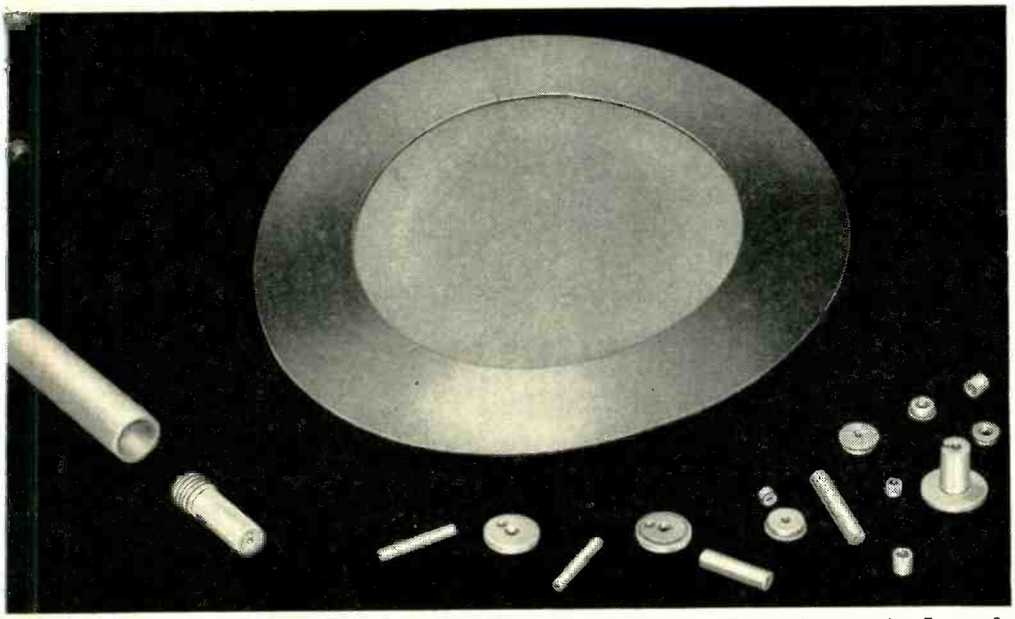

INSULATORS of TFE-fluorocarbon resins withstand severest climatic and flight conditions. High dielectric strength, moisture repellence, keep 1 KW of RF power isolated even in rarefied and humid air. (Antenna by Dorne & Margolin, Inc., Westbury, N.Y.; parts machined from TEFLON TFE-fluorocarbon resins by Tri-Point Plastics, Inc., Albertson, L. I., N. Y.)

TFE-fluorocarbon resins are among the few insulators that remain effective at microwave frequencies under severe conditions of mechanical and climatic shock. This is proven by their use as insulators in flush antennas for supersonic and near-sonic aircraft such as the Boeing 707.

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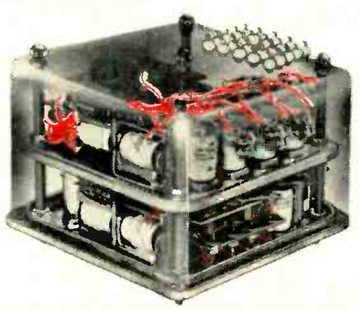
WIRE INSULATION and sleeving of TEFLON TFE-fluorocarbon resins permit tight wiring in this miniaturized relay unit for the supersonic B-58. (Unit by Potter & Brumfield, Inc., Princeton, Ind.; wire and sleeving by Warren Wire Co., Pownal, Vt.)



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through R_2 until its terminal voltage equals the supply voltage.

Best operation is secured with this circuit and its derivatives when resistance is kept high, capacitance low, and R_2 is very much greater than R_1.

Applications

Both circuits were developed for use with meteorological instruments. The first works extremely well with an inductance connected from trigger input to ground. The initial turning on of the trigger circuit supplies the start pulse, and the flyback from the inductance when the circuit is opened provides the shutoff pulse. The second circuit functions excellently as a pulse-stretcher. Within a wide range of trigger pulse repetition frequencies, the duration of the output pulse is always the same.

Diodes Offset Silicon Transistor Heat Drift

By **David H. Bryan**
Hawthorne, Calif.

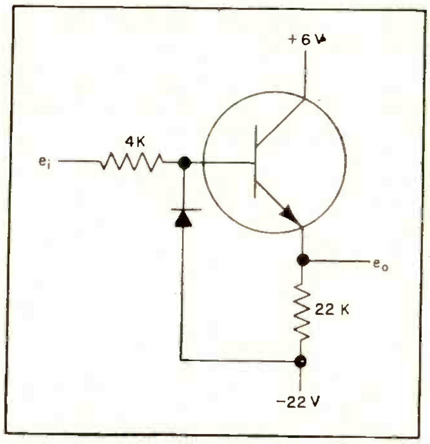

FIG. 1—Germanium diode with 4,000-ohm input resistor compensates drift in silicon transistor amplifier

IN BOTH germanium and silicon transistors, increased temperature decreases resistance of both the collector-to-base and emitter-to-base junctions. For germanium the change in the collector junction is sufficiently large to account for practically all heat drift effects. However, in silicon the change in

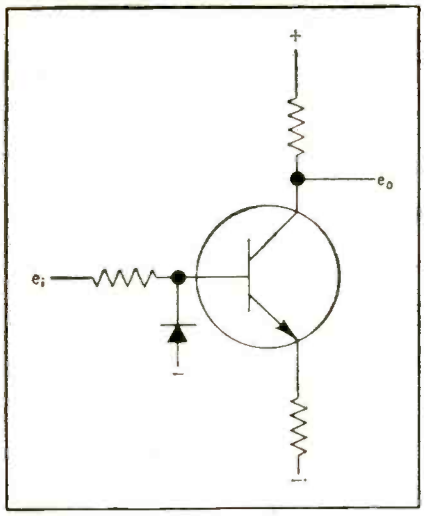

FIG. 2—If too much compensation results in this circuit, part of diode current can be bled to ground

collector-to-base junction resistance is practically negligible. The change in resistance of the emitter-to-base junction accounts for most of heat-drift effects. As a matter of fact the change in emitter-to-base resistance with changes in temperature is greater for silicon than for germanium because of the higher resistivity of silicon.

There are several methods of compensating heat drift in silicon transistor d-c amplifiers.

For an *npn* silicon emitter follower with 1-ma emitter current, output rises about 100-mv as room temperature rises to 55 C. This drift can be offset by adding a 4,000 ohms in series with the base and a back-biased germanium diode in parallel with the base. Over this temperature range diode current changes about 25 microamperes. This current through 4,000 ohms lowers voltage on the base 100 mv to provide compensation.

Using this network, the output variation with heat was found to be steady to within 10 mv. Since input impedance of the emitter follower is high, the 4,000-ohm resistor has little effect. The shunt diode offers about one-megohm resistance, which is also not significant.

A similar arrangement of compensation can be used for an amplifier circuit using emitter-resistor degeneration. If too much compensation results it is better to bleed part of the diode current to ground than to reduce the drop across the diode. This is because diode behavior is inclined to change operating point at low voltages but levels off at 20 volts or more. Hence more consistent behavior among diodes is obtained if the drop is maintained at twenty volts.

Applying this method to grounded-emitter transistor stages is not so effective unless several silicon diodes are used in series. In this type circuit the diode is in series with the collector and load resistor and is forward biased. The output can be thought of as the output of a two-input adding circuit comprising

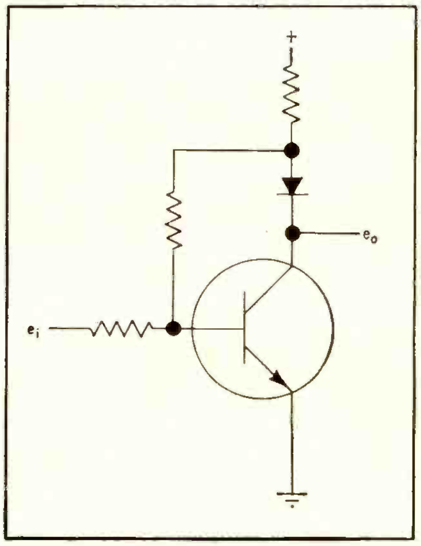

FIG. 3—Silicon diode with transistor junction form adder circuit to offset temperature drift

two diodes that drift the same amount with heat changes. However, the effect of each diode is opposite in sign and hence they tend to cancel.

Where a back-biased diode is used, it should be regarded as supplying a compensating current. This diode must be germanium since the leakage of silicon is negligible for these applications. On the other hand, when a forward-biased diode is used, silicon is a little better because there is more variation with heat. This diode should be regarded as a voltage source that provides a compensating voltage.

Electronics Saves Punch Press Dies

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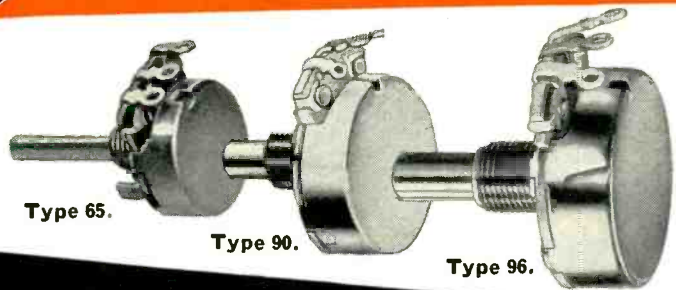

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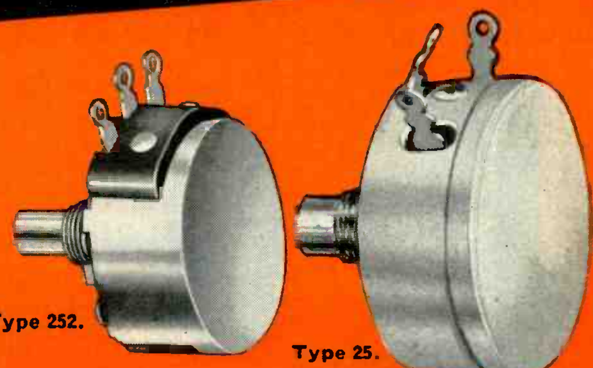

GENERAL SPECIFICATIONS

	MIL-R-19A		MIL-R-94B			
	RA20	RA30	Char.	RV2	RV4	RV5
Resistance Range (ohms)	3-15K	3-25K	X & Y	100-2.5 megs	100-5 megs	250-2.5 megs
Rotational Life	5% max, 25,000 cycles		X Y	10% max, 15,000 cycles 10% max, 25,000 cycles		
Load Life	3% max, 1,000 hours, rated load, 40°C		X Y	12% max, 1,000 hours, rated load, 70°C 10% max, 1,000 hours, rated load, 70°C		
Moisture Resistance	10% max, Method 106, MIL-STD-202, 3.5 megs min insulation resistance		X Y	10% average, 14% max, Method 106, MIL-STD-202, 50 megs min insulation resistance 6% average, 10% max, Method 106, MIL-STD-202, 100 megs min insulation resistance		
Low Temp. Storage	4% max		X Y	4% max 2% max		
Low Temp. Operation	4% max		X Y	4% max 3% max		
Thermal Cycling	4% max		X Y	10% max 6% max		
Acceleration	3% max		X & Y	3% max		
Shock	2% max		X & Y	2% max		
High Freq. Vibration	2% max		X & Y	2% max		
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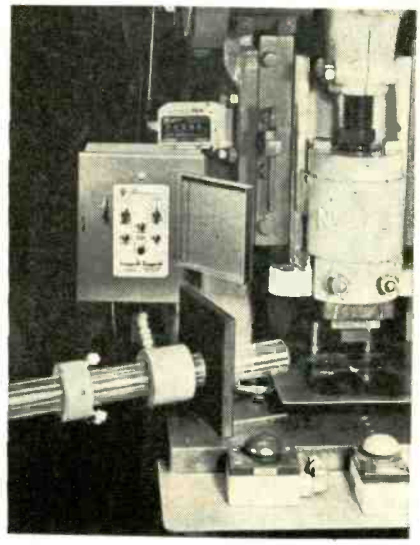
The Exclusive Specialists in Precision Mass Production of Variable Resistors



Punch press is stopped to avoid breaking die if punched piece is not ejected through r-f coil mounted on tube

presses is resulting in increased production.

Heart of the Robotron Corporation's die-saving device is a detector in the form of an r-f coil mounted on a cast acrylic tube. The detector responds when a stamped piece is not ejected by stopping the press from completing the stroke. This problem, called double heading, is a prime cause of die breakage.

The ejected piece is pushed through the tube by compressed air. As the piece goes through the r-f field, a relay is tripped. If a piece fails to pass through within a specified time, the relay contacts remain open and the press is stopped.

By eliminating double heading, less care is required by the operator. In addition, faster automatic feeds can be used.

A modification of the same detector can be used to count pieces.

UHF to Guard Fire Trucks

Transmitter Activates Lights at Intersection to Warn of Approaching Fire Vehicle

RECENTLY tested and planned for use in New York City's congested traffic is a uhf radio-controlled warning-light system designed to promote safe passage of fire vehicles answering emergency calls. The device, which is not associated with

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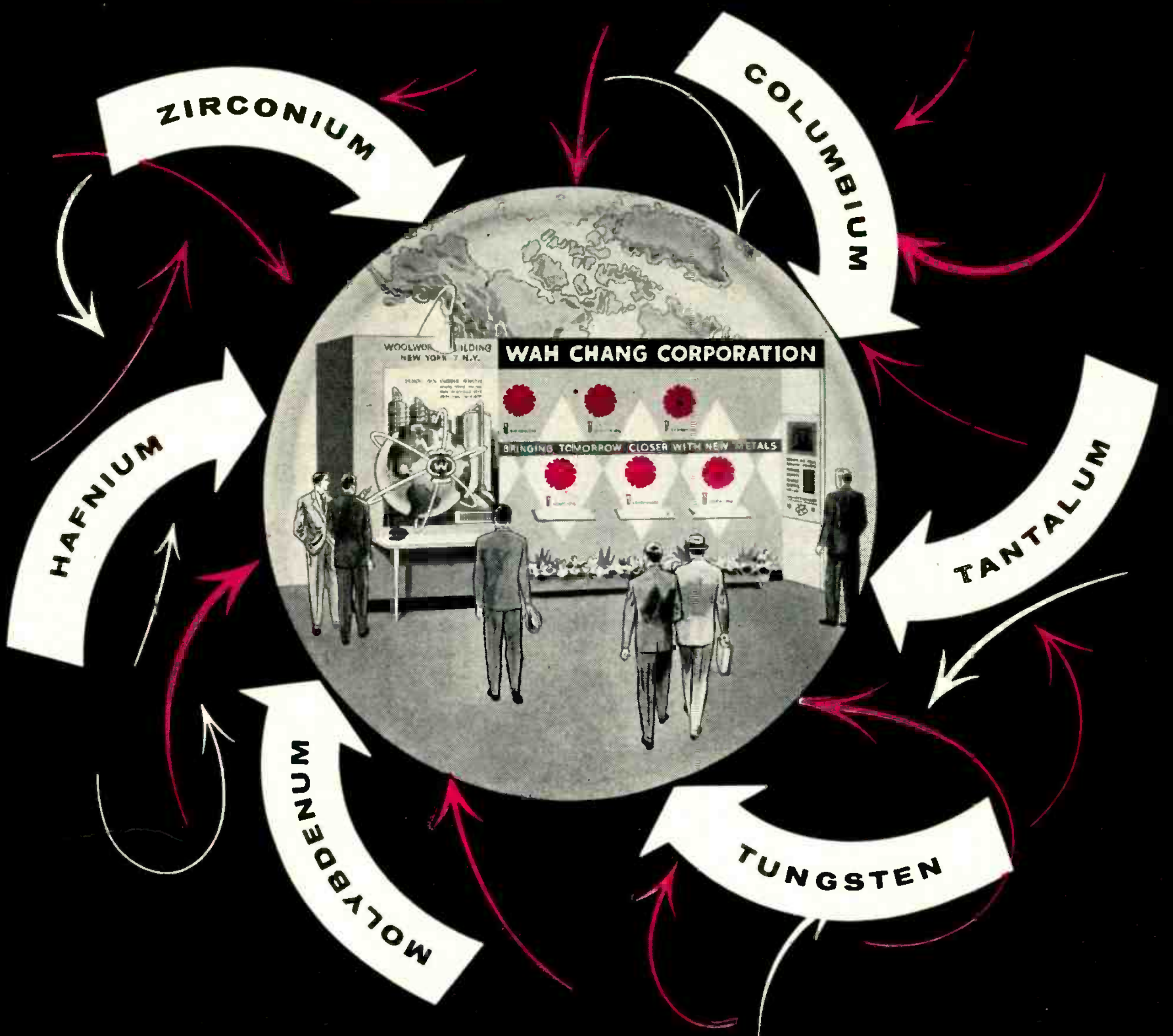

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Wah Chang Corporation metals are opening new horizons for the expanding electronics industry . . . new heights in high temperature performance, in absolute corrosion resistance, in space and weight reduction, in reliability!

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operation of city's traffic light system, is expected to reduce accidents to fire equipment and to benefit motorists.

The system consists of a three-watt f-m transmitter that is installed on the fire vehicle and operated by the driver. It activates a red beacon and four yellow signal lights in a transistorized receiver located on poles near the intersection. Developed by the fire department radio division and built by Motorola, the system uses a dual-tone decoded signal and carrier and is expected to operate on a frequency around 900 mc when final plans are adopted.

The transmitter generates sinusoidal tones in audio band along with the carrier to ensure signal capture by two-reed decoders employed in the receiver. Upon signal decoding, relays are energized to activate either red beacon or yellow lights or both.

The two-reed decoders are necessary to handle two pairs of dual-tone decoded signals, North-South and East-West, which are generated upon manual operation of two toggle switches on the transmitter panel. Operation of the N-S or E-W switch results in activation of the yellow lights facing in the selected direction. The succeeding switch operation causes deactivation.

Tv Controls Traffic

Bobby controls traffic lights by watching monitor as closed-circuit tv cameras see vehicles around bends and over bridges in Durham, England

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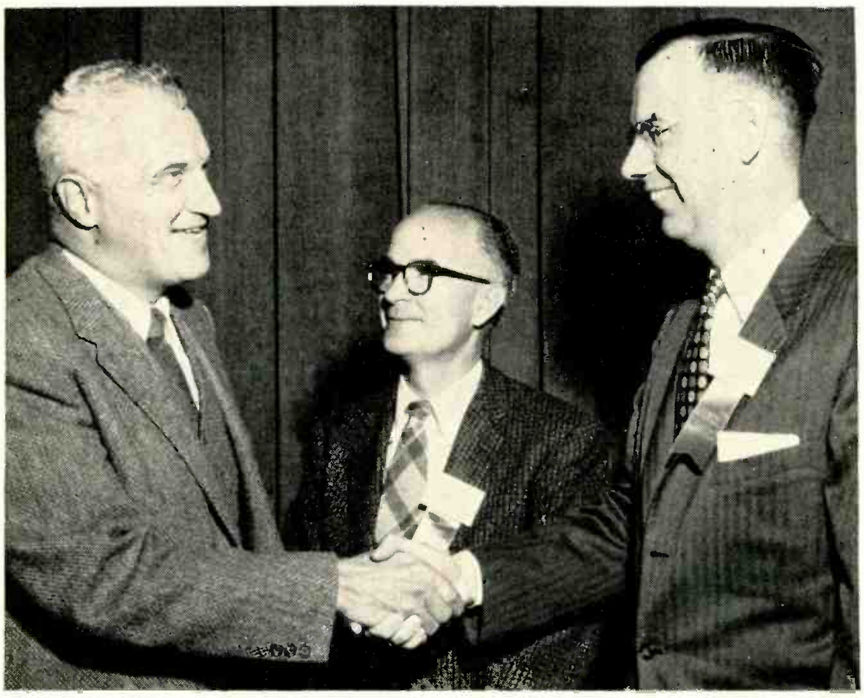
Transistors After Ten Years Of Development



Tenth anniversary of a little transistor which performs like a giant, invented by a little man who thinks giant thoughts. Left to right: Dr. G. P. Harnwell, President of the U. Of Pennsylvania; Dr. William Shockley, Noel Laureate, and Dr. J. H. Milligan, Jr., Chairman of the 1958 Transistor and Solid State Circuits Conference

IN THE TEN YEARS since Bell Labs announced its invention, the transistor has risen from an impractical 25 mw laboratory device to one of the most widely used components in electronics.

More than 28 million were sold last year at an average cost of $2.40 each. This price was twenty percent lower than the previous year. Dr. William Shockley has said he thinks a reasonable estimate for average cost five years from now is about twenty-five cents.

Transistor theory of a decade ago offered no promise for high frequency operation. One kilo-megacycle transistors are available today, and there is no reason to doubt that this will go up to ten kilo-megacycles in five years, and 100 kilo-megacycles in ten years. Limits set by the atomic structure have hardly been approached.

Can We Do It

As in all things, these advances will require a thorough analysis of the problems by imaginative men confident of their abilities. The papers delivered at the 1958 Transistor and Solid State Conference in Philadelphia, and the ambitious attitude of men attending the conference dispel any doubts on this count.

Many new materials and techniques for building transistors which operate a 500 mc or higher, were discussed at the conference. General feeling was that a very rapid birth of ideas will continue for at least the next few years.

In the final analysis, however, regardless of what secondary techniques are used, high frequency limit is determined by transistor geometry. Transistor dimensions determine the transit time which sets the theoretical high frequency limit for a particular material.

In a paper delivered at the conference, Dr. Shockley compared the advances made in transistor frequency response with changes in construction. Point contact transistors had the collector and the emitter mounted in the base in close proximity to each other. The ability to physically place the collector and emitter in the base without having them touch was the limiting factor.

Junction transistors were a tremendous improvement over the point contact type. N and P materials in the junction transistor are joined in one crystalline structure, with continuity of the crystalline lattice maintained across the junction. Dimensional control possible with materials grown into one crystalline structure is obviously much better than would be possible by placing the two elements near each other.

Increased knowledge in semiconductor physics, especially at the P-N junctions, and the development of new materials have resulted in the constant improvement of junction transistors. Many of the techniques now under investigation to improve transistors will have a short life. Some will probably never reach the practical stage. Time and competition will determine which approaches are best.

Dr. Shockley feels that one of the final solutions will be to eliminate the base connection entirely, and supply the transistor with an external d. c. Commercially available transistors up to this time have all been three element devices requiring connections to each element. He feels that the junction size necessary to attach a lead to the base connection is too large for high-frequency development.

A transistor diode originally developed at Bell Laboratories is now in pilot production at the Shockley Semiconductor Laboratory of Beckman Instruments Inc. It has a negative resistance (i.e. will produce amplification) when the proper dc bias is applied to it.

The negative resistance results when excess electrons or holes crossing a P-N junction with a high reverse bias generates secondaries which form an avalanche multiplication. Matching the characteristics of the deathnium centers to the properties of silicon

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aids the increase in carrier injection when current in the P-N junction is increased.

Only the dimension of the transistor diode which is in the direction of current flow must be small. All other dimensions can be large. Since it is not necessary to connect a lead to any of the larger junctions, the dimensions in the direction of current flow has no physical limitations.

Stable high gain amplifiers can be made by combining transistor diodes and gyrators. Shockley claims that less expensive, higher performing digital computers made of only transistor diodes and ordinary diodes are possible.

New Companies Needed

Organization of a few companies with the sole function of manufacturing semiconductor crystal material would be a great boom to the transistor industry. Starting point for a good deal of development work, which must be done on semiconductor devices, is a thin slice of a semiconductor crystal. The equipment necessary to produce crystals without imperfections, and with accurately controlled impurity concentrations is very costly. Suppliers who would sell semiconductor crystals to companies not able to absorb the initial equipment cost are needed in the industry.

It is also possible that instead of growing massive crystals and slicing them—a process in which most of the crystal ends up as dust—machines could be developed to grow plates. The plates which would be the same thickness as present-day slices would be better suited to mass production techniques.

Practical Production

Dr. Shockley made a statement in his talk which summarizes very well the practical position of transistor development:

"If any area is weak, it seems to me to be along the border line between exploratory research, with knowledge as an adequate goal, and development for production, with the aim of finding a useful production process, whether or not understood. I believe the field

would advance faster if somewhat more fundamental understanding were sought for the processes likely to be useful in production."

Expandable Rectifier For High Voltage

Silicon diodes joined together to make a High Voltage Rectifier at low cost

SILICON RECTIFIERS which can be assembled into series chains make high-voltage rectification available at a mass production price. Inexpensive threaded bushings are used to screw the required number of individual units end-to-end.

The rectifiers produced by the Rectifier Division, Audio Devices, Inc., 620 East Byer Road, Santa Ana, California, can also be used singly for low and medium-voltage applications.

A rectifier with a peak inverse rating of 12,000 v and a forward current rating of 500 ma can be made in about ten minutes by screwing together thirty A750 units, which have a peak inverse rating of 400 v.

High Power

Substantial amounts of power are available by using unit with higher current ratings. Thirty 40F1 units, which also have a peak inverse rating of 12,000v, and a maximum forward current rating of $1\frac{1}{2}$ amperes can provide 6 kw of rectified power in a single-phase half-wave circuit.

Maximum Ratings

Individual units now available for the expandable rectifier are sealed silicon diodes with peak inverse

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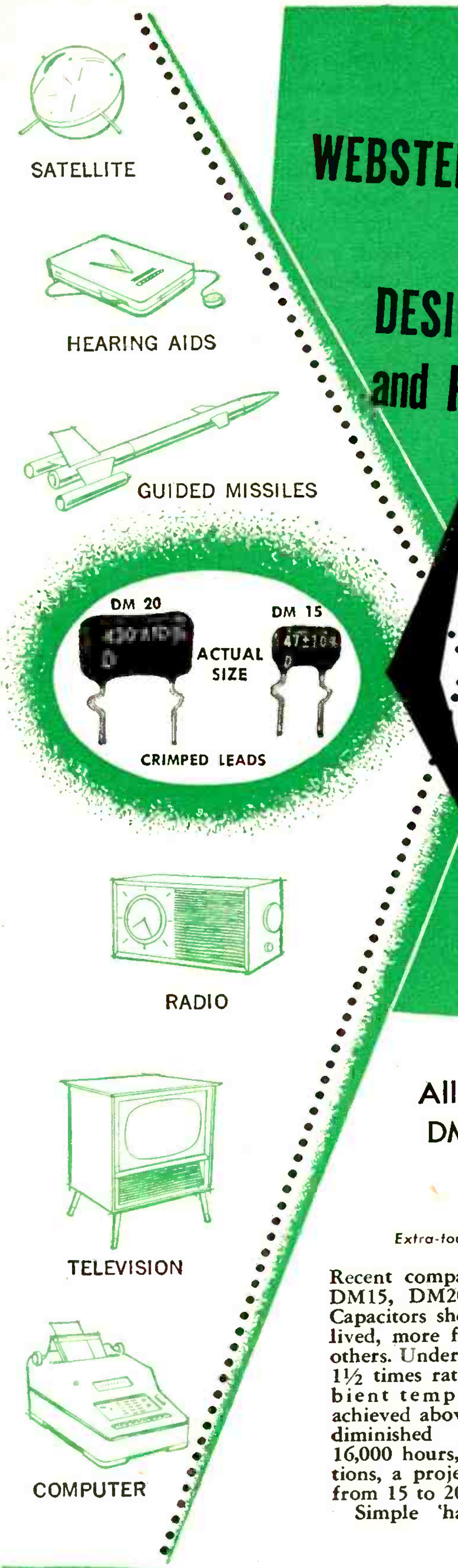
longevity (lon jev'i ti) *n.* Great length of life.

DESIGN, DEVELOPMENT and PRODUCT ENGINEERS SAY:



El-Menco *Dur-Mica* CAPACITORS

Wherever your specifications call for long-lived *miniaturized reservoirs*, El-Menco Dur-Mica Capacitors offer **PRE-PROVEN LIFE EXPECTANCY OF UP TO 20 YEARS.** These mighty midgets carry mammoth loads for *lasting* peak performance . . . guarantee you confident, worry-free planning.

All these points make El-Menco *Dur-Micas* DM15, DM20, and DM30 the finest obtainable.

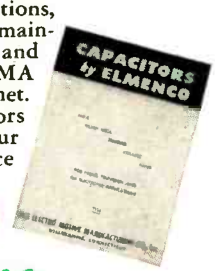
1. LONGER LIFE
2. POTENT POWER
3. SMALLER SIZE
4. EXCELLENT STABILITY — SILVERED MICA
5. PEAK PERFORMANCE

Extra-tough phenolic casings prolong life, increase stability over wide temperature range.

Recent comparison tests of El-Menco DM15, DM20 and DM30 Dur-Mica Capacitors showed them to be longer-lived, more fatigue resistant than any others. Under stepped up conditions of 1½ times rated voltage at 125° C ambient temperature, each in turn achieved above standard ratings of undiminished performance well past 16,000 hours, or, under normal conditions, a projected working lifetime of from 15 to 20 years!

Simple 'hairpin' design facilitates use in tight spots in television, radio, computers, miniature printed circuits, guided missiles, hearing aids and countless civilian and military applications, with little or no replacement and maintenance cost. All environmental and electrical requirements of RETMA and MIL C-5 specs have been met. Test El-Menco Dur-Mica Capacitors for yourself with our help. Our engineering staff is at your service upon request.

write for Free samples and catalog on your firms letterhead.



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El-Menco *Capacitors*

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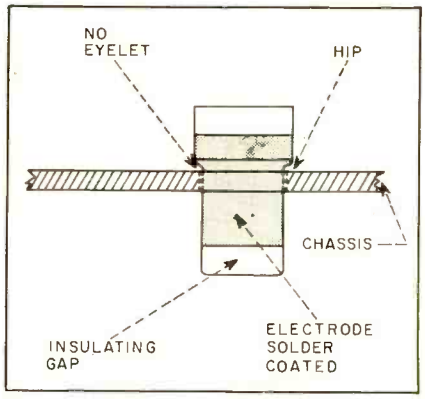
ratings ranging from 100 to 400v and maximum forward current ratings ranging from 500 ma to $1\frac{1}{2}$ A.

Assemblies can be rated at the product of the number of units times individual peak inverse ratings, without derating. A negative temperature coefficient of resistance gives a self balancing effect which tends to keep the voltage evenly distributed over the units in the chain, to limits well within the unit ratings. Up to about 20,000v the assemblies offer simple, inexpensive rectification. At higher voltages, precautions have to be taken to control corona and ionization.

Hip Mount Capacitors Save Space

DESIGNED TO SAVE SPACE and reduce assembly costs, the feed thru capacitor is particularly useful when compactness is an essential part of equipment design. The units are $\frac{3}{8}$ in. long, and protrusion from the chassis plane is only $\frac{9}{64}$ in.

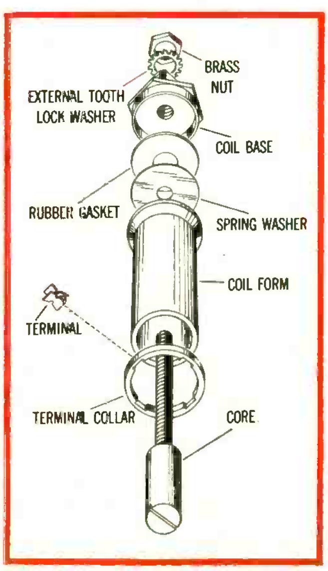


Hip keeps capacitor at uniform height and snug in hole

The CFT capacitors, designed by Cornell-Dubilier Electric Corp., South Plainfield, N. J. are self-positioning. The hip-ridge, holds insertion of the capacitor in the chassis hole to a fixed, always-uniform distance. No jigs are needed to maintain position for soldering the capacitor to the chassis.

The capacitor electrode is hot-solder coated. This feature permits the capacitor to be soldered to the

UNIVERSAL CERAMIC COIL FORMS FOR MILITARY AND COMMERCIAL APPLICATIONS



National Company, one of the nation's oldest suppliers of quality coils and coil forms, now introduces, for immediate delivery, a new line of ceramic coil forms, engineered to meet the most rigid military and commercial applications.

Available in 5 standard sizes, with or without terminal collars. Terminal collars accept up to four terminals per collar.

Internal, pre-set torque spring provides smooth, vibration-proof means of positioning and locking the adjusting cores. Keep coils tuned as set, even under severe vibration and shock.

Powdered iron cores available in choices of standard and long-core lengths. Color-coded to indicate optimum frequency ranges.

All material used are in accordance with applicable MIL-Specs.

Coil forms, collars, and terminals available at your National Parts Distributor. Coil forms supplied with spring washer, rubber gasket, coil base, external tooth lock washer and brass nut. Cores may be ordered from National Company. Pre-assembled forms to your prints quoted by National Company upon request.

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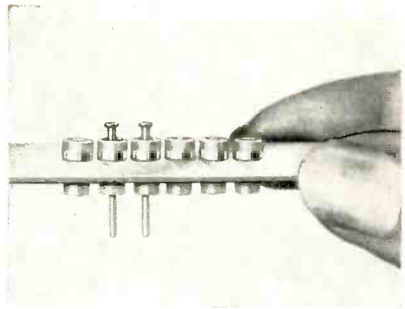
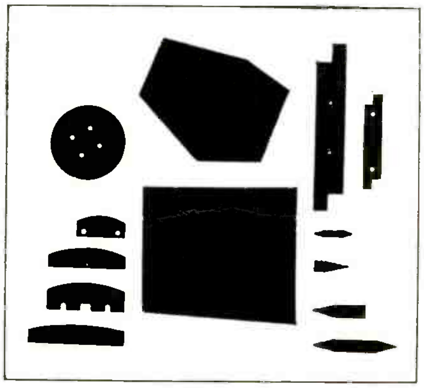


Feed-thru capacitor saves space and lowers assembly cost

metal chassis, eliminating use of eyelet fasteners.

Type CFT capacitors have a d-c working voltage of 600 v and are available in capacitance values from 4.7 $\mu\mu$f to 1000 $\mu\mu$f. Diameters of the head and shank ends are $\frac{7}{32}$ in. and 9.187 in. respectively. Operating temperature range is -55 C to $+85$ C.

Metal Film Mica Attenuators



Metal film mica can be easily cut into any desired shape

HIGHLY stable microwave attenuators, made of a thin film of pure metal deposited on scratch-free mica a few thousands of an inch thick, reduce RF leakage. Small size of a metallized mica high frequency variable attenuators permits a smaller slot width for guillotine design. This is desirable since RF leakage at the slot affects attenuation characteristics.

Electrical and environmental characteristics of the attenuator, developed by Filmohm Corporation, 48 W. 25th St., New York 10, N. Y., compare favorably with metallized glass elements. The metal film is

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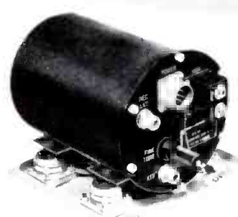
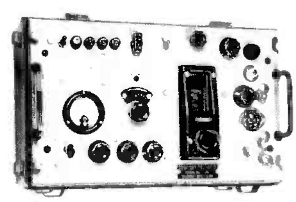
HETERODYNE FREQUENCY METER . . . accurate to .01% frequency measurement 100-10,000 mc (TFM-186).



GUIDED MISSILE BEACONS . . . high sensitivity, proven reliability available in S and L bands.



X-BAND POWER METER. . . frequency meter and calibrated signal generator, self-contained, immediate delivery. (TSG-147D)

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NEWS: FOR MISSILE DESIGNERS AND MANUFACTURERS

NEW ACCELERATION ACTIVATED SWITCHES FOR IN-FLIGHT MISSILE CONTROL

This miniature acceleration operated switch is designed for missile applications requiring positive switch functions at first motion, during, or after boost. Versatile locking arrangement permits cycling or recycling of switch during various phases of flight (requires 30 watt signal). It is conservatively rated and is designed for expendable one-time use.

The switch may be pre-set to activate at any first-motion level between 5 and 20 G's longitudinal acceleration. Average transverse accelerations can be tolerated during operation. Design permits locking or unlocking at accelerations 10 G's in excess of pre-set level. Switch functions within 50 milliseconds after reaching operational acceleration.

ADVANTAGES:

- Small size, uses standard BuOrd #18 synchro mount.
- Light weight, approximately 12 ounces (depending on model).
- Rugged. Meets military specifications for aircraft and missile use.
- Standard switch arrangements: 5 SPST make, break, or pulse. Custom arrangements available with minimum delay.
- Sealed construction permits use in explosive atmospheres.
- Standard temperature range −65°F to +250°F. Extended range to +500°F available with modified ratings.

NEW HIGH-SENSITIVITY S-BAND BEACONS

New superheterodyne S-Band Beacons for guided missile and drone-control applications. These receivers feature light weight, small size, excellent reliability, ruggedized construction.

PERFORMANCE DATA

Receiver-Transmitter

- Over-all triggering sensitivity: −65 DBM
- Receiver frequency: 2700-2900 mc
- Receiver frequency stability: ±2 megacycles per second
- Image rejection: 50 db minimum
- Peak transmitter power output: 100 watts minimum
- Transmitter pulse width: 0.75 microseconds
- Transmitter repetition rate: 200-1,000 pps
- Transmitter stability: ±2 megacycles per second
- Transmitter frequency range: 2850 to 2950 mc
- Size: 9″ x 5¼″ x 5″
- Weight: 8 lbs.

Power Supply

- Input Voltage: 115 volts at 400 cycles
- Input Power: 80 watts
- Size: 7″ x 5″ x 4¾″
- Weight: 5½ lbs.

A 28 volt DC supply is available on special order.

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sealed with a micro thin protective coating of Quartz.

Another application of mica is in rotary attenuator design which uses 0.001 thick mica sections, electrically matched at either end. Standard mica sheets are available from 0.001 to 0.005 in. thick, and in resistivities from 25 to 400 ohms per square. Elements can be hand cut to customer requirements and an instruction bulletin is available which details a method of hand cutting eccentric shapes.

New Components May Double Radar Range

DOUBLE the range and accuracy of antimissile radars is the goal of an all-out effort by Sperry Gyroscope. Practical application in specific U. S. missile systems of some of the newer microwave elements is the basis of the program.

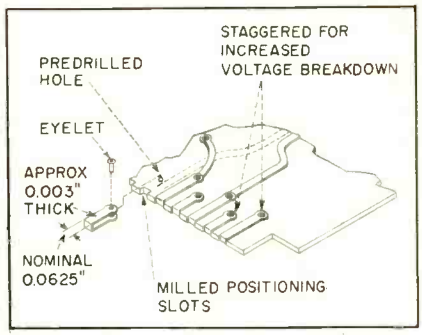
The firm will organize an additional applied physics laboratory for new microwave solid-state devices for missiles. Thirty scientists from Sperry plants will start the study with a three-day seminar to examine current progress in the field.

E. J. Venaglia, manager of Sperry's microwave electronics division, points out that although essential theory and phenomena have been known for years, many of the devices that could improve radar have remained laboratory curiosities.

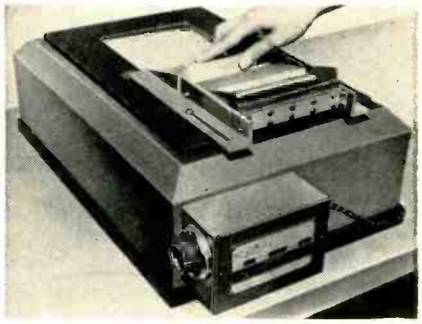
The application of semiconductor and ferromagnetic materials as concentrators, manipulators or generators of radar energy will be investigated. These devices include passive ferrite circuit elements, masers and parametric oscillators.

Preformed Contacts for Printed Wiring

INCREASED RELIABILITY has been attained in the fabrication of photo-etched, copper-laminated, printed circuit boards by the use of preformed contact strips and a solder-coating. Developed jointly by Her-



U-shaped copper contact strips anchor printed circuit conductors at mating edge of board



Silicon-rubber squeegee is used after solder bath to provide smooth coating on conductors

bert Winsker and Horace L. Walters of the Norden Laboratories Division, Norden-Ketay Corp., White Plains, N. Y., these techniques have been applied to printed circuits for military applications.

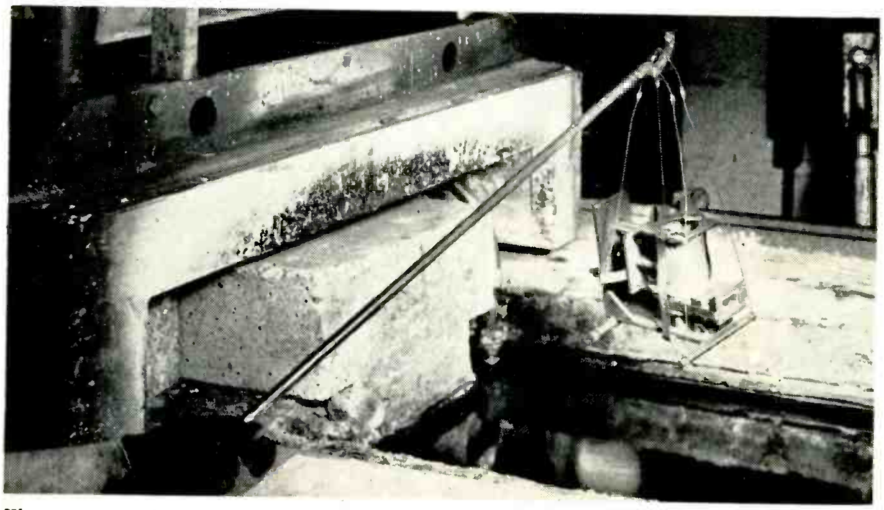
U-shaped beryllium copper contact strips are positioned in milled slots along the board's mating edge and secured either by eyeleting or riveting through previously punched holes. The positioning slots are cut during the key-slot milling operation, avoiding an additional operation.

To provide a superior conductive and protective coating, the strips can be plated before assembly. Additional strips can be added conveniently at any time to accommodate new circuit requirements. The metal strips, while providing a more positive contact with the receptacle, will not loosen after long usage. Since eyelets can be used to secure the strips, the technique is especially suited to double-sided circuit board designs where eyeleting is a normal method of completing the circuits from one side of the board to the other.

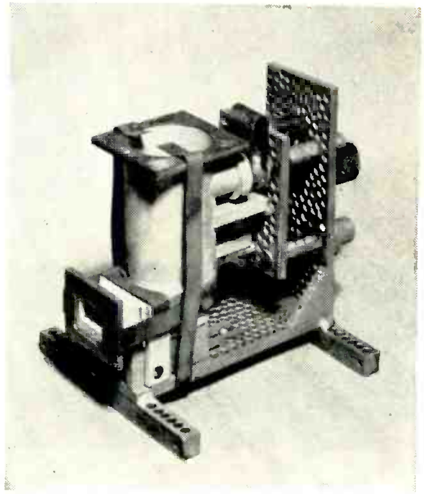
The technique provides simpler etching in less time and money.

Dip-Brazing Eases Machining of Complex Parts

By JOHN GOMBOS John Gombos Co. Irvington, N. J.



Klystron tube mount in holding fixture is lifted from molten salt bath. Operator uses "fishpole" to avoid 1,100 F heat



Spring-loaded fixture holds mount together during brazing

ALUMINUM DIP-BRAZING simplifies fabrication of complex components and permits fuller use of aluminum parts of varying thicknesses, shapes and alloys. The method opens up design possibilities prohibited by more difficult methods.

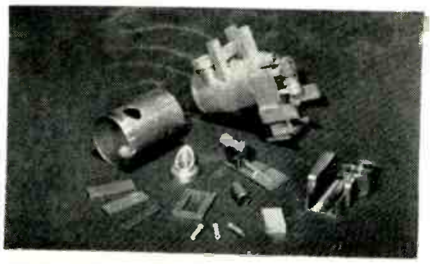
A klystron tube mount made by John Gombos Co., Irvington, N. J., is dip-brazed of 12 parts machined from wrought stock and 2 cast parts. It was formerly produced as a casting, which made finish machining very difficult.

Mount parts are now finish machined before assembly and carefully deburred. Burrs or imbedded grit will block the brazing material, which flows into joints by capillary action. Joint strength results from surface penetration.

Soil and oxides are removed by vapor degrease and chemical treatment. A dip in hot sodium hydroxide and rinse is followed by a dip in nitric-hydrochloric acid, cold and hot rinse.

Parts are assembled in a fixture, with brazing shims and formed wires in place at the joints. The proper amount of brazing material to produce a clean, well-filled fillet with no overflow is determined by trial.

Fixture accuracy is critical. Stainless steel or Inconel must be used to avoid contaminating the salt bath. Massive parts (of the fixture) are lightened by drilled holes to avoid heat distortion, maintain salt temperature, reduce salt dragout and hasten heating and cooling. Parts are not allowed to butt against a solid wall. Spring-loading the fixture holds parts rigidly in place to maintain tolerances of 0.002 inch.



Cast and machined parts in front of assembled mount

After fixturing, the assembly is preheated in an oven to 1,000F. It is then immersed in the molten flux salt. The salt bath is held within 2 degrees of 1,100 F. The maximum permissable temperature variation is 5 degrees.

Depending on massiveness of the parts, time in the bath may be 10 seconds to 3 minutes. Timing is determined by trial. The tube mount requires 30 seconds for brazing.

The brazed assembly is cooled at room temperature to 200-300 F. A boiling water dip removes most of the salt. Remaining salt is removed by dipping in nitric-hydrochloric acid, cold and hot water. All salt must be removed as its chlorides and fluorides would cause corrosion later.

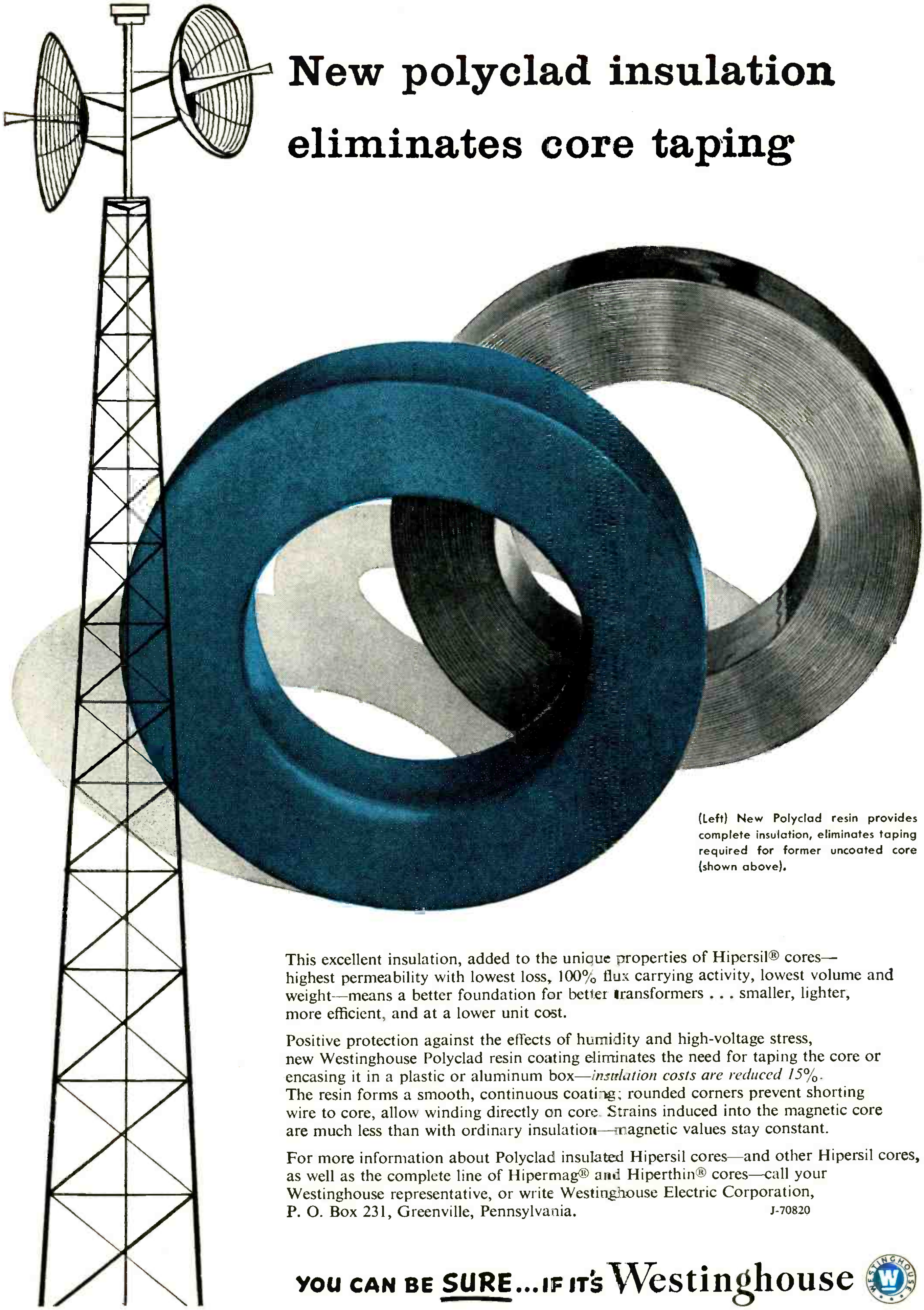
Joints may be pressure-tested or inspected visually. Since just enough brazing alloy is used to produce a satisfactory joint, an excess visible at any point may indicate a void.

Only recommended alloys are used for dip-brazing. The salt is available from Alcoa and other companies. The salt bath must be periodically tested for contamination, moisture and proper chemical composition.

Vertical X-rays Give Internal Dimensions

X-RAY METHOD devised by Howard Harlan, Dalmo Victor Co., Belmont, Calif. enables accurate internal measurements of waveguides and other components to be made directly from film. Inside contours, iris positions after r-f tuning tests, blind holes and similar dimensions have been measured

New polyclad insulation eliminates core taping



(Left) New Polyclad resin provides complete insulation, eliminates taping required for former uncoated core (shown above).

This excellent insulation, added to the unique properties of Hipersil® cores—highest permeability with lowest loss, 100% flux carrying activity, lowest volume and weight—means a better foundation for better transformers . . . smaller, lighter, more efficient, and at a lower unit cost.

Positive protection against the effects of humidity and high-voltage stress, new Westinghouse Polyclad resin coating eliminates the need for taping the core or encasing it in a plastic or aluminum box—*insulation costs are reduced 15%*. The resin forms a smooth, continuous coating; rounded corners prevent shorting wire to core, allow winding directly on core. Strains induced into the magnetic core are much less than with ordinary insulation—magnetic values stay constant.

For more information about Polyclad insulated Hipersil cores—and other Hipersil cores, as well as the complete line of Hipermag® and Hiperthin® cores—call your Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 231, Greenville, Pennsylvania. J-70820

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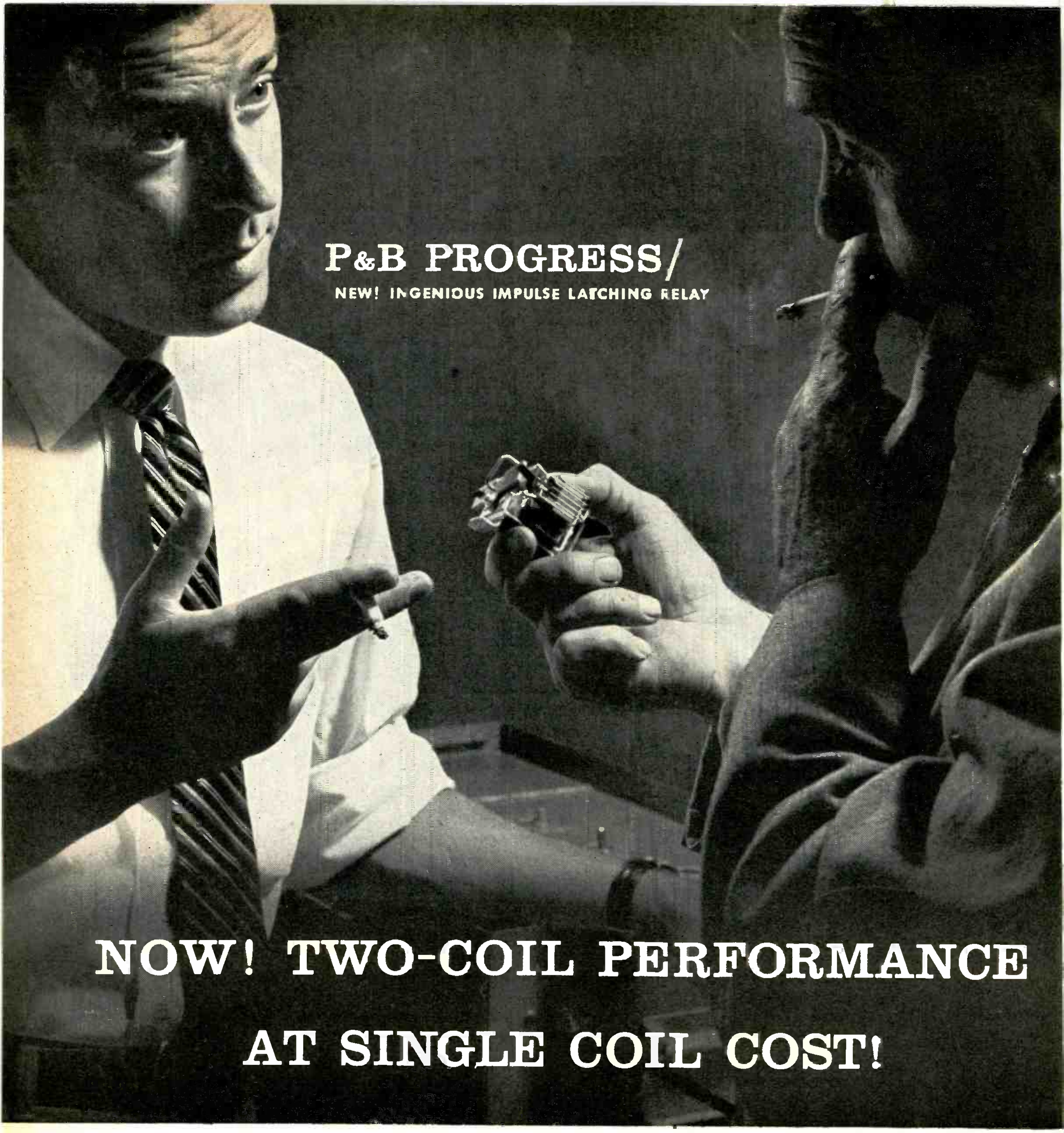
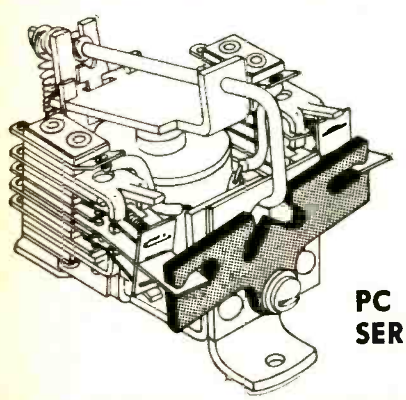
CIRCLE 147 READERS SERVICE CARD





PC SERIES

This new series, the PC, is an ingenious impulse latching relay which employs a single coil and armature to activate an insulated rocker arm. Switching is positive, fast (30 milliseconds).

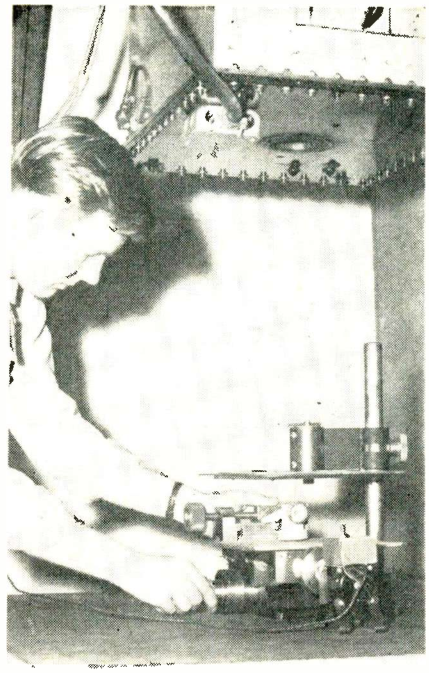
Its low cost, dependability and versatility make it ideal for a wide range of uses. For example, two leading TV set manufacturers use the PC in their remote control circuits as an "off-on" switch. It is also used by a maker of automatic garage doors. Conveying systems, automatic processing equipment, flow controls—the PC is right for these applications and many more.

Contact arrangements are available up to 4 Form C (4PDT), and the snap-action contacts are rated 5 amps. at 115 V. AC resistive. The relay may be ordered open, as shown, or in a metal dust cover.

Write or wire today for complete information.

See What's New in P&B Progress at Booth 3904-3906 IRE Show, New York City, March 24–27

POTTER & BRUMFIELD, INC., PRINCETON, INDIANA / SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY



Waveguide is positioned on Vernier table under slot in lead sheet

for quality control and design purposes.

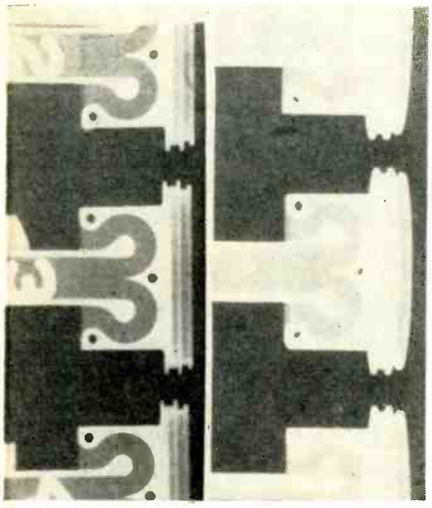
Any feature having a difference in thickness of 5 percent or more between two points may be measured. Accuracies of 0.0005 inch are obtained on parts ½ inch high and 0.001 inch accuracy on parts 1 inch high.

Enlarged or overlapping images are prevented by masking all x-rays except those which can pass vertically through a slot in a lead sheet. The part to be measured is placed on film and swept under the defined beam. Dimensions are later measured from the film in an optical comparator.

The slotted ½ inch lead sheet, backed by Plexiglas for strength, is mounted on the arm of a Vernier table. A 10 rpm motor is coupled to the table's longitudinal screw so that the table travels at 1 inch per minute.

The component is mounted in a fixture on the table so that the direction to be measured traverses across the slot. If dimensions in other directions are desired, another picture must be taken as the slot filters only vertical x-rays perpendicular to the travel.

Components must be mounted exactly square to the x-rays. Verti-



Film strips show difference between ordinary x-rays and new method (left)

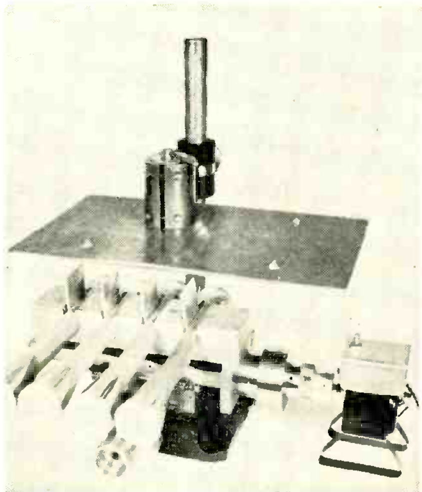


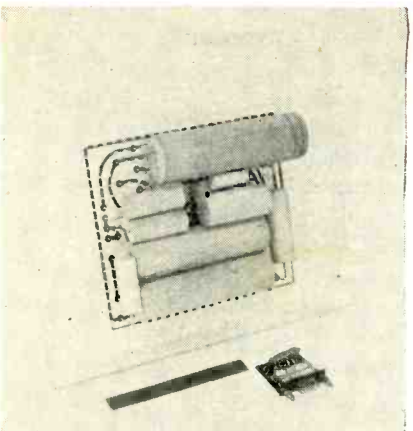
Table setup is shown here. Traversing motor is on skids so it slides with table

cal sides must be exactly parallel to the line of a plumb-bob hung from the focal point of the x-ray tube to the slot.

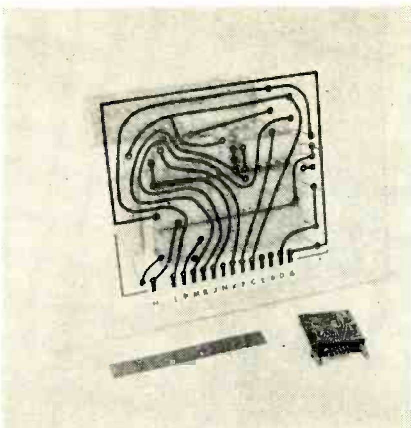
The smaller the slot, the better. However, decreasing slot size requires increases in voltage and reduced travel speed. The 1 inch per minute travel speed is satisfactory for $\frac{3}{16}$ inch aluminum using a 0.020 inch slot with 125 kvp and 10 ma source placed 30 inches from Ansco A film. Greater thicknesses may be measured by several passes. For example, three passes distinguish a change from $\frac{3}{4}$ inch to $\frac{7}{8}$ inch.

Models Simplify Circuit Planning

By **W. W. STALEY** Air Arm Division, Westinghouse Electric Corp, Baltimore, Md



Components assembled on layout board give 3-D picture of completed unit

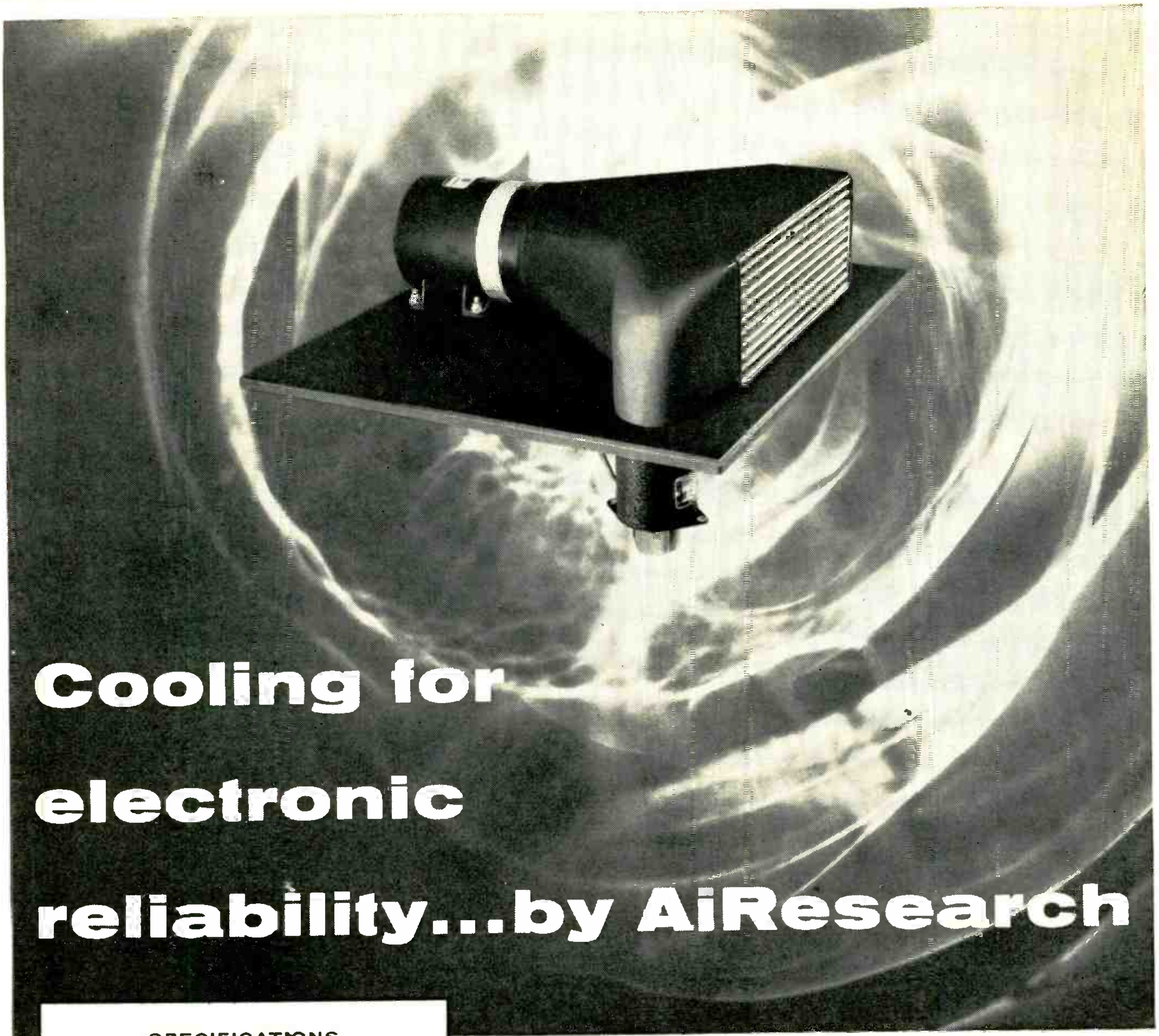


Board transparency makes taping the wiring pattern a simple procedure

THREE-DIMENSIONAL models of components, arranged on a transparent layout board, permit rapid conversion of hand-wired plug-in units to printed wiring.

The method reduces time required for conventional layout methods, time spent in sketching and resketching, arranging templates and drafting side views. In the conversion pictured, the packaging engineers had so minimized waste space that components had to be stacked very closely in order to stay within given physical boundaries.

The layout board is made of $\frac{3}{8}$ inch Plexiglas with an overall size of 12 by 14 inches. Fixed grid spacing is accomplished by drilling 0.070 inch holes with a spacing of 0.4 inch, a total of 589 holes. Hole



SPECIFICATIONS

COOLING CAPACITY	Full 1.5 kw at 50,000 ft. ambient pressure altitude and inlet conditions as follows:
AMBIENT AIR	TEMPERATURE: 10°C. PRESSURE: 1.7 psia FLOW: 3.6 lb/min
CONTAINER GAS	TEMPERATURE: 85°C. PRESSURE: 20 psia FLOW: 9.8 lb/min

The AiResearch unit shown above solves another critical electronic cooling problem in the following manner:

The larger fan, at top left of unit, draws cooling ambient air through the heat exchanger. Simultaneously, the smaller fan, at bottom center of unit, circulates dense, non-toxic sulfur hexafluoride (SF_6) through the heat exchanger and over the electronic equipment. The cooled gas maintains the sealed electronic equipment at the desired temperature.

The 20 by 24 inch honeycomb mounting base for the cooling components is designed by AiResearch to form an integral part of the pressurized electronic equipment container.

This cooling package, incorporating standard, proved components, was developed by AiResearch in minimum time. It and other air or liquid-cooled units for similar purposes are based on almost 20 years of experience in the development of cooling systems for aircraft, missile and nuclear applications.

Send us details of your problems or contact the nearest Airsupply or Aero Engineering office for further information.

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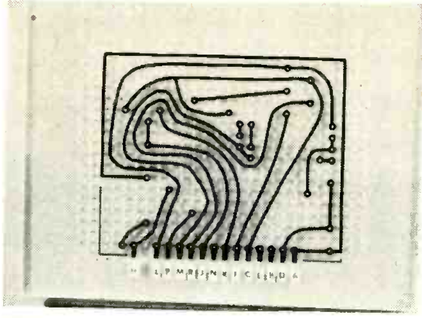
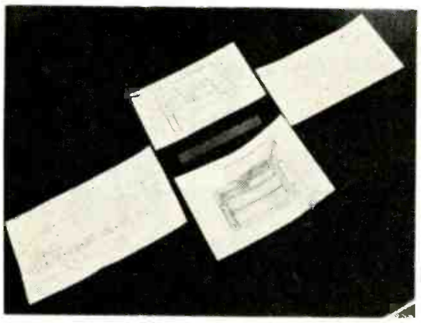
AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS



Photograph of taped layout could serve as negative for printing the circuit



Circuit layout prepared from sketches lacks clarity of models

spacing tolerance of 0.005 inch permits using the board for final conductor layout.

Component models are cut from hardwood doweling. Many components fit standard dowel sizes and near sizes may be substituted for odd component sizes. Brass welding rod 0.064 inch in diameter, which is easily cut and shaped by hand, is inserted into drilled 0.070 inch holes to represent the component leads.

Successful building and testing of laboratory models justifies confidence in the layout method. Actual units built required no relayout. Cost is negligible compared with savings rendered.

Assembly drawings could be replaced by a photograph of the final breadboard layout. The negative used for printing the circuit could be made from the tape layout on the back of the layout board.

New Kit Modifies Wire Wound Pots

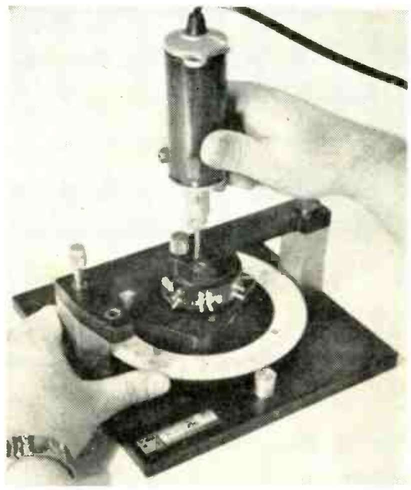
POTENTIOMETERS may be modified or made up from basic units with a new kit, supplied by Micro-Lectric Division, Micro Machine Works, Inc., Roosevelt, N. Y., for use on precision wire wound pots.

The kit enables pots to be prepared to specifications from basic units available without taps or buss bars, permitting quick field replacements. Pots may also be modified during experimental work or to satisfy engineering changes.

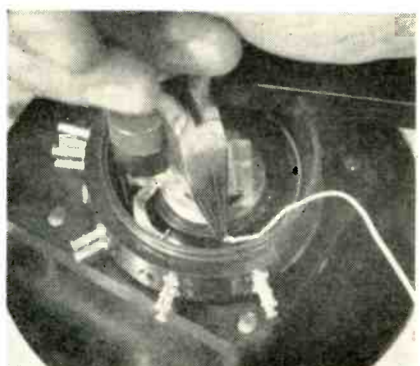
The kit contains 100 tap assemblies, 25 silver buss bar rings, buss bar cutting fixture, buss bar forming die, drill jig, electric drill and 20 other parts needed for precision drilling of tap holes and installation of taps and buss bars. A case is provided.

Potentiometer is first placed in nest of drill jig and locked in place. Tap drilling position is located by protractor in jig base. Taps may be spaced within 1.5 degrees. The tap hole is drilled through a bushing.

One-piece precious metal taps with color-coded leads are inserted in the holes. The taps are depressed with a plastic pick so that their spring pressure holds them against

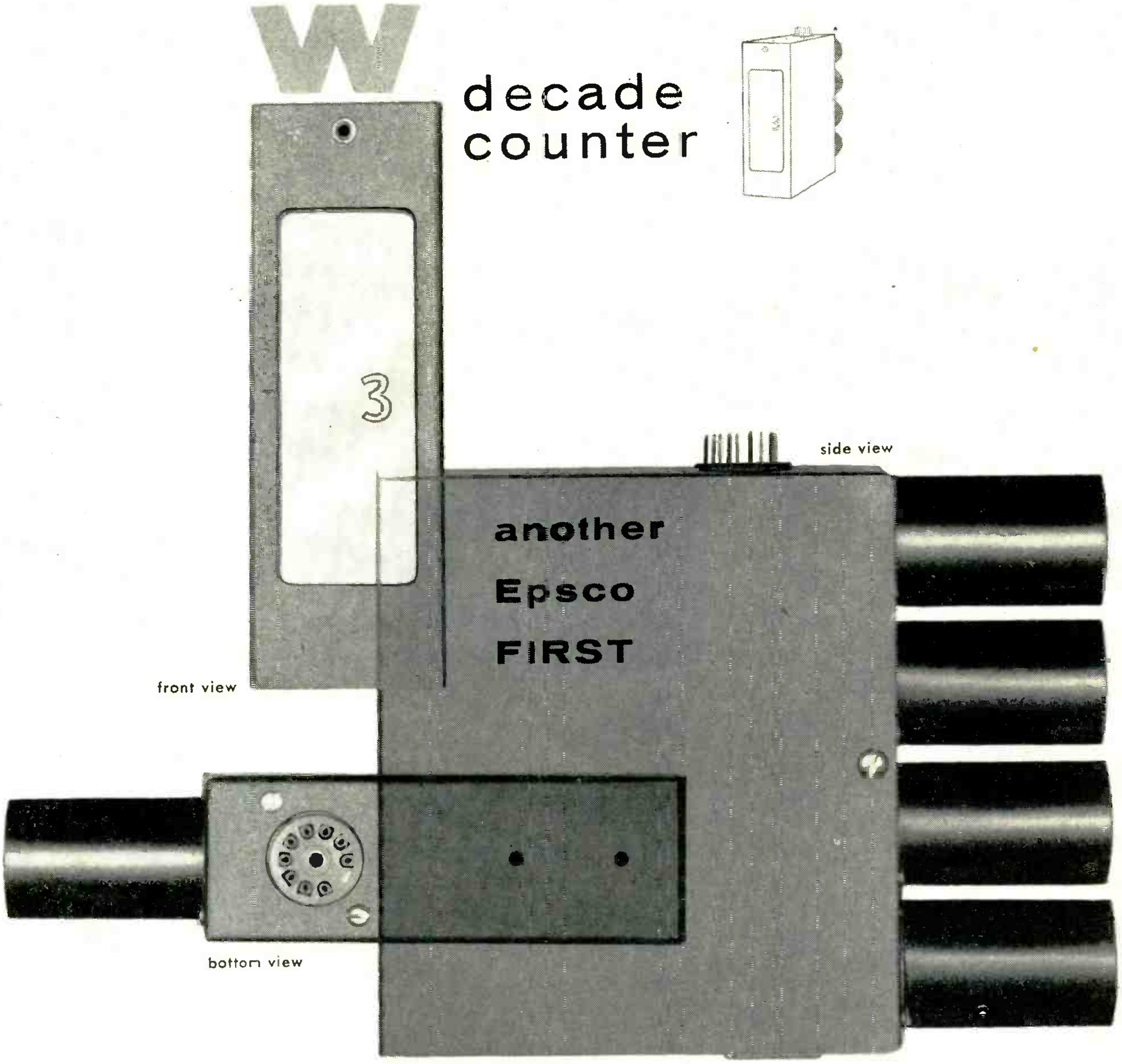


Tap hole is drilled through bushing after pot is positioned in drill jig



Tap is inserted in drilled hole

now TRANSISTORIZED decade counter



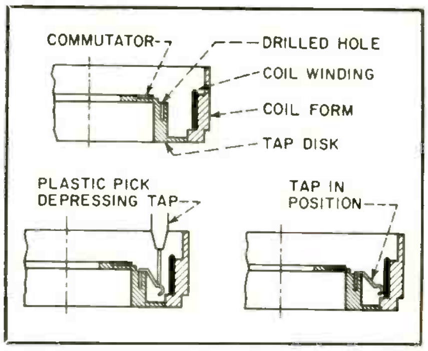
Three-fourths actual size

Once again Epsco Components scores a first . . . a completely transistorized 150KC decimal counter unit that offers unique advantages in compactness, light weight, and low power input requirements. Read-out is indicated in highly legible ⅜" numerals on a translucent panel. The mating of inherent transistor stability with reliable circuit design guarantees dependability for an indefinite period. Epsco's Model CT-101 features plug-in, encapsulated flip-flops, and is fitted with a 9-pin miniature plug as well as a 9-pin socket providing outputs for remote indication purposes.

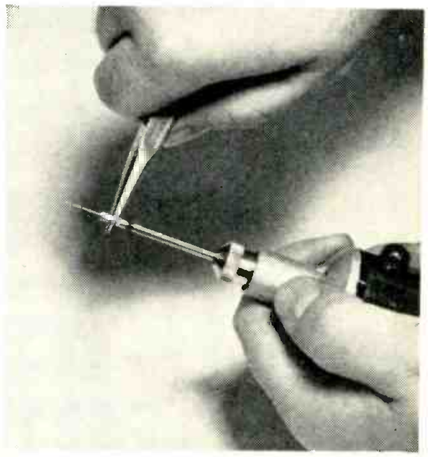
Custom engineering-production of electronic components (shift registers, magnetic logic elements, delay lines, special pulse transformers, plug-in logic elements, etc.) is our specialty. Write for technical bulletin. *See Decade Counter and other Epsco Components at IRE Booth 2120.* **Epsco Components, Dept. R-38 108 Cummington St., Boston 15, Mass.**

START-TO-FINISH cooperation . . . an Epsco guarantee

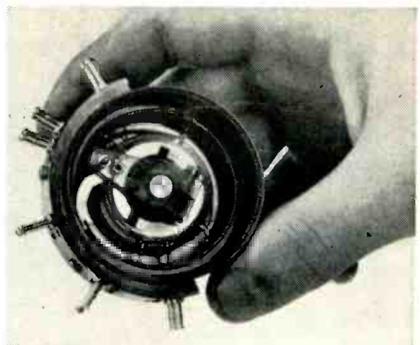
Epsco COMPONENTS



Method of springing tap into position against pot coil



Drill extension holds drills without solder so that drills may be changed with pair of pliers



Time taken to install five taps in this pot is reported as 30 minutes

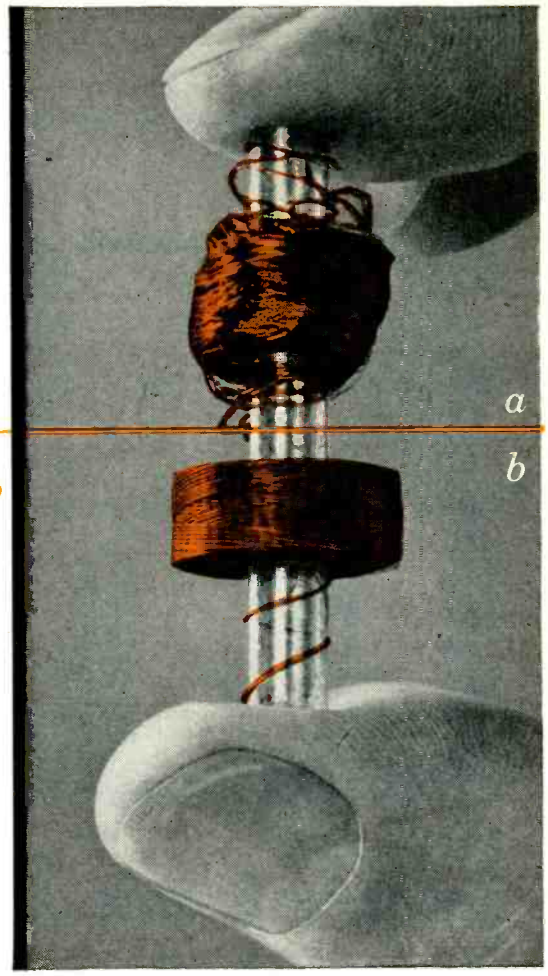
the coil winding.

The miniature drill extension supplied is made by Ritmar Corp., Huntington, N. Y. Its concentricity is reportedly more accurate than soldered drills. Turning a threaded locking sleeve clamps the drill in an internal holding slot. Drills are changed by loosening the sleeve with pliers. The extension has a uniform outside diameter of ⅛ inch, which fits bushings in drill jig.

If you have this problem, investigate

GRIP-EZE®

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



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

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

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

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

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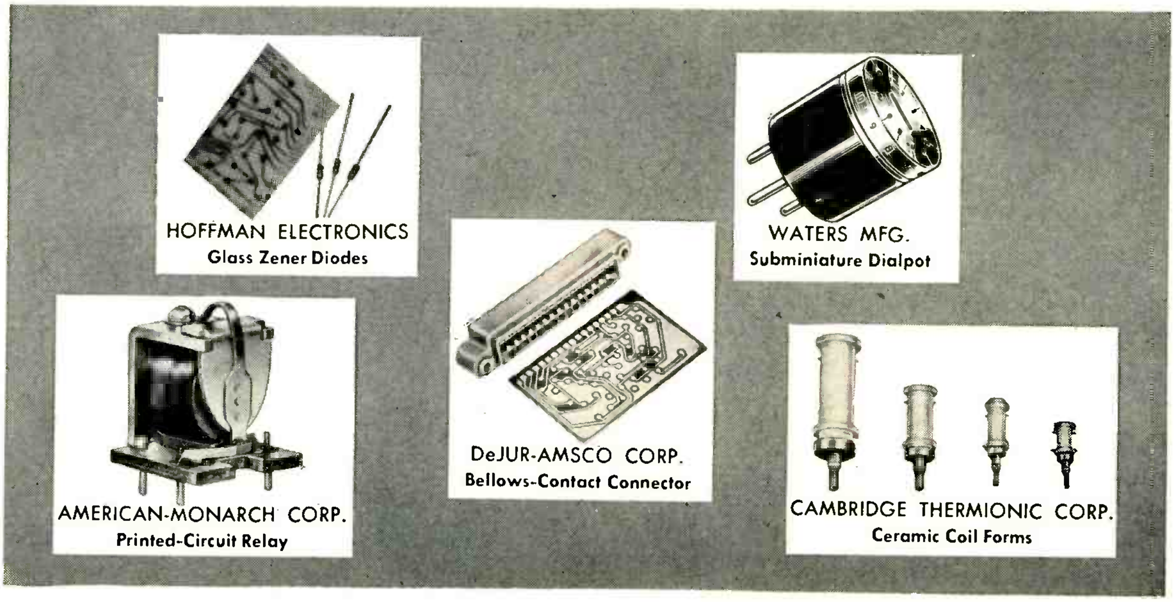
Unveil New P-C Components



Feature Stable Mounting

PRINTED circuits are part and parcel of the ever growing trend toward subminiaturization. Components for these circuits must be made to meet requirements of size and mounting stability.

American-Monarch Corp., 81 N.E. Lowry Ave., Minneapolis, Minn., (400), announces a tiny spdt relay designed specifically for direct application to p-c boards. Good mounting stability is maintained by wide spacing of the silver plated pins. Palladium inlay contacts assure positive contacting of dry circuit switching.

Now in production at **Cambridge Thermionic Corp.**, 445 Concord Ave., Cambridge 38, Mass., (401), are ceramic coil forms available with four terminals for mounting on p-c boards. Suitable for high temperature conditions and missiles, they are also equipped with the Cambion Perma-Torq locking device for set tuning. Terminals are electro solder plated ready for dip soldering.

Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ill., (402), introduces microminiature glass Zener diodes for circuits where mounting space is at a minimum. They are designed for clipping, limiting, regulating and similar applications.

Connectors with bellows action contacts have been developed by **DeJur Amsco Corp.**, 45-01 Northern Blvd., L.I.C. 1, N. Y., (403). It is possible for the connector to accept p-c boards that can vary in thickness from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. Self-alignment of the bellows contacts allows for any residual warpage of the p-c board.

Waters Mfg. Inc., Boston Post Road, Wayland, Mass., (404), has available a Dialpot subminiature potentiometer having a diameter of $\frac{1}{2}$ in. and an overall length of $\frac{1}{2}$ in. (including calibrated dial, excluding terminals). Terminals are located on a standard 0.1 in. grid as used in printed circuitry.

For more information use READER SERVICE CARD

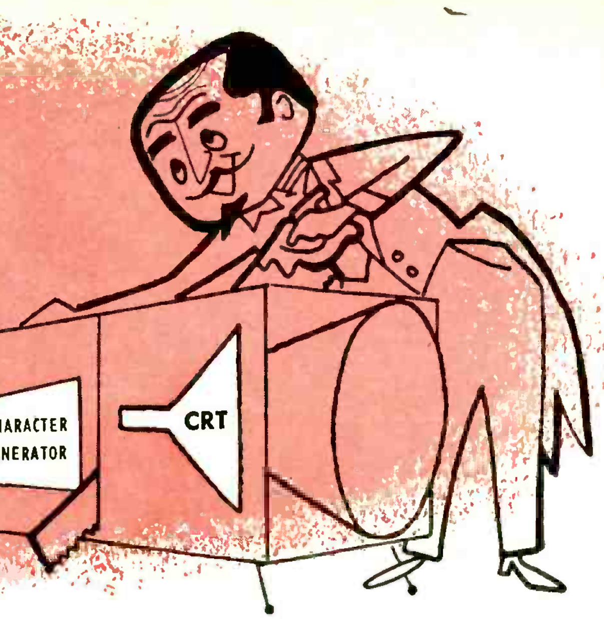
B-Power Supply compact unit

SORENSEN & Co., INC., Richards Ave., South Norwalk, Conn. Model 300B wide-range B-power supply, a new B-Nobatron, utilizes printed circuits for lightness, compactness and reduced cost. It features parallel or series operation, external sensing, excellent regulation and stability, and low ripple. It provides a regulated 0-300 v d-c output and unregulated 6.3 or 12.6 v a-c filament outputs, and is available in single or dual units in a cabinet or for rack mounting.

The front panel of the 300-B has a 4-position power and meter

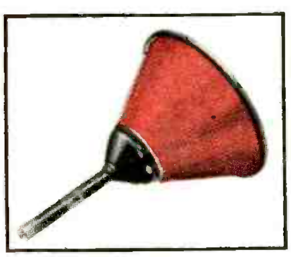
Separate

THE EXPENSE FROM THE EXPENDABLE . . .



Investigate

CHARACTER DISPLAY VIA CATHODE-RAY TUBES



No longer is it necessary to put all your eggs in one basket when it comes to character read-out displays. Now you can do it better, and more economically, with Du Mont cathode-ray display tubes in one of several commonly-known systems. Such a system permits the replacement of the display unit *alone*, eliminating the very expensive replacement of integrated tube and generator, and at the same time, provides these outstanding PLUS FEATURES . . .

- **Bright, flickerless display** — permits read-outs under high ambient light conditions. No annoying, low-frequency flicker.
- **Space-saving** — greatest screen diameter-to-length ratio. Du Mont display tubes are available in 5, 12, 15, and 19-inch screen diameters.
- **Versatility**—variable size characters, positioned anywhere on screen.
- **Low replacement cost** — the generator is completely divorced from the CRT. For replacement, only the cost of a moderately-priced tube.
- **Speed** — electrostatically-formed and electromagnetically-positioned characters for greatest speed and accuracy.

If you use, or are considering the use of character display read-out—investigate display by cathode-ray tubes — ***WRITE FOR COMPLETE DETAILS . . .***

DU MONT®

INDUSTRIAL TUBE SALES, ALLEN B. DU MONT LABORATORIES, INC., 2 MAIN AVE., PASSAIC, N. J.

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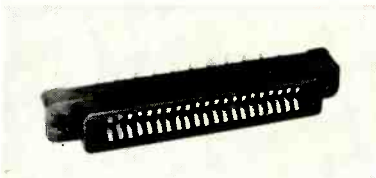
switch with OFF, DC-OFF, VOLTS and MA settings; a voltmeter-milliammeter; an output voltage control; d-c and a-c output terminals; and external sensing terminals. At the rear of the unit are a 3-prong input line cord, a plug for parallel operation of two units, two fuses, and another set of output terminals.

Electrical characteristics include positive or negative output voltage of 0-300 v d-c, 0-150 ma output current, regulation accuracy of ± 0.15 percent or ± 0.3 v, whichever is greater, 5 mv-rms maximum ripple, 2.0 ohms internal impedance, 105-125 v a-c 50/60 or 400 cycle input range, and two 6.3-v 5-ampere filament voltage circuits which may be connected in series or parallel.

A single 300-B in a cabinet is 10¾ in. wide by 9¼ in. high by 12 13/16 in. deep. A dual cabinet unit is 19 in. wide. The single or dual rack mounted types are 8¾ in. high. Weight of a single cabinet unit is 29 lb. **Circle 405 on Reader Service Card.**

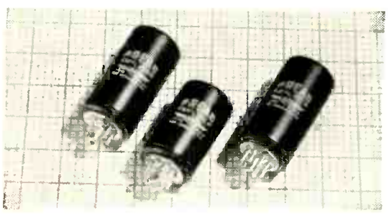
P-C Connector
in four small sizes

ELCO CORP., M. St., below Erie Ave., Philadelphia 24, Pa. The 6003 series answers the need for a microminiature printed circuit connector with 0.078 in. spacing between printed circuit contact lines. It comes in four sizes with 14, 21, 31 and 37 contacts, which are made of beryllium copper, silver plated or gold plated. The



connector is designed to receive a 1/16 in. board with commercial tolerances of ± 0.0075 in. Design of the contact guarantees low contact resistance at all board thicknesses with no change after a thousand insertions and withdrawals. Castings are made of glass-filled diallyl phthallate. They have very close tolerances and are stable under wide ranges of temperature and humidity. The contact tails have wire holes for soldering wires to it. A polarizing tab can be inserted at any contact location. **Circle 406 on Reader Service Card.**

Magnetic Amplifier
low-level unit



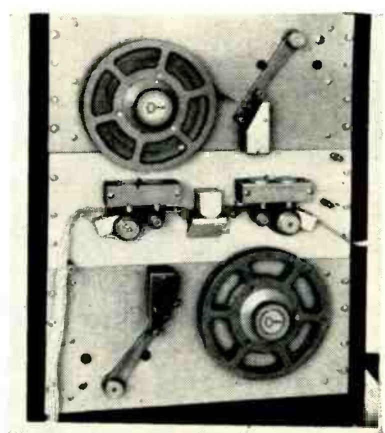
AIRPAX PRODUCTS CO., Middle River, Baltimore 20, Md. Preac amplifiers are a new line of high sensitivity magnetic amplifiers. Specifically designed as preamplifiers for such data sensing devices as thermocouples, strain gages, bolometers, and electrometers, these low-level units produce full output with inputs of fractions of microwatts. Three standard types provide power gains rated to be greater than 54 db, 60 db, or 51 db. As little as 0.0026 μw input produces full output of 4 v into a 5,000-ohm load. Null drift does not exceed 0.1 μa under this condition.

Preac amplifiers are rated for operation from 400 ± 40 cps power lines at 115 ± 11 rms volts. They draw less than 2w of power, which, for lowest null, should be free of even harmonics. These amplifiers accept d-c polarity reversible input signals and deliver unfiltered d-c polarity reversible outputs. **Circle 407 on Reader Service Card.**

Paper Tape Reader
strip and reel feed

DIGITRONICS CORP., Albertson Ave., Albertson, L. I., N. Y. The new compact Dykor paper tape reader provides all the advantages of strip and reel feed by combining both in one unit. Manual access time is reduced appreciably because short programs require no splicing, no tape switch is required to locate a desired block, and program filing is simplified. It stops within one character at a reading rate of 600 characters per sec and within two characters at 750 characters per sec because of a special braking system.

The tape is set in motion when a solenoid operates a pressure roller to squeeze the tape against a continuously-rotating capstan in a wringer-like action. Two oppositely-rotating capstans allow the tape to be driven in either direction, with



CIRCLE 154 READERS SERVICE CARD→

There is No Substitute for Reliability—

NEW *miniaturized* "MAG MOD"

Magnetic Modulators

All Magnetic Modulators strictly conform to MIL-T-27A. Some typical circuit applications for Magnetic Modulators are algebraic addition, subtraction, multiplying, raising to a power, controlling amplifier gains, mechanical chopper replacement in DC to fundamental frequency conversion, filtering and low signal level amplification.

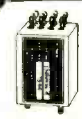
Actual Size

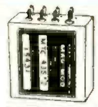
Especially Engineered for Printed Circuit Wafer Designed Structures and Circuit Assemblies Featuring:

- FASTER RESPONSE TIME
- NEGLIGIBLE HYSTERESIS
- EXTREME STABILITY (Ambient Temp. Range from −65°C to +135°C)
- COMPACT SIZE
- LIGHTWEIGHT
- INFINITE LIFE
- COMPLETE RELIABILITY

Miniaturization of the new Magnetic Modulator makes it possible to incorporate this component into wafer type structures and transistorized printed circuit assemblies without sacrificing ruggedness or reliability.

CONSULT **GENERAL MAGNETICS** on magnetic amplifier components for automatic flight, fire control, analog computers, guided missiles, nuclear applications, antennas, gun turrets, commercial power amplifiers and complete control systems. Call or write for Catalog B on miniature and standard components.





	Magnetic Input Modulator	Magnetic Input Modulator	Magnetic Thermocouple Converter
TYPE NUMBER	IMM - 436 - 2	IMM - 436 - 3	MTC - 435 - 2
Excitations Frequency—Carrier	400 cps	400 cps	400 cps
Signal Winding DC Resistance	1000 ohms ±15% each signal winding	1000 ohms ±15% each signal winding	10 ohms ±15%
AC Excitation Volts	5.5 V. @ 400 cps	2.5 V. @ 400 cps	6 V. RMS
Input DC Signal Range	0 to ±100 μa.	0 to ±80 μa.	0 to ±10 mv.
AC Output Range	0 to 2.2V. @ 400 cps (sine wave)	0 to 1.5V. @ 400 cps (sine wave)	0 to 2.7V. @ 400 cps (sine wave)
Overall Dimensions (Inches)	27/32x27/32x1 5/16	27/32x27/32x1 3/16	1 1/4x7/8x5/8
Null Amplitude (Noise Level)	20 mv. RMS	15 mv. RMS max.	25 mv. RMS max.
Output Impedance	7000 ohms	7000 ohms	10,000 ohms
Null Drift (In terms of input signal) −65°C to +100°C	±0.5 μa. max.	±0.5 μa. max.	±0.1 mv. max.
Hysteresis — % of maximum input signal	0.5% maximum	0.5% maximum	0.5% maximum
Type of Mounting	Male Stud	Female Insert	Male Stud
Maximum % Distortion in Output	25%	15 %	20%
Weight Ounces	1.3 oz.	1.2 oz.	1.5 oz.

GENERAL MAGNETICS • INC.

135 BLOOMFIELD AVE., BLOOMFIELD, NEW JERSEY

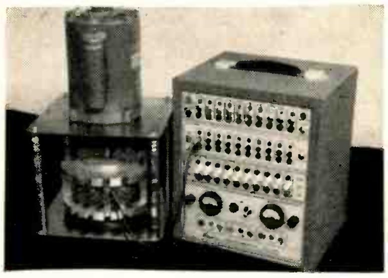
GM INC.

starting time less than 5 millisec. Thus by using the reverse feed control, programs requiring repeat feedings proceed more rapidly. To stop tape motion, the driving solenoid is released, and the stop solenoids are actuated.

All standard 5, 6, 7 or 8 level tapes (plus sprocket hole) are handled and $\frac{11}{16}$ in., $\frac{7}{8}$ in. or 1 in. wide tape can be used interchangeably. Safeguards provided are end-of-tape sensing and tape-break sensing, with an interlock preventing operation if the tape is improperly threaded. Photoelectric sensing makes fast reading possible.

Another feature is complete remote control including forward, reverse, stop and speed change. **Circle 408 on Reader Service Card.**

Recording Test Unit
uses semiconductors



NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa. A complete read-write test system for magnetic tape or drum memories, measuring 11 in. high, by 11 in. wide, by 9 in. deep, is available. Individual units are entirely transistorized, and printed circuit techniques are utilized throughout, resulting in excellent reliability, small size and low power requirements.

The modular units pictured are, from top to bottom, a 10 bit shift register for parallel-to-serial conversion of incoming data or serial-to-parallel conversion of outgoing data, a 10 channel NRZ write-amplifier, a 10 channel NRZ read-amplifier, and a regulated power supply.

These units are compatible with all other units in the line of the company's transistorized pulse programming equipment, and may be combined with over 40 functional units for digital data processing and data storage. **Circle 409 on Reader Service Card.**

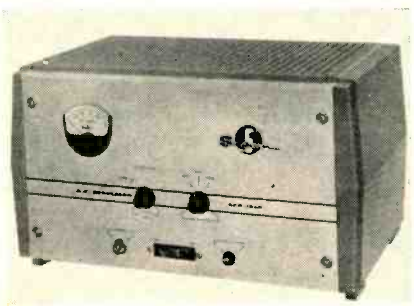
Zener Diodes
sixty-four types available

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., introduces a complete line of silicon Zener voltage regulator and reference diodes comprised of a series of types in each of seven styles. The listing of 64 types includes: miniature types rated at 500 mw, standard top-hat style with pigtail leads rated at 1 w, 3.5 and 10 w types featuring stud construction, double-anode types rated at 350 mw, 5 w multiple junction h-v types and the 1N430, 1N430A and 1N430B reference element types.

All diodes in this group are designed and manufactured to meet the most rigid military specifications. High temperature operation (−65 C to +150 C) and high load current capacity result from a most advanced thermal design. Sharp reverse breakdown characteristics provide the means for obtaining stable voltage regulation over a wide operating range. Mechanical features such as all-welded construction and hermetic sealing assure long term reliability.

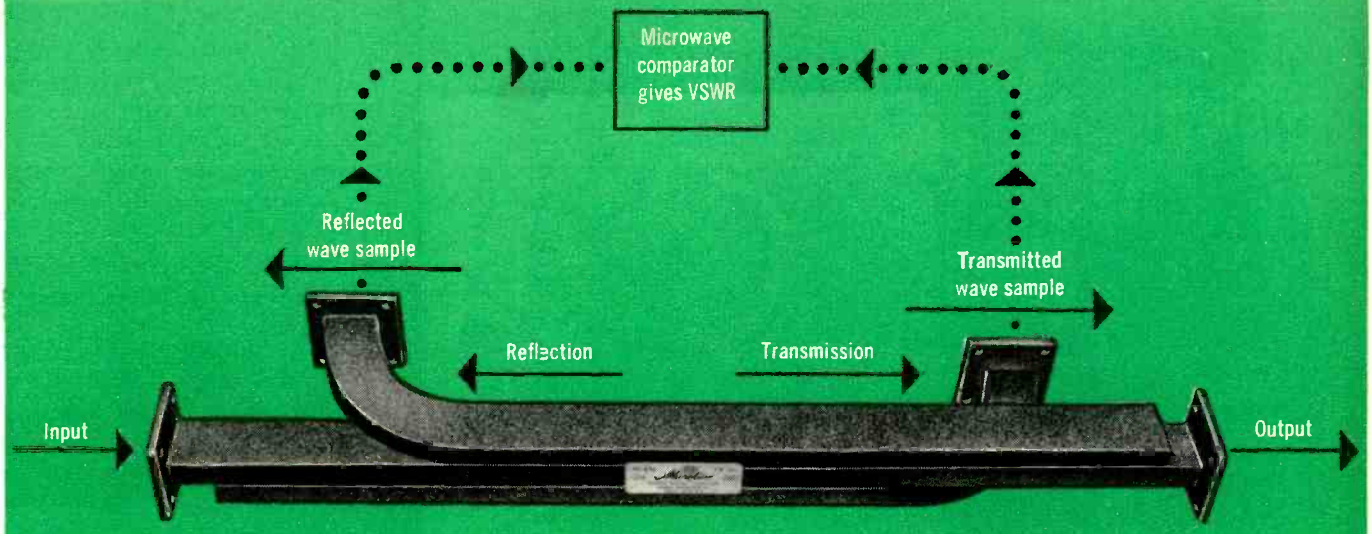
As a technical service to the design engineer, an x-y plot of the reverse breakdown characteristics is supplied with each diode. **Circle 410 on Reader Service Card.**

Voltage Regulator
all-purpose unit



SORENSEN & CO., INC., Richards Ave., South Norwalk, Conn. Model APR1010 is a tubeless all-purpose a-c voltage regulator with wide flexibility of operation. It can be used to regulate average and peak voltages as well as rms, independent of input waveform. By simply turning a switch, the regulator output can be matched to the special requirements of the load.

It provides five different sensing arrangements: internal (normal a-c regulation), external a-c (any a-c voltage), remote (115 v a-c at a remote location) constant current, and d-c. Terminals are provided at the rear of the unit to enable the 0.1 percent a-c load regulation accuracy to be held at a remotely located load. This feature also enables load voltages other than



New high-directivity bi-directional couplers

For continuous VSWR measurements

GENERAL CHARACTERISTICS

	Microline 604 S-Band	Microline 605 C-Band	Microline 608 X-Band
Frequency Range (kmc)	2.60-3.95	3.95-6.00	8.2-12.4
Waveguide Type (AN)	RG-48/U	RG-49/U	RG-52/U
Waveguide Size	3" x 1½"	2" x 1"	1" x ½"
Waveguide Flanges	UG-214/U	UG-149A/U	UG-39/U
Weight	18 lbs	9.1 lbs	2 lbs
Dimensions	48⅞" x 9 17/32" x 8 3/16"	31 11/16" x 7 11/32" x 5½"	18 1/16" x 3 7/8" x 2⅝"

Featuring two opposing couplers in a single waveguide unit, Sperry's new Microline® Bi-Directional Couplers provide complete coverage of waveguide frequency ranges. They are designed for VSWR measurements and continuous monitoring in combination with ratiometer, comparator, barretter mounts or other detectors.

Three models cover S, C and X bands, with uniform coupling (10db ± 0.5) and high directivity (40db) for accurate coupling calibration. If you'd like more information on the Sperry couplers shown here, write our Microwave Electronics Division for "latest data on directional couplers."

MICROWAVE ELECTRONICS DIVISION

SPERRY GYROSCOPE COMPANY
Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION

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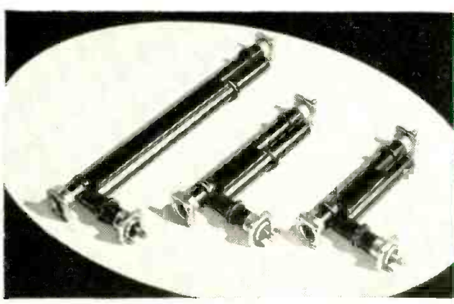
Visit our booths 1416-1422 at 1958 Radio Engineering Show, March 24-27.

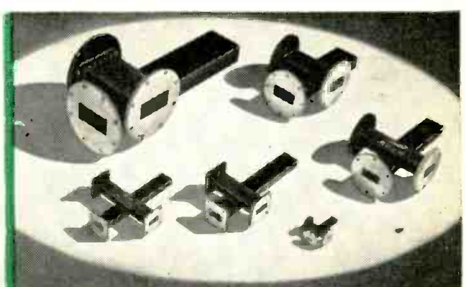


COAXIAL DIRECTIONAL COUPLERS

Used to monitor system power output and to provide local-oscillator or test-signal injection into receivers. Feature very low variation in coupling over 2-to-1 frequency range. Directivity is kept high by frequency-sensitive compensation.

BRANCH-GUIDE DIRECTIONAL COUPLERS

Serve as decoupling and isolating wave-guide sections, with negligible effect on other system components. Offer high directivity and uniform coupling over full frequency range. Can be permanently installed in system transmission line.



CROSS-GUIDE DIRECTIONAL COUPLERS

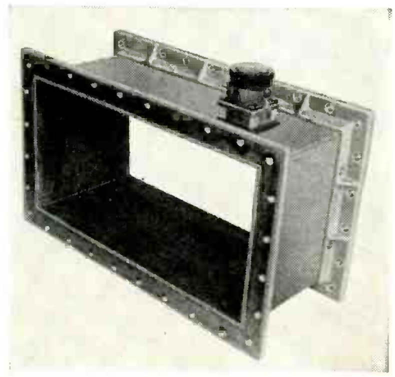
Designed to operate as space-saving one-way power monitors in waveguide transmission lines. For measuring power, VSWR and receiver sensitivity. Directivity is high and coupling is uniform over 40% frequency range.

CIRCLE 152 READERS SERVICE CARD

110-120 v to be accurately regulated by means of an external matching transformer, without disturbing the regulator wiring.

Other terminals at the rear of the APR1010 allow it to be used as a d-c controller. Full-wave capacity-input d-c power supplies can be regulated to an accuracy of 0.1 percent.

The APR1010 features 3 percent maximum harmonic distortion, 0.2 sec recovery with line changes and 0.1 sec recovery with load changes; ± 0.1 percent regulation accuracy with line or load changes; rapid starting; 0.04 percent drift in 24 hours and 0.1 percent drift in 1,000 hours. **Circle 411 on Reader Service Card.**



Waveguide RSWI small and compact

Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn, N. Y. The new waveguide rotary standing wave indicator greatly simplifies the measurement of vswr, reflection coefficient angle, hence impedance, in the low frequency range.

Operating by means of a probe rotating in the plane of circular polarization of a waveguide, the waveguide RSWI provides a nonambiguous read-out of the sign of reactive components. Small, compact and lightweight with an insertion length of only 10 in., it eliminates the need for bulky slotted sections or reflectometers in the large waveguide sizes. It is available in a wide selection of waveguide sizes from WR-650 to WR-4200. If desired, the rotating probe can be motor driven for remote operation and to provide an

PROBLEM:

WHAT IS THE SQUARE ROOT OF YOUR DESIGN PROBLEM?

ANSWER:

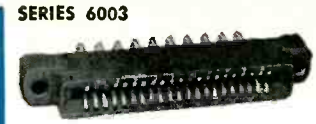
$$\sqrt{\frac{BP + I \times E^n}{\infty}}$$

Not in books nor tables nor scales nor what-you-will can the above equation be found. For it is an equation based on what the men of Elco can create-in-the-mind, translate-into-actuality and prove-in-application. It is, in a word, the engineered answer to your specific problem; and can be found in such new and reliability-proven components as you have come to know and see pictured here.

The equation above represents Brain Power, plus Ingenuity times Experience to the Nth power, divided by infinity. And the result is the square root of many design problems and operating characteristics. Characteristically, too, you must certainly find the answer to yours among Elco's quality line. Come to know it well.

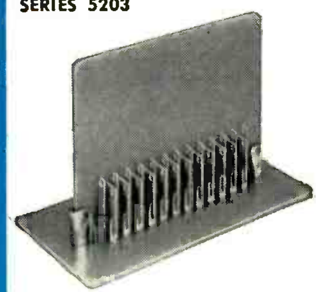
SEE US AT BOOTH 2234 IRE SHOW

SERIES 6003



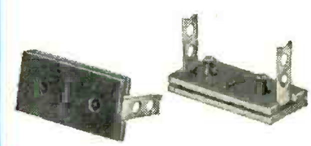
Micro-miniature printed circuit connector with .078" spacing between contact lines. 14, 21, 31 or 37 contacts. Receives .062" thick board with ± .0075" tolerances. Write for Bulletin 103-A.

SERIES 5203



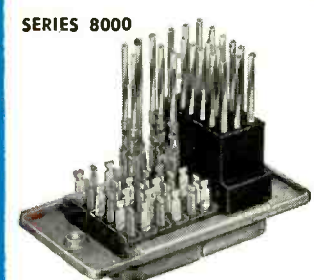
P. C. Varicon connector for plugging module boards perpendicularly into mother board. Designed for miniaturization with .100" contact spacing. For any number of contacts and any pattern. Write for Bulletin 108.

POWER TRANSISTOR SOCKETS



Designed to mate with Bendix Red Bank Power Transistor type #2N234, or other similar Power Transistors. Write for details.

SERIES 8000



Subminiature Varicon connector. 48 double-tier with honeycomb insulator shown. Other single and double-tier models, 8 to 80 contacts. Write for Bulletin 107.

ELCO-PACIFIC "B" SERIES

Cable or chassis type connector for light duty. Designed for audio, tv, geophysical and related use. 2, 3, 4, 5, 6 or 8 contacts. Current rating up to 30 amps; voltage, 2000 volts RMS. Female member has latch lock for fast coupling and guaranteed locking. Fully interchangeable with comparable units. Write for details.

IF IT'S NEW... IF IT'S NEWS ...IT'S FROM ELCO CORPORATION

"M" STREET BELOW ERIE, PHILADELPHIA 24, PA., CUmberland 9-5500

CIRCLE 355 READERS SERVICE CARD

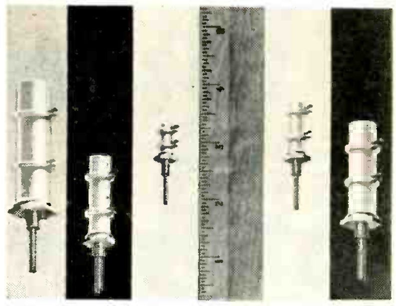
oscilloscopic presentation of vswr.

Other features are low residual vswr—less than 1.03; high accuracy—±2 deg maximum error in measurement of reflection coefficient angle with pure reactive load; high sensitivity—detects as little as 5 mw in the main waveguide; high-power application—permitted by adjustable coupling to detector; full frequency range—each waveguide band can be fully covered; adaptability for remote operation—because of the simple rotary motion involved. Circle 412 on Reader Service Card.

A-F Attenuator substitution unit

WEINSCHEL ENGINEERING, 10503 Metropolitan Ave., Kensington, Md. Model CF-1 a-f substitution attenuator is intended for measuring r-f power ratios in systems employing modulated r-f power sources and square-law r-f detectors. In such systems the audio voltage output from the detector is proportional to the r-f power input. It is necessary, therefore, to substitute audio attenuation equal to two times the change in r-f attenuation, all attenuation in decibels. This precision audio attenuator reads, in decibels, the change in r-f attenuation.

The a-f attenuator has a characteristic impedance of 2,000 ohms and is adjustable over a range of 104 db audio attenuation corresponding to 52 db r-f attenuation. A very linear cathode follower drives the attenuator, providing a high input impedance to the unit. The attenuator is terminated internally and designed for use with a moderately high impedance output indicator. Circle 413 on Reader-Service Card.



Ceramic Coil Forms 5 standard sizes

NATIONAL CO., INC., Malden 48, Mass. Designed for both military and commercial applications, a new line of ceramic soil firms is comprised of 5 standard sizes, each available with or without terminal collars; each terminal collar accepting up to four terminals per collar. All materials used are in accordance with MIL-specs. An internal pre-set torque spring positions and locks the adjusting cores thus keeping coils tuned as set, even under severe vibration and shock. Circle 414 on Reader Service Card.

SSB Tube new ratings

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y., has available new, ssb ratings on the type 6076 tube for new designs, equipment conversion, and for increasing present power output of linear amplifiers.

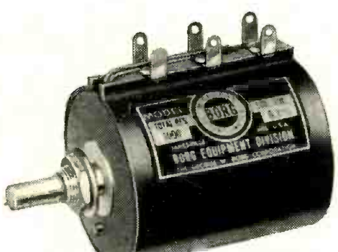
In the 2 to 5 kw envelopes power range, the 6076, a compact forced-

Why Gamble?

THERE'S A BORG MICROPOT® TO MEET YOUR EXACT SPECIFICATIONS!

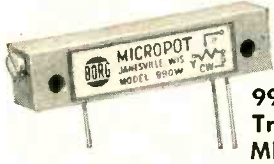
BORG MICROPOTS...
the Ultimate in Multi-Turn Precision Potentiometers

Borg offers a complete line of high-precision, linear potentiometers called MICROPOTS. Precision is Borg's business . . . that's why MICROPOTS offer so many exclusive advantages. Superior design and production methods make Borg MICROPOTS available in any quantity. Write today for the name of your nearest Borg Jobber or "Tech-Rep."



1100 Series MICROPOTS

A precision MICROPOT that offers your products a price advantage in today's competitive markets. Lug or lead type terminals. Accurate . . . dependable . . . long lived.

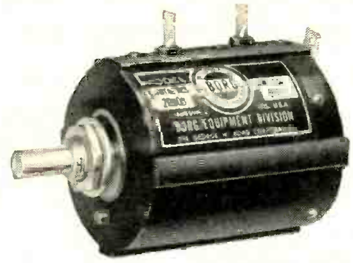


990 Series Trimming MICROPOTS

Small in size, lightweight, rugged and dependable. Three types of terminals . . . printed circuit, solder lugs or insulated wire leads.

900 Series MICROPOTS

Standard ten-turn and three-turn models to fit most special design needs. Extremely accurate and dependable under adverse environmental conditions including severe vibration and shock.



205 Series MICROPOTS

A quality MICROPOT. Designed for both military and commercial applications. Proven in many different mobile and stationary types of electronic circuitry.

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THE GEORGE W. BORG CORPORATION
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ELECTRONIC-MECHANICAL BORG EQUIPMENT

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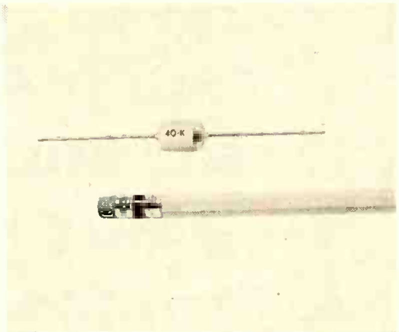
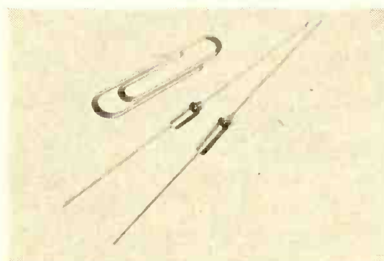
air cooled tetrode with a 3 kw dissipation rating, provides a range of powers hitherto only generated by paralleling a number of smaller tubes or under-rating larger ones.

Data are available on the use of the 6076 as a ssb amplifier that gives 38 db third and fifth order distortion products without r-f or envelope feedback in the 3 to 30 mc range. **Circle 415 on Reader Service Card.**



Silicon Rectifiers
axial leads

SARKES TARZIAN, INC., 415 College Ave., Bloomington, Ind. Type K silicon rectifiers feature 750 ma to 55 C (no heat sink). They provide axial lead mounting. Mass production results in very low prices to allow wide commercial application. The K series incorporates a positive environmental seal with special epoxy resin. Polarity is identified by color coded resin at each end. Voltage ratings are 100, 200, 300 and 400 v peak inverse. **Circle 416 on Reader Service Card.**



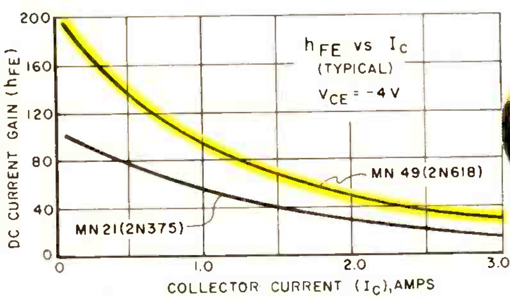
Tantalum Capacitor
solid electrolyte

MINITRONICS CORP., 328 Grand St., New York 2, N. Y. Type TQ subminiature tantalum electrolytic capacitor is a metal cased hermeti-

MOTOROLA NOW OFFERS BOTH HIGH AND MEDIUM GAIN 60-VOLT POWER TRANSISTORS

GENERAL SPECIFICATIONS

TYPE NUMBER	BV_{CBO} volts	BV_{CEO} (min) volts	h_{FE} @ 1A (typ)	G_e db	P_o Class A @ 75°C watts	$f_{\alpha e}$
MN49 2N618	−80	−60	90	40	5	8.5
MN21 2N375	−80	−60	55	37	5	10



Actual Size

for an extensive range of military & industrial applications

Select the Beta-range best suited for your requirements. Both units are supplied to the same stringent specifications and are available, now, in quantities at sensible prices.

use wherever high-voltage power transistors are required.

- Magnetic amplifiers
- DC converters and other switching service
- All audio amplifiers
- Motor controls
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- Line voltage regulators
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SAMPLE ORDER 2 EACH OF 2 TYPES—$25.00 available from your local Motorola distributor or from the Phoenix factory.

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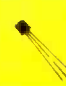
Audio, Switching & RF Transistors

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HOLLYWOOD 28, CALIFORNIA 6555 Sunset Boulevard HOllywood 5-3250

CIRCLE 151 READERS SERVICE CARD

cally sealed unit, containing solid materials exclusively. The capacitor cannot leak or corrode even if the seals are damaged or destroyed.

Type TQ capacitors operate over the temperature range of − 80 C to +85 C with a capacitance variation of only ±10 percent. The dissipation factor does not exceed 0.05 at 1,000 cps and 25 C. The leakage current at 25 deg is less than 0.05 $\mu a/\mu f/v$ or 0.1 μa, whichever is greater, measured after five minutes at rated d-c working voltage applied through a 1,000 ohm resistor to limit the charging current. The type TQ is a polarized capacitor to be used where no reversal of potential occurs. The case is the negative terminal. Circle 417 on Reader Service Card.

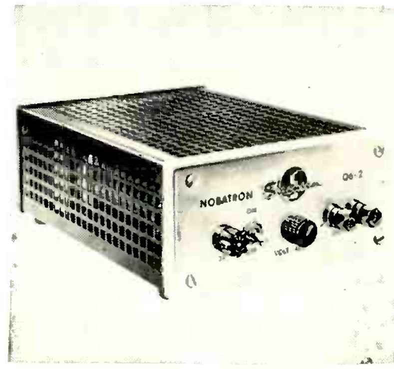
Portable Scope wide-band unit

THE SCOPES CO. INC., 20-02 Raphael St., Fair Lawn, N. J., announces the Serviscope, an inexpensive wide-band portable precision oscilloscope weighing only 16 lb. It features balanced, d-c coupled amplifiers giving flat response to 6 mc (− 3 db) and having a rise time of better than 0.06 μsec for less than 2 percent overshoot. Both fully automatic sync and precision trigger level selection are provided as well as tv field and frame sync selectors.

Built-in voltage and time calibrating signals facilitate quantitative measurements and X-expansion, about the center, gives a 50 cm effective trace length. Eighteen preset calibrated sweep speeds and frequency-corrected attenuator per-

mit time and voltage measurement over the ranges 0.1 μsec/cm to 0.5 sec/cm and from 20 mv to 250 v, a-c or d-c, respectively.

With dimensions of 6½ in by 8½ in. by 13½ in. overall the Serviscope offers expensive facilities in a small low cost package and is available for immediate delivery. **Circle 418 on Reader Service Card.**



D-C Supplies transistorized

SORENSEN & CO., INC., Richards Ave., South Norwalk, Conn. Six new all-transistor low-voltage, high-current d-c supplies are now available. First of a new line called Q Nobatrons, they offer performance on a par with that of the B-type high-voltage d-c supplies. Features include low ripple, fast response, transient-free performance, adjustable output, wide input frequency range, complete self-protection, cabinet or single or dual rack mounting, isolated output, small size and low cost.

They are said to be ideal for such applications as computer circuits and strain gage bridges. The units have a wide (2:1) range of output voltage. Exclusive circuit design prevents damage to transistors even if output is short circuited. Because no resonant regulators are used, Q-Nobatrons are insensitive to input frequency changes. Either positive or negative output may be grounded, or the output may be floating.

Input voltage of these d-c supplies is 105-125 v a-c single phase. Output voltages are 4.5-8 v, and 18-36 v. Output current ranges from 0-0.5 ampere to 0-4 amperes. Output voltage regulation is

Lowest Prices in the Industry for Highest-Quality OVENS

AMINCO'S famous forced-convection ovens solve the big problems in today's research and industrial laboratories; . . . they eliminate hot and cold pockets; they provide precise temperature control; and minimize power consumption.

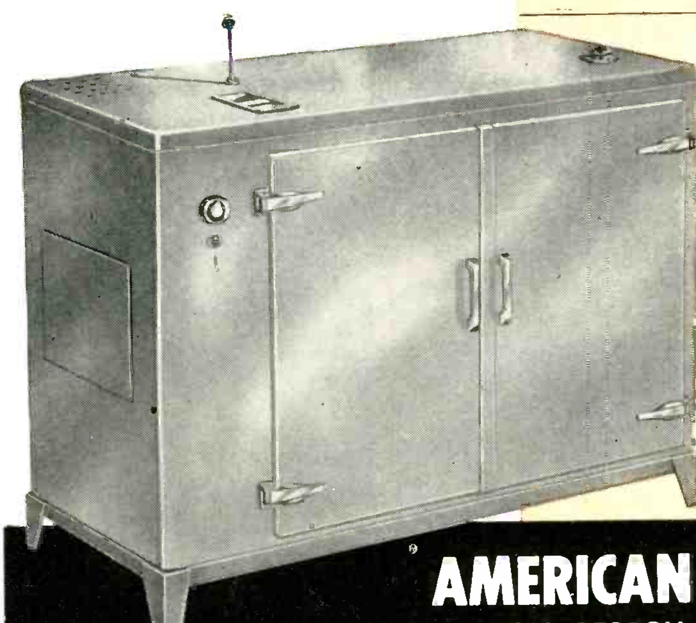
The many styles and sizes listed at right employ motor-driven blowers which produce movement of a large volume of heated air, horizontally across the work chamber. This, together with the circular arrangement of the heaters, results in uniform distribution throughout the entire work chamber.

All ovens listed are provided with positive locking latches, adjustable perforated shelves, and a removable control panel.

On special order, pyrex inner doors, explosion-proof fittings, and blow-out safety panels can be supplied.

Complete information furnished upon request, in new bulletin 34-37-Z

Immediate delivery from Stock!



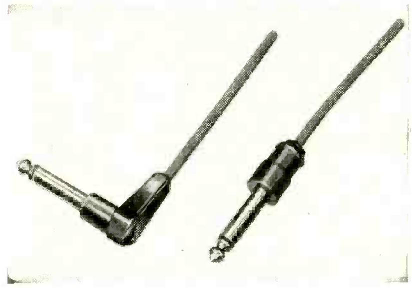
Compare these prices with any other top-quality ovens—the savings per cubic foot are substantial!

Description	Price per Cu. Ft.	Total Price
4-3510 Oven, with cold-rolled steel interior and Linco-flek exterior. 115 volts; size: 19 x 19 x 19 in.	$134.61	$ 525
4-3521 Oven, with cold-rolled steel interior and Linco-flek exterior. 230 volts; size: 37 x 19 x 25 in.	71.80	718
4-3540 Oven, with Linco-flek exterior, and stainless steel interior. 230 volts; size: 19 x 19 x 19 in.	161.53	630
4-3541 Oven, with Linco-flek and stainless steel interior. 230 volts; size: 37 x 19 x 25 in.	87.30	873
4-3560 Oven, with stainless steel interior and exterior. 230 volts; size: 19 x 19 x 19 in.	211.02	823
4-3561 Oven, with stainless steel interior and exterior. 230 volts; size: 37 x 19 x 25 in.	114.80	1148
4-3516 Oven, with Linco-flek exterior and cold-rolled interior. 230 volts; size: 19 x 19 x 19 in.	134.61	525
4-3522 Oven, with Linco-flek exterior and cold-rolled interior. 230 volts; size: 37 x 25 x 37 in.	42.27	837
4-3530 Oven, with Linco-flek exterior and stainless steel interior. 115 volts; size: 19 x 19 x 19 in.	161.53	630
4-3542 Oven, with Linco-flek exterior and stainless steel interior. 230 volts; size: 37 x 25 x 37 in.	54.50	1079
4-3550 Oven, with stainless steel exterior and interior; 115 volts; size: 19 x 19 x 19 in.	211.02	823
4-3562 Oven, with stainless steel exterior and interior; 230 volts; size: 37 x 25 x 37 in.	64.39	1275

AMERICAN INSTRUMENT CO., INC.

8030 GEORGIA AVENUE, SILVER SPRING, MARYLAND

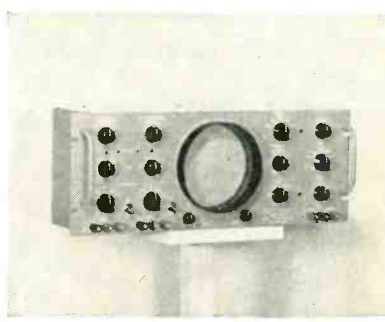
±0.25 percent for line and load changes combined. Ripple is 0.01 percent for all but one unit, which has a 0.02 percent ripple. Typical recovery time is 50 μsec. Ambient temperature extends from 0-40 C. Typical output impedance at 1,000 cps ranges from about 0.003 to about 0.02 ohm. Circle 419 on Reader Service Card.



Phone Plugs molded to cable

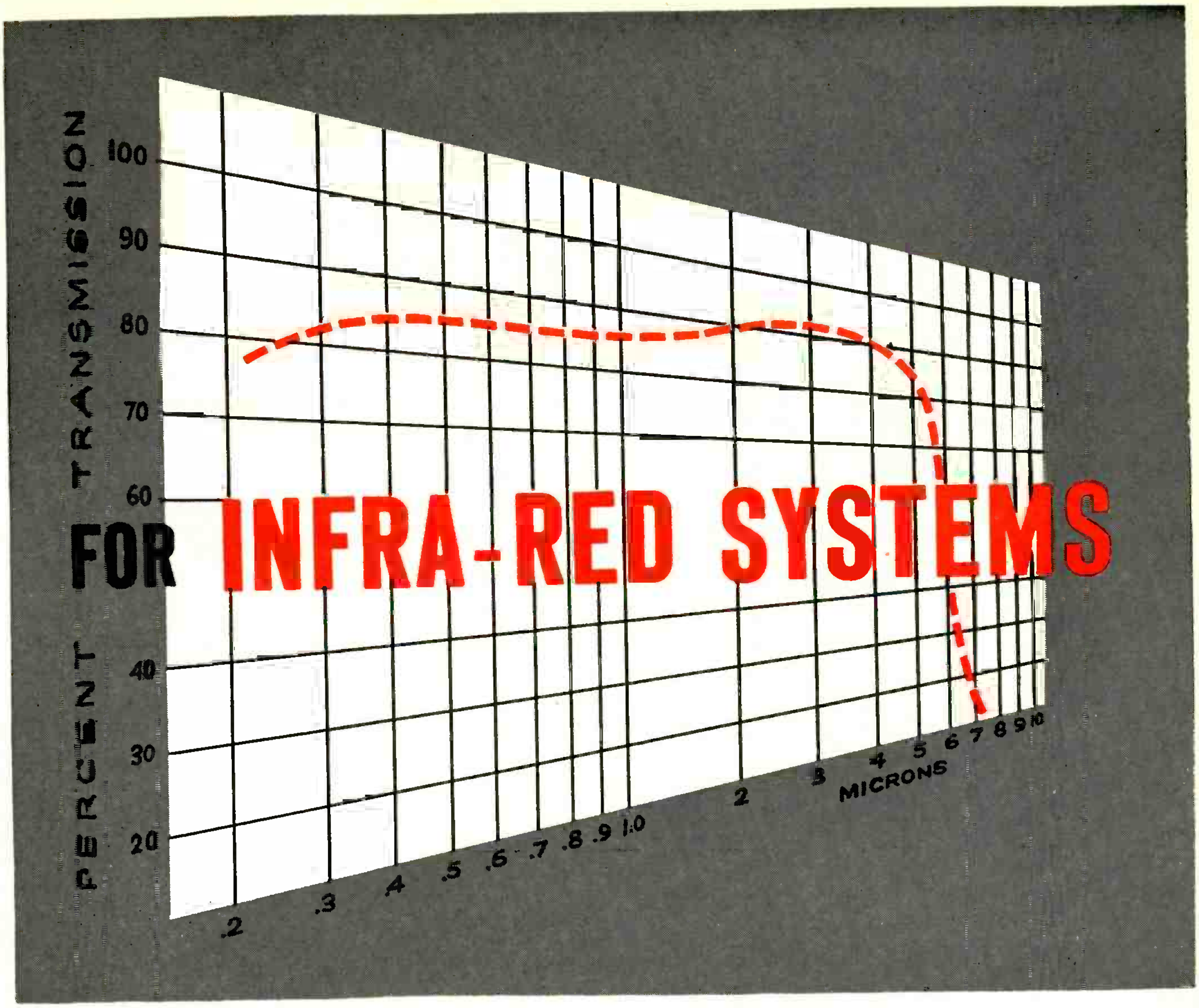
SWITCHCRAFT, INC., 1328 N. Halsted St., Chicago 22, Ill., adds to its line of components phone plugs molded directly to 2-conductor shielded cable. These are assembled in standard cable assemblies of the type often used in audio equipment for interconnecting amplifiers, microphones and so on. They are available in straight or angle types, as illustrated.

These assemblies will be available in packaged units or for specific requirements with plugs molded to special cables. Circle 420 on Reader Service Card.



Oscilloscope meets MIL-O-15525D

JAMES S. SPIVEY INC., 4908 Hampden Lane, Washington 14, D. C. Model 85-A oscilloscope is designed to fulfill the requirements of the automatic communications



SPECIFY LINDE Sapphire

TRADE-MARK

LINDE Sapphire is . . .

- Hard—Moh 9
- Transparent, single crystal, pure aluminum oxide
- Nonporous—0% porosity
- Easily sealed to metals and ceramics
- Priced competitively with sintered materials

LINDE Sapphire has . . .

- Strength at elevated temperatures
- High melting point—2040° C.
- Excellent IR transmission at high temperatures (above 500° C.)

LINDE Sapphire is available as . . .

- Windows
- Domes
- Rods and tubes
- Special shapes—to order

For more information about LINDE Sapphire . . . Write "Crystals Dept. BD-32," LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited

Linde

UNION CARBIDE

ENGINEERS AND SCIENTISTS interested in working in Synthetic Crystal Sales & Development, contact Mr. A. K. Seemann, Linde Company, 30 E. 42nd St., New York 17, N.Y.

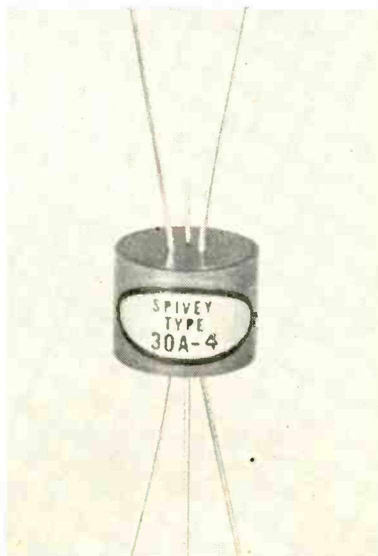
The terms "Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

field and allied operational systems. Special emphasis has been placed on providing superior low frequency sweep linearization and balanced input d-c amplifiers of high gain.

Horizontal sweep range is 3 cps to 40 kc in 4 bands with a minimum of 5 percent frequency overlap on each end of each band. Linearity is ± 1 percent on all frequencies up to 5 kc; ± 2 percent above that.

Vertical and horizontal amplifiers have 1 ground and 2 balanced inputs through 5-way binding posts spaced ¾ in. on centers. Input sensitivity is 5 mv/cm to 500 v/cm.

Size is 19 in. wide by 7 in. high by 19 in. deep. **Circle 421 on Reader Service Card.**



Pulse Transformers miniature type

James S. Spivey Inc., 4908 Hampden Lane, Washington 14, D. C. Type 30A miniature pulse transformers are designed to produce exceptionally fast pulse rise and recovery time. This is accomplished by using ferrite cores that have high effective permeability for abrupt changes in current and winding coils with very tight inductive coupling between windings on these cores.

The transformers are designed to meet MIL-T-27A specifications. They are epoxy, resin encapsulated

CIRCLE 188 READERS SERVICE CARD→

RELIABILITY*
INSIDE
THE
BLACK BOX

NEW PRODUCTS

FAIRCHILD

NEW RG-100 RATE

GYRO

THE SMALLEST EVER MADE†

This is truly the mightiest tiny Rate Gyro. It was designed primarily for *missile and aircraft application* as a control and stabilization element. The Fairchild RG-100 is so small (15/16″ dia. by 2″ long) that it requires jewel bearings identical within 100 millionth's of an inch. *An exclusive Fairchild feature* is uniform damping, for any required percentage of critical within ±15% through a range of —40° to +200°F. This is accomplished by varying the damping area, using the damping medium as a sensing device which varies with temperature changes.

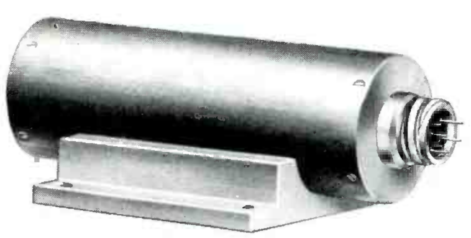
†with fully controlled damping.

TAKES 100 G'S OF SHOCK AND 15 G'S AT 2000 CPS VIBRATION EVEN AT VERY LOW RATES

This high resistance is due in part to another Fairchild exclusive design feature which does not require the torsion bar to act as a supporting medium. The Fairchild tiny mite Rate Gyro only weighs 3 ounces, but contains a dynamically balanced hysteresis motor which reaches an operating speed of 24,000 rpm in less than 20 seconds. It is available with a 2 or 3 phase winding, runs on 6.3V, 9V or 26V A.C. and has a power rating of 3 watts.

OTHER FAIRCHILD FEATURES:

INPUT RANGES for the standard unit are from 20° to 800° per second. Customer requirements outside of this range can be accommodated. OUTPUT is 6 volts at maximum rate, operating on 400 cps. LINEARITY is 0.1% to half scale and 3.5% to full scale. Total NULL varies from 15 to 40 mv depending upon maximum input rate and damping requirements of the customer.
GIMBAL BALANCE is 0.1% of full scale per G.
TEMPERATURE RANGE is —65° to +200° F. LIFE — 1000 hours.



TA-200

FAIRCHILD'S

NEW ACCELEROMETERS

FOR APPLICATION IN: Flight Control-Testing, Toss Bombing, Airborne Telemetering, Computers and other systems requiring the measuring of missile or aircraft maneuvering accelerations.

*Fairchild's Built-in SAFETY FACTORS Beyond the Specs for Reliability in Performance.

SPECIFICATIONS

Model	**TA-200**	**TA-300**
G Range	± 1 to ± 100G	± 1 to ± 100G
Natural Frequency	7-35 cps	20-100 cps
Damping Factor	.7 @ 25° C	.7 @ 25° C

OUTSTANDING FEATURES

1. TA-200, TA-300 low cross talk units.
2. TA-200 uses a spring mass, linear motion sensing device with jewel bearings for extremely low friction.
3. TA-300 is also an extremely low friction design using a spring mass, linear motion sensing device.

Fairchild has three accelerometers for measuring accelerations in the medium G Range.

TA-100 — a low natural frequency unit *(previously announced)*

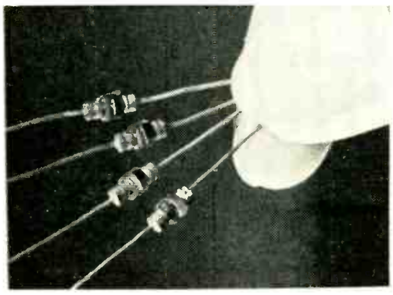
New TA-200 — a medium natural frequency unit

New TA-300 — a high natural frequency unit

These units use *special alloys* with a low temperature coefficient modulus. The use of these special alloys provide exceptionally *low hysteresis* and *excellent calibration stability* over a wide temperature range. All units use a potentiometer output (standard); can also be supplied with Fairchild's Nobl-ohm film resistance elements or AC type pickoffs.

for plug-in or printed-circuit and conventional-wiring applications.

Rise time is as low as 0.005 μsec, depending on transformer type and circuit; pulse repetition rate, up to 4 mc; operating temperature, -55 C to $+125$ C. **Circle 422 on Reader Service Card.**



Silicon Rectifiers tiny glass type

RAYTHEON MFG. Co., 55 Chapel St., Newton 58, Mass, has available the 1N645, 1N646 and 1N-648 tiny glass silicon rectifiers. These have peak inverse ratings from 225 to 500 v and are capable of handling 400 ma average forward current at 25 C or 150 ma at 150 C. **Circle 423 on Reader Service Card.**

Time Delay Relay thermal type

R.C.O. ELECTRONICS, 145 Valley St., Belleville, N. J., has in production a highly effective thermal time delay relay, model T-99. Actuated by heater and hermetically sealed for maximum stability, it is unaffected by moisture, altitude or dust

. . . ideal for use in military, commercial and communications equipment.

The delay relay operates on a-c, d-c or pulsating currents . . . 2 seconds to 3 minute delay periods. Vibrations and shocks will not damage the unit. When subjected to ambient temperature ranges from −60 C to +85 C, the relay delay interval varies slightly from room temperature delay periods.

Whether operation is intermittent or continuous, all relays are assured a useful longevity. Rapid installation is made possible by use of the standard intermediate shell 8-pin octal base. Special heater voltages are available for special requirements. Circle 424 on Reader Service Card.

Frequency Changer portable unit

Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn. Model FCR100 is a new low-impedance, portable frequency changer with a wide range of output frequency, excellent waveform, and low audio and radio noise. It is an ideal power supply for equipment drawing up to 100 va and operating best at frequencies other than that of the available main power source. It is also recommended for use in testing equipment over a range of frequencies anywhere between 45 and 2,000 cps.

Because of its low output distortion, it is said to be an excellent servo supply. Wide output-frequency range allows it to be used not only in 60-cycle applications, but also with higher frequency aircraft and missile components. Versatility of the unit is further enhanced by an auxiliary input which

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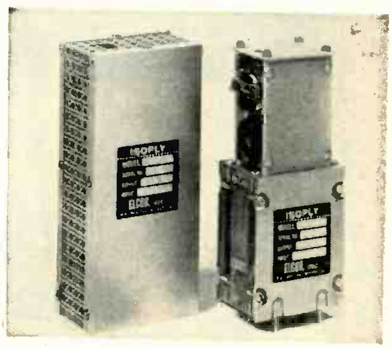
allows an external signal to be applied to its oscillator circuit. This permits the output frequency to be set with a high-precision frequency standard.

Other features include input voltage range of 105-125 v at 45-65 cps; output voltage range of 0-130 v with ±1 percent regulation for line or load; output frequency regulation of ±1 percent normally, ±0.01 percent with a built-in frequency standard or any accuracy obtainable with an external frequency standard; frequency drift of less than 1 percent in 24 hours; power factor of unity to 0.7 lagging at 100 va, unity to 0.5 lagging at 50 va, and fully inductive at 25 va; output distortion 1 percent maximum for 75-125 v output; and 0-40 C ambient temperature range. **Circle 425 on Reader Service Card.**



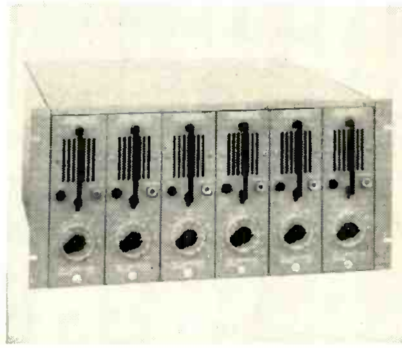
Power Supplies
transistor regulated

ELCOR, INC., P. O. Box 354, McLean, Va., announces a new series of transistor regulated power supplies for strain-gage bridges and other applications requiring a low-noise ungrounded power supply. Available are nine different models for 117 v, 60 cycle input, with output voltages ranging from 10 v to 50 v in steps of 5 v. Output current ratings range from 150 ma d-c at 10 v to 40 ma d-c at 50 v. Dimensions including the shield are 1 11/16 in. by 2 11/16 in. by 5 13/16 in., and weight is approximately 1 lb.

A novel feature is a special transformer construction that provides low shunt capacitance and very high leakage resistance from the output terminals to ground, permitting use of the supply as a floating source of d-c power in

bridge circuits or in other applications in which a signal voltage appears between the output of the power supply and ground.

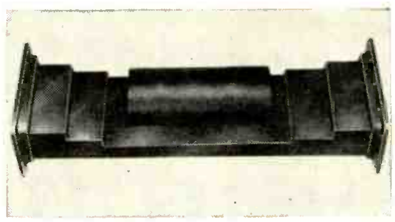
Other features include regulation of 0.4 percent; line regulation of 0.2 percent; output ripple of 0.01 percent; output voltage temperature coefficient of 0.02 percent per deg F; and noise and hum of less than 15 μv per kilohm impedance to ground. **Circle 426 on Reader Service Card.**



D-C Amplifier low noise level

DYNAMICS INSTRUMENTATION CO., 1118 Mission St., South Pasadena, Calif. Loss of data resulting from unexpected overscale input signals is avoided by the unique signal compression feature of the model 1250 d-c amplifier. The low noise level of 3 μv rms for 30 kc bandwidth is achieved by the special low-noise circuit.

Ground-loop and crosstalk problems are minimized by the very high degree of power line isolation. Specifications include voltage gain of 1,000, 2 μv zero stability, and 100 K input impedance. **Circle 427 on Reader Service Card.**



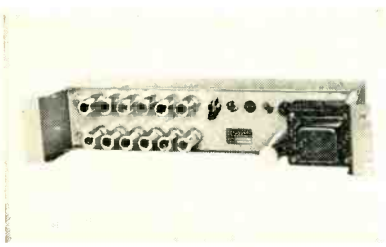
Ferrite Isolator operates in S-band

AIRTRON, INC., 1096 West Elizabeth Ave., Linden, N. J., has available a special resonant absorption ferrite isolator for operation in the S-brand region with female type N connectors to meet particular coax systems requirements.

Operating over a frequency range of 2,670 to 2,930 mc, the unit is especially beneficial in applications involving power amplifier type of transmitters because of the high degree of unidirectional isolation of the signal source from reflected r-f energy.

The standard type N (50 ohm) connectors are used on both the input and output of the basic waveguide structure, facilitating the connection of coaxial line systems. Three mounting brackets are used to support the unit permitting the disconnection of cables without removing the isolator and eliminating undue stress on the coaxial lines.

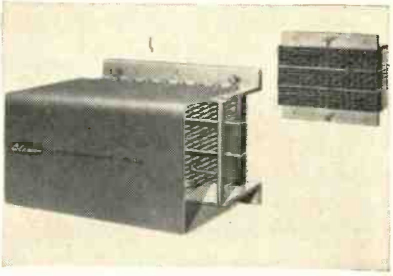
Electrical characteristics are: frequency range, 2,670 to 2,930 mc; isolation, 20 db minimum; insertion loss, 0.8 db maximum; input vswr, 1.20 maximum; and power handling capacity, 10 w average with a 2:1 load vswr. Circle 428 on Reader Service Card.



Chain Amplifier
r-f distribution

WESTBURY ELECTRONICS, INC., 300 Shames Drive, Westbury, N. Y., announces a new chain amplifier, model ABB-5 added to its present line of r-f distribution amplifiers. It provides truly broad band amplification of tv and f-m signals in the 15 to 230 mc region with a gain of 20 db and a frequency response flat ± 1.5 db. No matching cables or networks are required for use with 75 ohm cable. It is designed for continuous service with a self-contained power supply, manual gain control, and provisions for the addition of agc.

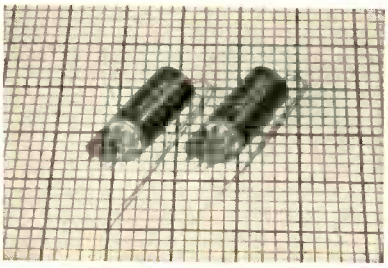
A unique feature of this amplifier is that complete loss of emission of one or more vacuum tubes does not interrupt the system but only reduces the gain by 1.5 db per tube. The unit is available in regular or rack mounting. Circle 429 on Reader Service Card.



Programming Plug has 240 pins

COLEMAN ENGINEERING CO., INC., 6040 W. Jefferson Blvd., Los Angeles 16, Calif., announces the model PR-240 programming plug set. The plug provides 240 pins, readily accessible, tapered to accept taper-lug jumper wires which are applied by hand pressure to effect jumper connections.

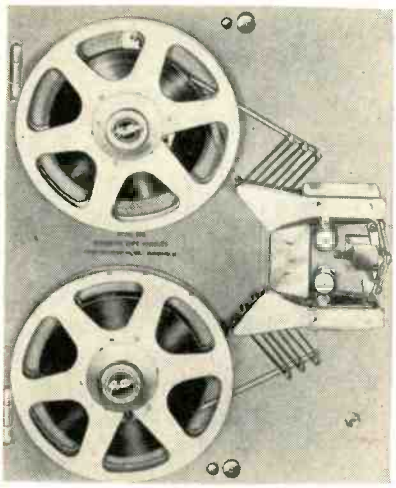
Features of the design include guide pins to align and polarize plug with receptacle, provisions for panel mounting the receptacle, and the protective cover for the plug. The unit, the cover of which measures 6 in. wide, $3\frac{1}{2}$ in. high and $2\frac{1}{8}$ in. deep, originally intended for use in the company's digital readout systems, is now available as a separate component. Circle 430 on Reader Service Card.



Choppers feature low noise

AIRPAX PRODUCTS CO., Cambridge Division, Cambridge, Md., announces a new type chopper with noise levels below 10 μv in low-impedance circuits. These noise levels are for wide-band noise extending from a few cps up to 40 kc and are measured by a thermocouple voltmeter (true rms reading).

The contacts are rated for operation in dry and nearly dry circuits yet withstand surges as high as 2 ma at 100 v into resistive loads. Drive is rated at either 400 ± 20 cps (type 2300) or 60 ± 6 cps (type 2400) at 6.3 ± 0.6 v rms. Normal operating temperature range is −65 C to +100 C. Units for operation to higher temperatures can be supplied on special order. In usual applications these choppers can be expected to remain within ratings for over 5,000 hours. **Circle 431 on Reader Service Card.**



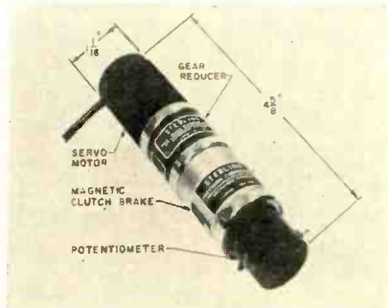
Tape Handler transistorized

Potter Instrument Co., Inc., Sunnyside Blvd., Plainview, L. I., N. Y. Model 906 completely transistorized digital magnetic tape handler features rugged dependability and remote control. Both high and low tape speeds are available in ranges of four speeds forward and reverse up to 150 ips. Rewind or search tape speeds are 400 ips.

The machine is capable of continuous cycling at any frequency from 0 to 200 cps without flutter. Start time is 3 milliseconds and stop time has been reduced to 1.5 milliseconds.

A vacuum loop device is used in conjunction with the tensioning system to provide proper tape tension at all times. Other features include in-line threading, end of tape sensing, and tape break protection.

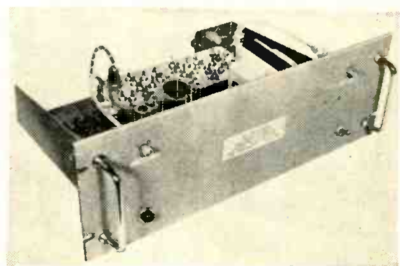
Close packing density, providing up to 47 channels is obtained by use of a Potter high density record/playback head. Circle 432 on Reader Service Card.



Servo Package combines four parts

Sterling Precision Corp., 34-17 Lawrence St., Flushing 54, N. Y. Model T-950 is a compact servo package combining a servo motor, a gear reducer, a magnetic clutch-brake and a potentiometer. In this particular unit, the motor is driving the potentiometer arm at a speed corresponding to the rotation of radar scanning antenna, (approximately 40 rpm). Upon a given signal the motor is uncoupled and the potentiometer is braked within two milliseconds.

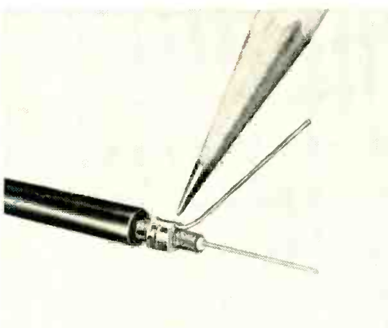
Using the same basic units, various combinations of operational requirements can be accomplished. Circle 433 on Reader Service Card.



R-F Amplifiers broadband type

Applied Research Inc., 76 South Bayles Ave., Port Washington, N. Y., has a new line of broadband r-f amplifiers ruggedly designed for consistently high performance and low maintenance cost. Model HFW octave r-f amplifiers are said to be a step forward in the application of advanced multipole network theory. The new units provide broadband bandpass amplification covering an octave or greater of frequency in the 40 to 600 mc spectrum with low noise, high gain and low power drain.

GE type GL-6299 co-planar triodes are combined with multipole networks to provide amplifiers with power gains of 5.5 db or greater per stage, with a 300 mc bandwidth. A number of these stages are cascaded to provide gain of 20 or 30 db. The frequency spectrum of 40 to 600 mc is covered by six basic octave r-f amplifiers, having the following frequency responses in megacycles: 40 to 80; 80 to 160; 100 to 200; 160 to 320; 225 to 400; and 300 to 600. Circle 434 on Reader Service Card.

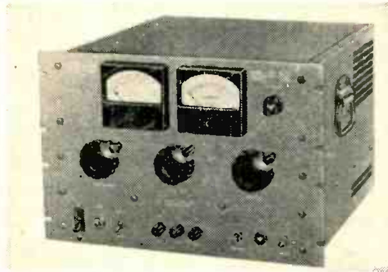


Ferrule for shielded wire

AMP Inc., 2100 Paxton St., Harrisburg, Pa., announces its new Automachine shielded wire ferrule for automated pigtailing.

Designed expressly for grounding the shield braid of coaxial conductors, the new Automachine feeds and attaches Automachine shielded wire ferrules and pigtail simultaneously to shielded wire leads. The Automachine's dual applicator permits attachment of ferrule and pigtail wire to a double ended shielded wire jumper or to two shielded wire leads at the same time, with pigtail wires whose length can be adjusted in the applicator.

The firm reports that the new process will reduce the cost of pigtailing by 75 percent by eliminating the tedious wire preparations formerly required. Circle 435 on Reader Service Card.



Voltage Adjuster and stepper

Kepco Laboratories, Inc., 131-38 Sanford Ave., Flushing 55, N. Y., announces release of a new line voltage adjuster and stepper designed to vary the input voltage for testing the performance of electrical and electronic equipment. Model 920 B provides for adjusting and stepping the line voltage from 95 to 135 v a-c for any fixed input voltage in the 95 to 135 v a-c range.

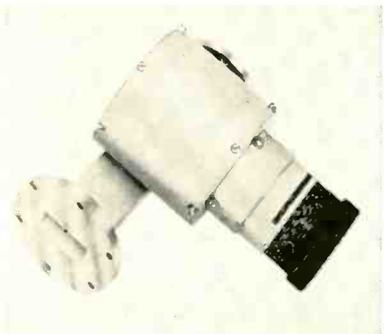
Output capacity is 3.5 kva for input line voltage above 114 v. This output capacity decreases linearly to 3 kva at an input line voltage of 95 v. The output step voltage can be adjusted from 0 to 40 v. Circle 436 on Reader Service Card.

Sweep Generator covers 100 kc—20 mc

Marconi Instruments, 111 Cedar Lane, Englewood, N. J., announces a sweep generator covering 100 kc to 20 mc with crystal markers throughout this range. Manufacturer claims that the instrument, model 1099, enables response measurements to be made with a discrimination of at least 0.01 db.

Output level (3 v maximum) is stabilized and the instrument is supplied with detector probes on both input and output. With these probes a greatly amplified indication can be obtained of the deviation of an amplifier frequency response from level, and measurements are largely independent of input level changes.

An instrument of this accuracy finds ready application in design and checking of filters and video circuits. **Circle 437 on Reader Service Card.**

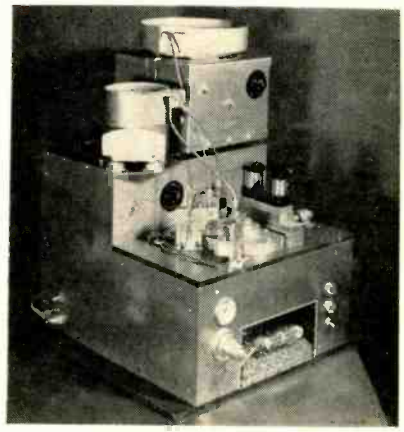


Frequency Meter direct-reading unit

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. Type 590-A direct-reading frequency meter allows quick determination and easy reading of frequencies in waveguide systems operating between 5,100 and 5,900 mc. It is available for general use as a separate unit, or it may be installed as a permanent part of another piece of equipment.

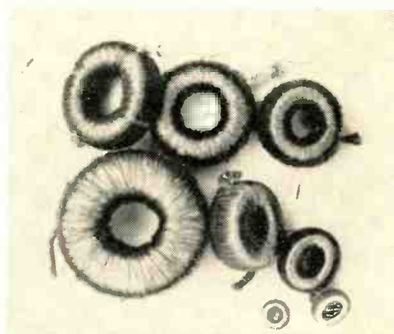
The 590-A consists of a TE_{011} mode cavity resonator tuned by a non-contacting plunger whose position is variable along the axis of the cavity. The calibration spiralled around a drum dial indicates frequency directly in mc. The cavity is coupled to a section of waveguide fitted at both ends with cover flanges, enabling the units to be inserted directly into any line of matching waveguide size.

A four-ft scale is attained through spiral calibration of the drum dial, with careful control of critical dimensions for low-cost accuracy. Unusually high resolution is provided because the extra-long scale covers a range of only 800 mc. **Circle 438 on Reader Service Card.**



Capping Machine automatic unit

STREMPEL INSTRUMENT CORP., Lake George, N. Y., has available a new automatic capping machine that automatically feeds and assembles rod shaped bodies and press-fit caps at a rate of 4,000 pieces per hr. Bodies and caps are bulk loaded into vibratory feeders. The machine also incorporates an automatic shut-off which stops the drive when either caps or bodies fail to feed. The drive and cycle timing are electrical. Capping operation is pneumatic. **Circle 439 on Reader Service Card.**

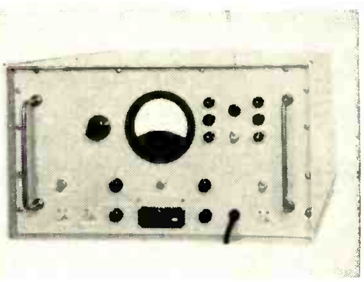


Toroids high tolerance

BARKER & WILLIAMSON, INC., Canal St. & Beaver Dam Rd., Bristol, Pa. Of interest to manufacturers of memory devices, chokes, filters, transformers and other components utilizing toroids, are a new line of specials, wound on high-permeability cores.

Sizes range from $\frac{5}{8}$ in. to 3 in. o-d with frequencies from 1,000 cps to 200 kc. They are available with inductance and Q values to specification. The manufacturer claims a high degree of stability vs voltage and temperature, and they can be designed to compensate for extreme variations in temperature.

Tolerances are said to range from 5 percent to 1 percent for special requirements, and finishes may be plain, waxed, potted encapsulated or hermetically sealed to meet MIL-T-27A. Circle 440 on Reader Service Card.

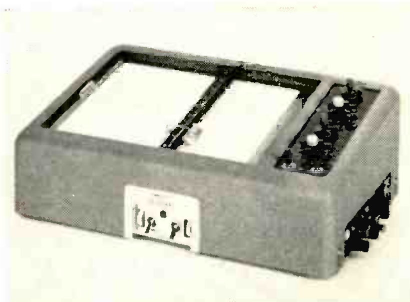


Phase Angle Meter and monitor

CONTROL ELECTRONICS CO., INC., Huntington Station, N. Y., has developed a phase angle meter and monitor that provides direct reading without ambiguity, together with high accuracy over a wide frequency and amplitude range.

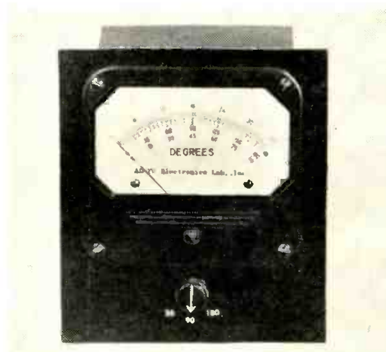
The rugged equipment provides accurate and rapid measurement of phase difference, no matching of amplitudes or wave forms being required. It offers direct reading 0 to 360 deg with accuracy ± 1 deg, 20 to 20,000 cps, and makes possible continuous, unattended monitoring of phase angle by use of chart recorder.

Model 120 is offered for use in the testing and inspection of servo amplifiers, feedback amplifiers, audio and power transformers, resolvers, goniometers, synchros and polyphase systems. It accepts sinusoidal or complex wave forms and an output is available which is suitable for use with recording equipment. Weighing 59 lb, its dimensions are $11\frac{1}{4}$ by 20 by 18 in. deep and it can be mounted in a standard 19 in. rack when the cover is removed. **Circle 441 on Reader Service Card.**



X-Y Recorder with time base

F. L. Moseley Co., 409 North Fair Oaks Ave., Pasadena, Calif., announces the model 3S Autograf X-Y recorder with built-in time base or sweep circuit on the x-y axis. It will plot versus time any physical or mechanical function which can be reduced to electrical form. Available at finger-tip control are five calibrated time intervals of from 5 sec to 500 sec for full scale x-axis pen travel. When the time base is not used, regular two-variable plotting may be accomplished as desired. **Circle 442 on Reader Service Card.**



Panel Mount Meter measures phase angle

Ad-Yu Electronics Lab., Inc., 249 Terhune Ave., Passaic, N. J. Type 410 panel mount phase meter has the following features: (1) No electron tube, battery or power supply. (2) No error due to harmonic or noise content. (3) No amplitude adjustment, no zeroing; direct reading in degrees. (4)

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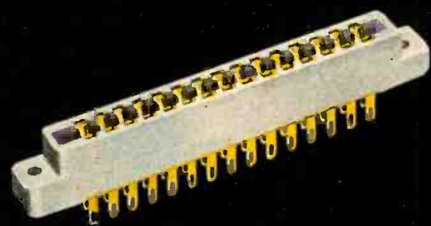
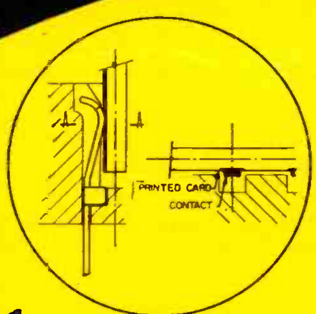


New UPCR-D Series

double row printed card receptacle

IMPROVED 4 WAYS!

It is part of U.S. COMPONENTS' research and development policy never to be satisfied . . . always on the alert for new ideas, materials, methods . . . and you are the benefactor. The new improved UPCR-D Series receptacles is an excellent example of the company's continuous progress in the field. Here is a foolproof precision connector series incorporating a number of new features, the result of a close liaison between application engineers and U.S. COMPONENTS. The proof is in the performance . . . write for sample and details! These new features are incorporated in over 150 types now available, meeting environmental requirements.



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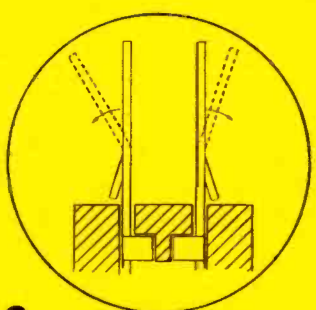
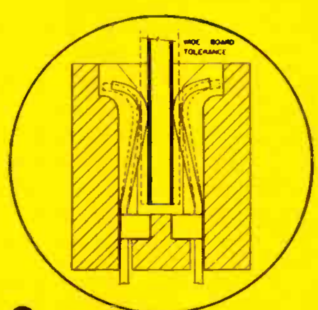
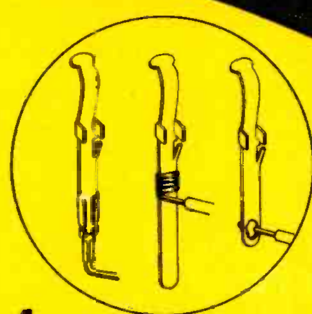


2. CONTROLLED TERMINAL HARDNESS, heat-treated beryllium copper permits flexibility in crucial areas maintaining maximum strength and no-creep.



3. WIDE BOARD TOLERANCE RANGE, controlled and repeated insertion and retention forces are assured over card range thickness of .062 or .093 of ±.010.



4. PRECISION CONTACTS, wire-solder, taper tab (amp 78), and wire-wrap versions. Government approved processing—silver and gold plated.

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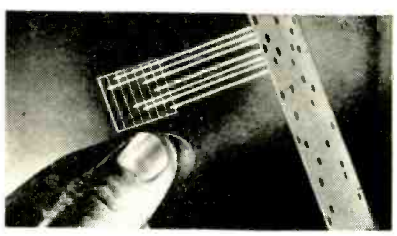
The device is very suitable for measuring phase angle between two periodic potentials of any shape, sinusoidal or nonsinusoidal, regardless of the relations between the peak values. Phase ranges are 0-36 deg, 0-90 deg, and 0-180 deg. **Circle 443 on Reader Service Card.**

Coil Checker
shows shorted turns

KARTRON, P. O. Box 472, Huntington Beach, Calif. Model 101-G for microminiature coils is the latest version of the shorted turn indicator. It checks unmounted electrical coils with inside dimensions down to less than 1/16 in. square with sensitivity approaching that of the other models 101-D and 101-E with larger mandrels, or probes. It will not check toroids. Manual 43 contains a full description. **Circle 444 on Reader Service Card.**

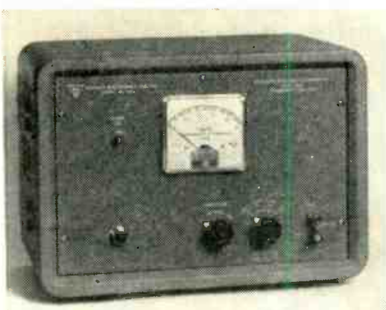


Photovoltaic Cells
silicon devices

HOFFMAN ELECTRONICS CORP., Semiconductor Division, 930 Pitner Ave., Evanston, Ill. A new series of silicon photovoltaic cells have a response time of less than 20 μsec, and a lifetime expectancy of over 10,000 years. They are particularly suitable for photoelectric devices requiring extremely fast response, dependability, maximum light sensitivity and low-cost.

The silicon cells, which are self-generating, require no external power supply. Their compact size allows for a greater number of control circuits than previously possible, where space is at a minimum.

The cells operate effectively through temperature variations from −65 C to +175 C and higher, with a spectral response range from 3,000 to over 10,000 Angstroms. Applications include punched tape and card readouts; programming controls; pinhole detection; remote switching controls; infrared sensing; automatic counting; heat, flame and hot-metal detection. Circle 445 on Reader Service Card.

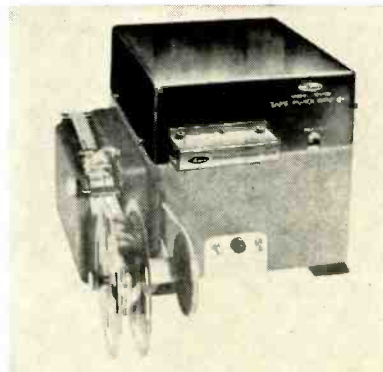


Signal Generator standard frequency

Ad-Yu Electronics Lab., Inc., 249 Terhune Ave., Passaic, N. J. Type 209 standard frequency signal generator has an accuracy of ± 0.005 percent. The instrument consists of a tuning fork oscillator, with negative feedback for amplitude stabilization; a twin-T filter with a cascode amplifier for elimination of harmonic distortion; an output cathode follower; a resistive attenuator with 2,500 ohms impedance; an output meter circuit to indicate the signal voltage at the output terminals; and a regulated power supply.

In conjunction with a power amplifier, such as the type 230, this instrument may become a valuable precision frequency power source for testing servo components.

The standard frequency is 400 cps; other frequencies can be supplied on request. Output voltage range is 0 to 10 v continuously variable. An output meter is supplied for direct indication of a signal voltage at output terminal on panel meter in rms value, with an accuracy of ± 3 percent. Output impedance is 2,500 ohms. Distortion is less than 0.5 percent. Circle 446 on Reader Service Card.



Input Unit
for tape punch

Coleman Engineering Co., Inc., 6040 West Jefferson Blvd., Los Angeles 16, Calif. A compact tape punch input unit recently developed by Coleman mounts directly on a motorized tape punch manufactured by Commercial Controls. The integral unit accepts digital input data, programs the desired format, and scans the digital information into the tape punch.

Designated model CCV-40, the new tape punch input unit features a patching program plug to permit format changes to be made easily, capacity up to 40 information bits (digits, command symbols, etc.), and a diode matrix to provide any desired code up to 8 channels.

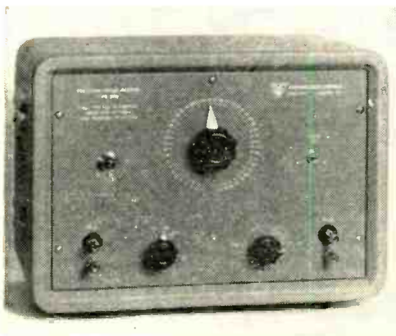
The unit is also available for rack panel mounting. Circle 447 on Reader Service Card.

Solid Electrolytics
with new ratings

Sprague Electric Co., 35 Marshall St., North Adams, Mass. Expansion of available ratings of solid electrolyte Tantalex capacitors to include new ratings from 0.22 μf to 4.7 μf at 35 v d-c is announced. These new higher ratings are expected to find wide application on 28 v electronic equipment used in aircraft and missiles, both of electron tube and transistor circuit design.

Sprague has also added 20 v solid-electrolyte Tantalex electrolytic ratings from 0.22 μf to 15 μf to its standard line.

These new designs are of the sintered-anode type and complement the lower capacitance wire-anode types previously announced. Circle 448 on Reader Service Card.



Phase Shifter with 0.1 deg accuracy

AD-YU ELECTRONICS LAB., INC., 249 Terhune Ave., Passaic. N. J. Type 208 precision phase shifter consists of resistant-capacitance phase shifter networks, an electron-tube phase inverter, and an output cathode follower.

The instrument is well adapted for precision measurement of phase angle between the output and input of an amplifier, filter, transformer, servo system, and any other four-terminal networks. It is also suitable for accurate calibration of phase measuring instruments, such as phase meters, phase shifters and others.

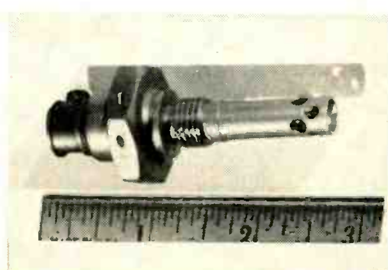
Phase range is 0 to 360 deg. Maximum error is less than 0.1 at 400 cps. Maximum input signal is 25 v rms. The frequency range for direct phase reading is 400 cps. With correction curve supplied with the instrument, the frequency range can be extended beyond this range.

The impedance looking into the

output terminals is 500 ohms nominal shunting resistance, and 2 μf series capacitor for d-c blocking. Input impedance is about 100 K in series with 2,000 $\mu\mu$f to ground. Circle 449 on Reader Service Card.

Molded Plugs fit standard tube sockets

METHODE MFG. CORP., 7447 W. Wilson Ave., Chicago 31, Ill. Seven and nine prong molded plugs which fit standard tube sockets now provide economical means for easily engaged multilead connections. Offering considerable space savings over the earlier octal and wafer type construction, plugs and mating sockets are available in both commercial materials and finishes and to the applicable requirements of JANS-28A. The connector pairs benefit from the high reliability and low cost inherent in high production vacuum tube socket terminals. Circle 450 on Reader Service Card.

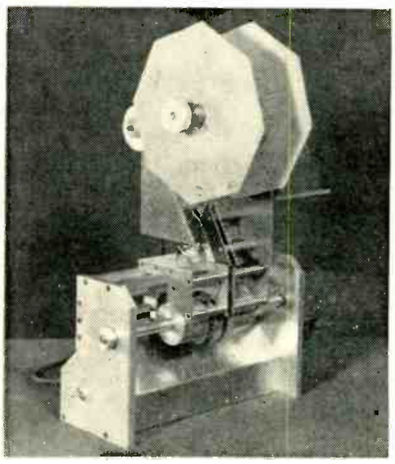


Transducer measures temperature

NACIMCO PRODUCTS, INC., National City, Calif. The instrument illustrated is a precision resistance thermometer type of temperature transducer utilizing deposited platinum film techniques. It has exceptional speed of response, and is said to be 50 to 100 times faster than any temperature measuring instrument heretofore available.

The new temperature transducer is extremely rugged and has the ability to withstand extremes of both vibration and pressure. It has a base resistance up to 10,000 ohms, with ranges from − 370 deg to + 500 F. Sensing element of the instrument is ⅛ in. in diameter and 0.030 in thickness.

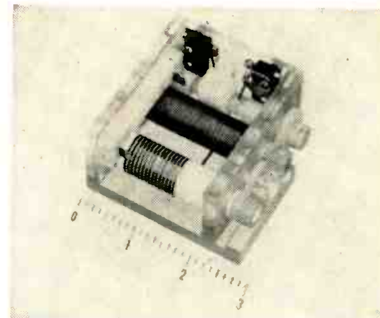
This deposited film type unit is offered in a number of configurations. Primarily developed for missile use, it is being used at present by a number of major companies working on missiles. A wide range of potential applications for automation and instrumentation are being projected. **Circle 451 on Reader Service Card.**



Reel-Pack Feed and clip-bend

STREMPEL INSTRUMENT CORP., Lake George, N. Y., announces two new units: an automatic clip-bend machine and an automatic reel-pack feed mechanism (shown mounted on the clip-bend). The clip-bend machine cuts leads of axial lead parts and bends them at right angles for mounting in wiring boards.

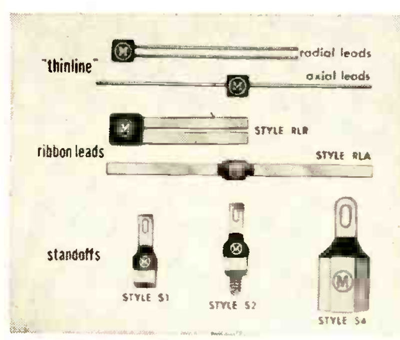
It is fully adjustable and will accommodate all commonly used parts. Operating rate is 4,000 pieces per hr. Set-up time, changing all dimensions, is approximately 2 min. The automatic reel-pack feed mechanism will feed reel-packed parts to any machine. This simple feed senses the emptying of parts from its discharge chute and refills, keeping up with any demand rate to 10,000 parts per hour. It has a universal mounting suitable for use in any existing machinery. **Circle 452 on Reader Service Card.**



UHF Loading Coil for antenna testing

Alto Scientific Co., 855 Commercial St., Palo Alto, Calif. Model O-21 self-contained uhf loading coil for antenna testing comprises two concentric drums wound with plated copper ribbon wire. Inductance is varied through a common, spring-loaded gear drive with a positive mechanical stop at high and low ends. Provision is made for application at an external mechanical tuning drive.

Designed for operation at frequencies from 24 to 52 mc, the new coil permits inductance to be varied from 3 to 0.1 μh. Q is greater than 50 at 52 mc and greater than 225 at 24 mc. Power handling capability is 25w. **Circle 453 on Reader Service Card.**



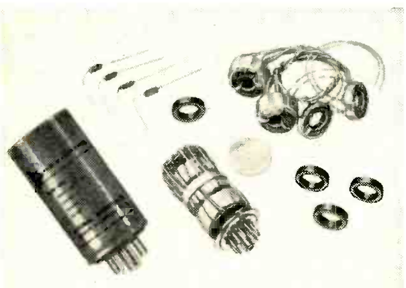
Eight Ceramics for capacitor reliability

Mucon Corp., 9 St. Francis St., Newark 5, N. J. Subminiature ceramic capacitors are now available in eight different ceramic materials to obtain the minimum size for the specific temperature characteristics required.

For example, a capacitor of 2.5 $\mu\mu f$ measures $\frac{1}{8}$ in. square when made with NPO ceramic which has a zero temperature coefficient; at the other extreme, a $\frac{1}{8}$in. square capacitor made with Super-K ceramic measures 1,000 $\mu\mu f$ but is usable only over a limited temperature range.

Various other ceramics give intermediate sizes and temperature characteristics.

Thinline capacitors with radial or axial leads, ribbon lead units or standoffs are also available with each ceramic. **Circle 454 on Reader Service Card.**



Magnetic Amplifier d-c to d-c

ACROMAG, INC., 22519 Telegraph Road, Detroit 41, Mich. Model 420 is a d-c to d-c magnetic amplifier especially designed for missiles, automatic pilots, helicopter rotor speed controls, jet engine fuel controls, and nuclear measuring and control equipments. It often replaces chopper-stabilized amplifiers where extreme bandwidth is not required.

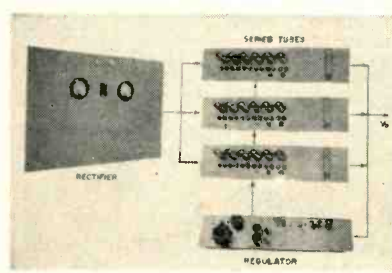
Model 420 has a transimpedance, Z_m, of 50,000 ohms and delivers full linear d-c output from 10μw of d-c control signal; frequency response extends from d-c to 25 cps, depending on circuits used. It contains a push-pull, full-wave, reversible-polarity magnetic amplifier and uses negative feedback for stabilization and for improved linearity. Special power supplies, bias supplies, and balance controls are not needed. Model 420 uses less than 3 w of power and operates from standard 115 v

400 cps power. It is completely self-contained.

Distorted supply waveforms, 10 percent voltage and frequency variations, and temperatures from -55C to $+85$C do not impair performance. The unit is hermetically sealed and ruggedized in a steel case 1½ in. in diameter by 3 in. in height. Weight is less than 9 oz. Circle 455 on Reader Service Card.

Casting Powder speeds encapsulation

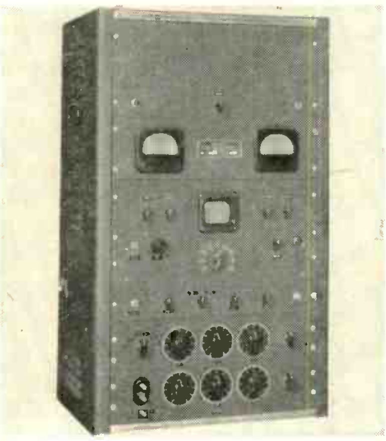
Epoxy Products, Inc., 137 Coit St., Irvington, N. J., has available the new Epoxy E-Form casting powder for the encapsulation of electronic components. It is a stable, dry blend of epoxy resin and hardener, in an easily handled, nontoxic powder form. Exhibiting all of the physical and electrical properties inherent in epoxy, the new powder offers the further advantage of liquefying and then hardening when heated. The powder was initially developed for use in conjunction with Epoxy E-Case shells. Circle 456 on Reader Service Card.



D-C Power Supply is modularized

Dynamic Controls Co., 1955 Massachusetts Ave., Cambridge, Mass. Modular construction of regulated d-c supplies allows fast installation of a system. The supplies are sectionalized into three basic panels for rack mounting: rectifier, regulator and series-tube. A single regulator controls any number of series-tube sections operating in parallel. The series-tube panels are conservatively rated at one ampere. The rectifiers come in three voltage ranges which in cooperation with the regulators give output voltages from 0 to 150, 150 to 300, and 300 to 500; current ratings are 1, 3, 6 and 10 amperes.

Expansion can be provided by paralleling series-tube sections and installing a larger rectifier or a parallel rectifier. Interchangeability reduces obsolescence. Output voltage performance is better than 0.1 percent for load and line changes, including transients. Circle 457 on Reader Service Card.



Impedance Bridge packaged system

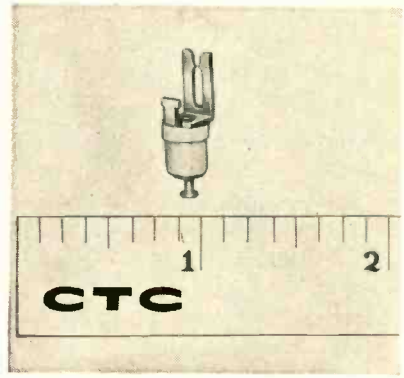
PENNSYLVANIA TESTING LABORATORY INC., Doylestown, Pa. A completely packaged unit is offered as a standard system for measuring inductances with high-voltage a-c applied simultaneously with large d-c currents.

Type 277 is complete and provides for inductance measurements from 1 μh to 1000 henries with superimposed d-c currents as high as 4 amperes and a-c voltages up to 250 v from 20 cps to 20 kc. No auxiliary equipment is necessary. The bridge oscillator, power amplifier and d-c power supply are included as well as a sensitive null indicator which will indicate independently the real and quadrature components of the bridge balance points.

The bridge ratio arms will dissi-

CIRCLE 212 READERS SERVICE CARD

pate 500 w a-c and/or d-c and remain 0.1 percent accurate. Effective resistance within a billion to one range is also measurable as well as inductance. **Circle 458 on Reader Service Card.**



Diode Clip
for secure shock support

Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass., has developed a new insulated diode clip. It is fastened to a teflon insulator for a press fit mounting and is designed to securely support ferrule contact diodes under conditions of shock and vibration.

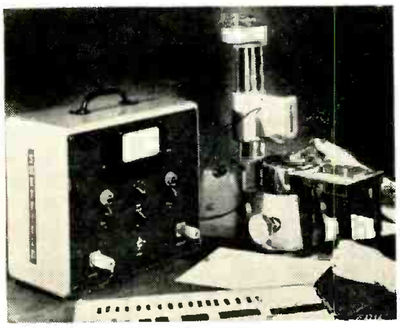
The clip (No. 2323), for mounting in hole diameter of 0.2055 in., can be used in chassis and panels up to ⅛ in. thick. The construction provides solder points above and below panel. **Circle 459 on Reader Service Card.**

Power Supply
for transistor circuitry

Dressen-Barnes Corp., 250 North Vinedo Ave., Pasadena, Calif. Model 6-3MB is a closely regulated d-c power supply for powering transistor circuits. Output is 0 to 60 v d-c, continuously variable, at 3 amperes maximum. No derating of output current, or of regulation and ripple specifications, is necessary from 1 to 60 v d-c.

Regulation for 60 v/3 ampere load is 20 mv change, no load to full load. For line voltage change of 105 to 125 v a-c (at 60 v/3 amperes output), regulation is 20 mv change in output voltage. Ripple and internal noise are below 1.5 mv rms. Unit is designed for very low output impedance and fast recovery time. One-percent meters are supplied.

The instrument is built to fit in a standard 19 in. relay rack. **Circle 460 on Reader Service Card.**

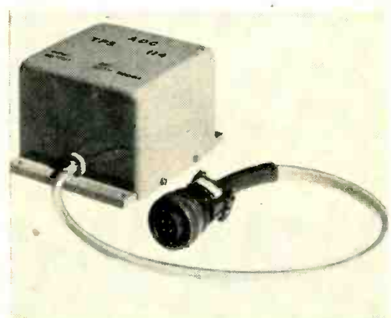


Comparator checks gage block size

The Sheffield Corp., Dayton 1, Ohio. One-millionth of an inch accuracy is obtained with a new electronic gage block comparator. The extreme accuracy of the new Dualjet comparator is based on the use of an opposed pair of transducer-type pick-up units.

Measurement is amplified either 100,000 or 10,000 times by an Accutron electronic amplifier. High magnification has a 0.000004-in. range and scale divisions of 0.000001 of an inch. A range switch permits instant change to low magnifications (10,000 to 1 with a 0.0004-in. range) without recalibration. The Accutron amplifier operates on 110-v, 50/60 cycle a-c. Compensation is provided for line voltage changes ranging from 95 to 125 v.

A precision ground, 40-pitch leadscrew on a steel column, rigidly mounted on the sturdy cast base, provides vertical coarse adjustment of the top gaging head. Fine adjustment is made with a cam and lever mechanism in the base with knobs that are completely isolated from gage head or anvil. The gage has interchangeable diamond points and a gage point lifting device to avoid scratching surfaces of work. Gaging pressure is 8 oz; vertical capacity, 4 in. A ratchet-type device raises or lowers the gage head in increments of 0.0005 in. **Circle 461 on Reader Service Card.**



Power Supply for mobile systems

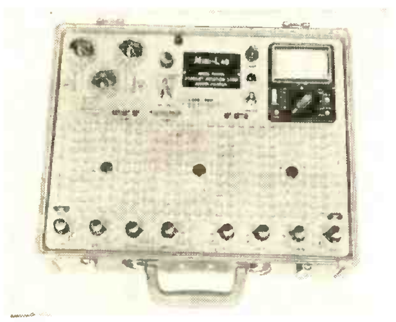
Aerophysics Development Corp., P. O. Box 689, Santa Barbara, Calif. A transistor power supply designed for use on vehicles subject to high shock and vibration environments has been developed.

Designated TPS-5, the transistor operates in ambient temperatures from −40 F to +70 C, and converts 28 v d-c at 3 amperes to 225 v d-c at 300 ma for operating mobile electronic systems or devices. Package dimensions are 2½ in. by 3½ in. by 4½ in. including mounting flanges. The unit weighs 1.5 lb. **Circle 462 on Reader Service Card.**

Hook-up Wire permanently color coded

General Cable Corp., 420 Lexington Ave., New York 17, N. Y. Spiracode is a new hook-up wire made by a modern, advanced technique of plastic extrusion which effects a permanent easy method of color coding hook-up wire that is actually colored plastic insulation solid to the conductor. This method of spiral plastic extrusion permits a solid multi-colored plastic insulation spirally applied in barber-pole fashion of any combination of colors up to three on solid or stranded conductor.

The spiral stripes of solid colors on Spiracode are nonmigrating, nonfading, sharp, crisp, permanent brilliant colors that are readily identifiable and easily traced even in the most complicated wiring systems and harnesses. Both vinyl plastics and polyethylene insulations are available on this new hook-up wire. Circle 463 on Reader Service Card.

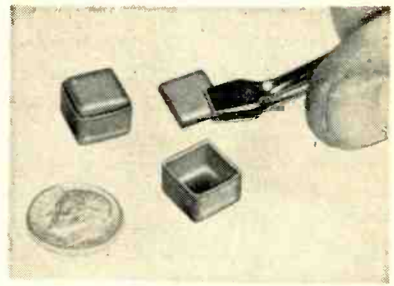


Breadboard for subminiature circuitry

Stanley Aviation Corp., 2501 Dallas St., Denver 8, Colorado. The Mini-Lab illustrated provides a novel technique in electronic breadboarding for the rapid development, assembly, study and testing of circuits and components. It offers many new features not previously available to engineers: built-in multimeter; regulated power supplies; expendable plugs for component leads; short, direct connections; eight potentiometers; built-in resistance and capacitance selector boxes; convenience, portability, reliability.

Designed specifically for subminiature, miniature and semiconductor circuitry, Mini-Lab contains a grid of tiny jacks arranged in the form of tie points, voltage busses, ground busses, coupling junctions, and input and output terminals.

Miniature and subminiature tubes, transistors and other semiconductors may be quickly plugged into the board. Components such as resistors, capacitors, transformers, chokes and the like are plugged in by means of expendable plugs easily crimped directly onto the leads. Circle 464 on Reader Service Card.



Shielding Capsules for miniaturized uses

Magnetic Shield Division Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill., has developed a new line of subminiature Co-Netic magnetic shielding capsules designed for subminiature reactors and transformers used in transistorized and printed circuits and other miniaturized applications. Virtually eliminated are hum and noise caused by low level extraneous electromagnetic and electrostatic fields. Much closer grouping of components is now possible due to shielding effectiveness. When required, shields can be pretinned for soldering without affecting magnetic shielding qualities. Shielding capsules may be produced in a wide variety of shapes and dimensions using standard methods or special hydroform techniques. Circle 465 on Reader Service Card.

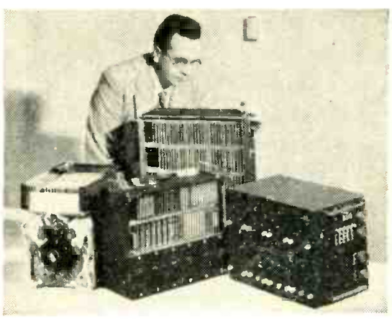
Readouts digital and message

Milman Engineering Co., 1831 Pontius Ave., Los Angeles 25, Calif. A line of newly developed digital and message readouts offers many possibilities for more effective presentation of data and information in bench, panel, and console applications.

The digital readouts present lighted digits zero through nine and decimal point, or other information such as polarity signs or special symbols. Modular design allows side by side mounting of the units for in-line presentation of information.

Message readouts will display, separately in one panel area, up to three different color-coded printed messages, greatly increasing the accuracy of visual observations. Message and color combinations are made to suit individual requirements. Superpositioning of messages in the readout reduces the amount of panel area required to present a given amount of information and eliminates panel art work and engraving.

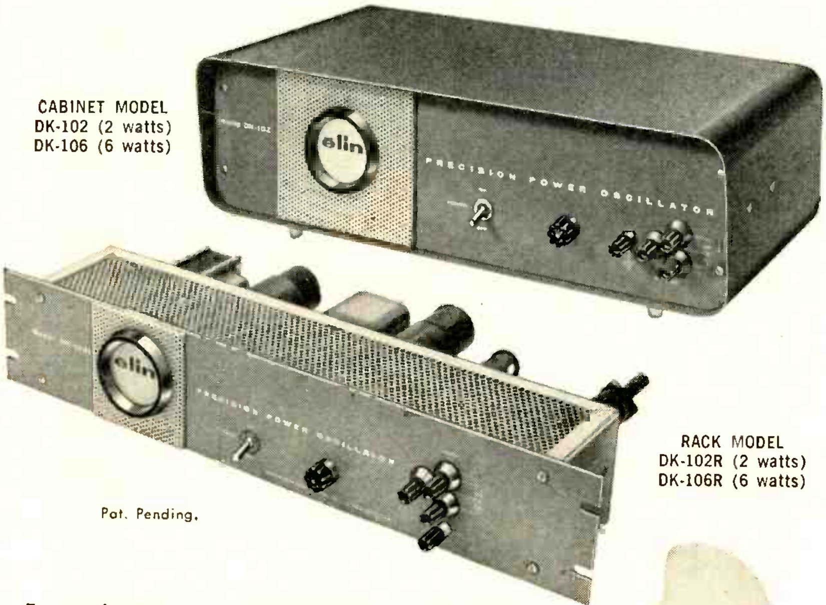
The units are designed for operation on 6, 14, or 28 v. Circle 466 on Reader Service Card.



Digital Computer for military aircraft

THE RAMO-WOOLDRIDGE CORP., 5500 W. El Segundo Blvd., Los Angeles, 45, Calif. The RW-30 digital airborne computer is designed to provide a lightweight, compact computing-control center for high-performance military aircraft. A completely transistorized device, it employs specially designed digital computing techniques and will perform all computations for navigation, fire control, bombing and weapon control with the speed demanded by modern weapons systems.

The complete computer has a volume of 4.19 cu ft and weighs only 203 lb. It consists of four separately packaged units—magnetic drum storage unit, arithmetic

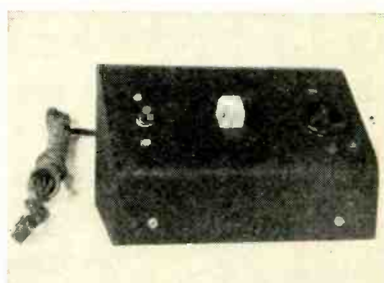


and control unit, input-output unit, and clock generator and power supply unit. Subminiature packaging techniques and silicon semiconductor circuitry are used throughout.

The RW-30 can conduct 4,000 complete arithmetic operations per sec, including access time and requires only 400 w of power, permitting a significant saving in aircraft auxiliary power equipment. **Circle 467 on Reader Service Card.**

Tiny Thermostat for −65 C to +150 C

CHATHAM CONTROLS CORP., 33 River Road, Chatham, N. J. The new model WP thermostat features a $\frac{3}{16}$ in. diameter and 0.690 in. body length. It incorporates the same type of bimetal actuated contact, extreme simplicity, reliable performance, accurate temperature control, fast thermal sensing and long contact life as the manufacturer's other models. The device is rated at $\frac{1}{2}$ ampere for 6-28 v a-c or d-c and 115 v a-c circuits. It has an externally adjustable temperature range from −65 C to +150 C. **Circle 468 on Reader Service Card.**



Surge Limiter has varied uses

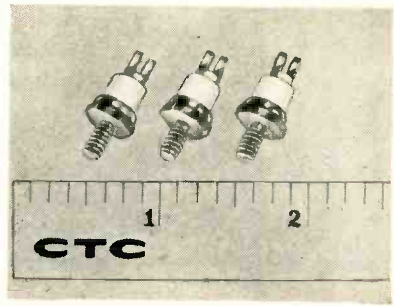
ATLANTIC ELECTRONICS LABORATORIES, P. O. Box 918, Asbury Park, N. J. The Surge-Volt Master is designed to limit to reasonable values the surge current when equipment such as radios, tv receivers, amplifiers, low-power transmitters, expensive test equipment and the like are turned on. After a suitable pre-heating period, full line voltage is applied to the load in question. Then a built-in voltage regulator maintains the line voltage approximately at 110 v, thus prolonging the life of such components as tubes, resistors, capacitors and the like. Presently available are Surge-Volt Masters in the 50-, 100-, 150-, 200-, 250-, 300- and 375-w ranges.

The Surge-Volt Master should prove useful in technical schools and universities, industrial production lines and laboratories. Circle 469 on Reader Service Card.

UHF Blade Antenna for 225-400 mc band

DORNE & MARGOLIN, INC., 30 Sylvester St., Westbury, L. I., N. Y. Type DM-C7 antenna is designed to operate in the 225-400 mc band for use with communication and data link equipment. This antenna is a highstrength swept-back aluminum blade, with a height of 7¾ in. from the aircraft skin, designed for use at speeds well into the supersonic region. Maximum thickness of the antenna is substantially less than 10 percent of the average chord length.

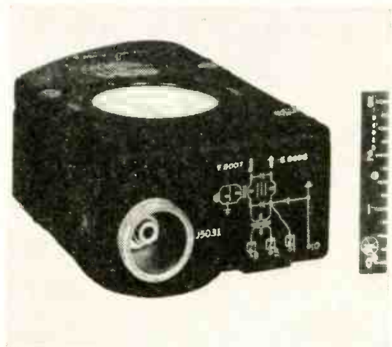
The antenna is designed to meet the environmental requirements of MIL-T-5422C and paragraph 412 of MIL-E-5272A. It can withstand more than 8 lb per sq in. lateral static load. Weight is approximately 20 oz and vswr is less than 2.5:1.0 over the 225-400 mc band. Circle 470 on Reader Service Card.



Insulated Terminals split type

Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass. Split solder terminals can be ordered in a wide variety of sizes and mounting studs, either in silicone impregnated ceramic, grade 15 (per JAN-1-10) or with Teflon insulation. Terminals are silver plated brass.

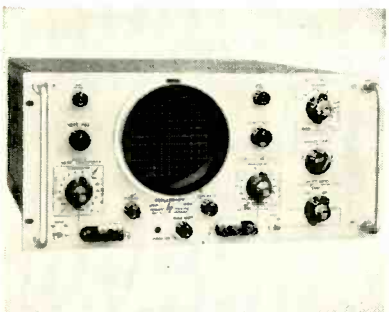
Three specific mounting studs are available: threaded (a variety of threads and lengths), rivet (several different lengths), and internally threaded. Circle 471 on Reader Service Card.



Pulse Transformer for airborne radar

Specialties, Inc., Skunks Misery Road, Syosset, L. I., N. Y. A new series of high power pulse transformer assemblies designed to match the impedance of a pulse forming network to a magnetron oscillator in a line type modulator are now being produced. They feature compactness and a high degree of resistance to temperature variations, mechanical shock and vibration.

A self-contained filament transformer, a radio noise filter and bypass capacitors are provided so that the magnetron can be properly driven from a pulse forming network and a 115 v, 400 cps power source. Models are available for use with a 50-ohm pulse forming network and a 2J51A, 4J52 or 6543 magnetron. Circle 472 on Reader Service Card.

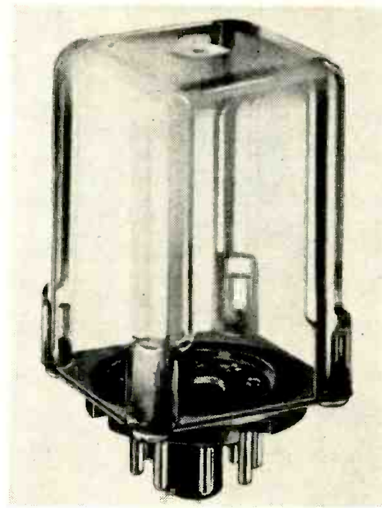


Oscilloscopes
two general purpose types

HEWLETT-PACKARD Co., 275 Page Mill Road, Palo Alto, Calif. The 130BR d-c to 300 kc high sensitivity oscilloscope, and the 150 AR d-c to 10 mc h-f oscilloscope, designed especially for mounting in a standard 19 in. equipment rack, have been announced. Model 130 BR (illustrated) has electrically similar vertical and horizontal amplifiers which have less than 1 deg relative phase shift at 50 kc an a 1 mv/cm sensitivity. Balanced signals may be used on the most sensitive ranges, hence many transducers may be connected directly to its terminals. Mounting is by front panel or by accessory brackets which permit easy withdrawal of the oscilloscope from the rack.

Model 150 AR d-c to 10 mc oscilloscope is mounted on slides for accessibility and features calibrated sweep magnifications of X5, X10, X50, and X100. Any portion of the magnified trace may be viewed. The 150 AR is used with plug-in vertical amplifiers; the 151A which has 5 mv/cm sensitivity, and the 152A dual trace amplifier, which has a 50 mv/cm sensitivity and presents two electrical phenomena for simultaneous viewing. Both amplifiers pass d-c to 10 mc, and sensitivity is accurate within ± 5 percent.

Both oscilloscopes have a universal synchronizing circuit; a single preset switch position establishes optimum triggering for nearly all conditions. Model 130 BR is $650; 150 AR, $1,200; 151A, $200; and 152A, $250. Circle 473 on Reader Service Card.



Plug-In Enclosures transparent plastic

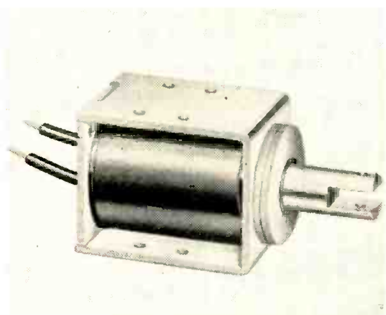
Line Electric Co., 271 South 6th St., Newark 3, N. J., offers its new PE series of transparent plug-in enclosures in clear and colored plastic. They protect electronic assemblies from the dangers of dust, dirt, sand and human tampering. They feature standard RETMA 8 and 11 pin bases, high impact characteristics, excellent electrical properties; and are rated for 85 C ambient. Base pins can carry 10 amperes continuously. Enclosures are available in clear, green, blue, red, purple or amber plastic. Size is 1⅝ by 1⅝ by 2¼ high. Weight is approximately 1¼ oz. Circle 474 on Reader Service Card.

Single Coil Relay latching type

Potter & Brumfield, Inc., Princeton, Ind., has announced a new single coil latching relay that selects alternate circuits or alternate circuit modes on successive impulses. Designated the PC, the relay employs an armature driven rocker type actuator to transfer one, two, three or four dpdt snap switches.

Gold flashed silver cadmium oxide contacts are rated at 10 amperes, 115 v a-c resistive. The relay can be operated from a-c or d-c sources and provides positive transfer on a single 30-millisec impulse. The spring action of the contact arms effectively latches the relay in the transferred position when coil power is removed.

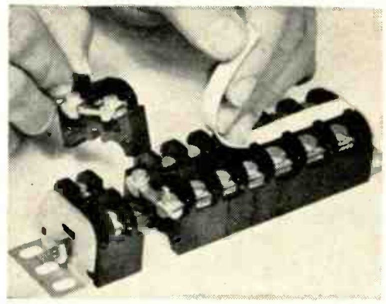
The PC was designed primarily for on-off and reversing features. It is used for remote tv controls, garage door openers, flow control motors and other applications requiring a low cost means for a transferring between alternate circuits at undefined periods. Circle 475 on Reader Service Card.



Powerful Solenoid for a-c or d-c operation

Guardian Electric Mfg. Co., 1621 West Walnut St., Chicago 12, Ill. A new more powerful version of the standard No. 4 solenoid is now being offered for a-c or d-c operation in both intermittent and continuous duty types. The new unit, equipped with $\frac{1}{2}$ in. diameter tapered plug and plunger, is said to lift up to 9 lb. Plunger stroke is adjustable from $\frac{1}{32}$ in. up to $\frac{3}{4}$ in. Two $\frac{3}{32}$ in. steel washers are welded to the front of the field piece to increase power efficiency of the solenoid. The plunger has slotted end with $\frac{1}{8}$ in. diameter holes for coupling.

This particular solenoid measures $1\frac{7}{16}$ in. wide by $1\frac{5}{8}$ in. high by $2\frac{3}{16}$ in. long, exclusive of plunger. The new solenoids are available from the manufacturer for any specific voltage from 6 to 230 v, 60 cycles a-c or d-c. All d-c units are also available for 400-cycle operation. **Circle 476 on Reader Service Card.**



Terminal Block compact device

GEMCO ELECTRIC CO., 25685 W. Eight Mile Road, Detroit 40, Mich. A new compact terminal block is available for custom assembly or in factory assembled strips rated at 600 v a-c or d-c, 15, 25, and 50 ampere ratings.

Features are: snap-in marking strip, and snap-on terminal block, both of which make modifications to a mounted terminal strip a fast operation.

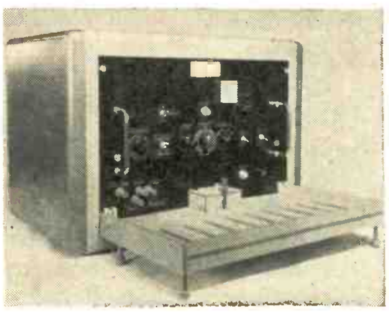
No special mounting rods are required—standard $\frac{3}{16}$ in. round cold rolled steel fits each molded piece and permits rapid assembly of special requirements. All three current ratings can be assembled into one mounting strip.

Open-type terminals and pan head screws which have captive wire clamps make wiring easy. **Circle 477 on Reader Service Card.**

Time-Mark Generator rack-mounting unit

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type RM181 generates five time markers—1, 10, 100, 1,000, and 10,000 μsec, and a 10-mc sine wave. Output amplitude is about 2 v. All six outputs are available at a common coaxial connector through use of a selector switch, and the five time markers are also available at front-panel binding posts. The markers and sine wave are derived from a 1-mc crystal-controlled oscillator with a frequency tolerance of about 0.03 percent and a short time stability, after initial warmup, of about 0.005 percent per hour. Dimensions are 5¼ in. high, 19 in. wide 9¼ in. rack depth (approximately 3 in. additional required for power cord), 11 in. overall depth. Price is $250.

The RM181 is also available with a temperature-stabilized crystal oven installed. This is priced at $270. Frequency stability is 2 ppm over a 24-hour period. Circle 478 on Reader Service Card.



Core Tester displays on cro

MACK ELECTRONICS, 40 Leon St., Boston 15, Mass., has available a tester which provides a display of magnetic toroid characteristics. Model 123 core tester provides a display of coercive force, saturation flux density, $B_r : B_m$ ratio, differential permeability and shows the shape of the hysteresis loop. The display, made on a cro, permits a quick evaluation of the basic core characteristics in relation to a specific circuit application.

The core tester is based upon current reset. The reset current is variable up to 6 amperes. The test probe is a single wire solid rod which permits manual testing rates up to 400 cores per hour. Circle 479 on Reader Service Card.

Literature

MATERIALS

Insulating Material. Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J. Technical data sheets, typical curing conditions and samples of Stanpreg A-Ph heat resistant phenolic resin pre-impregnated glass cloth are now available. **Circle 500 on Reader Service Card.**

Magnetic Shielding. Magnetic Shield Division, Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill. Data sheet 134 illustrates and describes the new seamless, non-shock sensitive, non-retentive Netic magnetic shields. The shields discussed are designed for greater effectiveness in attenuating both high and low frequencies of substantially increased transformer radiation in transistorized power supplies. **Circle 501 on Reader Service Card.**

Nickel Clad Copper Wire. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. A technical information bulletin describes the chemical composition, mechanical properties, conductivity and resistivity of Kulgrid 28 nickel clad copper wire developed for high temperature applications. **Circle 502 on Reader Service Card.**

COMPONENTS

Digital Devices. Anatran Corp., 45 West Union St., Pasadena, Calif. "Digitometry, A Concept of Digital Control and Indication" is the title of a new four-page technical bulletin. It describes five new components for use as digital actuators and feedback devices in servo and instrumentation system. **Circle 503 on Reader Service Card.**

Electromechanical Products. G. H. Leland, Inc., 123 Webster St., Dayton 2, Ohio. Bulletin No. 1157LS describes the company's line of Ledex rotary solenoids, selector switches, hermetically sealed selectors, and Synchramental

of the Week

stepping motors. Circle 504 on Reader Service Card.

High Speed Commutator. Wiancko Engineering Co., 255 N. Halstead St., Pasadena, Calif. Engineering data sheet 857-409 covers the series 25-1100 high speed commutator. The instrument discussed is a small, solid-state, electronic commutator designed to sample inputs from 10 to 100 pickups, at rates up to 30,000 samples per sec. **Circle 505 on Reader Service Card.**

Metal Film Resistor. Weston Electrical Instrument Corp., A Subsidiary of Daystrom, Inc., Newark 12, N. J. A 4-page folder describes the Vamistor, a metal film precision resistor in which the resistance element, actually a ribbon of metal, is thermally fused to the inside wall of a Steatite tube having silver terminals fired to each end. **Circle 506 on Reader Service Card.**

Metallized - Paper Capacitors. Aerovox Corp., New Bedford, Mass., has released a new engineering bulletin on type P83Z microminiature Aerolite molded thermoplastic metallized-paper capacitors. It provides complete specifications, size and capacitance tables as well as insulation resistance tables on these small capacitors. **Circle 507 on Reader Service Card.**

Precision Potentiometer. Beckman/Helipot Corp., Newport Beach, Calif. Current details of the series 7600 precision pot are completely covered in data sheet 1273 (superseding 54-14). In addition to dimensional drawings and descriptive text about the 10-turn, 1 13/16 in. diameter pot, the four-page data sheet now includes a table of coil characteristics for resistance values ranging from 350 to 450,000 ohms. **Circle 508 on Reader Service Card.**

Printed Circuit Connector. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. An illustrated bulletin gives specifications, outline dimensions and general information on the new series 600-93 printed circuit connector which features bellows action contacts. **Circle 509 on Reader Service Card.**

R-F Filters. All-Tronics, Inc., 45 Bond St., Westbury, L. I., N. Y., has published a four-page catalog listing custom r-f filters as stock items ready for off-the-shelf delivery. **Circle 510 on Reader Service Card.**

EQUIPMENT

Instruments. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Volume 32, Numbers 8 and 9, of the Experimenter deal with a 180-600 mc oscillator and capacitance bridges, respectively. **Circle 511 on Reader Service Card.**

Measuring Apparatus. Ad-Yu Electronics Lab, Inc., 249 Terhune Ave., Passaic, N. J. A single-page bulletin illustrates and describes the new type 202 highly accurate Vectorlyzer which makes possible a number of measurements—such as small phase angles, vector sum or vector difference of two voltages, ratio of two voltages, and others. **Circle 512 on Reader Service Card.**

Microwave Test Equipment. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md. A 32 page 2-color catalog describes microwave test equipment in the following fields: coaxial attenuators, d-c to 10,000 mc; insertion loss test sets, 0 to 30 db; modulated r-f sources, 50 to 2,000 mc; modulator, bolometer preamplifier; termination, d-c to 10,000 mc. **Circle 513 on Reader Service Card.**

Production Machinery. Kahle Engineering Co., 1307 Seventh St., North Bergen, N. J. Ten new catalog sheets cover machinery for the production of semiconductors and tubes. They include: an automatic whisker former and welder, a transistor button stem machine, an automatic final seal machine for glass bodied diodes, two manual type final seal machines for glass diodes, a crystal pulling machine, a motor speed programmer used with crystal growers, a fusing furnace for alloy junction transistors, and a specially adapted lead wire welder. An appendix sheet contains some useful tables. **Circle 514 on Reader Service Card.**

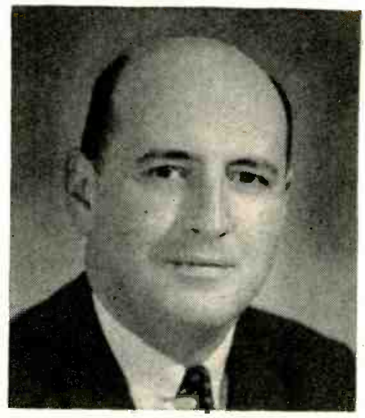
Remote Area Monitoring. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio. Form 3045A is a four-page bulletin descriptive of the company's remote area monitoring systems. It covers the basic units in the systems and gives specification data such as ranges, response, accuracy and stability. Model numbers, suggested uses, dimensions and weights are also included. **Circle 515 on Reader Service Card.**

Wide-Band Power Amplifier. Resdel Engineering Corp., 330 South Fair Oaks Ave., Pasadena 1, Calif., is issuing a technical folder on model 90173 X-band pulse/c-w wide-band power amplifier used in simulation of jamming signals, microwave filter testing, antenna testing and propagation studies; and attenuator testing. **Circle 516 on Reader Service Card.**

FACILITIES

Fabricating Facilities. D. E. Makepeace Co., Pine and Dunham Sts., Attleboro, Mass. A 5-page bulletin describes the melting, fabricating, testing and quality-control facilities available in the company's new nuclear and specialty metals plant. **Circle 517 on Reader Service Card.**

Pulse Techniques. Navigation Computer Corp., 1621 Snyder Ave., Philadelphia 45, Pa., has announced a newsletter, *Pulse Techniques*, about new applications for transistorized digital circuits. The first issue describes basic shift register operation and covers several applications of shift registers as pulse pattern and pulse burst generators. Future topics will include magnetic core testing, binary and decimal counter logic, arithmetic operations and magnetic tape and drum recording systems. **Circle 518 on Reader Service Card.**



Top row (left to right), GEORGE W. BAILEY, Chairman General Committee; STUART L. BAILEY, Vice Chairman, General Committee; DONALD G. FINK, Ex-Officio member, General Committee.

Bottom row (left), GEORGE HALLER, Chairman, Technical Program Committee; (right), ROBERT C. SPRAGUE, Guest Speaker, Annual Banquet.

IRE Ready For '58 Annual Convention

A COMPREHENSIVE 55-session program, involving some 280 papers ranging over 27 fields of radio-electronics, has been set for the 1958 IRE National Convention on March 24-27 in New York City. Thirty-three sessions will be held at the Waldorf-Astoria Hotel and 22 at the New York Coliseum. (In listing the program, locations are referred to as WA and C, respectively). An attendance of 50,000 engineers and scientists from 40 countries is expected.

The Coliseum will also house the Radio Engineering Show, at which approximately 20,000 items of the most advanced electronic apparatus will be displayed by 850 exhibitors, much of it for the first time. The exhibitors represent 80 percent of the total production capacity of the electronics industry.

High point of the technical program will be two special sessions on Tuesday evening, March 25. Panels of the leading experts will discuss "Electronics in Space" and "Electronics Systems in Industry."

The technical program was organized by representatives of 27 IRE professional groups under the chairmanship of George L. Haller, general manager of the General Electric Co. Defense Electronics division. The program covers a wide range of currently important topics, including controlled thermonuclear power atomic clocks and Masers, automation system of postal operations, medical electronics.

Presented for the first time are sessions on education, engineering writing and speech, and r-f interference, due to the establishment of new IRE Professional Groups in these fields within the past year.

The full program follows:

SESSION 1
Monday, March 24
2:30-5:00 P.M. (WA)

TUTORIAL SESSION ON DETECTION THEORY AND ITS APPLICATIONS

Detection as a Statistical Decision Problem, by David Van Meter, Melpar Research Dept.

Some Communications Applications of Detection Theory, by W. B. Davenport, Jr., Lincoln Lab., MIT.

Some Applications of Detection Theory to Radar, by Wm. McC. Siebert, Electrical Engineering Dept., MIT.

Human Factors in Detection and Speech Communications, by J. P. Egan, Psychology Dept., Indiana University.

SESSION 2
Monday, March 24
2:30-5:00 P.M. (WA)

VEHICULAR COMMUNICATIONS

Direct Despatch Service, by A. J. Dinnin, Bell Tel Co. of Canada.

A Unique Radio System Designed for Flood Forecasting, by W. C. Wray, Motorola, Inc.

A New Approach to Broadband Vehicular Antennas, by Helmut Brueckmann, U. S. Army Signal Engineering Labs.

Mobilization of Transistors, by R. J. Hansen, General Electric Co.

Vehicular Noise Problems in Modern Land Mobile Systems, by S. F. Meyer, Allen B. DuMont Labs., Inc.

SESSION 3
Monday, March 24
2:30-5:00 P.M. (WA)

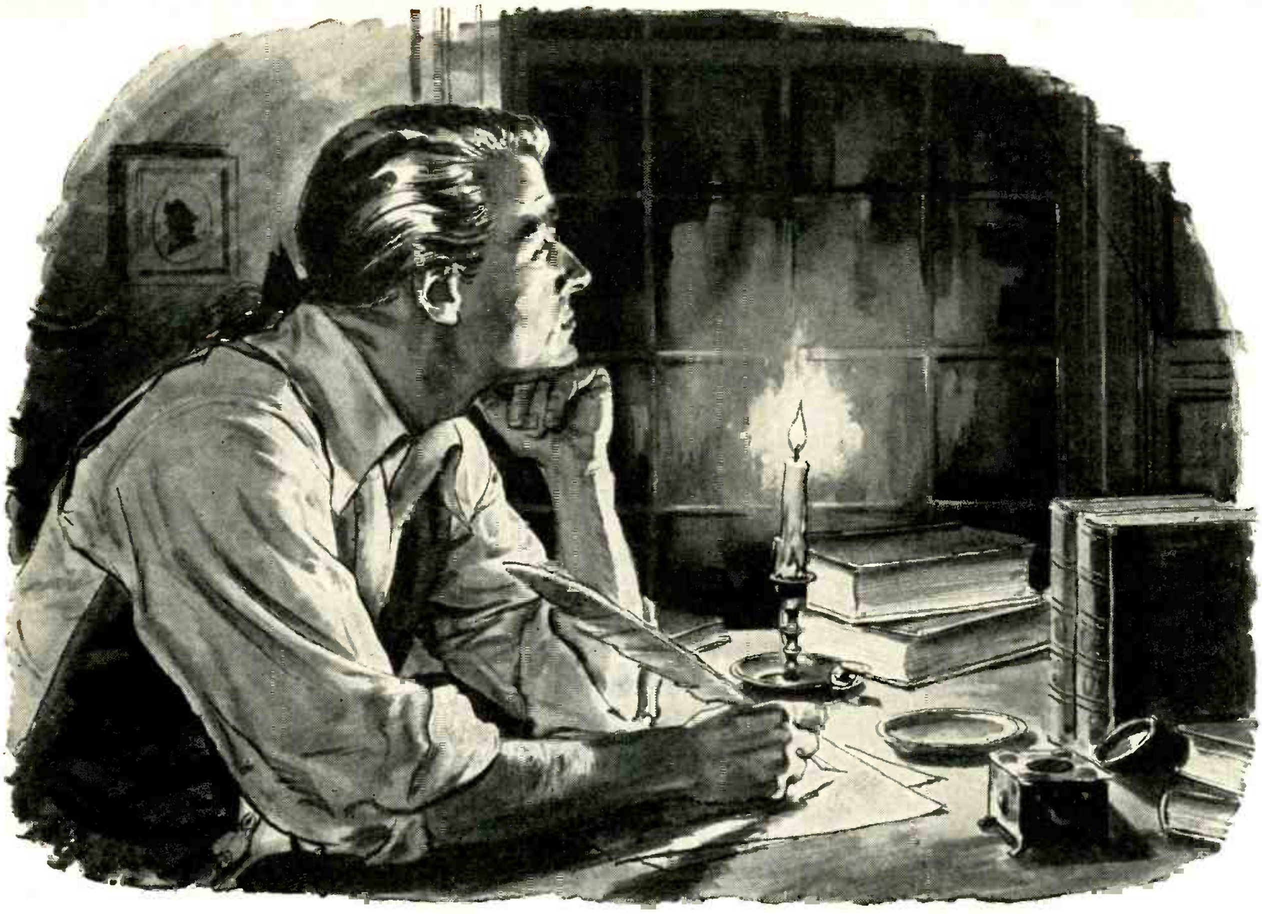
TELEMETRY AND REMOTE CONTROL

The RCA Flight Data System, by C. N. Batsel, Jr., R. E. Montijo, Jr. and E. J. Smuckler, Radio Corp. of America.

A Pulse Position Telemetry System, by L. Weisman and E. S. Teltscher, Ford Instrument Co.

Sample and Hold Circuits for Time Correlation of Analog Voltage Information, by W. T. Eddins, Radiation, Inc.

A Transistorized Six-Channel Airborne



Where Do Great Ideas Come From?

From its beginnings this nation has been guided by great ideas.

The men who hammered out the Constitution and the Bill of Rights were thinkers—men of vision—the best educated men of their day. And every major advance in our civilization since that time has come from minds *equipped by education* to create great ideas and put them into action.

So, at the very core of our progress is the college classroom. It is there that the imagination of young men and women gains the intellectual discipline that turns it to useful thinking. It is there that the great ideas of the future will be born.

That is why the present tasks of our colleges and universities are of vital concern to *every* American. These institutions are doing their utmost to raise their teaching standards, to meet the steadily rising pressure for enrollment, and provide the healthy educational climate in which great ideas may flourish.

They need the help of all who love freedom, all who hope for continued progress in science, in statesmanship, in the better things of life. And they need it *now!*

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Digitizer, by S. H. McMillan and W. A. Sutton, Strand Engineering Co.

Channel Selection for Multi-Carrier Telemetry, by L. S. Taylor and G. F. Bigelow, Range Instrumentation Dev. Division, White Sands Proving Ground, N. Mex.

Telemetering Receiving Station Time Pulse Detector, by J. Star, Applied Physics Lab., The Johns Hopkins University.

SESSION 4
Monday, March 24
2:30-5:00 P.M. (WA)

TECHNIQUES AND CRITERIA CONSIDERATIONS IN ELECTRONIC ENGINEERING

Use of Kros-Term System for Quick Retrieval of the Technical Detail from Large Pools of Information, by A. P. Vigliotta, U. S. Navy Tng. Device Cen., and K. D. Swartzel, Engleman and Co.

Techniques for the Presentation of Three-Dimensional Information, by E. J. Kennedy and E. F. LaForge, Rome Air Development Center, Griffiss Air Force Base.

Transistorized Airborne Military Television Techniques, by J. J. Kelly, Norden-Ketay Corp.

Design Criteria for Missile Automatic Test Equipment, by W. O. Campbell, The Martin Co.

Active Space-Frequency Correlation Systems, by W. E. Kock and J. L. Stone, Bendix Aviation Corp.

SESSION 5
Monday, March 24
2:30-5:00 P.M. (WA)

PANEL: EDUCATIONAL NEEDS IN SYSTEMS ENGINEERING

Chairman: R. P. Johnson, Vice Pres., Research and Development, The Ramo Wooldridge Corp.

Participants:
H. Chestnut, General Electric Co.
H. H. Goode, Dept. of E. E., University of Michigan.
S. Herwald, Westinghouse Electric Corp.
R. J. Kochenburger, Dept. of E. E., University of Connecticut.
W. K. Linvill, Dept. of Defense.
J. Moore, North American Aviation, Incorporated.

SESSION 6
Monday, March 24
2:30-5:00 P.M. (C)

ENGINEERING WRITING AND SPEECH

Roadblocks in Technical Writing, by T. Griggs, Eclipse-Pioneer Div., Bendix Aviation Corp.

Writing for a Technical Journal, by E. T. Ebersol, Jr., *Electronic Design*.

Non-Technical Help for Engineer-Writers, by R. B. MacPherson, Daystrom, Inc.

We Are What We Say, by A. Henesian, Lockheed Missile Systems Division.

Automatic Creation of Literature Abstracts (Auto-Abstracts), by H. P. Luhn, IBM Corp.

SESSION 7
Monday, March 24
2:30-5:00 P.M. (C)

RADIO FREQUENCY INTERFERENCE

Bandwidth Conservation in Pulse Modulated Radars, by R. A. Rosien and R. Shavlach, The University of Pennsylvania.

Measurement of Spurious Radiation from Missileborne Electronic Equipments, by A. L. Albin and C. B. Pearlston, Filtron Co., Inc.

Small, Lightweight, RF Interference Suppressors Using Transistors, by Walter Pecota, Sperry Gyroscope Co.

Transmission Interference in Low Level Instrumentation Systems, by J. C. Crosby, Consolidated Electrodynamics Corp.

Spurious Frequency Measurement in Waveguide, by Michael Morelli, Rome Air Development Center, Griffiss Air Force Base.

SESSION 8
Monday, March 24
2:30-5:00 P.M. (C)

ADVANCES IN PRODUCTION ENGINEERING

Automatic Transistor Classifier, by F. J. Morcerf, and L. F. Roehm, General Electric Co.

Circuit Packaging and Integration of Transistor Assemblies, by H. H. Hagens, U. S. Army Signal Engineering Labs.

Automatic Soldering Machine for Printed Circuit Assembly Boards, by W. L. Oates, Radio Corp. of America.

Wire Processing for Low-Volume Electronic Production, by R. D. Peters, General Electric Co.

"Case" History, by T. C. Combs, Zero Manufacturing Co.

Tension in Coil and Tape Winding, by E. J. Saxl, Tensitron, Inc.

SESSION 9
Tuesday, March 25
10:00 A.M.-12:30 P.M. (WA)

AUTOMATIC CONTROL—GENERAL

A Servo Pressure Control System for the Iron Lung, by G. A. Biernson, Sylvania Electric Products Inc., and J. E. Ward, Servomechanisms Lab., MIT.

Gain-Phase Relations of Non-Linear Circuits, by Emanuel Levinson, Sperry Gyroscope Co.

On the Design of Adaptive Systems, by H. L. Groginsky, Electronics Research Labs., Columbia University.

The Organization of Digital Computers for Process Control, by Geoffrey Post and E. L. Braun, Litton Industries.

A Self-Adjusting System for Optimum Dynamic Performance, by G. W. Anderson, J. A. Aseltine, A. R. Mancini, C. W. Sarture, Aeronutronic Systems, Inc.

SESSION 10
Tuesday, March 25
10:00 A.M.-12:30 P.M. (WA)

CONTROLLED THERMO-NUCLEAR POWER

Controlled Thermonuclear Fusion and Its Meaning for the Radio Engineer, by E. W. Herold, C. Stellarator Associates.

Hydromagnetic Instabilities—A Pictorial Approach, by Ira Bernstein, Project Matterhorn, Princeton University.

Microwave Measurements in Controlled Fusion Research, by Mark Heald, Project Matterhorn, Princeton University.

Measurements of Neutron Production in a Dynamic Pinch, by Robert Pyle, University of California, Radiation Laboratory.

Production of Intense Magnetic Fields and Their Relation to Fusion Reactors, by Morton Levine, Cambridge Research Center.

Plasmas for Propulsion, by Winston Bostick, Physics Dept., Stevens Institute of Technology.

SESSION 11
Tuesday, March 25
10:00 A.M.-12:30 P.M. (WA)

BROADCAST TRANSMISSION SYSTEMS

Video Modulation Limiter, by L. S. Sadler, Television Station WMTV.

Color TV Recording on Magnetic Tape,

Execs Dig In For IT&T Lab

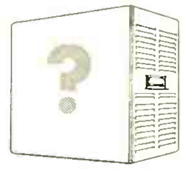
CLAD in Arctic gear worn by International Telephone and Telegraph Corp. engineers and technicians who man the DEW line in Canada and Alaska, two officials of that company are pictured breaking ground for a new building for IT&T's research division, Federal Telecommunication Laboratories, at Nutley, N. J. When the ceremonial shovel failed to break the frozen ground for Henri Busignies, right, president of FTL, John E. Gingrich, president of Federal Telephone and Radio Co., another IT&T division, dug in with a pick. In the background is FTL's 300 ft microwave radio research tower.

at I.R.E. Booth 3515-3517

the pioneer is the leader

PANORAMIC
RADIO PRODUCTS, INC.

MODEL . . .
ADVANCED NEW
Panoramic MICROWAVE SPECTRUM ANALYZER



New in range, advanced in design, this Panoramic Microwave Spectrum Analyzer will have its first showing March 24, 1958. Don't miss this newest addition to the long line of widely accepted Panoramic Spectrum Analyzers which embodies Panoramic's far-sighted development techniques and skilled design engineering.

steps into higher microwave frequencies

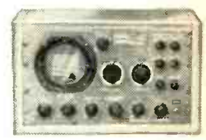
with an advanced *new* Panoramic Microwave Spectrum Analyzer

creates new application flexibility

with a single *new* Panoramic Broad Range Spectrum Analyzer

dynamically demonstrates Panoramic systems

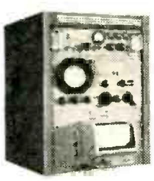
. . . instrumentation groups facilitating accurate and rapid electronic measurements



MODEL SPA-3
200 CPS—15 MC
***new* Panoramic**
BROAD RANGE SPECTRUM ANALYZER

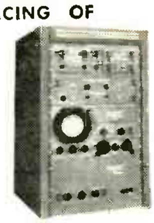
Answers the demand for a basic multi-purpose instrument with maximum application flexibility. Bands up to 3 mc wide may be centered on the screen anywhere from 0 to 13.5 mc with a calibrated center frequency dial. 20 db lin, 40 db log and square law amplitude scales; continuously variable resolution and sweep rate; high sensitivity make the SPA-3 a versatile and economical measuring tool for • video analysis • pulse spectra • noise studies • ultrasonic and RF waveform analysis.

POWER DENSITY ANALYSIS OF RANDOM WAVEFORMS
with Panoramic's PDA-1 • LP-1a • RC-3



Provides, at will, three modes of spectrum analysis of complex random data to suit a wide variety of applications • instantaneous power vs. frequency • average power vs. frequency • totalized power vs. frequency through use of a true integrator • data is reduced to a permanent 12" x 5" ink-on-paper recording.

AUTOMATIC CURVE TRACING OF ATTENUATION & PHASE SHIFT vs. FREQUENCY
with Panoramic's PA-1 LP-1a • TW-1 • SW-1

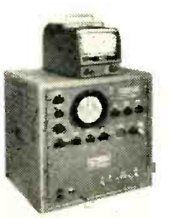


Automatically plots phase shift and attenuation characteristics on a common frequency scale. Graphic presentation of phase shifts reads from 0.180° full scale. Smaller angles can be magnified within and above this scale of detailed study. This unique system assures attenuation measurements free of effects of noise, hum and distortion products. TW-1 establishes optimum scan speed. SW-1 permits marker insertions or comparisons between networks.

Here is graphic easy-to-use instrumentation . . . that makes possible fast, accurate, reliable and complete measurement analysis . . . for new testing areas . . . for more critical analyses. See Panoramic's newly developed instruments. Learn how Panoramic instruments can help you. Panoramic Applications Engineers will be glad to work with you on your specific problems . . . or write, wire, phone NOW for more information. Ask to be put on our regular mailing list for The PANORAMIC ANALYZER featuring application data, and send for our new CATALOG DIGEST.

SSB (Single Side Band) TRANSMISSION ANALYSES
with Panoramic's SB-12a • RC-3

60 db dynamic range • four convenient pre-set narrow scan ranges plus continuously variable sweepwidths up to ±50 kc • 10 cps resolution capability • excellent sweep stability • exceptional I. F. skirt selectivity give you an accurate inked chart of dynamic transmission band occupancy, nonlinearities, residual carrier and suppressed sideband levels, hum and other low frequency modulations, out of band radiations, etc.



LOW FREQUENCY RESPONSE TRACING
0.5-2250 cps with Panoramic's LF-2 • G-5

Analyzes frequency response characteristics of • servo amplifiers • filters • acoustic reproducers • transformers • shaker tables, etc., in the low (subsonic) frequency range from 0.5 to 2,250 cps. Plots single line response to fundamental frequency only • discriminates against noise and hum • has virtually unlimited dynamic range.

PANORAMIC
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530 South Fulton Avenue,
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Phone: OWens 9-4600
Cables: Panoramic,
Mount Vernon, New York State

by J. L. Grever, Radio Corp. of America.

An Automatic TV Level Control Using Vertical Interval Test Signals, by J. R. Popkin-Clurman and Frank Davidoff, Telechrome Mfg. Corp.

Report on Remote Control of a Directive Antenna System, by H. E. Rhea, Triangle Publications.

A Novel System for Feeding a Single Tower AM, FM and TV Signals, by A. C. Goodnow, Westinghouse Broadcasting Co.

SESSION 12
Tuesday, March 25
10:00 A.M.-12:30 P.M. (WA)

STEREOPHONIC DISC RECORDINGS

RIAA Engineering Committee Activities with Respect to Stereophonic Disc Records, by W. S. Bachman, Columbia Records, Inc.

The Westrex Stereodisk System, by C. C. Davis and J. G. Frayne, Westrex Corp.

Tracing Distortion in Stereophonic Disc Recording, by M. S. Corrington and T. Murakami, RCA Victor Television Div.

Compatibility Problems in Stereophonic Disc Reproduction, by B. B. Bauer and R. Snepvangers, CBS Labs.

Phonograph Pickups for Stereophonic Record Reproduction, by W. S. Bachman, Columbia Records, Inc., and B. B. Bauer, CBS Labs.

The Requirements of a Record Changer, Component Parts and Associated Equipment for Stereophonic Record Reproduction, by W. Faulkner, V-M Corp.

SESSION 13
Tuesday, March 25
10:00 A.M.-12:00 Noon (WA)

PLANNING AGAINST TIME

Weapons Systems Development, by Gen. Bernard A. Schriever, Air Force Ballistic Missile Div.

Commercial Product Development, by Robert Thalner, Sylvania Radio and Television Set Div.

Scientific Manpower, by Howard A. Meyerhoff, Scientific Manpower Commission.

SESSION 14
Tuesday, March 25
10:00 A.M.-12:30 P.M. (C)

AERONAUTICAL AND NAVIGATIONAL ELECTRONICS

A Vortac Traffic Control System, by P. E. Ricketts, Rome Air Development Center, Griffiss Air Force Base.

Airborne Vortac DME for Federal Airways System, by S. M. Dodington and B. B. Mahler, Federal Telecommunication Labs.

IDEA—Integrated Defense Early-Warning Air Traffic Control, by B. H. Baldridge, General Electric Co.

The AN/APN-96 Doppler Radar Set, by M. W. McKay, General Precision Lab., Inc.

Increasing the Traffic Capacity of Transponder Systems, by H. Davis and M. Setrin, Rome Air Development Center, Griffiss Air Force Base.

SESSION 15
Tuesday, March 25
10:00 A.M.-12:30 P.M. (C)

MEDICAL ELECTRONICS

A New Nipkow-Disk Scanner for Accurate Cytological Measurements, by H. S. Sawyer and R. C. Bostrom, Airborne Instruments Lab., Inc.

Electrocardiograph Telemetering (Radio), by J. C. Webb, L. E. Campbell and J. C. Hartsock, Agricultural Research Service, U. S. Dept. of Agriculture.

Electronics in Biochemical Spectroscopy, by M. Rogoff, Federal Telecommunication

Labs., and T. Gallagher, Sloan Kettering Institute.

Patient Data Systems for Hospitals, by G. Guy Knickerbocker and G. N. Webb, Dept. of Medicine, Johns Hopkins Hospital.

A New Intracardiac Pressure Measuring System for Infants and Adults, by A. Warnick, Scientific Lab., Ford Motor Co., and E. H. Drake, Dept. of Adult Cardiology, Henry Ford Hospital.

The Electronic Evaluation of Fetal Distress, by E. H. Hon, Dept. of Obstetrics and Gynecology, Yale University School of Medicine.

SESSION 16
Tuesday, March 25
10:00 A.M.-12:30 P.M. (C)

GENERAL COMMUNICATIONS SYSTEMS

Digital Communication Systems, by R. L. Plouffe, Federal Telecommunication Labs.

Constant Amplitude Speech, by P. J. Ferrell, Rome Air Development Center, Griffiss Air Force Base.

Exploitation of Physical Phenomena for Communications, by J. L. Ryerson, Rome Air Development Center, Griffiss Air Force Base.

Reduction of Intermodulation in Microwave Systems by Using Ferrite Load Isolators, by N. P. Weinhouse, Collins Radio Co.

The Effects of Pulse Shape and Frequency Separation on FSK Transmission Through Fading, by G. L. Turin, Hughes Research & Development Labs.

A 45 Channel PPM System, by S. M. Schreiner and B. McAdams, Federal Telecommunication Labs.

New Trends in Directional Communications, by R. C. Benoit, Jr. and Francis Coughlin, Jr., Rome Air Development Center, Griffiss Air Force Base.

SESSION 17
Tuesday, March 25
2:30-5:00 P.M. (WA)

CHANGING DEMANDS ON THE BREADTH OF ELECTRICAL ENGINEERING EDUCATION —A PANEL DISCUSSION

Chairman: J. D. Ryder, Dean of Engineering, Michigan State University.

Participants:

S. W. Herwald, Westinghouse Electric Corp.
H. Pollak, Bell Telephone Labs., Inc.
D. B. Sinclair, General Radio Co.
G. K. Teal, Texas Instruments, Inc.

SESSION 18
Tuesday, March 25
2:30-5:00 P.M. (WA)

ATOMIC CLOCKS AND MASERS

A Gas Cell "Atomic Clock" Using Optical Pumping and Optical Detection, by M. Arditi, Federal Telecommunication Labs., and T. R. Carver, Princeton University.

The Atomichron—An Atomic Frequency Standard—Physical Foundations, by A. O. McCoubrey, National Company, Inc.

The Atomichron—An Atomic Frequency Standard System Operation and Performance, by W. A. Mainberger, National Company, Inc.

Analysis of the Emissive Phase of a Pulsed Maser, by H. H. Theissing, F. A. Dieter, and P. J. Caplan, U. S. Army Signal Engineering Labs.

A Two-Cavity Unilateral Maser Amplifier, by Nisson Sher, Philco Corp.

SESSION 19
Tuesday, March 25
2:30-5:00 P.M. (WA)

BROADCAST TRANSMISSION SYSTEMS AND COMMUNICA-

TIONS SYSTEMS

Remote Control of 50 KW Transmitter, by R. N. Harmon, Westinghouse Broadcasting Co.

Report on Multiplex Experimental Work at WCAU-FM, by E. J. Meehan, Station WCAU-FM.

Field Test of Compatible Single Sideband at WABC, by R. M. Morris, American Broadcasting Co.

Improved CSSB Equipment for the Standard Broadcast Service, by L. R. Kahn, Kahn Research Labs.

An Incrementally Tuned, Drift Cancelled Communications Receiver, by Saul Fast and R. Caulk, National Co., Inc.

Polyphase Telephone Carrier System, by J. R. Mensch, Rome Air Development Center, Griffiss Air Force Base.

Tele-Map, by Henry Hoffman, Jr., Rome Air Development Center, Griffiss Air Force Base.

SESSION 20
Tuesday, March 25
2:30-5:00 P.M. (WA)

AUDIO, AMPLIFIER AND RECEIVER DEVELOPMENTS

Distortion in Audio Phase Inverter and Driver Systems, by W. B. Bernard, Bureau of Ships, Navy Dept.

Latest Advances in Extra Fine Groove Recording, by P. Goldmark, CBS Labs.

Design of a Transistorized Record-Playback Amplifier for Dictation Machine Application, by R. Fleming, The Gray Manufacturing Co.

Single Tuned Transformers for Transistor Amplifiers, by S. H. Colodny, Philco Corp.

Design Considerations for Transistorized Automobile Receivers, by R. A. Santilli, Radio Corp. of America.

Voltage Sensitivity of Local Oscillators, by Wen Yuan Pan, Radio Corp. of America.

SESSION 21
Tuesday, March 25
2:30-5:00 P.M. (C)

BEAM AND DISPLAY TUBES

High Transconductance Wideband Television Gun, by E. Atti, Westinghouse Electric Corp.

The Annular Geometry Electron Gun: A New Electron Device, by J. W. Schwartz. RCA Labs.

Recent Developments in Shaped Beam Display and Recording Techniques, by R. M. Peterson and R. C. Ritchart, Stromberg-Carlson Co.

"ELF," A New Electroluminescent Display, by E. A. Sack, Westinghouse Electric Corp.

A Tube that Tells Time, by W. T. Eriksen and E. J. Handly, Raytheon Manufacturing Co.

SESSION 22
Tuesday, March 25
2:30-5:00 P.M. (C)

BIOLOGICAL TRANSDUCERS—PANEL DISCUSSION

Chairman: Otto H. Schmitt, Dept. of Physics, University of Minnesota

SESSION 23
Tuesday, March 25
2:30-5:00 P.M. (C)

RELIABILITY THROUGH COMPONENTS

Reliability of Missile Guidance Systems, by A. R. Gray, The Martin Co.

Component Part Failure Rate Analysis for Prediction of Equipment Reliability, by R. L. Vander Hamm, Collins Radio Co.

A Progress Report on the ARMA Inertial Guidance System Reliability Program, by E. F. Dertinger, American Bosch Arma Corp.

An Impulse Test for Evaluating the Vibrational Characteristics of Receiving Tubes Over a Wide Frequency-Range, by S. A. Jolly and W. U. Shipley, General Electric Co.

Reliability of Power Amplifier Klystrons in Tropo-Scatter Communication Systems, by R. F. Lazzarini and H. A. Bailey, Eitel-McCullough, Inc.

SESSION 24
Tuesday, March 25
8:00-10:30 P.M. (WA)

ELECTRONICS IN SPACE—A PANEL DISCUSSION

Chairman: L. DuBridge, President California Institute of Technology

Propulsion and Interplanetary Travel, by Wernher von Braun and Ernest Stuhlinger, U. S. Army Ballistic Missile Agency, and Krafft A. Ehricke, Convair Astronautics Division.

Navigation and Control, by C. Stark Draper, MIT.

Man in the Space Environment, by D. G. Simons, USAF, Holloman Air Force Base.

Communications and Telemetering, by J. B. Wiesner, MIT.

Terminal Environment, by Fred L. Whipple, Smithsonian Astrophysical Observatory.

A Prelude to Space Travel—The round table panel of eight scientists will discuss informally the major problems to be encountered, including the use of electronics for propulsion, navigation, communications, telemetering and instrumentation.

SESSION 25
Tuesday, March 25
8:00-10:30 P.M. (C)

ELECTRONICS SYSTEMS IN INDUSTRY—A PANEL SYMPOSIUM

Chairman: J. D. Ryder, Dean, College of Engineering, Michigan State University

Participants:

J. M. Bridges, Office of the Assistant Secretary of Defense (Research and Engineering.

C. C. Hurd, International Business Machines Corp.

T. R. Jones, Daystrom, Inc.

J. D. Ryder, Michigan State University.

The great impact which electronics had on American industry will be highlighted at this panel symposium.

J. D. Ryder will act as Chairman and open the symposium with a paper on "New Trends in Engineering Education." The emphasis in Dean Ryder's talk will be on strengthening the requirements in fundamental sciences, without which neither the demands of industry nor those of our defense establishments can be satisfied.

C. C. Hurd will discuss new ideas which found their entry in industry in connection with fully automatic processes.

T. R. Jones will speak about organization of complete electronic systems, utilizing the resources of several integrated organizations.

J. M. Bridges will highlight the military aspects associated with electronic systems engineering and their relationship to the electronic engineering professional society.

SESSION 26
Wednesday, March 26
10:00 A.M.-12:30 P.M. (WA)

AERONAUTICAL AND NAVIGATIONAL ELECTRONICS

Airborne Dual Antenna System for Aerial Navigation, by W. M. Spanos and J. M. Ashbrook, Federal Telecommunication Labs.

Engineering Evaluation of an Automatic Ground Controlled Approach System (AN/

CIRCLE 239 READERS SERVICE CARD

MSN-3), by R. M. Brooks and W. F. Hoy, Rome Air Development Center, Griffiss Air Force Base.

A Quantitative Analysis of Automatic Target Detection-Position Estimation Schemes Observing Scintillating Targets in Noise, by C. M. Walter, Air Force Cambridge Research Center.

Applying the Amplitron and Stabilotron to MTI Radar Systems, by T. A. Weil, Raytheon Mfg. Co.

Transistorized Airborne Frequency Standard, by G. R. Hykes, Collins Radio Co.

SESSION 27
Wednesday, March 26
10:00 A.M.-12:30 P.M. (WA)

STATISTICAL APPLICATIONS

Frequency-Domain Statistical Model of Linear Variable Networks for Finite Operating Time, by G. W. Johnson, IBM.

The Root Square Locus Plot—A Geometrical Method for Synthesizing Optimum Servo Systems, by S. S. L. Chang, New York University.

TV Bandwidth Reduction by Digital Coding, by W. F. Schreiber and C. F. Knapp, Technicolor Corp.

Subjective Experiments in Visual Communication, by R. E. Graham, Bell Telephone Labs., Inc.

Demonstration of Some Visual Effects of Using Frame Storage in Television Transmission, by M. W. Baldwin, Jr., Bell Telephone Labs., Inc.

SESSION 28
Wednesday, March 26
10:00 A.M.-12:30 P.M. (WA)

ELECTRONIC COMPONENT PARTS

Development of Electronic Components for the Nuclear Radiation Environment, by J. W. Clark, Hughes Aircraft Co.

Design of Shielded Air-Cored Inductors, by R. O. Schildknecht, Federal Telecommunication Labs.

Ceramic Coating Applications in the Electrical Field, by P. Huppert, Gulton Industries, Inc.

The Components Engineer and The Sales Engineer, Partners in Reliability, by P. C. Knox, Lutherville, Md.

Miniature Ruggedized Precision Meters, by J. F. Faughnan and R. E. Loiselle, Signal Corps Engineering Labs.

SESSION 29
Wednesday, March 26
10:00 A.M.-12:30 P.M. (WA)

CIRCUIT THEORY I AND ULTRASONICS I: SYMPOSIUM ON "MODERN ASPECTS OF DELAY LINES"

Low-Dispersion Wired Delay Lines, by M. J. DiToro, Polytechnic Research & Dev. Co.

Electrical Design of the Transducer Networks of a Magnetostrictive Delay Line, by L. Rosenberg and A. Rothbart, Federal Telecommunication Labs.

The Approximation Problem in Lumped Delay Line, by A. Papoulis, Polytechnic Institute of Brooklyn.

Coiled Wire Torsional Wave Delay Line, by R. N. Thurston and L. M. Tornillo, Bell Telephone Labs., Inc.

Variable Delay Line Using Ultrasonic Surface Waves, by J. D. Ross, S. J. Kapuscienski and K. B. Daniels, E. I. duPont deNemours & Co.

SESSION 30
Wednesday, March 26
10:00 A.M.-12:00 NOON (WA)

THE CANADIAN AUTOMATION SYSTEM OF POSTAL OPERATIONS

The Canadian Automation System of

Postal Operations, by M. Levy, Canada Post Office Dept.

Organization of the Electronic Computer for the Canadian Electronic Mail Sorting System, by A. Barszczewski, Canada Post Office Dept.

Coding and Error Checking in the Canadian System, by M. Levy and V. Czorny, Canada Post Office Dept.

The Canadian Automation System of Postal Operations, by H. Jensen and K. H. Ullyatt, Canada Post Office Dept.

SESSION 31
Wednesday, March 26
10:00 A.M.-12:30 P.M. (C)

RADAR IN MILITARY ELECTRONICS

Automatic and Continuous Radar Performance Monitor, by W. C. Woods, Sperry Gyroscope Co.

Analysis and Theoretical Investigation of New Military Electronic Missile and Aircraft-Borne Equipment, by D. Ehrenpreis, New York, N. Y.

Packaged High Power Radar Transceivers, by H. N. C. Ellis-Robinson, Marconi's Wireless Telegraph Co., Ltd.

Limitations of the Output Pulse Shape of High Power Pulse Transformers, by R. G. deBuda and J. Vilcans, Canadian General Electric Co., Ltd.

A Radar Electronic Countermeasures Simulator, by L. Sternlicht, The Hallicrafters Co.

SESSION 32
Wednesday, March 26
10:00 A.M.-12:30 P.M. (C)

MICROWAVE MEASUREMENT

Power Limiting Using Ferrites, by R. F. Soohoo, Cascade Research Corp.

An Ultra-Precise Microwave Interferometer, by G. R. Blair, McMillan Laboratory, Inc.

Direct Reading Microwave Phase Meter, by H. A. Dropkin, Diamond Ordnance Fuze Labs.

A Microwave Spin Resonance Spectrometer, by R. R. Unterberger, California Research Corp.

A New Microwave Rotary Joint, by W. E. Fromm, E. G. Fubini, and H. S. Keen, Airborne Instruments Laboratory, Inc.

SESSION 33
Wednesday, March 26
10:00 A.M.-12:30 P.M. (C)

SEMICONDUCTOR DEVICES

A New Passive Semiconductor Component, by R. M. Warner, Jr., Bell Telephone Labs., Inc.

Use of the RCA 2N384 Drift Transistor as a Linear Amplifier, by D. M. Griswold and V. J. Cadra, Radio Corporation of America.

High Current Switching Times for a PNP Drift Transistor. Numerical Analysis on the I. B. M. 704 Digital Computer, by A. Mitchell, International Business Machines Corp., and L. Lapidus, Princeton University.

A New High-Frequency Diffused Base Transistor, by J. Sardella and R. Wonson, Raytheon Manufacturing Co.

A New Five Watt, Class A, Power Amplifier, by G. Freedman, J. Williams, P. Flaherty, D. Root, D. Spittlehouse, W. Waring, P. Kaufmann, P. Whoriskey, Raytheon Manufacturing Co.

SESSION 34
Wednesday, March 26
2:30-5:00 P.M. (WA)

RELIABILITY THROUGH SYSTEMS

On an Analytical Design Technique, by J. B. Heyne, Hughes Aircraft Co.

Reliability or Life Performance, by A. R. Matthews, Wright Air Development Center, ARDC.

Reliability Improvement Through Redundancy at Various System Levels, by B. J. Flehinger, IBM Watson Lab.

Fundamental Techniques in Doppler Radar Navigation System Reliability Measurements, by P. D. Stahl, General Precision Lab., Inc.

Reliability Prediction and Test Results on USAF Ground Electronic Equipment, by E. Krzysiak and J. Naresky, Rome Air Development Center, ARDC, Griffiss Air Force Base.

SESSION 35
Wednesday, March 26
2:30-5:00 P.M. (WA)
INFORMATION THEORY: CODING AND DETECTION

On Communication Processes Involving Learning and Random Duration, by R. Bellman and R. Kalaba, The Rand Corp.

The Application of "Comparison of Experiments" to Detection Problems, by N. Abramson, Electronics Research Lab., Stanford University.

Signals with Uniform Ambiguity Functions, by R. M. Lerner, MIT, Lincoln Lab.

Evaluation of Some Error Correcting Methods Applicable to Digital Data Transmission, by A. B. Brown and S. T. Meyers, Bell Telephone Labs., Inc.

Algebraic Decoding for the Binary Erasure Channel, by M. A. Epstein, Lincoln Lab., MIT.

SESSION 36
Wednesday, March 26
2:30-5:00 P.M. (WA)
ELECTRONIC COMPONENT PARTS

Effect of High Intensity Radiation on Electronic Parts and Materials, by C. P. Lascaro and A. L. Long, U. S. Army Signal Corps Engineering Labs.

Some Guideposts to the Use of Metallized Capacitors, by W. C. Lamphier, Sprague Electric Co.

New Amplifiers for Automatic Control of Active D-C Loads, by E. Levi, Microwave Research Institute.

Magnetostriction Transducers for Mechanical Filters, by R. L. Sharma and H. O. Lewis, Collins Radio Co.

Application of Piezoelectric Ceramic Resonators to Modern Band Pass Amplifiers, by A. Lungo and K. W. Henderson, Clevite Corp.

SESSION 37
Wednesday, March 26
2:30-5:00 P.M. (WA)
COMPUTERS AND CONTROL

A Preventive Maintenance Program for Large General Purpose Electronic Analog Computers, by R. P. Sykes, The Ramo-Wooldridge Corp.

The TRICE—A High Speed Incremental Computer, by S. Ruhman and J. M. Mitchell, Packard-Bell Computer Corp.

Digital Moon Radar Antenna Programmer with Analog Interpolator Servo, by O. A. Guzmann, U. S. Army Signal Corps Engineering Labs.

A Balanced Precision Reference Regulator for Computer Application, by D. A. Noden, The Martin Co.

A Solid State Analog-to-Digital Conversion Device, by M. Palevsky, Packard-Bell Computer Corp.

J-Axis Translation of Transfer Functions, by J. L. Ryerson, Rome Air Development Center, Griffiss Air Force Base.

SESSION 38
Wednesday, March 26
2:30-5:00 P.M. (C)

INSTRUMENTATION SYSTEMS

An Earth Satellite Instrumentation for Cloud Measurement, by R. Hanel and R. A. Stampfl, U. S. Army Signal Engineering Labs.

A Precise Optical and Radar Tracking Range, by E. V. Kullman, Rome Air Development Center (RCEMI).

A High Speed Radar Signal Measurement and Recording System, by A. Nirenberg and R. Burfiend, Airborne Instruments Lab., Inc.; M. Baller, Cambridge Research Dev. Center, and A. Wight, Laboratory for Electronics, Inc.

A High Performance Multi-Channel Instrumentation System, by W. G. Wolber, Bendix Aviation Corp.

Instrumentation Dynamically Analyzed for Optimum Reliability, Weight and Geometric Space Envelope Subjected to Severe Vibrations and Shock, by David Ehrenpreis, New York, N. Y.

SESSION 39
Wednesday, March 26
2:30-5:00 P.M. (C)

MICROWAVE COMPONENTS

Yttrium Garnet UHF Isolator and Reciprocal Phase Shifter, by F. R. Morgenthaler, USAF and D. L. Fye, Air Force Cambridge Research Center.

High Power, Broadband, Microwave Gas Discharge Switch Tube, by S. J. Tetenbaum and R. M. Hill, Sylvania Electric Products Inc.

High Power Microwave Filters, by J. H. Vogelman, Rome Air Development Center.

A Band Separation Filter for the 225-400 MCS Band, by A. I. Grayzel, Lincoln Laboratory, MIT.

Direct-Coupled, Band-Pass Filters with $\lambda/4$ Resonators, by G. L. Matthaei, The Ramo-Wooldridge Corp.

SESSION 40
Wednesday, March 26
2:30-5:00 P.M. (C)

PROPAGATION AND ANTENNAS I—GENERAL

Extreme Useful Range of VHF Transmission by Scattering From the Lower Ionosphere, by R. C. Kirby, National Bureau of Standards.

Meteor Trail Propagation, by J. T. de-Bettencourt and Albert Ward, Pickard & Burns; and Bernard Goldberg, U. S. Army Signal Engineering Labs.

The Duty Cycle Associated with Forward-Scattered Echoes from Meteor Trails, by H. J. Wirth and T. J. Keary, U. S. Navy Electronics Lab.

A New Low Frequency Antenna, by E. W. Seeley and J. D. Burns, U. S. Naval Ordnance Lab.

Logarithmically Periodic Antenna Designs, by R. H. DuHamel and F. R. Ore, Collins Radio Co.

Phase Center of Helical Beam Antennas, by Seymour Sander, RCA; and D. K. Cheng, Syracuse University.

SESSION 41
Thursday, March 27
10:00 A.M.-12:30 P.M. (WA)

MAGNETICS AND COMPUTERS

A High Speed n-pole, n-position Magnetic Core Matrix Switch, by A. L. Lane and A. Turczyn, Technitrol Engineering Co.

Apertured Plate Memory: Operation and Analysis, by W. J. Haneman and J. Lehmann, RCA Labs; and C. S. Warren, RCA, Defense Electronic Products.

Molecular Storage and Read-Out with

Microwaves, by C. H. Becker, R. L. Pierce and J. R. Martin, Trionics Corp. P. O. Box 548, Madison 1, Wisc.

Calculation of Flux Patterns in Ferrite Multipath Core Structures, by S. A. Abbas and D. L. Critchlow, IBM.

Logic by Ordered Flux Changes in Multipath Ferrite Cores, by N. F. Lockhart, IBM.

Flux Responsive Magnetic Heads for Low Speed Read-Out of Data, by L. W. Ferber, Clevite Corp.

SESSION 42
Thursday, March 27
10:00 A.M.-12:30 P.M. (WA)

CIRCUIT THEORY II—UNUSUAL ASPECTS OF FILTER DESIGN

Multichannel-Filter Synthesis in Terms of Dipole Potential Analog, by H. A. Wheeler, Wheeler Labs.

Minimum Insertion Loss Filters, by E. G. Fubini, Airborne Instruments Lab., Inc., and E. A. Guillemin, MIT.

A New Approach to the Design of High Frequency Crystal Filters, by R. A. Sykes, Bell Telephone Labs., Inc.

Synthesis of Active RC Single-tuned Bandpass Filters, by J. J. Bongiorno, Microwave Research Inst.

A New Class of Filters, by A. Papoulis, Polytechnic Institute of Brooklyn.

SESSION 43
Thursday, March 27
10:00 A.M.-12:30 P.M. (WA)

ULTRASONICS II—DELAY LINE MEASUREMENTS

Measurements of Delay in Ultrasonic Systems, by D. L. Arenberg, Arenberg Ultrasonic Laboratory, Inc.

Precise Measurement of Time Delay, by J. E. May, Jr., Bell Telephone Labs., Inc.

The Measurement of Delay-Line Transducer Resistance, by J. J. G. McCue, Lincoln Lab., MIT, and J. A. Leavitt, Harvard University.

Ultrasonic-Delay-Line Terminating Circuits and Passband Measurements, by M. Axelbank, Lincoln Lab., MIT.

Measurement of Temperature and Frequency Dependence of Insertion Loss in Delay Lines, by A. H. Meitzler, Bell Telephone Laboratories, Inc.

The Measurement of the Total Spurious Responses of an Ultrasonic Delay Line, by M. S. Zimmerman, General Atronics Corp.

SESSION 44
Thursday, March 27
10:00 A.M.-12:30 P.M. (WA)

INDUSTRIAL ELECTRONICS

Distributor Test Stand, by J. A. Lovell, Airborne Instruments Lab., Inc.

A Digital Setting System for an X-Ray Thickness Gage, by V. A. Blumhagen, General Electric Co.

Application of Magnetic Core Logic to Industrial Controls, by H. Tellefson and S. Alessio, Panellit, Inc.

A Coordinated System of Automatic Controls, by R. R. Batcher, Douglaston, N. Y.

SESSION 45
Thursday, March 27
10:00 A.M.-12:00 Noon (WA)

ASPECTS OF RF INTERFERENCE IN MILITARY ELECTRONIC AND COMMUNICATIONS SYSTEMS

Treatment and Methods for the Reduction of Pulse and Random Interference, by P. M. Creutz, Packard-Bell Electronics Corp.

Reduction of Bandwidth Requirements for Radio Relay Systems, by D. L. Jacoby and R. H. Levine, U. S. Army Signal Engineering Labs., and Alfred Mack and Alan Meyerhoff, Radio Corporation of America.

Analysis of the Spectral Shape of Modulation Splatter, by R. Price, Lincoln Laboratory, MIT.

Near-Zone Power Transmission Formulas, by Ming-Kuei Hu, Syracuse University.

SESSION 46
Thursday, March 27
10:00 A.M.-12:30 P.M. (C)

DATA REDUCTION AND RECORDING

Instrumentation for Recording and Analysis of Audio and Sub-Audio Noise, by D. D. Howard, Naval Research Lab.

A Xerographic Cathode Ray-Tube Recorder, by H. H. Hunter, O. A. Ullrich and L. E. Walkup, Battelle Memorial Inst.

Theory of Magnetography, by S. J. Begun, Clevite Research Center.

Applications of Magnetography to Graphic Recording, by J. B. Gehman, Clevite Research Center.

A Shaft Position Digitizer System of High Precision, by L. G. deBey, Ballistic Meas. Lab., Aberdeen Proving Ground; and R. C. Webb, Colorado Research Corp.

A High Precision Digital Shaft Position Indicator, by D. H. Raudenbush, Telecomputing Corp.

SESSION 47
Thursday, March 27
10:00 A.M.-12:30 P.M. (C)

ANTENNAS II—GENERAL

Early Warning Radar Antennas, by J. M. Flaherty and Eugene Kadak, Westinghouse Electric Corp.

Phase and Amplitude Measurements in the Near Field of Microwave Lenses, by C. W. Morrow, P. E. Taylor, and H. T. Ward, Melpar, Inc.

Annular Slot Direction Finding Antenna, by H. M. Hougardy and Nicholas Yaru, Hughes Aircraft Co.

A Novel Antenna for Mobile Radio Relay Operation in the UHF Range, by F. J. Triolo, U. S. Army Signal Engineering Labs.

Lightweight, High Gain Antenna, by R. G. Malech, Airborne Instruments Lab., Inc.

Voltage Breakdown Characteristics of Microwave Antennas, by J. B. Chown, T. Morita, and W. E. Scharfman, Stanford Research Institute.

SESSION 48
Thursday, March 27
10:00 A. M.-12:30 P.M. (C)

MICROWAVE TUBES

Noise Characteristics of a Backward-Wave Oscillator, by J. B. Cicchetti and J. Munushian, Hughes Research and Development Labs.

The Pulsed M-Type Backward Wave Oscillator and Its Modes of Operation, by Gerald Klein and A. L. Winters, U. S. Army Signal Engineering Labs.

The ESTIATRON—An Electrostatically Focused Medium-Power Traveling-Wave Amplifier, by D. J. Blattner and F. E. Vaccaro, Radio Corporation of America.

The Generation of Shaped Pulses Using Microwave Klystrons, by D. H. Preist, Eitel-McCullough, Inc.

Wide-Band UHF 10 KW Klystron Amplifier, by H. Goldman, L. F. Gray, L. Pollack, Federal Telecommunication Labs.

SESSION 49
Thursday, March 27
2:30-5:00 P.M. (WA)

GENERAL SYSTEMS

Combat Computers, by W. F. Luebbert, U. S. Army Signal Corps Engineering Labs.

The USAF Automatic Language Translator, Mark I, by G. A. Shiner, Rome Air Development Center.

Non-Binary Switching Theory, by O. Lowenschuss, Sperry Gyroscope Co.

Automatic Type Size Normalization in

High Speed Character Sensing Equipment, by A. I. Tersoff, Intelligent Machines Research Corp.

Minimum Time Programming on a Drum Computer, by B. Shiffman, The Ramo-Wooldridge Corp.

SESSION 50
Thursday, March 27
2:30-5:00 P.M. (WA)

CIRCUIT THEORY III—APPLICATION OF TOPOLOGICAL AND GROUP CONCEPTS

Signal Flowgraph and Network Topology, by Omar Wing, Columbia University.

New Transpositions in Power Transformer Windings, by R. G. deBuda, Canadian General Electric Co., Ltd.

Two-Terminal Pair Symmetry Relations, by R. C. Kiessling, Lenkurt Electric Co.

Analysis of Nonreciprocal Networks by Digital Computer, by Wataru Mayeda and M. E. Van Valkenburg, University of Illinois.

On Non-Series-Parallel Realization of Driving-Point Function, by Wan H. Kim, Columbia University.

SESSION 51
Thursday, March 27
2:30-5:00 P.M. (WA)

ULTRASONICS III—MEASUREMENT OF RADIATED ACOUSTIC POWER

Power Handling Capability of Ferroelectric Ceramics, by G. W. Renner, R. A. Plante and T. F. Hueter, Raytheon Manufacturing Co.

Measurement of Acoustic Power Radiated from Underwater Sound Transducers, by R. J. Bobber, Office of Naval Research.

An Instrument for Determining Intensity of Ultrasound, by J. F. Herrick, B. H. Anderson and M. Neher, Mayo Clinic and Mayo Foundation.

Measurements of Acoustic Power in Industrial Ultrasonic Equipment, by W. Welkowitz, Gulton Industries, Inc.

Panel Discussion—Problems in Power Measurement

Panel Members G. E. Henry, General Electric Eng. Lab; S. E. Jacke, Detrex Corp; Frank Massa, Massa Labs., Inc; Murray Strasberg, David Taylor Model Basin.

SESSION 52
Thursday, March 27
2:30-5:00 P.M. (WA)

LONG DISTANCE COMMUNICATIONS

Single Channel Radioteletype Communication, by H. B. Voelcker, Jr., U. S. Army Signal Engineering Labs.

A World-Wide High Frequency SSB Radio Network, by Everett Bray, Collins Radio Co.

Comparison of Multi-Channel Radioteletype Systems Over a 5,000-Mile Ionospheric Path, by A. T. Brennan, Stromberg-Carlson Co; Bernard Goldberg and Arthur Eckstein, U. S. Army Signal Engineering Labs.

Basic Analysis on Controlled Carrier Operation of Tropospheric Scatter Communication Systems, by L. P. Yeh, Westinghouse Electric Corp.

Transportable Tropospheric Scatter Communications Systems, by A. J. Svien, Collins Radio Co.; and J. C. Domingue, Signal Communications Dept.

Evaluation of IF and Baseband Diversity Combining Receivers, by R. T. Adams and B. M. Mindes, Federal Telecommunications Labs.

Transmission of Digital Data over Multi-Hop Tropospheric, by C. N. Lawrence and

R. L. Marks, Rome Air Development Center.

SESSION 53
Thursday, March 27
2:30-5:00 P.M. (C)

HIGH ACCURACY INSTRUMENTS, MEASUREMENT AND CALIBRATION

A Feedback Amplifier with Negative Output Resistance for Magnetic Measurements, by W. P. Harris and I. L. Cooter, National Bureau of Standards.

Millimicrosecond, Wide-Aperture, Electro-optical Shutter, by J. A. Hull, Avco Mfg. Corp.

A Quartz Servo Oscillator, by Norman Lea, Marconi's Wireless TelegraphCo., Ltd.

A New Method to Simplify Bridge Type Measurements on Quartz Crystal Units, by Erich Hafner, U. S. Army Signal Engineering Labs.

RF-Voltage Calibration Consoles, by M. C. Selby, L. F. Behrent and F. X. Ries, National Bureau of Standards.

SESSION 54
Thursday, March 27
2:30-5:00 P.M. (C)

ANTENNAS III—MICROWAVE ANTENNAS

A Compact Dual-Purpose S-Band Beacon and VHF Telemetry Antenna, by W. O. Puro, W. G. Scott and W. A. Meyer, Melpar, Inc.

A Volumetric Electrically Scanned Two-Dimensional Microwave Antenna Array, by J. L. Spradley, Hughes Aircraft Co.

Closely Spaced Polyrod Arrays, by L. W. Mickey, G. G. Chadwick, Melpar, Inc.

Wave Guide Loaded Surface Wave Antenna, by R. F. Hyneman and R. W. Hougardy, Hughes Aircraft Co.

Dielectric Image Line Surface Wave Antenna, by H. W. Cooper, Murray Hoffman and Sheldon Isaacson, Maryland Electronic Mfg. Corp.

A Dual Beam Planar Antenna for Janus Type Doppler Navigation Systems, by H. Saltzman and G. Stavis, General Precision Lab., Inc.

SESSION 55
Thursday, March 27
2:30-5:00 P.M. (C)

RADIO & TELEVISION

Design Problems in Transformerless Single Rectifier TV Receivers, by D. Sillman, Westinghouse Electric Corp.

Problems in Two Dimensional Television Systems, by R. M. Bowie, Sylvania Electric Products, Inc.

A New High-Power Horizontal-Output Tube Deflection System for Color Television, by J. P. Wolff, and R. G. Rauth, Radio Corp. of America.

Improvements in Deflection Amplifier Design, by C. Droppa, Sylvania Electric Products, Inc.

AGC Design Considerations for TV Receivers, by R. H. Overdeer, Philco Corp.

Exhibitors at the show and their booth numbers are as follows:

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New York 36, N. Y. 3119

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Avion Division
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Paramus, N. J. 1107

AMP Incorporated
3822 Eisenhower Blvd.
Harrisburg, Penna. . .3821, 2427-2429

A & P Metal Products Mfg. Corp.
111 Bloomingdale Road
Hicksville, L. I., N. Y. 4116

Ace Electronics Associates, Inc.
99 Dover St.
Somerville 44, Mass. 1807

Ace Engineering & Machine Co., Inc.
Tomlinson Road
Huntingdon Valley, Pa. 1728

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Acton Laboratories, Inc.
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1117 Commonwealth Ave.
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Ad-Yu Electronics Lab., Inc.
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Aeroprojects Inc.
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West Chester, Pa. 1913

Aerovox Corp.
740 Belleville Ave.
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Airborne Instruments Lab.
160 Old Country Rd.
Mineola, L. I., N. Y. . .1301-1305, 1400

Aircom Incorporated
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Winthrop 52, Mass. M-21

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535 Avenue A
Bayonne, N. J. 3829

Air-Marine Motors, Inc.
369 Bayview Ave.
Amityville, L. I., N. Y. 2315

Air-Maze Corporation
25000 Miles Road
Cleveland 28, Ohio. M-22

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Ft. Lauderdale, Fla. 3502-3504

Airtron, Inc.
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Linden, N. J. 3318

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Nashville 10, Tenn. 1816

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Alden Products Co.
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Alford Manlfacturing Co., Inc.
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Electronic Products Div.
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Mineral Wells, Texas 1805

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136 W. Greenfield Ave.
Milwaukee 4, Wisconsin. . . .3706-3708

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Jersey City 4, N. J. 4323

Alpha Wire Corp.
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Chicago 31, Ill. . . . . .1919 & 1921

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Hempstead, N. Y. 1729
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6110 Cass Ave.
Detroit 2, Michigan. 4033

American Machine & Foundry Co.
Defense Products Group
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New York 6, N. Y. 4008

American Molded Products Co.
2727 W. Chicago Ave.
Chicago 22, Ill. 4110

American Plastics Corp.
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New York 17, N. Y. 4115

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American Television & Radio Co.
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1830 S. 54th Ave.
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New Hope, Pa. 4121

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14-13 118th St.
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Appliance Manufacturer
201 North Wells St.
Chicago 6, Ill..................4535

Arco Electronics, Inc.
64 White St.
New York 13, N. Y..............2738

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Artos Engineering Co.
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Milwaukee 46, Wisc.............4228

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Associated American Trading Division
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New York 56, N. Y.........4239-4241

Associated Missile Products Corp.
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2709 North Garey Ave.
Pomona, Calif. 1513

Associated Testing Labs., Inc.
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Caldwell, N. J. 1818

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East Newark, N. J..............2430

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625 McGrath Highway
Somerville, Mass. M-12

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Philadelphia 41, Pa.............3104

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Ridgefield, N. J. 3946

Baird-Atomic Inc.
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Cambridge 38, Mass..............3221

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Newark 2, N. J..................2123

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Boonton, N. J. 3402-3404

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145 Hudson Street
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Boonton Electronics Corp.
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65 Bay St.
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727 W. Glendale Ave.
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CGS Laboratories, Inc.
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120 Cross St.
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Belmont, Calif. ....1111 & 1112

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445 Concord Avenue
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Paramus, N. J.............4306-4308

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The Capitol Machine Co.
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Century Electronics & Instruments, Inc.
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Chester, N. Y. 4428

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3501 West Addison St.
Chicago 18, Ill. 1203

Christie Electric Corp.
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Los Angeles 43, Calif. 2810

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New York 17, N. Y. 2601

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Cleveland 2, Ohio 2319

Clevite Research Center
Div. of Clevite Corp.
540 East 105th St.
Cleveland 8, Ohio 2003

Brush Instruments
Div. of Clevite Corporation
3405 Perkins Ave.
Cleveland 14, Ohio 2616-2626

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Roseville, Mich. 4117

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Caldwell, N. J. 4055

Sigmund Cohen Corp.
121 S. Columbus Ave.
Mount Vernon, N. Y. 2428-2521

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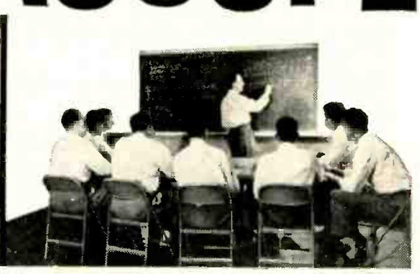

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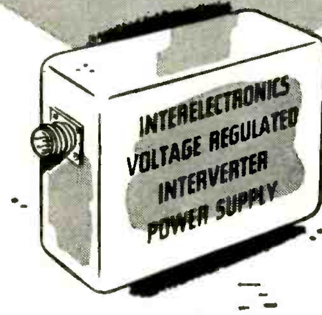

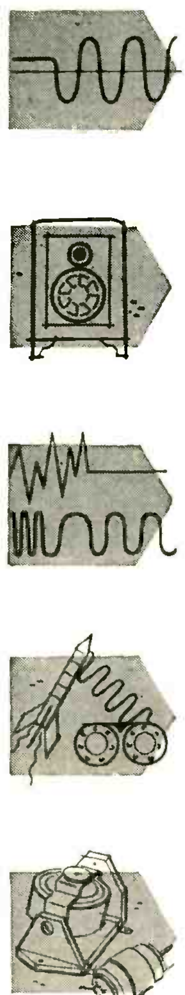

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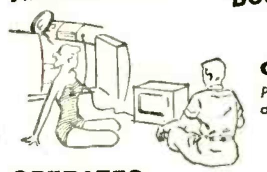

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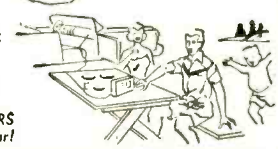

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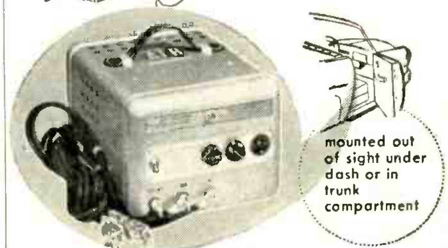

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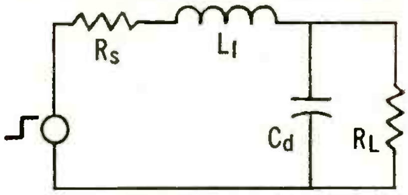
Pulse Notes

Control of Rise Time and Overshoot in Pulse Transformers

A pulse transformer with a turns ratio greater than unity ($n > 1$) can be approximated by the circuit below for the duration of the leading edge of the applied pulse.



Where R_S is the internal resistance of the pulse source, R_L load resistance, L_I and C_d, leakage inductance and distributed capacitance, respectively. If the transformer is matched ($R_S = N^2R_L$), this circuit is valid for step-up and step-down transformers.

Optimum step function response (minimum rise time and overshoot) occurs when $\sqrt{\frac{L_I}{C_d}} = R_L$. Under these conditions overshoot is approximately 4%; rise time from 10% to 90% of pulse height approximately equal to $1.52\sqrt{L_I C_d}$. If $\sqrt{\frac{L_I}{C_d}}$ is less than R_L, overshoot and ringing occur. Making $\sqrt{\frac{L_I}{C_d}}$ greater than R_L rounds the leading edge and increases rise time. Circuit designers should note that any shunt capacity in the load is effectively added to C_d which causes $\sqrt{\frac{L_I}{C_d}}$ to be less and overshoot greater than indicated by transformer specifications.

Leakage inductance and distributed capacitance are functions of winding geometry such as insulation pad thickness, wire spacing, and interleaving. These parameters must be accurately controlled during manufacture to meet rise time and overshoot specifications. In the Pulse Engineering Stat-Tran*, a rectangular coil form permits precise control of the winding configuration which contributes to uniform leading edge response.

A new catalog describing the Stat-Tran* and other pulse transformers is yours for the asking.

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NEW BOOKS

Propagation des Ondes Electromagnetiques de Haute Frequence

By J. Ortusi.
Societe Francaise De Documentation Electronique, Paris, 1957, 320 p, 3,100 fr.

This book is the second of a French scientific series entitled "Collection des Annale de Radio-electricite" edited by M. Ponte. It deals with the subject of high-frequency electromagnetic wave propagation.

The author has confined himself to three areas of current interests, each covered by a separate chapter. These three areas are wave propagation in anisotropic media, multiple terminal waveguides and wave propagation around the earth.

Two other chapters deal primarily in basic background materials for these specialized topics. The first is a brief treatment in Maxwell's equations and energy relationship. The second chapter deals with mathematics involved in propagating waves. Most of these introductory materials can of course be found in ordinary text books, but they are useful for reference and guidance in the notations used by the author for subsequent development.

Major Areas—The high-frequency wave-propagation field consists of mainly two major areas, namely one in dealing with the waveguide components with which the energy is directed and transformed in the equipment and the other in dealing with the electromagnetic wave propagation in the space after radiated from the antenna. In these two areas, two major new developments occurred in the last few years. In the component field, the introduction of anisotropic media such as ferrites not only offers challenging problems for theoreticians, but also offers a great deal of opportunity for engineers to make entirely new microwave devices such as circulators, isolators and other nonreciprocal devices. Since these are new developments, it is useful to have such a summary of the basic theories involving anisotropic medium which now appears only in scattered literatures. The multiple terminal waveguide components that can be built with or without ferrites are discussed more in terms of physical principles rather than in detailed mathematics.

In the space wave propagation field, the rapid development in the last few years has been the theoretical and experimental understanding scattering wave propagation which puts the beyond-the-line-of-sight propagation for microwaves on a systematic engineering basis. The author has assembled a number of nomograms and charts which will help engineers in the design and selection of power requirements, antenna gain, etc., for a given signal-to-noise reception between different distances around the earth and with various terrain conditions.

This book should be a useful reference for those who are engaged in the studies of microwaves propagation and as an introductory to those who would like to learn more about the latest developments in this field.—C. C. WANG, *Sperry Gyroscope Co., Division of Sperry Rand Corp., Great Neck, N. Y.*

THUMBNAIL REVIEWS

The Science of Engineering Materials. Edited by J. E. Goldman, John Wiley & Sons, New York, 1957, 517 p, $12.00. An outgrowth of a series of studies and conferences on the introduction of solid-state physics and chemistry into engineering education, this book will be of interest to persons entering work in surfaces, dielectrics, strength of materials, magnetism, semiconductors and amorphous materials.

The Index of Technical Articles. Iota Services Ltd., 38 Farrington St., London, E.C. 4, England. Monthly index of articles appearing in scientific, industrial, technical and trade journals published in Great Britain. Entries are in modified form of Universal Decimal Classification System and consist of title and author of article and name, volume, number and date of periodical. Prices are 6 months, 3 guineas; 1 year, 6 guineas and single copy 10/6.

COMMENT

Classroom Tv

In omitting the name of General Precision Laboratory (GPL) from "Classroom Tv Makes Grade" (Jan. 24, p. 19), you are giving less than a fair picture of those organizations contributing to the field. In view of your publication's high standards of accuracy in reporting on the electronics field, we trust you will bring these facts to the attention of your readers.

General Precision Laboratory has been active in the educational tv market for several years. Its broadcast and closed-circuit tv equipment is in use in 40 schools, colleges and other institutions throughout the country. Further, GPL is the outstanding developer of large-screen projection tv systems. In addition to their use for group communications and information display, these portable systems are currently aiding in instructing students in closed-circuit and off-the-air applications.

In the area of video recording, 19 of the 32 educational tv stations on or scheduled to be on the air have GPL recorders and a number of others are expected to acquire these systems.

Stewart Pardee
General Precision Laboratory
Pleasantville, N. Y.

A List of -Istors

("Fast Cryogenic Memories Bow," Oct. 1 '57, p 8) reports a new electronic component, the persistor. Present terminology of -istor components is continually growing into an intriguing list. To keep a finger on the pulse of all that is happening in electronics is an arduous task indeed. The rapid advancement of research, design and development is outpacing the ability of the individual design engineer to catch up with all that is new.

This list of -istor components may stir the curiosity of some who may not be familiar with all the names.

The transistor consists of a

specially processed semiconductor, either germanium or silicon, which can amplify electrical currents. At low frequency and low power, where vibration resistance is important, the transistor can surpass the vacuum tube, but it is a poor performer at high frequencies and high temperatures.

The spacistor takes over at high frequencies where the transistor fails due to slow motion of the charge carriers through the base region. A strong accelerating field in the base region accelerates the charge carriers to permit amplification at 10,000 mc. The upper temperature limit is 500 C against 200 C for the transistor.

The dynistor is a semiconductor diode with the unique characteristic of having two distinct conductivities in the reverse direction. It can switch from blocking to hyperconductive condition in less than a microsecond. It can operate with continuous current as high as 11 amperes.

The magnistor is a small ferrite reactor with fast response. It can control pulses of one or two microseconds duration.

The nesistor was introduced by Robert G. Pohl last August. It is a semiconductor with a wide range of negative resistance characteristics.

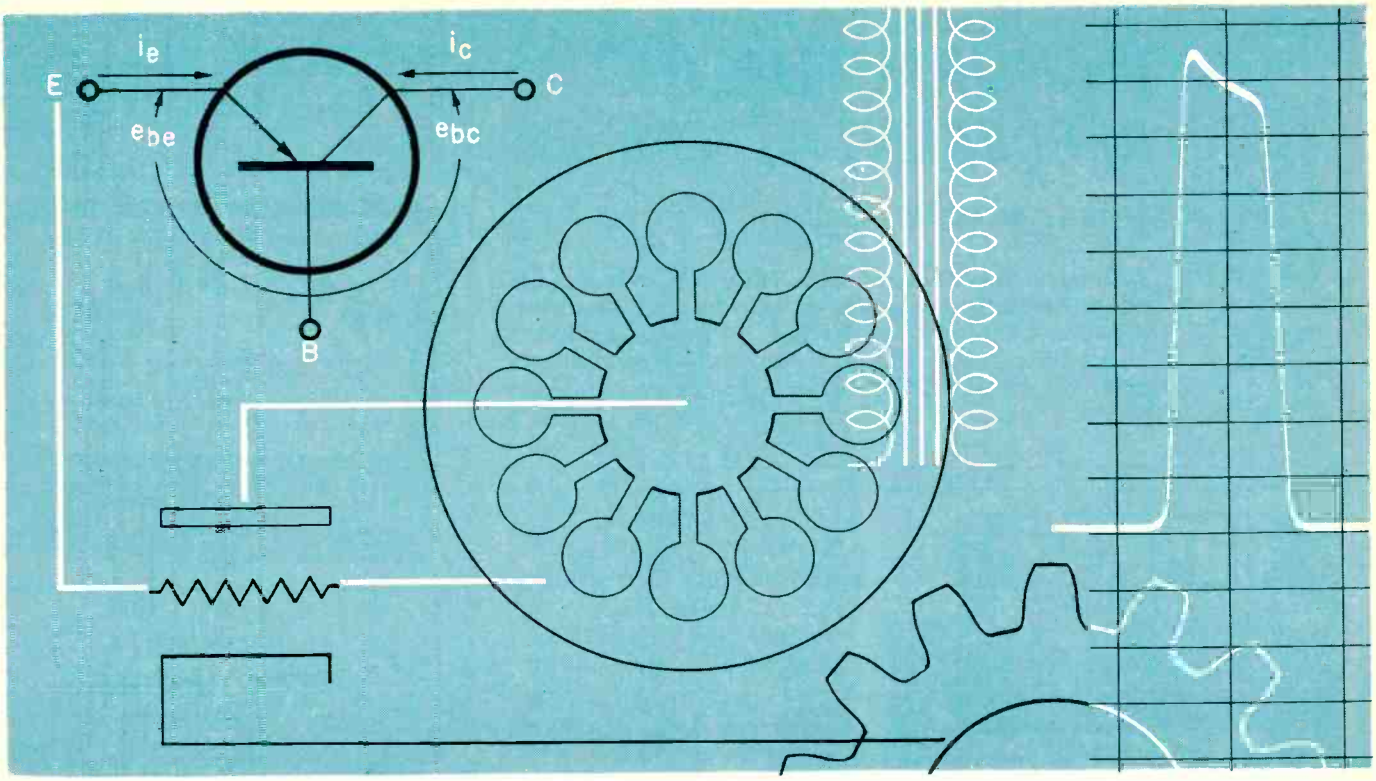
The thermistor is a well known versatile component with negative resistance-temperature characteristics.

The varistor is a voltage-sensitive nonlinear resistor made of thyrite compound.

The precistor is a boron-carbon resistor which maintains a high degree of accuracy under varying temperatures; it is used where resistance stability is essential.

The persistor is a small bimetallic loop which operates at temperatures close to absolute zero. Its resistance is zero in the superconductive state and a current started by a pulse will continue to flow unhindered in the metallic loop until reversed by another pulse. A half million persistors can be assembled in a cubic foot of space.

John J. Rivera
Federal Telecommunications Labs
Belleville, N. J.



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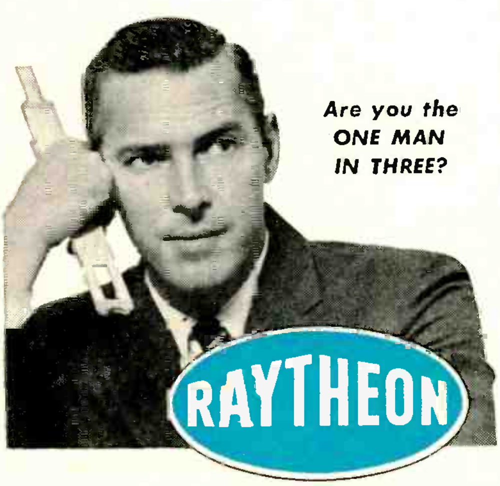

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As a service to readers, ELECTRONICS presents the advertisements for some of the leading manufacturers' representatives in the electronic industry. These firms are qualified to help the *Manufacturer* with his distribution problems; the *Buyer* with his product needs.

PROFESSIONAL SERVICES

• CONTACTS •

EMPLOYMENT OPPORTUNITIES

(Continued on pages 331-337)

ADDRESS BOX NO. REPLIES TO: Box No. Classified Adv. Div of this publication. Send to office nearest you.
NEW YORK 36: P. O. BOX 12
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POSITIONS WANTED

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Chief Engineer, 16 years experience—last 7 in management—desires to make change. Heavy background military electronics, nuclear controls, and commercial test equipment. Business & professional environment of prime importance. Present location NNJ. PW-7445, Electronics.

GRADUATE EE'S: GENERAL ELECTRIC DISCLOSES HIGH PRIORITY PROGRAM FOR ATLAS

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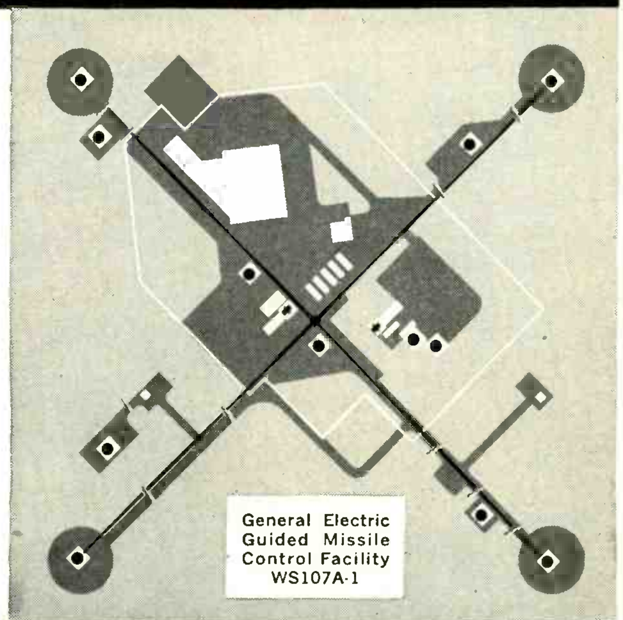
required for portions of G.E.'s ICBM ATLAS Guidance System



Delivering an ICBM over a > 5000 mile trajectory into the target area demands a guidance system of unprecedented accuracy—and this is the calibre of the electronic system General Electric engineers are creating for ATLAS.

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RF and Microwave components & plumbing
Communications control devices
Doppler radar design & development
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Write in complete confidence to Mr. E. A. Smith, Room 3-E

MISSILE GUIDANCE PRODUCT SECTION

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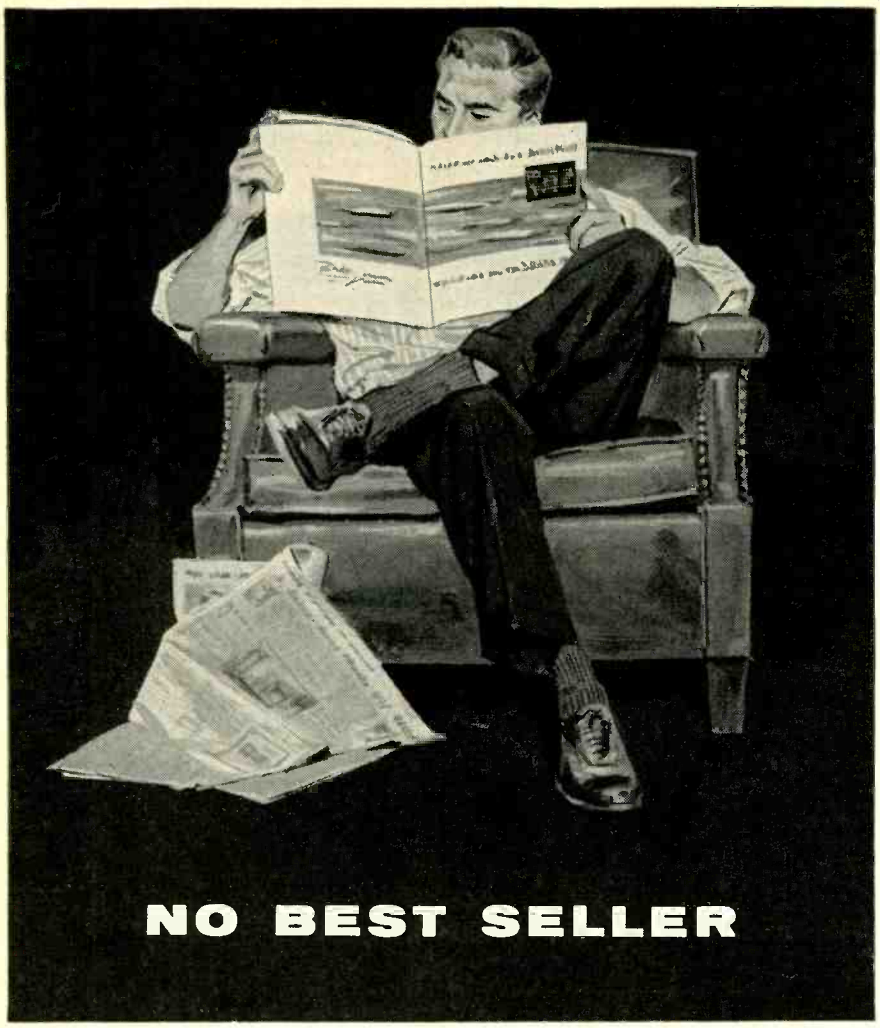
Court Street, Syracuse, N.Y.



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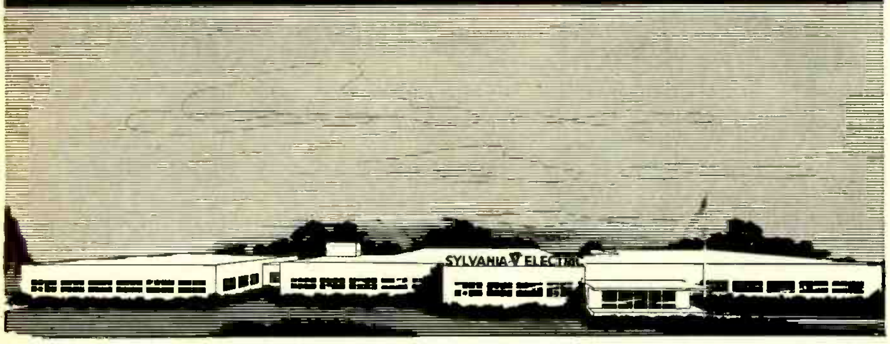

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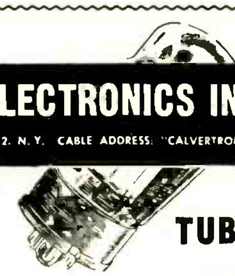

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2X2A	1.24
3AL5	.62
3AU6	.72
3AV6	.62
C3J	11.99
3A2	1.29
3A3	1.29
3A4	.48
3A5	.68
3BC5	.82
3BE6	.82
3B4	.66
3BN6	1.02
3BU8	.99
3BY6	.89
3BZ6	.79
3B5	2.39
3B7/1291	2.06
3B23	3.00
3B24W	4.00
3B25	5.00
3B27/836	3.00
3B28	3.50
3C22	55.00
3C23	7.85
3C24	1.99
3C33	5.00
3C34	5.96
3C37	19.00
3C39	70.90
3C45	6.75
3CB6	.79
3CF6	.79
3C56	.78
3D6/1299	.48
3D21A	2.75
3D23	4.50
3DT6	.68
3E29	7.98
3J31	35.00
3K23	150.99
3Q4	.66
3Q5	.86
3S4	.68
3V4	.99
3X2500A3	99.92
4A1	1.92
4AP10	7.42
4A11	.98
4B25	8.00
4B26	7.49
4B27	4.72
4B28	3.00
4B31	20.99
4B32	8.00
4B35/349A	7.09
4B36	6.89
4BC8	1.30
4BN6	1.00
4BQ7A	1.19
4BS8	1.19
4BU8	.92
4BZ7	1.25
4C21	8.99
4C35	15.00
4CB6	.74
4D21/4-125A	$25
4-400A	46.00
4E27	9.99
4E27/5-125	39.00
4J22	98.00
4J31	60.00
4J50	90.00
4J51	215.00
4J52	49.80
4J53	100.00
4-65A	14.50
4-125A	26.00
4X150A	18.50
4-250A	30.00
4X250B	41.99
4X500A	50.00
4X500F	50.00
5AM8	1.05
5AN8	1.09
5AQ5	.71
5AS4	.64
5AS8	1.09
5AT8	1.01
5AV8	1.09
5AW4	1.10
5B/4B22	5.32
5BE8	1.06
5BK7A	1.06
5BQ7A	1.21
5BR8	.96
5C22	20.00
5CG8S	1.01

5CL8	$1.01
5D21	4.75
5D23	9.50
5J6	.89
5J23	65.00
5J26	145.00
5J29	4.00
5J33	4.32
5R4GY	1.25
5R4WGY	2.65
5T4	1.25
5T8	.99
5U4	.59
5U8	.99
5V4	.89
5V6	.69
5V4G	1.39
5W4	.99
5X4	.59
5X8	.99
5Y3	.59
5Y4	.59
5Z3	.79
5Z4	1.12
C6A	7.10
C6J/5C21	9.89
C6M	Q
6A3	1.69
6A5	4.00
6A6	1.15
6A7	.99
6A8	.99
6AB4	.59
6AB5	1.48
6AB7	1.29
6AC5	.90
6AC7	.79
6AD4	Q
6AD5	1.89
6AD6	1.29
6AD7	1.39
6AE5	1.89
6AE6	1.89
6AF4	1.29
6AF6	.98
6AG5	.69
6AG7	.97
6AH4	.89
6AH6	.99
6AJ4	1.69
6AJ5	1.08
6AK5	.69
6AK6	.69
6AL5	.59
6AL7	1.29
6AM4	1.29
6AM8	.99
6AN4	1.49
6AN5	3.39
6AN8	.99
6AQ5	.66
6AQ5W	1.98
6AQ6	.56
6AQ7	1.12
6AR5	.99
6AR6	1.95
6AS5	.99
6AS6	1.79
6AS7G	3.49
6AS8	.99
6AT6	.49
6AT8	.99
6AU4	1.29
6AU5	1.19
6AU6	.59
6AU8	.99
6AV6	.59
6AW8	1.12
6AX4	.79
6AZ8	1.19
6B4G	1.00
6B5	.99
6B6	.89
6B7	1.29
6B8	1.35
6BA5	.99
6BA6	.59
6BA7	.99
6BA8	.99
6BC4	1.49
6BC5	.69
6BC7	1.10
6BC8	1.19
6BD4A	6.95
6BD5	1.69
6BD6	.69
6BE6	.50
6BF5	1.08
6BF6	.69
6BF7	1.99
6BG6	1.49
6BG7	1.99
6BH6	.79
6BH8	1.05
6BJ6	.72
6BJ7	.80
6BK5	1.11
6BK7	.99
6BL6	57.29
6BL7	1.95
BN4	.69
6BN6	1.08
6BN7	1.99
6BQ5	1.99
6BQ6	1.19
6BQ7	.99
6BR8	.99
6BS8	1.15
6BU8	.89
6BV8	.99
6BX7	1.11
6BY5	1.19
6BY6	.75
6BZ6	.75
6BZ7	1.25
6BZ8	1.49
6C4	.49
EL6C	16.29
EL6CF	16.29
6C5	.69
6C6	1.08
6C8	1.08
6C21	13.49
6CA7	3.90
6CB5	2.29
6CB6	.80
6CD6	1.49
6CF6	.85
6CL6	1.10
6CS6	.70
6CD6	1.80
6CE5	1.15
6CG7	.89
6CG8	1.12
6CM6	.79

6CM6	$0.89
6CM7	.85
6CN7	.81
6CR6	.72
6CS7	.89
6CU5	.75
6CU6	1.29
6D4	2.39
6D6	.99
6D8	.99
6DC6	.89
6DE6	.79
6DG6	.82
6DN6	2.89
6DQ6	1.49
6DT6	.69
6E5	.79
6E6	1.15
6E7	1.29
6F4	2.25
6F5	.63
6F6	.99
6F7	.99
6F8	1.39
6H6	4/$1
C6J	17.29
6J4	1.25
6J5	.59
6J6	.59
6J7	.99
6J8	1.39
6K4	2.00
6K5	.99
6K6	.59
6K7	.79
6K8	.99
6L5	.99
6L6	1.19
6L6W	3.49
6L6Y	1.49
6L7	.99
6N60	2.00
6NO120	2.00
6N7	.99
6P5	.79
6Q5	1.89
6Q7	.95
6R7	.99
6R8	1.59
6S4	.59
6S5	.99
6S7	1.29
6S8	.99
6SA7	.69
6SA7W	1.69
6SB7Y	1.19
6SC7	.89
6SD7	1.11
6SF5	.69
6SF7	.89
6SG7	.79
6SH7	.69
6SJ7	.69
6SK7	.72
6SL7	.89
6SN7	.72
6SQ7	.74
6SR7	.79
6SS7	.89
6ST7	.99
6SU7	2.01
6SV7	1.29
6SZ7	1.89
6T4	1.19
6T7	1.19
6T8	.98
6U4	.59
6U5	.83
6U7	.89
6U8	.98
6V3	1.39
6V4	.99
6V6	1.39
6V6GT	.90
6V8	1.29
6W4	.79
6W6	.89
6W7	.99
6X4	.39
6X5	.49
6X8	.99
6Y5	1.69
6Y6	.89
6Z4	.90
6Z5	1.29
6Z7	1.39
6ZY5	1.39
7AK7	5.95
7A4	.79
7A5	.89
7A6	.72
7A7	.79
7A8	.72
7AD7	.99
7AF7	.99
7AG7	.99
7AH7	.92
7AU7	.89
7B4	.72
7B5	.75
7B6	.79
7B7	.79
7B8	.85
7C4	.69
7C5	.79
7C6	.82
7C7	.82
7C8	1.19
7C29	69.00
7E5	.99
7E6	.99
7E7	1.15
7F7	.95
7F8	1.20
7G7	1.05
7G8	1.89
7H4	1.89
7H7	.79
7J7	1.20
7K7	1.10
7L7	.99
7N7	.89
7Q7	.99
7R7	1.25
7S7	1.20
7V7	1.20
7W7	1.20
7X6	.82
7X7	1.15
7Y4	.69
7Z4	.72
8AU8	1.19
8CG7	.75
8CN7	.85

8CN7	$0.90
9CL8	1.19
10	2/$1
10Y	2/$1
12A	.99
12A4	.75
12AT6	.59
12A5	1.20
12A6	.59
12A7	1.26
12A8	.75
12AD6	.77
12D7	.90
12AF6	.69
12AH7	1.08
12AL5	.59
12AQ5	.75
12AT6	.59
12AT7	.89
12AU6	.63
12AU7	.69
12AV6	.55
12AV7	.99
12AW6	.85
12AX4	.99
12AX7	.79
12AY7	1.29
12B4	.95
12BA6	.65
12BA7	.99
12BD6	.59
12BE6	.59
12BF6	.59
12BH6	.79
12BH7	.99
12BK5	1.05
12BN6	1.05
12BR7	.89
12BV7	1.00
12BY7	1.00
12BZ7	.99
12C8	.95
12CA5	.80
12CN5	.79
12CR6	.82
12CU5	.78
12CU6	1.45
12DQ6	1.48
12H6	.75
12J5	.69
12J7	.69
12J8	1.35
12K8	.89
12K8Y	1.12
12L6	.79
12Q7	.79
12SA7	.69
12SC7	.89
12SF5	.69
12SF7	.89
12SG7	.89
12SH7	.89
12SJ7	.75
12SK7	.75
12SL7	.79
12SN7	.69
12SQ7	.69
12SR7	.69
12V6	.79
12W6	.89
12X3	1.49
12X4	.55
12Z3	.99
14A4	1.08
14A5	1.49
14A7	.83
14AF7	1.00
14B6	.95
14B8	1.19
14C5	1.08
14CF	.95
14E6	1.20
14EF	1.19
14F7	1.00
14F8	1.29
14HF	.99
14J7	1.29
14N7	1.29
14Q7	1.00
14R7	1.29
14S7	1.19
14W7	1.19
14X7	1.05
14Y4	.97
15	.35
15E	1.19
15R	.34
C16J	Q
FG17	4.45
17AX4	1.08
18	.35
19	.35
19AU4	1.10
19BG6G	2.15
19C8	1.15
19J6	1.00
19T8	1.16
19V8	1.12
19X8	1.20
20	.49
T20	2.00
RK20	Q
A21	12.95
PJ21	7.50
KY21	8.90
22	.45
246/3C24	1.95
24A	.39
WANTED TUBES	
CE36C	1.10
CE36D	1.00
25A6	1.19
25A7	2.19
25AV5	1.45
25AX4	1.07
25BK5	1.08
25BQ6	1.39
25C5	.81
25CA5	.99
25CD6	1.85
25CU6	1.45
25D8	1.89
25DN6	1.99
25DQ6	1.69
25L6	.72
25T	Q
25W4	.77
25W6	.90
25Y5	1.08
25Z5	.72
25Z6	.75
25Z6W	2.25
26	.39
26A7	3.69

27	$0.39
FG27A	8.28
HV27	19.39
28D7	2/$1
30	.89
31	.39
GZ32	1.49
32	.39
32L7	1.12
ECC83	2.00
33	.29
FG33	15.00
GZ34	4.25
34	.39
EL34	3.90
35	.39
35A5	.69
35B5	.59
35C5	.59
35L6	.59
35TG	2.00
35W4	.52
35Y4	.69
35Z3	.69
35Z4	.59
35Z5	.57
36	.39
REL36	2/$1
EL37	3.15
37	.39
38	.39
RK38	8.50
39/44	5/$1
RK39	2.99
TZ40	3.00
40	.87
41	.39
42	.75
43	.75
45	3/$1
45Z3	.49
45Z5	.65
46	.90
47	.39
RK47	3.00
48	1.98
RK48	Q
49	.39
50A5	.69
50B5	.69
50C5	.69
50L6	.69
50Y6	.75
HY51Z	Q
52	.89
53	.98
HK54	4.00
55	.89
T55	7.00
56	.59
57	.75
58	.79
59	1.49
RK59	1.30
APR60A	Q
RK60	1.17
RK61	2.50
HY65	.90
KT66	3.49
FG67	7.00
HY69	2.20
70A7	1.39
70L7	1.39
71	.79
RK73	2/$1
75	.81
HY75	5.00
75TL	10.00
76	.49
77	.39
78	.39
79	.39
80	.59
EM81	2.39
EZ80	.81
81	1.59
ECC81	2.50
EZ81	Q
FG81	3.20
QK81	Q
82	.97
ECC82	2.00
83	.95
83V	.89
ECC83	2.00
84/6Z4	.69
EL84	2.10
85	.89
ECC85	1.59
EF86	1.28
89	.89
EB91	.81
EC90	1.26
EF94	.96
EK90	.99
EZ90	.79
ECC91	1.15
VR92	5/$1
FG95	16.00
FG97	Q
FG98	14.00
100TH	6.00
100TL	10.00
102D	3.00
102F	2.75
102G	3.00
FG104	28.00
FG105	13.00
F108	12.00
111H	3/$1
114B	3/$1
HY115	5/$1
117L7	2.39
117N7	1.98
117Z3	.69
117Z4	1.10
117Z6	1.10
CK118	Q
174A	Q
VXR130	1.00
CV147	4.95
CV148	4.95
152TL	31.75
FG166	6.50
FG172	13.50
FG190	4.98
HF200	10.25
201	.39
203A	2.20
204A	15.00
205B	4.95
211	2/$1
RX215	5.00
215	4.00
217C	1.25

227A	$2.50
RX233A	.50
242	10.00
244A	9.50
245A	4.00
249B	2.50
249C	4.25
250R	3.50
250TH	24.00
250TL	20.00
252A	14.35
HK254	9.35
254A	2.35
257B	7.00
259A	21.75
274A	3.50
274B	.50
275A	3.40
276A	4.00
300B	6.70
HF300	19.45
303A	8.45
304TH	12.50
304TL	16.50
307A	.75
310B	8.00
313C	2.25
316A	4/$1
322A	50.00
323B	12.50
324A	Q
325A	Q
331A	Q
339A	8.00
5340	2.50
348A	4.00
349A	4.00
350A	2.35
350B	2.25
351A	10.00
353A	3.15
354A	2.00
355A	10.80
356B	3.45
357B	Q
359A	1.00
366A	Q
368AS	4.59
371B	.95
380A	1.15
387A	3.50
388A	.99
394A	2.50
395A	4.50
396A	2.00
399A	3.50
403A	1.00
403B	2.15
410R	110.00
W.E.417A	10.50
WL417A	2.50
421A	3.50
434A	1.98
446A	2/$1
446B	1.49
450TH	54.00
450TL	43.50
GL451	4.00
HK454	Q
460	10.00
464A	1.00
471A	2.00
473	164.95
501AX	1.00
502A	1.50
502AX	1.49
503AX	.90
505AX	1.49
506AX	.95
507AX	1.49
509AX	1.00
510AX	2.69
511X	3.20
512AX	1.95
518AX	1.95
522X	1.70
525AX	1.90
526AX	1.90
527AX	1.95
528AX	1.49
529AX	1.89
531	3.79
531DX	1.70
532DX	1.95
533AX	1.90
534AX	1.95
535AX	1.50
536AX	1.49
537AX	1.95
538DX	1.45
539DX	1.95
541DX	1.50
542DX	1.95
542DXS	2.25
543DX	1.50
544DX	1.45
546DX	1.95
547DX	1.50
548DX	1.95
549DX	1.85
551AX	2.25
555AX	2.25
556AX	2.25
559	3/$1
569CX	1.15
570AX	2.25
571AX	1.49
573AX	1.95
574AX	1.95
575A	10.00
601B	3/$1
605CK	1.95
606BX	1.15
608CX	1.95
KU610	3.50
HY615	2/$1
WL616	42.50
619CX	1.95
KU618	Q
624CX	1.95
KU627	6.50
WL629	Q
631P1	4.95
WL670A	Q
KU676	29.50
KU677	Q
WL678	39.00
WL686	20.00
701A	3.95
702A	1.00
703A	1.00
704A	2/$1
705	2/$1
707A	2.00
707B	3.50

708A	$2.50
709A	1.20
710A	4.00
713A	1.00
NL714	9.50
714AY	7.50
715B	2.50
715C	10.00
717A	4/$1
718BY	22.00
718DY	22.00
718EY	22.00
720BY	35.00
721A	1.00
721B	6.75
722A	.75
723AB	7.45
724AB	.60
725A	2.75
726B	7.90
726C	8.25
730A	7.25
750TL	29.00
801A	4/$1
802	2.00
803	2.00
804	8.85
805	4.75
807	1.10
808	.85
809	3.00
810	Q
811	2.70
811A	2.85
812	3.30
812A	3.50
813	8.65
814	1.75
815	1.99
816	1.80
826	2/$1
827R	90.00
828	7.50
829B	8.00
830B	3/$1
832A	6.75
833A	45.00
836	2.00
837	1.10
838	.70
841	2/$1
843	3/$1
845	4.00
849	17.00
852	4.00
860	3.00
861	14.50
864	5/$1
865	3/$1
866A	1.45
869B	32.25
872A	.95
874	.90
875A	Q
878	2/$1
884	1.00
885	.85
889A	75.00
891R	100.00
892	100.00
923	1.35
925	1.89
927	.70
930	1.50
931A	3.50
932	1.20
945	Q
954	10/$1
955	4/$1
956	4/$1
957	5/$1
958A	2/$1
959	1.15
991	5/$1
CK1005	3/$1
CK1006	4.35
CK1007	2/$1
CK1027	2.25
CK1087	2.95
CK1089	2.40
CK1090	2.69
R1100	12.95
R1130	10.50
E1148	5/$1
1201	.95
1203	.95
1231Z	5.50
1232	.95
1237	.95
1294	.95
1608	2.50
1609	4.95
1612	1.20
1613	.89
1614	1.50
1616	.60
1619	4/$1
1620	2.00
1621	1.20
1622	1.45
1623	1.50
1624	1.00
1625	3/$1
1626	5/$1
1629	8/$1
1630	.65
1631	1.00
1632	4/$1
1633	3/$1
1634	2/$1
1635	1.50
1636	.70
1641	1.20
1642	3/$1
1644	.65
1649	2.00
1680	2.00
1850A	36.00
1851	1.95
2050	1.25
2050W	3.45
2051	.85
R4330	18.35
5514	4.50
5516	6.45
5517	.90
5528	4.00
5545	34.55
5551	20.00
5552	52.50
5553	90.00
5554	145.00
5555	140.00
5557	4.50

5558	$4.25
5559	6.75
5560	16.50
5561	29.50
5563	27.00
5575	90.00
5581	2.00
5568	52.50
5586	121.00
5590	2.76
5591	2.20
5603	5.00
5608	3.00
5618	3.25
5632	12.10
5637	2.75
5638	2.40
5639	4.00
5640	5.00
5643	3.50
5644	5.00
5646	3.00
5647	3.25
5651	1.20
5654	1.20
5656	3.50
5657	100.00
5663	1.15
5670	1.00
5672	1.25
5676	.69
5678	.79
5684	13.50
5686	1.75
5687	1.80
5691	4.50
5692	4.75
5693	3.00
5694	3.00
5697	2.25
5702	1.25
5703	.70
5703WA	4.00
5704	1.10
5713	100.00
5718	1.15
5719	1.25
5725	1.00
5726	.72
5727	.95
5744	1.25
5732	2.00
5736	115.00
5744	1.00
5750	2.00
5751	1.25
5762	95.00
5763	1.25
5769	200.00
5780	185.00
5783	2.50
5784	3.00
5787	3.00
5812	1.50
5814	.50
5820	50.00
5829	1.75
5838	7.50
5840	2.75
5841	2.50
5844	2/$1
5842	10.00
5849	.98
5851	3.80
5852	2.25
5870	1.95
5875	1.65
5879	1.20
5881	2.75
5899	3.00

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5965	.90
5977	2.00
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6012	5.25
6035	9.00
6038	8.50
6095	2.00
6116	115.00
6135	2.29
6146	4.25
6214	Q
6216	2.99
6292	25.00
6626	3.69
6627	3.99
6792	6.39
7193	20/$1
8000	9.00
8002	10.00
8005	4.45
8008	3.25
8011	1.95
8012	1.25
8013A	3.50
8019	Q
8020	1.95
8025A	2.50
9001	.65
9002	.45
9003	.95
9004	4/$1
9005	1.85
9006	5/$1
9376	Q
9903	Q

CR-TUBES

2AP1	2.00
2AP1A	5.00
3AP1A	6.50
3AP5	9.00
3BP1	1.50
3BP1A	4.50
3BP5	12.00
5ABP1	21.00
5ADP1	24.00
5ADP7	25.00
5AP1	2.95
5BP1	3.98
5BP1A	9.00
5BP4	3.00
5BP7A	25.00
5CP1	1.75
5CP1A	6.50
5CP5	12.00

5CP7	$5.05
5CP7A	6.20
5CP11A	24.00
5FP4A	3.00
5FP5	9.05
5FP7	8.00
5FP7A	10.00
5FP14A	8.00
5GP1	5.75
5HP1	3.98
5HP4	2.00
5JP1	7.00
5JP1A	14.95
5JP2	3.75
5JP5	5.00
5JP7	12.00
5JP7A	18.00
5JP11	18.00
5JP14	25.00
5LP1	12.50
5LP1A	27.50
5LP2	27.00
5LP2A	36.00
5LP4A	36.00
5LP7A	23.00
5NP1	2.95
5RP1	25.00
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5RP11A	50.00
5SP7	50.00
5SP7A	75.00
7BP1	4.25
7BP4	8.00
7BP4A	12.50
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917	1.25
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1074P11	25.00
1080P15	45.00
1123P15	45.00
1291P15	45.00
1808	9.00
1850A	36.00
2511A5	45.00
25005A5	45.00
2501A3	45.00
2523N1	45.00
1N21	6/$1
1N21A	.60
1N21B	.85
1N21C	2.45
1N23B	.69
1N23C	2.45
1N25	2.15
1N26	3.45
1N31	1.75
1N32	7.95
1N34A	.45
1N38A	.50
1N39	2.50
1N43	.65
1N44	1.00
1N45	1.00
1N48	.40
1N52	.65
1N54	.55
1N63	1.40
1N65	.85
1N67	.45
1N69	.40
1N70	.65
1N81	1.15
1N82	.60
1N90	.75
1N91	1.20
1N92	2.70
1N93	3.45
1N119	.85
1N126	.75
1N127	1.35
1N128	1.15
1N198	2.25
1N497	1.10
1N498	1.30
1N499	1.50
1N500	2.00
1N501	2.40
1N502	3.25
2N156	7.99
2N158	7.99
2N180	5.74
2N181	7.19
1N503	7.19
1N504	14.00
1N505	21.50
1N506	28.50
1N507	43.00
1N508	61.00
1N511	7.19
1N512	14.00
1N513	21.50
1N514	28.50
1N515	43.00
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1N521	21.50
1N522	28.50
1N523	43.00
1N524	61.00

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APS-15 SPARE PARTS

CU-73/APS-15A, SCS #2Z3265-73 right angle bend. E plane, 6½" x 10", with directional coupler on 6½" arm, type "N" takeoff 20 db coupling....**$12.50 each**

Z-607 Dwg. Symbol. Approx. 150 degree bend with 90 deg. twist. One end pick-up loop with press. fitting **$6.50**

Z-614; Philco 756-1142, CG124/APS-15A. Wave-selector: approx. 16" L. with 15 deg. bend at center (E-plane) 20 db coupling..........................**$12.50**

Philco 348-1425, 180 deg. bend, with pressure fitting **$4.50**

Z-609, Philco 348-1629, 13½" run, with bend & 90 deg. twist (on 3½" section)..........................**$6.75**

Z-606: 8" run with 30 deg. bend (E-plane) one end **$4.50**

Philco 348-1427 E plane bend 11" x 6½"..........**$6.50**

CGI/APS-3 Philco 358-5212, S-curve 16" L with round contact flanges..........................**$5.75**

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
5DP50 (GE)	5.6	36	645	.155	$9.47
BDAR83	14	..	375	.150	6.50
PCSX-15	14	2.8	220	.08	8.95
DM33A	28	7	540	.250	3.95
B-19	12	9.4	275	.110	5.50
			500	.050	
DA-3A*	28	10	300	.260	3.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	1000	.350	10.50
DAG-33A	18	3.2	450	.06	2.50
BDAR 93	28	3.25	375	.150	6.95

† Less Filter   * Replacement for PE 94.

PE 94, Brand New.. 5.95

INVERTERS

800-1B Input 24 vdc, 62A. Output: 115 V, 800 cy. 7A. 1 phase. Used excellent..........................$18.75

PE-218H: Input: 25/38 vdc. 92 amp. Output 115V 300/500 cy. 1500 Volt-ampere. NEW.................$32.50

PE206: Input: 28 vdc, 36 amps. Output: 80 V 800 cy. 500 volt-amp. Dim. 13 x 5½ x 10½. New......$22.50

EICOR—ML 3011-5. Input: 13.75 V; 18.4A, Output: 115V/400~, 3φ. 0.95 PF. 100 VA. New......$37.50

LELAND #10563. Input: 28 vdc/12A. Output: 115 vac/400 cycle/3 phase, 115 va. Slightly used, ex. cond. $32.00

SPECIAL VALUES!

LP-18 LOOP, manually operated, enclosed in streamlined housing $7.50

LP 24, ALFORD LOOP, originally designed for 108 mc glide path equipment. Circular radiation pattern of substantially horizontal polarization. Beamwidth approx. 2 degrees. Ideal for earth satellite tracking. **$24.00**

COAX. SLEEVE ANTENNA, Link 1509. Complete with 100 ft. coax. Sleeve is adjustable from 27" to 41"; antenna from 25" to 41"..........................$32.00

SPARK CHRONOGRAPH, L&N #5200, for ballistic measurements $17.50

Receiver front end cavity resonator: Tunes 2700 to 3400 mc with a loaded Q of 3000, 50-ohm. type N input. Video output from 1N27 crystal. May be used at quarter wave (1.1 to 1.4 kmc)..................$22.50

10 CM. ANTENNA ASSY. (Airborne), 30" dish with coax. dipole feed. Focal length is 10½" Horiz. polarization, 350 deg. azimuth. Tilt: plus and minus 20 deg. 28 vdc drive motor, selsyn takeoff........$65.00

CRYSTAL OVEN, B liley #TCO 2B. Loctal base, with provision for 2 crystals, 6.3V heater 75 deg. Cent. $2.50

COAX. SWITCH, 4 pos. 52 ohms imp. Fitted with type N connectors. Useful up to 3,000 mc..........$17.50

APT-4 Jamming transmitter. Uses 5J30 or 5J31 magnetron. Power output: 130 watts, 350-760 mc. New complete wih tubes.............................$115.00

FILTER, Artificial Line: WECO D163169, 650 ohms imp. insertion loss: 5 db..........................$32.50

Trihedral radar reflector, MK-1, aluminum......$3.50

SPLICER, for 11/16 perforator tape. WECO #X-61859 list 20 SCS #4TW 61859-20. Complete set, with number tape dispenser..............................$8.50

MN 28Y Control box, unit of MN 26 compass. New.$3.75

Noise filters, Mallory NF-1, 100 amp/35vdc......$1.00

Power supply unit, navy-type—EL-2, Input: 115 vac. 60 cy. Output: 135 vdc/10 ma. 90 vdc/5ma; 3 vdc/360 ma. New, complete with spare parts box. To be used with model TBX radio gear.........................$9.50

BC 602 Control box for SCR 522 (pushbutton)....$3.75

24-Volt Transformer. Input 115v/60 cy. Output 24v/3A $1.79

Phase shifter. Helmholz type 0-360 deg..........$2.50

Capacitor, oil-filled, 0.25 mfd./25.000 volts dc.....$15

Hydrophone. MODEL MI-2. A lattice of 3 crystals in a disk-like structure: 17-37 Kc......................$27.50

TEL. REPEATER, EE 89, complete with tubes and tech. manual $17.50

TEL. REPEATER, EE 99, with 12 vdc. vibrator power supply (PE 204) $24.50

F.T.&R. 101-A. Two-wire applique, contains equalizing devices, and balancing circuit. Used for adapting 2-wire military circuits to 4-wire systems.......$47.50

Butterfly tank unit: Tunes 60-300 mc. Ideal for frequency meter, grid-dipper, signal source etc. New complete with acorn tube socket..............$5.75

WAVEGUIDE FLANGES

UG 39/U	$1.20	UG 51/U	$1.85
UG 40/U	$1.65	UG 52/U	$3.40
UG 40A/U	$2.00	UG 52A/U	$3.40

"K-BAND" WAVEGUIDE

Right Angle Bend E or H Plane, specify combination of couplings desired..........................$12.00

Mitred Elbow, cover to cover......................$4.00

TR-ATR-Section Choke to cover....................$4.00

Flexible Section 1" choke to choke...............$5.00

"S" Curve Choke to cover.........................$4.50

PULSE NETWORKS

H-616 10KV, 2.2 usec., 375 PPS, 50 ohms imp..$22.50

H-615 10KV, 0.85 usec., 750 PPS, 50 ohms imp..$22.50

H-605: 25 KV, "E" CKT. 1.5 usec. 400 PPS. 50 Ohms Impedance. 5 sections..........................$62.50

7-5E3-1-200-67P. 7.5 KV "E" Circuit. I microsec. 200 PPS, 67 ohms impedance 3 sections............$7.50

7-5E4-16-60, 67P, 7.5 KV "E" Circuit. 4 sections 16 microsec. 60 PPS, 67 ohms impedance.........$15.00

7-5E3-3-200-67P. 7.5 KV. "E" Circuit, 3 microsec. 200 PPS, ohms imp. 3 sections.................$12.50

G.E. 6E3-.5-2000 50 P2T: 6 KV., "E" Circuit 0.5 usec /2000 PPS/50 ohms/2 sections $6.00

G.E. #3E (3-84-810) (8-2.24-405) 50P4T: 3KV "E" CKT Dual Unit; Unit 1, 3 sections, 0.84 Microsec. 810 PPS, 50 ohms imp.; Unit 2, 8 Sections 2.24 microsec. 405 PPS, 50 ohms imp.................$6.50

TEST EQUIPMENT

TS-12/AP. Slotted line test set. Made of RG 52/U plumbing, and supplied as 2 major units: Unit 1 is a high gain, dual channel amplifier with a low impedance input. The output is a 3-inch meter which reads SWR directly. The amplifier operates from 115v, 60-400 cycles. Unit II is a small transportable carrying case containing the following waveguide components: (RG52/U) lea slotted line and probe: one MX 158/U spare carriage and probe: two UG81/U waveguide-to-type "N"-transition: two UG80/U transition from RG52 to RG51 waveguide: one UG79/U. transition, waveguide to type N: one CG88/U resistive termination: one CG90/U extension. Also included in the waveguide set are waveguide stands, cables, hardware, crystals. Frequency range: 8700 to 10,500 mc. Price..............$95.00

P4E Synchroscope: 4 mc. bandwidth with a gain of 100. 5-inch display, includes 2-stage video amplifier. Writing speeds 0.04/0.166/0.5/2 in per microsec*...$75.00

TS/28/UPM Synchroscope. Uses 5CP1 tube and may be used as a regular scope with repetitive sweeps. Signal gain is 100 with a bandwidth of 5mc. Triggered sweeps range from 1 to 6 micro-sec. per inch*.$135.00

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P.P.I. REMOTE REPEATERS

VD 7" Upright
VE-7" Table Type
VF-5" "B" Scope "5" P.P.I.
VG-24" Plotting Table
VJ-12" Upright
VK-12" Upright
VL-12" Upright R.H.I. IND.
All indicators are 110v 60 cyc.

RDO & APR-4

SEARCH RECEIVERS

The RDO is a very elaborate radar search receiver greatly improved over the APR-4. The set uses APR-4 tuning units, but is much more versatile, having input metering, D.B. output meter, automatic noise limiter and greater selectivity and sensitivity. The RDO is recommended when only the very best will do. Input 110/60 cys.

BC-342 BC-312

1.5-18MC Communication Receivers. The BC-312 Operates From 12V D.C. The BC-342 From 110V 60 Cyc. These Sets Incorporate a Crystal Filter B.F.O. Antenna Tuner Etc. We Can Supply These Receivers in Large Quantities.

SCR-536 HANDI-TALKIE

3-6 MC Hand Held Trans-Rec. with range of approx. 1 mile. This set is comp. self contained, Inc. Batteries. We can supply these sets in large quantities tested.

SHORAN

AN/APN-3-AN/CPN-2

The AN/APN-3 and AN-CPN-2 are Precision distance measuring installations. This equipment operates on 225 mc. The range is 250 miles with an accuracy of 25 feet. This equipment is widely used by geological companies for prospecting and mapping. Power input is 110v 400 cyc and 28v DC.

MAR POINT TO POINT RADIO SET

Portable 225-398 mc point to point 10 chan. crystal controlled voice and new radio set. This is a very late radio set used for point to point and ground to air communication. The transmitter output is 8 watts on 10 pre-set crystal controlled channels instantly selected by a band switch. The REC is also crys. controlled on the trans. freq. The set is inclosed in 3 water proof shock proof cabinets that may be set up in a few minutes on location. This equipment is ideal where a reliable radio link easily transported is needed. Power Input is either 24 VDC 115/230V AC or DC. Complete sets avail. Write

AN/PRC-6

47-55 MC HANDI-TALKIE

This is the Standard MIL. F.M. Handi-Talkie With a Range of About 1 Mile. The Set Operates From Batteries With an Output of .25 Watts. the Set is Self Contained With Its Own Antenna. Weight is Approx. 6 Lbs. The Set is Crystal Controlled and Will operate with PRC, SCR 508, 608 SCR-300 Etc. Quantities Avail.

AN/TRC-1-3-4

100 MC RADIO-RELAY EQUIPMENT

The AN/TRC series is a mobile portable set for duplex or simplex radio telephone point to point communication. This set will operate with the CF series carrier systems to provide multi channel operation. The TRC operates on 100 MC with an output of 10-50 watts. The set is crystal controlled. Complete sets avail. Input 110v 60 cyc.

SCR-399-499

Mobile and fixed station high power radio sets; the SCR-399 is mounted in a HO-17 shelter. The SCR-499 is transported in carrying cases to be set up for field operation. Freq. of the sets Is 2-18 mc. pwr output is 350w. Phone and C.W. 2 communication receivers are provided. Input is 110v 60 cys.

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SOLA 30710—PRI: 95-125/190-250v. 50/60 cy. SEC: 115v. 1% Regulation 2000va. Our Price $125.00

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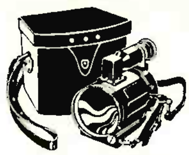
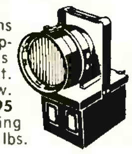
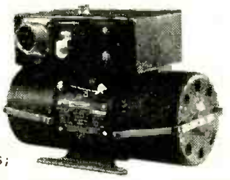
INFRA RED SNOOPERSCOPE





High quality now at surplus prices. Eastman Kodak Infra-Red SNOOPERSCOPE Receiver, Type 8, 7" long with 5" SCHMIDT ultra-high-speed Objective Lens (approx. f 0.5). Elaborate optical system, many coated lenses Uses 2 penlight batteries. Govt. cost approx. $300. Factory-new. Shipping wt. 9 lbs. Price **$19.95**
Waterproof Snooperscope Carrying Case, extra. Shipping wt. 3 lbs. Price **$3.00**
Dual purpose U.S.N. floodlight throws strong beam of invisible infra-red rays. With infra-red lens, spare sealed beam lamp, batteries. Shipping wt. 23 lbs. Price **$14.95**

INVERTERS

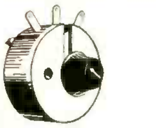


10042-1-A Bendix
DC Input 14 volts;
Output: 115 volts;
400 cycles. 1-phase; 50 watt **$35.00**
12116-2-A Bendix
Output: 115 VAC; 400 cyc; single phase; .45 amp. Input: 24 VDC, 5 amps **$25.00**
12117 Bendix
Output: 6 volts; 400 cycles, 6 volt amperes, 1 phase. Input: 24 VDC; 1 amp. **$15.00**
12121 Bendix
Input: 24 volt D.C. 18 amp. 12000 r.p.m. Output: 115 volts, 400 cycle, 3-phase. 250 volt amp, 7 pf. **$49.50**
12123 Bendix
Output: 115 V; 3 phase; 400 cycle; amps. .5; Input: 24 VDC; 12 amp. **$49.50**
12126-2-A Bendix
Output: 26 volts; 3 phase; 400 cycle; 10 VA; 6 PF. Input: 27.5 volts DC; 1.25 amps. **$24.50**
12142-1-A Bendix
Output: 115 volts, 3 phase, 400 cycle, 250 VA. Input: 27.5 VDC, 22 amps. Voltage and frequency regulated. **$99.50**
12147-1 Pioneer
Output: 115 VAC, 400 cycles; single phase. Input: 24-30 VDC; 8 amps. **$19.95 each**
10285 Leland
Output: 115 volts AC; 750 VA, 3 phase, 400 cycle, .90 pf and 26 volts. 50 VA single phase, 400 cycle, .40 pf. Input: 27.5 VDC, 60 amps. cont. duty, 6000 rpm. Voltage and frequency regulated. **$59.50**
10563 Leland
Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 pf. Input: 28.5 VAC; 12 amps. **$25.00**
F16 Jack & Heintz
Output: 115 volts, 400 cycle, 1 or 3 phase, 250 VA pf. 9. Input: 27.5 volts, 20 amp. Electronic frequency and voltage regulated. **$99.50 each**
PE109 Leland
Output: 115 VAC, 400 cyc.; single phase; 1.53 amp.; 8000 rpm. Input: 13.5 VDC; 29 amp. **$50 00**
PE218 Leland
Output: 115 VAC; single phase pf. 90; 380/500 cycle; 1500 VA. Input: 25-28 VDC; 92 amps.; 8000 rpm.; Exc. Volts 27.5 BRAND NEW **$30.00**
AN 3499 Eicor, Class "A"
Input: 27.5 volts at 9.2 amps. AC. Output: 115 volts, 400 cycles; 3 phase, 100 voltamp; continuous duty. **Price $39.50 each**

MG54D BENDIX INVERTER

Output: 200/115 volts; 400 cycle, single or 3 phase; .80 pf, 250 VA. Input: 28 VDC, 22 amps. **$99.50**

POWER RHEOSTATS

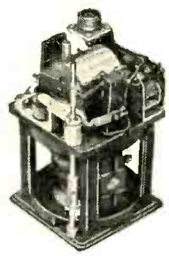


Standard Brands: 5 ohms; 100 watt; 4.48 amps. 100 ohms; 100 watt; 1.0 amp. Boxed, brand new with knob. **$2.50 each or $25.00 per doz.**

MINNEAPOLIS-HONEYWELL RATE GYRO (Control Flight)

Part no. JG7005A-11 series 9. 115 volts A.C., 400 cycle, single phase. Potentiometer take off resistance 530 ohms. Speed 21,000 r.p.m. Angular momentum 2½ million, CM²/sec. Weight 2 lbs. Dimensions 4-7/32 x 3-29/32 x 3-31/64.
Price **$22.50** each

SCHWEIN REMOTE CONTROL DUAL GYRO

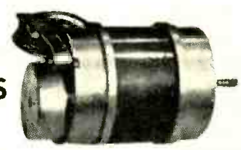


Type 45600 Free & Rate Gyro. Contains two 28 VDC constant speed gyros . . . vertical and horizontal. Both gyros exceed 30,000 RPM. Size: 8" x 4½" x 4½". Complete with metal cover. **$22.50 ea.**

400 CYCLE GENERATOR

Self-excited, AC/DC, mfgd. by Homelite, Model 18A120-D-28-1. Output 115 volts, 400 cycle, single phase, 39 amps and 28 volts D.C. at 17.9 amps at 4,000 r.p.m.
Price **$100.00** each

SELSYNS-SYNCHROS



1CT cont. Trans 90/55V 60 cy.	$37.50
1DG Diff. Gen. 90/90V 60 cy.	37.50
1F Syn. Mtr. 115/90V 60 cy.	37.50
1G Gen. 115V 60 cy.	37.50
1SF Syn. Mtr. 115/90V 400 cy.	12.50
2J1F1 Gen. 115/57.5V 400 cy.	7.50
2J1F3 Gen. 115/57.5V 400 cy.	10.00
2J1FA1 Gen. 115/57.5V 400 cy.	7.50
2J1G1 57.5/57.5V 400 cy.	5.00
2J1H1 Diff. Gen. 57.5V 400 cy.	7 50
2J5D1 Cont. Trans. 105/55V 60 cy.	17.50
2J5F1 Cont. Trans. 105/55V 60 cy.	17.50
2J5H1 Gen. 115/105V 60 cy.	17.50
2J15M1 Gen. 115/57.5V 400 cy.	17.50
5CT Cont. Trans. 90/55V 60 cy.	34.50
5D Diff. Mtr. 90/90V 60 cy.	34.50
5DG Diff. Gen. 90/90V 60 cy.	34.50
5F Syn. Mtr. 115/90VAC 60 cy.	34.50
5G Syn. Gen. 115/90VAC 60 cy.	34.50
5HCT Cont. Trans. 90/55V 60 cy.	42.50
5SDG Diff. Gen. 90/90V 400 cy.	12.50
6DG Diff. Gen. 90/90V 60 cy.	25.00
6G Syn. Gen. 115/90VAC 60 cy.	34.50
7G Syn. Gen. 115/90VAC 60 cy.	42.50
R110-2A Kearfott Cont. Mtr. 115V 400 cy.	17.50
R200-A Kearfott Cont. Trans. 26/11.8V 400 cy.	15.00
R210-1-A Kearfott Trans. 26/11.8V 400 cy.	20.00
R220-T-A Kearfott Receiver 26/11.8V 400 cy.	20.00
R235-1A Kearfott Resolver 26/11.8V 400 cy.	22.50
C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
C78249 Syn. Diff. 115V 60 cy.	5.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 22V 60 cy.	7.50
403 Kollsman Autosyn. Mtr. 32V 60 cy.	7.50
FPE-25-11 Diehl Servo Mfr. 75/115V 60 cy.	19.50
FPE-43-1 Resolver 400 cy.	25.00
FJE-43-9 Resolver 115V 400 cy.	19.50
999-0411 Kollsman 26V 400 cy.	15.00
13770410 Kollsman 26V 400 cy.	10.00
15158-0410 Kollsman 26V 400 cy.	20.00
10047-2A Bendix 26V 400 cy.	12.50
2900 Transicoil 115V 400 cy.	15.00
15CX4a Synchro Transmitter MK 22 MOD 1	15.00 ea.

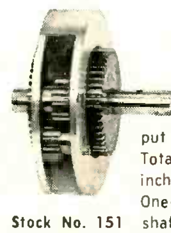
DIFFERENTIAL

Size 2-11/16" long 1-11/16" dia. 1-1 reverse ratio. ¼" shaft on each end; one shaft 25/32" long, one shaft 15/32" long. Input and output gear 1-23/32" dia. 53 teeth.

Stock No. 150

$3.50 ea.

SIMPLE DIFFERENTIAL



1 to 1 reverse ratio; 48 teeth on input and output gear, 1-1/32 inch diameter. Total outside diameter 1-25/32 inches. Shaft size is ¼ inch. One shaft is 9/16" long; other shaft is 3/16" long. **$5.00**

Stock No. 151

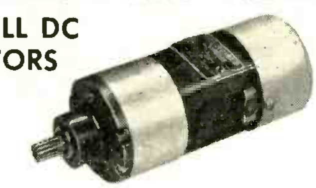
BALL DISC INTEGRATOR

Forward & Reverse 2¼-0-2¼. Input shaft spline gear 12 teeth 9/32" dia. ⅜" long. Output shaft 15/64" dia. x 15/32" long. Control shaft 11/32" x ⅜" long. Cast aluminum construction. Approx. size 3" x 3" x 2¾".

No. 145 $17.50 ea.

(All Shafts Ball Bearing Supported)

SMALL DC MOTORS



(approx. size overall 3¾" x 1¼" dia.:)

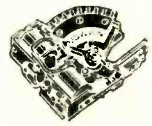
5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled	$15.00 ea.
5069600 Delco PM 27.5 VDC 250 rpm	12.50
5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w. brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled	15.00 ea.
58A10A118 GE 24 VDC 110 rpm	10.00
58A10AJ37 GE 27 VDC 250 rpm reversible	10.00
58A10AJ52 27 VDC 145 rpm reversible	12.50
5BA10AJ50, G.E., 12 VDC, 140 rpm	15.00
206-1001 PM Planetary Gear Reduced Motor with Magnetic Brake. Mfgd. by Air Equipment 26 volts 600 ma 145 rpm	17.50
58A10FJ33, G.E., 12 VDC, 56 rpm reversible	15.00
806069 Oster series reversible 1/50 h.p. 10,000 rpm. 27.5 VDC 1⅝" x 3½"	5.00
C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm	3.00
7100-8-PM Hansen 24 VDC 160 rpm	7.50
SSFD-6-1 Diehl PM 27.5 VDC 10,000 rpm	4.00
6-volt PM motor mfgd. by Hansen 5,000 rpm 1¼" in dia., 2" long overall	4.00

LARGEST STOCK OF RELAYS IN THE WORLD

STEPPING SWITCHES

PRODUCTION QUANTITIES • MOST MAKES IN STOCK

SS5



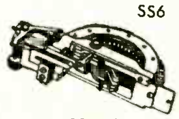
Step & Reset

Minor Switch 10 steps and off. Contacts: Nos. R960, 975, 976 Gold plated brass; Bridging wiper; Others—beryllium-copper, Nonbridging wiper; 2 coils, step and reset; Net Wt: 1 lb.

Volts—DC	1 level Stk#	1 level Price*	2 level Stk#	2 level Price*	3 level Stk#	3 level Price*
6- 12	R960	9.50	R977	10.50	R642	11.50
24- 36	R975	10.50	R978	11.50	R600	12.50
48- 60	R976	11.50	R979	12.50	R645	13.50
100-125	R643	12.50	R644	13.50	R646	14.50

Off-normal springs; 1A, 1B; #ONS1 .... 1.00 extra
(Please specify if required)

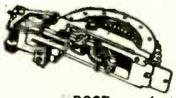
SS6



Mfd. by Western Electric; 22 step; 5 levels; Bridging wipers; Contacts: Gold plated brass. Interrupter Switch: 1 Break-Make; Net Weight: 2 lb 2 oz. "Homing" type; 180° wipers; Step in one direction. Single coil.

#R926;	6 to 12 VDC	ea. 13.75*
#R980;	24 to 36 VDC	ea. 14.75*
#R981;	48 to 60 VDC	ea. 15.75*
#R615;	100 to 125 VDC	ea. 16.75*

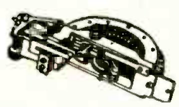
SS7



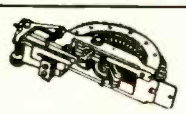
Mfd. by Western Electric; 44 step; 2 circuits; Bridging Wipers; Contacts: Gold plated brass; Interrupter switch: 1 break-mate; Net weight: 1 lb 14 oz; "Homing" type; 360° wipers; Single coil; Step in one direction.

#R927;	6 to 12 VDC	ea. 13.75*
#R982;	24 to 36 VDC	ea. 14.75*
#R983;	48 to 60 VDC	ea. 15.75*
#R616;	100 to 125 VDC	ea. 16.75*

AUTOMATIC ELECTRIC TYPE 44: Single coil; step in one direction; 11 position; 120° wipers; 4 levels, 1 bridging, 3 non-bridging; 1C interrupter switch; 1A, 1C, off-normal springs:



#R1650 6-12VDC	20.50	#R1652 48-60VDC	22.00
#R1651 24-36VDC	21.25	#1653 100-110VDC	22.25



AUTOMATIC ELECTRIC TYPE 13: Homing type; single coil, step in one direction; 25 position; 180° wipers; 1b interrupter spring. All units have 1 bridging wiper, remaining non-bridging.

Volts DC	2 level		3 level		4 level		6 level	
6- 12 V	#R1654	22.25	#R886	23.25	#R1659	24.25	#R888	25.25
24- 36 V	#R1655	23.00	#R900	24.00	#R1660	25.00	#R889	26.00
48- 60 V	#R1656	23.75	#R887	24.75	#R1661	25.75	#R890	26.75
100-115 V	#R1657	24.50	#R1658	25.50	#R1662	26.50	#R1663	27.50

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Prices listed with asterisk (*) are subject to QUANTITY DISCOUNTS

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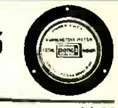
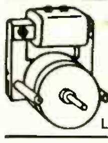
3" Round Elapsed Time Meter $12.75



WESTON PHOTRONIC CELL............$4.50

PHOTO ELECTRIC Switch
Darkness throws the switch —turns light on at dusk . . . off at dawn. Fools burglars who watch for signs of an empty house. $10.94



TELECHRON Motors

1 RPM	$3.95	3.6 RPM	$3.15
2 RPM	2.90	60 RPM	4.85
3 RPM	3.90	3 RPHr	2.85
4 RPM	3.90	1 RP 2Hr.	2.80
		1 RP 12Hr.	3.25

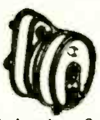
1 RPM—50 Cycles, $1.85
Laboratory Special 1 of Each Motor $25

D-E-L-A-Y-E-D A-C-T-I-O-N LIGHT SWITCH
Shuts light off automatically almost a minute later. Keeps porch or garage light on after you shut it off. $3.50

DEALERS WRITE FOR PRICES

6 Watt Most POWERFUL TELECHRON MOTOR
110 V. 60 Cy
1 RPM 6.50

HAYDON TIMING MOTORS



1 REV 4 Hours	$1.70
1 RPM 230v 60cy	1.00
1 RPM 110v 60cy	2.60
2 RPM 230v 60cy	1.00
30 RPM 110v 60cy	2.60
450 RPM, yes 450 RPM	1.30
HANSEN Synchron 4 RPM	4.24
CRAMER 4 RPM	4.65
Laboratory Special 1 of Each Motor	$15

RELAY CONTACT BURNISHERS .59—2 for $1.00

PM MOTORS
Made by DELCO or DIEHL $3.75
Removed from equipment

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SOLA CONSTANT-VOLTAGE TRANSFORMER

Ends fluctuating line voltage!

Big Discount Off . . .
the factory price at a 1-input 2,000 VA unit! And here's another bonus! This Air Forces 2,000 VA overstock, Sola Cat. No. 30768, has 4 inputs! 90-125 V., 190-250 V., 60 cy. or 50 cy. Isolated secondary is constant 115.0 V. ± 1% from no-load to full-load at 17.4 amp. So, if you choose, use it as a 220:115 V. step-down. And slash $97.50 off the factory 1-input price! Brand new in original wood box. 4 cu. ft. Ship. wt. 254 lbs. F. O. B. Pasco, Wash. Only... **$147.50**

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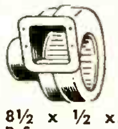
CENTRIFUGAL BLOWERS

FOR VENTILATION, AIR SUPPLY, HEAT FLUSHING

100 C.F.M.—3" DIA. ROTOR

ROTOR: 3" x 2"
HOUSING: Steel. 4" dia. discharge flange. 3" inlet, 2" outlet.
MOTOR: AC, 60 cyc. 115 volt, 3000 rpm enclosed, continuous duty. OVERALL: 6 x 6 x 6 No. BL 100 HS............ $8.95

275 C.F.M.—5¼" DIA. ROTOR



ROTOR: 5¼" x 3"
HOUSING: Steel. 4¾" sq. discharge flange. 5¼" inlet, 3½" sq. outlet. MOTOR: AC, 60 cyc, 115 volt, 1550 rpm. Continuous duty. OVERALL: 8½ x ½ x 7 No. BL 275-R-S $14.95

ORDER NOW—WHILE STOCKS LAST—PROMPT SHIPMENT

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Good USED Equipment

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GENERAL RADIO GR 1533A High Speed Motion Picture Strobe Light. With or without camera. POR

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TS-352TU	135.00
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100D	$ 350.00
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803A	325.00

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APR-4	700.00
APR-5	250.00
APR-10	300.00

3C-49A Target Scoring Set . . . POR EE-1A Elect. Equip. Test Set. POR GERTSCH

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I-208	70.00
IE-19	250.00
ME-51U	175.00

SPERRY GYROSCOPE Remote Flight Control Line Analyzer . . . POR

URM-15	500.00
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Note: All above test equipment can be certified to meet original specs.

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ART-13A 10/20/40 Channels
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BC-348
CRT-3 Gibson Girl
ILS System
MN-20
MN-26
MN-31C
MN-36
MN-60B
MN-62A
MR-39B
RTA-1B
SCR-522
SCR-578 (Gibson Girl)
SCR-718ABC
51R3 OMNI Rec.
17L3 VHF Xmtr

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3EP1	1.25	7CP1	2.00
5BP1A	8.50	9LP7	10.00
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2J29	25.00	4J52	50.00
2J31	12.25	4J58	125.00
2J32	9.50	4J64	40.00
2J33	28.50	5J23	75.00
2J34	10.00	QK60	19.50
2J37	28.50	QK62	19.59
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500-2E29	300-6SK7GTY	260-374A	3000-957
100-2G21	350-6SK7W	100-381A	2000-1625
300-3AP1	200-6SK7Y	250-387A	300-2050W
50-3C22	600-6Y6G	500-407A	30-5559
200-3C45	300-7CP1	300-408A	300-5702WA
700-3FP7	800-12AT7WA	250-417A	100-5703WA
500-NS4	1000-12C8	100-703A	2000-5718
500-NS5	100-12H6	400-CK-705	300-571C
100-4X150A	600-12SH7	20-714AY	300-5763
300-C5B	400-14J7	400-715B	5000-5814
700-6AB7	400-HR-24	100-723A/B	500-5886
1000-6AC7	100-15E	1000-815	100-5993
100-6AT6	600-15R	200-726C	200-5915
300-6AU6WA	100-VT-158	300-838W	2000-6045
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5635	4.00	5718	1.75	5963	1.25
5636	2.40	5719	1.40	5967	9.50
5637	3.00	5744	1.00	5969	9.50
5639	5.75	5751	2.00	5992	6.75
5641	4.00	5763	.90	5993/TE-10	8.00
5643	3.85	5783	3.75	5995	9.75
5644	5.00	5784	4.00	6000	2.00
5645	4.75	5784WA	6.00	NL710/6011	12.00
5646	3.75	5787	3.75	6021	3.00
5747	3.75	5787WA	4.75	6073	1.50
5651	1.25	5814	.40	6080	3.50
5651WA	3.25	5814A	1.50	6111	3.75
5654/6AK5W	1.25	5814WA	3.00	6112	4.00
		5829WA	3.50	6130	4.50
5654/6AK5W /6096	2.75	5840	3.00	6201/12AT7WA	2.50
5663	.95	5840A	4.25	6211	1.00
5670	1.95	5844	1.40	6263	9.50
5670WA	4.00	5854	1.30	6280/416B	35.00
5691	4.75	5886	3.00	6524	11.00
5692	5.00	5894	17.00	8012	1.00
		5896	3.00		
		5898	7.50		
5696	.75	5899	3.25	9002	.45
5702WA	3.85	5902	4.00	9003	.90

RECTIFIERS & REGULATORS

OB2	$ .50	3B26	$92.50	371B	$2.50
OB2WA	2.25	3B28	4.00	575A	10.00
OB3	.90	3B29	4.75	583	5.00
OC3	.50	5R4GY	1.25	869B	30.00
OC3W	2.25	5Y3WGT	1.30	705A	.65
OD3	.50	5X3	2.20	836	1.20
OD3W	2.25	249B	2.50	872A	1.00
1V	.90	249C	2.50	876	.75
		250R	3.95	878	.50
2C53	9.00	267B	4.95	VXR2700	6.00
RX-21	4.50	313C	2.25	991	.32
3B24W	4.25	314A	80.00	5931/5U4WG	4.00
3B24WA	7.00	371A	1.00	8013	3.00

KLYSTRONS

1K015XA/X481		2K55	$14.00	707B	$1.75
B,C,D	$40.00	3K30	90.00	723A/B	6.50
SRX16	100.00	6BL6	24.00	726A	4.75
2K25	10.00			726C.WE	18.00
		6BM6	27.50	726C.RAY	11.50
2K28	24.00				
2K45	25.00	6BM6A	28.50	5611	40.00
2K48	45.00	WL417A	2.00	5981/5650	45.00
2K54	14.00	QK405	48.00	6116	45.00

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C1K	$6.50	FG105	$11.00	NL1051FG-271/5551	$50.00
1C	1.00	FG154	9.00		
2D21W	.80	VT-158	9.00	NL1052/5552/FG235A	82.00
3C45	5.00	FG-271	22.00		
4B25	5.00	323B	3.45	2050W	3.50
C5B	1.00	354A	8.00	5559/FG57	8.00
EL5B	5.00	393A	3.35	5560/FG-95	17.00
				5796	7.00
5C22	20.00	394AWE	3.00	5948/1754	100.00
C6M/5528	5.00	KU-627	7.00	5966/E36	33.50
FG-32	4.00	WL653B	75.00	6130	4.50

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OA3/VR75	.85	5JP7A	25.00	274B	.75	885	.75	5798	10.00
OB2	.50	5JP11A	8.50	275A	4.00	889RA	100.00	5800	6.00
OB2WA	2.00	5LP1	12.50	276A	10.00	902	2.00	5801	3.50
OB3/VR90	.85	5LP2A	5.00	279A	150.00	917	1.35	5803	3.00
OC3/VR105	.55	5R4GY	1.20	282A	2.00	918	1.00	5814A	1.50
OC3W	2.25	5R4WGY	3.00	282B	2.50	920	2.75	5814WA	2.75
OD3/VR150	.50	5RP1A	7.50	285A	4.50	923	1.75	5819	30.00
OD3W	2.25	5RP11A	50.00	286A	3.25	927	1.00	5820	400.00
1AD4	1.00	5X3	2.00	287A	2.25	928	2.75	5822	50.00
1B24	5.00	5Y3WGT	1.25	293A	7.00	929	1.25	5824	2.00
1B27	7.50	5Y3WGTB	3.25	300A	8.00	931A	3.50	5827	3.50
1B35A	6.50	6AC7W	.60	300B	8.00	959	1.15	5828	6.00
1B45	17.50	6AG5WA	2.25	301A	7.50	CK-1006	3.00	5829	.80
1B53	17.50	WE-6AK5	1.25	304TH	17.50	1237	2.85	5829WA	2.50
1B63A	16.00	6AK5W	1.00	304TL	17.50	HY-1269	2.50	5830/FG41	85.00
EL-C1K	6.00	6AL5W	1.00	307A	.75	1603	4.00	5838	7.50
1P21	30.00	6AN5	2.10	309A	10.00	1614	1.75	5839	4.50
1P22	4.00	6AN5WA	4.25	310A	3.50	1620	3.50	5840	2.85
1P25A	12.50	6AQ5W	1.65	310B	10.00	1624	1.25	5841	4.00
1P28	12.50	6AR6	1.20	311A	4.50	1846	50.00	5842/417A	12.00
1P29	1.85	6AS6	1.25	313C	2.00	2050	1.25	5847/404A	13.50
2AP1	1.90	6AS6W	2.00	313CA	2.00	2050W	2.25	5852	2.50
2AP1A	2.85	6AS7G	2.25	323A	7.50	5528/C6L	5.00	5854	.75
2B22	3.00	6AU6WA	2.00	323B	2.50	5545	30.00	5876	5.00
2B23	15.00	6BA6W	1.00	328A	3.25	5550/415	32.50	5879	1.25
2BP1	3.50	6BE6W	2.00	329A	7.50	5553/FG258A	75.00	5881/6L6WGB	3.00
2C36	35.00	6BL6	25.00	336A	2.50	5557/FG17	4.50	5886	2.75
2C39	4.00	6BM6	25.00	337A	6.00	5558/FG32	4.50	5894	16.00
2C39A	10.00	6C4WA	3.00	339A	10.00	5559/FG57	5.75	5899	3.25
2C40	6.00	6C21	12.50	347A	3.50	5560/FG95	15.00	5902	3.75
2C43	7.50	6D4	1.50	348A	4.00	5561/FG104	30.00	5902A	5.00
2C50	5.00	EL-C6J	10.00	349A	4.00	5584	3.00	5910	.50
2C51	2.85	6J4	1.00	350A	3.00	5591/403B	2.50	5915	.50
2C52	2.50	6J4WA	1.75	350B	2.00	5610	1.00	5931	3.75
2C53	9.75	6J6W	.75	354A	7.50	5632/C3J	7.50	5932/6L6WGA	3.00
2D21	.75	6J6WA	2.00	355A	10.00	5633	4.00	5933	1.50
2D21W	.95	6K4	2.00	375A	9.50	5634	5.00	5933WA	7.50
2E24	1.90	6K4A	2.50	393A	5.50	5635	4.00	5948/1754	100.00
2E26	3.00	6L6WGA	3.00	394A	3.00	5636	2.25	5949/1907	75.00
2J51	150.00	6L6WGB	3.00	396A	2.85	5636A	3.00	5962/BS101	3.50
2K25	10.00	6Q5G	2.75	400A	5.00	5637	3.00	5963	1.25
2K26	38.75	6SK7WA	1.50	403A	1.25	5638	2.50	5964	1.00
2K29	30.00	6SL7WGT	1.00	403B	2.50	5639	5.00	5965	1.00
2K30	50.00	6SN7WGT	.75	404A	13.50	5639A	5.50	5975	2.50
2K33A	100.00	6SN7WGTA	3.50	407A	2.25	5640	5.00	5977	2.50
2K34	95.00	6X4WA	2.75	408A	2.00	5641	3.75	5979/BS1	7.50
2K35	150.00	6X5WGT	1.50	409A	4.00	5642	1.10	5980/BS2	3.50
2K41	95.00	7MP7	15.00	416B	30.00	5643	3.50	5981/5650	40.00
2K45	30.00	7YP2	50.00	417A	12.00	5644	5.00	5987	8.50
2K47	100.00	12AT7WA	2.50	418A	17.50	5645	4.00	5992	6.00
2K48	35.00	12AU7WA	2.50	420A	8.50	5646	2.50	5993	6.00
2K50	125.00	12AX7W	1.85	421A	4.00	5647	3.00	5998/421A	3.50
2X2A	.75	12SX7GT	1.50	422A	6.00	5650	40.00	6005/6AQ5W	1.65
3AP1	1.50	12SY7	1.60	429A	10.00	5651	1.00	6005/6AQ5W/6095	3.50
3AP11A	3.50	FG-17	4.50	450TH	35.00	5651WA	2.75	6012	3.50
3B22	1.50	HK-24	1.50	450TL	40.00	5654/6AK5W	1.20	6014/C1K	6.00
3B24	.50	HK-24G	3.00	464A	1.00	5654/6AK5W/6096	2.20	6021A	4.00
3B24W	4.00	25T	5.00	CK-503AX	.75	5656	3.75	6028/408A	2.00
3B25	5.00	25Z6WGT	3.25	CK-510AX	1.00	5663	.50	6037	30.00
3B26	2.50	26Z5W	2.50	GL-575A	12.00	5667	125.00	6038	7.50
3B28	3.75	FG-27A	20.00	631-P1	5.00	5670	2.00	6045	1.50
3B29	4.50	VX-33A	3.00	673	12.00	5670WA	3.50	6073	1.25
3BP1	2.00	35T	5.00	677	27.50	5672	1.00	6080	3.25
3C22	45.00	35TG	2.50	678	40.00	5675	8.00	6080WA	5.25
3C23	4.25	VX-55	3.00	701A	2.00	5676	.75	6087	4.00
3C24/24G	3.00	FG-57	5.50	715B	2.50	5678	.65	6095	1.50
3C30	2.50	RK-61	2.75	715C	10.00	5684/C3J/A	9.50	6096	1.25
3C31/C1B	2.50	RK-65/5D23	7.75	719A	10.00	5685	10.00	6098/6AR6WA	6.00
3C33	5.00	FG-67	6.00	721B	6.50	5686	2.00	6100/6C4WA	3.00
3C45	5.00	HY-69	2.50	723A/B	6.00	5687	2.25	6101/6J6WA	2.00
3D22	9.50	HY-75	2.00	725A	2.00	5687WA	5.00	6109	3.00
3E22	5.00	FG-81A	5.00	726A	3.50	5691	4.50	6111	3.75
3E29	8.00	FG-95	12.50	726B	7.50	5692	4.75	6112	4.00
3GP1	2.00	100TH	6.00	726C	10.00	5693	3.50	6130/3C45	4.00
EL-C3J	7.50	101F	2.50	750TL	35.00	5702	1.25	6135	1.85
EL-C3J/A	9.50	102L	2.50	802	2.50	5702WA	3.50	6136/6AU6WA	2.00
3J21	15.00	FG-104	30.00	804	7.50	5703	.75	6137	2.00
3J31	25.00	FG-106	10.50	805	2.50	5703WA	3.50	6146	4.35
3KP1	8.50	121A	2.50	807	1.25	5704	1.15	6186/6AG5WA	2.00
3X2500A3	150.00	FG-172	12.50	807W	1.15	5719	1.30	6189/12AU7WA	2.50
4-65A	12.85	HF-200	10.00	809	3.00	5719A	2.00	6199	28.00
4C27	10.00	203A	2.50	810	12.50	5720/FG33	17.50	6201/12AT7WA	2.50
4C33	125.00	242C	10.00	811	2.85	5725/6AS6W	2.00	6263	9.50
4C35	15.00	244A	3.50	813	8.75	5726/6AL5W	1.00	6264	7.50
4E27	7.50	245A	5.00	814	1.50	5727/2D21W	1.25	6280/416B	35.00
4J45	50.00	249B	3.00	815	1.85	5728/FG67	6.00	6352	4.85
4J46	50.00	249C	3.50	828	9.00	5734	14.75	6463	1.85
4J47	50.00	250R	5.00	829B	8.50	5744WA	4.00	6626/OA2WA	2.50
4X150A	18.50	251A	38.75	832	4.50	5749/6BA6W	1.00	6627/OB2WA	2.00
4X500F	38.75	252A	6.50	832A	8.00	5750/6BE6W	2.00	6655	50.00
5BP1A	7.50	253A	2.50	836	1.15	5751/12AX7W	1.85	6754	17.50
5C21	18.75	254A	2.00	837	1.25	5755/420A	8.50	8005	4.85
5C22	25.00	257A	10.00	845	2.50	5763	1.00	8013A	4.50
5CP1A	7.50	259A	7.50	866A	1.35	5783	2.50	8014A	60.00
5CP7	5.00	262B	5.00	866 JR	1.50	5784	4.00	8020	1.25
5CP11A	9.50	267B	4.50	869B	50.00	5784WA	5.00	8025	1.15
5HP1	1.25	268A	5.00	GL-872A	2.00	5787	3.25	8365/2K41	50.00
5JP1	7.00	271A	8.50	872A	1.00				

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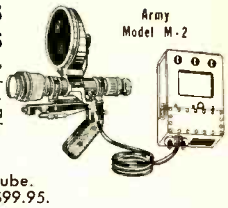

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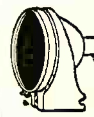

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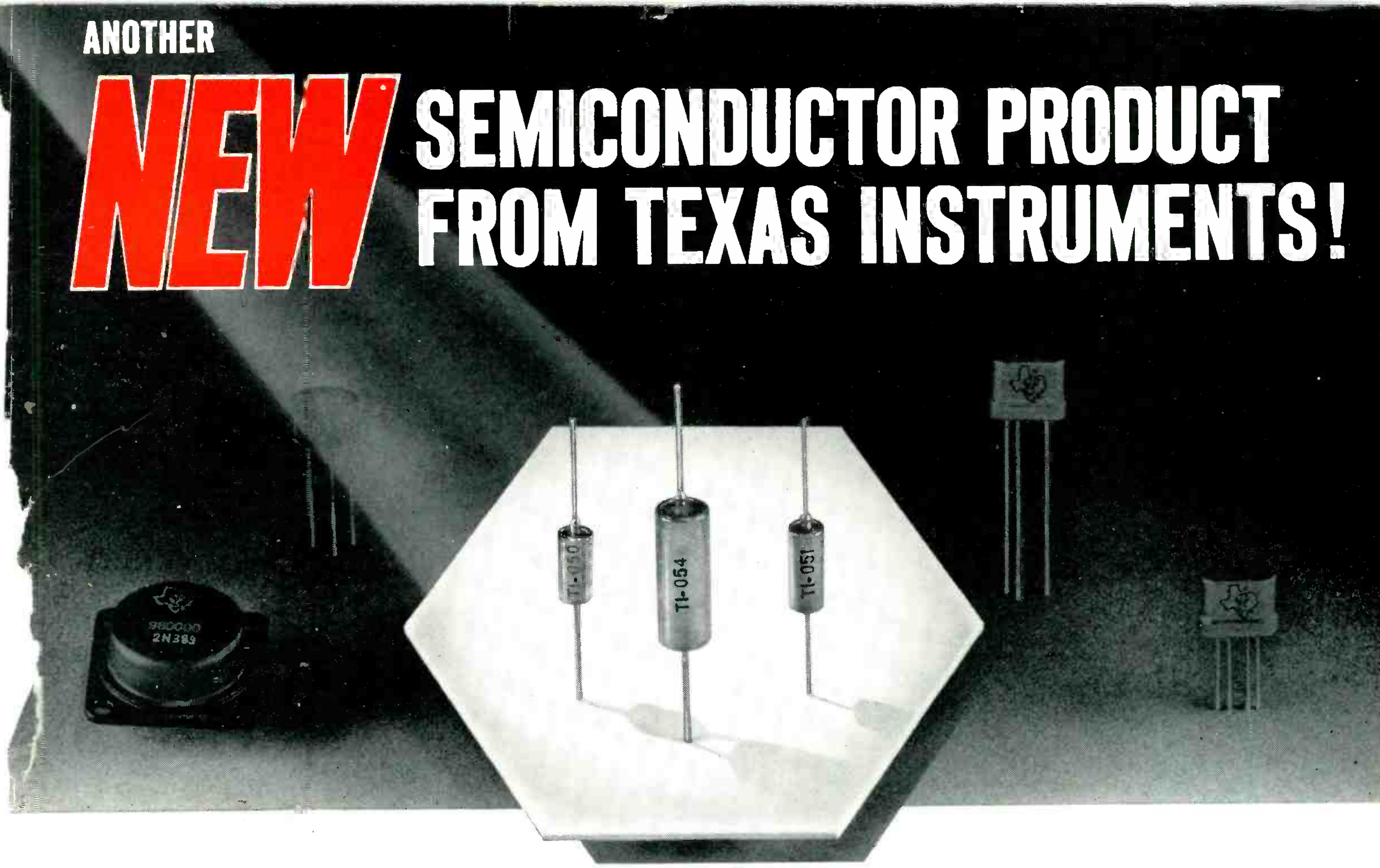

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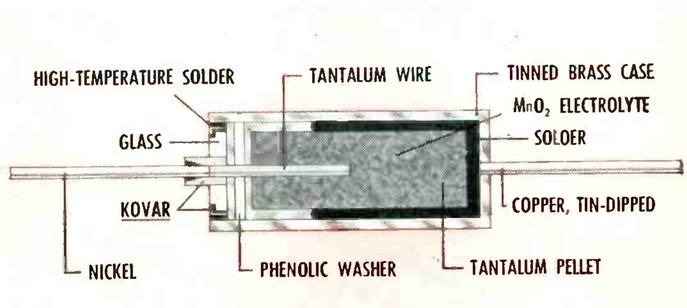

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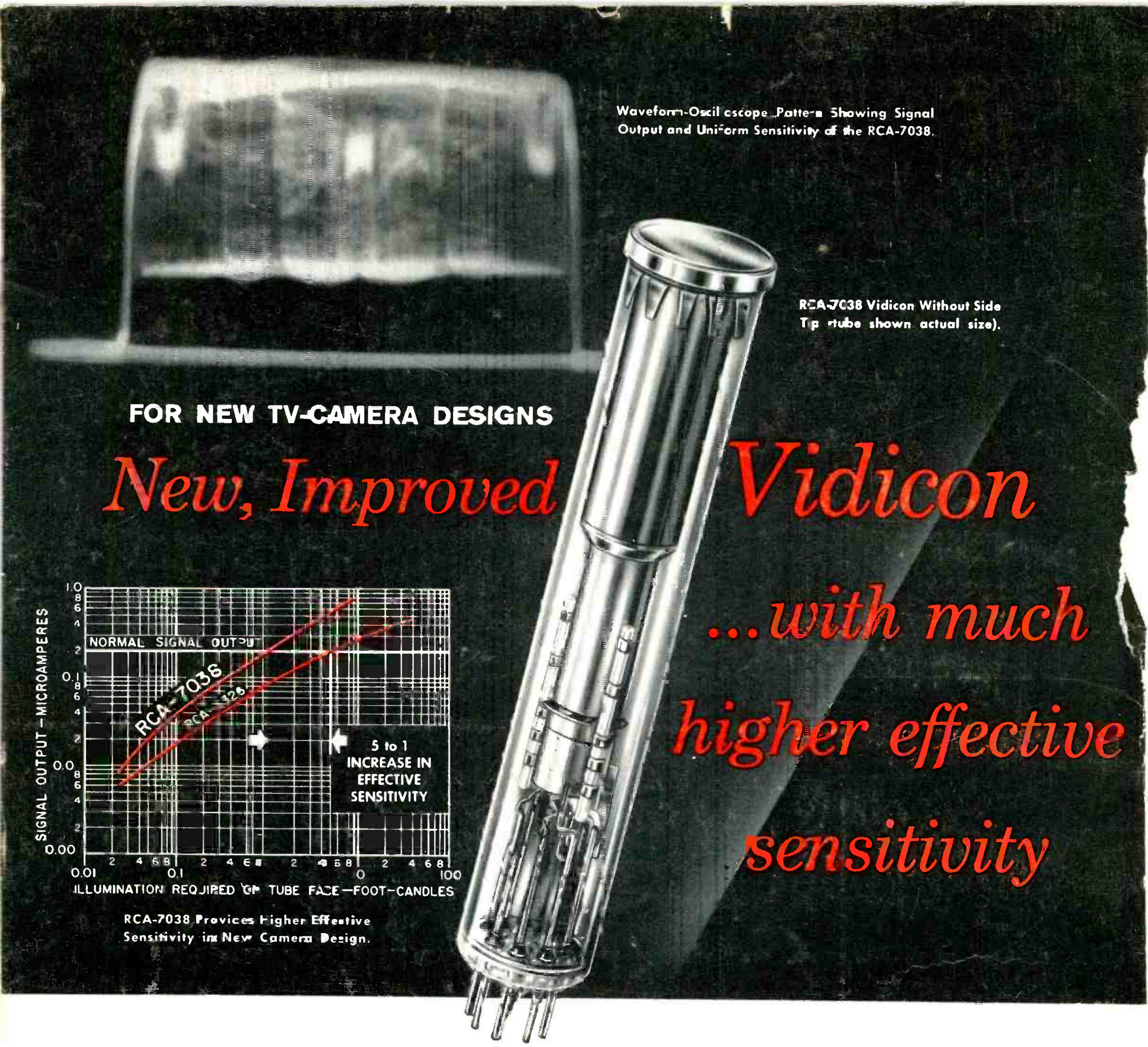

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