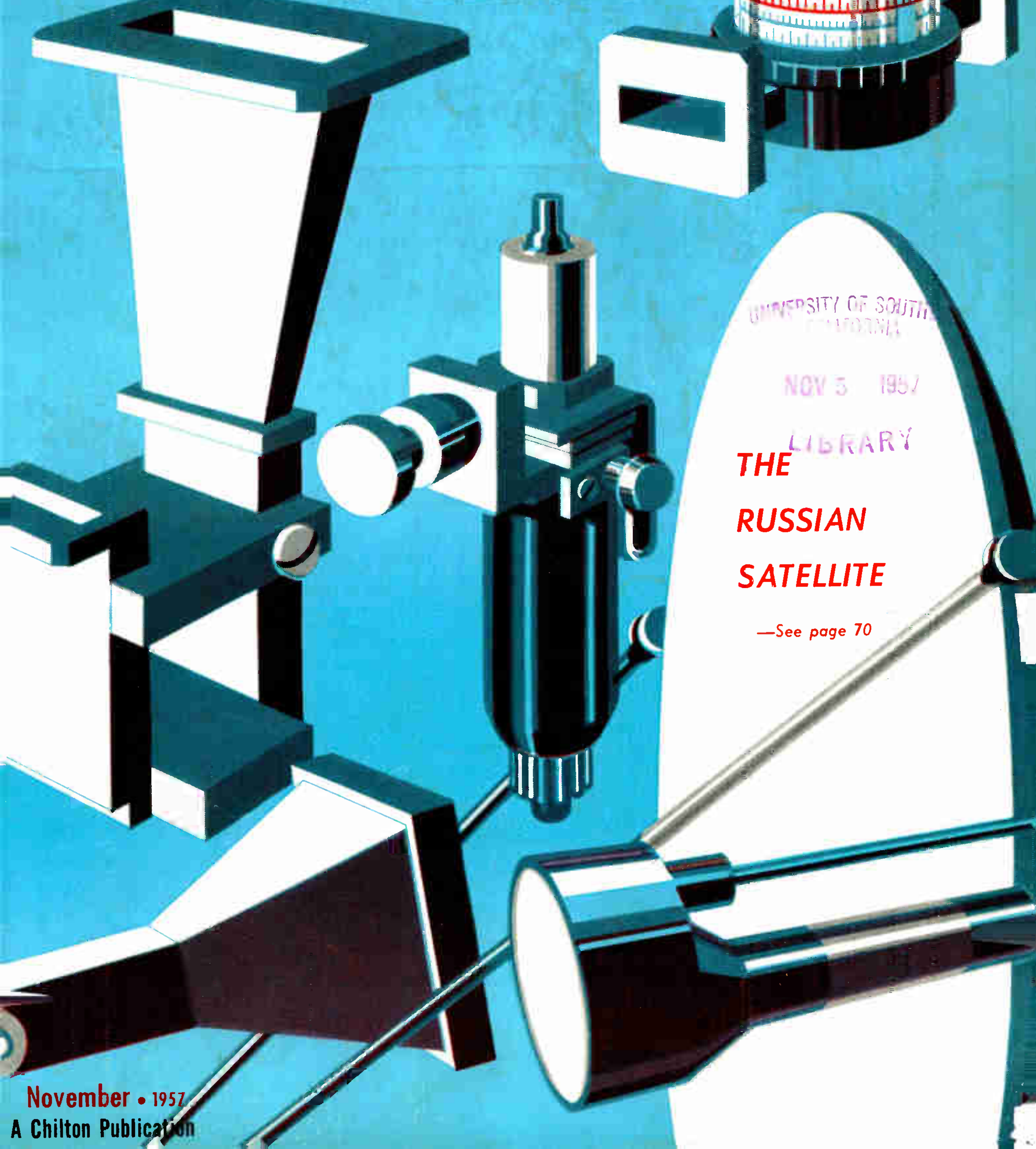
ELECTRONIC INDUSTRIES

& TELE-TECH



THE RUSSIAN SATELLITE

—See page 70

November • 1957
A Chilton Publication

100% FACTORY TESTED RMC TYPE "C" DISCAPS RATED AT 1000 V.D.C.

TC	1/4 Dia.	5/16 Dia.	1/2 Dia.	5/8 Dia.	3/4 Dia.	7/8 Dia.
P-100	1- 3 MMF	4- 9 MMF	10- 20 MMF	—	—	—
NPO	2- 13	14- 29	30- 69	70- 85 MMF	86-115 MMF	116-150 MMF
N- 33	2- 13	14- 29	30- 56	57- 62	63-100	101-150
N- 75	2- 14	15- 29	30- 56	57- 68	69-125	126-150
N- 150	2- 15	16- 30	31- 67	68- 75	76-140	141-175
N- 220	3- 15	16- 30	31- 75	76-100	101-140	141-175
N- 330	3- 15	16- 30	31- 75	76-100	101-150	151-190
N- 470	3- 20	21- 40	41- 80	81-120	121-200	201-240
N- 750	5- 29	30- 68	69-150	151-180	181-300	301-350
N-1500	15- 50	51-120	121-200	201-270	271-400	401-560
N-2200	47- 75	76-150	151-200	201-300	301-680	

Temperature coefficients up to N-5200 available on special order.

Temperature Compensating

Type C DISCAPS meet all requirements of the RETMA specification REC-107-A. Lower self inductance and smaller size make them ideal VHF and UHF applications. These DISCAPS are rated at 1000 V.D.C. to provide a higher safety factor than other standard ceramic or mica capacitors.

RMC maintains absolute quality control, one phase of which consists of a 100% test for capacity on all DISCAPS. Constant production checks of Type C DISCAPS assure that all specifications on temperature characteristics are met.

Many manufacturers have shown their confidence in RMC standards by eliminating these phases of their incoming inspection at a savings of time and money. Write for information on your company letterhead.

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Circle 1 on Inquiry Card, page 101

ELECTRONIC INDUSTRIES

& TELE-TECH

Vol. 16, No. 11 **November, 1957**

MONTHLY NEWS ROUND-UP

NEW ELECTRONIC EQUIPMENT

DEPARTMENTS

Report On "Sputnik"! 70

The Russians' feat of blasting a satellite into the outer space must be evaluated separately—as a scientific achievement, and as a propaganda victory.

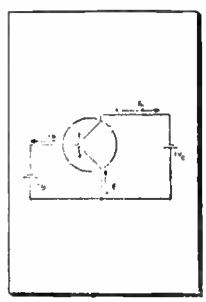
The Ultrasonic Art 58

Report of a four-month survey by EI on the progress being made by ultrasonics in the fields of metal joining, machining, drilling and material inspection, in addition to cleaning.

High-Powered Simulator 78

Very high levels of microwave power can be achieved by periodically injecting energy from a directional coupler into a waveguide cavity made in the form of a closed loop.

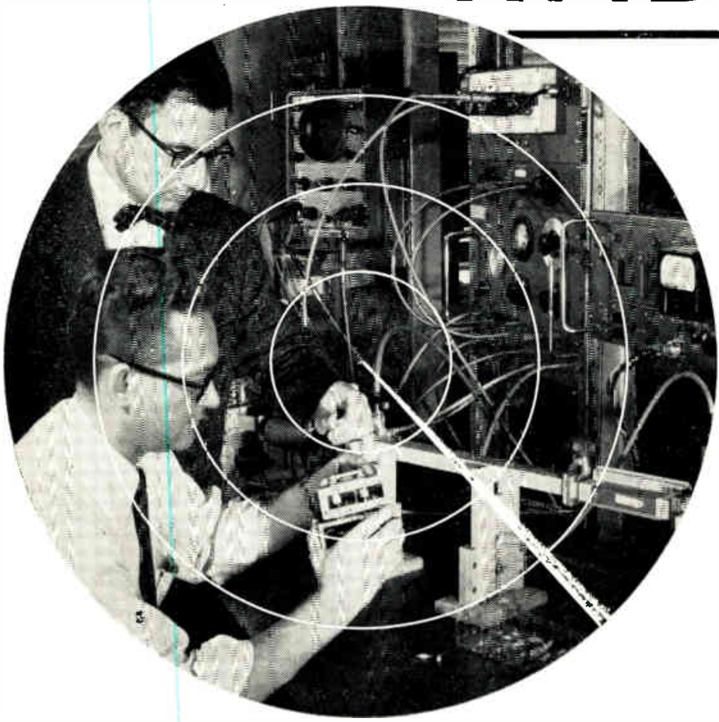
Biassing Transistors 75



Establishing the operating point of the transistor and stabilizing it against temperature variations and replacement is simplified by these design formulas for bias components.

ELECTRONIC INDUSTRIES & Tele-Tech, November 1957, Vol. 16, No. 11. A monthly publication of Chilton Company, Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila., Pa. Accepted as controlled circulation publication at Phila., Pa. 75¢ a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $5.00; 2 yrs. $8.00; 3 yrs. $10.00. Canada 1 yr. $7.00; 2 yrs. $11.00; 3 yrs. $14.00. All other countries 1 yr. $10.00; 2 yrs. $16.00.

RADARSCOPE



FOR NEW RELAY SYSTEM

Bell Labs scientists A. Uhlir, Jr., and P. I. Sandsmark examine a diode modulator similar to that used in the cross-country TH microwave relay system going into construction late 1958.

EYE-OPENING CLAIM by Blonder-Tongue Labs last month that their new "Bi-Tran" system of TV transmission will allow simultaneous transmission of two programs on the same channel. If true, it could sharply affect the pay-TV picture. The lack of a clear-cut technical explanation of the system generated a good deal of conjecture as to exactly how it operates. Blonder-Tongue would say only, "The method involves the transmission of two different pictures in the same bandwidth. A series of positive or negative signals enable picture A or picture B to be visible on the TV screen while the other picture is cancelled."

NEW TRAVELING WAVE TUBE developed by RCA is expected to reduce weight and substantially increase operating reliability of microwave relay and radar equipment. The tube eliminates the need for bulky electromagnetic focusing equipment.

MORE EFFICIENT RECTIFIERS are promised by the research now going on with aluminum antimonide, gallium arsenide, and indium phosphide. The new compounds offer inherently better electrical characteristics and higher ambient temperature operation range. They all have melting points between silicon and germanium and their energy gaps are higher than silicon.

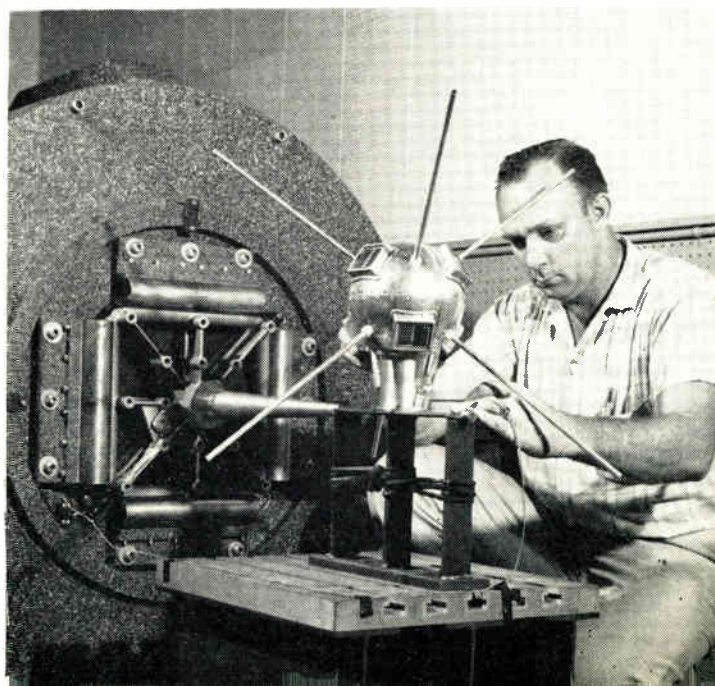
STRONG BID for American business is coming from the Japanese. Last month an association of 16 Japanese manufacturers opened a show room at 1140 Broadway, New York City, displaying a wide line of microphones, speakers, turntables, capacitors and switches among others. American manufacturers should watch this development closely, and learn from the experience of the camera industry. Top-quality Japanese cameras are now cornering the medium price reflex camera market. If the same precise effort goes into these new Japanese components American manufacturers can expect keen competition.

EDUCATIONAL TV NETWORK, using microwave distribution between institutions and CCTV within institutions has been proposed for sixteen southern states. The proposed network would serve 600,000 college students in 216 colleges, and cost approximately $204,080,000.

AIR/GROUND COMMUNICATIONS in general and radiotelephone in particular are being discussed at the five-week meeting of the International Civil Aviation Organization in Montreal. In recent years radiotelephone has replaced telegraphy for air/ground communication; in some areas it is also being supplemented by SELCAL, which rings a bell when the aircraft is called. The group will try to set up procedures for world-wide application of these improvements. Other items on the agenda are standards for primary and secondary surveillance radar, the single-side band issue, and the development of procedures for light testing of the VHF Omni-directional radio range (VOR) short range navigation aid.

SATELLITE TESTING

Wayne Traylor of Naval Research Lab, Washington, D. C., readies a six-inch satellite for a vibration test to 25 G's. A similar unit will be test fired later this year at the Air Force Missile Test Center, Cape Canaveral, Fla. Rectangular units house solar batteries.



LOOK FOR aircraft firms to step up their electronic activity as the military aircraft program is cut back. Sub-contractors are already being warned that business will fall off, and the general decrease in business will force the prime contractors to look for new markets as well. For most of them, the electronic field will be a natural, since they have well-staffed electronic sections.

HI-FI SPEAKER CONES are being molded in Japan from liquid paper pulp and a variety of other materials, including aluminum, kapok fiber, silk, bamboo-pulp, bubbled polystyrol and metallized paper. The cones are claimed to be remarkably uniform in quality and to possess a fine frequency characteristic.

THE FCC is considering legislation that would require VHF radio telephone equipment on the bridges of all ships. The proposal grew out of recommendations made by the House Committee on Merchant Marine and Fisheries after their investigation of the Andrea Doria mishap. The feeling is that routing all communications through the ship's radio operator puts an unnecessary hardship on the vessel's skipper, that much more efficient and safe navigation could be obtained if the captains of nearby vessels can communicate directly with each other.

BELL LABS scientists have developed gold-bonded germanium diodes and diffused p-n junction silicon diodes that provide useful amplification when used in converter stages of microwave equipment. The gain has been most significant in up-converter stages. Gains as high as 6 db have been achieved with gold-bonded germanium diodes when converting from 75 MC to 6000 MC. Such a converter stage is useful as a modulator for a microwave transmitter.

INFLATIONARY TREND is due to the rising costs of labor and the continuing heavy tax burden, points out the NAM. They back up their claim with figures that show that manufacturers' profits, as a percent of sales, dropped from 4.9% in 1948 to 3.1% in 1956. The industries that have suffered most are those that employ the largest numbers of people for a given dollar volume of sales.

DARKHORSE in the race for a commercial electronic refrigeration unit is Japan. Sources in that country claim that they have already solved the previously difficult problem of producing at a low cost the semiconducting metals that are the heart of the heat absorbing junction. One major problem, they say, remains—but will not provide further details. The eventual unit, they predict, will lower the temperature by 40°C. and cost no more than the present refrigerator.

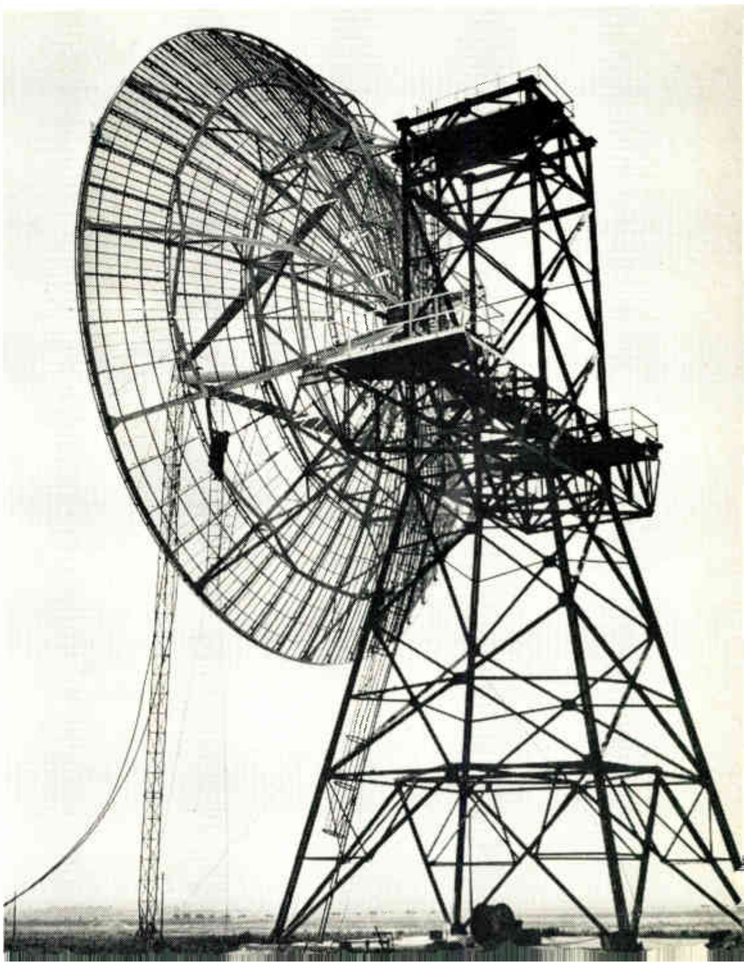
NEW MICROWAVE RELAY SYSTEM to carry cross-country telephone, radio and television signals will be under construction by the end of 1959. Bell System estimates that the present transcontinental microwave system (TD-2) will have become fully loaded by 1960. The new system, TH, will be a long-haul broad-band system, operating at 6,000 MC.

COMPUTER INFORMATION can be transmitted over a conventional telephone line or radio with high accuracy using the new Kineplex system developed by Collins Radio. The system is described as being a high-capacity phase-shift data transmission system which will accept at its input, with suitable conversion, binary data from any source.

WHAT DOES THE RUSSIAN SATELLITE MEAN? To electronics? As a propaganda weapon? As a scientific achievement? What effect will it have on the defense plans of the U. S.? For the answers read the special report by ELECTRONIC INDUSTRIES beginning on page 70 of this issue.

NEW EUROPEAN MICROWAVE

The first direct telephone service between Italy and Spain went into operation last month. One end of the over-the-horizon link is this 60 ft. paraboloid on the island of Sardinia. IT & T supplied the equipment and engineering direction.



As We Go To Press . . .

RADIATION CHECK

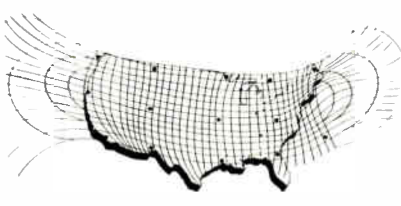
Army personnel install special equipment in a tank to determine how close it can be to the blast without danger to crew. Site is the Atomic Proving Grounds, Nev.

New Air Navigation, Anti-Collision System

A modular air navigation system that provides a continuous graphic display of position, track and ground speed, and also warns of the proximity of other aircraft, is being introduced in the U. S. by Stavid Enginering Inc., Plainfield, N. J. The system was developed by the French firm of A.I.R.

The basic "Radio Web" system, so-called for the grid pattern on which its technique is based, utilizes transmitting towers spaced 600 miles apart. For trans-oceanic navigation the stations can be placed 2000 miles apart.

The system designers estimate that fifteen ground stations could effectively control all aircraft within the U. S. to a position accuracy of ½ mile in uncongested areas and to 200 yards in controlled zones.



Stations located as shown here could control all air traffic in the U. S. to within ½ mile.

Stavid Engineering has broken the system down into modules which they believe will take care of all aircraft, regardless of size, speed or operating procedures.

Industry Unites For Microwave Hearings

The Electronic Industries Assoc. is presenting a series of eight witnesses from leading microwave firms to support its request from the FCC for more microwave spectrum space above 890 MC and a more liberal policy on the use of private microwave. The FCC fact-finding inquiry which began last spring is now being resumed.

James B. Williams of Philco Corp. testified for EIA in the spring hearings. First witness of this session was Dr. Daniel V. Noble of Motorola, followed by Rodney D. Chipp, Federal Telecommunication Labs., and Elmer D. McArthur, G. E. Research Lab. Also scheduled to appear are: Samuel R. McConoughey, General Electric Co.; Angus A. McDonald, Motorola Inc.; Maury G. Staton, R.C.A.; and B. Frederick Wheeler, R.C.A.

One of the points being emphasized in the EIA presentation is that users should have "freedom of choice"; under the present rules, separate microwave, or other type, communication links are not authorized where common-carrier facilities exist.

The EIA is endeavoring to prove two points: that adequate spectrum space does exist for private microwave use, and that private microwave would be in the best interests of the public.

See "Report on the Satellite"—p. 70

Magnavox Drops Metal Case, Cites Shock

The electrocution of the 7-year-old Skokie, Ill., youngster by contact with a metal TV cabinet had quick repercussions last month. Magnavox announced that they were discontinuing metal cases, and simultaneously municipal authorities in South Bend, Ind., reportedly were threatening to ban sales of metal case TV receivers.

Magnavox president Frank Freimann stated frankly that they could not risk the sales resistance that they believed would develop to metal case receivers. Other manufacturers, however, seemed inclined to discount the long-range effect of the scare, pointed to the many years of service metal cabinets have given in the past without accidents.

Under pressure of the South Bend proposal the Electronic Industries Assoc, called on their Safety Standards Committee to reconsider the metal cabinet question. Their decision came up the same; there is no inherent shock hazard with metal cabinets, nor is there any reason to ask for more rigid requirements.

NEW AIR AID

Special airborne TV system developed by General Precision Labs, Pleasantville, N. Y., allows the pilot to visually check the outside of his aircraft. Here he checks functioning of the aircraft's front nose wheel.

MORE NEWS ON PAGE 10

STEMCO THERMOSTATS

for electronic and avionic applications

Features to fit your *special requirements* for avionic and electronic applications—from standard, production-line Stemco thermostats. That's just *part* of the Stemco story.

Because Stevens makes the widest range of bimetal thermostats in the industry, we offer an unusual number of basic design types . . . various terminal arrangements and mounting provisions . . . different temperature ranges and performance characteristics. In addition, Stemco thermostats feature small cubage, light weight and proven reliability—*at a production price.*

So get the Stemco story *first*. Write, call or wire *now* while your product is in the planning stage.

*Refer to Guide 400 EO for U. L. and C. S. A. approved ratings.

TYPE A*

Semi-enclosed

nsulated, electrically inde-endent bimetal disc gives ...t response and quick, ...ap-action control. Oper-...ion from —10° to 400°F ... higher on special order. ...ious mountings and ter-...ls. Rated from 4 to 13 ...ps at 115 volts AC, de-...nding on service condi-...ns; 4 amps at 230 volts ...C and 28 volts DC. ...ulletin 3000.

TYPE C

Hermetically sealed

Electrically identical to semi-enclosed Type C but sealed in crystal can. Also supplied as double thermostat "alarm" type. Turret terminals or wire leads. Bulletin 5000.

TYPE M*

Semi-enclosed

Electrically independent bimetal disc type for appliance and electronic applications from —10° to 350°F. Rating: 8 amps at 115 volts AC, 4 amps at 230 volts AC and 28 volts DC. Virtually any type terminal. Bulletin 6000.

TYPE A

Hermetically sealed

lectrically identical to ...mi-enclosed Type A. Tem-...eratures from —10° to ...00°F. Various enclosures ...nd mountings, including ...rockets, available. For ...pliance, electronic, ...paratus applications. ...etin 3000.

TYPE C

Semi-enclosed

Small, positive-acting. Electrically independent bimetal strip for operation from —10° to 300°F. Rated at approximately 3 amps, depending on application. Terminals and mountings to customer specifications. Bulletin 5000.

STEVENS *manufacturing company, inc.*

Lexington and Mansfield, Ohio

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®

STEMCO

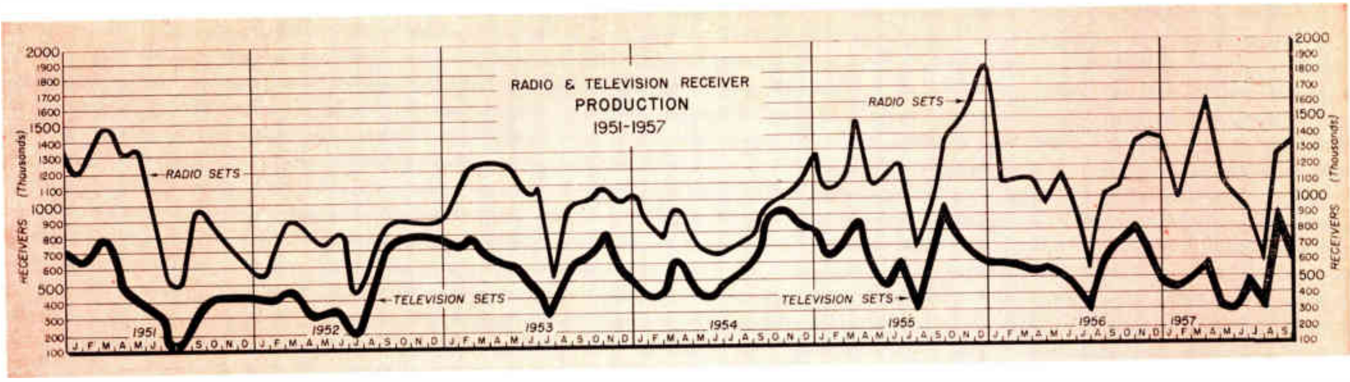
THERMOSTATS

TYPE M

Hermetically sealed

Electrically same as semi-enclosed Type M. Can be furnished with pin or solder-type terminals, wire leads and various mounting brackets. Bulletin 6000.

TOTALS



TUBE SALES

	Picture Tubes		Receiving Tubes	
	Units	$ Value	Units	$ Value
January	760,860	$ 13,594,525	37,571,000	$ 31,170,000
February	728,363	13,134,778	44,460,000	36,631,000
March	833,257	14,850,847	43,010,000	37,007,000
April	629,838	11,394,043	27,970,000	25,384,000
May	758,328	14,031,519	32,836,000	28,955,000
June	1,104,013	19,981,319	35,328,000	31,314,000
July	491,935	9,835,586	33,077,000	27,042,000
August	930,296	17,984,185	43,029,000	34,886,000
TOTAL	6,236,890	$114,806,802	297,281,000	$252,389,000

—*Electronic Industries Association*

TRANSISTOR SALES

	1957 Sales (units)	1957 Sales (dollars)	1956 Sales (units)
January	1,436,000	$4,119,000	572,000
February	1,785,300	5,172,000	618,000
March	1,904,000	5,321,000	708,000
April	1,774,000	4,880,000	832,000
May	2,055,000	5,636,000	898,000
June	2,245,000	6,121,000	1,130,000
July	1,703,000	4,216,000	885,000
August	2,709,000	6,598,000	1,315,000
TOTAL	15,611,300	$42,063,000	6,958,000

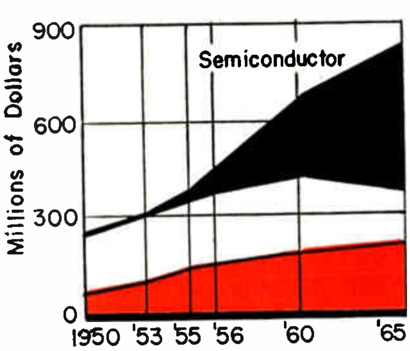
—*Electronic Industries Association*

GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in September 1957.

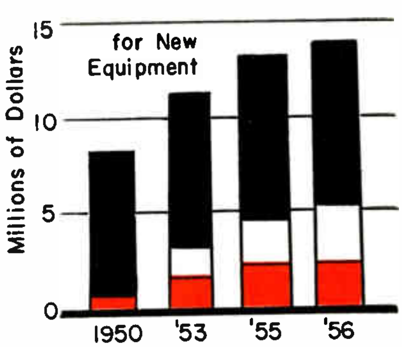
Antennas & Accessories	698,718
Antenna Towers & Supports	33,486
Batteries, Dry	1,268,912
Coder-Decoder	1,180,283
Crystal Units	92,830
Indicators	80,014
Indicators, Radar	456,000
Intercom Equipment	26,059
Microphones	68,767
Monitors	40,224
Networks	56,317
Radar Equipment	5,278,388
Radiac Equipment	63,819
Radio Direction Finders	1,093,107
Radio Receivers	121,764
Rectifiers, Metallic	93,600
Relay Assemblies	46,724
Relays	139,552
Resistors	27,179
Spare Parts	162,554
Switches	52,768
Syncros	74,900
Tape, Recording	25,500
Television Equipment	52,576
Testers	142,955
Test Sets, Radio	124,095
Tubes, Electron	1,939,831
Wire & Cable	148,090

Tubes vs Semiconductors-Sales



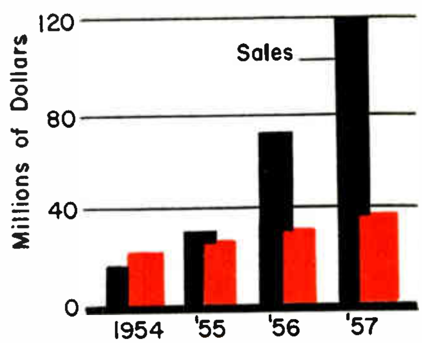
RECEIVING TUBES:
for new equipment
for replacement

CRT: New vs Replacement Sales



For Replacement
rebuilt
new

R & D vs Sales: Semiconductors



Estimated R & D

—*NEDA Journal—Vol. 13, No. 9*

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Circle 4 on Inquiry Card, page 101

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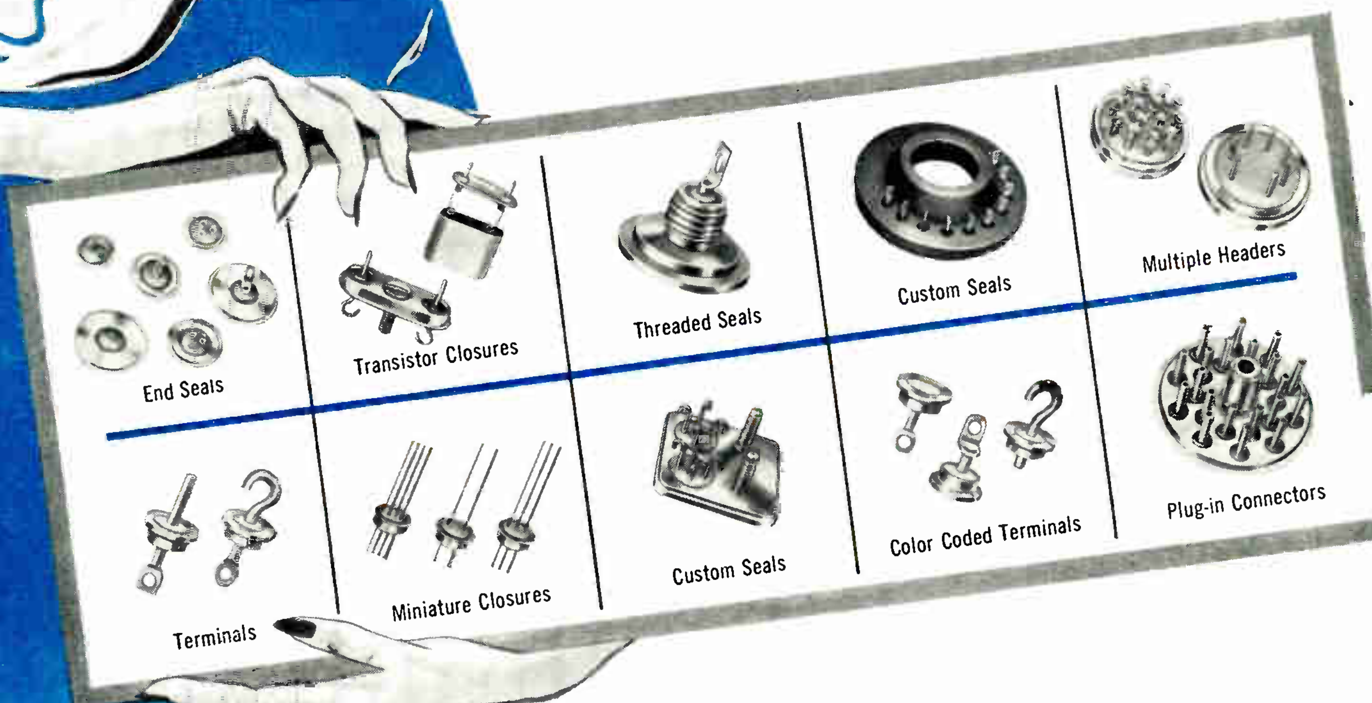

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ELECTRICAL INDUSTRIES

A Division of Philips Electronics, Inc. — MURRAY HILL, NEW JERSEY

Circle 5 on Inquiry Card, page 101

As We Go To Press

Doppler Radar System For Commercial Lines

General Precision Labs last month took the military wraps off their lightweight "RADAN" Doppler navigation system. The system is now being made available for commercial airlines.

The RADAN (Radar Doppler Automatic Navigator) weighs 89 lbs. and occupies 4.4 cubic feet of space. It consists of an antenna-receiver-transmitter, frequency tracker, plus control and display panels. The transmitter operates at a frequency of 8800 MC.

RADAN measures ground speed with an error of less than 1%, and drift angle within 0.5°. Coupled to a navigational computer and compass, it enables an aircraft to reach its destination with an accuracy of better than 2% of the distance traveled.

The system utilizes four beams, two pointed left- and right-forward, and two pointed left- and right-aft. Left-forward and right-aft beams are transmitted simultaneously, the other two antennas likewise. The Doppler frequency shift between transmitted and received signals indicates the ground speed of the aircraft.

The drift angle is found by comparing the return from left and right beams. Since the antenna array aligns itself with the ground track of the aircraft any offset from the aircraft axis indicates the drift angle.

A DC-3, equipped with RADAN and a unique airborne closed circuit TV system will be demonstrating the GPL systems in various parts of the country during the next few months.

Spectrum Study

The Board of Directors of the Electronic Industries Assoc. last month recommended a cooperative long-range study of the radio spectrum, covering both military and civilian uses of frequencies. The last comprehensive study of frequency allocations was conducted by the Radio Technical Planning Board toward the end of World War II.

ELECTRONIC SHORTS

▸ **Nuclear power operators have been directed by the Atomic Energy Commission to take out insurance against reactor accidents. The new order specifies a rate of $150,000 per thousand kilowatts of thermal energy.**

▸ Ceramic radomes, not susceptible to charring and strength loss when subjected to extreme heat as are reinforced plastic, have been delivered to the USAF ARDC for use on missiles. Gladding, McBean & Co., a West Coast ceramics manufacturer, has supplied the ten "high-alumina" prototypes.

▸ **Construction is now under way on the last of 10 Minitrack radio tracking stations for the IGY earth satellite. This station, located at Woomera, Australia, the southern end of the satellite's orbital plane, will provide scientists with information at half-globe circling intervals.**

▸ The first ballistic missile division headquarters has been established by the USAF at Cooke AFB, Lompoc, California. The 1st Missile Division, commanded by Col. William A. Sheppard, will plan and prepare for future operational ballistic missile units.

▸ **The ARDC's Wright Air Development Center's new commander is Brig. Gen. Stanley T. Wray, USAF. He succeeds Maj. Gen. Thomas L. Bryan, Jr., USAF, who recently underwent major surgery and is expected to have a long convalescent period.**

▸ An overall review of the Navy's surface-to-surface missile program has resulted in the cancellation of the Triton project. The amount expended on this program to date is approx. $24 million. The most desirable design features will be incorporated into future missiles systems.

▸ **The first Snark guided missile squadron will be activated late this year by the USAF. The squadron will be assigned to SAC and will be commanded by Lt. Colonel Richard W. Beck, USAF. The Snark, first intercontinental guided missile, is manufactured by Northrop Aircraft, Inc.**

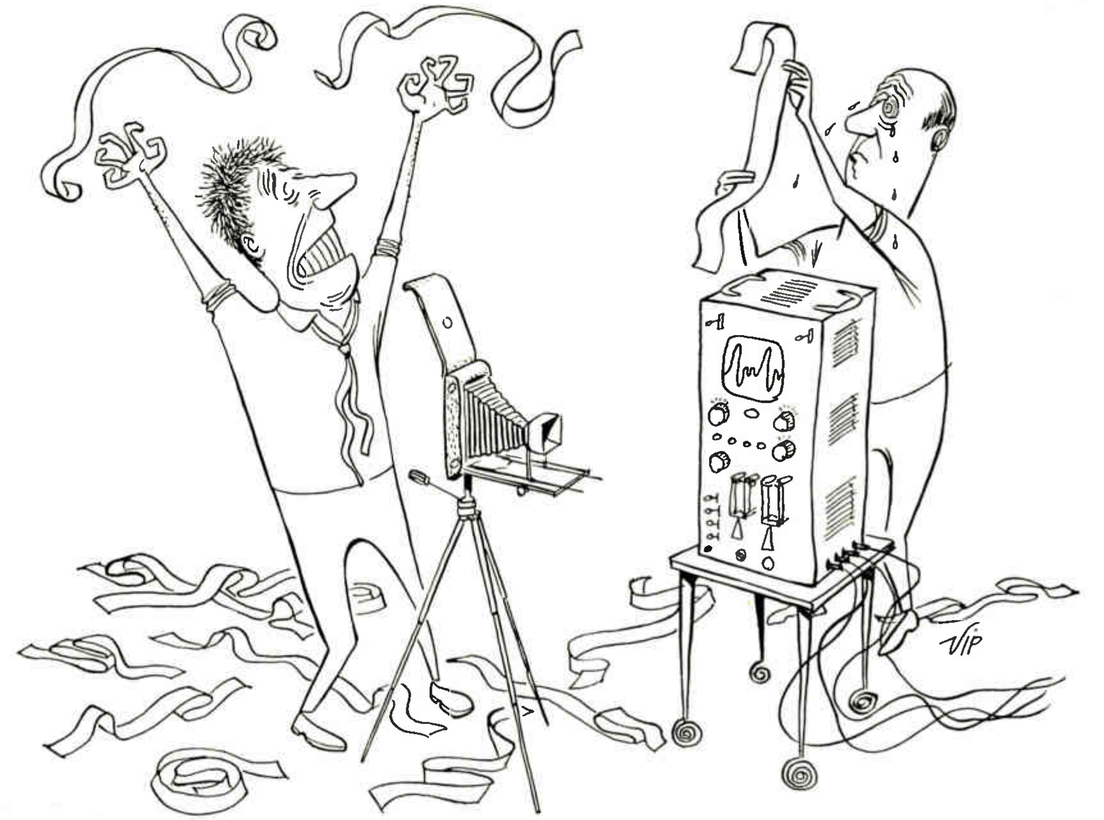
▸ Eniwetok Atoll, famous for the atomic experiments, is the site of the USAF non-nuclear balloon-supported rocket firing. The launching platform for the four-stage rocket is suspended at an altitude of 100,000 feet. This is the second test phase of research project "Far Side," which is seeking atmospheric data at altitudes of from 1,000 to 4,000 miles.

▸ **Transformer and choke cores, and infra-red lighting equipment for testing fluorescence in minerals are among the items recently removed from the Bureau of Foreign Commerce's Positive List. Exporters may now ship these items to most countries without applying for individual licenses.**

▸ The Naval Ordnance Laboratory has developed a hypervelocity gun that fires midget missiles at 12,000 mph. The two-stage, gas-fired, 40mm gun is designed to perform basic aeroballistic research on missiles in the laboratory. Not a weapon, the gun fires a special nylon-sphere test projectile and is made of standard gun steel alloy. The gun uses a hot gas mixture in two firing chambers to fire the projectile. Chemical reaction and shock increase the gas pressure to approximately 60,000 psi before firing.

▸ **European electronics manufacturers are ahead of their American competitors in many respects, according to D. Leslie Gulton, President of Gulton Industries. Upon his return from a 10-week tour of European firms, the executive reported that much greater customer acceptance of new products and innovations is the success key. Industrial ultrasonic applications are also more advanced.**

▸ Development of a technique which permits ground observers to 'look over a pilot's shoulder' has been announced by the Air Research and Development Command. Telemetry system reproduces the pilot's radar scope. Better training for all-weather interceptor pilots and performance evaluation improvement are expected as the end results. Experiments were conducted on the F-86D, but technique may be adapted for jet aircraft in the century series.



PROBLEM: Wave-form photography

Attempts at photographing elusive wave forms on conventional scopes have been, hitherto, a prodigious waste of time and film. Now, hair-trigger photography can be a thing of the past.

SOLUTION: a Hughes MEMO-SCOPE® Oscilloscope. What does the MEMO-SCOPE do that no other scope can? A storage-type oscilloscope, it can instantly "freeze" any number of selected traces *until intentionally erased.* Photos may thus be taken *at leisure*—with just one camera setting—one exposure—for each permanent record required. No tedious repetition. No more wasted film. The resultant savings can quickly pay for this "transient recorder with a memory."

If you haven't yet seen a demonstration of the MEMO-SCOPE Oscilloscope, ask a Hughes representative to arrange one. He'll quickly do so—at your convenience—in your area. Please send for Application Data Sheets Nos. MSAD-A1 and MSAD-A2. Write to:

HUGHES PRODUCTS
MEMO-SCOPE Oscilloscope
International Airport Station, Los Angeles 45, California

HUGHES MEMO-SCOPE OSCILLOSCOPE

STORAGE TUBE—5-inch diameter Memotron® Direct Display Cathode Ray Storage Tube. Writing speed for storage: 125,000 inches per second. The optional Speed Enhancement Feature multiplies writing speed approximately four times.

OSCILLOSCOPE—Controls: intensity, focus and astigmatism are provided for conventional adjustments. Flood gun, storage and erasure permit regulation of the storage performance.

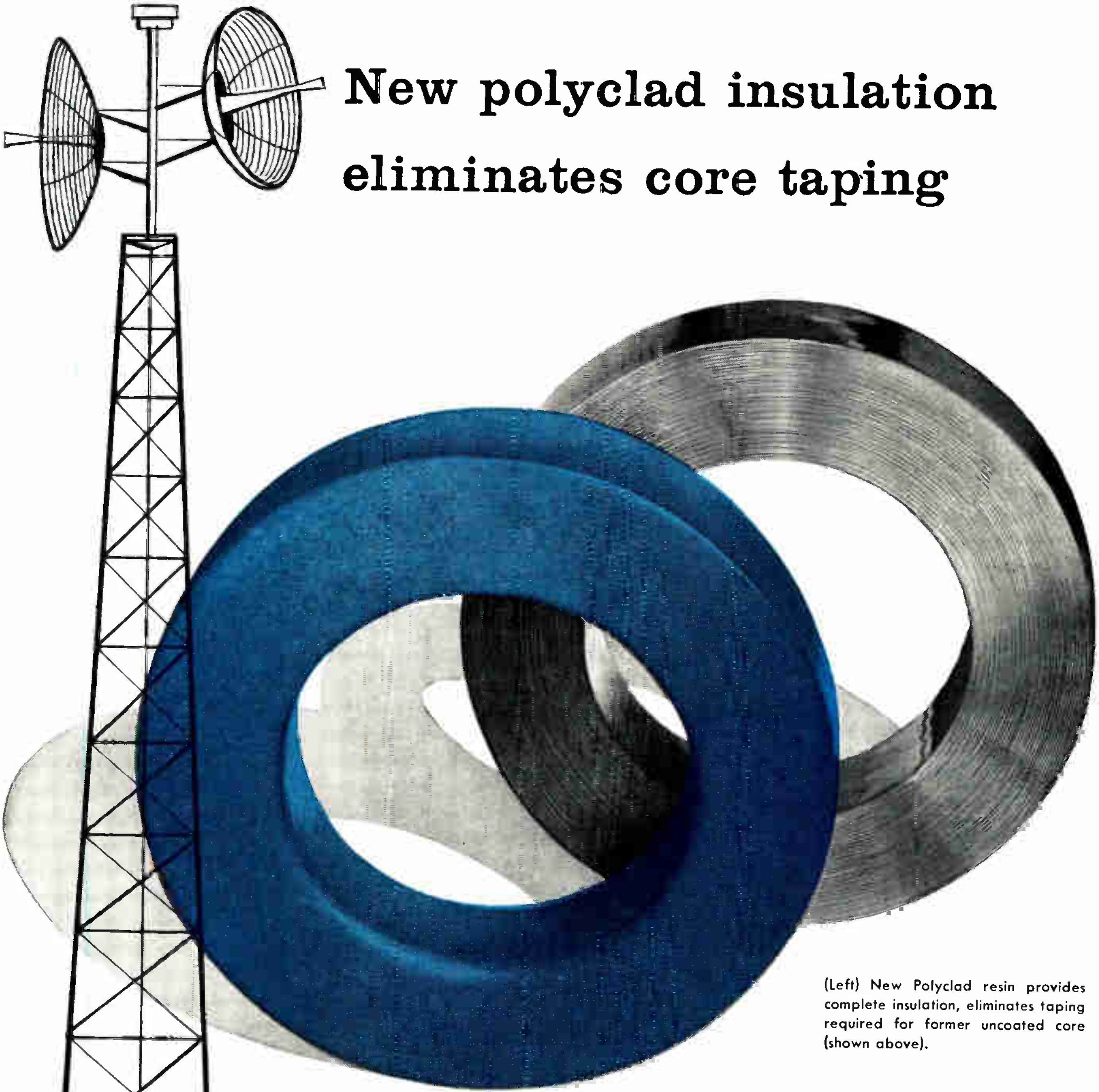
PREAMPLIFIER TYPE WB/4—Standard equipment with the described instrument. Frequency response: Vertical, DC to 250 KC down 3 db at 250 KC. Sensitivity: 10 millivolts to 50 volts per division (0.33") in 9 calibrated steps. Or, it is adjustable continuously with a 10:1 vernier.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

 Circle 6 on Inquiry Card, page 101

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

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

Electronic Industries' News Briefs

Capsule summaries of important happenings in affairs of equipment and component manufacturers

EAST

GE'S HEAVY MILITARY ELECTRONIC EQUIPMENT DEPT. has begun construction of two additional buildings, each occupying approximately 50,000 sq. ft. The space will be used to consolidate various GE product service facilities in the Syracuse area.

STROMBERG-CARLSON has just informally celebrated with Ford Motor Co. the delivery of the one millionth loudspeaker for Ford automobiles.

WESTON ELECTRICAL INSTRUMENT CORP. has opened a district sales office at 16607 James Couzens Highway, Detroit, to serve southeastern Michigan.

FILTORS, INC., has completed its new engineering building and now is in full operation. All facilities have been expanded with the addition of up-to-date equipment and devices.

FAIRCHILD CAMERA AND INSTRUMENT CORP. has moved its Systems Management and Engineering Dept. to 5 Aerial Way, Syosset, N. Y.

TELE-DYNAMICS, INC., has completed occupation of new plant facilities at 5000 Parkside Ave., Philadelphia. The new one-story center occupies some 100,000 sq. ft.

AUERBACH ELECTRONICS CORP., with headquarters in Narberth, Pa., is the name of a new firm specializing in the application of data processing techniques.

SILICON CRYSTALS, INC., has been established to engage exclusively in the growing of silicon crystals and other semiconductor metals. The new firm is located at Foot of Madison Street, Wilmington 99, Del.

C. P. CLARE & CO. has begun construction on a new plant at Fairview, N. C. The new plant will provide 45,000 sq. ft. and will be completed by June 1958.

AIRPAX PRODUCTS CO. has located its Central Engineering Div. at Fort Lauderdale, Fla. The air-conditioned building includes 14,000 sq. ft. of laboratory and production space, as well as offices.

ESC CORP. has opened its new Electronic Components Div. The new division will be devoted to development and manufacture of specialty transformers and associated electronic components.

MINNEAPOLIS-HONEYWELL REGULATOR CO. has again begun its classes on industrial control instruments at the Instrumentation Education Center conducted by its Industrial Div., Philadelphia.

CONTROL, DIV. OF MAGNETICS, INC., has announced new standard lines of saturable reactors featuring high permeability magnetic cores.

FAFNIR GEARING CO. has constructed an advanced and effective dust-free assembly and inspection department as part of a recently concluded million dollar expansion program.

SYLVANIA ELECTRIC PRODUCTS, INC., has broken ground on a million-dollar addition to the Physics Laboratory at the company's 57-acre Research Laboratories in Bayside, N. Y. The new wing will add 34,000 sq. ft.

MID-WEST

DALE PRODUCTS INC., mfrs. of precision resistors, potentiometers and electronic equipment, has added a new 16,000 sq. ft. plant to their resistor manufacturing facilities in Columbus, Neb.

ALTEC SERVICE CO. has been selected to design, fabricate, and install sound systems in Municipal Auditorium, Minot, S. D., and Michigan State University, Lansing, Michigan.

REMINGTON RAND UNIVAC has recruited nearly 1,000 professionals and non-professionals for their operations in the Twin City area in the last 5 yrs.

MOTOROLA, INC., will furnish Wayne County, Michigan, with the country's first Radio Control Traffic Light System to operate in the uncrowded 960 MC microwave band.

TEXAS INSTRUMENT INC. has introduced a new transistorized system for measuring liquid level in any of 100 remotely located storage tanks. Called "Data-Gage" the system was designed especially for the oil and chemical industries.

DAYSTROM, INC., has formed Controlonics Group to provide industry with entire electronic systems for the instrumentation and automatic control of industrial process.

INDIANA STEEL PRODUCTS CO. is now making ceramic permanent magnets for dc motor fields. The company's Indox V makes this possible.

RADIO CORP. OF AMERICA has received a half-million dollar order from WMBD, Inc., of Peoria for the first planned million-watt uhf television station in Illinois.

PERFORMANCE MEASUREMENTS CO., Detroit, has developed a new torque measuring system which eliminates the need for trunnion mounted dynamometers.

FOREIGN

KAAR ENGINEERING CORP. has appointed Radiowealth, Inc., as exclusive dealer for their products in the Philippines. Radiowealth headquarters are at 418-442 Tanduay Street in Manila.

CANADIAN WESTINGHOUSE CO. has equipped its new half-million dollar laboratory at Hamilton, Ontario, with two Tenney Environmental test chambers. The equipment enables tests of airborne electronic equipment for vibration, impact, sustained acceleration, climatic, and altitude.

A. B. DUMONT LABORATORIES, INC., have appointed Electronics Service Supply Co., Ltd., of Calgary, Alberta, as exclusive Canadian Distributor for Du Mont land mobile radio equipment.

HYCON MFG. CO. announced that its Aerial Surveys, Inc., subsidiary is now photographing some 35,000 sq. mi. of Bolivia for the Bolivian Gulf Oil Corp.

ELECTRODOS NACIONALES, S.A., an affiliate of Union Carbide Corp., has begun construction on a new graphite electrode plant near Monterrey, Mexico. Production is scheduled to start in 1958.

WEST

LING ELECTRONICS, INC., has announced plans for the construction of a new 38,000 sq. ft. plant in Culver City area.

STROMBERG-CARLSON-SAN DIEGO has begun construction of an engineering department building at the main plant. The new building will increase the space of the main plant by 50% and bring the total area of the division in San Diego to 52,700 sq. ft.

BECKMAN INSTRUMENTS, INC., through its Los Angeles Computation Center is completing the second of a series of free courses on the theory and operation of analog computers.

ELECTRONIC TECHNIQUES, INC., of Van Nuys is a new firm offering nation-wide services for basic design, manufacture and assembly of circuit structures in modular form as conventional deck, turret or printed circuitry forms.

GEORGE STEVENS CO., winding machine manufacturing firm, has opened a West Coast display room at 34444 W. 8th, Los Angeles. Vic Sheffield will be in charge.

MOTOROLA, INC., collaborating with Modern Distributors, Inc., is participating in the Bartlesville "Telemovies" experiment by providing monitor TV receivers to Video Independent Theatres Inc., sponsor of the closed circuit project.

LOCKHEED MISSILES' giant X-17 rocket, fastest instrumented missile ever flown by the U. S. has begun a nationwide USAF tour as the first ballistic vehicle to be exhibited across the country.

AMPEX CORP.'S Manager of Advance Videotape Development, Charles P. Ginsberg, will receive this year's David Sarnoff Gold Medal Award from the Society of Motion Picture and Television Engineers for his work in the development of the practical video recorder.

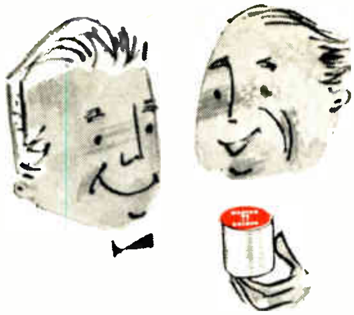
ELECTRODATA DIV., BURROUGHS CORP., has begun production of the Datatron 220, a new general purpose electronic data processing system which incorporates the capabilities of million-dollar-plus computers at about half the cost.

INTERNATIONAL ELECTRONIC RESEARCH CORP. has expanded its operations into the electron and aviation instrument and equipment fields with the announcement of two new divisions, Electronics International Co. and Aircraft Electronics of Burbank and Long Beach, Calif., respectively.

PACKARD-BELL ELECTRONICS CORP. has received two Army-Navy contracts totalling $750,000. Contracts provide for research and development of missile test equipment and aircraft detection and identification mobile electronic equipment.

HUGHES AIRCRAFT CO., Semiconductor Div., has opened a field sales engineering office at 535 Middlefield, Palo Alto, Calif., servicing Northern California and the Pacific Northwest.

CG ELECTRONICS CORP., a wholly-owned subsidiary of Gulton Industries, Inc., has expanded its production facilities approximately five times their original manufacturing space. The expansion will affect electroplating and printed circuit activities.

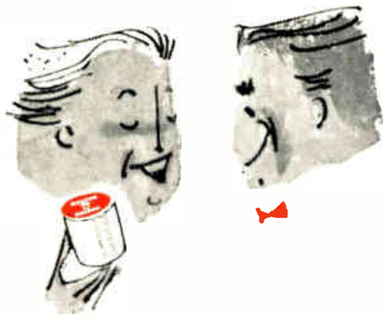


"We are sold on Kester '44' Resin-Core Solder, Jim. It's the fastest acting solder we have ever seen."

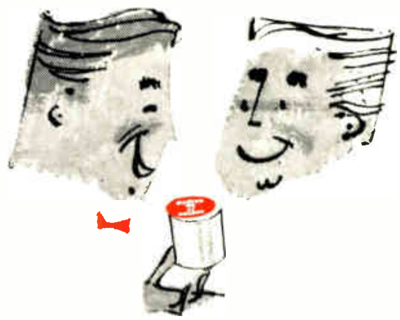
"Been using Kester Flux-Core Solder for almost half a century, Tom; nothing like it."

"Kester Solder spools are always marked with the exact alloy, Joe; no code markings."

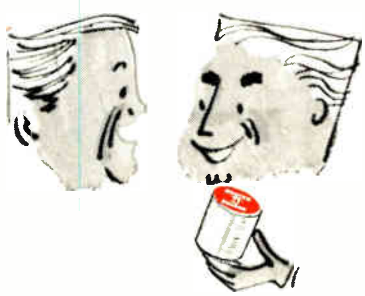
"Nothing like Kester Solder, Fred, for keeping costs in line."



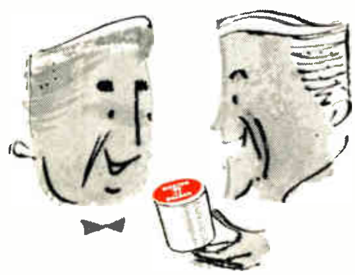
"Our girls swear by Kester, Bert; they claim soldering is much easier."



"Kester 'Resin-Five' Core Solder is the choice for our production, Paul."



"Our work goes much faster now, Bill, since we switched to Kester Solder."



"We had a tough soldering job, Harry, but Kester engineers licked it in a hurry."

SEND TODAY for your free copy of the Kester book, "Solder . . . Its Fundamentals and Usage". . . 78 pages of technical information.

HOW THE WORD GETS AROUND

You hear comments like these everywhere informed people in the electronics industry get together to "talk shop." It's a fact . . . there is nothing quite like Kester Solder. And that's why it's so universally popular.

KESTER SOLDER

Company 4210 Wrightwood Avenue • Chicago 39, Illinois
Newark 5, New Jersey • Brantford, Canada

10,000,000 WATTS OF PACKAGED POWER!

This young Bomac engineer has 10,000,000 watts of power at his fingertips.

Here is an immense new range of power, harnessed for testing Bomac products — power for measuring the life of gas-switching tubes, for assessing tube leakage and temperature rise, for determining high power characteristics of pressurizing windows — power with a vital purpose:

Better microwave tubes, higher power capacities today . . . *still* better tubes, *still* higher power capacities tomorrow.

Write for Bomac's 6-page, file-size folder containing details and specifications on more than 500 different microwave tubes and components.

Bomac LABORATORIES, INC.,
Dept. EI-11 *Beverly, Mass.*

Offices in major cities: — Chicago • Kansas City • Los Angeles • Dallas • Dayton • Washington
Seattle • San Francisco • Toronto **Export:** Maurice I. Parisier, 1860 Broadway, N. Y. C.

Circle 9 on Inquiry Card, page 101

Top Awards To Baker, Hull, Watson-Watt

The Institute of Radio Engineers, Franklin Institute and the A.I.E.E. last month announced the winners of their top annual awards for contributions to the electronic field.

Dr. Albert W. Hull, noted electron tube pioneer, will receive the IRE Medal of Honor for "outstanding scientific achievement and pioneering inventions and development in the field of electron tubes."

Dr. W. R. G. Baker, vice-president of G. E., will receive the IRE Founders Award for "outstanding contributions to the radio engineering profession through wise and courageous leadership in the planning and administration of technical developments which have greatly increased the impact of electronics on the public welfare."

Other IRE awards: The Morris Liebman Memorial Prize, to Edward L. Ginzton; the Harry Diamond Memorial Award, to Edward W. Allen, Jr. of the F.C.C.; and the Vladimir K. Zworykin Television Prize, to Charles P. Ginsburg, Ampex Corp.

The Franklin Institute awarded the Elliott Cresson Medal to Sir Robert Watson-Watt, radiophysicist of Toronto, Canada, for his contributions to the conception of pulsed radar, and his leadership in its development.

The Institute's Stuart Ballantine Medal for outstanding achievement in the field of communications went to two navy scientists, Dr. Robert M. Page and Leo C. Young, of the U. S. Naval Research Lab., Washington, D. C., for their work with pulsed radar.

The Institute's John Price Wetherill Medal was awarded to Warren W. Carpenter for his contributions to the field of switching while associated with the Bell System.

The American Institute of Electrical Engineers named Dr. William L. Everitt, of the Univ. Illinois the second recipient of the Medal in Electrical Engineering Education. Dr. Everitt is a former president of the IRE.

Coming Events

A listing of meetings, conferences, shows, etc., occurring during the period November to March that are of special interest to electronic engineers

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Nov. 2-8: 2nd World Metallurgical Congress, by American Soc. for Metals; Chicago, Ill.

Nov. 6-8: 3rd Annual Symp. on Aeronautical Communications, by IRE; at Hotel Utica, Utica, N. Y.

Nov. 6-8: 10th Annual Conf. on Electrical Techniques in Medicine and Biology, The Joint Executive Committee on Medicine and Biology; at Sheraton - Plaza Hotel, Boston, Mass.

Nov. 7-8: 7th Annual ISA Instrumentation Symp.; at Hotel Sheraton, Phila., Pa.

Nov. 8-10: Hi Fi Show; at New Washington Hotel, Seattle, Wash.

Nov. 11: Plastics for Airborne Electronics Symp., by Society of Plastic Engineers; at Ambassador Hotel, Los Angeles.

Nov. 11-13: Radio Fall Mtg., by IRE & EIA; at King Edward Hotel, Toronto, Canada.

Nov. 11-13: 3rd Instrumentation Conf., by IRE; at Atlanta, Ga.

Nov. 11-15: NEMA Annual Mtg.; at the Traymore Hotel, Atlantic City, N. J.

Nov. 13-14: Mid-America Electronics Conv., by IRE; Municipal Auditorium, Kansas City, Mo.

Nov. 13-15: Industrial Audio-Visual Exh.; at Trade Show Bldg., New York, N. Y.

Nov. 15-16: New England Radio-Electronics Meeting, by IRE; at Mechanics Hall, Boston, Mass.

Nov. 17-21: 8th National Plastics Exposition, by SPI; at International Amphitheatre, Chicago, Ill.

Nov. 18-20: Conf. on Magnetism & Magnetic Materials, by AIEE, APS, AIMME, IRE & ONR; at Hotel Sheraton Park, Washington, D. C.

Nov. 18-22: 3rd Electron Microscope School, Norelco; 750 S. Fulton Ave., Mt. Vernon, N. Y.

Nov. 25-26: IAS International Meeting, by IAS; at Canadian Aeronautical Inst., Canada.

Dec. 1-6: Annual Meeting of ASME; at Hotels Statler, Sheraton & McAlpin, New York.

Dec. 4-5: Annual Vehicular Communications Mtg., by IRE; at Statler Hotel, Washington, D. C.

Dec. 9-13: Eastern Joint Computer Conf., by IRE, ACM, and AIEE; at Park Sheraton Hotel, Washington, D. C.

Dec. 18-22: Conf. on Maintainability of Electronic Equipment, by EIA; at Univ. of Southern Calif., Los Angeles.

Jan. 6-8: 4th National Symp. on Reliability & Quality Control, IRE; at Hotel Statler, Washington, D. C.

Jan. 20-24: AIEE Winter General Meeting; Hotel Statler, New York, N. Y.

Jan. 22-24: Conf. on Automation, by EIA; at Arizona State College, Tempe, Ariz.

Jan. 27-30: 11th Annual Symp. on Modern Methods of Analytical Chemistry; at Louisiana State Univ., Baton Rouge, La.

Feb. 10-14: Committee Week, by American Soc. for Testing Materials; at Hotel Statler, St. Louis, Mo.

Feb. 20-21: Conf. on Transistor & Solid State Circuits, by IRE; at Univ. of Pennsylvania, Philadelphia, Pa.

Feb. 20-24: Industrial Relations Conf., by EIA, at Town & Country Hotel, San Diego, Calif.

Mar. 11-13: 8th Annual Conf. on Instrumentation for the Iron & Steel Industry; at Roosevelt Hotel, Pittsburgh, Pa.

Mar. 16-21: Nuclear Engineering & Science Conf., IRE, ASME, EJC & ANS; Chicago, Ill.

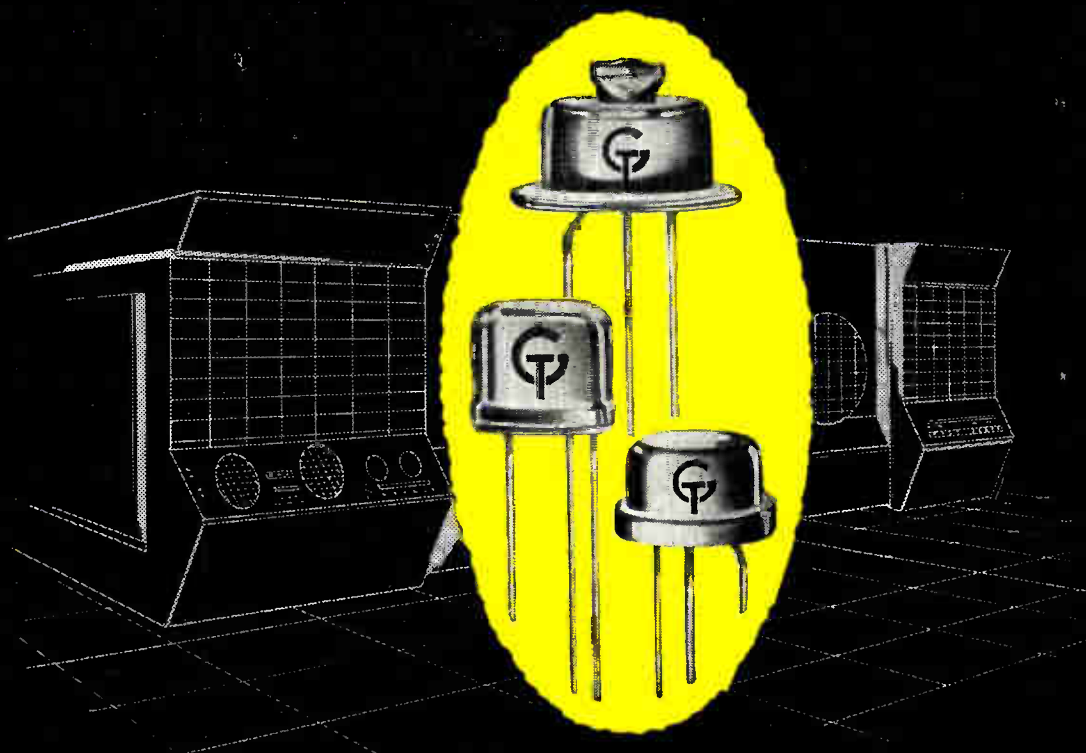
Mar. 24-27: IRE National Convention; at Waldorf-Astoria Hotel & Coliseum, New York, N. Y.

Abbreviations:

ACM: Association for Computing Machinery
AIEE: American Inst. of Electrical Engrs.
AIMME: American Institute of Mining and Metallurgical Engineers
APS: American Physical Society
ASME: American Society of Mechanical Engineers
EIA: Electronic Industries Assoc.
IAS: Inst. of Aeronautical Sciences
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
NEMA: National Electrical Manufacturers Assoc.
ONR: Office of Naval Research
SPI: Society of Plastic Industries

VERSATILITY OF DESIGN

TRANSISTORS



G.T. computer transistors

- MINIATURIZATION
- PORTABILITY
- RELIABILITY
- EXTENDED LIFE

Simplifying and miniaturizing circuitry with GT germanium alloy type transistors, control engineers are now able to design lighter weight, portable, more reliable units than by previous methods with conventional components.

General Transistor's PNP and NPN transistors are playing a vital role in advancing the designs of control systems.

Versatility of design is now available — write today for Bulletin G-100 containing all types list and dimensional drawings.

Typical Applications:

- Relay Amplifier
- Direct Current Switch
- Photoelectric readout & control
- Micro and millisecond switching
- Servo driver applications
- Control lighting
- Phase detector circuitry
- Low level modulation

GENERAL TRANSISTOR CORPORATION

91-27 138TH PLACE, JAMAICA 35, NEW YORK

Circle 10 on Inquiry Card, page 101

Personals

John J. Lynott, Harold G. Markey, and Robert C. Schneider have been promoted to the position of staff engineer at the Research Laboratory of IBM.

Dr. Robert Frank Miller, former member of the faculty at the University of Wisconsin Electrical Engineering School, has joined the Delco Radio Div. as a research engineer in the Semiconductor Research & Engineering Dept.

A. G. Holtum, Jr. was recently appointed to the position of chief engineer with the Andrew California Corp. He was previously with the Army Electronic Proving Ground, Ft. Huachuca, Ariz., where he held the position of Chief, Radio Communications Div., Signal Communications Dept., engaged in scientific testing and evaluation of communication systems and concepts.


A. G. Holtum, Jr.


S. M. Berkowitz

Samuel M. Berkowitz has joined Philco Corporation's Government & Industrial Div. as an executive engineer in air traffic control. He was with the Philadelphia Franklin Institute research and development laboratory for the last 10 years. During this time he was engaged in systems engineering and development in the field of military and civilian air traffic control.

Cliff N. Williamson is now chief engineer of the Central Engineering Div., Airpax Products Co.

Robert S. Babin, electronic engineer, has joined the technical staff of the Communications Div., The Ramo-Wooldridge Corp. He was formerly electronic scientist with the U. S. Dept. of Defense, Washington, D. C.

Roy C. Irick has joined Pacific Semiconductors, Inc. as head of applications engineering. He was formerly project engineer on the Sidewinder guided missile at the U. S. Naval Ordnance Lab.

Roe Nardone is now director of Haydu Electronic Products, Inc. and also director of engineering.

Arthur R. Marshall has been appointed engineering supervisor in the Boston District of the ElectroData Div. of Burroughs Corp.

NOW... *Ruggedized*

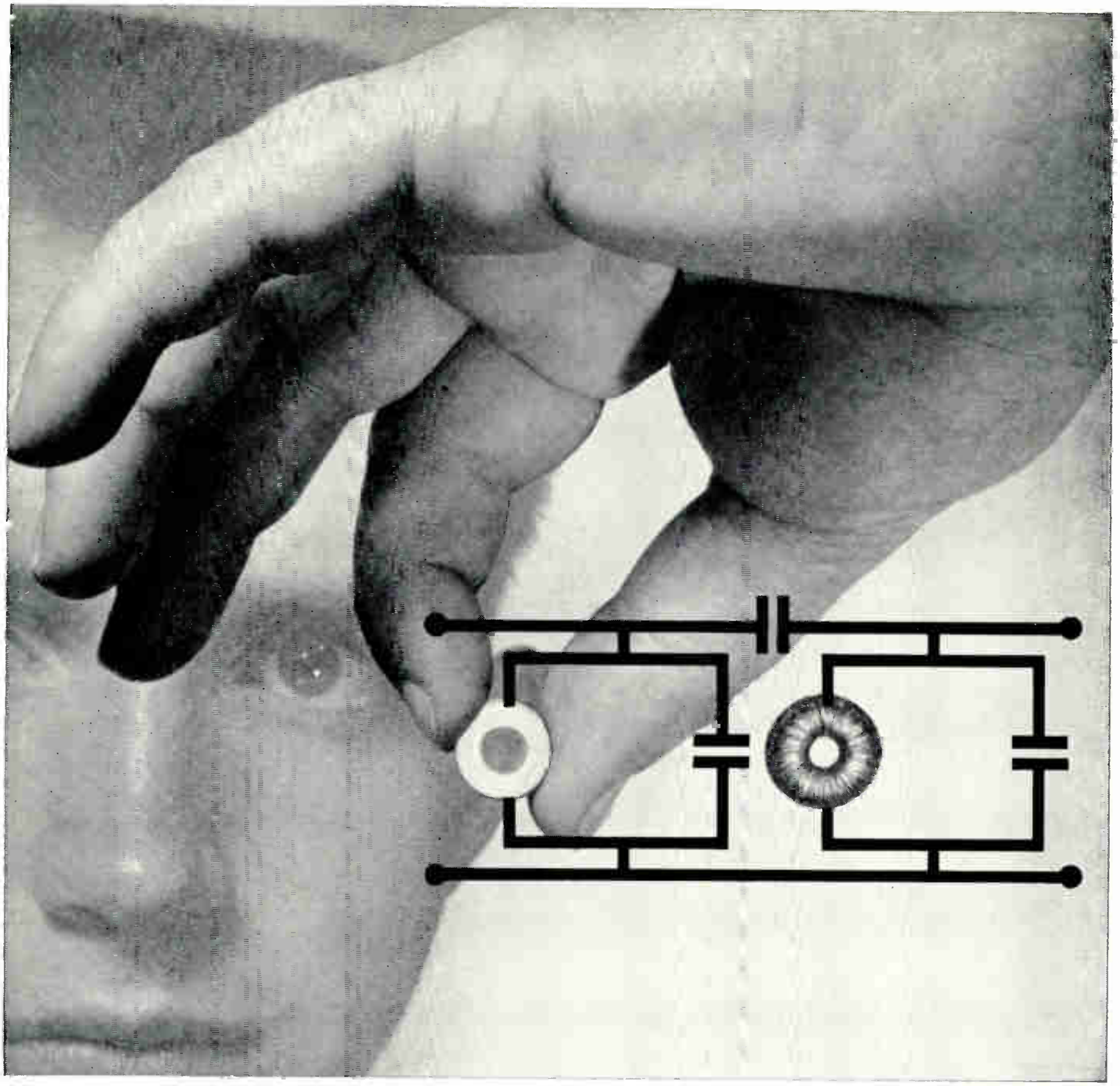
PANEL METERS *with* LONG 250° SCALES

First with a comprehensive line of ruggedized d-c and a-c panel meters, Weston now provides these instruments in the popular 3½″ size with *long readable scales, higher accuracy, improved sensitivities* and *superior ballistic characteristics*. Designed to meet, *and surpass in scale length and accuracy*, all requirements of MIL-M-10304A. They incorporate all Weston ruggedized design features including integrally molded and bonded shock mounting plates; shock-absorbing spring-backed jewels; screw driver type zero correctors, front sealed; anti-static treated plastic sealed windows; self shielding etc. For all the facts, consult your nearest Weston representative, or write—Weston Electrical Instrument Corporation, Newark 12, New Jersey.

WESTON *Instruments*

A DAYSTROM UNIT

Circle 12 on Inquiry Card, page 101



Now you can use molybdenum permalloy powder cores in miniaturized circuits

When your engineering neighbor talks about "Cheerios" these days, he's apt to be discussing a new breakfast cereal-sized molybdenum permalloy powder core which has found a happy niche as a miniaturized filter component. Guided missiles, which are filling the troposphere these days, typically use these little fellows in their amplifier circuits. Small (down to .300-in. ID), they are tough and easy to use. They also provide a markedly high degree of stability with time, temperature and magnetization.

Made by Magnetics, Inc. (Performance-Guaranteed, of course) they provide the highest permeability and lowest core losses possible in use in filter, audio and carrier frequency circuits. We provide extras, too—you may specify our very exclusive feature—color-coding. Color-coding tells your assemblers how many turns to put on your cores without the lost time and extra expense of special testing.

Want more facts? There's a brand new bulletin (PC-103A), full of important information. It's yours by writing *Magnetics, Inc., Dept. TT-35, Butler, Pennsylvania.*

MAGNETICS inc.

SAVE SPACE AND WEIGHT IN AIRBORNE RADAR

Miniaturized 3″ to 12″ diameter radar tubes save space and weight in military and commercial installations. Ideal for use in airborne radar or *any* installation requiring high performance with miniaturization.

Du Mont miniaturized radar tubes feature short overall length and small neck diameter. Nine-pin miniature design saves base and socket weight. Reasonable power requirements aid in reduction of associated circuitry size and weight.

Detailed specifications upon request . . .

DU MONT RADAR TUBES

TABLE OF IMPORTANT SPECIFICATIONS

Type	Diameter	Length	Focus	Deflection	Neck Diameter	Voltage	Deflection Angle	Screen
B1173	3″	5⅛″	Elect.	Mag.	⅞″	7KV	70°	Alum.
K1517	3″	6⅜″	Elect.	Mag.	⅞″	8KV	Off Center Neck	Alum.
5BCP—	5″	7″	Mag.	Mag.	⅞″	8KV	70°	Reg.
B1174	5″	6 5/16″	Elect.	Mag.	⅞″	8KV	70°	Alum.
B1142	7″	8½″	Mag.	Mag.	⅞″	8KV	70°	Reg.
B1175	7″	7 13/16″	Elect.	Mag.	⅞″	10KV	70°	Alum.
B1191	10″	10 5/16″	Elect.	Mag.	⅞″	10KV	70°	Alum.
B1132	10″	12½″	Elect.	Mag.	1 7/16″	10KV	78°	Reg.

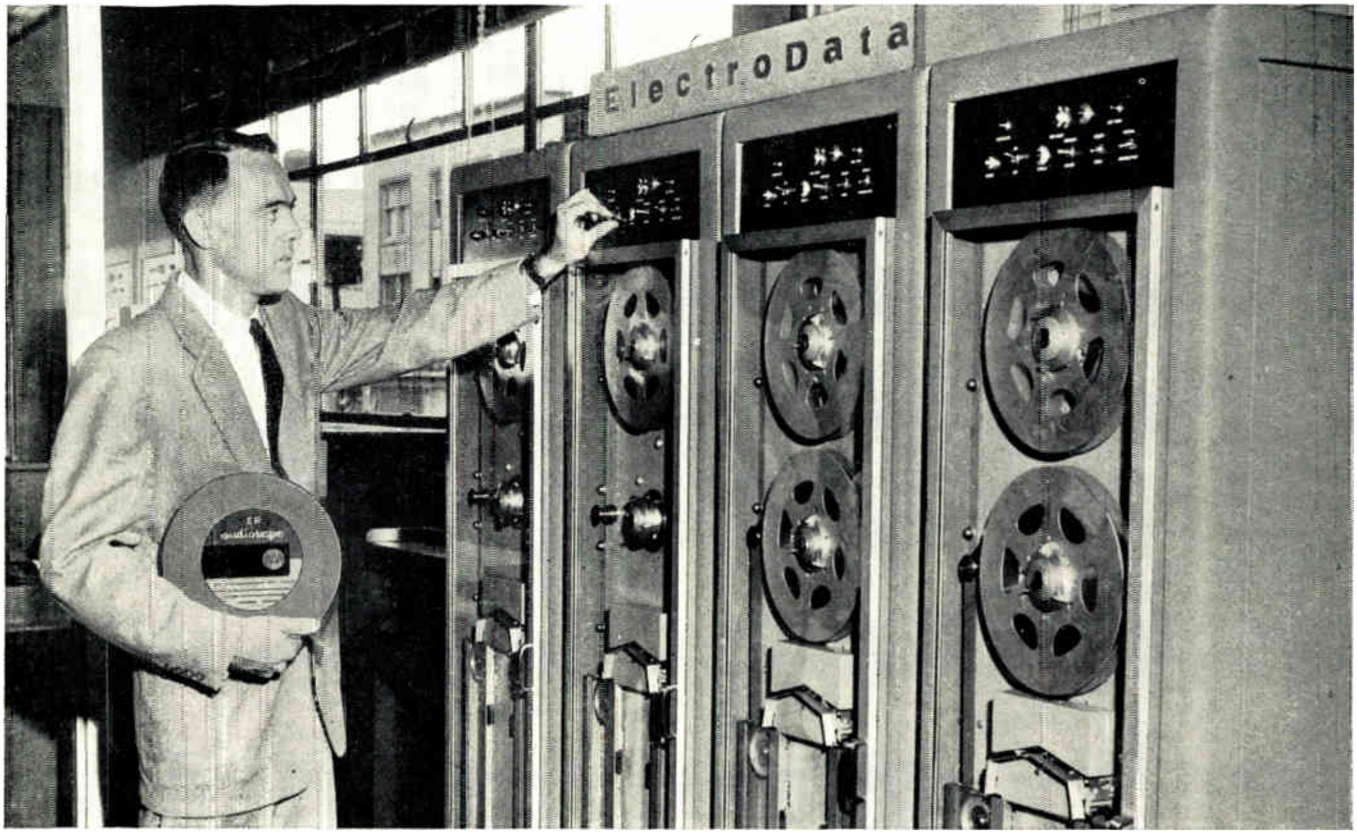
Industrial Tube Sales, Allen B. Du Mont Laboratories, Inc., 2 Main Ave., Passaic, N. J., U.S.A.

Circle 14 on Inquiry Card, page 101

General Insurance of America Tested

. . . and picked audiotape

TRADE MARK



Chief Engineer Cites Audiotape's "oxide dust-free coating, uniform signal output . . . high precision"

When General Insurance Company of America bought four Electrodata tape transports 18 months ago, they knew one thing: their computing system should have the finest magnetic recording tape available. It was decided that the best way to make the final decision was to test.

The tests started immediately. Every nationally known make of magnetic recording tape was used on the transports for at least a month. The result was clear; type EP Audiotape was chosen.

As D. G. Jessup, Chief Engineer of General's Computing Department, wrote in a letter to Audio Devices, "To obtain the optimum reliability and performance from our computing system we need the oxide dust-free coating, uniform signal output level correct in both directions of travel, and high precision reels which you supply. Keep up the good work!"

The extra precision Mr. Jessup found in type EP Audiotape is not a matter of chance. Rather it is the result of meticulous selection and inspections that start when the master rolls of base materials are examined for uniformity. The quality control is continued through the manufacturing process, ending only when the tape is checked by a defect counter, rejects discarded, and the defect-free tape packed in sealed containers. This high standard of control is backed up by our guarantee that every reel of type EP Audiotape is defect-free.

For more information on Type EP AUDIOTAPE, contact your nearest Audio sales engineer, or write for bulletin T112A.

it speaks for itself

audiotape

TRADE MARK

AUDIO DEVICES, INC., 444 Madison Ave., New York 22, N. Y.
Offices in Hollywood and Chicago
Export Dept.: 13 East 40th St., New York 16, N. Y.

Statement of Policy for 1958 by

ELECTRONIC INDUSTRIES

A Chilton Publication

Circulation Policy:

50,000 The publisher guarantees a distribution in excess of 50,000 copies of ELECTRONIC INDUSTRIES by the end of the first quarter of 1958. Your ELECTRONIC INDUSTRIES representative will give you details. (Rates established June 28, 1957)

Editorial Policy:

ENGINEERS All important technical advances will receive their first engineering treatment in depth in ELECTRONIC INDUSTRIES. This editorial policy is piloted by our engineer-readers' demand for exact detail not available in semi-technical reports. Today's fast-breaking electronic developments simply cannot be adequately communicated to engineers without editorial treatment in depth.

In 1958, therefore, readers can depend on ELECTRONIC INDUSTRIES' editors to be first in describing technical breakthroughs with usable thoroughness.

Publishing Policy:

MONTHLY In a field served by many weeklies, a monthly publication like ELECTRONIC INDUSTRIES must assume industry leadership. Readers expect its pages to reflect considered editorial judgement; to assemble working concepts from the flood of new design ideas; and to contain important details unavailable from other sources.

ELECTRONIC INDUSTRIES is one of sixteen magazines published by the Chilton Company, one of the nation's largest publishers of industrial and trade magazines. Readers and advertisers can depend on Chilton Company for a monthly electronic publication of engineering stature.

SIX STARCH STUDIES IN 1958

ELECTRONIC INDUSTRIES is the only electronic publication to offer a continuing program of Starch advertising readership studies. To meet advertisers' requests for this extra service, six issues have been scheduled for Starch studies in 1958. Issues will be January, March, April, July, October and December.

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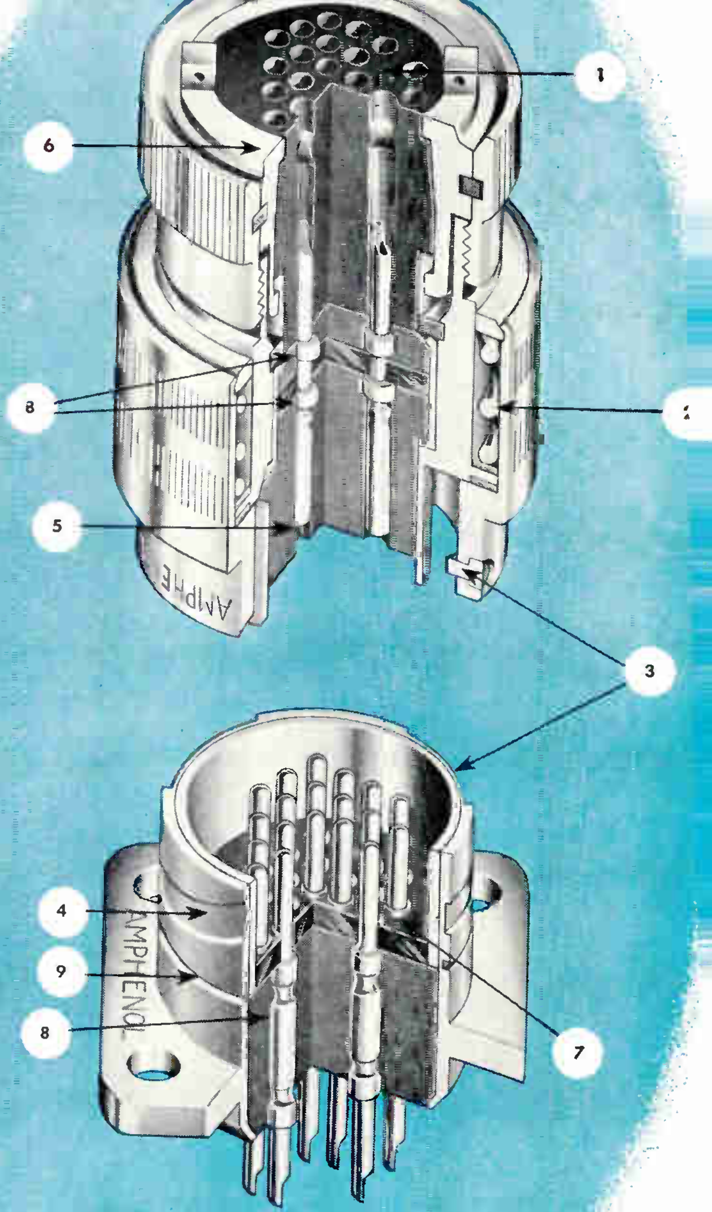
 Circle 16 on Inquiry Card, page 101

MINNIE

MINIATURE CONNECTORS

. . . the only miniature connector line fully conforming to the "E" REQUIREMENTS OF MIL-C-5015C.

Meet minniE—a complete line of miniature connectors with outstanding reliability features! The first miniatures to meet fully the "E" performance requirements of MIL-C-5015C, minniE's are environmentally sealed to resist moisture and humidity; ruggedly built to resist shock and vibration; imaginatively designed to provide application versatility.



FEATURES

1. Environmentally sealed with unitized back end grommet. (Also available with provision for potting.) Either grommet seal or potted seal meets moisture resistance requirement of MIL-C-5015C, Paragraph 4.5.21.
2. Spring-loaded coupling ring provides a positive locking action in the bayonet slot, and a constant compensating force which eliminates the effects of resilient face seal compression set.
3. Stainless steel bayonet slots and pins reduce wear and frictional characteristics. The three pin bayonet coupling minimizes the rocking action of the mated plug and receptacle.
4. Flattened incline angle of bayonet slots reduces mating force requirement.
5. Hooded contacts resist test prod damage as defined in Paragraph 4.5.14 of Amphenol Specification 340-43-2108.
6. Unitized grommet seal; clamp and grommet form a single unit for ease of assembly and maintenance.
7. Face seal gasket with individual barriers to isolate each contact.
8. Hard insert dielectric (plus resilient face seal) positively retains contacts with no possibility of contacts being pushed out of the insert.
9. A visual full engagement indicator is included in the design to insure the user that he has fully engaged the connectors. The indicator is an orange line around the receptacle shell.

- When using mated sealed connectors, no derating for altitude is necessary at 70,000 feet.
- Test voltage 1,500 volts RMS 70,000 feet on sealed connectors.
- Vibration per Method 204 of MIL-Std-202A. 10 to 2,000 cps at 20 g's.
- Temperature cycling range per MIL-C-5015C, Paragraph 4.5.3 increased to 257°F. maximum and —67°F. minimum.

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AMPHENOL

AMPHENOL ELECTRONICS CORPORATION *1830 S. 54th Ave., Chicago 50, Illinois*

*Please send me a copy of **MINNIE** catalog.*

NAME____________________

TITLE____________________

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NUMBER & STREET____________________

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AVAILABILITY:

4 CONSTRUCTIONS: "E", Potting, Jacketed Cable, Cable Clamp
5 SHELL SIZES: 12, 14, 18, 20, 22
17 INSERT ARRANGEMENTS: Up to 48 contacts; coax and hermetic seals also

Circle 17 on Inquiry Card, page 101

Letters
to the Editor

"Sunspots Aid Radio"

The Editor,
ELECTRONIC INDUSTRIES:

I refer to the article "Sun Spots Aid Radio Circuits" in the June, 1957, issue of ELECTRONIC INDUSTRIES and particularly to the explanation to Fig. 3 which says: "Sun spot count and radio signal quality over the past three years show positive correlation in this chart" and can only say that the almost very opposite is true.

The curve for the signal quality clearly indicates that the time of best reception for the three years falls in the June-July period, whereas the very opposite is true for the sun spot activity curve.

Furthermore whereas the sun spot numbers show a tremendous and steady increase according to the well established 10-11 year sun spot cycle, there is no such parallelism noticeable in the quality of reception curve. Also, Mr. Nelson's theory that the collective action of gravitational field of the planets may explain the varying sun spot activity is absolutely untenable because for it to be true a 10 to 11 year planetary position cycle with respect to the sun should be provable which, of course, it cannot.

H. D. Isenberg
Dielectric Materials Co.
5315-17 N. Ravenswood Ave.
Chicago 40, Ill.

The Editor, ELECTRONIC INDUSTRIES:

I would like to answer the letter from Mr. Isenberg through you.

1. The Central Radio Propagation Laboratories of the National Bureau of Standards, Boulder, Colorado, will confirm my statement that the rise in the Sunspot Cycle was accompanied by improved radio conditions.

2. This graph is for the 10 PM EST. monthly average. Due to the long hours of daylight over the North Atlantic in June and July these two months are always the best months of the year since the long hours of daylight along the radio-path permit us to work on the higher night frequencies which are relatively free from noise.

3. The worst months of the year are always March-April and Sept.-Oct. The graph shows a distinct rise in signal qualities for these months as compared to 1954 and the beginning of 1955 at which time the Sunspots started to rise.

4. The signal quality curve does not continue to rise after a certain point has been reached because signals are rarely rated as better than Fair to Good or Good by anybody on

(*Continued on page* 28)

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Letters

to the Editor

(*Continued from page 25*)

a world wide basis. Part of the reason for this is that the quality rating is taken as an average for a group of stations. If only one signal was rated it would sometimes be rated as excellent.

5. The planets have a very definite effect upon the sun and the sunspot curve as has been shown by many investigators during the past 100 years. I use the planets as the primary data source for my 90 per cent accuracy forecasting system.

J. H. Nelson
Propagation Analyst
RCA Communications
66 Broad St.
New York 4, N. Y.

"Electronics In the Automobile Industry"

Editor, ELECTRONIC INDUSTRIES:

Following the publication of "Electronics in the Automobile Industry" in the Sept. issue of ELECTRONIC INDUSTRIES, A. Gardiner of Dayton, O. wrote and informed me that the reduction in size and weight of various components when replacing dc by ac reaches the optimum for a frequency of the order of 240 cps.

Among the letters received, one came from New York, requesting data on Fig. 5 and did not bear any address. Would this reader please get in touch with me again?

I have received a number of very interesting letters since the article was published. Unfortunately I have not yet enough additional data or details. I have written to France for more information.

Dr. A. V. J. Martin
Dept. of Electrical Engrg.
Carnegie Inst. of Technology
Schenley P rk
Pittsburgh 13, Penna.

"Balloon Flight"

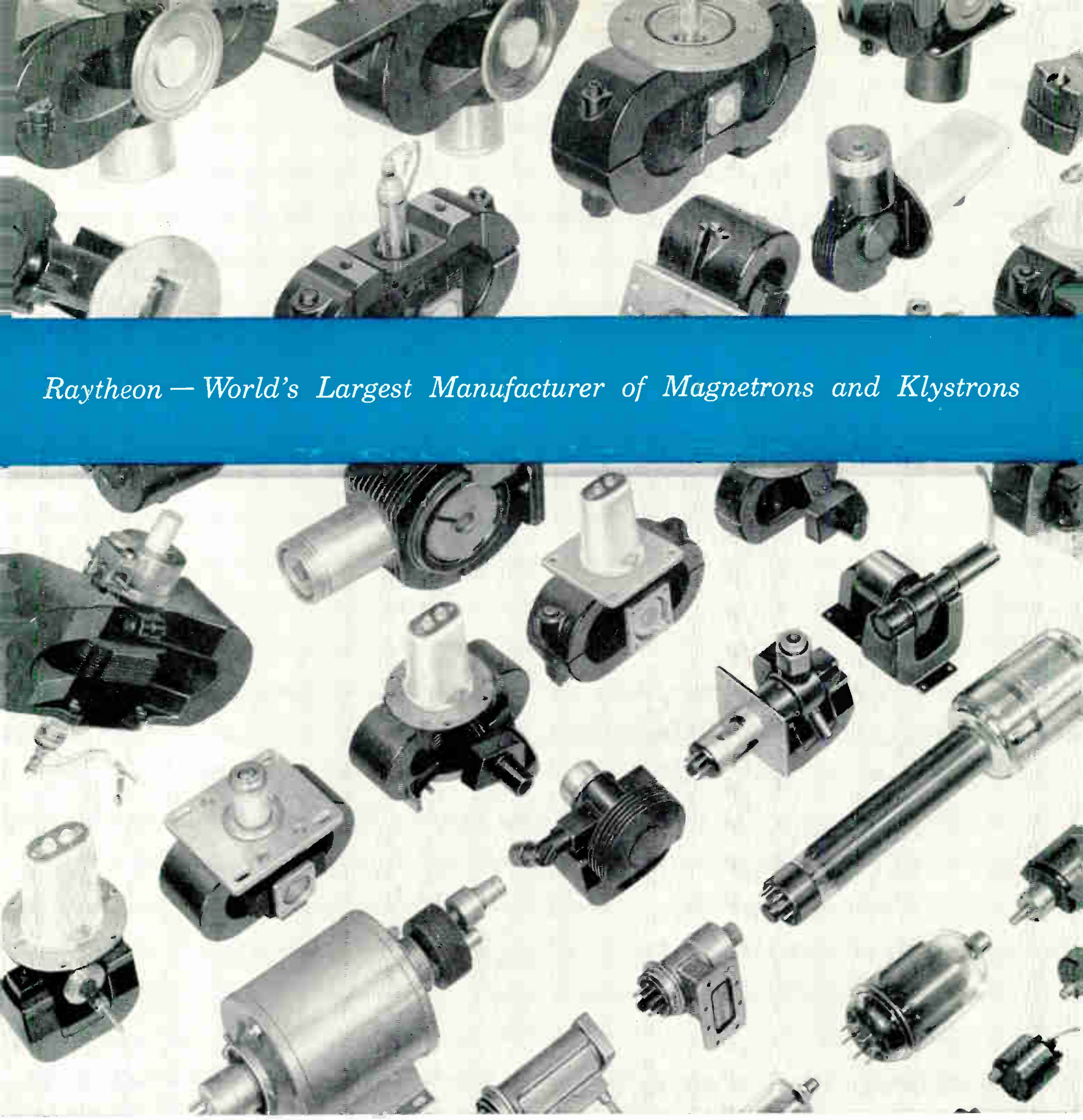
Editor, ELECTRONIC INDUSTRIES:

I wish to thank you and your organization for the assistance last Wednesday of Mr. Arnold Look with my balloon ascension at Valley Forge, Pa.

He was of inestimable value both technically and manually and greatly contributed to the success of the venture.

I do hope that he was able to gain a familiarity with balloons and aerostatics that will be of value in the future.

Donald L. Piccard
219 Dickinson Avenue
Swarthmore, Penna.



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Magnetrons from 1 to 5,000,000 Watts — Klystrons from 600 to 60,000 Mc — Backward Wave Oscillators from 1,000 to 15,000 Mc. Plus, a broad line of special tubes including storage tubes, rectifiers, square law and traveling wave tubes. Write for complete data booklet on the most complete line in the industry.

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Circle 22 on Inquiry Card, page 101

BUILD STABILITY and LONG LIFE into your low voltage power supplies

with SANGAMO Type DCM Electrolytic Capacitors

SC57-9

These high quality electrolytic capacitors are especially designed for use as energy storage components in DC circuitry where peak power requirements exceed the maximum output of the associated power supply.

Sangamo Type DCM Capacitors provide exceptionally low equivalent series resistance . . . have extremely high capacity for case size in low voltage ranges . . . are designed to permit high ripple current without overheating. They minimize ripple voltage and insure steady, stable DC voltage. Use of the Sangamo DCM eliminates any need for heavy, bulky choke components.

Type DCM Capacitors can be supplied in maximum energy content rating of 80-watt seconds in voltage ratings from 15 to 450 VDC. Maximum capacity value of 33,000 mfds. can be supplied at 15 WVDC.

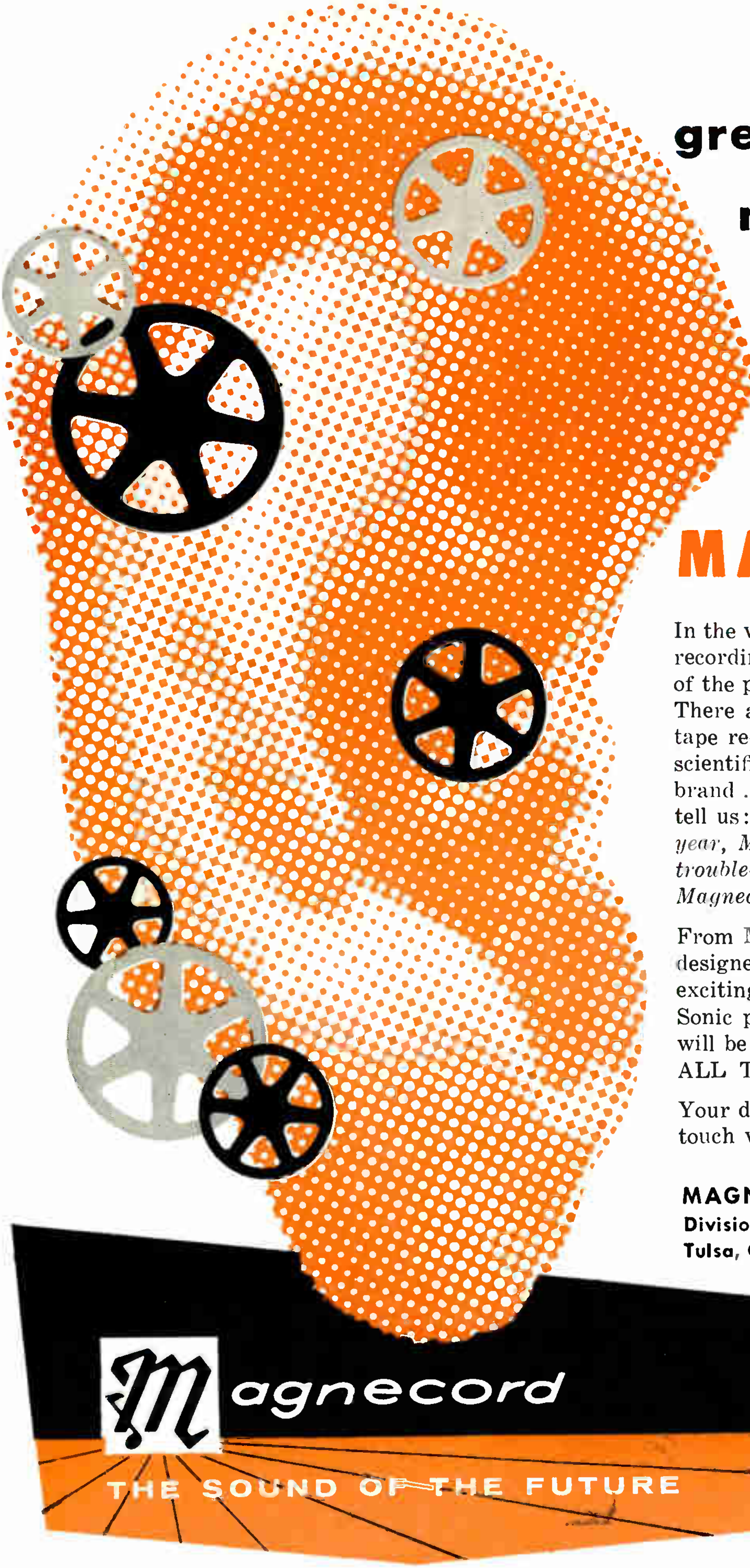
Write for Engineering Bulletin TSC-114C.

CAPACITY CHART

Rated Voltage	Surge Voltage	Max. Cap. 1⅜ x 4⅛	Max. Cap. 1¾ x 4⅛	Max. Cap. 2 x 4⅛	Max. Cap. 2½ x 4⅛	Max. Cap. 3 x 4⅛
5	7	8500	15000	20000	33000	45000
15	20	6000	10500	13500	24000	35000
25	40	4500	8000	10000	17500	25000
50	75	1750	3250	4250	8000	10000
75	100	1000	1500	2250	4250	6000
100	135	675	1250	1500	3000	4000
150	185	600	1000	1250	2500	3500
200	250	300	500	600	1000	1500
250	300	225	375	450	850	1200
300	350	200	350	400	750	1100
350	400	170	300	375	700	1000
400	475	140	250	325	575	850
450	525	125	225	275	500	800

For additional capacity and voltage combinations, write us.

SANGAMO Electric Company
SPRINGFIELD, ILLINOIS



great new ideas coming from MAGNECORD

In the world of professional tape recording MAGNECORD is the name of the pioneer, the originator. There are probably more Magnecord tape recorders in professional and scientific use in America than any other brand . . . and as many of our users tell us: *"day in and day out, year after year, Magnecord quality performance is trouble-free and rugged. We depend on Magnecord!"*

From Magnecord engineers and designers you may expect new and exciting developments . . . SOON! Sonic perfection never before achieved, will be featured in the NEW . . . ALL THROUGH Magnecord equipment.

Your distributor will know. Keep in touch with him.

MAGNECORD
Division of Midwestern Instruments, Inc.
Tulsa, Oklahoma

Circle 24 on Inquiry Card, page 101

SMALLEST... lightest in its class!

new

OAK

SERIES M

DC-AC low level inverter

*Depending on packaging

designed for 30G vibrations from 0-500 CPS

While the rugged Series M is probably the smallest, lightest, polarized relay ever built, electronic designers will find that it has other characteristics equally exciting. For example, tests indicate that variations of the standard unit produce the *lowest* noise level ever achieved in this class of chopper.

Another valuable feature is the unusually wide selection of custom-built packages available to designers. These include: side, vertical, and flange mounts; coil leads at top or bottom; straight plug-in; flexible pigtails; solder mounts; dual unit package; and double sealing with shock mounting between the two cans.

Investigate the Series M now. Contact your Oak representative, or write for complete data.

UNIQUE DESIGN ELIMINATES PARTS FOR UNUSUAL SIMPLICITY

The Series M chopper gains its extreme simplicity from a new design approach based on the advantages of an oriented ceramic magnet. In addition, the switch unit contains no organic insulation, is mounted independently of the drive coil, and has its own hermetic seal.

Operating Frequency—0-1000 cps; special units to 1800 cps.
Coil—6.3 volts ±20% at 60 to 500 cps; 60 ma max at 400 cps; 85 ohms (DC).
Phase Angle, Lag—55° ±10° at 400 cps; 20° ±2° at 60 cps.
Dwell Time—165° min.
Dissymmetry—15% max.
Mounting—Any position.
Temperature—From −55°C to +100°C; special to +125°C.
Weight—Less than ¾ oz. for the plug-in unit.

OAK MFG. CO.

1260 Clybourn Ave., Dept. V, Chicago 10, Ill.
Phone: MOhawk 4-2222

SWITCHES • ROTARY SOLENOIDS • CHOPPERS • VIBRATORS • SPECIAL ASSEMBLIES

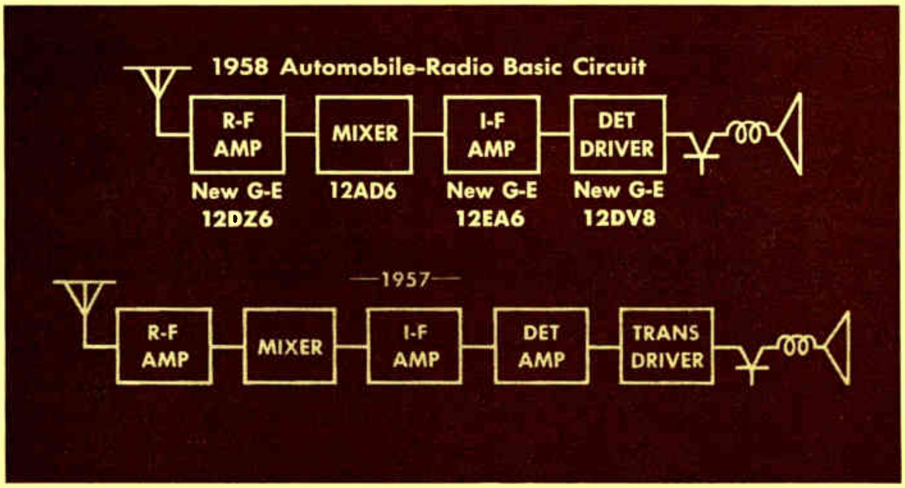
Circle 25 on Inquiry Card, page 101 Circle 26 on Inquiry Card, page 101 →

GENERAL ELECTRIC

TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY

Three New General Electric Tubes Cut Automobile Radio Costs, Simplify Circuitry, Improve Reception



EXTRA-SENSITIVE PERFORMANCE IN 1958 CAR RADIOS—YET FEWER TUBES! A G-E 9-pin miniature detector-driver tube now does the work of both the detector-amplifier and transistor-driver tubes formerly used. At the same time, new high-gain G-E r-f and i-f amplifier tubes materially increase sensitivity, for clearer reception.

Two years' creative design and development by G-E tube engineers, who worked in close cooperation with the major manufacturers of automobile radios, stand back of three new high-gain tubes that make 1958 car radios more economical to build, with fewer sockets. From the time 12-volt vibratorless radios appeared, frequent conferences between car-radio designers and G-E tube engineers have called into play the latest and best in tube thinking. The G-E 12AF6 was one important outcome. This was 1956's largest-selling new receiving tube!

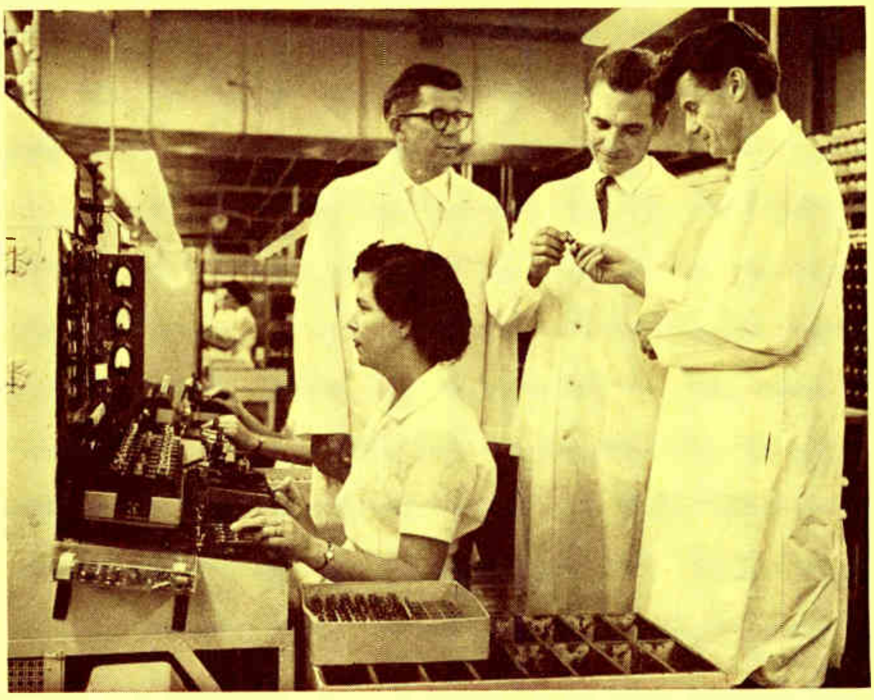
Now . . . a year later . . . General Electric promotes still higher standards of car-radio performance with Types 12DZ6, 12EA6, and 12DV8. Phone any G-E tube office on the next page for full information.

Noise Rejection is Design Feature of G-E Twin Pentodes 3BU8 and 6BU8

Showing by their performance how up-to-the-minute tube engineering can benefit the TV manufacturer—reduce his costs, improve picture quality—General Electric's 3BU8 and 6BU8 are thrifty multi-function tubes that within a single envelope, perform both noise-cancellation and AGC functions.

Turn page to study the recommended application of these tubes! Oscilloscope readings are included—also plate-characteristics curves—in order to aid television circuit designers.

35,000,000th 5-Star Tube Milestone in High Reliability



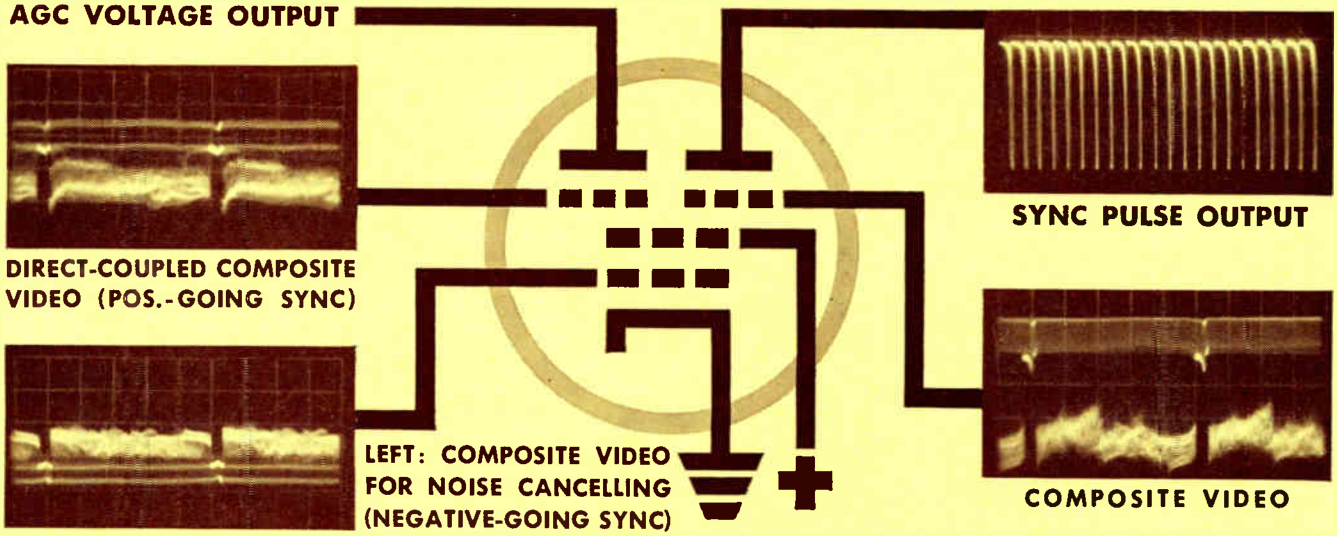
RIGHT: R. M. Duncan, manager of General Electric's Owensboro, Ky., tube plant (second from right), and two of his staff inspect the 35,000,000th 5-Star high-reliability tube, a 5670, which has just passed its initial electrical-characteristics tests. Record high total for these tubes proves their wide use in critical military, airborne, and industrial applications.

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

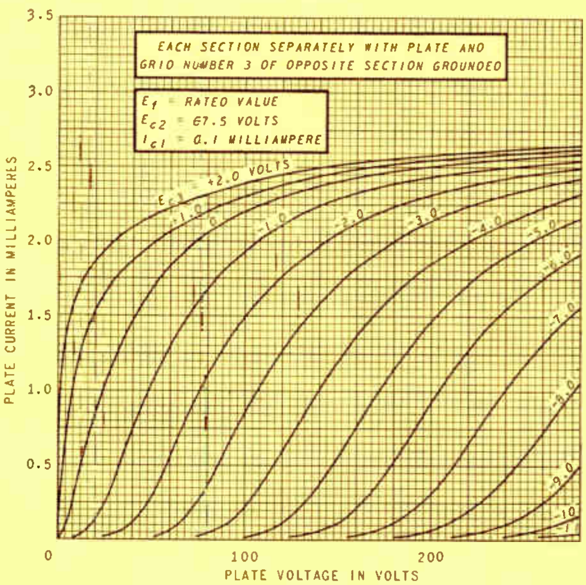
Developed and designed by G.E., Types 3BU8 and 6BU8 are twin pentodes that provide outstanding low-noise performance, with economy. The two tubes are identical except for heater ratings (3.15 v, 6.3 v). Also, the 3BU8 has controlled heater warm-up for service in 600-ma series-string circuits.

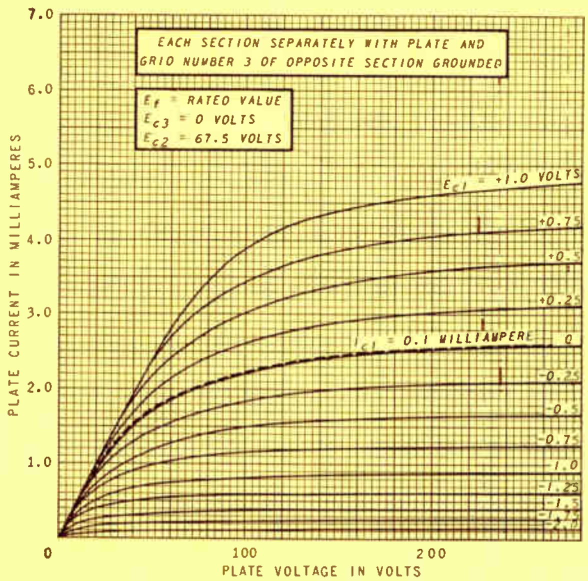
Cathode, Grid No. 1, and screen grid are common for both sections of the 3BU8 and 6BU8. Use of a common No. 1 grid makes possible the rejection of noise pulses from both tube sections. The recommended application for these G-E twin pentodes is: one section, AGC keyer or amplifier . . . the other section, combined sync amplifier, separator, and clipper.

Reproduced below from photographs, are scope readings of tube performance, element by element, in this recommended application.



SHOWN BELOW ARE AVERAGE PLATE CHARACTERISTICS, TYPES 3BU8 AND 6BU8





For further information, write or phone your nearest G-E tube office below:

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

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

WESTERN REGION
11840 West Olympic Boulevard
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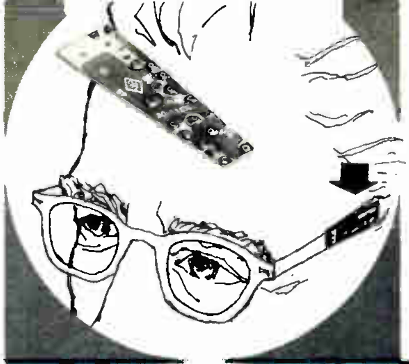
Progress Is Our Most Important Product

GENERAL ELECTRIC

162-1C7

RECEIVING TUBE DEPARTMENT, GENERAL ELECTRIC COMPANY, OWENSBORO, KENTUCKY

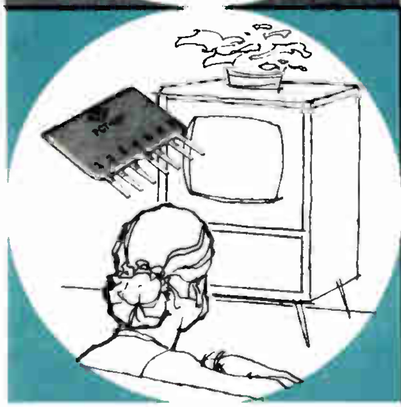
Centralab 1922 1957 35 YEARS

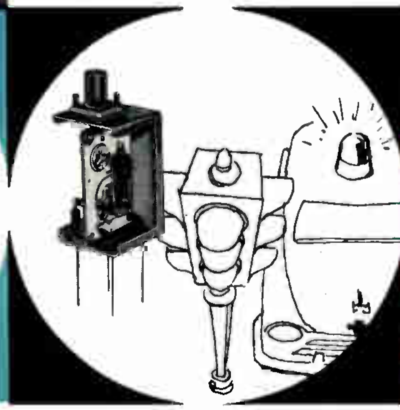


HEARING AIDS — PEC provided compact design, making attractive eye-glass hearing aid possible.

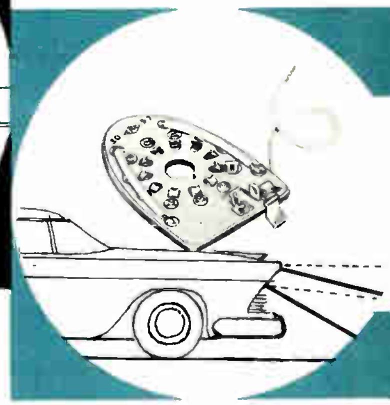
TRAFFIC — PEC helps control flow of traffic for safe passage of emergency vehicles.

TV SETS — 17 PEC's replaced over 100 parts, simplifying assembly and improving performance.





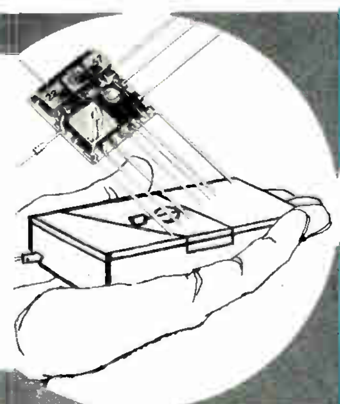
AUTOMOTIVE — PEC provides photo-multiplier tube socket and 20 resistors in one space-saving, packaged unit.



Centralab®

Proof of Reliability and Versatility...

85,000,000 PEC's* (Packaged Electronic Circuits) used in these and other applications



Packaged circuits mark decade of electronic progress

Centralab PEC's — combining capacitors, resistors, inductors, and wiring in one compact sub-assembly — were originally designed for military applications. And due to their reliability and versatility, more than 85,000,000 have been used during the past ten years to guarantee circuit performance in countless electronic products. New developments promise even greater design flexibility for future applications.

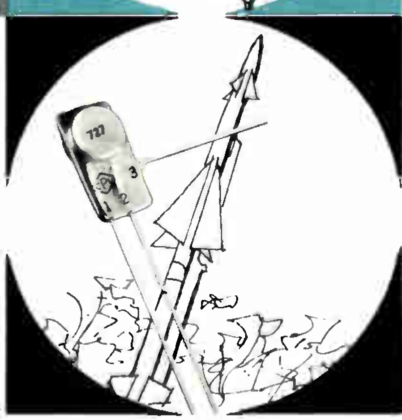
ELECTRONIC ORGAN — PEC filter reduces sharp transient of keying to give natural touch response.

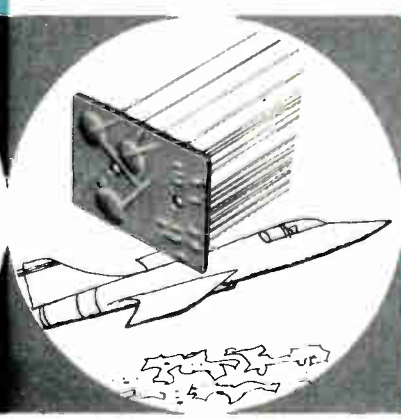
JET AIRCRAFT — PEC's simplify assembly of instrument panels . . . guarantee circuit performance.

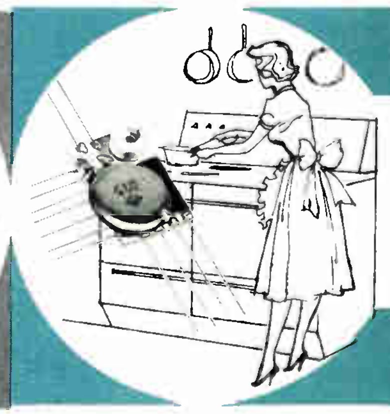
APPLIANCES — PEC in surface burner control enables finer selectivity of temperature.

PORTABLE RECORDER — PEC amplifier provides large recorder quality to miniature tape recorder.

GUIDED MISSILES—Rugged, compact PEC's save space, are shockproof and resist extreme heat.







Centralab A DIVISION OF GLOBE-UNION INC.
914 EAST KEEFE AVENUE • MILWAUKEE 1, WISCONSIN
IN CANADA: 804 MT. PLEASANT RD. • TORONTO, ONTARIO

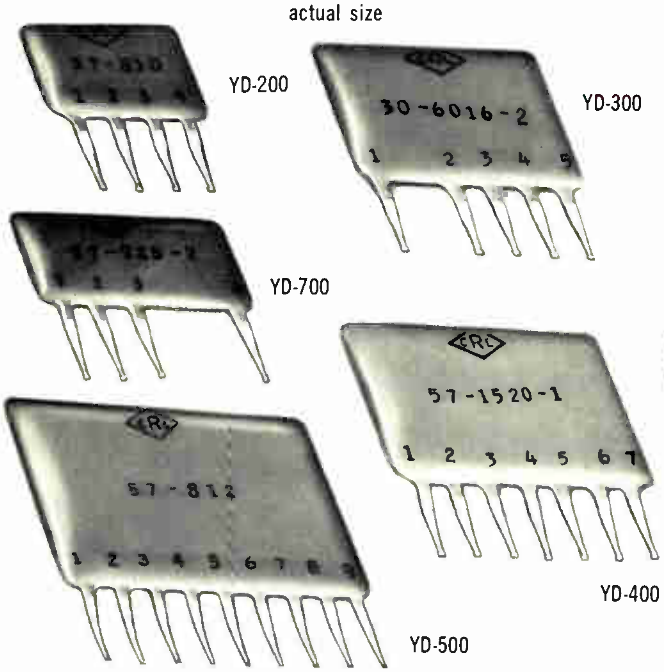
*Trademark

Continued on next page . . .

Centralab offers you TWO TYPES of PEC's*

STANDARD COUPLATES®

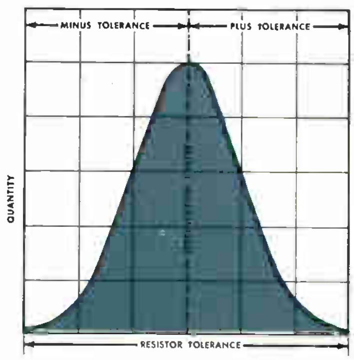
actual size



An infinite number of PEC combinations available from these five basic designs

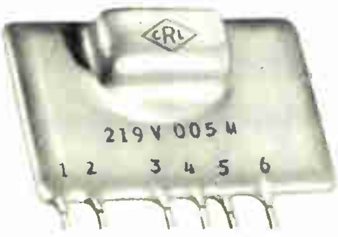
Centralab can adapt the basic shapes shown above to meet a broad variety of design requirements. These five basic Couplates can be furnished with any of five types of terminals . . . narrow tab as illustrated, or your choice of wide tab, long wire, stub wire, and crimped wire to meet your specifications.

All resistors are produced to nominal resistor values



Circuitry performance is more stable because the tolerance is a distribution over the nominal and not fringe values.

NOW! Extended Capacity Ranges



Maximum capacities:

150 to 600 volts up to .5mf
6 volts up to 2.0mf.

This increases the scope of P.E.C.'s for your applications.

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Litho in U.S.A.

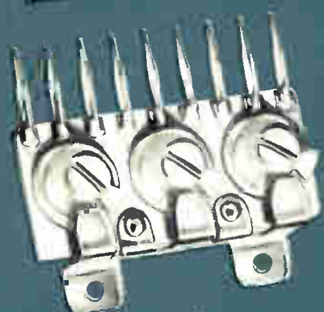
SPECIAL DESIGNS

Any shape and contour available for miniaturization and simplification

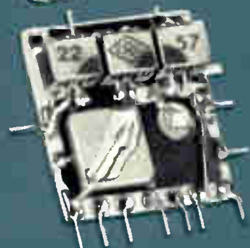
Centralab can produce special packaged electronic circuits to your requirements and to any applicable MIL. specifications. The PEC's shown below illustrate a few recent solutions to customer problems.

• **POTTED AND MOLDED CIRCUITS**
Provide long life and reliability under extreme operating conditions.

• **THE ULTIMATE IN MINIATURIZATION**
Micro-miniature PEC for printed-board insertion contains four ± 10% resistors and four .055 mf. ± 20% capacitors.



• **TRIMMER RESISTORS**
These CRL units save money by using bank of trimmers in applications not requiring frequent or continuous adjustments.



• **INCORPORATE DIODES, COILS, AND SOCKETS**
Cut assembly errors and costly procedure of purchasing, inventorying, and testing of individual components.

Centralab — originator and undisputed leader in P.E.C. development — offers you a responsible source for your Packaged Electronic Circuits. You can rely on our expert engineering assistance and modern production facilities to meet your quality and quantity requirements. Most important, Centralab offers you 35 years of experience in design, manufacture, and application of electronic components. Write for complete information on products and service.

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914 EAST KEEFE AVENUE • MILWAUKEE 1, WISCONSIN
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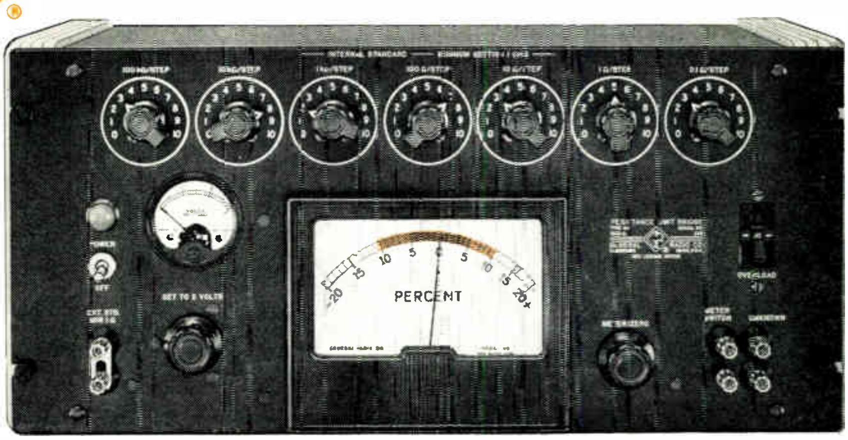
Rapid Production Testing

with the GR TYPE 1652-A RESISTANCE LIMIT BRIDGE



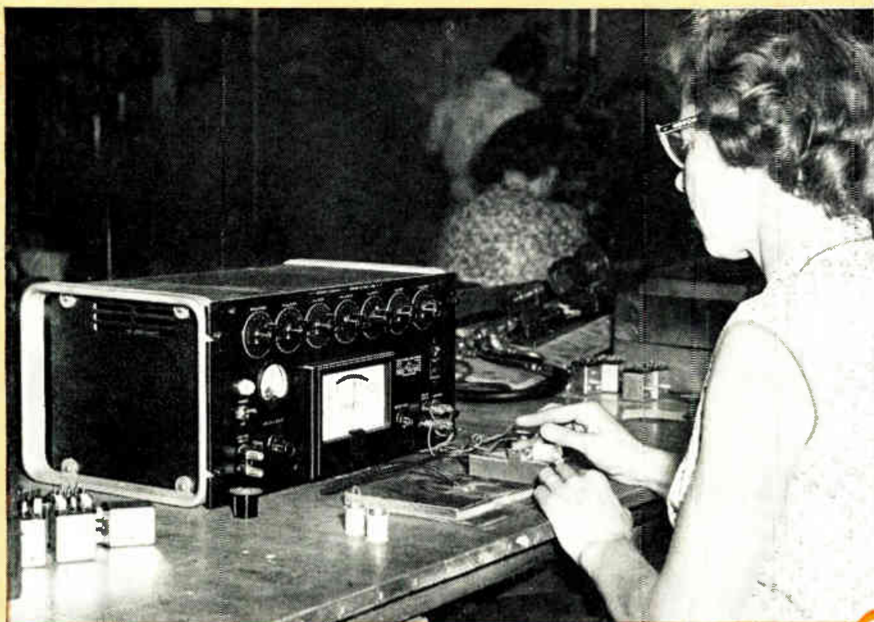
✓ No Balancing

✓ Direct Reading

✓ Built-in Resistance Standards

✓ Can be Adapted for Automatic Sorting

The G-R Limit Bridge can be easily used by anyone. Built-in resistance standards are set to the component's specified value. As each unknown is connected to the Bridge, a large easily-read meter indicates component resistance directly as a percentage of its specified value . . . no further adjustments are necessary and measuring procedure reduces to simply placing the unknown into the Bridge circuit and reading one meter. Computations are eliminated, the possibility of error is reduced, and valuable testing time is saved.



The Hart Manufacturing Company of Hartford, Connecticut, producer of "Diamond H" precision relays and switches, maintains a continuous check on relay coils with the General Radio Resistance Limit Bridge. Two Bridges are used in their production operations . . . one in the coil winding department for initial d-c resistance measurements, and one in the inspection department for final specification checks on the assembled relay.

Type 1652-A Resistance Limit Bridge $495

Resistance Range: Used as a limit bridge, 1 ohm to 1,111,111 ohms. Used as a Wheatstone bridge, 1 ohm to 1,111,111 ohms with internal standard; 1 ohm to 2 megohms with external standard.

Limit Range: Meter reads from −20% to +20%; ±5% and ±10% scales clearly indicated with color coding.

Accuracy: As a limit bridge, ±0.5% or better; for matching resistances, ±0.2%. As a Wheatstone bridge with internal standard, ±0.25% above 10 ohms, ±0.4% below 10 ohms. With external standard, ±0.2% + accuracy of standard (from 1 ohm to 2 megohms).

Mounting: The bridge is supplied for either relay rack or table mounting.

Write for complete information

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass., U.S.A.

Broad Avenue at Linden, Ridgefield, N. J. NEW YORK AREA — 1000 N. Seward St. LOS ANGELES 38

8055 13th St. Silver Spring, Md. WASHINGTON, D. C. — 1150 York Road, Abington, Pa. PHILADELPHIA

1182 Los Altos Ave., Los Altos, Calif. SAN FRANCISCO — 6605 W. North Ave., Oak Park, Ill. CHICAGO

In CANADA: 99 Floral Parkway, TORONTO 15

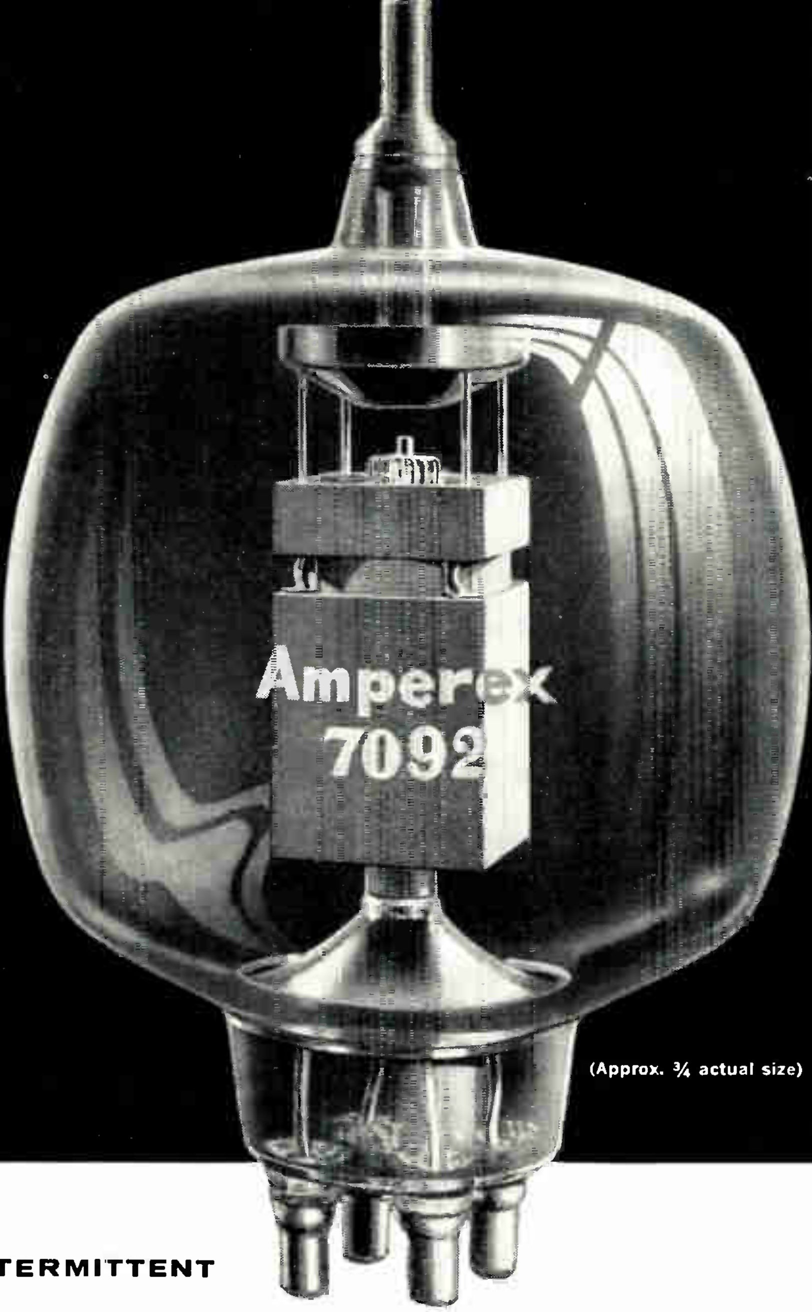
All G-R Products are now covered by a *2-Year Warranty*

Introducing...

the world's most compact radiation-cooled high-power INDUSTRIAL TRIODE

...the new

Amperex® 7092



(Approx. ¾ actual size)

2 KW CONTINUOUS, 3 KW INTERMITTENT

INTO INDUSTRIAL LOADS – CLASS C – WITHOUT WATER COOLING

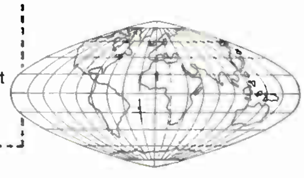
INDUSTRIAL OSCILLATOR, CLASS C CONTINUOUS DUTY SINGLE PHASE, RECTIFIED, UNFILTERED PLATE SUPPLY

Typical Operation (Per Tube)

Frequency	50	50	50	Mc
D.C. Plate Voltage	2700	3600	4500	Volts
D.C. Grid Voltage	-270	-325	-360	Volts
Peak R.F. Grid Voltage	625	685	720	Volts
D.C. Plate Current (Full Load)	630	630	630	mA
D.C. Plate Current (No Load)	180	155	135	mA
D.C. Grid Current (Full Load)	180	160	145	mA
D.C. Grid Current (No Load)	305	270	250	mA
Grid Resistor	1500	2000	2500	Ohms
Driving Power (Approx.)	125	123	115	Watts
Plate Load Impedance	2250	3000	3800	Ohms
Plate Dissipation*	540	640	780	Watts
Plate Input	2100	2800	3500	Watts
Tube Plate Output	1560	2160	2720	Watts
Tube Efficiency	74	77	78	Percent

*For 50% duty cycle, averaging time 10 seconds, plate dissipation may be increased 50%.

- extra-thick hard-glass envelope for exceptional ruggedness and temperature resistance
- thoroughly dependable service in ultrasonics, induction and dielectric heating at a 40% saving in tube and accessory costs
- thoriated-tungsten filament—6.3 volts, 32.5 amps
- available from stock



ask Amperex

...about new tubes for high-power industrial applications

Further details available from Industrial Tube Division

AMPEREX ELECTRONIC CORP., 230 DUFFY AVENUE, HICKSVILLE, L.I., N.Y.

In Canada: Rogers Electronic Tubes & Components, 11-19 Brentcliffe Road, Leaside, Toronto 17.

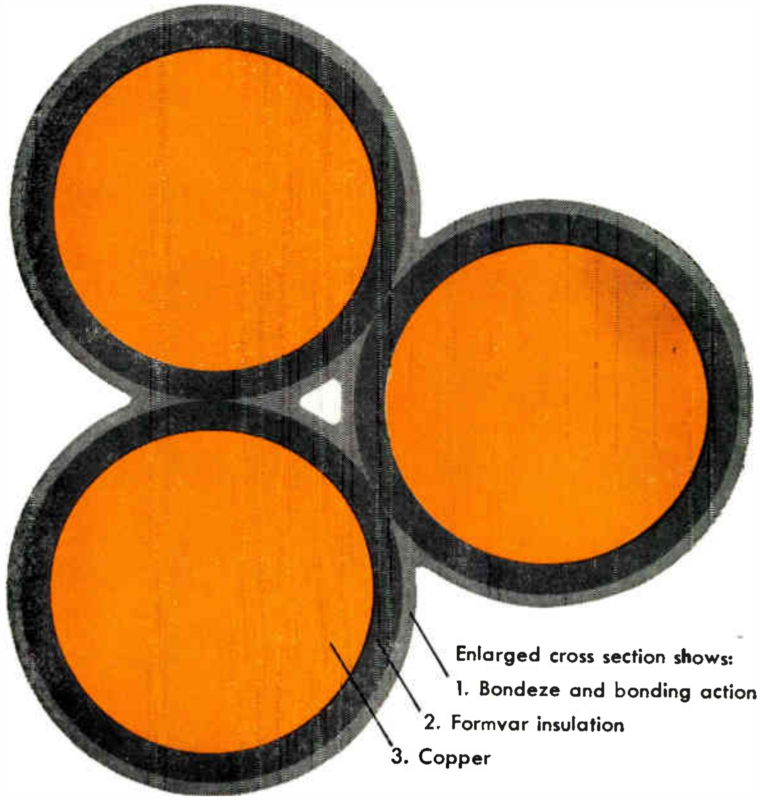
Circle 28 on Inquiry Card, page 10[illegible]

For quick bonding, turn to turn, with a single application of heat or solvent . . .

Specify

PHELPS DODGE BONDEZE®

MAGNET WIRE



These successful uses of Bondeze suggest unlimited new redesign possibilities, often at overall savings.

COILS Random-wound, layer, paper-section and solenoid coils for brakes and clutches, instruments, television, radio and other applications.

TRANSFORMERS Paper-section, random-wound, oil-filled, air-cooled and high voltage for distribution, current, X-ray, television, radio and other applications.

MOTORS Windings for shaded pole, series fields, instruments, induction and others.

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

FIRST FOR LASTING QUALITY— FROM MINE TO MARKET!

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

NEW

oblique plier with the exclusive Klein Shear Cutter

Patent applied for

207-5C shear cutting oblique plier 5½ inches long. Will cut dead soft or extremely hard wire. Blade replaceable. Plier never needs sharpening. Regular cutting knives at the nose. Coil spring keeps jaws apart ready for use.

Here is the greatest advance in oblique cutters. This new Klein tool with shear blades is ideal for cutting hard wire such as tungsten filament or dead soft wire. Also recommended for cutting small bundles of wire. The shearing action assures easy, positive cutting at all times.

Regular cutters at the nose give added usefulness and convenience. Shear blade is replaceable. Plier never needs sharpening.

This plier is supplied with a coil spring to keep the handles in open position. Can also be had with Plastisol dipped handles if desired.

Write for full information

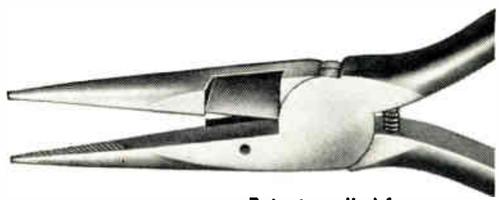
ASK YOUR SUPPLIER

Foreign Distributor:
International Standard Electric Corp.
New York

KLEIN LONG NOSE SHEAR CUTTING PLIERS

Patent applied for

208-6C long nose shear cutting plier. A 6½-inch long nose plier with shear blades. Will cut dead soft or extremely hard wire. Blade replaceable. Plier never needs sharpening. Point of nose 1/16-inch diameter. Coil spring keeps jaws open ready for use.



Patent applied for

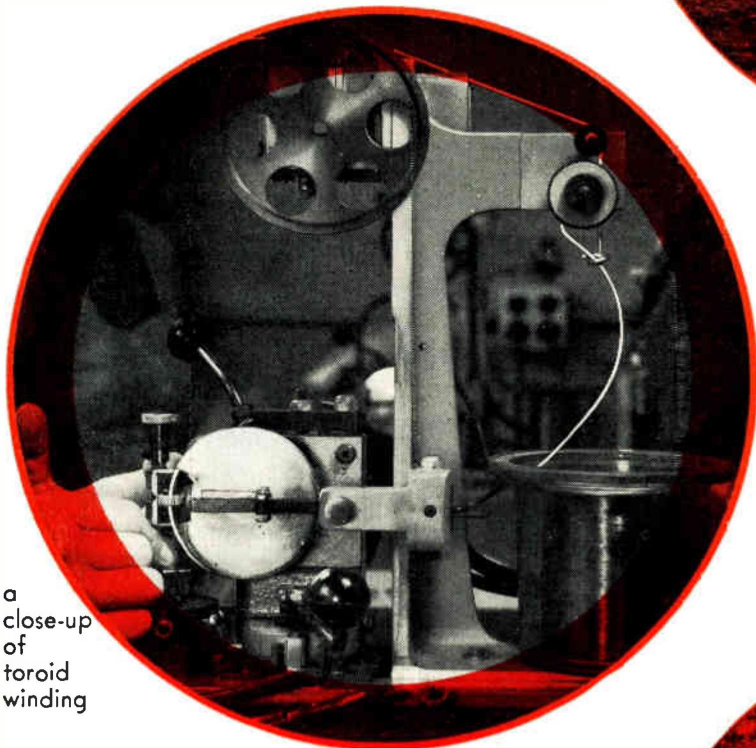
208-6NC. Similar in design to 208-6C but reverse side designed to put a positive 3/16-inch hook on the end of a resistor wire. Smooth one-motion operation saves production time on every television or radio set.

Mathias KLEIN & Sons
Established 1857 · Chicago, Ill., U.S.A.
7200 McCORMICK ROAD • CHICAGO 45, ILLINOIS

Burnell moves a ~~step~~ *plant* further

in toroid, filter and related network leadership

our new Pelham Manor plant

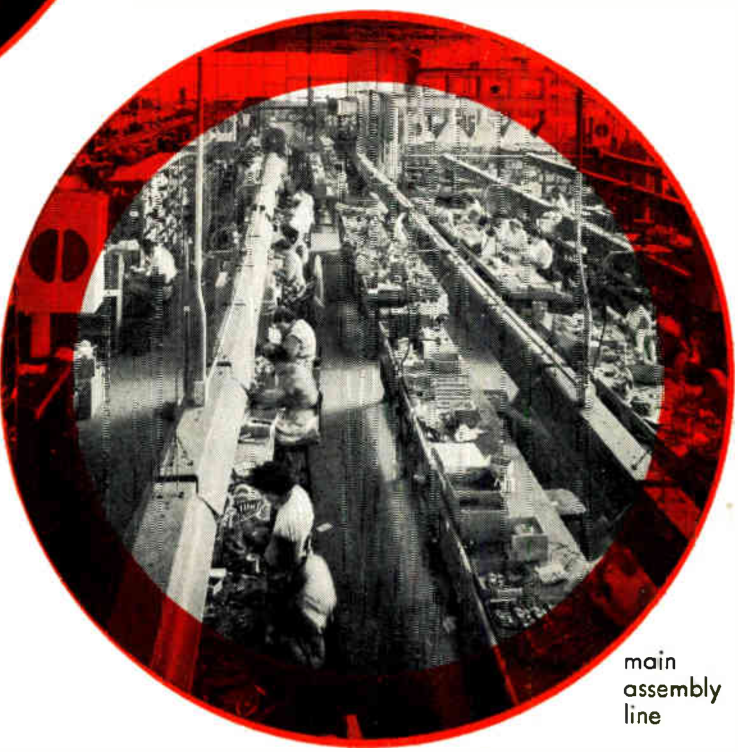


a close-up of toroid winding

Burnell & Co. is now producing toroids, filters, and related networks in its new Pelham Manor plant — largest and best equipped of its kind in the country. For customers, this means fast attention to samples, quicker delivery of orders, more solutions to network problems.

look to Burnell to remain first in . . .

advanced research
product development
new design ideas
new circuit components
new production methods
economy



main assembly line

Burnell & Co., Inc.

first . . . in toroids, filters, and related networks

EASTERN DIVISION
10 PELHAM PARKWAY
PELHAM MANOR
NEW YORK

Dept. T-127

PACIFIC DIVISION
720 MISSION STREET
SOUTH PASADENA
CALIFORNIA

Circle 31 on Inquiry Card, page 101

Tele-Tips

THE SATELLITE was a natural for practical jokesters. In Clifton, N. J., a resident spotted a silver sphere floating about 100 ft. over the Passaic River. Seeing the letters "U.S.S.R." painted on the side he immediately called the police. The cops found that it was a basketball bladder tied to cord tangled in over head wires, and on the side were painted "upski" and "downski" and a number of other words all ending in "ski." Pieces of scrap metal were attached to simulate antennas. At the same time "hams" were being warned not to transmit on the satellite frequencies. Seems that a few jokers had been duplicating the Russian signals and confusing tracking stations.

HAMS were asked to report their reception of the satellite's signals to Radio Magazine, Moscow.

ULTRASONICS can be used to diagnose certain diseases, scientists at Armour Research Foundation have found. The beam of sound is bounced from the deep tissues of the body to a screen, where medical men and specialists can interpret the readings and determine the disease and its effect on the body.

PATTERN FOR SUCCESS. An engineering education is fine, but is it sufficient training for the future? The Univ. of California raised the question after surveying their alumni for a description of the progress made by engineers. All start out in design and operation. Only 9% are in administration and management within the first decade. Engineers start climbing the ladder in 10 to 15 years after graduation. Then the percentage increases to 19%. Twenty years after graduation there are 32% in the administration and management field. And, finally, 30 years after graduation 48%—or almost half—of the engineers are no longer in design or operation.

(*Continued on page 47*)

AlSiMag® ALUMINA CERAMICS

have more to offer!

WIDEST VARIETY of Alumina materials available from any source. Vitrified or porous compositions . . . 85% and higher. Industry approved . . . accurately controlled. Greater freedom for designers who can usually find in our special purpose AlSiMag Alumina materials the exact combination of characteristics desired. Custom formulations for unusual requirements.

SUPER PROPERTIES: High strength—tensile, flexural, compressive. Superior electrical characteristics at high temperatures and frequencies. Rugged resistance to thermal shock, mechanical shock, vibration, abrasion. Hardness up to 9 on Mohs' scale. Chemically inert. Permanently rigid. Withstand radiation bombardment without producing contaminants.

OTHER PLUS FACTORS: Precision tolerances. Wide range of physical sizes and shapes, standard and custom designs. Fast delivery in any quantity. Prototype service if desired . . . enables designer to test performance under actual operating conditions before investing in tooling. Continuing research to satisfy customers' current and future requirements.

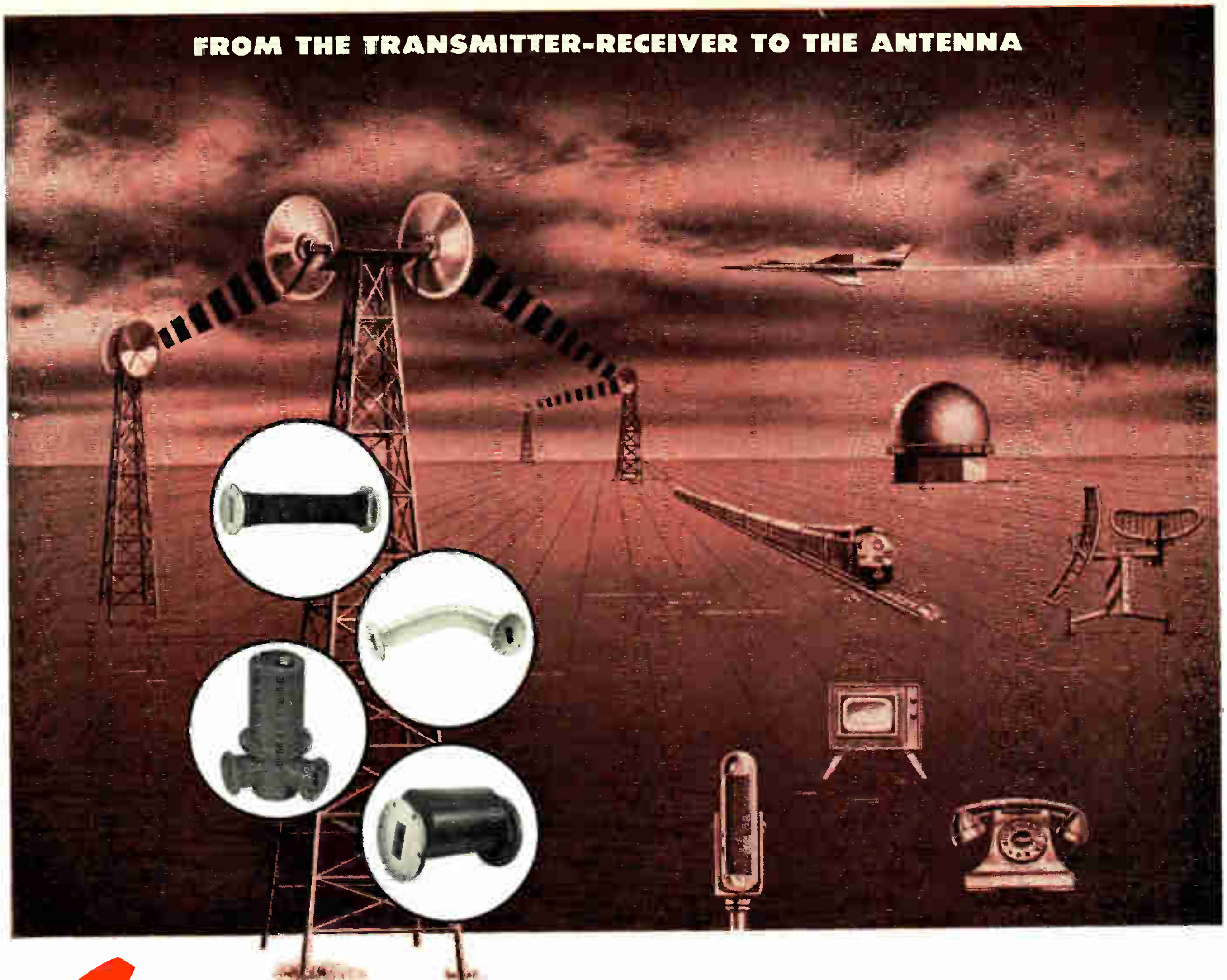
Blueprint or sketch, with details of operation, will bring you complete information on the AlSiMag Alumina best suited for your application. NEW Bulletin 575 covering several of the most popular AlSiMag Aluminas sent on request.

A Subsidiary of Minnesota Mining and Manufacturing Company

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
56TH YEAR OF CERAMIC LEADERSHIP

For service, contact Minnesota Mining & Manufacturing Co. Offices in these cities (see your local telephone directory): Atlanta, Ga. • Boston: Newton Center, Mass • Buffalo, N. Y. • Chicago, Ill. • Cincinnati, O. • Cleveland, O. • Dallas, Texas • Detroit, Mich. • High Point, N. C. • Los Angeles, Calif. • New York: Ridgefield, N. J. • Philadelphia, Pa. • Pittsburgh, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Calif. • Seattle, Wash. **Canada:** Minnesota Mining & Manufacturing of Canada, Ltd., P. O. Box 757, London, Ont. **All other export:** Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.



Airtron inc.

supplies the vital links in microwave transmission

Airtron, Inc. supplies a complete line of microwave relay waveguide components for system manufacturers and installations throughout the free world.

Many of Airtron, Inc.'s special designs have become so widely used that today they are considered standard units — proof of Airtron, Inc.'s practical design experience which can meet the most stringent engineering requirements of the ever-growing microwave relay field.

Recognition and acceptance of Airtron, Inc.'s microwave components are predicated on the many advances that Airtron, Inc. is daily contributing; and on its having one of the most extensive microwave manufacturing facilities in the world. As proof, a new series of **high conductivity copper waveguides** (100% conductivity) recently introduced by Airtron, Inc. has opened up a new era of high efficiency performance in long line microwave relay transmission. Unique configurations in **flexible waveguide,** transmission lines, **broad band ferrite** isolators, mechanical and ferrite switches, and antenna feed horns have already become standard in their field.

Airtron, Inc. has kept pace with these developments. Since its inception over a decade ago, the company has expanded into five separate divisions, each concerning itself with a separate phase of microwave production, yet each flexible enough to be able to draw on the know-how of all the other divisions. All of Airtron, Inc.'s manufacturing plants combine the best in engineering, production and quality control.

Airtron, Inc. offers designers and manufacturers a triple service . . . the creative design engineering born of a decade of microwave specialization; practical production abilities and equipment; six, separate manufacturing plants to produce reliable and precise microwave components.

Airtron inc.
LINDEN, NEW JERSEY

FOREIGN AFFILIATES
AIRTRON CANADA, LTD., TORONTO, CANADA | W. H. SANDERS (ELECTRONICS) LTD., STEVENAGE HERTS, ENGLAND | SIVERS LAB., HAGERSTEN, SWEDEN

MICROWAVE AND ELECTRONIC ENGINEERS — OUTSTANDING OPPORTUNITIES WITH AIRTRON, INC.

Circle 35 on Inquiry Card, page 101

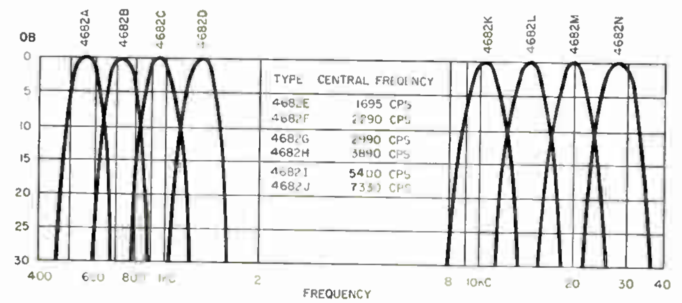
OUR MILLIONTH FILTER SHIPPED THIS YEAR...

FILTERS

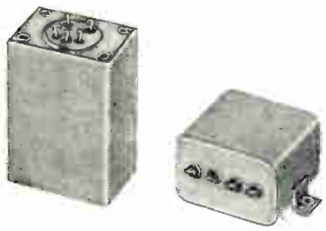
FOR EVERY APPLICATION

TELEMETERING FILTERS

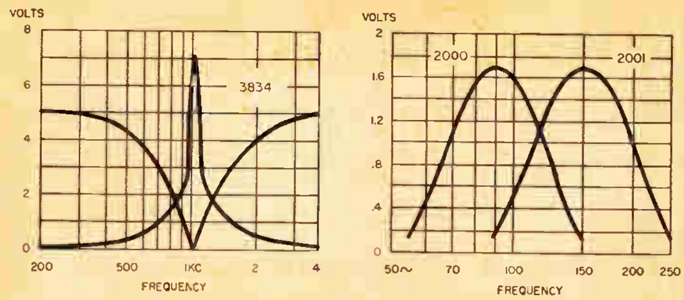
UTC manufactures a wide variety of band pass filters for multi-channel telemetering. Illustrated are a group of filters supplied for 400 cycle to 40 KC service. Miniaturized units have been made for many applications. For example a group of 4 cubic inch units which provide 50 channels between 4 KC and 100 KC.



Dimensions:
(4682A) 1½ x 2 x 4"



Dimensions:
(3834) 1¼ x 1¾ x 2-3/16".
(2000, 1) 1¼ x 1¾ x 1⅝".



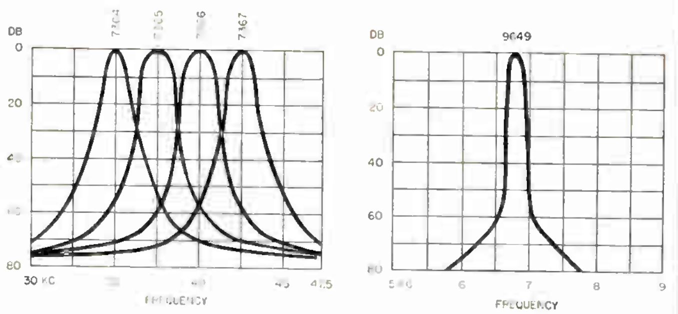
AIRCRAFT FILTERS

UTC has produced the bulk of filters used in aircraft equipment for over a decade. The curve at the left is that of a miniaturized (1020 cycles) range filter providing high attenuation between voice and range frequencies.

Curves at the right are that of our miniaturized 90 and 150 cycle filters for glide path systems.

CARRIER FILTERS

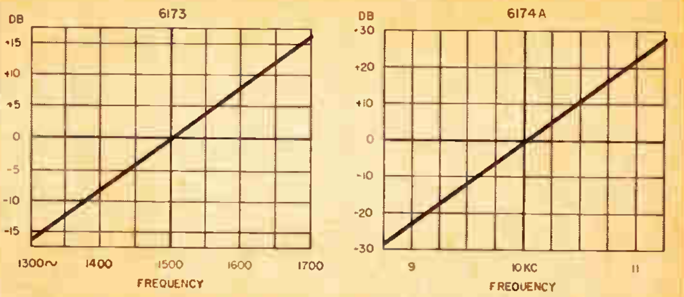
A wide variety of carrier filters are available for specific applications. This type of tone channel filter can be supplied in a varied range of band widths and attenuations. The curves shown are typical units.



Dimensions:
(7364 series) 1⅝ x 1⅝ x 2¼".
(9649) 1½ x 2 x 4".

DISCRIMINATORS

These high Q discriminators provide exceptional amplification and linearity. Typical characteristics available are illustrated by the low and higher frequency curves shown.



Dimensions:
(6173) 1-1/16 x 1⅜ x 3".
(6174A) 1 x 1¼ x 2¼".

For full data on stock UTC transformers, reactors, filters, and high Q coils, write for Catalog A.

UNITED TRANSFORMER CO.

150 Varick Street, New York 13, N. Y. EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y. CABLES: "ARLAB"
PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.

Tele-Tips

(*Continued from page 22*)

RADAR SPEED METERS got a 10-7 vote endorsement as a legal means of speed enforcement in Pennsylvania, but raised the ire of at least one automobile club. They said that they doubted that radar was sufficiently developed to curb speeders as well as "tried and effective" methods.

RADIATION FOR SALE. Industrial and academic organizations interested in radiation processing can use Applied Radiation Corp.'s linear electron accelerator on a rental basis. The firm's 10 mev Mark 1-F2 accelerator is the highest energy industrial accelerator operating in the U. S.

IRRADIATED FOOD, requiring no refrigeration, will be further explored by the Quartermaster Corps of the U. S. Army using an electron linear accelerator built by Varian Associates. Varian now holds contracts for three linear accelerators valued in excess of $1 million.

UNLIMITED POTENTIAL is seen for our nation's economy by Illinois Institute of Technology President Dr. John T. Rettaliata—if we place sufficient emphasis on incentives to make the most effective use of the gifted individual. Warns Dr. Rettaliata, "While large numbers of engineers and scientists will be needed, it will be the creative man who will make the greatest contribution toward reaching our future objectives. Effective use of the creative man requires an understanding and tolerant attitude which recognizes that ideas can be more important than facts; and imagination, even intuition, more important than logic." He urges industry cooperation to reduce the tragic loss of potential scientific and engineering talent through the failure of great numbers of college caliber high school graduates to continue their formal education at the higher level.

Circle 37 on Inquiry Card, page 101

← Circle 36 on Inquiry Card, page 101

Books

Technical Aspects of Sound, Volume II

Edited by E. G. Richardson, Ph. D., D. Sc. Published 1957 by Elsevier Publishing Co. Amsterdam, The Netherlands. Distributed in the USA by D. Van Nostrand Co., Inc. 120 Alexander St., Princeton, N. J. 412 pages, xii pages. Price $11.75.

Sound, from its creation to its reception together with all the intermediate phases, is completely covered in this collective volume by scientists of international repute. Neither language nor distance has been a barrier in the selection of the contributors, each of whom is well-known and considerably experienced in his branch.

Here is the basic theory of acoustics together with all applications of sound and ultrasonics.

This work will meet your needs whether you desire a modern survey of the field or the solution of a particular problem in acoustics.

Each division is built up from the fundamentals of the subject, and a copious bibliography for each section provides a complete reference to specific detail.

This book is the most complete and the latest work in an expanding and useful sphere of science.

Television Engineering, Principles and Practice, Volume 3

By S. W. Amos, B. Sc. (Hons), A.M.I.E.E. & D.C. Birkinshaw, M.B.E., M.A., M.I.E.E. Published 1957 by Philosophical Library, Inc., 15 E. 40th St., New York 16. 226 pages. Price $15.00.

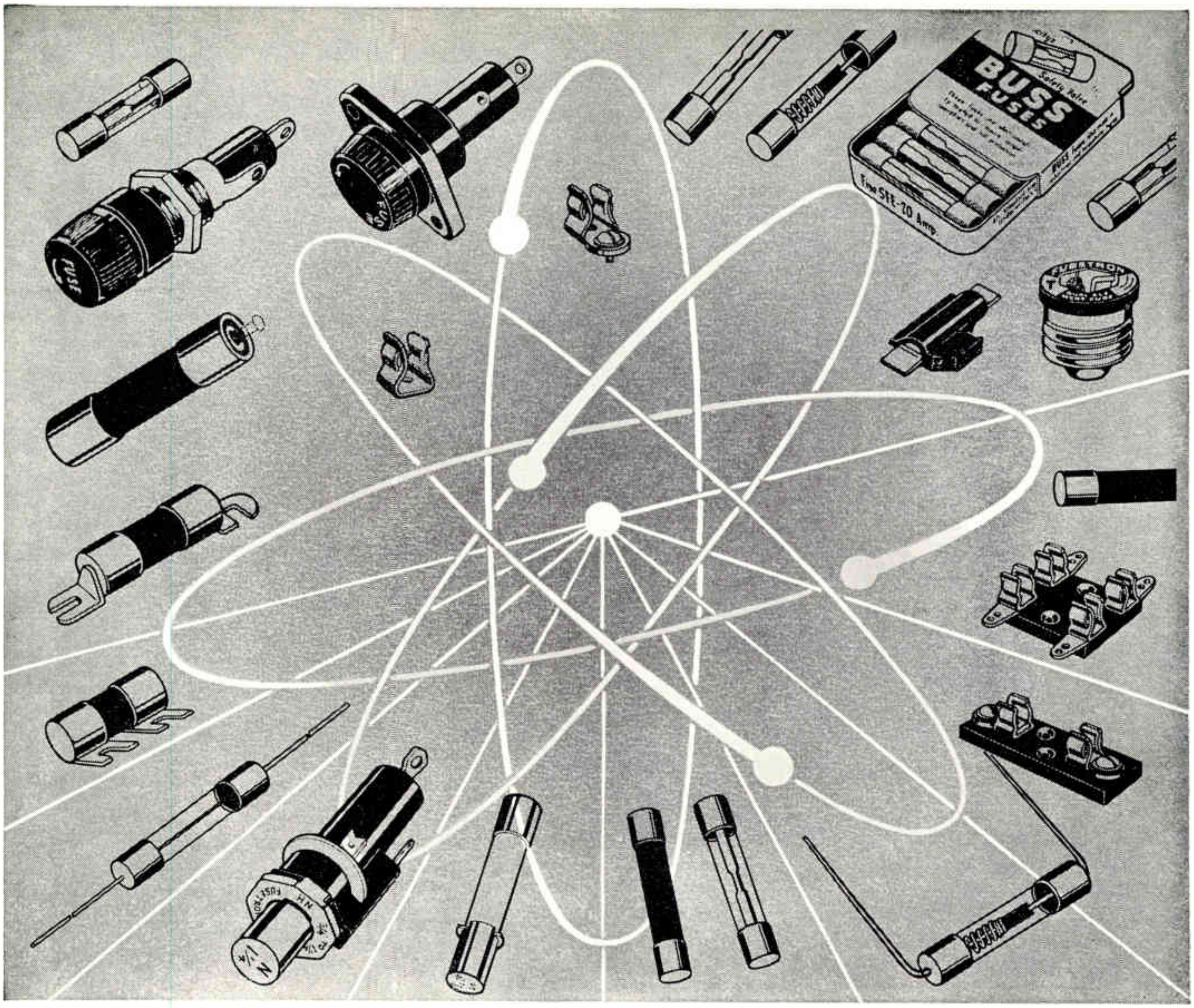
This volume gives the application in television of sinusoidal, rectangular, sawtooth, and parabolic waves and shows the mathematical relationship between them. The main body of the text is devoted to the fundamental principles of the circuits commonly used to generate such signals, the treatment being largely descriptive by nature, and therefore less mathematical than of the previous volumes.

Electrical Engineering Circuits

By Hugh Hildreth Skilling. Published 1957 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 724 pages, xi pages. Price $8.75.

This lucid and stimulating presentation of ac circuits accomplishes a two-fold purpose. First, it gives students a strong foundation in a subject by devoting approximately ⅔ of its coverage to traditional topics. Secondly, it offers meaningful discussions of newer concepts, preparing students for advanced courses in electrical networks and systems design. By means of this approach, the barrier that has existed between elementary circuit courses and the new ideas and language of the more advanced courses is broken down.

Circle 39 on Inquiry Card, page 101



To assure proper operation *under all service conditions* Every BUSS and FUSETRON fuse is Electronically Tested

You can rely on BUSS and FUSETRON fuses for dependable electrical protection because . . . every fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

By standardizing on electronically tested BUSS and FUSETRON fuses, you are providing equipment with maximum protection against damage due to electrical faults. And, you are guarding against the possibility of faulty fuses blowing needlessly and causing unnecessary shutdowns.

Because BUSS and FUSETRON fuses do operate properly, they can help protect the good name of your equipment for quality and service.

Should you have an unusual protection problem, BUSS places at your service the facilities of the world's largest fuse research laboratory and its staff of engineers. It is possible that these experienced fuse engineers have already solved a problem similar to yours.

For more information on BUSS and FUSETRON Small Dimension fuses and fuseholders . . . Write for bulletin TT. Bussmann Mfg. Division McGraw-Edison Co. University at Jefferson, St. Louis 7, Mo.

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

1157

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

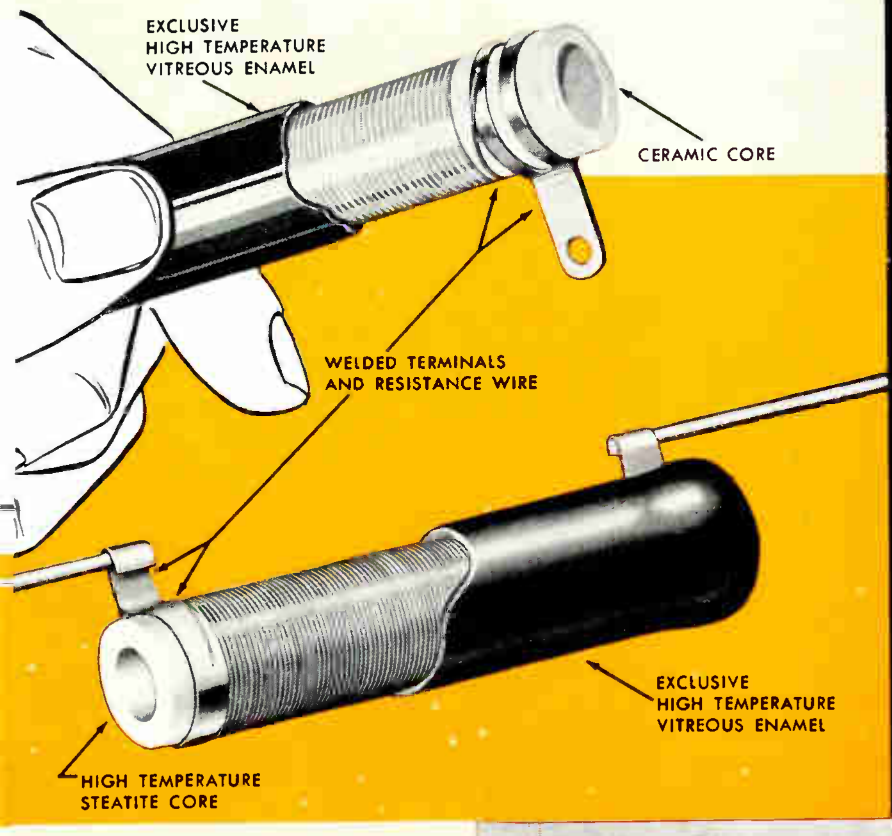
MAKERS OF A COMPLETE LINE OF FUSES FOR HOME, FARM, COMMERCIAL, ELECTRONIC, AUTOMOTIVE AND INDUSTRIAL USE.

 Circle 40 on Inquiry Card, page 101

OHMITE®

WIRE-WOUND, VITREOUS-ENAMELED

POWER RESISTORS . . . *industry's most complete line*



WELDED RESISTANCE WIRE Ohmite Resistors have the resistance wire welded to the terminals instead of soldered or brazed. This provides a perfect and permanently stable electrical connection that is unaffected by vibration or high temperature.

WELDED TERMINALS Another Ohmite Resistor feature is the welded terminal band. The band is permanently held together around ceramic core by means of welding, providing a strong, permanent fastening.

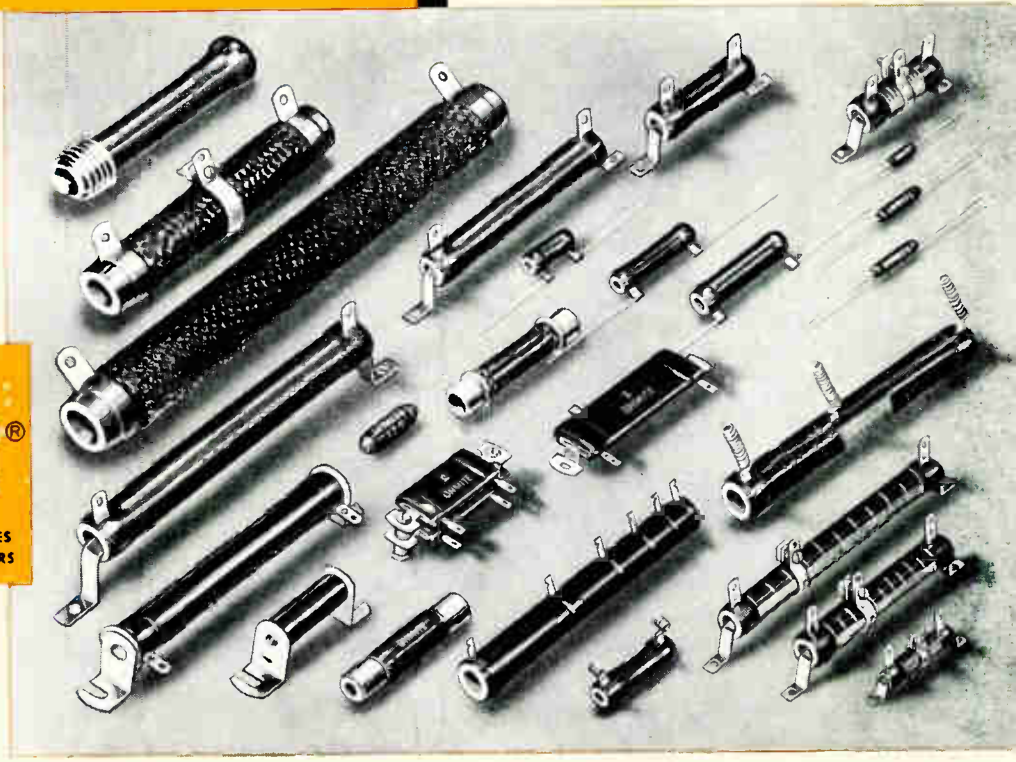
STRONG CERAMIC CORE This strong, rugged core has excellent electrical characteristics, and is unaffected by cold, heat fumes, or high humidity.

EXCLUSIVE HIGH TEMPERATURE VITREOUS ENAMEL This special-formula enamel was developed by Ohmite after extensive research. Its thermal expansion is properly related to that of core, terminal, and resistance wire.

Ohmite offers resistors in more than 60 sizes—ranging from 2½" diameter by 20" long to ¼" diameter by 9/16" long—to meet your exact requirements. MANY SIZES ARE CARRIED IN STOCK.

Ohmite offers the most complete line of wire-wound, vitreous-enameled POWER RESISTORS on the market . . . fixed, adjustable, tapped, noninductive, and precision resistors in many sizes, types of terminals . . . available in a wide range of wattages and resistances.

Write on company letterhead for Catalog No. 40.



BE RIGHT WITH

OHMITE®

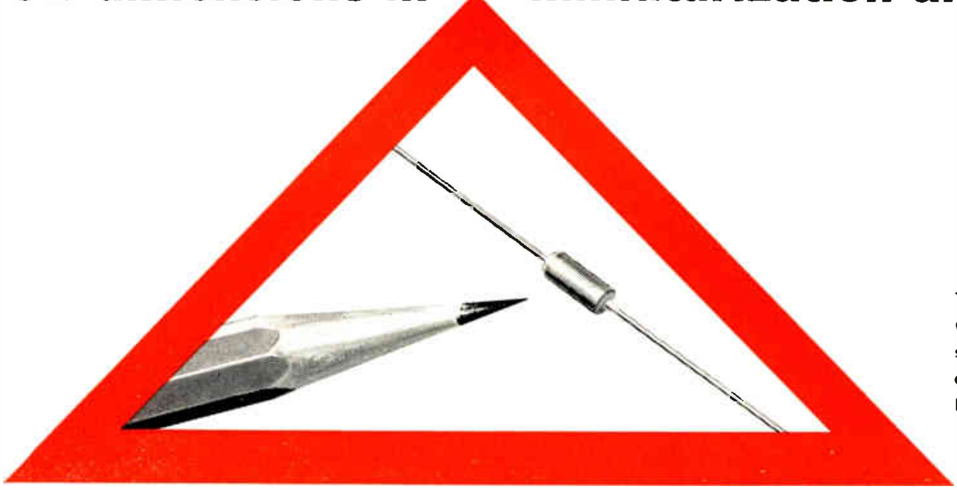
RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES
TANTALUM CAPACITORS • VARIABLE TRANSFORMERS

OHMITE MANUFACTURING COMPANY
3662 Howard Street
Skokie, Illinois

Circle 41 on Inquiry Card, page 101

SOLID-ELECTROLYTE TANTALEX® CAPACITORS

new dimensions in miniaturization and reliability



This solid-electrolyte Tantalex Capacitor (shown 1½ times actual size) is rated at 4.7 μF, 10 volts d-c, and is only ⅛" in diameter by ¼" long.

Now, circuit designers in computers and military electronics have an electrolytic capacitor that offers greater miniaturization than ever before . . . with no sacrifice in reliability. Sprague's recently announced solid-electrolyte Tantalex Capacitors find ideal application in the transistor circuits of these critical fields.

The tiny sintered tantalum anode of Type 150D Tantalex Capacitor is impregnated with a solid, non-corrosive, semi-conductor material which cannot leak under any circumstance. It combines true miniaturization with electrical stability previously unobtainable in an electrolytic capacitor of any type.

Thermal coefficient of these capacitors is sufficiently low and linear so that for the first time a circuit designer can think of an electrolytic in terms of parts per million capacitance change. Nominal value is +500 ppm/°C. The capacitor may be used without derating over a range from +85°C to as low as −80°C, a temperature at which no other electrolytic has proved useful.

Solid construction permits the Type 150D to withstand the severe shock and vibration encountered in missile and ballistic applications. Hermetic sealing makes it completely immune to humid atmospheric conditions.

Complete performance data covering the wide range of sizes and ratings are in Engineering Bulletin 3520A, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Mass.

★ ★ ★

Sprague, on request, will provide you with complete application engineering service in the use of Tantalex Capacitors.

SPRAGUE®
the trademark of reliability

SPRAGUE COMPONENTS:

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

ELECTRONIC INDUSTRIES
& TELE-TECH
ROBERT. E. McKENNA, Publisher • BERNARD F. OSBAHR, Editor

"Sputnik"— Guide for the U.S.!

The launching of the Russian satellite "Sputnik" comes as another crushing blow to America in the field of international politics. While the Russians deserve all credit for this remarkable accomplishment, a study of the facts (see p. 70) reveals this to be a very deliberately timed event. It also shows that to the Russians the cold war is a very real war indeed and that continued apathy and complacency on our part could well turn out to be fatal.

The cold war in reality is a struggle to influence the minds of men throughout the world. It can be further defined as being differences between the "haves" and the "have-nots," and of course the latter group far outnumbers the former.

Through the years Americans have enjoyed the greatest standards of living and of freedom in the entire world. Men everywhere are envious and many wish that they, too, could share. As long as we maintained a position of intellectual and physical strength and leadership, our heritages were assured. Now, however, we have a real competitor claiming to be the panacea for the "have-nots."

It seems to us, in the international sphere, that running a country is very much akin to running a business. The running of a business involves close integration of idealistic aims to achieve practical results. In past years we seem to have had only an idealistic approach to many matters affecting the cold war; viz. the Girard case, Little Rock, and now Sputnik. It appears that we need now to reshape our thinking quickly to incorporate realism. We also need to integrate our efforts in future research and development so that the country as a whole benefits rather than any one military service.

In the past ELECTRONIC INDUSTRIES has carried many items describing the growth of Russian technological potential. Figures have been published on the number of engineering and technical graduates and compared them with our own to show the extent of the growth. Now it is obvious that the time has come where we must establish realistic technological training programs to assure ourselves of needed scientific manpower in the future.

We used to laugh at Russian claims of having invented such things as electric light and the telephone. To the uninformed masses of "have-nots" throughout the world, Sputnik may make these claims believable. A current rumor has it that the Russians may soon announce a locomotive driven by atomic energy. If this turns out to be the case, we may again lose another cold war battle. After all didn't we concentrate on atomic ship propulsion . . . on military submarines?

Sputnik has demonstrated the indispensable role of the electronic engineer in the world to come. We also know that the available number of electronic engineers is extremely limited, and again that there are only a limited number of replacements in sight. It would be well if each engineer today could participate in some program to help train the youth of America.

An electronic club in each town or community would be helpful. Here boys could become "hams" or learn how to build and repair electronic equipment and here they can come to see the boundless opportunities that this field of science presents. Extensions of programs such as provided through the Miranda Lux Foundation in San Francisco, the Career Day Conferences sponsored by the Technical Societies Council of New York, and the student guidance provided by the Society of Professional Engineers offers opportunities for individual participation. We are now studying a number of these plans for the advancement of scientific education. In an early forthcoming issue we shall be glad to summarize the results of this study. Meanwhile, any suggestions that you as a reader might have would be most welcome!

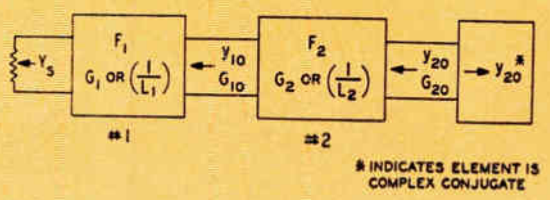


Fig. 1: Phenomenological representation of linear network.

Designing Low-Noise Microwave Receivers

A reliable microwave receiver with noise figure in the 6-db range can be designed on the basis of theory and practical suggestions resulting from low noise research studies over the past few years. The author includes experimental data on microwave crystal mixers.

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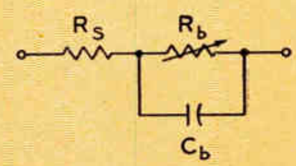


Fig. 2: This is the electrical equivalent circuit of the microwave crystal diode.

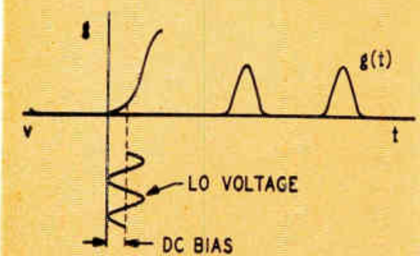


Fig. 3: Diode bias and local osc. power cause pulse-time-varying conductance.

Fig. 4: Basic mixing mechanism is time-varying conductance, r-f to i-f.

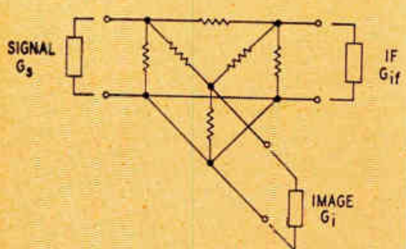


Fig. 5: Equivalent mixer network.

Part One of Two Parts

THE parameters of low-noise crystal microwave receivers were described in 1948 by Torrey and Whitmer[1]. Since that date considerable advance has been made in crystal-rectifier physics, and in the quantitative understanding of its contribution to low-noise microwave performance. The improved crystals of today have increased the number of important parameters that must be considered in low-noise design, and have also demanded improved evaluation and measurement techniques.

Parameters

The over-all noise figure of any linear electrical system can be analyzed phenomenologically in terms of externally measurable parameters of a cascade of arbitrary portions of the network. The over-all noise figure F_{1-n} is specified exactly from the noise figure, F_i, and available gain, G, of the various portions as follows:

$$F_{1-n} = F_1 + \frac{F_2 - 1}{G_1} + \cdots \frac{F_n - 1}{G_1 G_2 \cdots G_{n-1}} \qquad (1)$$

The superheterodyne receiver analysis requires only two of these sections as shown in Fig. 1. The first box represents the mixer, and the second box the i-f amplifier excluding the second detector. The noise temperature t of any box is inherently related to its noise figure F and gain G by the formula

$$t = FG \qquad (2)$$

From Eqs. 1 and 2 for the two-block cascade, the classic formula, relating over-all receiver noise figure F_r to mixer conversion loss L_x, mixer noise temperature t_x, and i-f noise figure F_i, is derived to be

$$F_r = L_x (t_x + F_{if} - 1). \quad (3)$$

The subscript $_x$ refers to the crystal mixer, box 1, and the subscript $_{if}$ refers to the i-f amplifier, box 2, in Fig. 1. Because the gain G of a crystal mixer is always less than unity, the reciprocal term of "loss" L is used. The terms of Eq. 3* are in the dimensional terms of power ratio, and the formula is identical to that originally derived by Friis.[2]

Receiver noise figure F_r is defined as the ratio of 2 ratios: the signal-to-noise power ratio into the receiver, divided by the signal-to-noise power ratio out of the receiver.

Mixer conversion loss L_x is defined as the ratio of signal power into the mixer divided by the signal power out of the mixer, always greater than unity.

Noise temperature t_x is the ratio of the available noise power out of the mixer to the available noise power from an equivalent resistor at 290° K.

I-F noise figure F_{if} has similar definition to receiver noise figure F_r, except that it is applied to the i-f amplifier.

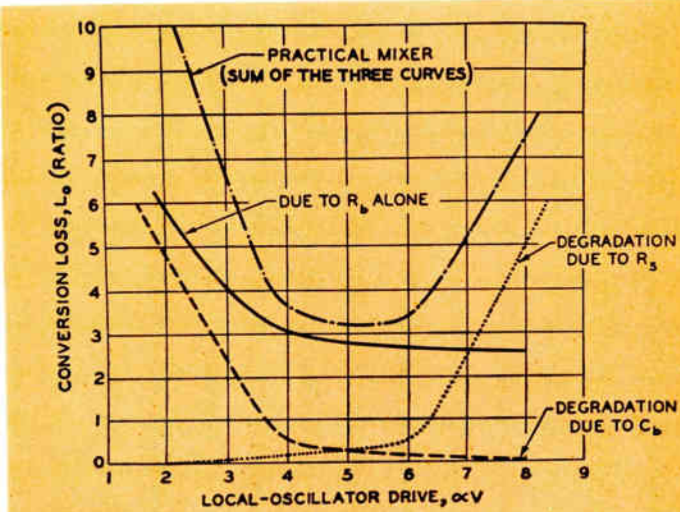


Fig. 6: Conversion loss vs. local oscillator drive—if diode is barrier resistance only, conversion loss is shown by solid curve.

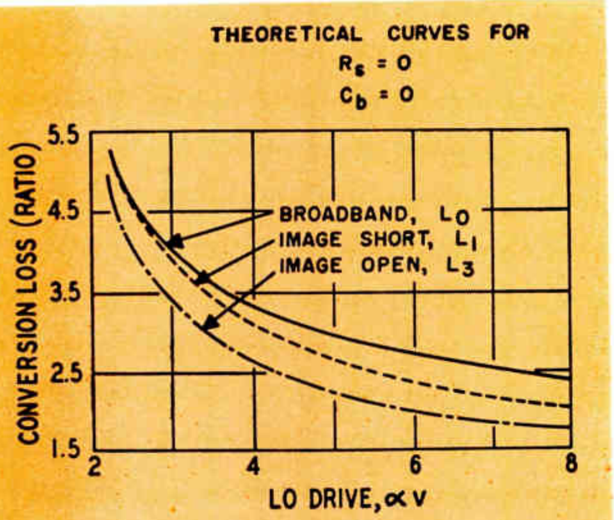


Fig. 7: This is a comparison of the theoretical curves resulting from use of broadband mixing, image-open mixing, and image-short mixing.

For low-noise crystal microwave receivers, we shall be considering values (in power ratio terms) for F_r in the range between 3 and 8, values for L_x between 2 and 6, values for t_x between 1 and 2, and values for F_{if} between 1 and 2, also. Eq. 3 shows that the over-all receiver noise figure F_r is sensitively affected by conversion loss L_x because of its direct proportionality. The mixer noise temperature t_x and i-f noise F_{if} may have nearly anything from a linear effect to almost zero depending on relative magnitudes.

Crystal Diode

A microwave crystal diode has an electrical equivalent circuit as shown in Fig. 2, where the barrier resistance R_b is shown to be variable because its value will change with voltage. Mixing comes about entirely from this variable element. The other two elements, spreading resistance R_s and variable capacitor C_c, are called "parasitic elements." Their existence only degrades the mixing capability of the barrier resistance alone. The existence of R_s and C_c is inherent in the physical structure of the crystal diode, so that mixer deterioration due to parasitics can be minimized only by proper choice of r-f frequencies and crystal physics.

The application of bias and local oscillator power across the non-linear resistance of a crystal causes it to act as a pulse-time-varying conductance $g(t)$ as shown in Fig. 3. Theory shows that conversion loss can approach perfection, that is, L_x approaches l as the conductivity pulses approach infinity in magnitude and zero in time duration.

In other words, the ideal converter is a perfectly conducting switch which is cyclically closed for infinitesimal time duration. The major advantage of crystal rectifiers over tubes when used as mixers is the much higher peak conductivity obtainable from crystals. The purpose of the bias is to place the local oscillator at the point of greatest curvature in the conductivity of the diode. For germanium microwave crystals this point is inherently a few tenths of a volt in the forward (that is, high-conducting) direction; for silicon crystals the best bias is very close to zero. The parasitic elements of R_s and C_c effectively limit the local oscillator excursion to a few tenths of a volt.

The sharpness of the nonlinearity of variable resistance is given by the magnitude of the coefficient α in the formula relating the current and voltage of a crystal rectifier.

$$I = A\left[e^{\alpha(V - IR_s)} - 1\right] \quad (4)$$

where I = current thru the diode,
V = voltage across the diode, and
A = a constant determinable from crystal physics.

Crystal physics dictates 40 as a maximum theoretical value of α for any crystal rectifier at room temperature. Present-day metallurgy in both silicon and germanium achieves rectifiers whose nonlinearity coefficient α is between 20 and 30. The difference between an α of 25 and a perfect one of 40 can be largely compensated for by adjustment of the magnitude of the local oscillator voltage V. Thus the merit of a semi-conductor is predominantly the extent to which its crystal physics can minimize the "parasitic elements."

A good compromise for crystal mixer diodes in the high microwave frequencies is to choose the physics parameters so that the deterioration due to spreading resistance and barrier capacity will be equal. Then the deterioration can be shown to be proportional to the product of $R_s C_b$. In the best present-day X-band microwave crystal diodes, the barrier capacity C_c causes negligible deterioration for frequencies below 8 KMC. For frequencies higher than 8 KMC, the degrading effect of the $R_b C_c$ product becomes increasingly important. Crystal physics has shown that this product is inherently three times lower in germanium than it is in silicon.

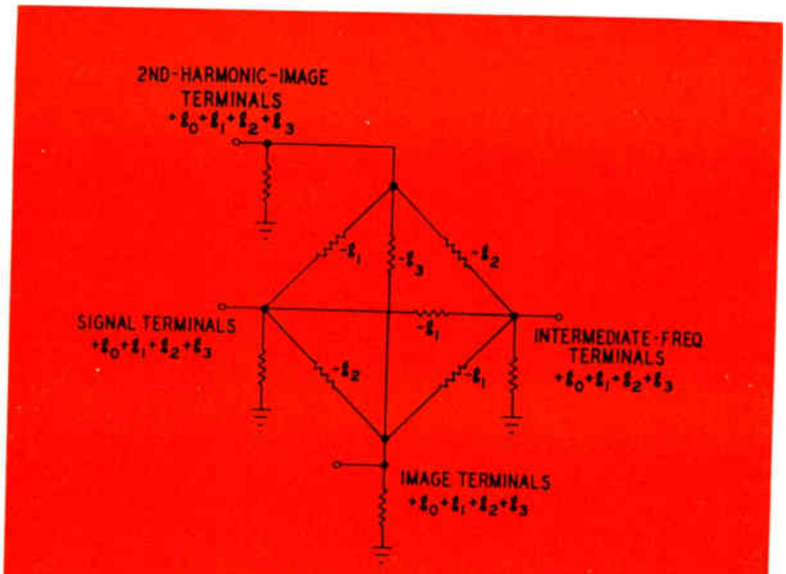


Fig. 8: In this equivalent mixer circuit, the additional fourth terminal is at the second harmonic frequency.

Mixer Network

The essential mechanism of mixing is the time-varying conductance between r-f and i-f terminals as shown in Fig. 4. A small r-f signal impressed at the r-f terminal will be linearly translated to an i-f signal at the i-f termination. If the terminations are designed to be short circuits for all but their own respective frequencies, the theory shows that the mixer performs exactly like the passive resistive network of Fig. 5. The single r-f termination has become two, at the conventionally defined frequencies of signal and image.

When crystal barrier capacity is included in the analysis, the terminal shunt arms of Fig. 5 become complex instead of resistive. The reactive portion can be tuned out with the terminations, so that the conversion loss capabilities of a crystal diode including its parasitic can be quantitatively calculated from diode crystal physics.

In the high microwave frequencies, the simplest r-f terminations are so broad in frequency selectivity that both the signal and image terminations in Fig. 5 are identical. When the termination is also an impedance match, the mixer operation is defined to be "broadband," with the conversion loss specified by the symbol L_o.

The symmetry of network of Fig. 5 is such that equal portions of the energy impressed in the signal channel are converted to the i-f and image. Therefore "broadband" conversion loss can never be theoretically less than 2 (3 db).

One can see, from the circuit standpoint, that to achieve broadband conversion loss L_o of less than 4 (6 db), the impedances of the series arm in Fig. 5 must be somewhat smaller than the shunt arms. Thus, the lower the conversion loss, the less the isolation between i-f and r-f termination. Because of this lack of isolation, both r-f and i-f terminations are difficult to adjust in practice.

Because of the loss of energy into the image termination, the broadband mixer is least critically affected by terminal variations as well as by changes in bias and local oscillator operation conditions. Because of this mixer simplicity, all microwave crystal diode specifications of conversion loss, noise temperature, and i-f impedance are explicitly or implicitly meant to be for the "broadband" conditions.

From the crystal diode and network theory above, it is possible to calculate conversion loss quantitatively. If the diode consists of barrier resistance R_b alone, broadband conversion loss L_o will be that of the solid line in the theoretically calculated curves of Fig. 6. At X-band the best silicon and germanium diodes have the parasitic degradation about equally divided between spreading resistance and barrier capacity as shown by the designated curves in Fig. 6.

At strong local oscillator drive (large αV) excessive energy is lost in the spreading resistance, while at weak local oscillator drive, the barrier capacity shunts the barrier resistance. The two parasitic losses added to that inherent in the barrier resistance R_b give the actual conversion loss L_o of the crystal diode as shown by the upper curve of Fig. 6. These curves show the basis for the choice of an optimum local oscillator injection. For germanium, lowest conversion loss will occur in the presence of a slight forward bias while for silicon lowest conversion loss will occur with a bias close to zero.

Narrowband Performance

By terminating the image of Fig. 5 either in a "short" or an "open," lower conversion loss can always be achieved than for "broadband" mixing. These two conditions are respectively "image short" and "image open" definitions of "narrowband mixing." Compared to broadband mixing, the i-f and r-f input impedances of the mixer are much higher for image open and much lower for image short.

Image-open conversion is given the special symbol L_3 for conversion loss and for image-short mixing the corresponding conversion loss symbol is L_1. Theory shows L_3 less than L_1 less than L_0 as graphed in Fig. 7. The differences between each two are greater, the lower the broadband conversion loss L_0 capabilities of the crystal diode. Fig. 7 shows the maximum difference that can be expected, for it is calculated with the assumption that the parasitic elements of R_s and C_b are zero.

The penalty for the better conversion loss capabilities of narrowband mixing is in the more critical design. Signal and i-f terminals have strong interactions on each other, bias and local oscillator variations are somewhat more critical, the desired signal match and image reflection are generally difficult to achieve.

When the local oscillator must be tuned over a range of frequencies such as in a UHF TV tuner, constancy of termination is difficult. There are many applications, however, such as the TV tuner, which must block out signals from the antenna on the image frequency, thus forcing the use of some form of narrowband mixing.

In general, the major emphasis in mixer design should be in constancy of image termination and constancy of local oscillator injection over the desired range of frequencies. Variations in these parameters cause far greater degradations to conversion loss than the benefits derivable from the narrowband operation.

Harmonic Image

The best present-day X-band crystal mixer diodes, with broadband conversion loss L_0 less than 6 db, and operating in the microwave range of 3000 MC or less, will have an equivalent mixer network even more complicated than the 3-terminal pair of Fig. 5. It will have 4 terminals as shown in Fig. 8, ω represents the local oscillator frequency, β the i-f frequency, and $\omega - \beta$ the conventional image frequency.

Three of the terminals of Fig. 8 are the same as Fig. 5, the fourth terminal is at the second harmonic image of $2\omega + \beta$. If the losses in the crystal cartridge and mixer are just as low for the frequencies near the second harmonic of the local oscillator as for those near the local oscillator frequency, the conversion of signal energy to second harmonic is just as great as to conventional image.

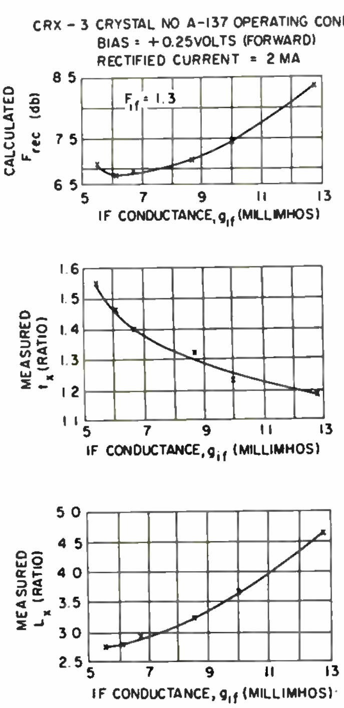
In a very careful UHF mixer study,[3] signal, image, and second harmonic image terminations were carefully isolated by filter networks. With the Philco germanium X-band crystal, the effects of these terminations on conversion loss, noise temperature, and i-f impedance were measured with the results shown in Table 1. With the best IN21D crystal the variations were almost as great.

For all measurements, bias and local oscillator injection were kept constant, and the r-f and i-f impedance matching were optimized for each measurement.

First to be noted is the more than 4-to-1 variation in i-f impedance; next, the fact that the interchange of open and short termination at the conventional image and the second harmonic image have equal effects as predicted from theory. As in the conventional narrowband mixing, "open" terminations always give lower conversion loss than "short" terminations.

For the last column of Table 1 an i-f noise figure of 2 db is assumed, and it is seen that the over-all receiver noise figure will have a range of nearly 3 db depending on the type of image and second harmonic image terminations. The range will be much greater than this if the signal match and i-f transformation are not optimized for each condition.

Fig. 9: L_x, t_x, and F_{rec} vs i-f conductance.



Conversion Conclusions

Mixing with crystals of high conversion loss (over 8 db) is simple and noncritical. Image terminations have negligible effect either for improvement or degradation. Mixer design for crystals with low conversion loss (6 db or less), and with high losses at second harmonic due to cartridge losses or barrier capacity, can be concerned with the first harmonic image termination only.

Crystals with low conversion losses, used at sufficiently low microwave frequency so that second harmonic losses are no greater than fundamental, must have both first and second harmonic image terminations of the mixer specified. The manufacturer need only measure the performance of a crystal for the "broadband" condition, which specifies the second harmonic image to be shorted.

Performance for all other first and second harmonic image terminations is calculable. Best X-band microwave mixer diodes such as IN23D in silicon, and IN263 in germanium, have so little degradation from barrier capacity that the microwave noise figure performance is substantially identical for all frequencies below 10,000 MC.

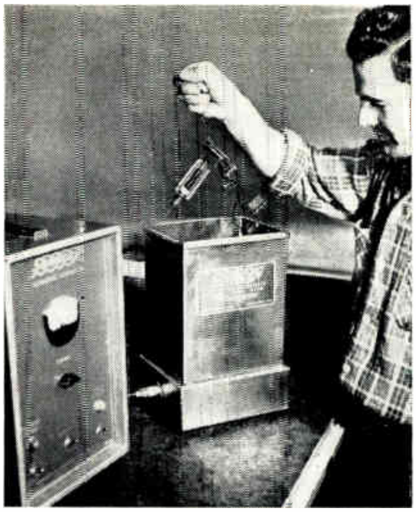
Noise Temperature

The noise temperature t_x of a mixer is determined by conversion loss and the noise mechanism within the crystal diode is given by the following function for the "broadband" type of mixer:

$$t_x = \bar{t}\left[1 - \frac{2}{L_0}\right] + \frac{2}{L_0} \qquad (5)$$

where L_0 is the broadband con-

(*Continued on page* 152)



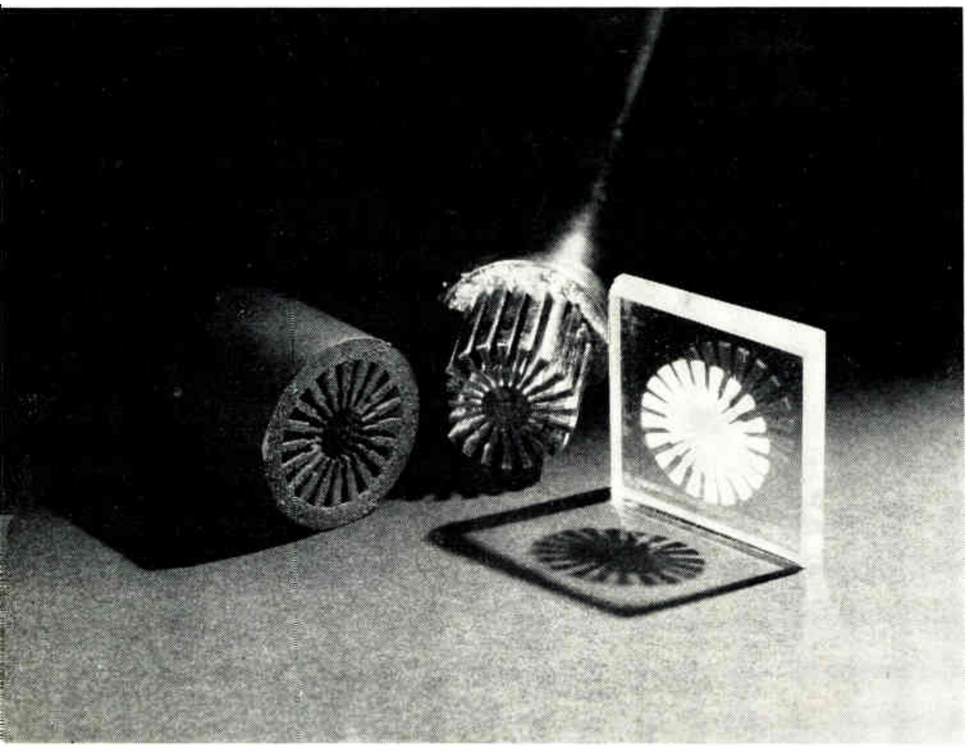
Cleaning intricate shapes ultrasonically
Photo—Branson Ultrasonic Corp.

ULTRASONICS
—The New Electronic Art

After a brief apprenticeship as a cleaning and soldering tool ultrasonics has now branched out into a wide variety of slicing, machining, measuring, drilling and burglar alarm applications. How the ultrasonic motion is applied, and how to choose the right transducers and generators for a given operation, are described here.

By **JOHN E. HICKEY, JR.**
Assistant Editor
ELECTRONIC INDUSTRIES & Tele-Tech

Fig. 1: Ultrasonic machining was used to make these cuts. Tool is shown in the center
Photo—Raytheon Manufacturing Co.



Part One of Two Parts

TWO years ago commercial ultrasonic equipment was virtually unheard of. Today it is one of the fastest growing fields in the electronic industries. Sales of equipment is expected to reach $30 million for 1957.

Twenty-odd firms have formed the Ultrasonic Manufacturers Association to further advance this art.

Today ultrasonic equipment is being built for cleaning, metal joining, machining, detection and testing, and use in the medical field. Ultrasonics is generally considered to be frequencies above 15 KC. Ultrasonic frequencies to 15 MC are being used in the medical field and to 100 MC for flaw detection.

Systems for the production of ultrasonic vibrations are termed ultrasonic generators. These generators essentially consist of an electronic unit. Basically, the electronic unit contains an oscillator and power amplifiers. The amplifiers are usually straightforward design.

The ultrasonic energy is applied to gases, liquids, and solids to produce desired changes or effects. Some of the desired effects are:

Cavitation—A formation of bubbles in a liquid during the rarefaction cycle. When the compression occurs, the bubble collapses. During the collapse tremendous pressures are produced. These pressures may reach several thousand atmospheres. Thousands of these bubbles are formed in a small volume of the liquid. It is cavitation that produces many of the biological, detergent, mechanical and chemical effects in the application of high intensity sound of the various mediums.

Emulsification—is the suspension of fine particles or globules in a liquid. Emulsions are generally produced by violent agitation. When two immiscible liquids are subjected to intense sound vibration, an emulsion will be formed.

Coagulation—small particles in smoke, dust, and mist agglomerate when the mixtures are subjected to strong sound waves. Intense sound waves have been used to coagulate and precipitate particles in smokestacks. Metals are sometimes degassed with this method.

Chemical—When high intensity ultrasonic waves are passed through some liquids, reactions that would normally take place are accelerated; in other cases effects are brought about that would normally be absent without ultrasonic vibration. It is difficult sometimes to determine whether the effects are due to the sound alone or the thermal effects that are a result of the sound energy.

Temperature rises of several degrees per minute can be obtained. This heat is due to the dissipation of sound by absorption in the liquid. This quite often obscures the effects which can be attributed to the sound alone. The applications of heating by ultrasonics remain to be seen.

Biological—brain surgery, body mapping, therapy and dentistry are some useful effects. It appears that bacteria can be destroyed by cavitation. Knowledge is still greatly lacking in this area.

The Transducer

The transducer may be considered as the heart of any ultrasonic equipment. Its job is to transform the electrical energy to a mechanical or working energy. This working energy appears as vibratory motion and may run from a few watts to several kilowatts, depending on the type of work that the unit is required to do. The same is true with the frequency of operation.

Generally two types of transducers are used, the magnetostrictive type and the piezoelectric type. Magnetostrictive transducers are mechanically rugged and are usually used for producing large acoustical outputs at lower ultrasonic frequencies, while the piezoelectric transducers are utilized for the higher frequencies. There is a third type of transducer which can be used in air—the whistle or siren.

Magnetostrictive Transducers

Ferromagnetic materials such as iron, cobalt, nickel, and alloys of these metals undergo a change

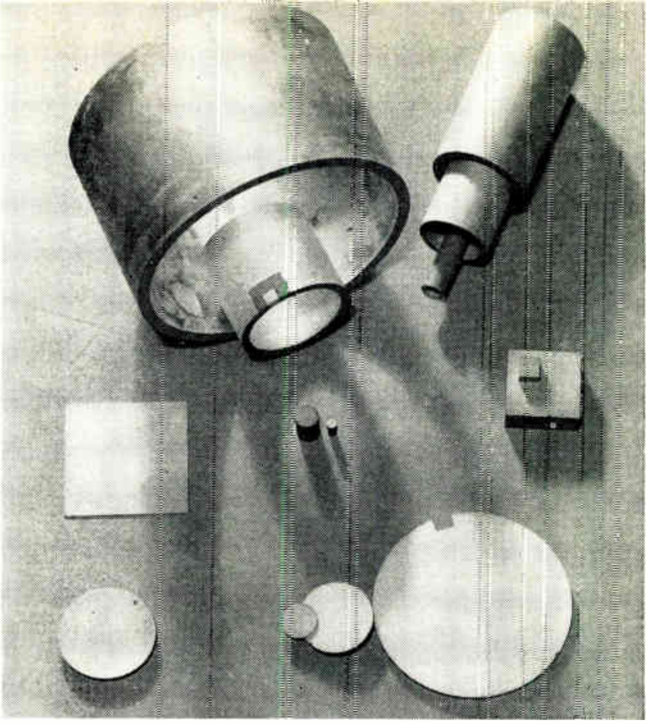


Fig. 2: Ceramic pieces may be made to any shape for transducers
Photo—Gulton Industries, Inc.

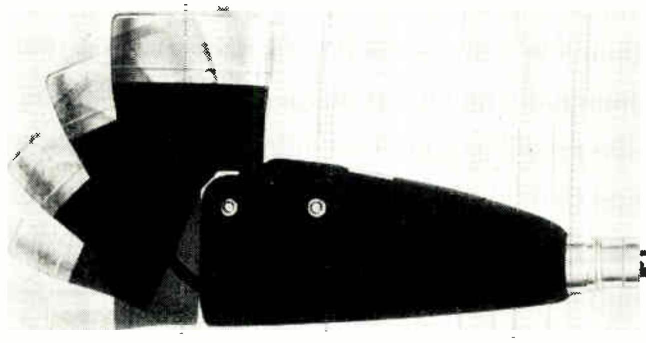
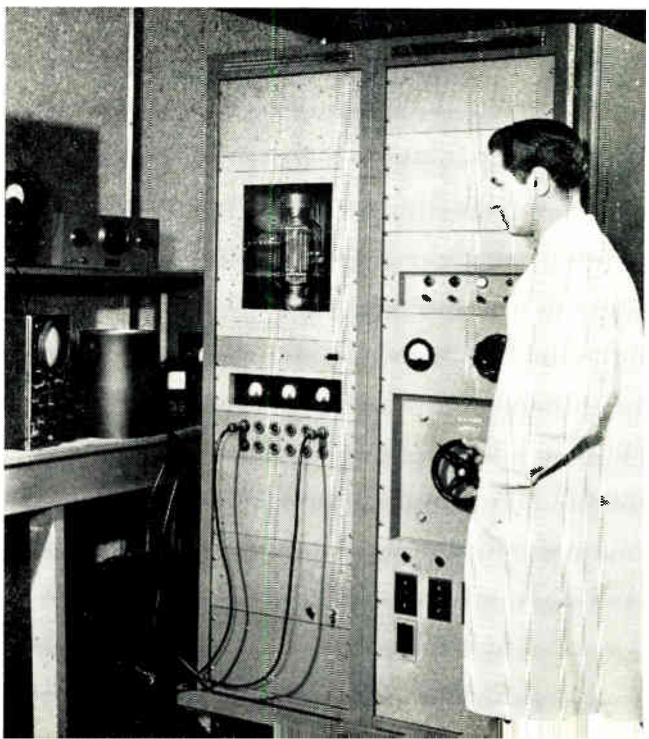
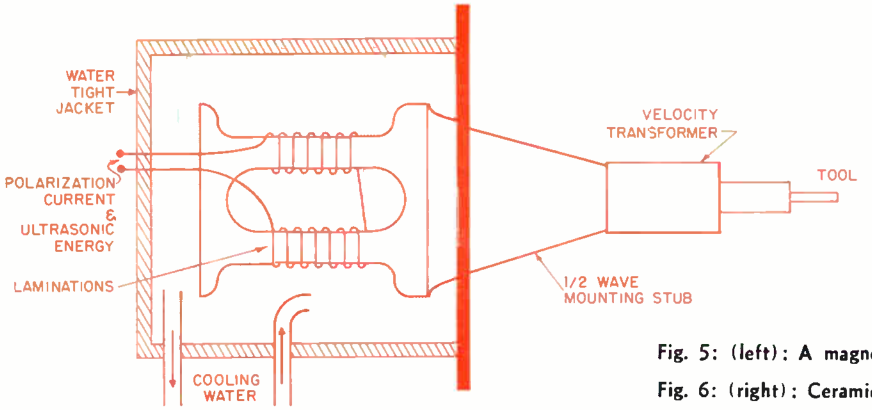


Fig. 3: Medical ultrasonic applicator head can assume 5 positions
Photo—The Birtcher Corp.

Fig. 4: The ultrasonic generator has a power output of 1500 w.
Photo—Designers for Industry, Inc.





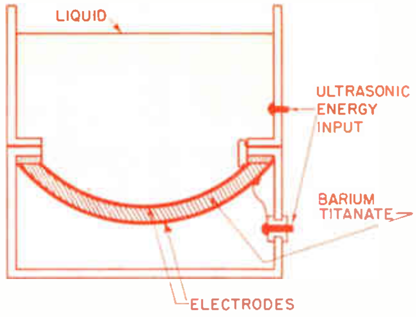


Fig. 5: (left): A magnetostrictive type transducer using water cooling

Fig. 6: (right): Ceramic transducer being used for ultrasonic cleaning

Ultrasonics (continued)

in dimensions when subjected to a change of magnetic state. The effect is reversible. A combination of these effects are used in sonar. Ferrites are also being used. These sintered metal mixes offer very high resistivity, so that the troublesome eddy current losses which occur with the metallic transducers are greatly reduced.

Usually the element in these types of transducers consists of a consolidated stack of thin nickel alloy laminations. The magnetostrictive material is laminated for the same reason as the cores of transformers, to reduce eddy current loss. A coil is wound around the laminations. The output of the power amplifiers is fed to this coil. A second winding is placed on the laminations to supply a polarizing field. Sometimes the same coil is utilized for polarization. The polarizing field is chosen to give maximum magnetomechanical coupling into transducer material and corresponds to a flux density of about two thirds saturation in most materials.

Transducers are water or air cooled. For water cooling operations, the coil and laminations are sometimes surrounded by oil and the water cooling coils are placed inside of the oil. This method of cooling is used in high power operations where a large amount of heat is generated.

The advantages of these types of transducers are many. They are easily constructed, mechanically rugged, not damaged by rough handling, or by the rather high temperatures to which they may be subjected and they can be made to match the output of the electronic chassis quite easily. This type of transducer with a stainless steel head will also withstand immersion in corrosive types of materials, and external pressures. They are used extensively in soldering, brazing, welding and machining operations.

Piezoelectric Transducers

We are all familiar with the piezoelectric effect, which is a generation of electrical current when pressures are applied to certain types of materials. The converse of this is also true. The most important of the piezoelectric materials are quartz, Rochelle salts, ammonium dihydrogen phosphate and barium titanates. Quartz crystals, however, because of their mechanical qualities are extensively used in ultrasonic generators for the high frequency regions.

The efficiency of conversion in the electrical-acoustical energy of the quartz transducer is quite high—in the order of 90%. They are not affected by high temperatures. Their impedance is relatively high, therefore a transformer must be used to couple the transducers to a vacuum tube amplifier.

With these types of transducers the material is clamped between two plates known as electrodes. Electrical connection is made to each of these electrodes and the electrical energy fed to the electrodes.

Transducers fabricated from ceramics are becom-

Fig. 7: Water cooled magnetostrictive transducers with velocity transformers
Photo—Acoustica Associates, Inc.

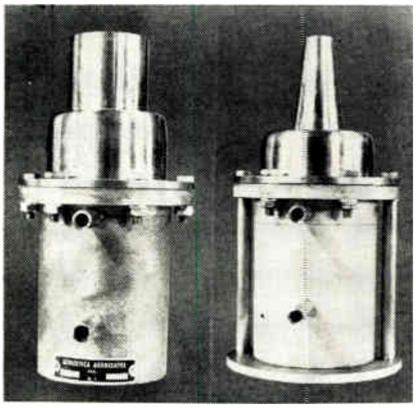


Fig. 8: Transducer designed for degreasing, cleaning or processing use
Photo—Gulton Industries, Inc.

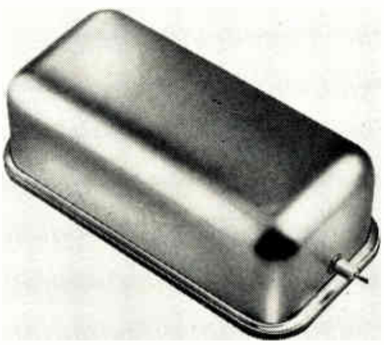
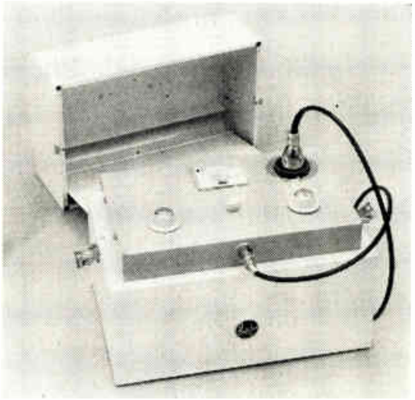


Fig. 9: Medical therapy unit has a variable output to 15 watts at 1 mc
Photo—The Birtcher Corp.



ing quite popular today. While they are usually referred to as "piezoelectric," they are more properly referred to as "polarized electrostrictive" elements. When the polycrystalline electrostrictive material is subject to an electric field, its dimensions are modified similar to other piezoelectric type materials. The relative change in its dimensions is a function of the absolute value of the applied electric field, temperature, nature of the material, and its particular treatment. This effect is called electrostriction.

These ceramic transducers are usually made of material known as barium titanate. A useful feature of this material is its ability to be polarized by placing in a strong dc electric field for a fixed amount of time. This eliminates the need of constant polarization such as with the magnestriction type of transducer.

Ceramic transducers can be formed to any size and shape for a multitude of design functions, functioning actions and mountings while at the same time efficiency has increased and machining to close tolerances becomes practical. They are rather strong and rugged and can handle fairly large amounts of power and can be electroded as required. The electrodes are usually silver which is fired on the major faces according to the desired patterns. (Fig. 2 shows some shapes that may be formed.) To prevent cavitation damage the transducer electrodes are glazed.

These ceramic transducers are manufactured to operate up to 10,000 KC at temperatures to 100°C and are well suited for the purpose of concentrating energy on a focal region. They can be fired into a desired shape and be prepolarized in such manner as to provide efficient operation. For example—a concave transducer can be prepolarized along a direction of curvature so that when operating, intense radiation is focused in the center of the curvature. Alternatively a cylinder of barium titanate, polarized radially, can be made to focus intense radiation on its axis and this can be used to treat liquids passed along the cylinder. Also, these transducers will vibrate in different modes dependent upon the driving frequency, the dimensions and the elastic properties of the ceramic itself. Mode of operation is determined by the use to which the transducer will be placed.

Transducers usually do their work in a liquid or, as in medical uses, pressed against the body. The reason for this lies in the fact that air is a very poor medium for ultrasonics.

Electrical connections and mountings are made at a null or no vibratory point. The reason for this is quite obvious. The transducers' physical size is determined by the frequency of operation, the power being applied to it and the type of vibratory motion required.

More on Cavitation

Inasmuch as a good deal of ultrasonic processes make use of liquids, further discussion of cavitation is in order. Some of the phenomena associated with cavitation are: chemical effects such as the liberation of free chlorine when cavitation takes place in a mixture of water and carbon tetrachloride; bubbles of various sizes particularly at low frequencies; fluorescence of the material when cavitation is very intense; characteristic noise which is especially loud at low frequencies and high intensities; and abrasion and cavitation damage to a body submerged in a container.

Cavitation is caused when suitable liquid elements are subjected to tension and then shortly after to compression. Cavitation is the effect desired for cleaning and machining operations. It should be kept in mind, however, that materials left in the cleaner too long will be damaged by this cavitation.

When each of the cavitation bubbles collapses, a shock wave is generated in which the peak pressure attains values as high as 10,000 to 100,000 atmospheres. The high repetition rate of shock waves, especially in ultrasonic cavitation, is therefore held responsible for the observed damage. The detection of cavitation is quite often difficult. It may be detected by use of optical magnification or observing the diffusion of light by the bubbles or with the use of a special probe. With experience, at lower frequencies, it can be detected by ear.

In the following sections we will deal more specifically with the various applications of ultrasonics. The types of equipment and a description of their operation is included.

Fig. 10: Drilling microscopic holes in very hard material with ultrasonics
Photo—Lockheed

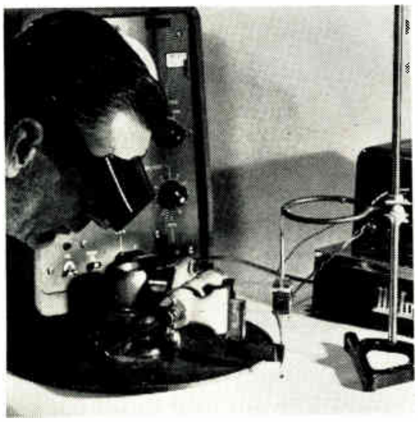


Fig. 11: Welder operating at 2,000 watts welds foil to thicknesses of 0.080 in.
Photo—Aeroprojects, Inc.

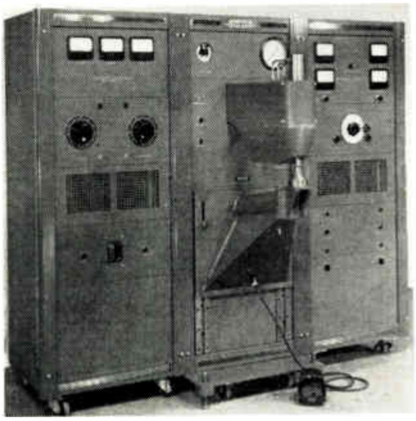
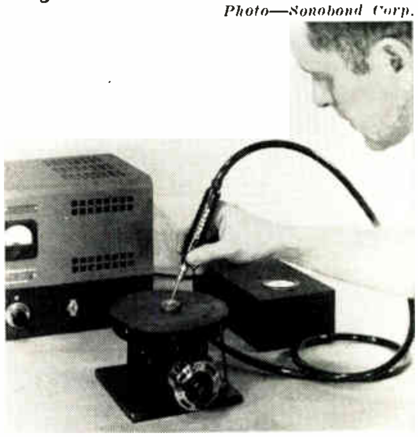


Fig. 12: Small ultrasonic hand soldering unit being used to tin a silicon disc
Photo—Sonobond Corp.



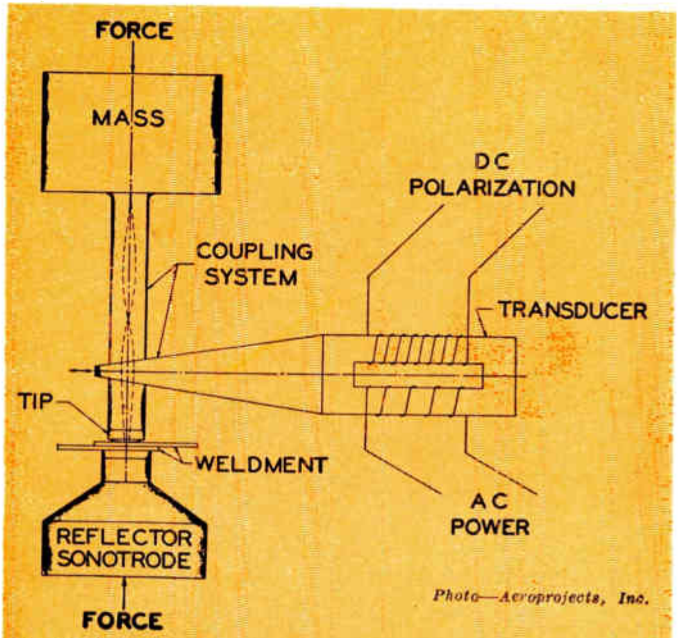


Fig. 13: Schematic diagram of the ultrasonic welding head

Ultrasonics *(continued)*

Metal Joining

Soldering is normally considered to be the joining of two metals with a separate alloy having a melting point between 750°F and below that of the metals being joined.

In the metal joining field this was the first application of ultrasonics. Perhaps the largest single advantage of ultrasonic soldering is the joining of aluminum to aluminum, or aluminum to other metals such as, steel or copper without the use of fluxes. The elimination of flux also eliminates contaminates, corrosion, and the post-cleaning problems.

Ultrasonic soldering has been found effective for dip-soldering of components, and printed circuit boards, the soldering of silicon and germanium transistor elements, and also the soldering of Formvar coated wires without removing this coating or insulating material. A wide range of materials can be effectively soldered by the ultrasonic fluxless process, including the joining of dissimilar metals. However, the problem of unequal thermal expansion must be considered, but with adequate design good joints can be produced.

Ultrasonics lends itself well to the tinning of odd sheet and form surfaces. Specially designed soldering tips for tinning operations of odd shaped pieces can be readily made.

The ultrasonic soldering frequencies are usually between 15,000 and 70,000 CPS, operating at power levels from 15 to 2,000 watts. Ordinarily the transducer is a magnostrictive type utilizing nickel or iron-cobalt lamination while some are ceramic. The sleeving and coupler act as a heat sink to dissipate heat away from the transducer during the soldering operation.

A point that should be made clear, is that, an external source of heat for melting of the solder, heating the iron, and heating the materials to be soldered is still required. Heat may be applied electrically or by flame. Ultrasonic soldering irons are heated electrically similar to normal soldering irons with wattages to 75 watts.

Effectively what the ultrasonic soldering equipment does is to take the place of a flux. This is accomplished through the use of cavitation. As the active face of the device is moved through molten solder, the vibratory energy produces cavitation within the liquid solder between the face of the radiating coupler and the face of the work piece. The surface can be wetted by the liquid metal as a result of the erosion of oxide and contaminate surface films in the cavitation zone. The wetting of the metals with solders is therefore effected without the use of chemical agents or mechanical abrasives, thereby eliminating the necessity for pre-cleaning and post-cleaning operation.

Brazing

Ultrasonic brazing is comparable to ultrasonic soldering processes. Brazing is used where the end results require a joining metal having a melting point or flow-range above the normal soldering temperatures. It may be required, for example because of strength or corrosion problems encountered on normal soldered joints, or because limitation of the soldering-process in destroying insulating coatings. Generally, production applications of brazing techniques are presently limited to fluxless brazing of copper, aluminum, and similar metals with aluminum-silicone or aluminum brazed metals having melting points between 850-1250°F.

The physical and mechanical effects achieved with ultrasonic brazing are similar to those achieved in ultrasonic soldering. Present ultrasonic brazing equipment resembles, in appearance, the soldering units. Several modifications are incorporated however, due to the higher temperatures utilized. The brazing tip must resist the severe alloying effects of molten aluminum and similar brazing materials. A special gas-fired tip heater is employed, and high-capacity cooling is included to remove heat conducted back from the tip. This protects the transducer.

The equipment operates in the frequency range of 15,000 to 60,000 CPS at power levels from 25 to 2,000 watts. The brazing tip may be either gas fired or electrically heated. The gas mixture on the gas fired type is fed right into the handle of the ultrasonic brazing probe tip. The flame then emanates from the end of the ultrasonic probe at its tip. In other words it operates like a normal brazing torch with the ultrasonic unit placed right in the heart of the flame. The ultrasonic effects for brazing are the same as those for soldering.

Welding

In the metal joinings field ultrasonic welding is the newest and perhaps the most unique utilization of energy. Welding with ultrasonic equipment is used for joining similar or dissimilar metals by the introduction of the vibratory energy. In the welding process the pieces to be joined are clamped at low pressures usually between 10 to 350 psi between two

(*Continued on page* 138)

A Report on

Developments in Printed Microwave Components

Housing and connecting problems are eliminated as the printed microwave components described in this article make a complete line practical. Some, not feasible in transmission lines, are realizable.

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BECAUSE of the wide variety of microwave transmission line requirements, viz., operational frequency, power handling, size, weight, and impedance level, it is difficult to choose a "one-best" type of line for all applications. The problem is somewhat similar whether the line be waveguide, coaxial line, or strip.

In a line operated in a TEM-type mode, however, the size variations tend to be less severe with the above parameter changes, particularly with regard to frequency. Fig. 1 shows a cross sectional view of two stripline types, together providing good coverage of most performance specifications. It is believed that this makes a good compromise for the least number of different line types.

Fig. 1a, a hi-Q line, occupies about 10 times the volume of the miniature line shown in Fig. 1b. The hi-Q line, per se, is generally smaller than its coaxial or waveguide counterpart.

The hi-Q lines are intended to be used where moderately high peak powers (up to about 100 kw) are required, or where transmission line unloaded Q-factors of the order of a couple thousand are needed (see Fig. 2a). The dual center strip, one ounce copper conductor (a thickness of about 25 skin depths at S-band) shown in Fig. 1a, is supported between an outer aluminum sheath by a 1/32 in. teflon fiberglass board. This forms a housing smaller than X-band waveguide in cross section.

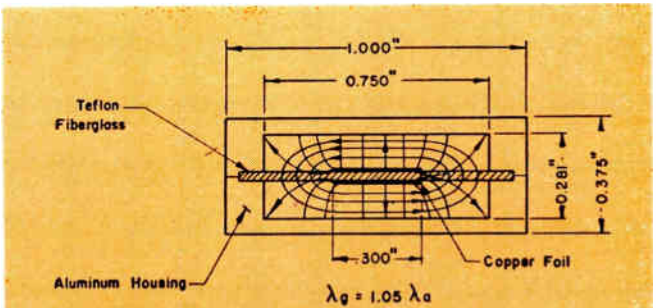
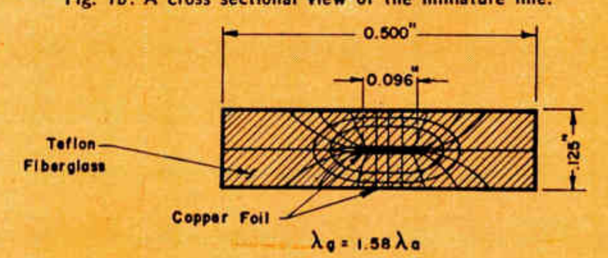


Fig. 1a: Cross sectional view of hi-Q line reveals that it is about twice the size of the miniature line, but still smaller than coax.

The aluminum sheath of the hi-Q line is composed of two extruded channels placed face-to-face and riveted together. The useful frequency range of this line is between dc and at least 8.0 KMC where the waveguide TE_{10} mode can be supported. To preclude higher mode propagation, a narrower line is advised for X and K-band operation.

The electromagnetic field in the hi-Q line, existing principally in air, is propagated in a medium having an equivalent index of refraction of 1.05. The principal transmission loss is due to the copper-strip center conductor, with a very small amount of fringing-field dielectric loss also being present. The fringing field in the dielectric also accounts for a refractive index greater than unity. Fig. 2a summarizes these losses for 50-ohm line components.

Fig. 1b: A cross sectional view of the miniature line.



Environmentally, the hi-Q line has a negligible moisture absorption and a thermal temperature coefficient of expansion of about 20 ppm/°C. Attenuation at 100% relative humidity is approximately twice that under dry conditions.

For vibration in a direction normal to the plane of the strip, impedance modulation at certain frequencies is possible. Complete measurements of this

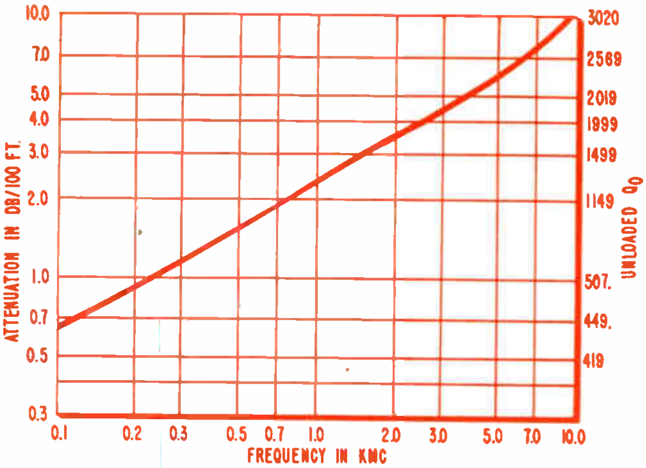


Fig 2a: The transmission loss for 50-Ω hi-Q line components.

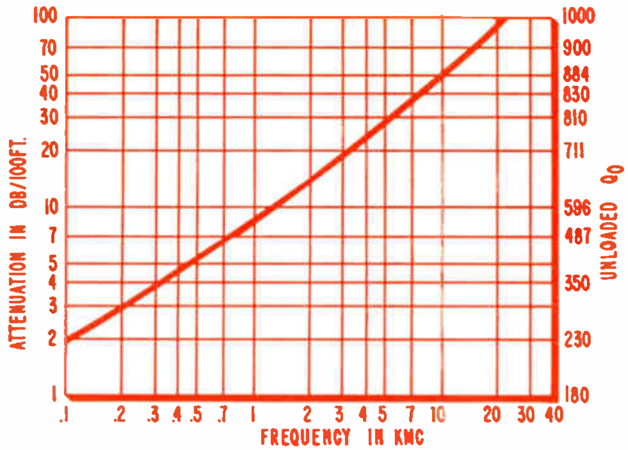


Fig. 2b: Dielectric causes main transmission loss in miniature line.

have not been made. Theoretically, however, a ±10% excursion of the center strip conductor off axis between ground planes would correspond to about 0.01% modulation of a signal in a section of line having a small transmission variation vs frequency dependence.

Impedance molulation can be obviated by mechanical isolation or by dielectrically loading the line with low loss material such as teflon. The resulting transmission loss for teflon loading would approximately double the loss of the unloaded line at S-band.

Regarding the problem of homegeneity, minimizing transmission loss, and using a dielectric material with low water absorption, two new materials have become available since the foregoing measurements were made. These are (1) pure teflon copper clad and (2) copper foil cladded to polyethylene by teflon adhesive.

The miniature lines are designed for use where high power is not required (handles up to at least 10 kw peak) or where transmission line unloaded Q-factors less than about 1000 are satisfactory, see Fig. 2b. The line may be used at frequencies from dc to at least K_u—band. Structurally, the center copper strips of both half sections of the line are placed face-to-face to form a transmission medium of teflon fiberglass having a refractive index of about 1.6.

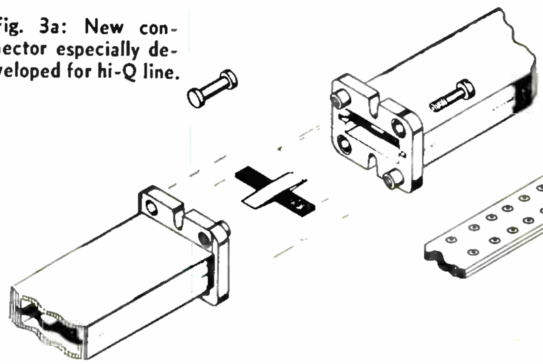
Where highly frequency sensitive elements are etched in the line, one half section has the entire center strip removed except near the transitions or conntors. This avoids the consequences of registration errors.

The half sections are secured together by eyelets to mechanically bond them, and to mitigate radiation loss in the event the parallel plane mode should otherwise be set up and supported. The principal transmission loss is due to the dielectric; conductor loss is also significant, Fig. 2b. Because of the very short length required to realize components (λg strip = 0.8 in. at 9375 MC), the resulting loss in practice is still small.

Up till recently, the practical use of printed microwave components (PMC) has been limited because of the lack of suitable connectors with which to join components. Waveguide or coaxial connectors were frequently used to join PMC, resulting generally in inadequate impedance matching and compromise in subminiaturization. Although some strip line connector types have been reported, to our knowledge none has had universal properties, rapid coupling features, small size, and low VSWR.

Fig. 3a shows a newly developed connector especially designed for use with the hi-Q line. Printed microwave components using these may be connected or disconnected rapidly from each other with all combinations of possible mating. This character-

Fig. 3a: New connector especially developed for hi-Q line.



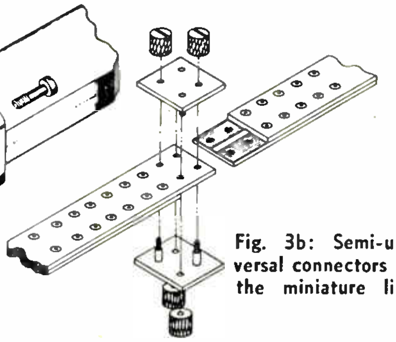
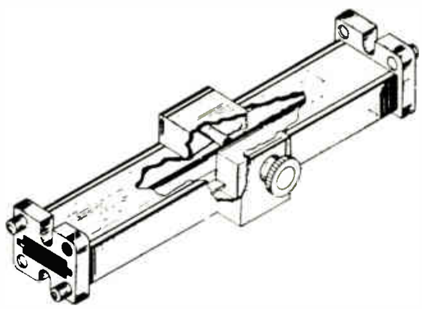


Fig. 3b: Semi-universal connectors for the miniature line.

Fig. 4: Depicted is a variable phase shifter operating in the same fashion as its much larger waveguide counterpart.



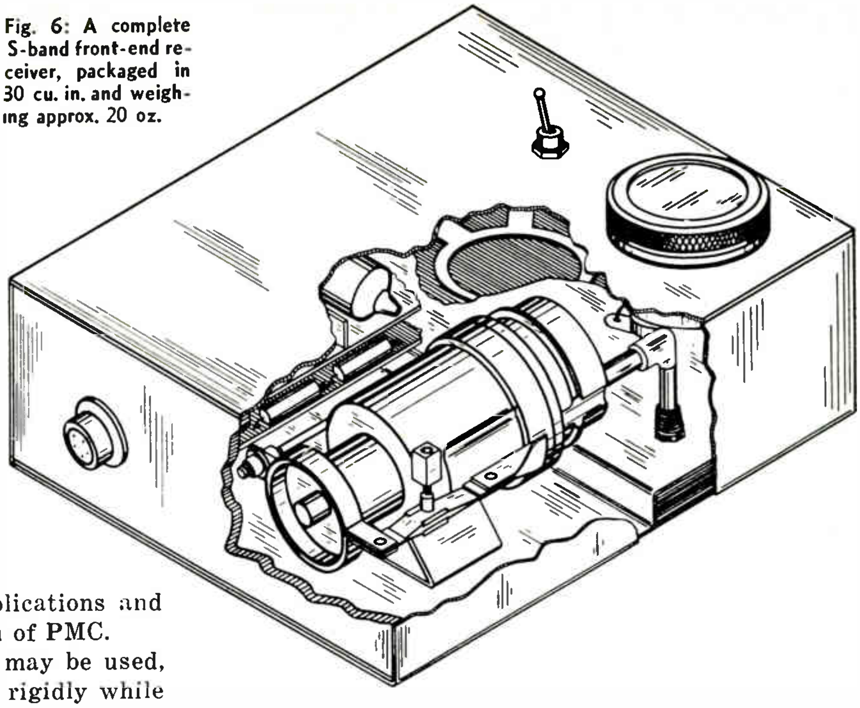


Fig. 6: A complete S-band front-end receiver, packaged in 30 cu. in. and weighing approx. 20 oz.

istic greatly facilitates test-bench applications and assures effecting a desired combination of PMC.

The cross bars indicated in Fig. 3a may be used, if desired, to secure components more rigidly while making tests. For permanent applications, the components may be secured with screws since the tubing-pins are threaded. Rubber gaskets may be inserted for weather proofing. The nominal VSWR of the universal connectors and that contributed by a PMC matched load is about 1.03, from 1.8 to 4.0 KMC.

Fig. 3b shows the semi-universal connectors developed for the miniature line. They permit a dove-tailed coupling at either end without additional mating transitions. A locking clamp firmly secures the coupling. The nominal VSWR of these connectors plus a matched load is about 1.05, from 8 to 11 KMC.

Hi-Q Line

Fundamental to any suitable strip line is a slotted line and probe with which to make VSWR measurements. Fig. 5 shows a slotted line mounted in a Hewlett Packard 809B universal carriage; the tunable probe is a PRD model 250A. The slot width, kept as narrow as possible, 0.093 in., is adequate to receive the 0.080 in. dia. probe sheath and is tapered at both ends to minimize impedance mismatch.

The line is machined from a thick solid block of aluminum to help obviate camber, twist, or warp and is long enough to permit at least one half wavelength to exist at 850 MC. Residual VSWR is less than 1.02 and variation of probe coupling with travel is negligible.

Fig. 4 depicts a variable phase shifter operating in the same fashion as its much larger waveguide counterpart. Two thin slabs of polystyrene are positioned axially in the strip line and are moved transversely across the line to give more than 180° of phase variation at S-band (60° at L-band and 360° at C-band).

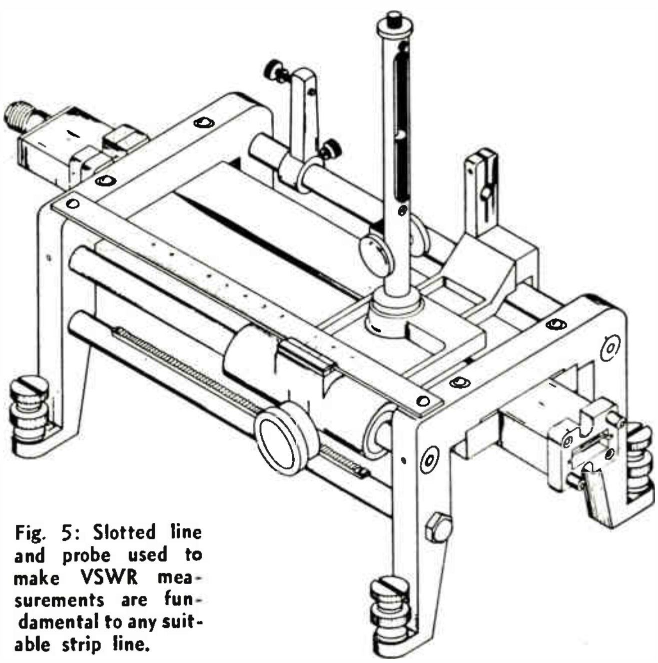


Fig. 5: Slotted line and probe used to make VSWR measurements are fundamental to any suitable strip line.

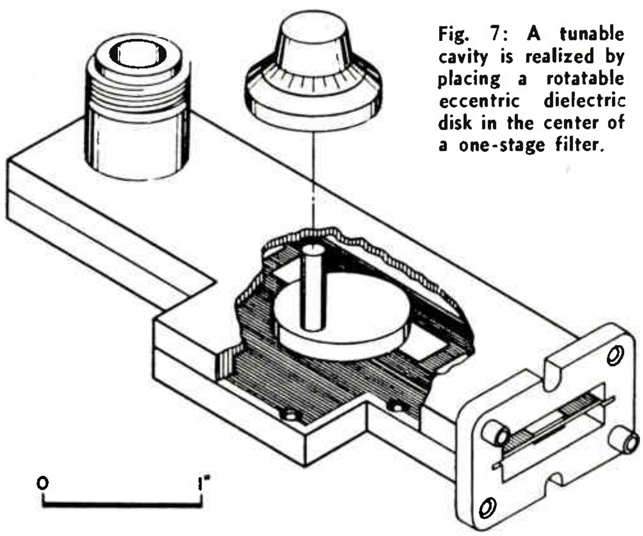


Fig. 7: A tunable cavity is realized by placing a rotatable eccentric dielectric disk in the center of a one-stage filter.

Printed Microwave Components *(Continued)*

Long tapers at both ends of the dielectric slab result in a VSWR averaging 1.20 over more than an octave centered at S-band. Among other uses, this phase shifter is designed to replace telescoping coaxial units since applications of the latter are restricted by changes in physical dimensions during use.

The increasing demand for pre-selectors or band-pass filters has resulted in the design and realization in hi-Q line of units having Butterworth or Tchebycheff responses with loaded Q-factors from 3 to about 50, and 1 through 8 stages. This previous filter art has now been reduced to a science.

Similar in principle to those reported earlier,* Fig. 8 depicts a typical 5-stage, capacitively-coupled, band-pass filter realized in a hi-Q line. Rejection of spurious responses at, or near, harmonics of the fundamental response is possible by stepping the impedance within the chambers.

By placing a rotatable eccentric dielectric disk in the center of a one-stage filter, Fig. 7, a tunable cavity is quite readily realized. The tuning range provided by this polystyrene dielectric cam covers about a 30% band at S-band. Although possible, ganged tuning becomes difficult due to the problem of tracking and preserving the desired response factor.

Other hi-Q components developed include: matched loads and pads using IRC resistor cards (VSWR generally less than 1.03); end-on and normal-type transitions (universal spade connection was developed to give a cheap and simple solderless type-N coaxial to strip-line transition); crystal mounts for both cartridge and coaxial crystals (universal design permits cartridge type to plug into modified UG 58A/U connector on strip line transition); hybrid ring circuits (greater than 30 db isolation over 10% band and 20 db isolation over 30% band); wide-band directional couplers; low and high-pass filters (several hundred db/octave readily realized); and Y-junctions, tees, and elbows. A ferrite switch, or gas tube, would complete the package, but this has not yet been worked on in strip line because of limited resources.

Additionally, an improved matched load using Eccosorb HF 853 is under study. All components are readily provided with the new universal connector, type-N, or other connectors for coaxial line applications. Transitions from waveguide to strip line display a smaller band width than transitions to coaxial line. Generally speaking, PMC have greater bandwidth than their waveguide counterparts because of dispersion in the latter line.

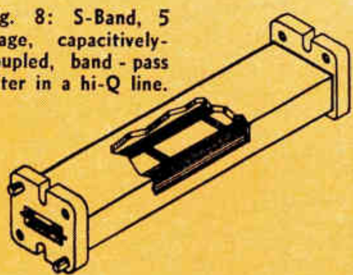
* "Band Pass Filters Using Strip-Line Techniques," by E. H. Bradley and D. R. J. White; *Electronics*, pp. 152-155, May 1955.

Miniature Line

The variety and method of physical realization of the miniature line components moderately closely approximates the hi-Q line. Fig. 9 shows a modified Type N, UG 58A/U connector mounted to the miniature line.

Many different configurations of strip-to-coax center conductors were tried before the low impedance match shown was realized. The center conductor of the type-N connector is tapered down and is sweat soldered directly to the copper strip, resulting in a broadband impedance match. An aluminum sheath completely surrounds the strip line at the coaxial connector. This makes fabrication simpler and insures that the parallel-plate mode will not be set up or propagated. Consequently, the line does not radiate.

Fig. 8: S-Band, 5 stage, capacitively-coupled, band-pass filter in a hi-Q line.



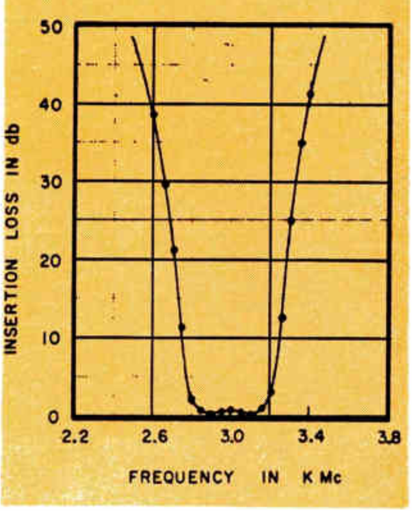
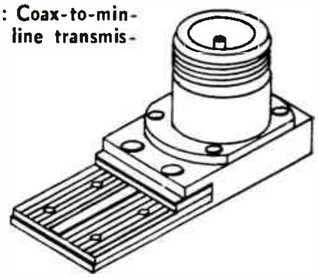
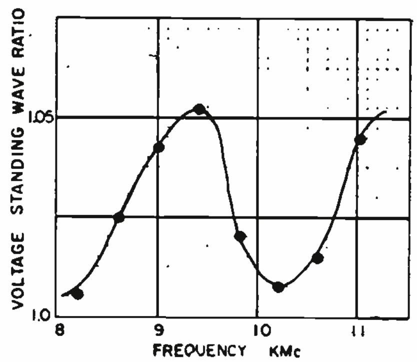


Fig. 9: Coax-to-miniature line transmission.



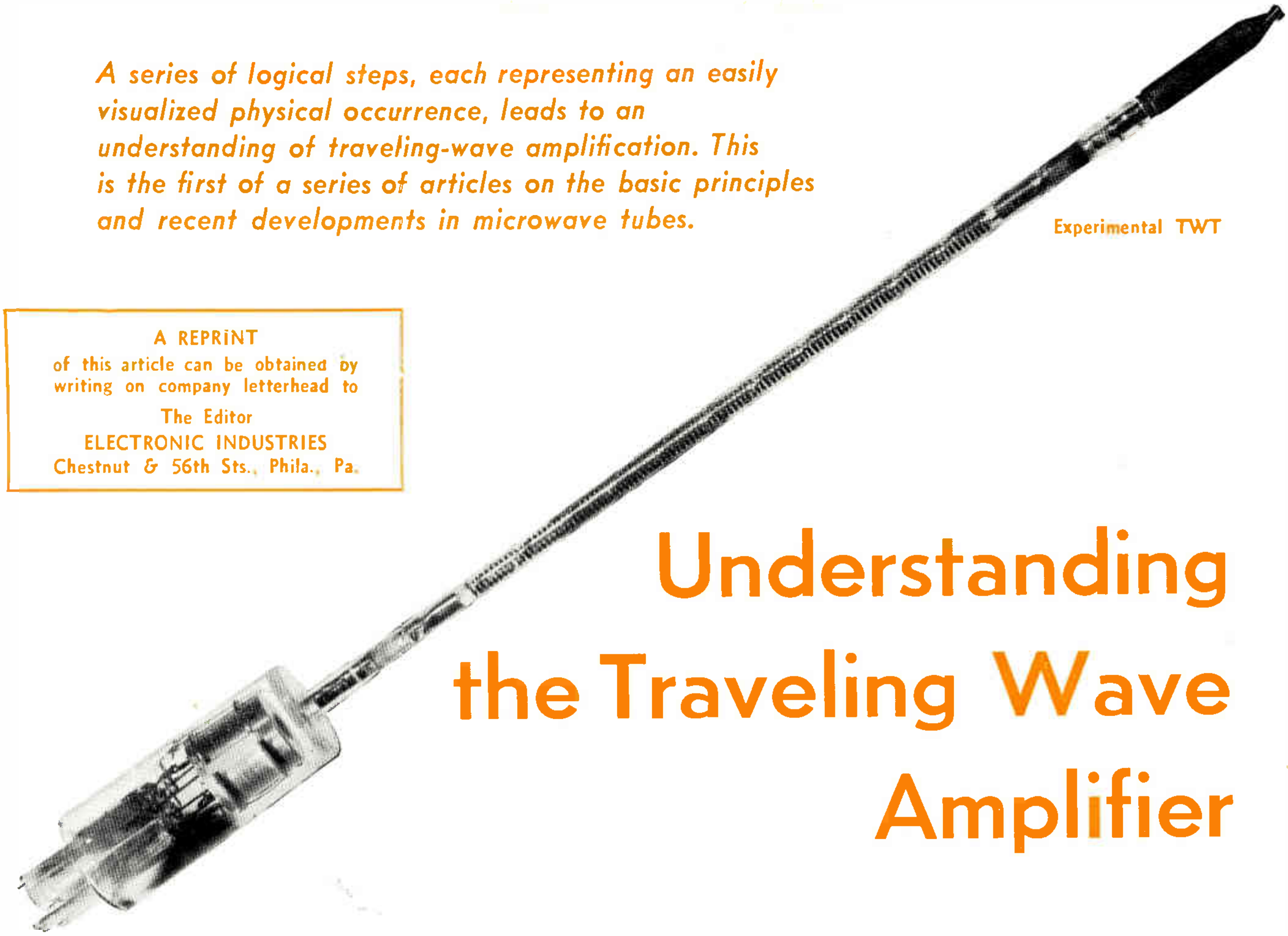


Several different configurations of crystal mounts have been designed. One successful mount in miniature line, Fig. 10 uses the relatively new 1N369A Sylvania Tripolar crystals which have a built-in dc return, r-f bypass, and video or i-f output terminal. The 1N369A is a coaxial crystal somewhat smaller than the 1N26 and lending itself nicely to strip line mounting.

The Sylvania people were good enough to further cut down the sheath size so that the tiny probe center conductor can be "plugged into" a small eyelet located in the strip line. The output terminals are joined to a modified Microdot connector No. 3101, resulting in an overall design having excellent compactness and good performance. From 8 to 11 KMC, the crystal video sensitivity is greater than —40 dbm and the impedance match is less than 1.4 VSWR.

(*Continued on Page* 144)

A series of logical steps, each representing an easily visualized physical occurrence, leads to an understanding of traveling-wave amplification. This is the first of a series of articles on the basic principles and recent developments in microwave tubes.



Experimental TWT

Understanding the Traveling Wave Amplifier

By DONALD A. DUNN
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THE following explanation is primarily based on Kompfner's original theoretical approach to traveling-wave amplification.[1] Although more elegant methods of analysis have since been devised, this early theory leads to an answer after a series of logical steps, each of which represents an easily visualized physical occurrence.

Basic Structure

A traveling-wave amplifier in its simplest form comprises a slow-wave structure and an electron beam, traveling near the structure, with a velocity very near the velocity of propagation of a wave on the slow-wave structure.

Fig. 1 shows such a slow-wave structure which is a helix. The r-f power is supplied to the gun end of the helix in the form of a traveling wave which has a strong component of electric field parallel to the direction of electron motion. Power is removed at the collector end of the helix. By means of a continuous interaction between this electric field and the electron beam, amplification is obtained.

Since the wave and the electrons travel at nearly the same velocity, each electron experiences a force that is substantially constant with time. By interaction with each electron over a long period of time, it is possible to obtain very high amplification of the wave with what is a relatively low impedance circuit, as compared with a resonant cavity such as is used in klystrons. As a direct consequence of the use of a nonresonant circuit, it is possible to achieve very wide bandwidth in a traveling-wave amplifier.

Interaction Process

To understand this continuous interaction process, visualize a constant-amplitude traveling wave of electric field as shown in Fig. 2. Positive E means the force on an electron is to the left in Fig. 2, and negative E means the force on an electron is to the right. A uniform distribution of charge is visualized as traveling at exactly the same velocity as the wave to the right in Fig. 2. If one now imagines oneself as traveling with the wave and the beam, it is seen that between A and C all electrons will move to the

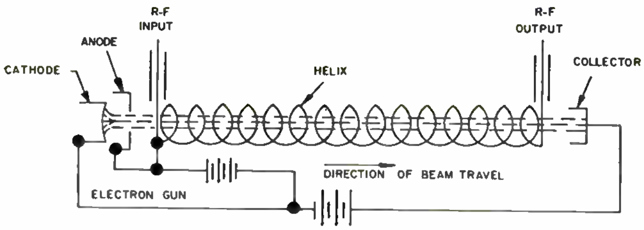

Fig. 1: The electron beam travels near helix slow wave structure.

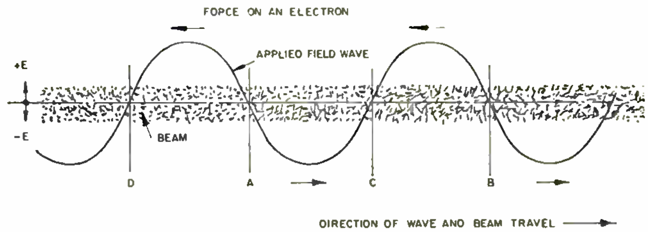

Fig. 2: Visualization of the continuous interaction process.

Traveling Wave *(continued)*

right, and between B and C all electrons will move to the left, so that within one wave period, from A to B, there will be a tendency for the electrons to form a bunch at C.

Similarly, electrons in the half-periods on either side of A are moving away from A with the consequent formation of an "anti-bunch" at A, i.e., an absence of negative charge at A. The process of bunch formation is a cumulative one, i.e., the longer the electrons are subjected to the field, the denser the bunch they form. It is easily demonstrated that the alternating current as seen in a stationary frame of reference due to the passage of these bunches is proportional to the square of the time the electrons have been subjected to the field.

But another way, the charge density of the bunches grows as the square of the distance traveled from the input of the tube where the electrons are first subjected to the field. The physical picture is as shown in Fig. 3.

A bunched beam, moving near a circuit of the type we are considering, will induce a field on the circuit. The circuit may be considered to be divided into a series of gaps of infinitesimal length. The action of the beam may be analyzed on the basis of the action at each gap separately. Then the total effect may be obtained by adding the actions at the separate gaps in proper phase.

If there is some total field present at a specified gap, the bunched beam, on passing through that gap, will deliver an amount of power to the circuit at that point given by the product of the ac current passing through the gap and the voltage across the gap. The voltage across the gap is the product of the field and the gap length. This induced power may be resolved into an induced field wave traveling to the left, and an equal induced field wave traveling to the right, as indicated in Fig. 4.

At gap 1, induced field waves dE_1 are propagated to the left and right from z_1. Similar waves are initiated at all other values of z. The total field at any z is the sum of all induced waves arriving at that z from both directions.

For the case of exactly equal electron velocity and circuit phase velocity, all field waves traveling to the right add exactly in phase. Waves traveling to the left may be considered in pairs such as dE_1 and dE_2 Fig. 4, separated by a quarter wavelength on the circuit.

If these two paired waves were equal in amplitude, they would exactly cancel, because dI_2 has advanced 90° in phase in going from z_1 to z_2 along the beam, and dE_2 advances another 90° in going back from z_2 to z_1 along the circuit, so that it is 180° out of phase with dE_1 when it reaches z_1 and combines with dE_1. Actually, dE_2 is greater than dE_1, since the induced voltage waves increase in amplitude as the square of distance due to the increasing current which is causing this excitation.

However, only a small total field wave will result which is traveling to the left for the case where the increase in current per quarter wavelength is small. It will be traveling at such a high velocity relative to the beam that it will cause no further interaction with the beam.

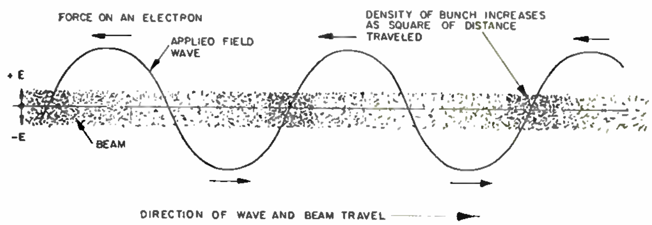

Fig. 3: Bunch charge density grows with square of distance traveled.

Total Induced Field

The total field wave traveling to the right which has been induced by the ac current is in phase with the ac current and is therefore 90° out of phase with the original applied field wave (Fig. 3). The amplitude of this total induced wave increases with distance at a higher rate than the current wave in the beam which induced it. This is so because of the in phase addition of the infinitesimal waves of Fig. 4.

The induced field dE is proportional to the inducing current $i(z)$ which, as a first example, may be taken to be a constant, $i(z) = i_0 =$ constant. It is also proportional to the gap-length dz over which the field dE may be said to exist, i.e., $dE = Ki_0dz$, where K is a constant. Adding induced waves dE from 0 to z, neglecting phase factors because all waves add in phase, it is found that the total induced field increases linearly with distance:

$$\text{Total induced field at } z = \int_0^z dE = \int_0^z Ki_0 dz = Ki_0 z$$

In the actual case, *i(z)* is a constant times distance squared, $i(z) = i_0 z^2$, so the induced field *dE* increases as distance squared, and the total induced field increases as distance cubed:

$$\text{Total induced field at } z = \int_0^z K i_0 z^2 dz = \frac{K i_0 z^3}{3}.$$

Fig. 5 shows this secondary field wave in the presence of the applied field wave and the current induced by the applied field.

Secondary Field Wave

The secondary field wave will induce a current on the beam in exactly the fashion that current was induced by the applied field wave. Bunching will take place which is 90° out of phase with the secondary field wave and hence with the original bunching. This new secondary buncing will increase as the fifth power of distance, analogous to the square-law increase of bunching caused by a constant-amplitude field.

The process repeats: a field is induced on the circuit by the secondary current wave, this new tertiary wave increasing as the sixth power of distance, since it was induced by a current increasing at a fifth-power rate, and so on *ad infinitum*.

The final form of the field wave on the circuit may be obtained by adding this infinite series of waves as the cube of distance, because it starts with the highest amplitude. For some distance it will be the dominant wave and the total field will grow as the cube of distance.

Next, the tertiary wave becomes dominant, so the total field appears to grow as the sixth power of distance, etc. Thus, the rate of growth is rapidly increasing as distance increases, and, as it turns out, the rate of growth is increasing as fast as the wave amplitude is growing, i.e., the growth is exponential.

The fundamental processes that have made this ever-increasing rate of growth with distance possible are threefold. First, there is the cumulative growth of current induced by a field moving with the current, giving a square-law increase of current for a constant applied field. Second, there is a sort of cumulative feedback action taking place at each point along the tube, due to the infinite series of induced current waves reinducing field waves which reinduce current waves, etc., at each point along the tube. These two effects do not, however, account for the exponential gain, since, as has been shown, each successive reinduced wave is much smaller than the previous wave, at the point where the action takes place.

The essential third process is the propagation along the circuit of waves that have been induced near the input. The sum of the waves that have been induced

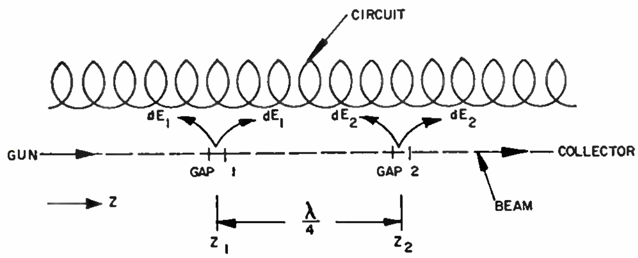

Fig. 4: Induced power is resolved into opposite traveling field waves.

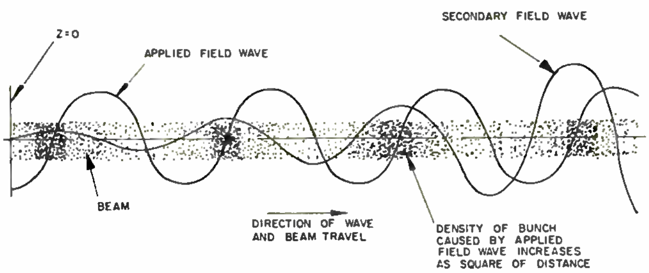

Fig. 5: Secondary field wave, applied field wave, induced current.

to obtain a closed form of expression. This is carried out in Kompfner's early paper,[2] and results in an exponential increase of signal on the circuit. It is possible to see qualitatively that this general form of increase will result.

Qualitative Analysis

First, note that each successive induced wave increases at a higher rate than the wave that induced it, because of the in phase addition of all wavelets traveling in the direction of the beam. Second, there is only weak coupling between the beam and the circuit, so that each time a wave is formed its amplitude is smaller than that of the wave that induced it, near the input of the tube.

Now consider the over-all field amplitude as a function of distance along the tube from the input. Near the input, the strongest field is the applied field and so the field is relatively constant for some distance. The first increasing wave to have substantial amplitude will be the secondary wave, which is increasing at all points previous to a point in question is available to participate in the cumulative feedback process at this point, and the new waves set up at that point not only grow with distance but also add in phase to produce remodulation at each subsequent point along the tube. The final result is a wave that grows faster and faster the longer the distance over which interaction takes place.

Energy Transfer

One point that is made clear by this method of analysis is the question of how the beam transfers energy to the circuit wave. In the analysis we have been through, neglecting space charge, there is no net energy required to bunch the beam. On the average, as many electrons are speeded up as are slowed down and the total kinetic energy of the beam does not alter in a linear analysis. With no space-charge forces tending to force the beam back to its unbunched position, there is no stored energy in

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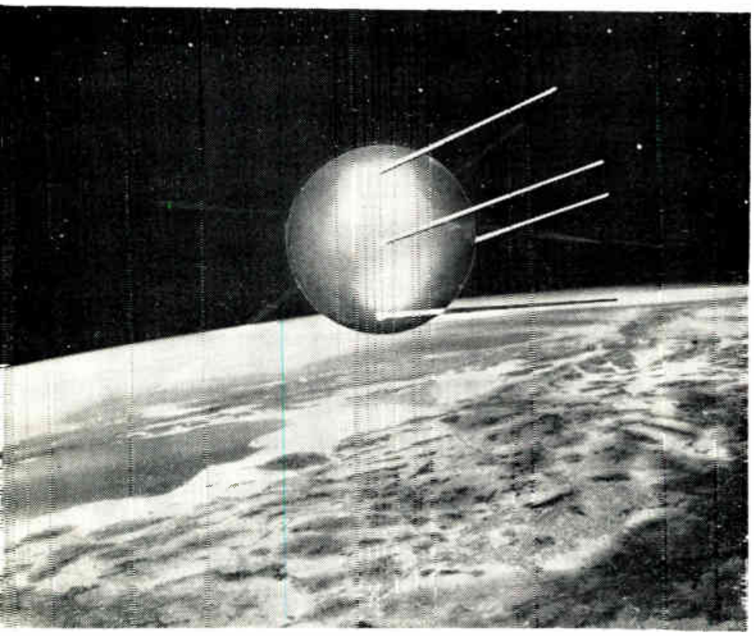


Artists conception of "Sputnik" rocketing through space

"SPUTNIK"

Aside from its obvious value as a smashing propaganda victory, the Russian satellite also promises to profoundly affect the future of the electronic industry and the over-all defense effort.

On Oct. 3, 1957 the United States "Project Vanguard" was well over two years old, and proceeding according to plan. It had originally grown out of the rocket experiments of the three U. S. services, but a presidential order in Aug. 1955 turned it over to the Navy, with instructions to tie in the operations with the International Geophysical Year, beginning July 1, 1957 and ending Dec. 31, 1958. The object was to fire a 22-lb. satellite 300 miles up into the atmosphere, where it would circle in an orbit and report through telemetering channels on conditions in the upper reaches of space.

No secret was made of the timetable. Details were released at regular intervals on the construction of the rockets, the instrumentation for the satellite itself, and the number of tests that would be made. Though the Navy was nominally in charge there was little secrecy and there was no diversion of military effort to aid the program.

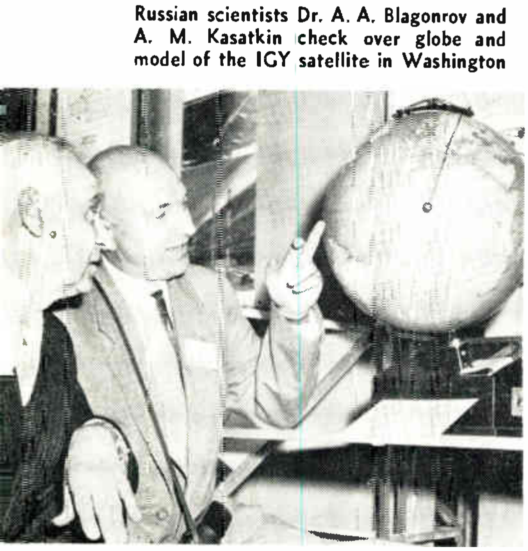
Tied in with the satellite launching was a network of radio tracking stations and optical tracking stations to be constructed which would report on the satellite's course and collect the information transmitted from the sphere. Construction on these projects was slow, and there seemed little reason to accelerate development of the satellite vehicle itself. Vanguard employees were working straight time—with no overtime.

On Oct. 4, the picture suddenly changed. The Russians, at a cocktail party in Washington, electrified the world with the announcement that they had successfully launched a 185-lb. satellite into an orbit some 500 miles up. The satellite was bulleting around the earth at 18,000 miles per hour, and emitting "beeps" that allowed tracking stations to follow its elliptical course.

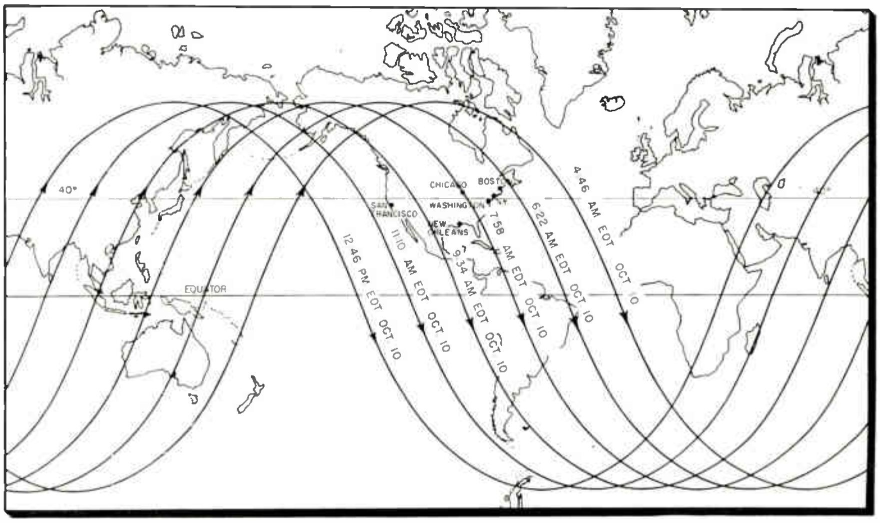
As the days followed it became clear that the Russians had scored an impressive diplomatic and scientific victory. By beating the U. S. they had forged a particularly effective propaganda tool for use in the delicate areas of the world, and scientifically they had established themselves in the forefront of rocket research.

The satellite that the Russians threw up reportedly

Russian scientists Dr. A. A. Blagonrov and A. M. Kasatkin check over globe and model of the IGY satellite in Washington



Tracking stations quickly supplied schedules showing the satellites progress



What Are Its Technical Implications?

Propaganda Value of Sputnik

Timing: *Launching was made prematurely, in conflict with international agreement to give advance warning. Russians knew that vastly more data could be collected if launching was made even a few weeks later, when international tracking network was completed.*

Orbit: *Longest life, and most effective collection of data requires firing more or less eastward, along equator. For propaganda value, Russians fired into a Polar orbit — sending Sputnik over nearly all the inhabited portions of the earth.*

Frequency: *For sound scientific reasons, 108 mc was made the international "Satellite frequency" some time ago. Refraction effects, and required weight of transmitters and batteries are minimized by going to this high frequency —but, because almost any short wave receiver throughout the world can pick up the lower 20 and 40 mc signals, these were chosen by the Russians. A not accidental side effect was to make US tracking efforts seem amateurish since all our equipment was designed for 108 mc.*

carried only a radio—no other instrumentation. It was broadcasting on 20 MC and 40 MC which made for difficult tracking since the comparatively low-frequency signals were bent by the ionosphere. All parties to the IGY, including the Russians, have agreed on the use of 108 MC but the Russians insist that this effort is not part of the IGY contribution, that any of their future satellites will be transmitting on 108 MC, and all parties will be notified of the telemetering code employed.

A minor victory was scored by the U. S. tracking teams which, though caught completely unprepared, managed to convert their tracking gear within 48 hrs. from 108 MC to 20 and 40 MC and begin tracking the satellite's course.

A helping hand, too, came from the country's "hams" who turned in hundreds of reports on the sphere's location.

Details on the Russian satellite came in slowly. The first reports described it only as weighing 185 lbs, and carrying a battery powered radio. On the third day after its launching it was discovered that the third stage rocket too, was orbiting around the earth. It lagged some 600 miles or so behind the satellite.

On the fifth day after the launching it was reported that the nose cone section too was circling around the earth. At this point reports indicated that the Russians were getting temperature data from the satellite as well, through some form of telemetering. The reports came from some Russian newspapers.

The Russians also announced at this time that they would launch a completely instrumented rocket on Nov. 7, some four weeks away.

To properly evaluate the Russian achievement it should be viewed from three angles; for its propaganda value, as a feat of rocketry, and as an indication of Russian progress in electronic guidance.

As a diplomatic coup the Russian satellite can hardly be underrated. The Russians had run a poor second to the U. S. and Britain in the race for the atom bomb and the hydrogen (thermonuclear) bomb, and seemed destined for some time to stand in the

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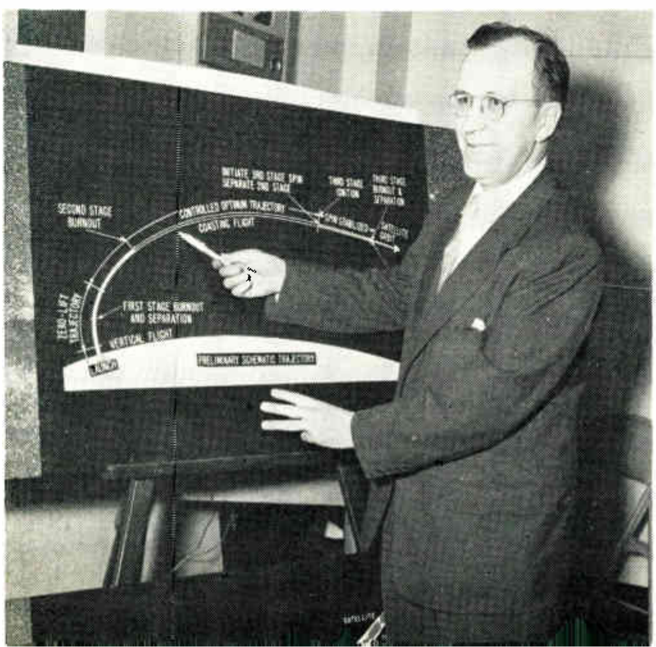
Dr. John Hagen, Vanguard director, explained satellite problem



Plastic model of the U. S. scientific earth satellite

Sputnik History

***June 25, 1954:* Office of Naval Research agrees to attempt satellite launching with Redstone, topped by Loki rocket cluster. This project "Orbiter" was scheduled for firing in fall of 1957.**

***October, 1954:* First serious discussion of IGY Satellite by world scientific group. Consensus was, attempt should be made.**

***April 15, 1955:* USSR announces plan for launching of artificial "moon".**

***May, 1955:* U. S. Navy "Orbiter" project is well along, plans for launching orbit are finalized. Later decision for Vanguard cancelled Orbiter plans.**

***July 29, 1955:* U. S. announces formal IGY Satellite plans, including statement that data from tests would be shared openly with whole world.**

***June 1, 1957:* Russia hints impending "breakthrough" in satellite race.**

***June 18, 1957:* USSR announces intention to launch several satellites, the first during the official IGY period.**

***September 30, 1957:* The Russians announce for the first time they will use 20 and 40 mc transmitting frequencies for their first satellite.**

***October 4, 1957:* Successful Russian satellite launch is made at about 5 PM EDT. Russians claim high control resulted in altitude of 600 miles, only 1 mile from decided height. First signals heard in US are picked up by RCA Communications, Inc. on Long Island. NRL picks up signals at 8:30 PM. Transmissions are alternate .3 sec bursts at 20.005 and 40.002 mc.**

***Oct. 5:* Doppler effect observed by RCA Communications indicates speed of 17,712 mph. NRL back-tracing places launch site as "north of Caspian Sea." Moscow predicts instrumented flights to moon in few years. U.S. reveals plan for sub-satellite planned for third U.S. satellite launching; the light "space-ball" will be a hollow aluminum foil ball designed to give important drag figures as it falls behind heavier instrumented stellite.**

***Oct. 6:* Russian Sputnik sticks, gives one continuous transmission from 3:35 to 3:43 PM EDT, then resumes normal transmission. NRL completes crash conversion of 6 Minitrack stations to 20 and 40 mc.**

***Oct. 7:* Converted Minitrack begins to produce usable computed data. French aviation expert reveals U.S. "big Brother" project to develop TV-equipped satellite.**

***Oct. 8:* Reds announce program working toward manned space stations for launching space ships—destination Mars. USSR confirms presence of telemetered data on Sputnik signals—fails to reveal code.**

***Oct. 10:* First three-ton U.S. satellite camera rushed into operation. Clouds prevent satellite sighting. Russians intimate much larger satellite due within a month or two.**

***Oct. 11:* U.S. computers finally obtain sufficiently accurate data to lock on satellite path. Convair astronautic expert predicts unmanned interplanetary research vehicles within 3 to 5 years. Moscow reveals project "Destination-Moon"—a one day trip! Also tell of experiments for inducing a coma for crew members of space ships.**

Industry Officials Said . . . .

Dr. Orestes H. Caldwell, First Federal Radio Commissioner; Fellow, IRE:

"In its first few days aloft, the Russian satellite demonstrated how important radio and electronic devices will be to the future science of astronautics or space navigation.

"Sputnik's course in its orbit has been faithfully tracked by its "beep" signal. Even its rotation on its own axis has been evident from the cyclic ten-second changes in signal strength. New triumphs of telemetering are promised for future American and Russian satellites.

"But all these marvels of electronic miniaturization crammed inside the frail shells, depend on battery life. And in the battery field—alas!—there has been little progress in watt-hours per pound, from the ponderous chemical cells of Edison's day.

"With our recent understanding of the tremendous energy resident in even a few grains of matter, development of new equivalent power sources (weighing one-thousandth, or less, of our present heavy batteries) should now be concentrated upon. For here is an evident and most-promising field of possibilities, and success here will remove the last thralldom of the ever-burgeoning electronic art."

Dr. Alfred N. Goldsmith, Consulting Engineer and Founder, Institute of Radio Engineers:

"Clearly major advances are being made in rocket propulsion, control, and guidance as well as extraterrestrial radio communication. Space platforms are in prospect, to be followed by returnable moon rockets, first unmanned and then manned. More remote but increasingly plausible are manned and round-trip interplanetary vehicles.

"Temporarily the international balance of power has been readjusted by both the launching of the earth satellite and the alleged availability of long-range ballistic missiles. But these are healthy stimulants to further competitive activity and longer-lasting balances of national, political, and military positions.

"If world war can be avoided, mankind faces a great scientific and cultural advance. Astronomy, geophysics, meteorology, nuclear theory and electronic methods will be vastly expanded and improved. The peaceful uses of mankind's new and hard-won knowledge will, it is hoped, predominate and thus contribute greatly to a better future for humanity."

Dr. Daniel E. Noble, Exec. Vice-Pres., Motorola, Inc.:

"The intensely dramatic, and confusing political impact of the successful man-made satellite far overshadows its scientific importance. As a scientific stunt it is magnificent, whether Russian or American, but so long as our understanding of such common phenomena as magnetism, the electric field, and gravitation, remains in its present primitive state, it is difficult to justify, in terms of the limited yield to scientific knowledge, the possible total worldwide satellite cost of three or four hundred million dollars. The successful mounting of the satellite has probably distorted more perspectives, including mine, than any other achievement in the history of mankind. It is a profligate, but still a magnificent, stunt."

Maj. Gen. Holgar Nelson Toftoy, Commander, Redstone Arsenal, Huntsville, Ala.:

"We were told that this was not a race. But the wisdom of this course remains to be evaluated."

Dr. Richard W. Porter, Engineering Services Div., General Electric Co. Member of the U. S. Committee for the International Geophysical Year:

"Man has for the first time stretched his hand outside the cradle in which he was born! The establishment by Soviet scientists and engineers of the first artificial earth satellite is a tremendously significant accomplishment—of which those responsible can justifiably be proud—both now and for all time. . .

"Aside from its obvious importance to scientists and engineers everywhere, this event has a very special significance to the United States. It has demonstrated in dramatic and absolutely unmistakable terms that the U.S.S.R. must be regarded as a serious competitor in the world of science and technology. . .

"Actually, it has never been any secret that at least twelve years ago the U.S.S.R. set out determinedly to equal and surpass the United States as soon as possible in all fields of science. There have since been a number of challenges, most of which we have foolishly disregarded or ignored. Today we have a challenge which cannot be overlooked unless we are completely resigned to the eventual role of a second-class nation.

"The importance of the 'sputnik,' therefore, is not so much in the fact that it has come into being several months before, instead of several months after, the equivalent U. S. test satellite, but rather in the fact that its erection was accomplished in a manner indicative of broad skill and experience, and that this basic skill and experience has been acquired in a fantastically short period of time. The trend is clear. Although we have not yet been completely surpassed, *we are being surpassed* in many fields, make no mistake about it. . . ."

Secretary of Defense Neil H. McElroy:

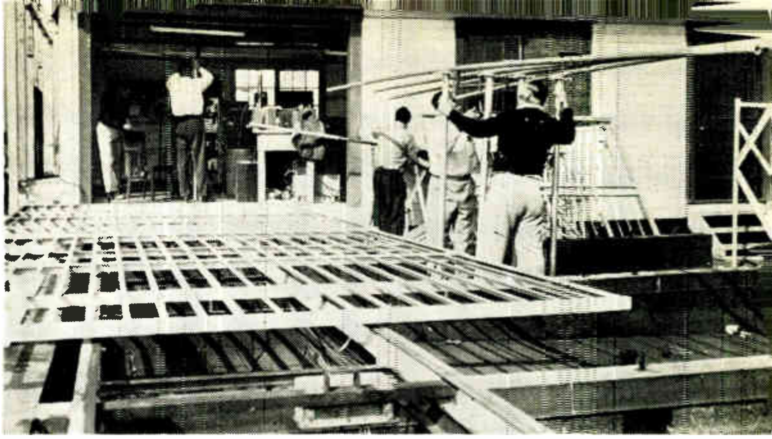
"Russian missile programs have made it seem not unimportant to us to end bottlenecks (in our own program). We aren't thinking in terms of much greater defense spending. Economy is not incompatible with good defense. The speedup will probably take the form of increased testing, more overtime work at missile centers, and more rapid evaluation of missile data."

Rear Adm. Rawson Bennett, Chief, U. S. Naval Research:

"This success (of the Russians) was somewhat a surprise in point of time, but not a surprise in terms of Russian capability. The scientific community did not doubt the Russian capability if they seriously intended to create a satellite, which obviously they did. The Navy is steadily moving toward the launching of our first satellite. A preliminary launching will take place (in December). There was no race to place a satellite in orbit as far as we are concerned. The American project is an economically run one in which cost has been carefully considered. It is our distant goal to send manned rocket ships into outer space."

Dr. Lloyd V. Berkner, vice chairman, of International Committee, International Geophysical Year:

"Russia used a very large rocket to launch the satellite, which might be very effective in the military field. It would be a fair conclusion (that this indicates a Russian ability to deliver a missile to the U. S.) if you could also assume they knew how to aim it perfectly. Evidently, the aiming in the launching of the satellite was extremely good or they would not have achieved such a good orbit."



Naval Research Center scientists and technicians quickly constructed antennas to receive on 20 MC and 40 MC

shadow of the Western powers in scientific achievement. This fact weighed heavily against them in the field of power politics. But all this changed with the launching of the satellite. For at least the short period following the launching all of the West's previous achievements were forgotten; the admiration of the world went out to the Russians.

Viewed as a feat of rocketry the Russian achievement is, if anything, more impressive. American experts voiced frank astonishment at the size of the satellite. If the Russians could put up one weighing 185 lbs, they said, they could also put one up weighing much more. Dr. Joseph Kaplan, leader of the U. S. IGY program, warned that it was almost certain now that the Russians had developed rocket motors much more powerful than anything in the U. S. arsenal. The first stage rocket reportedly developed over 270,000 lbs. of thrust. As the American press dug into the reasons behind the Russians' victory a certain picture began to take shape. Many of the details were being let out to the public for the first time.

Russian rocket research had, for years, been ahead of the Americans. As far back as 7 and 8 years ago American scientists had de-emphasized the development of large rockets because it was felt that none could be developed which would be capable of delivering the weight necessary for an atomic bomb. The Russians, apparently, had gone ahead. When the comparatively lightweight hydrogen bombs were developed some three years ago the Russians were nearing completion of the space vehicles capable of delivering them, and the American rocketeers were then given the job of bringing our rocket research up to the level of the Russians.

A number of American rocket experts stated hopefully that they felt that now they were closing the gap, that the gap now was not three years but one, and that at the present rate of progress another few years should see our rocket technology on a level with the Russians.

But for the moment the inferences to be drawn from the satellite were exceedingly grave. Various Washington sources warned gloomily that every American overseas base must now be considered indefensible, that all were within range of the rocket that propelled the satellite into its orbit. This view, however, did not take into consideration the fact that the satellite launching proved little, if anything, regarding Russian progress in electronic guidance systems. In blasting the satellite into the upper reaches of space the Russians faced few of the guidance problems that enter into the design of a ballistic weapon.

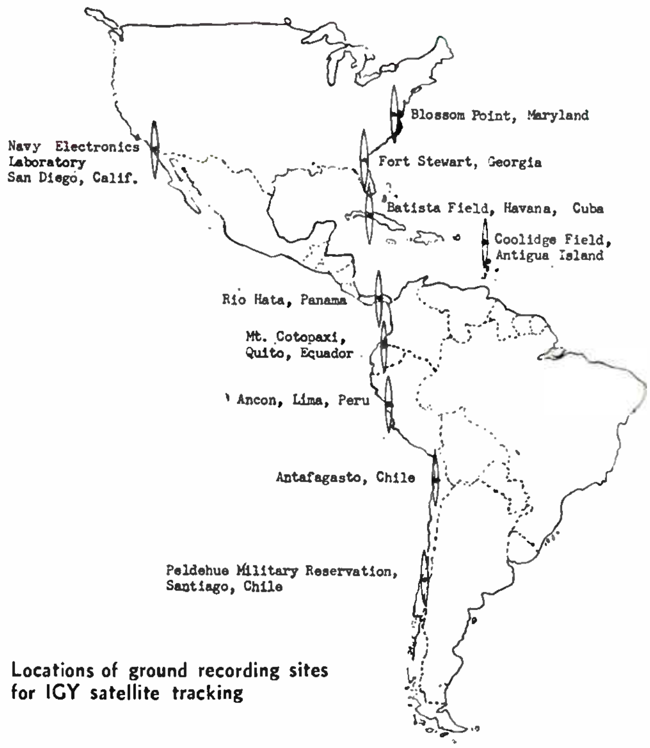
U.S. Satellite Experiments[1]

Two groups of scientific experiments are planned for the first U. S. instrumented satellite: an extensive study of the satellite environmental conditions, and a study of solar radiation in the region of the Lyman alpha spectra of hydrogen.

Environmental experiments will also supply data on operating ambients for test equipment to be installed in succeeding satellites. Experiments will include the measurement of temperature at three points in the satellite. Surface temperatures of the outer shell will be measured at one pole and at one point on the equator. The third temperature measurement is that of the instrumentation compartment, all measured by thermistors.

Skin temperatures are expected to vary approximately 60°C in each orbit when heated by solar radiation and cooled by radiation into space while in the earth's shadow. Mean surface temperatures are expected to lie in the range of —10°C to +30°C. It is desired to measure surface temperatures to within ±5°C. Surface temperatures during launching may go as high as 200°C due to aerodynamic heating but will quickly return to lower values, and these extreme values will not be accurately measured. Instrumentation compartment temperatures are not expected to vary much due to thermal insulation from the outer shell, and are expected to approach an equilibrium temperature some 20°C to 25°C above whatever mean skin temperature is established. Instrumentation compartment temperatures are to be measured to within ±2°C.

Measurements will be made of surface erosion. Four small gages will be used, two at the poles and two at the equator. The gages are deposited-thin-film resistors cemented to the outer surface of the satellite. Electrical resistance will increase with erosion.



Locations of ground recording sites for IGY satellite tracking

Sensitive microphones are attached to the satellite skin to detect collisions with micrometeorites. A transistorized amplifier-pulse shaper gives a uniform output pulse for each collision. The cumulative count will be detected by ground stations along the orbit. Collisions with larger particles, puncturing the outer shell will be studied by monitoring pressure in two pressure zones built into the skin. A bellows-actuated potentiometer measures the differential pressure, and a pressure switch will monitor absolute pressure of one zone.

The second group of experiments relates to solar radiation in the region of Lyman alpha line in the hydrogen spectra. A photon detector will be used which is sensitive only to radiation in the spectral region under study. The solar Lyman alpha detector will present a variable signal with short time variations which will be additionally modulated due to spin of

(*Continued on page* 149)

What the U. S. SCIENTIFIC Satellite Will Accomplish

Three major areas can be explored by a scientific satellite: the immediate vicinity of the satellite can be sensed, accurate observations of the orbit can lead to knowledge of major physical phenomena and astronomical observations can be made which use the satellite as a platform for instruments. The US satellite program has been designed to obtain maximum information in these fields.

Orbit: The first US earth satellite will be launched at about 40° from the equatorial plane. This will provide radio detection by the north-south fence of Minitrack stations at each revolution, thus the satellite will sample conditions over an 80° band centered on the equator, and will be observable from many nations.

Tracking: Using the overlapping ranges of the Minitrack network, the US satellite will be accurately spotted at least once each circuit of the earth. The use of 108 mc transmissions will minimize refractions in the transmission path, and make possible the use of an extremely light-weight, 100 mw transmitter.

Structure: The US satellite has been designed as an optimum compromise between weight and experimental effectiveness. The highly polished globe will be visible to the naked eye under optimum conditions, and the payload is sufficient to accomplish the experiments suggested by the scientific world.

Experiments: The scientific earth satellite program of the U.S. will include experiments to gain information about air density at high altitudes, composition of the earth's crust, actual shape of the earth, temperatures, number and impact strength of meteorite particles, ultraviolet radiation, cosmic rays and other phenomena which may be decided upon during the project. All these tests will send telemetered data to Minitrack stations and digested by the computers set up for this purpose. Results will be shared internationally.

Systematic Design of

Transistor Bias Circuits

Proper design of transistor amplifiers requires special attention to operating point stability. Professor Murray defines a practical stability factor, and derives design formulas for bias components. These bias concepts can be readily extended beyond the examples given.

By **RAY P. MURRAY**
Associate Professor
U. S. Naval Postgraduate School
Monterey, California

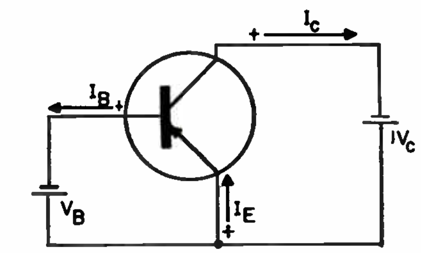


Fig. 1: The biasing of a PNP transistor in the common-emitter circuit. Base-emitter circuit is biased in the forward direction and is a low-impedance circuit.

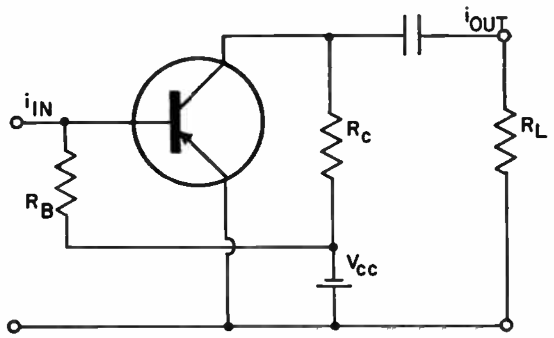


Fig. 2: In this basic unstabilized, common-emitter amplifier circuit, both collector and base bias are obtained from a single battery.

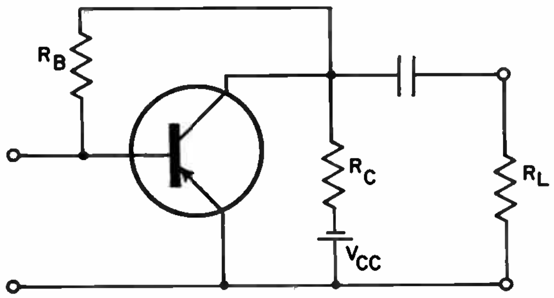
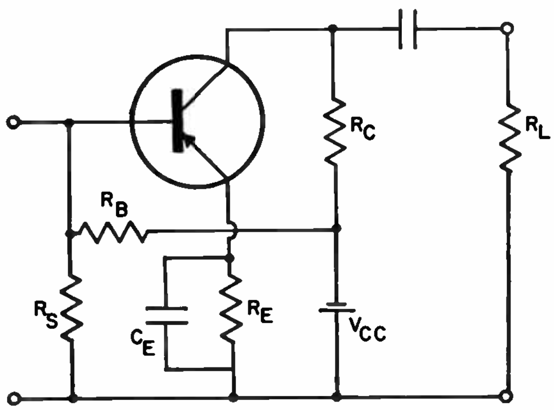


Fig. 3: In this stabilized common-emitter amplifier, stabilization is obtained from the collector voltage. The amount of stabilization depends on R_B and R_C.

Fig. 4: Unlike the stabilized common-emitter amplifier shown in Fig. 3, this circuit obtains stabilization from the emitter current. This is a common circuit.



TRANSISTOR circuits are biased to establish the desired operating point and to stabilize this operating point against temperature variations and transistor replacement. The bias circuits should not have an undue effect on other performance factors such as gain, impedance levels and power consumption.

Common-Emitter

Before considering our primary problem, let us review some of the fundamentals of the common-emitter circuit. Fig. 1 shows the biasing of a PNP transistor in the common-emitter configuration. The base-emitter circuit is biased in the forward direction and is a low-impedance circuit, whereas the collector-emitter circuit is biased in the reverse direction and

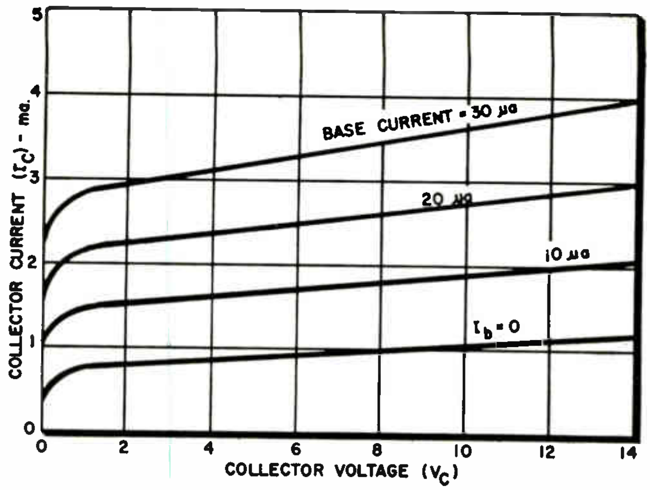


Fig. 5: Common-emitter characteristic curves are shown for the circuit of Fig. 1. Beta may be determined from these curves, and has a value of about 75 near $V_C = 3$ volts and $I_B = 5$ μamp.

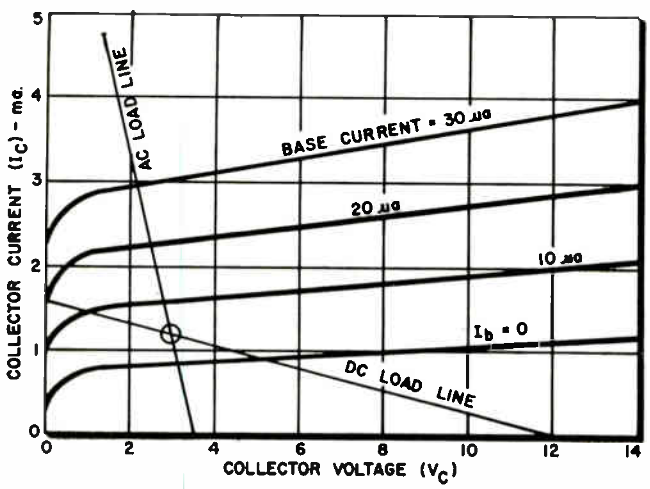
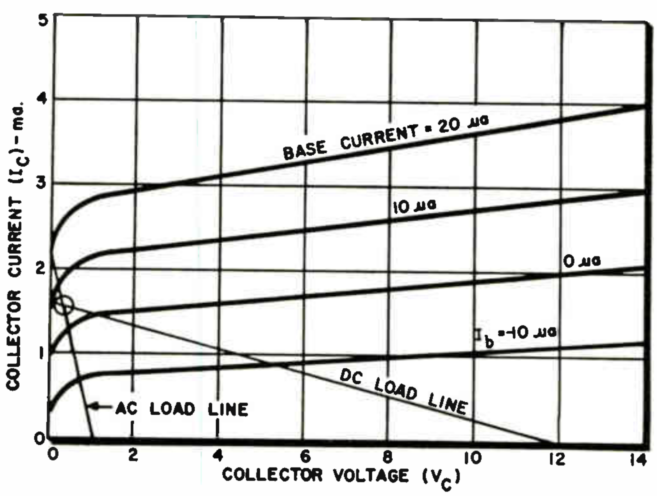


Fig. 6: Load-line analysis of unstabilized common-emitter amplifier of Fig. 2. Temperature instability is a problem.

Fig. 7: This load-line analysis of the unstabilized common-emitter amplifier of Fig. 2 demonstrates the shift of operating point due to a 10°C temperature rise in operating temperature.



is a high-impedance circuit. Now if the base connection is opened, the collector current will be very small —in the order of a few tenths of a milliampere. If the base circuit is closed, the base current reduces the reverse resistance of the collector-emitter circuit and the collector current increases. This dependence of collector current on base current is the basis for amplification in the common-emitter circuit.

It is convenient to think of the collector current as consisting of two components: a leakage current, I_{CL}, which would be present if the base circuit were open; and a component, I_{CB}, due to the effect of the base current.

$$I_C = I_{CL} + I_{CB} \qquad (1)$$

Since the component due to the base current is dependent on the characteristics of the transistor and the amount of base current, Eq. 1 may be written as

$$I_C = I_{CL} + \beta I_B \qquad (2)$$

where β, the common-emitter current amplification factor, represents the effect of the base current upon the resistance of the collector-emitter path. β depends somewhat upon the operating point and therefore the relation between base current and collector current is not exactly linear.

These current relations are represented by the common-emitter characteristic curves shown in Fig. 5. β may be determined from these curves and has a value of about 75 in the vicinity of $V_C = 3$ v. and $I_B = 5$ μamp.

Basic Amplifier

In the basic amplifier circuit of Fig. 2, both collector and base bias are obtained from a single battery. Since the base-emitter voltage is usually very small, the value of R_B may be found by dividing the battery voltage by the desired value of base bias current. R_L represents the load presented by the following circuit. The circuit operating point depends on the base bias current and the values of V_{CC} and R_C. The current gain

$$A_i = \frac{i_{out}}{i_{in}} \qquad (3)$$

will be something less than the current amplification factor of the transistor, depending to a large extent on the relative values of R_L and R_C. A load-line or equivalent-circuit analysis may be carried out to show the actual gain. The example in the following section will illustrate the load-line analysis.

Example 1
Unstabilized Amplifier

Given: Amplifier circuit of Fig. 2.
Characteristic curves of Fig. 6.

Supply Voltage: V_{CC} = 12 v.
Operating Point: V_C = 3 v.
I_B = 5 μa.
I_C = 1.2 μa.
β = 75
R_L = 500 ohms

Solution:

$$R_B = \frac{V_{CC}}{I_B} = 2.4 \text{ megohms}$$

Construct the dc load line (Fig. 6) through the specified operating point and (V_{CC} = 12v, I_C = 0). R_C may be determined from the graph or by

$$R_C = \frac{V_{CC} - V_C}{I_C} = 7500 \text{ ohms}$$

The current gain may be determined from the graph by assuming an input signal current and then from the ac load line (R = 469 ohms) finding the component of the collector signal current that flows in R_L. For example, if i_{in} = 5 sin ωt microamperes, then i_C = .38 sin ωt milliamperes. The component of i_C that flows in R_L is

$$i_{out} = \frac{R_C}{R_C + R_L} i_C = .356 \sin \omega t \text{ ma}$$

and

$$A_i = \frac{i_{out}}{i_{in}} = \frac{356 \sin \omega t}{5 \sin \omega t} = 71$$

The circuit of Fig. 2 may exhibit drastic changes in performance if it is subjected to temperature variations or if the transistor is replaced with another unit of the same type. Since proper temperature compensation usually provides sufficient circuit stabilization to take care of variations in individual transistor characteristics, we shall concern ourselves with the temperature problem only.

One of the most important changes in transistor characteristics is the lowered reverse resistance of the collector junction with an increase in temperature. Thus, collector current rises with temperature, and since a higher collector current results in the generation of more heat, the transistor may be destroyed by a soaring current. At least the operating point will shift considerably. It is the leakage current component (I_{CL}) of the collector current that is sensitive to temperature changes. For germanium transistors, I_{CL} changes about 10% per degree Centigrade. The effect of this increased collector current is to shift the operating point, and may therefore produce a very significant change in amplifier performance. Fig. 7 shows the new operating point of the circuit of Fig. 2 after a 10°C increase in temperature. Compare this with Fig. 6.

Let us define this operating point instability as

$$J = \frac{dI_C}{dT} \text{ amps/C}^\circ \tag{4}$$

For the unstabilized circuit of Fig. 2

$$J = \frac{d\,(I_{CL} + \beta I_B)}{dT} \tag{5}$$

and considering only the leakage current to be temperature dependent,

$$J = \frac{dI_{CL}}{dT} \tag{6}$$

Transistor circuit stabilization is generally accomplished by an automatic change in base bias current to counteract variations in the leakage current. That is, I_B of Eq. 7 is caused to vary with temperature by means of negative feedback. This is similar to the stabilization of the volume level of a radio receiver by the automatic volume control circuit. Care must be taken that the negative feedback for the bias circuit does not introduce an undesired amount of degeneration in the signal circuits.

In order to judge the performance of the stabilizing circuits, we shall define the stability factor as

$$S = \frac{J_u - J_s}{J_u} \tag{7}$$

where J_u and J_s are the instability of the unstabilized and stabilized circuits respectively. In this way, a stability factor of zero indicates no added stabilization and a factor of unity or 100% indicates complete stabilization. Although the proper value of S depends upon the particular application, 90% stabilization is usually sufficient for low-level amplifiers subject to normal temperature variations.

One simple method of producing stabilization is to employ the collector voltage as the voltage source for the base bias circuit as shown in Fig. 3. If I_C should increase due to a temperature rise, V_C decreases and therefore the base bias current decreases tending to restore the collector current to its original value. The amount of stabilization depends on the relative values of R_B and R_C. To find the instability of the stabilized circuit it is necessary to solve for the collector current. For the amplifier of Fig. 3, neglecting the base-emitter voltage

$$I_C = \frac{(R_C + R_B)\, I_{CL} + \beta V_{CC}}{R_B + R_C + \beta R_C} \tag{8}$$

and

$$J_s = \frac{dI_C}{dT} = \frac{R_C + R_B}{R_B + R_C + \beta R_C} \frac{dI_{CL}}{dT} \tag{9}$$

The stability factor is therefore

$$S = \frac{\beta}{\frac{R_B}{R_C} + \beta + 1} \tag{10}$$

From Eq. 10 it may be seen that good stabilization requires that the ratio of R_B to R_C be small.

Example 2
Stabilized Amplifier

Given: Amplifier circuit of Fig. 3.
Characteristic curves of Fig. 5.

Supply Voltage:	V_{CC}	=	12 v.
Operating Point:	V_C	=	3 v.
	I_B	=	5 μa.
	I_C	=	1.2 μa.
	β	=	75
	R_L	=	500 ohms
Required Stability:	S	=	0.90

Solution:

$$R_C = \frac{V_{CC} - V_C}{I_C + I_B} = 7470 \text{ ohms} \qquad R_B = \frac{V_C}{I_B} = 600{,}000 \text{ ohms}$$

From Eq. 10, S = 0.48. If the operating point and supply voltage are specified it is necesesary to accept the stabilization that results. In many cases this is unsatisfactory, and it is desirable to use a more elaborate circuit in which the bias and stabilization can be specified independently.

Better performance can be obtained with the circuit of Fig. 4. It is one of the most commonly used

(*Continued on page* 147)

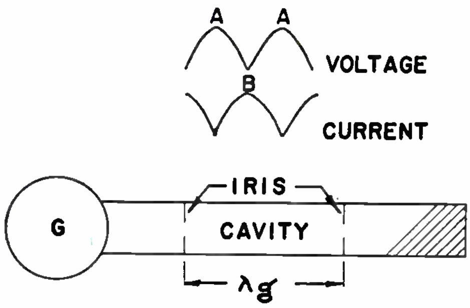


Fig. 1: Simulation with a transmission cavity

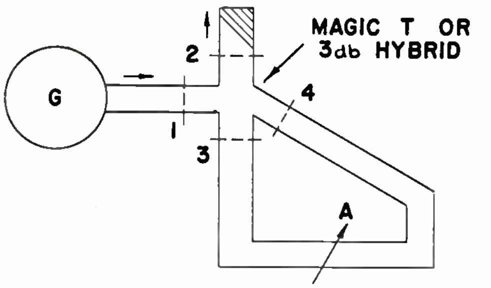


Fig. 2: A 3 db hybrid simulator

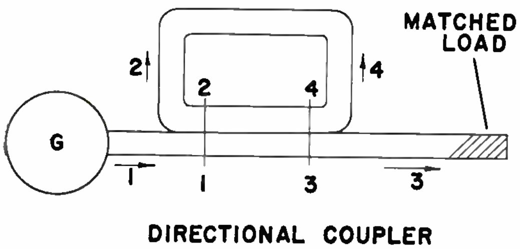
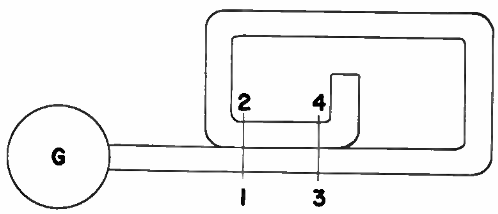


Fig. 3a: Directional coupler simulators

Fig. 3b: Alternative circuit to Fig. 3a



IT frequently becomes necessary in microwave system development to test certain components at higher power levels than can be attained with available power generators.

One method of accomplishing this would be to insert between a generator and a matched load, a cavity consisting of appropriately spaced irises of proper susceptance magnitude as shown in Fig. 1. The standing waves set up between the irises results in a voltage or current level many times that available at the generator, the exact value depending on the *Q* of the cavity.

A component being tested in the cavity at position *A* is subjected to high voltage while a component placed at position *B* is subjected to high current.

This method has been successfully used for life testing of TR tubes under development but it suffers from several disadvantages, the chief ones being the lack of flexibility of adjustments and the non-uniform voltage and current distributions in the cavity.

Energy Storage

There has recently appeared in the literature a method for storing energy in a cavity by periodically injecting energy from a directional coupler into a waveguide cavity made in the form of a closed loop. In contrast to the method of storing energy in the form of standing waves, this method stores energy in a continuously circulating or traveling wave.[1, 2, 3]

Since many microwave waveguide components are designed for a system during the development of the generator, this resonator is an extremely economical and flexible tool for high power simulation. It is the purpose of this article to discuss the properties, and give a general picture, of the operation of such resonators from an engineering standpoint, together with a discussion of their practical application.

TW Resonator

As an introduction to the TW resonator, consider the hybrid circuit of Fig. 2 in which arm 3 is connected to arm 4 through loop *A*.

A unit voltage vector applied to terminal 1 is split into 2 vectors of magnitude $\frac{1}{\sqrt{2}}$ proceeding outward from arms 2 and 3. The wave in arm 3 travels to arm 4 and again divides in a similar fashion between 2 and 3. If the loop length is adjusted so that the reinjected wave in 3 reinforces the incoming wave, the loop is at resonance.

For the case of no loss in the loop, the steady state voltage can be obtained by grouping the terms of the successive wave amplitudes to be the sum of the infinite decreasing geometrical series.

$$E_3 = \frac{1}{\sqrt{2}} + \frac{1}{2} + \frac{1}{2\sqrt{2}} + \frac{1}{4} \cdots$$

$$= \frac{1}{\sqrt{2} - 1} \cong 2.42$$

Therefore, in this 3 db coupling circuit with no losses, the ratio of voltage in the traveling wave to that of the incident wave is 2.42. We may say that the "simulated" voltage gain or voltage multiplication

Microwave High-Power Simulator

By periodically injecting energy from a directional coupler into a waveguide cavity made in the form of a closed loop much higher power levels can be achieved than are available from microwave power generators. Energy is stored in a circulating or traveling wave.

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Salem Rd., Beverly, Mass.

Fig. 4: Early version of an L-Band Simulator for TR testing

M, is 2.42 and the "simulated" power gain M^2 is 5.85. Any loss in the loop will, of course, reduce the value of M.

The Q of the cavity is limited by the heavy coupling. At first sight, the power multiplication is puzzling but it should be realized that the high power is not available for use, and any attempt to extract the power would heavily load the cavity and reduce the multiplication.

By readjusting the circuit and the coupling, it is possible to obtain a Q which approaches infinity as the losses approach zero.

Consider the circuit of Fig. 3a, where the 3 db hybrid is replaced by a directional coupler. Arm 4 is again connected to arm 2 to form the cavity loop. When the loop has been adjusted so that the wave

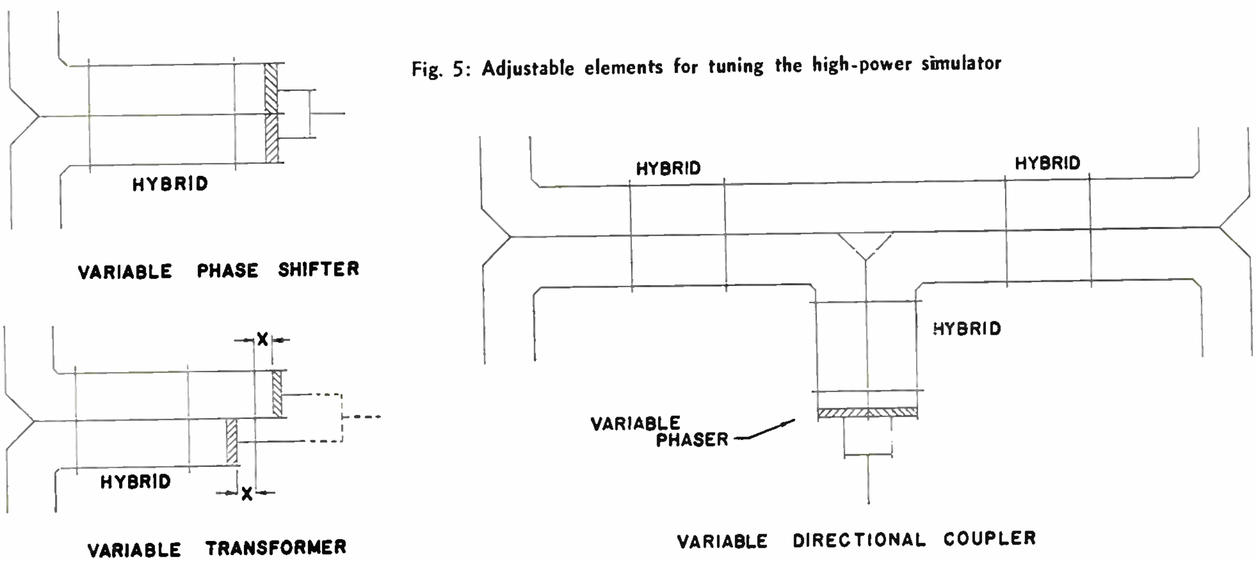


Fig. 5: Adjustable elements for tuning the high-power simulator

High-Power Simulator *(Continued)*

proceeding into arm 4 travels around the loop and reinforces the incident wave, the build up of voltage can be seen to be an arithmetic series which can increase to infinity. Evidently any loss in the loop will reduce the attained voltage exactly as finite losses reduces the attainable Q in a cavity.

It is a property of this circuit and the alternate one, Fig. 3b, that the power multiplication M^2 at resonance is a function of the coupling factor and the loop attenuation. When the coupling is adjusted to an optimum value, the power multiplication is the maximum attainable for the attenuation and all of the generator power circulates in the loop with no power reaching the load on the primary line.

If the coupling is not optimum, large power multiplication values can still result but it will be less than the maximum. In this case, some of the generator power will be dissipated in the load on the primary line.

With losses of the order of 0.2 db, power multiplications of the order of 20 to 25 are readily achieved, that is a 500kw generator can provide the equivalent of 10 to 12.5mw, obviously with a tremendous financial economy.

Resonator Characteristics

All of the characteristics of the traveling wave resonator, or simulator for short, can be derived from the scattering matrix of the directional coupler. In this representation the characteristics of a directional coupler may be written as

$$\begin{vmatrix} E_{o1} \\ E_{o2} \\ E_{o3} \\ E_{o4} \end{vmatrix} = \begin{vmatrix} S_{11} & S_{12} & S_{13} & S_{14} \\ S_{21} & S_{22} & S_{23} & S_{24} \\ S_{31} & S_{32} & S_{33} & S_{34} \\ S_{41} & S_{42} & S_{43} & S_{44} \end{vmatrix} \begin{vmatrix} E_{i1} \\ E_{i2} \\ E_{i3} \\ E_{i4} \end{vmatrix}$$

where, the E_o terms represent the voltage amplitudes of the waves traveling away from, and the E_i terms represent the corresponding amplitudes of the waves travelling toward the terminals.

Assuming we have a perfect directional coupler (infinite directivity) with a unit vector incident on terminal 1, $E_{i1} = 1$ then it will be seen that $E_{i2} = E_{04}$ and $E_{i4} = E_{o2}$, i. e., the inward wave into 2 is the outward wave from 4 and vice versa, then

$$\begin{vmatrix} E_{o1} \\ E_{o2} \\ E_{o3} \\ E_{o4} \end{vmatrix} = \begin{vmatrix} 0 & 0 & \sqrt{\frac{C-1}{C}} & \frac{j}{\sqrt{C}} \\ 0 & 0 & \frac{j}{\sqrt{C}} & \sqrt{\frac{C-1}{C}} \\ \sqrt{\frac{C-1}{C}} & \frac{j}{\sqrt{C}} & 0 & 0 \\ \frac{j}{\sqrt{C}} & \sqrt{\frac{C-1}{C}} & 0 & 0 \end{vmatrix} \begin{vmatrix} 1 \\ E_{o4}e^{-(\alpha+j\beta)} \\ 0 \\ E_{o2}e^{-(\alpha+j\beta)} \end{vmatrix}$$

where, $E_{i3} = 0$, a matched termination on the primary line is assumed. The coupling factor C (not the coupling coefficient) is here defined as the ratio of power of arm 1 to the power in arm 4 when matched loads are applied to arms 2, 3 and 4. The loop attenuation is $e^{\alpha} = 10^{A/20}$, A being loop attenuation in db. andβ is the phase shift of the loop.

Assuming the loop is adjusted for resonance, $e^{-J\beta} = o$, we can solve for E_{04}, the forward wave in loop as well as E_{01}, E_{02} and E_{03} and obtain[1]

$$M = E_{04} = \frac{1}{\sqrt{C} - e^{-\alpha}\sqrt{C-1}} \qquad (1)$$

It is seen that, as expected, the multiplication is a function of coupling and attenuation. M is maximized by choosing an optimum value for

C

$$C_o = \frac{1}{1 - e^{-2\alpha}} \qquad (2)$$

and

$$M\ max = \sqrt{C_o} = \sqrt{\frac{1}{1 - e^{-2\alpha}}} \qquad (3)$$

Analogous equations can be derived for the circuit of Fig. 3b, here

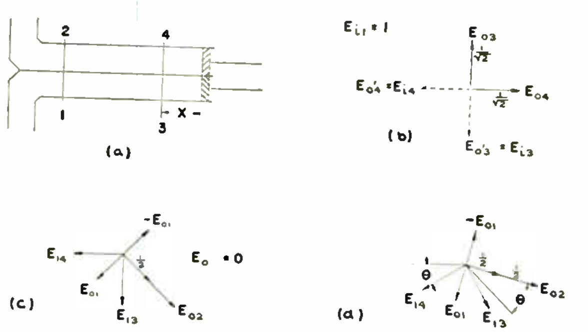
$$M = E_{04} = \frac{\sqrt{C-1}}{\sqrt{C} - e^{-\alpha}} \qquad (4)$$

$$C_o = e^{2\alpha} \qquad (5)$$

$$M\ max = \sqrt{\frac{1}{1 - e^{-2\alpha}}} = \sqrt{\frac{C_o}{C_o - 1}} \qquad (6)$$

It will be noted that the maximum M is identical for the 2 circuits. However, the optimum coupling is different. In Fig. 3a, as the attentuation increases the coupling must be tightened, i. e., C decreased. The converse is true for Fig. 3b. It should be pointed out

Fig. 6: Vector analysis of the variable phase shifter



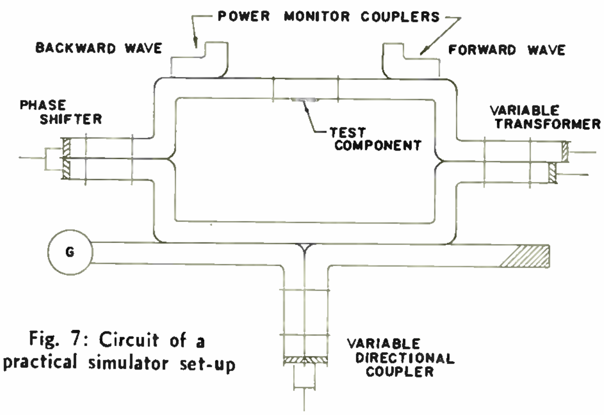


Fig. 7: Circuit of a practical simulator set-up

that reflections from the primary line load or discontinuities in the loop can also be greatly magnified and result in a high VSWR in the loop. These can readily be matched out, however.

Fig. 9 shows the relation between M^2 max., loop loss and the optimum coupling for loop losses up to 1 db which is likely to be the greatest range of usefulness. Power multiplication for circuit Fig. 3b and for other than optimum coupling for both circuits are readily derived from Eqs. 1 to 6.

Flexibility

In the practical realization of a simulator, it is desirable for flexibility to provide a variable directional coupler, an adjustable phase shifter, a variable transformer and directional couplers to measure and monitor the forward and backward wave.

The adjustable coupler is used to adjust the multiplication to the maximum or other desired value, the phase shifter to adjust the loop to resonance, and the transformer for adjusting the VSWR in the loop to an acceptable value for the work at hand. Although these items can be obtained in many forms, they can all be made by combining 3 db short slot hybrids in a very straight forward manner as shown in Figs. 5a, 5b and 5c.

The variable phase shifter consists of a 3 db hybrid with a ganged plunger which moves the 2 shorts together. By arranging to move the short circuits an equal amount in opposite directions from a common plane, the variable phase shifter becomes a variable transformer. Evidently a suitable mechanism which allows both types of motion will provide a device which acts as both a variable phase shifter and variable transformer. Combining 2 hybrids with a variable phase shifter as shown in Fig. 5c results in a variable directional coupler.

Vector Analysis

All of the relations expressing the phase shift, susceptance and coupling as a function of the position of the shorting plungers can be derived from the scattering matrix equations. However, they can be readily verified by a simple vector analysis as shown in Fig. 6 for the variable phase shifter. A short circuit at the output terminals results in a reversal of vectors E_{o3} and E_{o4} as shown in Fig. 6b.

Upon returning through the hybrid, these are resolved and recombined to $E_{o2} = 1$ and $E_{o1} = 0$, where the primes denote the vectors reflected from the shorts $E_{o3} = E_{i3}$ and $E_{o4} = E_{i4}$, Fig. 6c. Moving the plungers a distance x

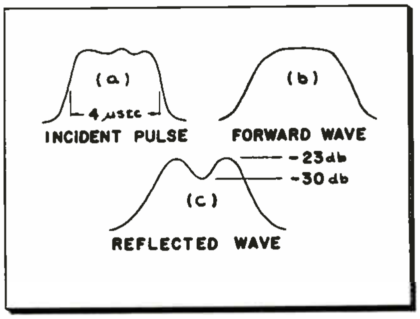


Fig. 8: Wave forms in the simulator

merely rotates the entire vector diagram through an angle θ, where,

$\theta = e^{-\frac{4\pi j x}{\lambda_g}}$ thus showing that any phase is obtainable by varying x. In a similar fashion, the vector analysis can be used to verify the variable transformer and directional coupler.

Operation

A practical simulator set up utilizing these components is shown in Fig. 7. A satisfactory tune up procedure is as follows:

1) Energize generator and set frequency in main line,

2) Adjust coupling and phase to obtain an appreciable forward gain in the loop,

3) Adjust transformer to minimize the VSWR. By successfully repeating steps 1 to 3, the gain can rapidly be adjusted for the maximum attainable value for a specified attenuation in the circuit.

Because of the high energy storage and relatively low loss, the Q of the simulator is quite high and, when adjusted for large multiplications, the frequency must be held closely. Operation at the peak or on the side of the resonance curve is permissible. It has been found that once tuned up and stabilized it will hold for long periods of time with only minor adjustments. Thus the simulator is satisfactory for continuous life testing with only normal monitoring and routine adjustments required.

The high Q results in a slow build up and decay which must be taken into account with pulsed operation. This is shown in Fig. 8 together with the sharp distortion of the backward wave. The cancellation of the backward wave is quite selective, although in the case shown, a maximum VSWR of 1.15 and a minimum VSWR of 1.08 was obtained. Caution is indicated when using short pulse width, i.e., wide spectrum band width.

The Q of the simulator can be derived from the fundamental definition relating stored energy to energy lost per cycle and is given by

$$Q = 2\pi \frac{L}{\lambda_o}\left(\frac{\lambda_g}{\lambda_o}\right)\frac{1}{1 - e^{-2\alpha}}$$

where, L is the length of the loop.

The simulator may be simplified for many tests under certain circumstances. If a tunable magnetron is available, a directional

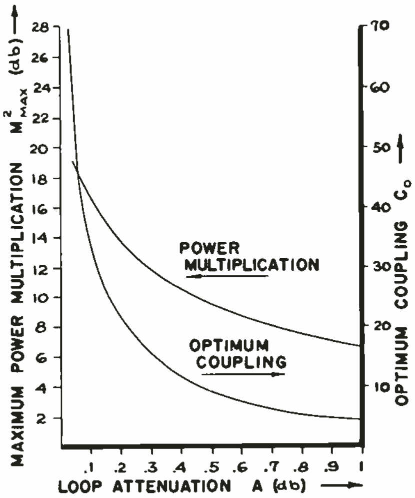


Fig. 9: Maximum multiplication and optimum cooling vs. loop attenuation

coupler of appropriate coupling for the anticipated loss can be selected. Resonance can be obtained by tuning the magnetron without the use of a phase shifter and the VSWR can be minimized by slightly distorting the guide. "C" clamps have been found to be quite satisfactory for this purpose at L band.

In addition to being a very useful tool for breakdown studies and high power testing, the simulator should find an important application in precision measurements of low attenuation in low level laboratory test benches. Fig. 4 shows

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What's New . . .

Aperture Cards File Microfilm

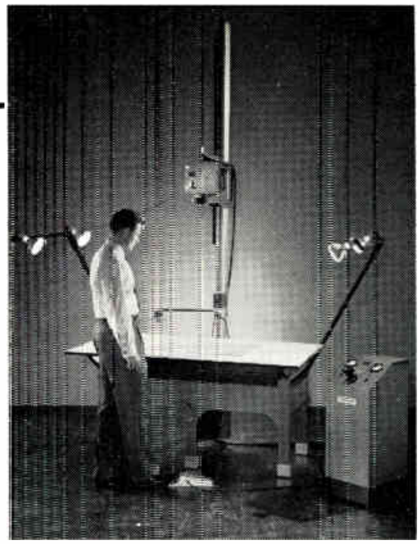


Fig. 2: This micro-file machine films drawings up to 37½ x 52½ inches—reduction varies from 12 to 30 diameters.

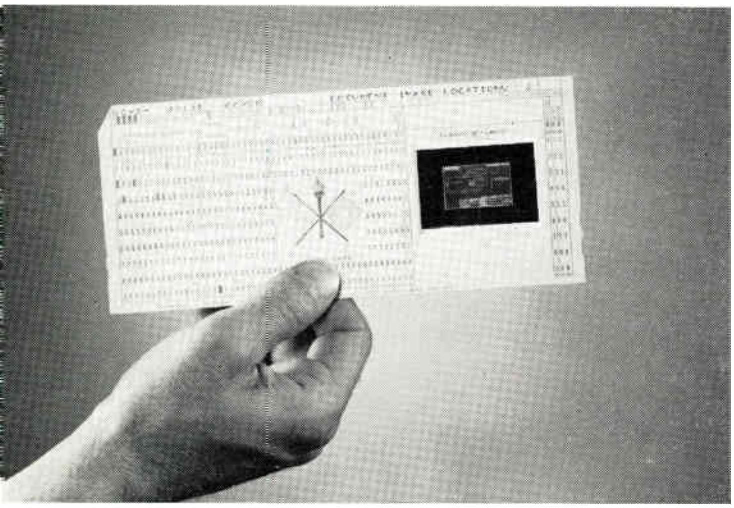


Fig. 1: Mounting microfilmed drawings in a tabulating aperture card establishes a simple medium leading to tremendous cost savings in the filing, reference, and production of paper copies. Complete system available from Recordak Corp., Wanamaker Building, N. Y. 3, N. Y.

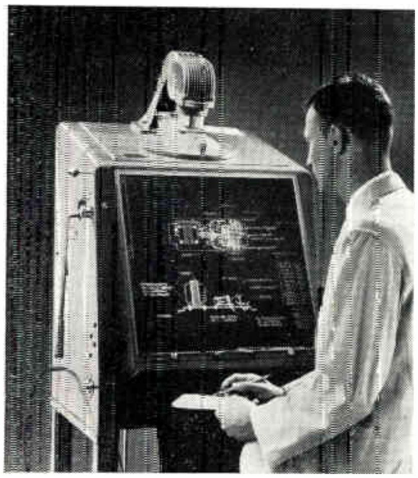
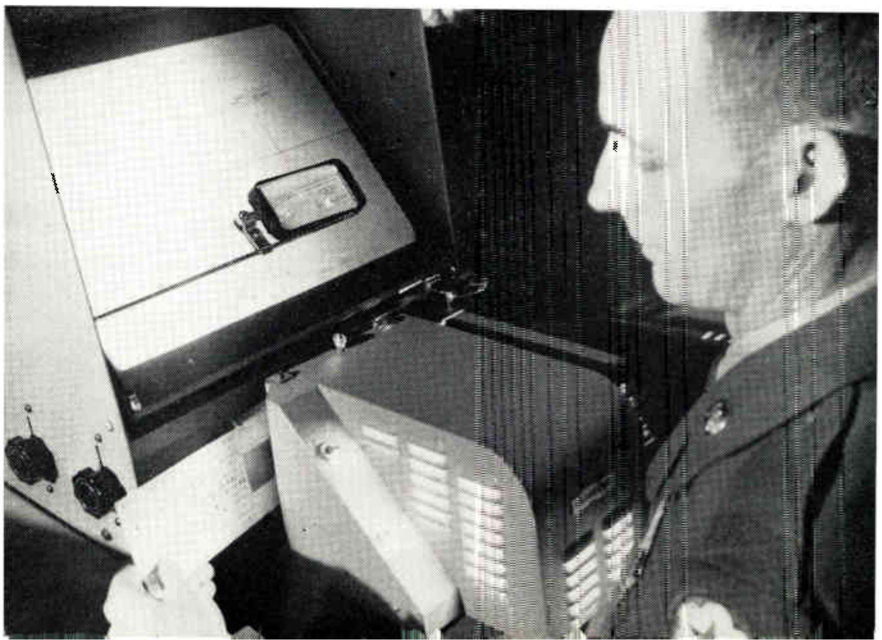


Fig. 5: In some smaller companies it is customary to use a central microfilm reader for all drafting room reference work.

Fig. 3: Processed microfilm is closely inspected for scratches as it leaves the drying cabinet in the Recordak laboratories.

Fig. 4: A special reader is used during the transfer of 300,000 Signal Corps drawings to aperture cards at Ft. Monmouth, N. J. The aperture cards are fed into the reader in sequence while the roll film passes through image by image to be cut and mounted.



Computer Reads Microfilm

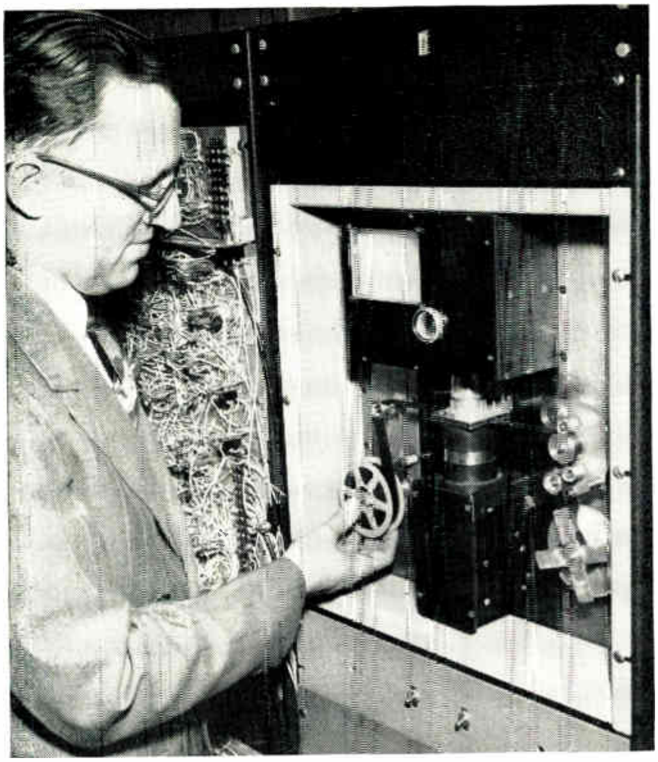


Fig. 1: Film scanning assembly uses flying spot and CRT.

THE National Bureau of Standards has completed FOSDIC II —a high speed electronic device that can read microfilmed copies of punched cards and search for cards containing specific information. FOSDIC II (Film Optical Scanning Device for Input to Computers) is an extension of the work which resulted in the original FOSDIC, a device to read microfilmed Census documents.[1]

Sponsored by the Weather Bureau, the present machine is designed to aid in the high-speed processing of weather data contained on over 300 million punched cards at the Weather Records Center in Asheville, North Carolina. It is essentially an electronic scanner which reads filmed images of these punched cards, searches for cards containing specified information, and copies the selected information onto new cards for computer input. The device was developed by M. L. Greenough, and E. C. Palasky of the Bureau's electronic instrumentation laboratory to link large files of permanent data on punched cards with automatic data processing equipment.

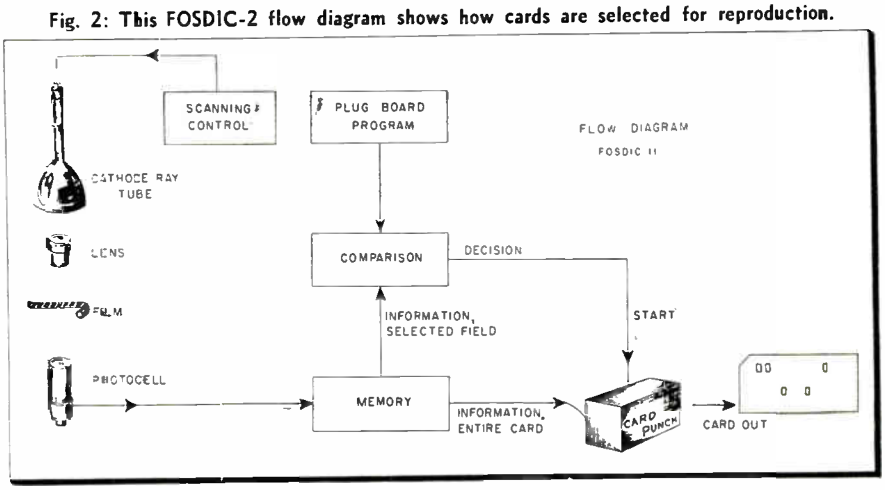
In maintaining punched card files, the cost of storage and the difficulties of preservation have always been pressing problems. Cards are subject to handling damage and individual loss, and the paper stock itself deteriorates in inactive storage. Moreover, with extremely large quantities of cards, access to the information contained on them is time-consuming. Through the use of microfilms of the punched cards, together with FOSDIC II to rapidly recover the data, (1) file storage space can be reduced by a factor of over 100, (2) the searching logic permits a high degree of selection, (3) duplicate files can be easily and economically prepared, (4) visual inspection of the data content and condition of the storage file is readily apparent with a microfilm viewer, and (5) data can be preserved almost indefinitely. Chiefly for these reasons, microfilm was selected as the new storage medium rather than magnetic tape.

The central element of FOSDIC II is the electronic scanning assembly. Light from the screen of a cathode-ray tube is focussed upon the microfilm image, and the transmissivity of small, discrete areas on the film is measured by a photoelectric cell. By moving the electron beam around on the face of the cathode ray tube, any selected area of the image may be examined. Control of the position of the illuminated area, and interpretation of the photoelectric signals, are functions performed by the associated electronic circuitry. Through positional control, or scanning, the point of light travels in prescribed manner from one point to the next in turn.

Since there is only one electron beam in the cathode ray tube, the scanning style is serial in its time sequence. With this serial method, only a few circuits are used repeatedly, rather than the converse as for a parallel or multiple-sensing approach. As a result, for the same amount of equipment, it is possible to emphasize refinement of performance rather than speed. However, FOSDIC II is still many

(*Continued on page* 155)

Fig. 2: This FOSDIC-2 flow diagram shows how cards are selected for reproduction.



Part one of this report summarized basic data for the design of a successful Meteor Burst System. Now, the authors describe the 820-mile VHF link now operating between Bozeman, Montana and Palo Alto, Calif. The over-all teletype and voice systems are described, together with the special system components developed for this type of communication.

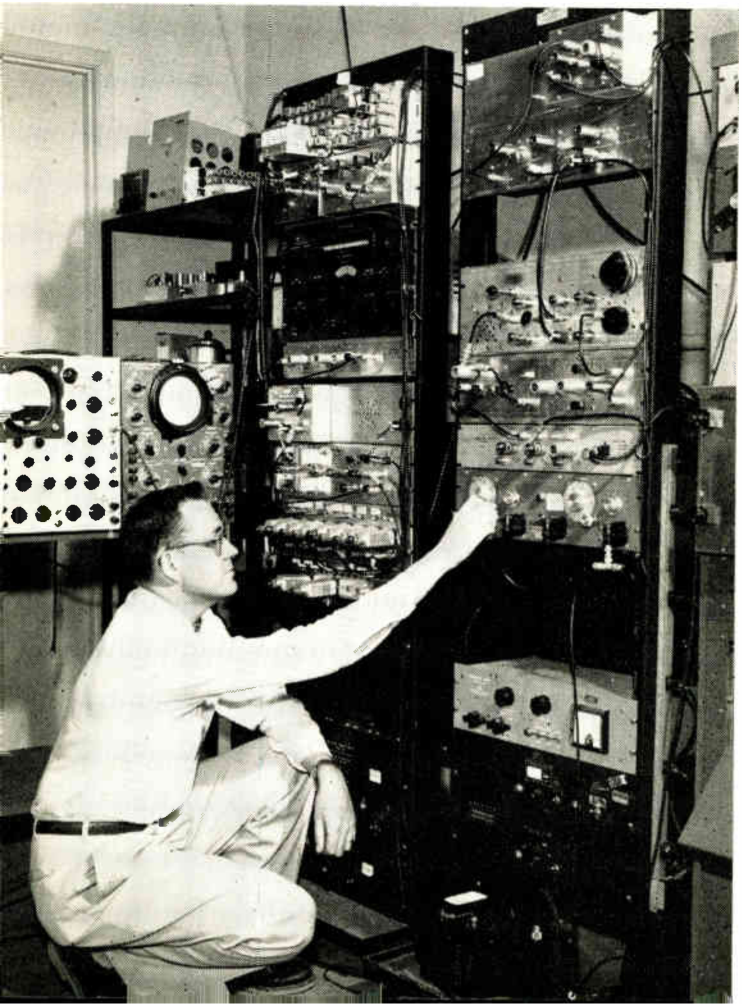
VHF Propagation

Part Two of Two Parts

By W. R. VINCENT, R. T. WOLFRAM, B. M. SIFFORD, W. E. JAYE, and A. M. PETERSON

Sanford Research Institute
Menlo Park, California

Fig. 23: SRI research engineer Russell Wolfram makes adjustments to the Meteor-Burst VHF receiver at the field site receiving station.



THE reflection of radio signals from meteor ionization trails offers a number of attractive characteristics as a propagation mode for communication circuits. Such trails are capable of reflecting incident VHF signals for distances up to 1500 miles between transmitter and receiver. The paths are unaffected by ionospheric variations and other disturbances which occur in the h-f band. They can also provide a certain measure of security of information and resistance to jamming.

Stanford Research Institute has constructed an experimental meteor-burst system now in operation between Bozeman, Montana, and Palo Alto, California. The great circle distance between these points is 820 miles. The frequencies used are 40 and 32 MC. Both teletype and voice information has been successfully transmitted over the link. This article describes the over-all teletype and voice systems and the special system components developed for this type of communication.

Unique Design Considerations

Meteor particles enter the E-region of the ionosphere in great numbers. The signals propagated to a remote receiver by reflection from the individual ionized meteor trails can also be very numerous, but they differ greatly in intensity, duration, and frequency of occurrence. The number of signals of usable intensity and duration is proportional to transmitter power, receiver sensitivity, and, within certain limitations, antenna gain. If these equipment parameters were made sufficiently high the received signal could be essentially continuous.

Even with moderate power and antenna gain a fraction of the signals will be of sufficient intensity and duration to effect an appreciable transfer of information. With equipment designed to synchronize transmission with appropriate meteor trails between sending and receiving stations, it is possible to con-

Fig. 24: Meteor-Burst operational sequence: (1) constant VHF beam from receiving station, (2) notice from receiving station to start message transmission, (3) message transmittal, (4) message-termination signal from receiving station.

By Ionized Meteor Trails

Presented at 1957 WESCON

vey messages in the VHF band over distances completely beyond normal line-of-sight ranges.

The amplitude-*vs*-time characteristic of a typical meteor-reflected signal is shown in Fig. 31. The maximum amplitude may be as high as 50 db above receiver noise, and the rate at which signals are received may vary from 10 to many thousands per hour. The usable duration of an individual burst can fluctuate in a random manner from a few milliseconds to whole minutes.

The most efficient way to make use of this varying-amplitude signal would be to transmit information at the highest rate consistent with the signal power received. This would require a variable rate and variable-bandwidth system. It is simpler but less efficient to transmit at a fixed information rate and only during those portions of bursts when the received signal remains above a specified intensity level.

The over-all information transfer rate in this case will be the product of the transmission rate during bursts and duty cycle—the percentage of time the received signal is above a preset threshold level. The fixed-rate system (referred to as a threshold system) implies that the transmitting terminal must know when a usable path exists, so it can control the flow of information and synchronize it with these signal bursts. This in turn requires a recognition signal to indicate that a signal path exists. As meteor-reflected signals follow reciprocity laws, the existence of a path can be determined from a signal originating at either terminal.

Also, since information can be transmitted at a higher than normal rate during bursts, special-data storage and rate-changing components are required if information is to be put in and taken out of the system at its normal rate.

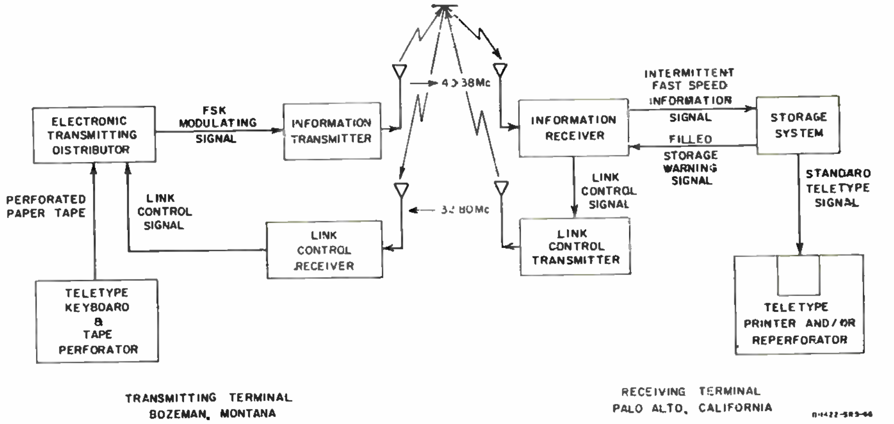
Bozeman-Palo Alto Link

The present Bozeman - Palo Alto system is designed as a one-way communication link; information other than that required for operation of the link is transmitted only one way—from Bozeman to Palo Alto. In this paper the information-sending station at Bozeman is designated T, and the receiving station at Palo Alto is designated R. In the Bozeman - Palo Alto link, CW signals are transmitted continuously from both T and R. When R determines that a usable signal is being received it modulates its transmitter and notifies T to begin sending.

The Teletype System

In the design of this initial meteor-burst teletype link, proved methods and standard circuits are used except where the nature of the meteor channel requires special techniques. Standard 60-WPM teletype equipment is used as the information source and termination. Conventional frequency-shift binary-keying modulation was selected, which allows the use of standard class C power amplifiers in the transmitters. The equipment has initially been designed to transmit information during bursts at 10 times the normal 60-WPM teletype rate, or 600 WPM. A block

Fig. 25: This is a block diagram of the teletype system used in the VHF transmissions.



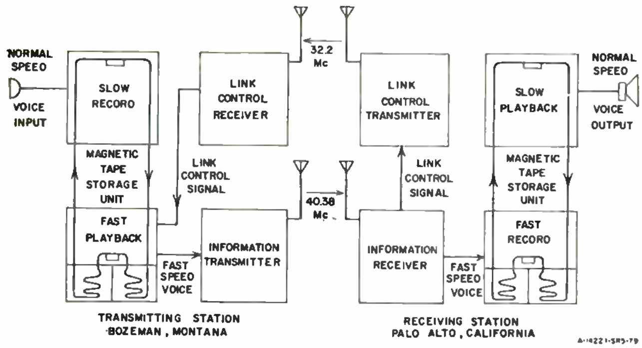


Fig. 26 (above): Block diagram of the fast-slow voice system.

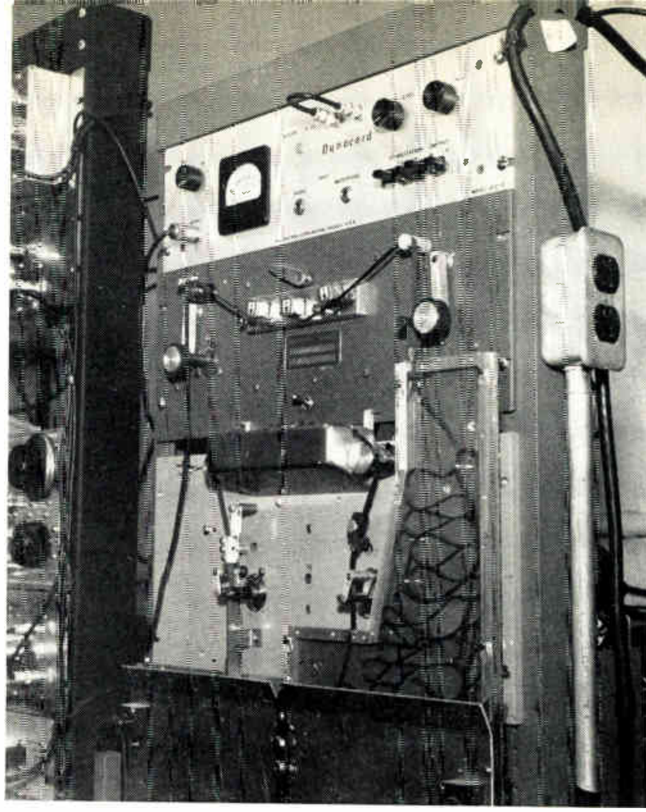


Fig. 27 (right): Tape storage bins allow transition between steady slow rate and sporadic bursts of high rate information.

Meteor Trails *(Continued)*

diagram of the teletype system is shown in Fig. 25.

A closed loop circuit is utilized to determined when a useful meteor path exists and to relay control information to T. A two-kw, FSK modulated transmitter at T transmits continuously on one of its two frequencies. When a path exists this signal is received at R by a conventional superheterodyne receiver having two narrow band filters (650 CPS) to select the two FSK frequencies before detection.

At signal levels below the desired threshold, the signal reaches the filters without limiting. The output of the two filters is rectified and added destructively. When the output of one filter exceeds that of the other by a predetermined amount, indicating an acceptable signal level, a signal is generated—the *link start control*—which notifies T that transmission of information may begin.

An FSK transmitter at R, duplicate of the one at T, also transmits continuously. The link start control signal generated by the detector output causes this transmitter to shift its transmitting frequency. A receiver at T (exactly like the one at R) detects this shift and begins transmitting information. The FSK transmitter at T and receiver at R, used to determine a suitable meteor path, also transmit and receive teletype information. Hence the detectors in the receiver at R perform the normal FSK function as well as indicate when the signal is at a suitable level for communication.

Once the transmission of information is begun, the detector output follows the FSK signal within the response of the filters. This information signal is regenerated and sent to the storage system. To detect the end of the burst the rectified outputs of the filters are constructively combined. As one of the two frequencies is always transmitted, this signal will be independent of the FSK modulation and will be a function of the received signal strength only. Another decision circuit operates on this combination to generate a link stop control order when the signal has faded below a usable level.

Thus when the transmitter frequency at R is shifted back, transmission of information is stopped at T. This method allows the receiving terminal to control the starting and stopping of information according to signal-to-noise conditions at the receiving site. It also enables R to stop information if the storage systems become filled or if there is a malfunction at R.

The operating frequency of the information transmitter at T is 40.38 MC and the frequency of the control transmitter at R is 32.8 MC. These frequencies are close enough to give good path correlation yet far enough apart to avoid cross-coupling problems.

Two three-element Yagi antennas are used at each terminal for receiving and transmitting. These antennas are spaced about 200 ft apart in a direction normal to their line of directivity and supported on poles 30 ft above the ground.

Conventional perforated paper tape is used as a buffer storage at the transmitting terminal. From the perforated tape, a Ferranti high-speed tape reader and electronic distributor generate a sequential keying signal which modulates a two-KW transmitter during bursts. This keying signal is the normal, nonsynchronous teletype code in which each character is represented by a sequentially transmitted start pulse, five information pulses, and a stop pulse. During a burst the information is transmitted at 600 WPM. The FSK deviation at the transmitted frequency is 2.5 KC.

Two novel information storage and speed-changing components have been developed for use at R. One uses a continuous loop of magnetic recording tape on which the fast-speed teletype signal is recorded. After this recorded information is played back, the tape is erased and returned to the bin of tape available for recording. The other is a magnetic core storage component where the fast-speed information is stored in magnetic core matrices and read out at slow speed into standard printing equipment. Both systems can be adapted to operate in reverse as a storage system at T: i.e., store slow-speed information and read out at fast speed during bursts.

Signal Fading Rates

In contrast to continuous systems, where the signal must be used throughout a fade, a burst system needs to tolerate signal fading only until the information transmission can be halted. Certain irreducible time delays are encountered in controlling the starting and stopping of information transmission from a remote terminal. Approximately 17 ms after a start signal is generated in the receiver at R the first information pulse should arrive. Starting delays cause only a slight reduction in duty cycle. However, an additional 16 ms may be required before the information cuts off at R; the transmitter distributor cannot stop in the middle of a character.

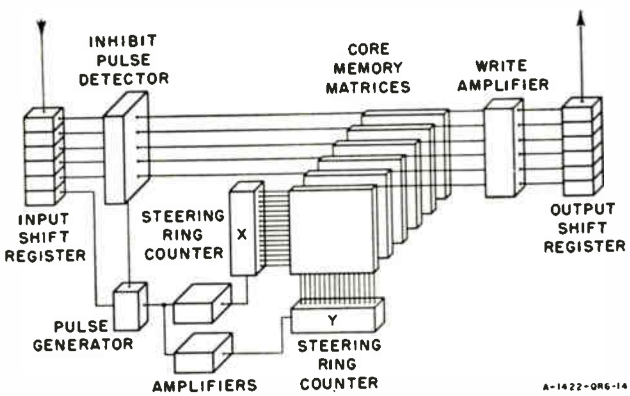


Fig. 28 (above): Block diagram of magnetic core storage system.

Fig. 29 (right): This magnetic core matrix functions at high rates; principal drawback is inability to read and write simultaneously.

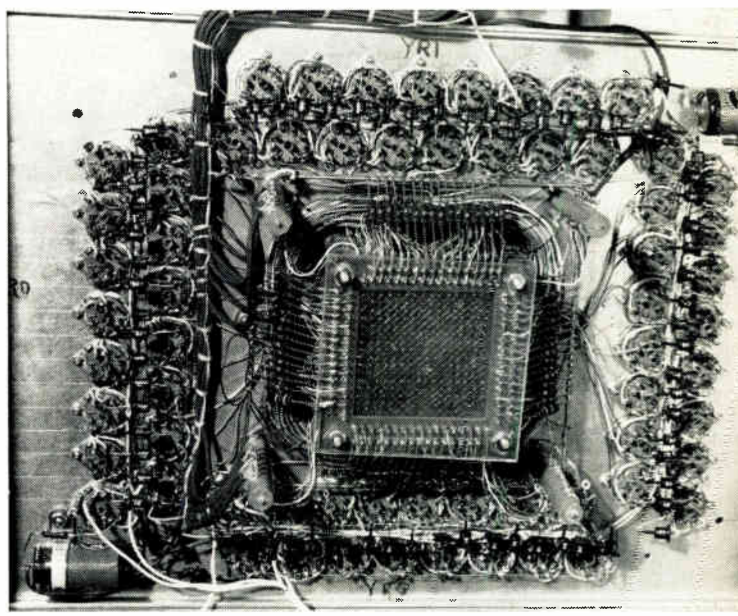
Stopping the link is a more serious problem, especially when rapidly fading signals are encountered, because of the increased probability of end-of-burst errors. Meteor-signal fading rates as high as 500 db/sec have been observed on this circuit. To compensate for the effect of such high-fading rates in this system, the stop threshold level (received signal level at which link stop control signal is given) has been set higher than the information detectors call for at a given error rate. This again is at the expense of duty cycle. With a constant signal-to-noise ratio of about 9 db at the input of the detector in this system, character errors can be held to one per cent. The stop threshold level is generally set at about 15 db above the noise level. This will accommodate fading rates up to about 200 db/sec. However, the fading-rate problem is far from solved, and it will undoubtedly receive further attention in design of future meteor-burst systems.

Electronic Transmitting Distributor

At the transmitting terminal, information in the form of perforated paper tape is converted to a fast-speed serial modulating signal and transmitted by the information transmitter when R signals the presence of a meteor burst. This operation is performed by the electronic transmitting distributor which consists of a Ferranti high-speed tape reader, tape control circuits, register and counter, master oscillator, and a pulse generator.

The perforated tape is fed into the Ferranti tape reader. This commercially built unit reads the tape perforations by means of light beams and photocells. The tape is friction-driven by a rotating shaft started and stopped by a magnetically operated clutch and brake. The tape control circuits regulate the current in the brake and clutch coils to advance the tape after each READ operation. The five hole positions for each character are read simultaneously and these signals then fed to the vacuum tube register and counter unit.

The timing of the information bits from the distributor is controlled by the master oscillator and



pulse generator which produces timing pulses for the register and counter. The register and counter unit accepts the timing pulses and the information signals from the tape reader, plus the link control signal from the receiver, and delivers serial output signal. This modulates the information transmitter during bursts.

When the link control signal indicates the presence of a burst the register accepts and stores the parallel input information bits, and the counter uses the timing pulses to read out the stored bits serially. A signal is then fed to the tape control circuits and the tape is advanced to the next character. When this occurs the tape control circuits signal the register and counter and the character is then either transmitted or not, according to the position of the link control signal.

By varying the frequency of the master oscillator, information can be transmitted at any rate from 0 to 2000 WPM. However, the receiving terminal equipment was designed specifically for a 600 WPM rate. Tests at other rates have not been attempted.

Magnetic Tape Storage System

The fast-speed teletype information from the receiver detector is recorded on magnetic tape in the form of an on/off modulated 13-KC carrier. The tape is played back at one-tenth the recorded speed and the signal, now a 1.3-KC carrier, is detected and used to operate a Model 19 teletype page printer and tape reperforator.

The magnetic tape storage system includes the delay shift register, the tape control circuits, and the magnetic tape storage unit. Illustrated in Fig. 27, the latter consists of a dual-speed, continuous-loop tape transport mechanism, record and playback amplifiers, and mechanism control circuits. A continuous loop of one-fourth inch magnetic tape runs successively through the fast-speed drive mechanism, where the tape is erased and recorded at 48 inches per second; into a storage bin; then out of the bin and through the slow-speed drive mechanism, where it is played back at 4.8 IPS; and finally into the blank tape storage bin to await further recording.

The storage bins can each hold approximately 120 feet of tape, providing about 30 seconds of fast-speed recording time or 5 minutes at standard teletype speed. Because the average burst length with the power and threshold levels used is much shorter than this, the loss in duty cycle owing to lack of storage space is negligible.

The enclosed tape bins and narrow filler-tube arrangement shown in Fig. 6 proved to be a very satisfactory solution to a perplexing problem involving static-charge accumulation. This caused sticking of the magnetic tape and consequent trouble in keeping the tape in the bins. The tape mechanisms utilize synchonous - motor - driven capstans and magnetically actuated pinch rollers. The fast-speed mechanism, using thyratron actuator drive circuits, has a tape starting time of less than two ms. Standard heads and amplifiers are used for tape recording and playback and a permanent magnet for tape erasure.

A fundamental design objective required that the storage system be controlled by received information only, so that storage would not be wasted when the message was for some reason not transmitted during a burst. Therefore, the received information signals are also applied to the tape drive control circuits where they are processed and used to start and stop the recording and playback tape drive mechanisms in the tape storage unit.

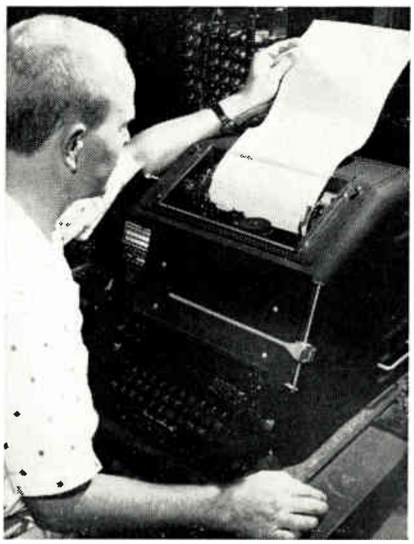


Fig. 30: A teletype message is received from Bozeman, Mont., by SRI's Joseph Wheeler.

Upon receiving the fast-speed information signal the tape control circuits start both tape drive mechanisms. At the end of the information burst the fast-speed drive is stopped but the slow-speed drive continues running until all the recorded information has been played back.

Magnetic Core Storage System

A block diagram of this system is shown in Fig. 28. The fast-speed serial teletype information from the receiver detector is first fed into a vacuum tube shift register where it is converted to a parallel output signal. The start pulse and the five information bits of each teletype character are then fed out of the shift register, each going to one of six magnetic core storage matrices (see Fig. 29). At the end of the burst the stored information is read out of the matrices in parallel, one character at a time, into an output shift register. This register converts the parallel signals to a normal speed serial output signal for operation of standard teletype printing equipment.

Each of the six storage matrices consists of a rectangular plane of 240 toroidal memory cores arranged 15 by 16. Such cores have two permanent magnetic states and are thus ideally suited to store binary information. Each core is traversed by two lines, the X line and the Y line. During switching of a core a current of half the amplitude necessary to switch the core from one state to the other flows in one X line and one Y line, respectively. Only the core at the intersection of these two lines will have enough drive to switch. This system is called the coincident-current method of switching.

The matrices are driven from a unit composed of memory cores and diodes, called a magnetic steering ring counter. This receives input pulses, resets itself, and steers the input pulses to the desired output lines. A circuit of this kind requires only two drivers, instead of one driver per line, or 31 drivers in all.

The READ operation is triggered by the start pulse of the teletype character, which triggers a pulse generator. The short duration pulse thus generated follows two distinct paths. The first path is split into what are called the X channel and the Y channel. In each of these, the pulse is amplified separately. The X and Y pulses are then fed to the X and Y magnetic steering ring counter respectively, then to the rows and columns of the matrices.

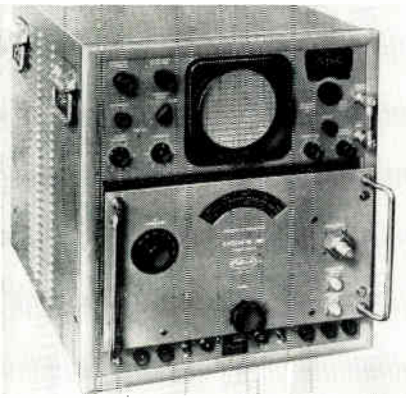
The second path leads to the inhibit pulse detector. There, each of the five remaining information bits from the shift register is fed to an electronic gate together with the pulse generated by the start pulse of the character. Depending on the information in the shift

(Continued on page 98)

New Products . for the Microwave Engineer

SPECTRUM ANALYZER

The Model TSA-W, is a new addition to a line of spectrum analyzers. A new marker has been provided with a range of 80 MC and employs a vernier control for measurements of



small frequency differences. Another new feature is a logarithmic display in addition to the linear display. This effectively increased the dynamic range of the instrument and permits detailed examination of minor lobes. It utilizes interchangeable plug-in heads to cover the frequency range of 10 MC to 44 KMC. Polarad Electronics Corporation, 43-20 34th St. Long Island City 1, New York.

Circle 213 on Inquiry Card, page 101

CERAMOPLASTICS

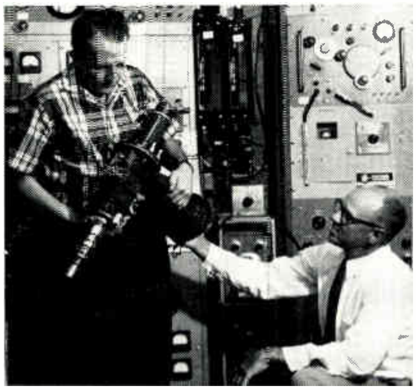
High thermal endurance, desirable electrical characteristics, mechanical shock resistance, and permanent, total dimensional stability are major advantages to be derived from the use of ceramoplastics in the manufacture of radomes for guided missiles. Supramica 555 ceramoplastic is a molding material utilizing synthetic mica. Mounting rings or metal reinforce-

ments can be molded in as part of the manufacturing process, and will remain tightly anchored over the entire operating temperature range. Mycalex Corp. of America, 60 Clifton Blvd., Clifton, N. J.

Circle 214 on Inquiry Card, page 101

AMPLIFIER TUBE

An amplifier tube with internal resonant cavity circuits capable of tuning from 1700 to 2400 mc is available. The only r-f connections to the VA-800 are an input line with less

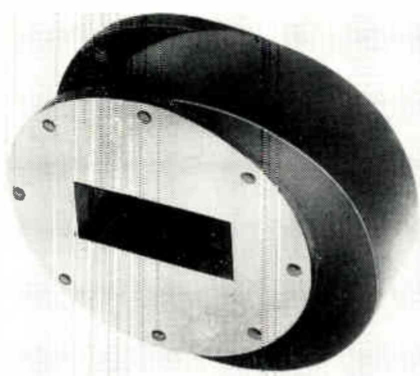


than 1 w. of drive power and an output line to carry 10,000 w. of r-f power to the antenna. All resonant circuits are an internal part of the tube and can be tuned readily to any spot. The only electrical requirements are supplies for the cathode, beam voltage, and the beam focusing magnet. No warm-up adjustment periods are necessary. Varian Associates, 611 Hansen Way, Palo Alto, Calif.

Circle 215 on Inquiry Card, page 101

MINIATURE ISOLATOR

The "C" Band 150 kw ferrite minature isolator was designed to operate in the 5000 MC frequency range. These ferrite resonant absorption isolators furnish constant uni-directional magnetron to load isolation. They feature a waveguide size of 2.00 x 1.00 O.D. with a weight of less than 3.5 pounds. The ferrite material is mounted directly on the waveguide

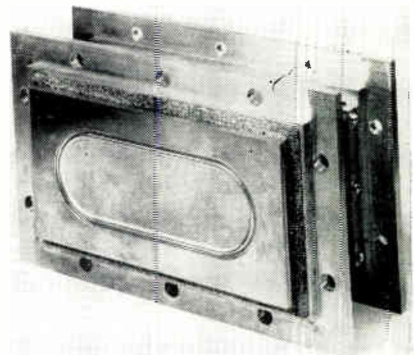


wall and full waveguide opening has been used. Five units are available to collectively cover the frequency range from 5250 to 5750 megacycles. Airtron, Inc., 1101 W. Elizabeth Ave., Linden, N. J.

Circle 216 on Inquiry Card, page 101

PRE-TR TUBE

The BL-612, an L-band pre-TR tube was designed with ceramic windows for use in high power applications. Preliminary tests indicate that successful operation at 6 megawatts



(peak) and 12 kilowatts (average) is possible and the bandpass is from 1250 to 1350 megacycles. Two gaskets are supplied with the BL-612 to allow mounting in a standard 10-hole L-band mounting seat. The tube weighs approximately 5½ pounds and is 8 11/16 inches long, 5 7/16 inches wide and 3.600 inches (maximum) in height. Bomac Laboratories, Beverly, Mass.

Circle 217 on Inquiry Card, page 101

FERRITE ISOLATORS

High-power K_u-band ferrite isolators are now available. Model IK$_u$H1 covers a frequency range of 16.0 to 17.0 KMC; it provides a minimum of 20 db isolation and a 0.5 db maximum insertion loss over the full band. Model IK$_u$H3 is a miniaturized unit which weighs less than 1½ lbs. and is less than 2 in. long; it provides a minimum isolation of 14 db and a

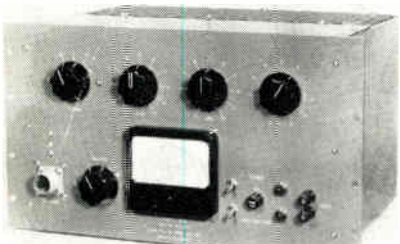
maximum insertion loss of 0.3 db over the 16.0 to 17.0 KMC band. Both units have a power handling capability of 135 watts average, 135 kw peak. Raytheon Manufacturing Co., Seyon Bldg., Waltham 54, Mass.

Circle 218 on Inquiry Card, page 101

New Products ... for the Electronic Industries

NUCLEAR POWER SUPPLY

The Model 405, has been designed primarily as a stable voltage source for the new 14 stage photo multiplier tubes. The high current capability of the supply permits simultaneous operation of a number of multiplier tubes. Output is from 600 to 3110 volts dc at 0 to 15 ma. A 1.02 v. sample of the output is available at the front panel for potentiometric monitoring. Regulation for a line voltage change of 20% is 0.01%. For a load change of 10 ma. regulation is 0.005%. Stability is 0.005% /hr. John Fluke Manufacturing Co., Inc., 1111 W. Nickerson St., Seattle, Wash.



Circle 195 on Inquiry Card, page 101

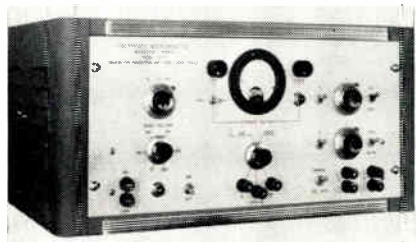
ELECTROLYTIC CAPACITORS

Type EE and EM electrolytic capacitors are 2 subminiaturized units especially designed for transistorized circuits and miniaturized low voltage dc equipment. Featuring low leakage characteristics for minimum battery drain, Type EE (epoxy and fill) and EM (spun end with rubber bushing) are small hermetically sealed electrolytics. They have applications in hearing aids, transistorized pocket radios, miniaturized recorders and many other miniature units. Available in voltages of 1, 3, 6, 8, 16, 26, and 50 volts. Astron Corp., 255 Grant Ave., E. Newark, N. J.

Circle 197 on Inquiry Card, page 101

TRANSISTOR ANALYZER

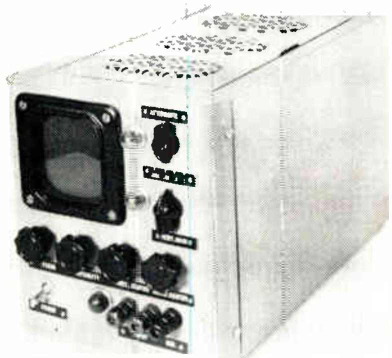
Model TA-10 Unijunction Transistor and Diode Checker traces, on an oscilloscope, the negative resistance or emitter characteristic curves of the G. E. type ZJ14 unijunction transistor (double based diode type). Interbase and emitter voltages are metered and adjustable at front panel. Checking of all type diodes is readily performed by scope display of forward and reverse current characteristic curves. Go, no-go type quality control and production procedures are easily set up. A transistor circuit power source is provided. Polyphase Instrument Co., Bridgeport, Pa.



Circle 199 on Inquiry Card, page 101

NULL INDICATOR

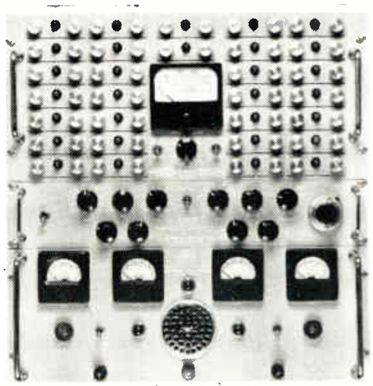
A new electronic null indicator, Model 457, is for use as a dc voltage null detector in bridges. The unit uses a chopper-stabilized amplifier and features high input resistance, extreme sensitivity, balanced input, and practically zero drift. Specifications are: input resistance, 2 megohms; maxium gain, 20 µv/in.; noise, less than 1 µv.; drift, less than 1 µv; input, 3 terminal balanced; 60 cps attenuation, 400; linear time constant, 40 msec; overload, withstands 300 v. indefinitely. The Millitest Co., 88 Madison Ave., Hempstead, N. Y.



Circle 196 on Inquiry Card, page 101

TELEMETER EQUIPMENT

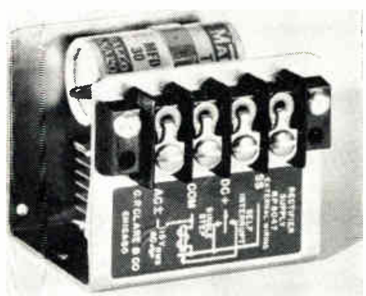
Designed for use in airborne or trailer-installed telemeter receiving stations and in portable ground checkout equipment, this 27-channel decommutation system occupies 19½ in. of panel height in a standard relay rack. Overall depth is 13 in. Model TDS30-1 Decommutation System is completely self-contained within 3 chassis assemblies consisting of gating unit, pulse selector and regulated power supply. Two spare gating units are maintained on standby for instant use. Arnoux Corp., 11924 W. Washington Blvd., Los Angeles 66, Calif.



Circle 198 on Inquiry Card, page 101

RECTIFIER UNIT

A handy rectifier unit to rectify 115 v. 60 cps ac to operate any Clare 115 vdc stepping switch is available. The device will operate either a single switch or a group of switches, one at a time. Within its ratings, it may also be used to operate a relay or a group of relays. The device is 2 x 2¼ x 2 5/16 in. It can be mounted on either of 2 surfaces by 2 No. 6-32 machine screws. The tapped mounting holes are on 2 in. centers. The name plate shows the external wiring connections. C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill.

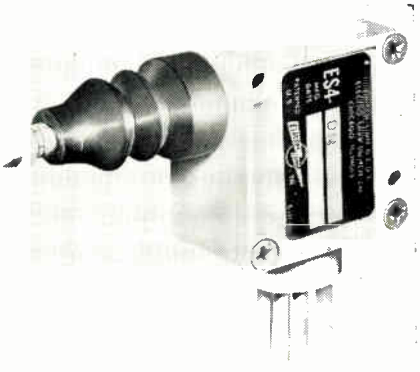


Circle 200 on Inquiry Card, page 101

New Products . . . for the Electronic Industries

DPDT SWITCH

A new die-cast switch provides simultaneous, one-way action on 2 poles. The snap-action of the 4 circuit switch mechanism is totally independent of the speed of the plunger movement. The basic switch is housed

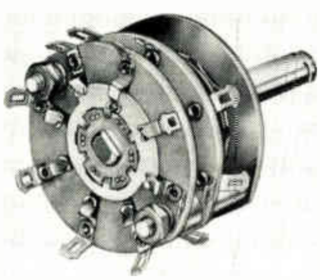


in an aluminum die-cast case with a splash-proof neoprene boot to protect its switching mechanism. The ES4-DM3 is designed to eliminate complicated one way dogs, extra switches, and costly relays. Simultaneous break of two poles permits great flexibility in wiring variations. Rated at 15 amps 125/250 vac, 30 vdc. Electro Snap Switch & Mfg. Co., 4218 W. Lake St., Chicago 24, Ill.

Circle 201 on Inquiry Card, page 101

ROTARY SWITCH

A tiny rotary switch that will fit in a 1⅛ in. circle, requiring less than one square inch of panel area is available. Designated as Series A, it can be supplied in 8, 10, and 12-position wafers, with the latter providing up to 18 insulated contacts. Standard shaft diameter is ¼ in., but 5/32 in. and ⅛ in. shafts are also available. Solid rivets fasten clips to

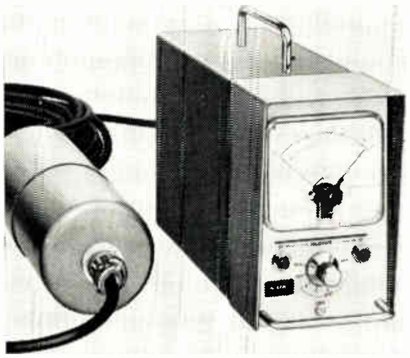


the switch sections. Silicone fibre glass, meeting specification MIL-997 type GSC, is used for the switch stator. The rotor is punched from KEL-F. Oak Mfg. Co., 1260 Clybourn Ave., Chicago 10, Ill.

Circle 202 on Inquiry Card, page 101

RADIATION MONITOR

The Model GA-3B provides a system that has been engineered to give the much-desired accuracy, stability, reliability and sensitivity required of this type of equipment. The unit is completely self-contained and bat-

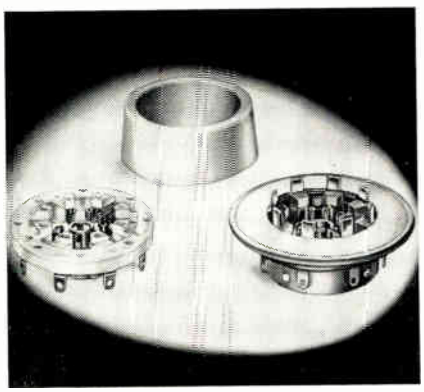


tery-operated. The system consists of a control unit with meter relay, manual reset, 3 or 6 decade log scale, calibration controls, electronic calibration test adjustments and 10 mv recorder output. Calibration methods allow for complete electronic check and adjustments at both ends of scale independent of radiation. Riggs Nucleonics Co., 2390 Olive Ave., Altadena, Calif.

Circle 203 on Inquiry Card, page 101

TUBE SOCKET

Designed for commercial and military application with high power tubes of the 4X150A type, this new low-cost high efficiency socket is available in several versions — with or without integral 2700 mmf screen grid-by-pass capacitor, with cathode terminals grounded or ungrounded to shell. A high quality heat resistant steatite chimney is also available fea-



turing tapered construction which directs air flow through the tube cooling fins. The basic socket is molded of tough low-loss Kel-F plastic. Tube pin contacts are heat treated. E. F. Johnson Co., Waseca, Minn.

Circle 204 on Inquiry Card, page 101

WIRE WOUND RESISTOR

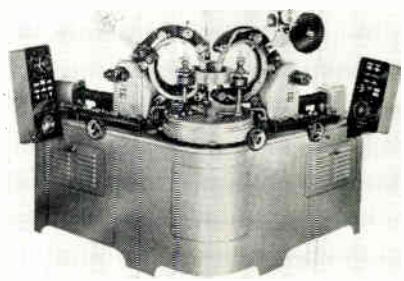
The adjustable precision wire wound resistor is totally encapsulated to surpass all applicable Mil Specs. Comp-U-Trim 113 is a precise trimming pot embedded within the body of precision wire wound resistor.

Similar temperature co-efficient wire is used for both the main and trimming sections. With values up to 1.5 meg ohms, it can be adjusted to 0.1% of the nominal value and trimmed to 0.001%. Special temperature coefficients and wider trimming variations are available. No. 20 AWG tin copper leads can be specified. Eastern Precision Resistor Corp., 675 Barbet St., Brooklyn 7, N. Y.

Circle 205 on Inquiry Card, page 101

COIL WINDING MACHINES

A new series of automatic dual-purpose toroidal winding and taping machines has been introduced. These machines feature simultaneous, separate or sequential 360° continuous winding of wire and/or tape in one operation, and can be operated by one unskilled operator. The new series consists of 2 models: UT-14, with a wire diameter range of #20-#7, and



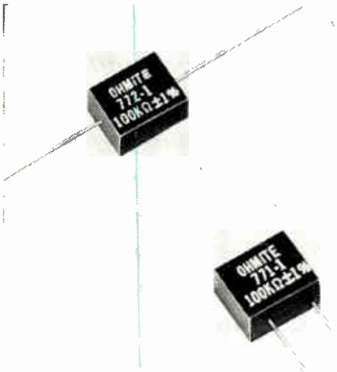
UT-20, having a range of #14-#5; both accommodating most commercial ¾ or 1 in. tapes. Machines are for faster and more economical production of toroidal coils. Universal Mfg. Co., 410 Hillside Ave., Hillside, N. J.

Circle 206 on Inquiry Card, page 101

New Products . . . for the Electronic Industries

PRECISION RESISTORS

New metal film resistors available can be used at full ¼ w. rating in an ambient of +150° C, or up to ½ w. at 105° C or derated to 0 at 190° C. They are designated Series 77 in the

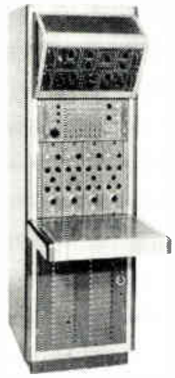


Riteohm precision resistor line. They employ no wire for the resistance element. Resistance range available is 100 ohms to 300 K ohms. Standard tolerance ±1%, but tolerances can be supplied. Reactance is low due to the absence of wire coils. Consequently, these units can be used in high frequency and pulse circuits for which wire wound units are unsuitable. Ohmite Manufacturing Co., 3657 Howard St., Skokie, Ill.

Circle 236 on Inquiry Card, page 101

CURRENT PULSE GENERATOR

Model 1020 programmed current pulse generator is a "packaged" system, providing precisely controlled, fully programmed current pulses for the research, development and pro-



duction testing of digital systems and components. Programming is based on an 8 step, periodically repeated pattern with a maximum step repetition frequency of 200 KC. PRF of up to 400 KC. may be obtained. Some features are synchronization with external equipment before any one or more discrete pulse events and 10-turn current controls on all 4 amplifiers. Rese Engineering, Inc., 731 Arch St., Philadelphia 6, Pa.

Circle 238 on Inquiry Card, page 101

HIGH FREQUENCY CHOKES

A new family of (4) ferrite bead chokes ranging from .3 to 1.3 microhenries with 30 MC ac resistance of from 25 to 100 ohms. Designed for use as filament chokes, parasitic sup-

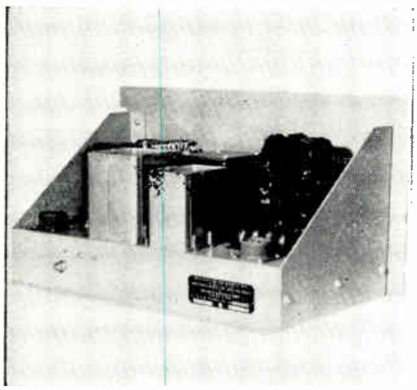
ACTUAL SIZE

pressors and series elements of low-pass filters for frequencies of from 5 to 200 MC. Each is color coded for easy identification; will handle 2 a. filament current with a voltage drop of less than 0.02 v. Insulated with a Fiberglas Silicone rubber covered sleeve. Performance will be unaffected by extremes of humidity and temperatures up to the ferrite Curie point of 125° C. National Co., Inc., Malden 48, Mass.

Circle 240 on Inquiry Card, page 101

VOLTAGE REGULATOR

An all-magnetic, tubeless, 3 kva ac line voltage regulator for use in 115 v., 400 cps. 1 θ and 3 θ military ground support and laboratory equipment is now available. Designated number 75-113-0, the unit maintains a constant 400 cps. ac line voltage regardless of line or load variations. Regulation is held within ±0.5% against line changes between 100-

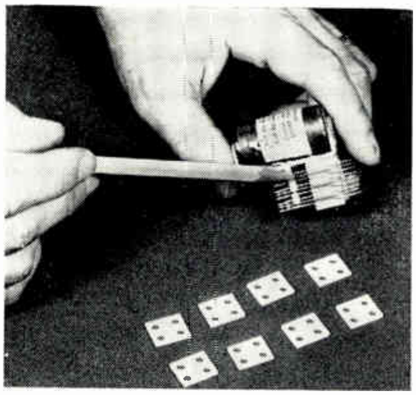


130 v. load changes from 2.5-25 a., and frequency changes between 380 and 420 cps. Output wave form distortion is 5% maximum. Magnetic Research Corp., 3160 W. El Segundo Blvd., Hawthorne, Calif.

Circle 237 on Inquiry Card, page 101

HEAT RESISTANT LAMINATE

Phenolite G-7-830 is a glass-base, silicone resin laminate specially developed for high temperature electrical applications. It has heat resistance rating of 500° F, short time, and 400° F, continuous. Dielectric strength perpendicular to laminations is 400 v./mil, short time, for 1/16 in. thicknesses and 350 v./mil, short time, for ⅛ in. thickness. The im-

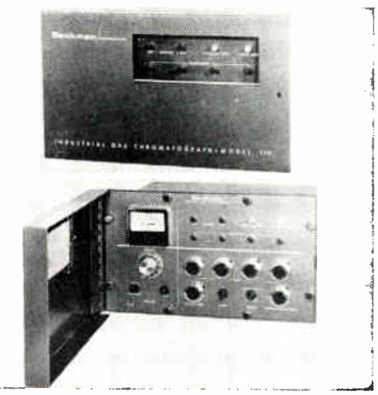


proved heat resistance and good dielectric strength of the spacers permits relay operation at proportionately higher temperatures. National Vulcanized Fibre Co., 1057 Beech St., Wilmington 99, Del.

Circle 239 on Inquiry Card, page 101

CHROMATOGRAPH

The series 120 chromatograph records measurements made by the new analyzer "series A2" developed for use in class I, group D, locations. It features ±0.2° C temperature control for operation up to 110° C and provision for true split column operation allowing complete analysis of up to 4 high and/or low boiling point components in a single stream. A



single action 5-way linear sample injection valve which duplicates the action of 5 conventional 2-way valves is the heart of the gas handling system. Beckman Instruments, Inc., 250 Fullerton Rd., Fullerton, Calif.

Circle 241 on Inquiry Card, page 101

TIME INDICATOR

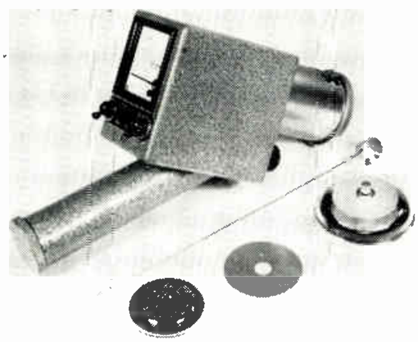
Series HD-656 sealed elapsed time indicator is available. This 2½ in. diameter meter is enclosed in a housing which meets Mil Specs, and has 5, easy-to-read digit counters that

register 1/10 minute or 1/10 hour increments to 9999.9, or hour steps to 99999. Unit is equipped with self-starting synchronous motor for 110-125 v., 60 cycles ac, and capable of operating continuously from −55° C to −85° C. Sealed housing is a combination of sturdy drawn steel case and die cast aluminum mounting flange. Has sealed solder lugs. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 242 on Inquiry Card, page 101

STATIC CHARGE DETECTOR

A new portable instrument for detecting and measuring static electricity charges is now available. The Stratometer is designed for instant measurement of trouble spots in process flow, providing immediate determination as to whether or not disturbance is caused by static. It not only indicates the existence of static

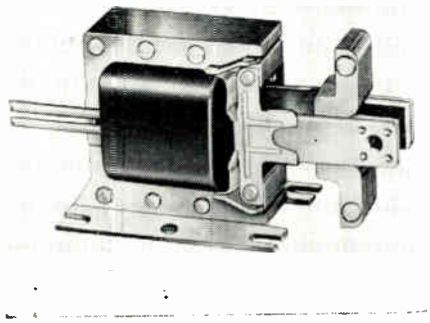


but also pinpoints the area of disturbance, enabling installation of appropriate static eliminators. The meter is built around a chamber which ionizes the air in the vicinity of the static disturbance. U. S. Radium Corp., Morristown, N. J.

Circle 243 on Inquiry Card, page 101

SOLENOID

No. 18 A.C. Solenoid with a patented Permaseal coil is available. The coil winding is completely encapsulated in thermo-setting epoxy. It prohibits penetration by water, ex-

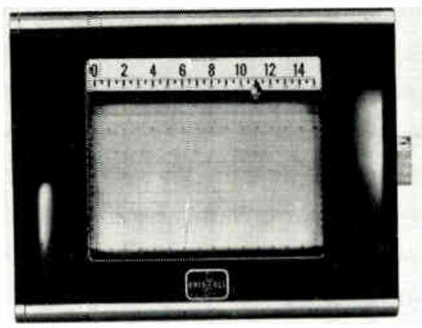


treme humidity, oils, salt air, acid and alkaline solutions, ether, alcohol, hydraulics and other fluids. High dielectric strength, resistance to abrasion and thermal or mechanical shock are added features. With ⅛ in. plunger stroke, they lift up to 11 lbs. Stroke is adjustable from 1/32 in. to 1 in., dc units are also available for 400 cps operation. Guardian Electric Manufacturing Co., 1621 W. Walnut St., Chicago 12, Ill.

Circle 244 on Inquiry Card, page 101

X-Y RECORDER

A new electronic Dynamaster X-Y recorder has just been made available. The new strip-chart recorder will automatically plot a continuous curve showing the relationship of one measured variable to another. Some typical uses include plotting temperature vs. pressure in the process industries, position of intake parts vs.

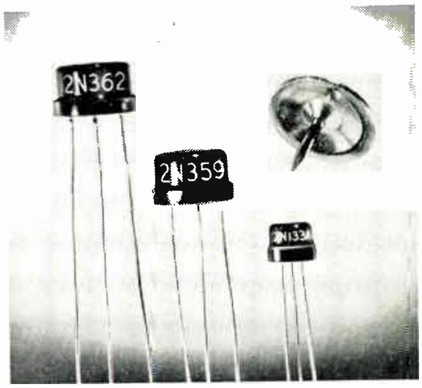


gas flow in wind tunnel research, location on web vs. thickness in paper making, and speed vs. torque in motor operation. It records on a 12 in. strip chart, and is available in pen speeds up to 0.4 sec. The Bristol Co., Waterbury 20, Conn.

Circle 245 on Inquiry Card, page 101

PNP TRANSISTORS

Twelve new germanium PNP transistors for audio applications are available. Six in the JETEC-30 package are for driver and output use as follows: types 2N362 and 2N363 are

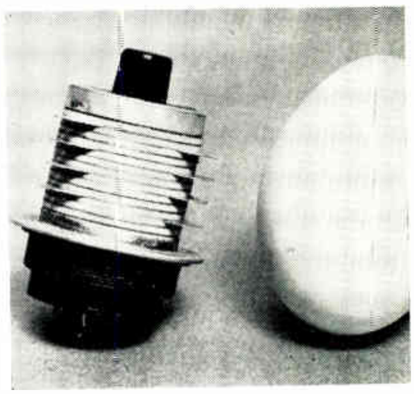


drivers; 2N422 is a low noise unit; types 2N359, 2N360 and 2N361 are all capable of 500 mw output in class B. The other 6 are: types 2N130A, 2N131A and 2N132A are amplifiers; 2N133A is a low noise amplifier with maximum noise factor of 6 db; 2N138B is an output type capable of 50 mw in class B; type CK754 is a high gain transistor. Raytheon Manufacturing Co., 55 Chapel St., Newton 58, Mass.

Circle 246 on Inquiry Card, page 101

CERAMIC RELAY

A new type of relay designed for use under severe environment conditions as in missiles and aircraft applications as well as in other electrical applications is now being produced. The contacts of the new relay are in a vacuum surrounded by a sturdy stacked ceramic enclosure. The type RA1 ceramic relay is a

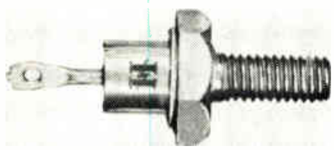


single pole-double throw relay; the type RA4 is a four pole-double throw relay. The RA4 relay is about the size of a hen's egg and weighs approximately 1 lb. Jennings Radio Manufacturing Corp., P. O. Box 1278, San Jose, Calif.

Circle 247 on Inquiry Card, page 101

VOLTAGE REGULATORS

A series 10 w. voltage regulator (zener) diode for voltage control in aircraft, missiles, land vehicles and other equipment is available. The larger diffused junction area offers

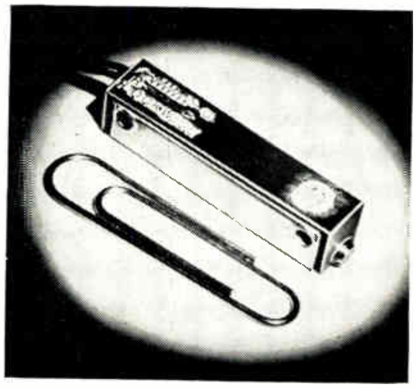


low dynamic impedance and permits closely controlled characteristics. Standard units are available in the range of 10 v. to 100 v., with tolerances of 5% and 10%. The wide range of low voltage values, together with good long-time stability makes them especially suited to transistor and mag-amp circuitry. Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ill.

Circle 207 on Inquiry Card, page 101

PRECISION POTENTIOMETER

A tiny precision potentiometer for pad or trim resistance functions is called the "Padohm." Screwdriver-adjusted, it is available from 100 to 20,000 ohms, and standard overall re-

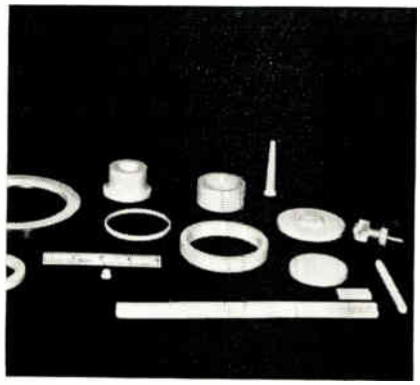


sistance tolerances of ±10% with standard linearity of ±2%. In 2 types: Type L rated at 0.25 w., derated to 0 power at 105°C., and Type H, 0.40 w. derated to 0 power at 135°C. Especially intended for extreme ambient conditions of temperature, moisture, shock and vibration. Effective electrical travel is 98% min. of mechanical travel in 25 turns. Clarostat Mfg. Co., Inc., Dover, N. H.

Circle 209 on Inquiry Card, page 101

HIGH PURITY ALUMINA

High-purity, aluminum oxide ceramics for use in radomes, wave guide components, vacuum tube envelopes and for applications where high resistance to radiation is required is



available. It has unique dielectric properties in the microwave region. At 50 KMC its loss factor is only 0.000093. Most significantly its dielectric constant of 9.38 ± 1% remains stable over the entire temperature range up to 1000° F. Material can be fabricated in a wide range of shapes to extremely close tolerances. Kearfott Co., Inc., 1378 Main Ave., Clifton, N. J.

Circle 211 on Inquiry Card, page 101

SWEEPING OSCILLATOR

Twenty cycles to 20 KC range in a single dial sweep is a unique feature of the new Model 207A Audio Sweep Oscillator. It employs a new variation of the time tested r-c oscillator circuit and achieves its extreme frequency range without bandswitching and with good stability. The accuracy is ±4% including warmup drift

and aging of tubes and components. The oscillator has been designed for motor drive to speed the testing of audio circuits and devices of many kinds. Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.

Circle 208 on Inquiry Card, page 101

FLAT-TOP RESISTORS

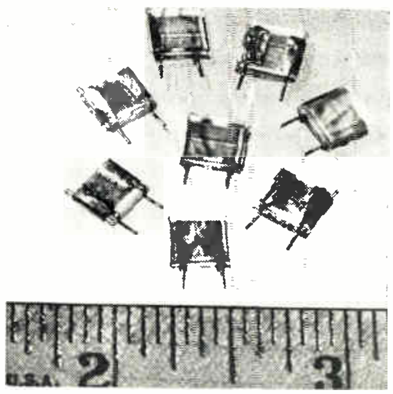
A new flat-top, encapsulated wire wound precision resistor designed for easy, rapid mounting on printed circuit panels with no support required other than the wire leads is available. Type P resistor is a single ended, miniature series available in 7 sizes, from ¼ in. diam. x 5/16 in., up to ⅜ in. dia. by ¾ in. Resistance values

to 3 megohms. Ratings from 1/10 w. to 0.4 w. Can be operated in up to 125°C. Tolerances from 1% to 0.02%. Will withstand all applicable tests of MIL-R-93A. Resistance Products Co., 914 S. 13th St., Harrisburg, Pa.

Circle 210 on Inquiry Card, page 101

GLASS CAPACITORS

Two new subminiature fixed glass capacitors, called WL capacitors, were designed to be used on printed circuit boards and applications requiring high quality components. High temperature soldered leads allow the capacitors to be connected directly to the circuit board; no clamping is required. Both measure less

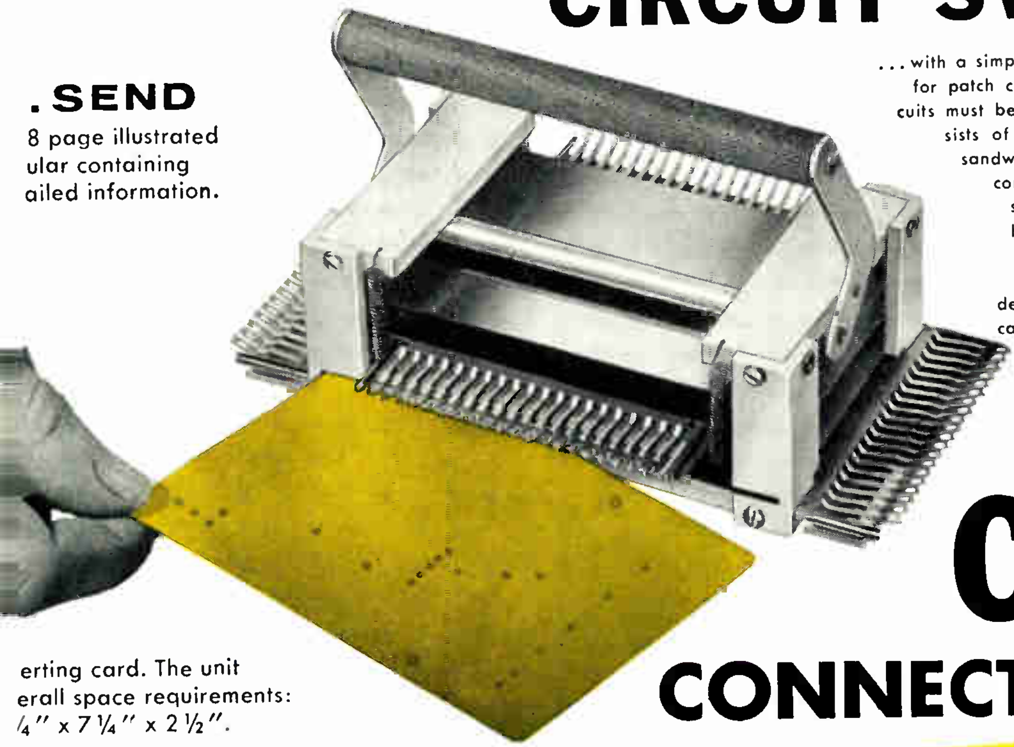


than 0.1 in. thick. WL-4, the smallest may be obtained in capacitances up to 1000 μμf at 300 v. rating. The WL-5 is larger and made in capacitances up to 2200 μμf at this rating. Corning Glass Works, Corning, N. Y.

Circle 212 on Inquiry Card, page 101

!OW...YOU CAN SIMPLIFY CIRCUIT SWITCHING

.SEND
8 page illustrated
ular containing
ailed information.

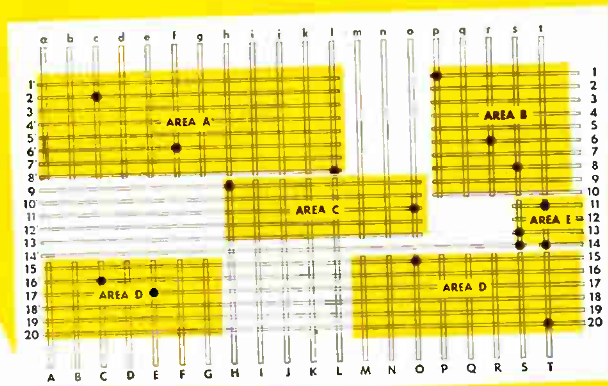


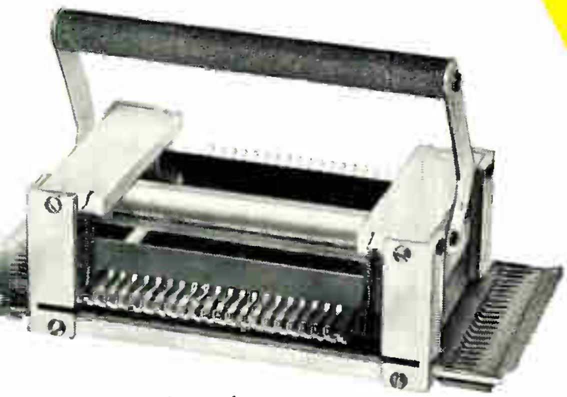
...with a simplified circuit switching device that substitute for patch cord panel systems in applications where circuits must be changed at random intervals. The unit consists of a molded block with 400 floating contacts sandwiched between two printed circuit boards. The contacts make connections between groups of strip conductors on the two printed circuit boards except where the punched card interposes an insulation. Perforations in the card permit connections to be made where desired and later changed by inserting a new card. Ordinary 3" x 5" cards are used, containing the 400 perforations in a 20 by 20 array. The contact blocks can be mounted in multiples for more complex circuits on larger printed circuit boards.

erting card. The unit
erall space requirements:
/4" x 7 1/4" x 2 1/2".

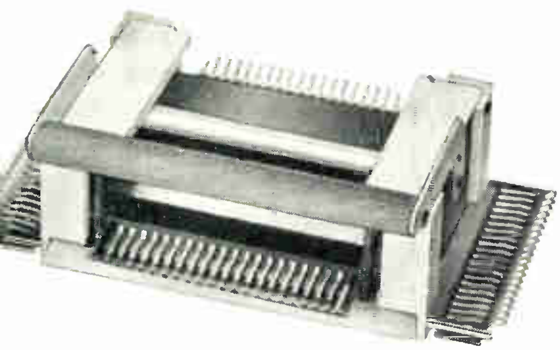
CINCH
CONNECT-O-MATIC

Typical Switching Arrangement Possible with Cinch Connect-O-Matic.
The diagram represents vertical and horizontal backing plates realistically superimposed on one another. The gaps in the printed conductors are to electrically isolate different areas of the backing plates.
In this arrangement any of 8 leads in area A can be selectively connected to 12 other leads in this area; any of 10 leads in area B can be selectively connected to 5 other leads in this area; any of 5 leads in area C can be selectively connected to 8 other leads in this area; any of 6 leads in area D can be selectively connected to 15 other leads in this area; any of 2 leads in area E can be selectively connected to 5 other leads in this area; The dots shown represent a hole position in a typical punched card used with this arrangement.





)pen position. Lever is
disengaged and the card slot is open



Closed position. The card has been inserted (Top illustration) and the lever engaged to close the unit, thus making the desired connections.

Cinch ELECTRONIC COMPONENTS

Centrally located plants
at Chicago, Illinois;
Shelbyville, Indiana;
La Puente, California;
St. Louis, Missouri

CINCH MANUFACTURING CORPORATION
1026 South Homan Ave., Chicago 24, Illinois
Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

WASHINGTON News Letter

OPENS DOOR—The door for tests of subscription television has been opened part way by the FCC in a careful approach under which it provides for acceptance and consideration of applications from present or proposed television stations to conduct pay TV tests for a period not to exceed three years. The applications will not be acted on before next March 1. The FCC left it up to the individual applicants to decide which of the five subscription television systems they wished to use. The three veteran pay TV proponents—Zenith Radio Corp., Skiatron, and Telemeter—have been joined by two other organizations, Blonder-Tongue Laboratories of Newark, N. J. and Teleglobe Pay-TV System of New York, in the outlining of plans for subscription systems to the FCC. Meanwhile, Congress plans to take up the pay TV situation early in its new session next year.

FREQUENCY SPACE TRADE—Climaxing five years of study and negotiations, the Office of Defense Mobilization and the FCC recently announced a "trade" of frequency space under which the government will be assigned 80 kilocycles in the 46-50 megacycle area for ionospheric scatter operations, and non-government land mobile users will receive 1200 kc of space in the 150.8-152 mc band. The ODM emphasized that, in the selection of the bands, "extreme care was taken to avoid interference with the television broadcast service." It stated that "protection to this service is provided for, and encroachment on television service is not contemplated."

REDUCED COMPETITION—The Justice Department is opposing the lease-maintenance tariffs of the American Telephone and Telegraph Co. for private mobile radio telephone systems and microwave networks and the Bell System has countered that the Department's argument, if accepted, would result in reducing competition by eliminating entirely the services by the telephone companies. The AT&T stressed that, although important governmental, safety, utility and business organizations "have found it advantageous to obtain their private mobile radiotelephone systems" from the telephone companies, the latter furnish considerably less than 5% of the radio stations in all private mobile systems now in use. The Bell System also brought out that the telephone companies would furnish the mobile services under regulated tariffs which would in no way result in any compulsion on the public to obtain their systems from the telephone companies.

USAGE ASSIGNMENTS NOT NEEDED—Reports that it might be necessary to make usage assignments over the backbone routes of the Bell System's intercity television transmission network were put to rest recently by the American Telephone and Telegraph Co., Long Lines Department. No allocation, it was announced, will be required after consideration of network TV channel needs. The earlier reports had indicated that usage allocation might be required because of the growing need for TV channels, differences in time zones, growth of the American Broadcasting Co. network and a large increase in coverage planned by the Sports Network. The intercity TV network system now reaches 487 stations in 332 cities over 77,000 channel miles.

TAX RULINGS—The Internal Revenue Service has ruled that the manufacturers' excise levy on radio and television sets does not apply to sales of equipment for a radiopaging system, and the components for such a system are not taxable. In addition, the IRS ruled that a nonprofit organization providing and maintaining a two-way radiotelephone system for its members on a mutual or cooperative basis qualifies for exemption from federal corporation income tax. Excise exemption for radiopaging equipment comes under the provision of law exempting non-entertainment radio equipment.

MEDICAL RADIO USES—The need for adequate two-way mobile radio facilities among the nation's physicians, in both urban and rural areas, is being stressed by the American Medical Association. Its newly-formed communications committee is conducting an intensive education program among appropriate government agencies and physicians throughout the country. At the same time RCA Chairman David Sarnoff, in a recent address in Washington on future electronics developments, predicted the use of electronic medical diagnosis methods through computer devices that will aid doctors in determining illnesses of patients.

National Press Building
Washington 4

ROLAND C. DAVIES
Washington Editor

IMPROVED SENSITIVITY for 110-degree tubes...

There's more than meets the eye in this Stackpole Ceramag 110° yoke core. Molded as a solid piece, it is then cracked into halves so perfectly that the cracks defy detection. Thanks to this almost zero air gap, flux loss is at a minimum . . . sensitivity greatly increased.

And . . . to save weight and material costs, the neck is flared rather than molded into the cylindrical shape of conventional yoke cores.

BRIGHTEN the TV PICTURE with

STACKPOLE *Ceramag*

FERROMAGNETIC CORES

HIGHER VOLTAGES at lower cost

Boosting flyback voltages while shrinking transformer size and cost have been Ceramag specialties since Stackpole pioneered the use of ferrite-cored flybacks in 1946. Now, higher efficiency Ceramag grades in shapes and sizes to meet your requirements, set the pace in terms of greater electrical and mechanical uniformity.

ELECTRONIC COMPONENTS DIVISION

STACKPOLE CARBON COMPANY • St. Marys, Pa.

Circle 44 on Inquiry Card, page 101

Meteor Trails

(*Continued from page 88*)

register, each gate opens or remains closed. If it opens, the pulse is allowed to pass, amplified, and fed to the corresponding matrix on an inhibit line. This line traverses every core, but in such a manner that the half-current pulse it carries will subtract from the half-current pulses on the X and Y lines and prevent switching of the core.

The WRITE operation is essentially identical with the READ operations except that the inhibit gates are inoperative and the X and Y pulses now take a reverse polarity. Each core switched during the READ operation will now be switched back and switching signals will be generated. These signals are detected by the WRITE line in each matrix, a line which also traverses every core. The signals are then amplified and fed to the output shift register.

The memory used in this system is capable of storing 240 complete characters, the equivalent of 40 seconds of normal teletype speed.

The Voice System

In the design of the initial voice system equipment it was decided to limit the transmission bandwidth to a maximum of 20 KC. For this reason SSB modulation is used and the voice information is transmitted during bursts at five times the normal rate, the actual bandwidth of the transmitted signal being 16.5 KC.

A block diagram of the voice system is shown in Fig. 26. A closed loop circuit similar to that used in the teletype system is employed to detect a useful meteor path and to relay control information to T. A one-kw SSB transmitter at T sends out a continuous 100 watt recognition signal. When a path exists, this signal is received at R by a duplicate of the FSK teletype receiver. When the receiver output indicates an acceptable signal level a link control signal is generated which signals T to begin sending information. The return control link from R to T utilizes the same equipment as the teletype system; a two-kw FSK transmitter at R and an FSK receiver at T. A shift in frequency of the signal transmitted from R, initiated by the link control signal, is detected at T and information transmission from T is started.

The spoken message goes into a microphone at T and thus enters the system. The microphone output is fed to a magnetic tape storage unit and recorded and stored on a continuous loop of magnetic tape. When T is signalled to transmit information, the recorded voice signal plays back at five times the recording speed and feeds into the SSB transmitter. After playback the tape is erased and stored in a bin for further recording. The transmitter radiates a single sideband having a bandwidth of 15 KC and conveying normal voice frequencies from 300 to 3300 CPS multiplied by five.

When transmission of this signal is started, the 100-watt recognition signal is shifted 2.5 KC to a frequency corresponding to the carrier frequency of the voice sideband. This shift is detected by the FSK receiver at R and a signal generated which

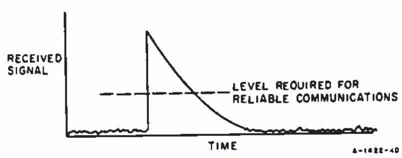


Fig. 31: A typical meteor-reflected signal

starts a second magnetic tape storage unit. The voice sideband is received at R with the same preamplifiers and first converter used with the FSK receiver. After conversion the voice signal is amplified in a special wideband i-f amplifier and demodulated by a product detector. The audio output from the detector is fed to the magnetic tape storage unit. The fast-speed voice signal from the detector is recorded on a continuous loop of recording tape and played back at one-fifth the recording speed to produce a normal-speed voice output signal. This signal is fed to an audio amplifier and loudspeaker for aural monitoring and to a standard tape recorder for permanent recording of the voice information.

The SSB transmitter at T consists of an exciter, a power converter, and a one-kw linear power amplifier. The linear amplifier utilizes 4X250B power tetrodes in a push-pull-parallel Class B_I circuit. The exciter uses the Weaver method of SSB generation.[1]

The operating frequencies of the transmitters at T and R are the same as the teletype system frequencies. Also, the same antennas are used for both systems.

Magnetic Tape Storage Units

The magnetic tape storage unit at R is the same unit used with the teletype system at R except that the speed ratio between the record and playback operations is now 5:1, the playback tape speed being changed to 9.6 IPS.

System Results

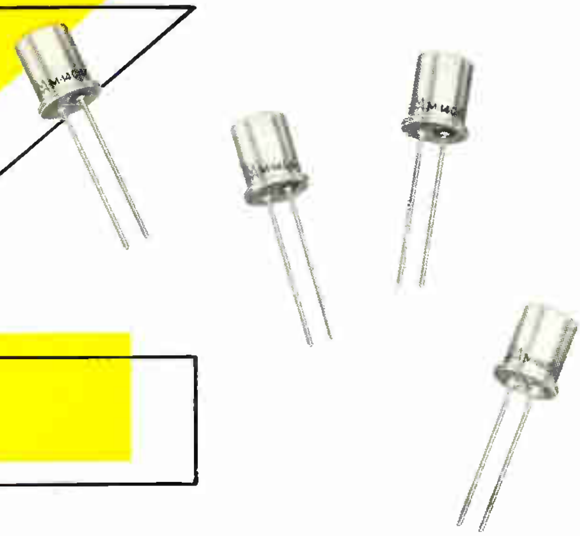
Operation of this system to date has definitely proved the feasibility of long range VHF communications via meteor-reflected signals. Reliable teletype and voice messages have been consistently received and much insight into both the theoretical and, more particularly, the practical aspects of meteor-burst communications has been gained. As the propagation method became more familiar, improvements in the system and its operation have continually been made. Additional improvements can of course be achieved, particularly in the overall communication rate and reliability.

Acknowledgements

The authors wish to acknowledge the many contributions to the success of this project by the Special Techniques Group at Stanford Research Institute, under direction of Dr. A. M. Peterson. Special thanks are owed to Prof. D. K. Weaver and his staff at Montana State College for efficient operation of the transmitting terminal and for his assistance in the preparation of this report.

The work described in this paper was sponsored by the Air Force Cambridge Research Center, Contract No. AF 19 (604)-1517.

1. D. K. Weaver Jr., "A Third Method of Generation and Detection of Single-Sideband Signals," Proc. IRE, vol. 44, pp. 1703-1705 (December 1956).



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MOTOROLA M14 MAXIMUM RATINGS
(25°C to 75°C Ambient)

TYPE NUMBER*	M14A2 M14C2	M14A3 M14C3	M14A4 M14C4	
Peak Inverse Voltage	200	300	400	volts
D C Rectified Current	500	500	500	ma
Surge Current For 2 Milliseconds (Square Wave)	35	35	35	amps
Surge Current, One-Half 60 Cycle—Sine wave Repetitive	5	5	5	amps
ELECTRICAL CHARACTERISTICS	**25°C**	**75°C**		
Typical Forward Voltage Drop at 0.5A	.80	.72		volts
Typical Reverse Current @ Maximum Rated Voltage	.10	10		μA
Maximum Forward Voltage Drop at 0.5A	1.0			volts
Maximum Reverse Current @ Maximum Rated Voltage	.05	.5		ma

*Units having anode connection to case designated as M14A. Units having cathode connected to case designated as M14C. Numerical suffix indicates peak inverse voltage

FOR COMPLETE INFORMATION concerning The M14 Silicon Power Rectifier write, wire or phone Motorola, Inc., 5005 East McDowell Road, Phoenix, Arizona. BRidge 5-4411.

provides more efficient conversion with less power consumption

- Extremely uniform forward characteristics. Internal power dissipation decreases as temperature increases
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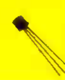
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Circle 45 on Inquiry Card, page 101

MICROWAVE PROGRESS

Signal Sources and Receivers

What a tankful of gasoline is to the automobile, the klystron tube is to the microwave system — a reliable and efficient power source.

Internal and external cavity type klystrons are used in PRD microwave oscillators. Both types belong to the reflex klystron group which is usually preferred because it provides easy tuning over a relatively wide frequency range and easy frequency or amplitude modulation.

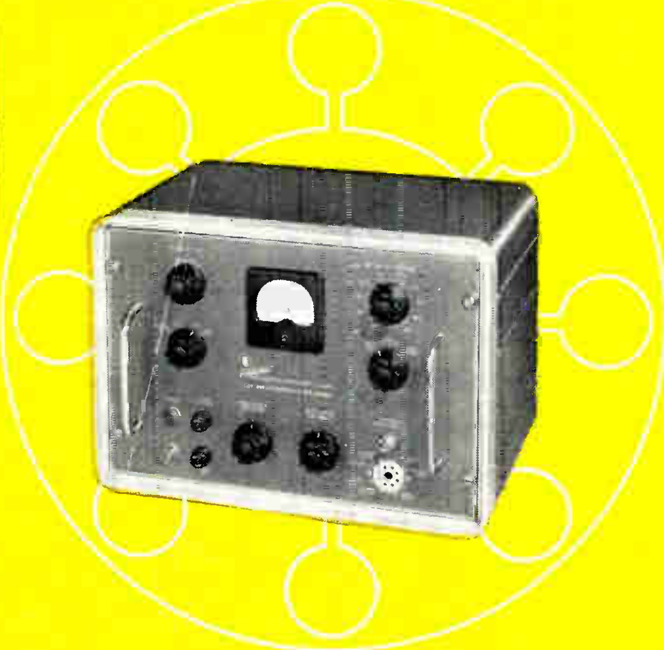
The coaxial cavity is most often used for broadband oscillators since its principal mode is the *TEM*. This permits greater frequency coverage than either the *TE* or *TM* modes of rectangular waveguide sections.

PRD's line of signal sources is conveniently operated through the use of PRD Klystron Power Supplies. Electronically regulated beam, grid, and reflector voltages provide extremely stable klystron output signals.

A spectrum analyzer is a special type of self-contained receiver. It presents an instantaneous display of the power spectrum of the input r-f pulse on an oscilloscope screen. Basically, it is a superheterodyne receiver with a frequency modulated local oscillator.

While the analyzer delivers an accurate envelope of the pulse frequency spectrum, it does not necessarily display each frequency component, since the frequency separation between adjacent spectral lines on the screen is a function of the local oscillator sweep rate, f_S, as well as the PRF, f_R. Actually, the number of lines produced on the screen is f_R/f_S. By varying f_S, the operator can control the spectrum detail presented.

Data such as that contained in the foregoing paragraphs are available in our PRD Reports. Published periodically, these reports give practical information on virtually every aspect of microwave research and engineering. Mathematical derivations, graphs, and charts are always included. If you'd like to receive these reports (there's no charge of course), we'll be happy to add your name to our mailing list. Please address your request to: Reports Dept. 20.



PRD Klystron Power Supply for low and medium voltage klystron tubes

Three Protective Devices Prevent Klystron Burn-out!

Another first from PRD. A compact, easily transportable klystron power supply that provides: a protective diode to safeguard the reflector against turning more positive than the cathode; a fuse in the klystron cathode return to protect the beam supply; and a "Beam Off" position to allow for warming up of the klystron filament.

A special feature of Type 809 Klystron Power Supply eliminates readjustments when changing from cw to square wave modulation. The top of the square wave is automatically clamped to the previously chosen reflector voltage.

With good stability and regulation, and with square wave and saw tooth modulation plus provision for external modulation, Type 809 Klystron Power Supply is equally at home in the laboratory or on the production line.

SPECIFICATIONS

	Type	Voltage (volts)	Current (milliamperes)	Additional Specifications
Output	Beam	Continuously variable 250 to 600	0 to 65	Ripple: < 5mv RMS
	Reflector	Continuously variable 0 to −900	50 μa max.	Ripple: < 10mv RMS
	Filament	6.3	2 amperes	±3% center tapped

	Type	Frequency Range (cps)	Nominal Voltage (volts)	Rise Time (microseconds)	Decay Time (microseconds)	
Modulation	Square Wave	400 to 2000	0 to 90	<10	<10	Clamping circuit maintains top of square wave within 2 V of cw reflector voltage.
	Saw Tooth	60 (fixed)	0 to 125			

Price — $350 f.o.b. Brooklyn, N.Y.

For additional details on PRD 809 Klystron Power Supply, contact your local PRD Engineering Representative or write to Technical Information Group, Dept. **20.**

PRD

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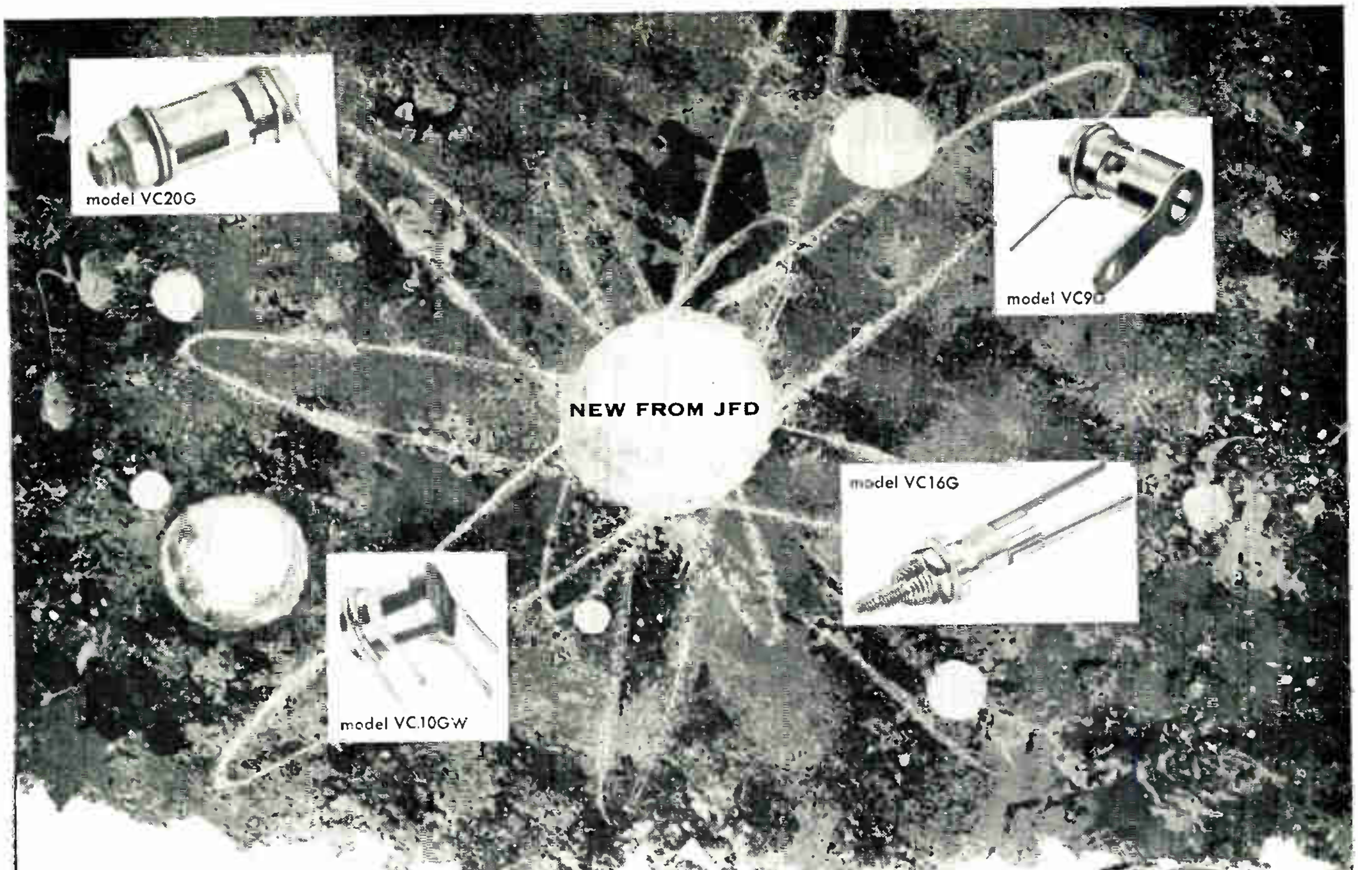

Trimmer Capacitors for Miniaturization and Subminiaturization

model VC10GW actual size

WHERE DESIGNS CALL FOR MAXIMUM RANGE IN MINIMUM PHYSICAL SIZE

VC9G Trimmer series (lug & lead type for printed circuits)

Model	Capacitance Range (MMF) Min.	Max.
VC9G	0.8	8.5
VC10G	0.8	4.5
VC31G	0.8	12
VC32G	0.8	18
VC42G	1	21
VC43G	0 8	30

VC9GW Trimmer series (4 wire type for printed wiring boards)

Model	Capacitance Range (MMF) Min.	Max.
VC9GW	0.8	8.5
VC10GW	0.8	4.5
VC31GW	0.8	12
VC32GW	0.8	18
VC42GW	1	21
VC43GW	0.8	30

VC20G Trimmer series (panel type)

Model	Capacitance Range (MMF) Min.	Max.
VC20G	0.8	8.5
VC21G	0.8	4.5
VC22G	0.7	12
VC23G	0.8	18
VC24G	1	30

These new miniature types incorporate the exclusive new JFD telescoping tuning assembly. Both the telescoping piston and self-contained adjustment shaft function as a low inductance coaxial assembly within the dielectric cylinder. This innovation makes possible a highly compact variable trimmer piston capacitor of minimum size for the given capacitance range—up to 50% reduction in overall length compared to previous similar types.

VC16G Split stator series (panel type)

Model	Capacitance Range (MMF) Plate to Plate Min.	Max.
VC16G	0.8	2.5
VC17G	1.1	4.5
VC18G	1.8	7.5
VC80	0.4	1.0
VC81	0.6	1.6
VC82	0.85	2.8
VC83	3.0	6.0

The new JFD Split Stator trimmer series was expressly engineered for critical push pull radio frequency circuits and similar sensitive networks. The extreme stability and low temperature coefficient of the quartz dielectric types recommend these trimmers for applications requiring extreme low-loss operation with maximum tuning resolution. Where maximum range for physical size is needed, you have your choice of the JFD glass dielectric solit stator type.

JFD keeps pace with new trimmer capacitors ready to meet new challenges. The result is today's JFD line of 42 Precision trimmers (the industry's largest) to meet your most critical network design and production needs.

Write for Bulletins 201A, 202A, 203A and 204A, for comprehensive electrical data on above JFD trimmers.

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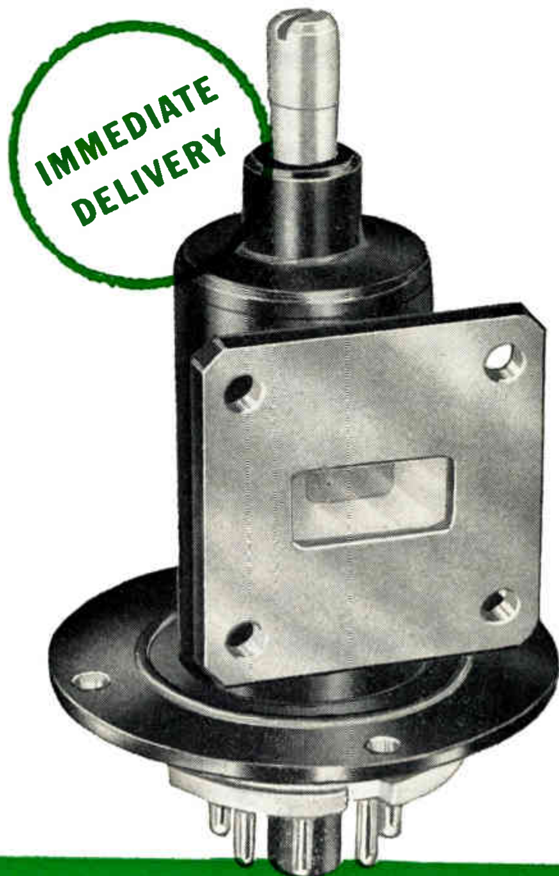
1462 62nd Street, Brooklyn 19, New York

Circle 47 on Inquiry Card, page 101

SRU-55 Series Klystrons give high power at low voltage

Small reflex oscillator klystrons for 14.5-17.0 kmc and 15.7-17.0 kmc



SRU-55 OPERATING SPECIFICATIONS		SRU-55A OPERATING SPECIFICATIONS
14.5 to 17.0 kmc	Frequency	15.7 to 17.0 kmc
300 v	Beam Voltage	300 v
45 to 75 mw	Output Power (optimum load)	40 to 45 mw
20 mw	Minimum Output Power	20 mw

Ready for immediate delivery are two Sperry K Band Klystrons. The SRU-55 and SRU-55A satisfy a multiplicity of requirements yet are manufactured with the economies of a single tube type.

The SRU-55 was developed primarily as a local oscillator in radar systems. Only $3\frac{13}{32}$" high and $1\frac{5}{16}$" in diameter, it couples rugged construction with superior vibration characteristics to withstand the severe environment of airborne applications for thousands of hours. The SRU-55 exhibits high frequency stability under abrupt changes in line voltage. Objectionable leakage has been controlled to eliminate need for external shielding. Other features include low voltage operation and ease of tuning over an extremely broad range with no appreciable hysteresis.

The SRU-55A was designed especially as a signal source for test sets like the AN/UPM-28-29. Other applications: local oscillator in microwave receivers and spectrum analyzers; low-power transmitting tube. Important features include minimum leakage and excellent test modes. Dimensions and operating features are similar to those of SRU-55. Write or phone your nearest Sperry district office for more details.

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PROFESSIONAL OPPORTUNITIES

Reporting late developments affecting the employment picture in the Electronic Industries

Design Engineers • Development Engineers • Administrative Engineers • Engineering Writers
Physicists • Mathematicians • Electronic Instructors • Field Engineers • Production Engineers

Layoffs Follow Cutback In RCA Defense Contracts

Officials of the Radio Corp. of America have confirmed reports that mass layoffs are now taking place at their Camden, N. J., plants as a result of cutbacks in defense work. Some reports indicate that the total of employees laid off may reach 700, but company officials insist that it will be lower.

Attempts are being made by RCA management to absorb the majority of the people affected by the cutback into commercial operations operated by RCA in the Camden area.

An RCA spokesman minimized the importance of the cuts. "The overall effect," he said, "is expected to involve less than 3% of the more than 12,000 persons employed in RCA's Camden plant."

Government Opens Tests To College Juniors

In order to improve its position in the competition for talented college people the Federal Government is now opening its Federal-Service Entrance Examination to college juniors as well as seniors, graduates and others of equivalent experience.

The first examinations will be held on November 16, with subsequent examinations in January, February, March, and May 1958. Government appointments run from 200,000 to 300,000 each year.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 103.

Engineer Shortage Continues, White House Aid Warns

A warning against "deluding ourselves into complacent thinking" that the skilled manpower shortage has been solved, "merely because cancellation of some defense orders has resulted in a temporary slackening of demand for engineers in the aircraft and electronics industries," was voiced by the Chairman of a White House Committee.

Dr. Howard L. Bevis, Chairman of the President's Committee on Scientists and Engineers, predicted that the scarcity of scientists, engineers and skilled technicians would continue to be a "national problem of major proportions at least until 1965.

"We must seek ways of closing the gaps in our manpower ranks. One immediate solution is represented by the graduates of two-year technical institutes. Expert technicians from these institutions, properly utilized, can release scarce scientists and engineers from routine duties and permit our existing supply of professionals to make maximum creative use of their training.

"The following program is now going into effect:

"1. Technicians in the Federal Government will get new status and responsibility through a reorganization of Civil Service job descriptions recently put into practice.

"2. Accrediting standards for technical institutes are being developed by five out of six regional accrediting organizations so graduates of technical schools will acquire new prestige.

"3. The Dictionary of Occupational Titles—'Bible' of job classification—is being supplemented by the Department of Labor to cover

(*Continued on page* 114)

DISTRIBUTION OF ENGINEERS

Approximately 8% of Korean veterans entering college major in engineering. Here is the breakdown.

Electrical Engineering	37,902
Mechanical Engineering	16,946
Civil Engineering	9,278
Industrial Engineering	5,707
Chemical Engineering	4,935
Aeronautical Engineering	3,123
Agricultural Engineering	1,046
Mining Engineering	959

Figures were obtained from the Veterans Administration by the National Science Foundation and reported in their "Engineering and Scientific Manpower Newsletter."

Too Many Fail In Engineering Courses

Less than two-thirds of the freshmen who enroll in engineering complete the first year and many others fail to complete the four-year training. These are the findings at the Univ. of California.

One of the solutions being recommended is better aptitude tests, to go beyond the academic and mechanical aptitude presently given. Donald F. Harder, supervisor of testing and guidance, recommends "that some aspects of personality, such as interests and values, might also play an important part in the selection of engineering candidates."

The New E.E. Looks at Industry

A comprehensive, impartial survey reveals what electrical engineering seniors consider before they accept a position. Interesting statistical data will surprise both employers and educators.

By M. S. OLDACRE, Dr. JOHN D. RYDER, and Dr. S. REID WARREN, Jr.

THE continuing discussion about a shortage of engineers and scientists suggested that knowledge of the opinions of electrical engineering students about to graduate might contribute to a solution of the difficulty.

In April, 1955, Eta Kappa Nu Asso. sent questionnaires to 57 colleges in which it had chapters. The questionnaires were distributed to seniors and graduate students; they asked for facts and opinions about employment plans.

Completed questionnaires were received from 930 students in 45 colleges. The results were analyzed by Stanford Research Institute (SRI), and presented in a report entitled Employment Plans of Electrical Engineering Graduates.[1]

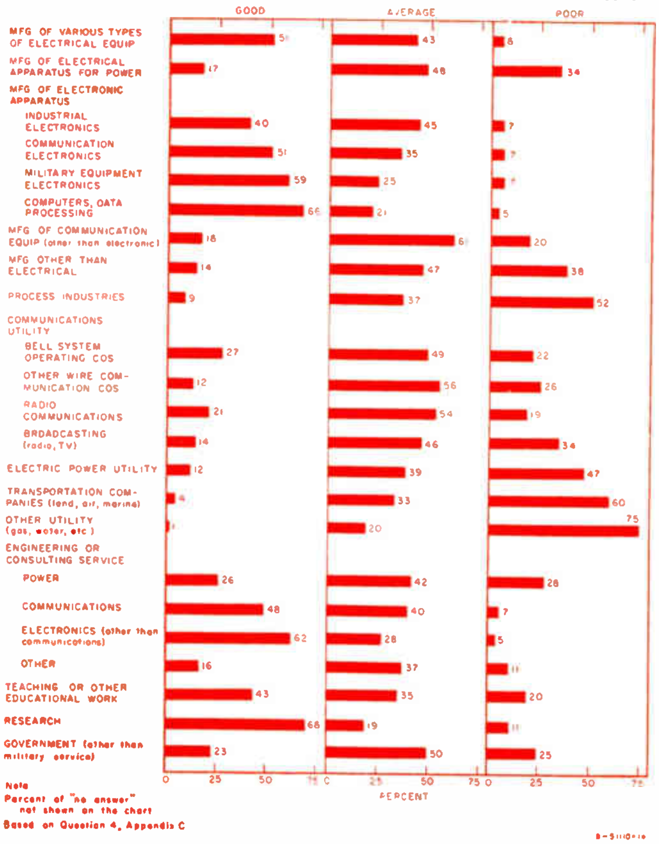
Survey Interest

The results of the 1955 survey aroused interest among diverse groups. There were discussions of the results in meetings of national committees of several professional societies.

A paper[2] based upon the data of the survey was presented to the AIEE in New York, February 2. 1956. Editorial comment appeared in several pro-

M. S. OLDACRE, Coordinator of Energy Research, Stanford Research Institute, Menlo Park, Calif., DR. JOHN D. RYDER, Dean of Engineering, Michigan State Univ., East Lansing, Mich., and DR. S. REID WARREN, JR., Vice President, Univ. Of Pennsylvania, Phila., Pa.

Fig. 1: Students' opinions of opportunities in various businesses.



fessional and trade journals. Eta Kappa Nu was urged to conduct a more comprehensive survey in 1956.

In response to the last suggestion, Eta Kappa Nu Asso., in cooperation with several AIEE and IRE committees and SRI, prepared a new and more extensive questionnaire and submitted it to the seniors and graduate students in electrical engineering of 145 colleges in March, 1956. The completed, useful questionnaires totaled 3433; they came from students in 129 colleges.

The 1956 survey was also conducted by SRI. In 1955, the cost of the survey was borne by SRI. In 1956 Eta Kappa Nu asked—by letters to the presidents of nearly 120 companies—that industry contribute to the cost of the survey. Generous contributions from a large fraction of the companies have provided funds for a majority of the costs of the survey.

Copies of the final report[3] prepared by SRI have been distributed to the companies that contributed to the cost of the survey, to the colleges from which information was obtained from students, and to officers of the cooperating societies and members of sponsoring committees.

Purpose of 1956 Survey

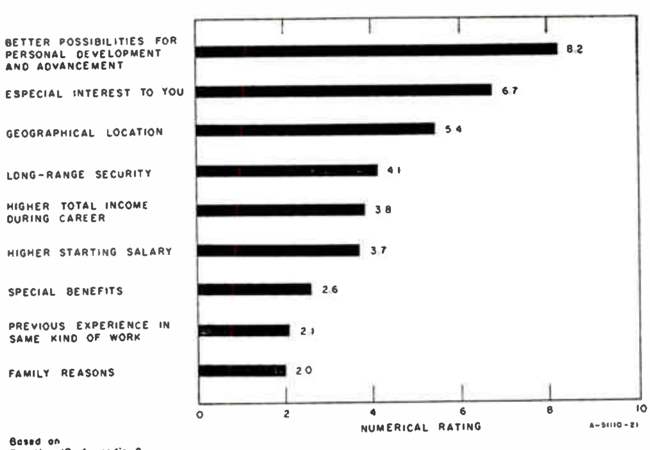
The primary purpose of the 1956 survey was to learn the reasons for the decisions of the members of the graduating classes regarding their employment. Information was requested regarding opinions about different kinds of business, different occupations, and the position actually accepted. Additional information was sought on many other items that might help in evaluating the strength or weakness of the engineering curricula and employers' personnel practices.

This article presents selected data from the Eta Kappa Nu 1956 survey, and comments critically on a few aspects of these data.

It should be noted at the outset that the number of respondents (3433) is approximately equal to 50% of the total graduates in electrical engineering in 1956. This is therefore a very large sample; nevertheless, those who did not respond may have had opinions different from those reported in this survey.

(*Continued on page* 156)

Fig. 2: Factors which influence a senior's choice of employment.



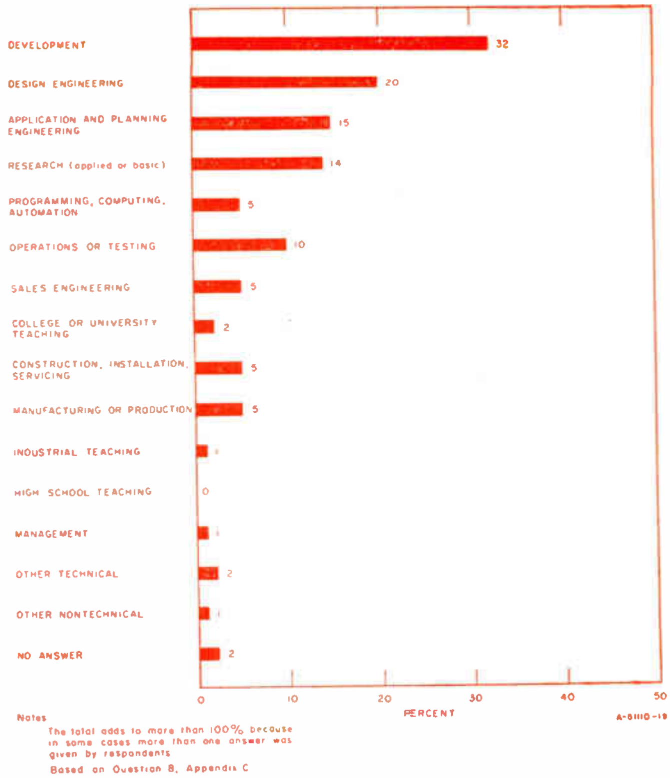
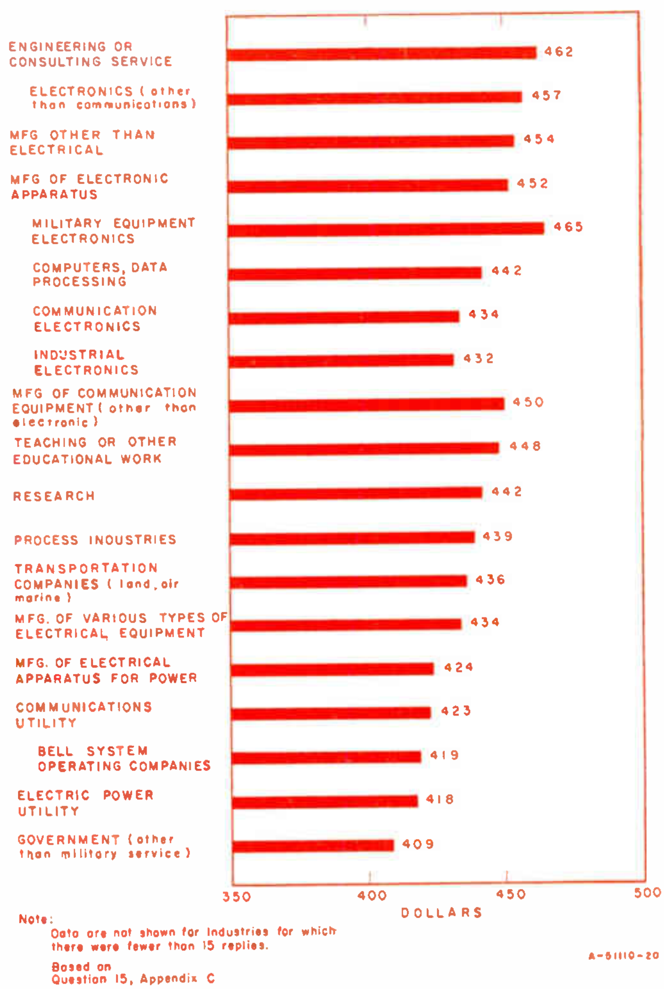
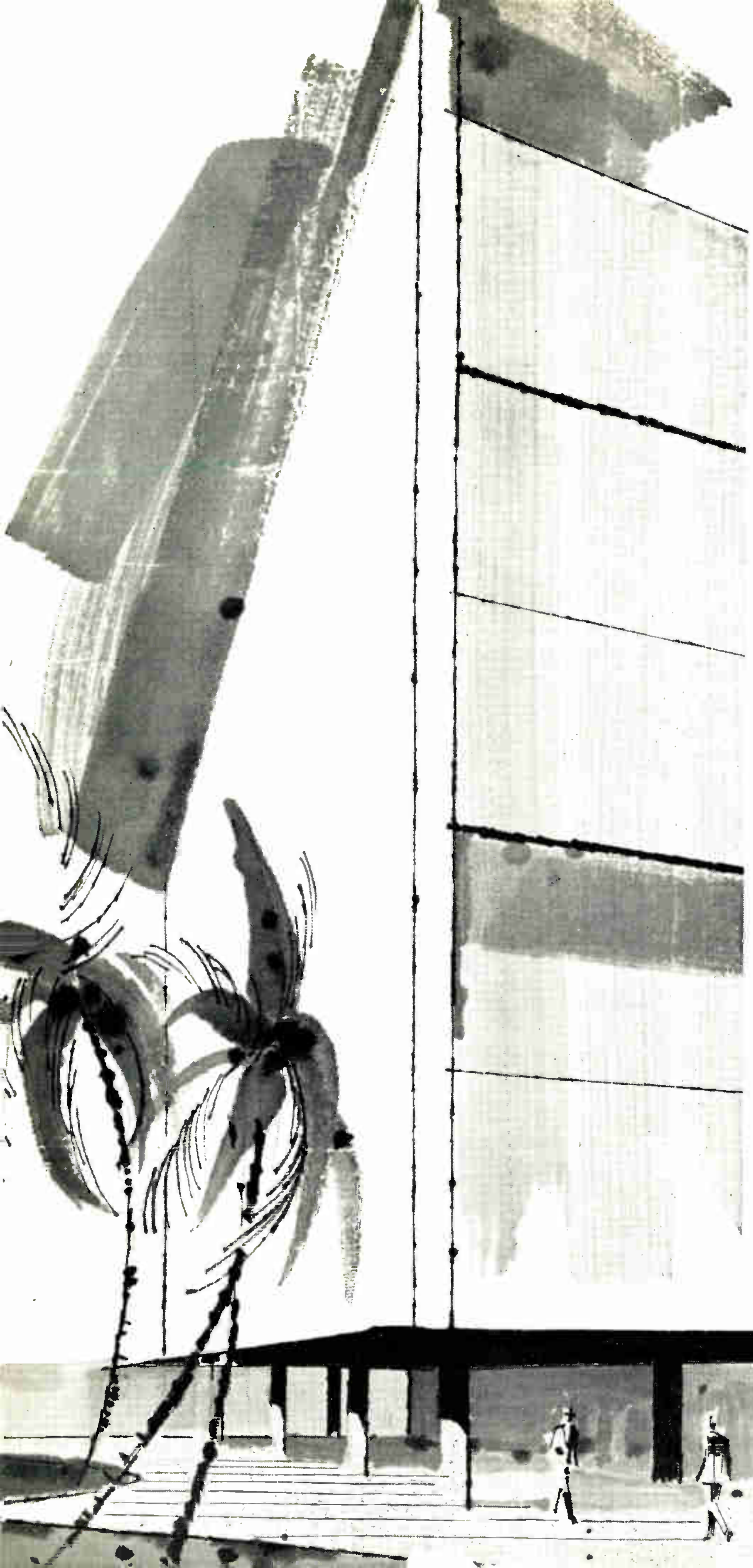


Fig. 3 (above): Choice of kind of position accepted by students.

Fig. 4 (below): Average monthly salary reported by job acceptees.





NEW HUGHES ELECTRONICS FACILITY SEEKS QUALIFIED ENGINEERS

Exclusive new Hughes developments such as three-dimensional radar systems and high-speed data processing systems promise to place Hughes foremost in the field of advanced electronics. For the purpose of furthering these exclusive developments, Hughes is establishing a new facility at Fullerton, California.

This newest facility of the Hughes Aircraft Company will be a completely integrated organization. It will encompass all activities . . . from development through manufacturing and Field Engineering. This growth presents a wide range of opportunity for present and prospective employees.

The new Ground Systems Division will focus its attention on complex electronic and electro-mechanical systems for ground and shipborne applications. These systems will be produced for the military and promise great commercial potential.

Engineers with experience in microwave, circuit design and systems design should apply by writing to the address below.

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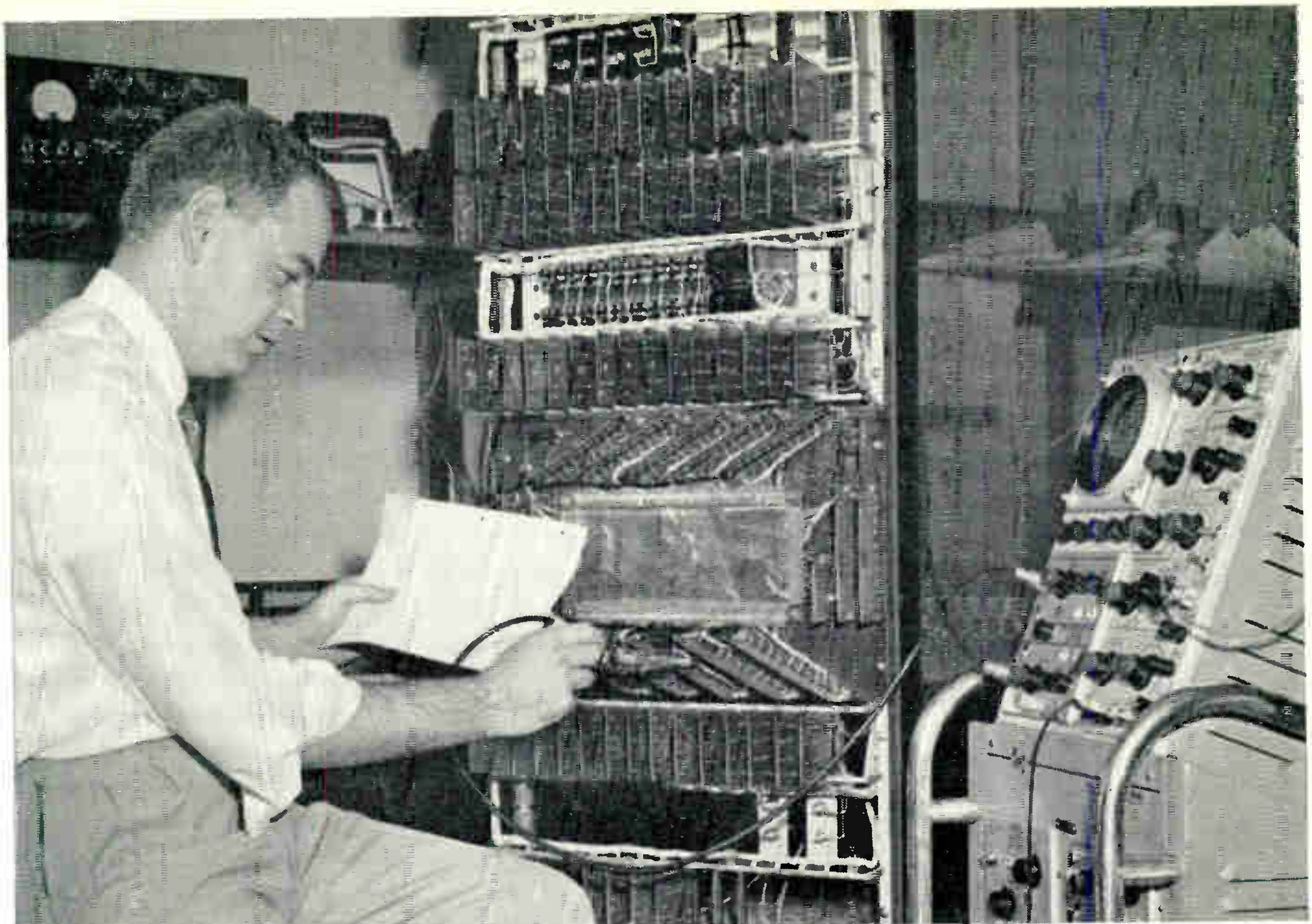
HUGHES

GROUND SYSTEMS DIVISION

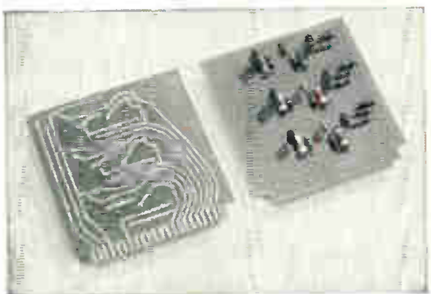
Personnel Selection and Placement

HUGHES AIRCRAFT COMPANY

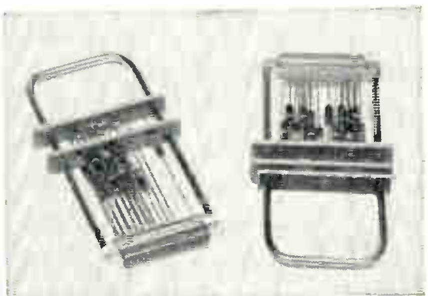
Fullerton, Orange County, California



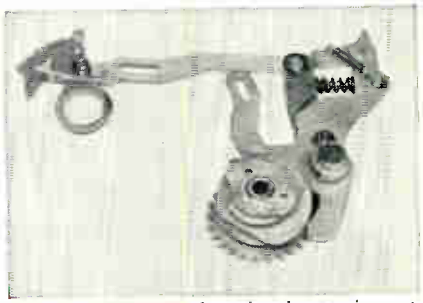
AN NCR ELECTRONIC ENGINEER checks the wave form of a transistorized magnetic core array tester.



TRANSISTOR printed circuit for digital computer development program.



MAGNETIC character recognition matrix for check sorters.



MECHANISMS for intricate in-put, out-put devices.

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Circle 501 on Inquiry Card, page 103

Circle 502 on Inquiry Card, page 103

Industry News

Loren E. Gaither has assumed the duties of Director of Communications Engineering for Philco G & I Division.

Alan H. Bodge has just been elected a Vice President of Audio Devices, Inc.

Charles B. Thornton, President of Litton Industries, Inc., has had an honorary LL.D. degree conferred upon him by Texas Tech for distinguished service to his country in the field of electronics.

A. Ross Simpson was recently named Engineering Manager of the Chicago Military Electronics Center, Motorola, Inc.

James K. Nunan was elected to the newly created post of Vice President—Electronics at Clevite Corp.

J. K. Nunan

C. S. Rockwell

Charles S. Rockwell will serve as President and General Manager of the Ford Instrument Co., succeeding the retiring Raymond F. Jahn.

Clarence A. Wetherill, the new Engineering Staff Specialist of Stromberg-Carlson, San Diego, formerly directed electronic development groups at Convair.

Edward R. Corvey . . . to the post of Assistant Group Executive for Business Operations of AMF's Defense Products Group.

Ezra Sheffers joined Ace Electronics Associates, Inc., as Department Head of the Methods and Quality Control Dept.

Dale V. Cropsey has assumed the duties of Vice President in charge of Industrial Divisions for Elgin National Watch Co.

George A. Baird . . . to the new post of Associate Director of Engineering, Burroughs Corp.

R. L. Beam has recently been elected the Executive Vice President for Engineering of Hazeltine Electronics.

Dr. James G. Buck is the new Director of Research and Development at Erie Resistor Corp. Dr. Buck comes to Erie from Sylvania Electric Products, Inc.

David R. Miller is the new Manager of the Computer Systems Laboratory at Colorado Research Corp.

(*Continued on page* 114)

Circle 505 on Inquiry Card, page 103

Industry News

(*Continued from page* 112)

Allen B. DuMont, Jr., is now Manager of the Receiver Div. of A. B. DuMont Laboratories, Inc.

Frank J. Delves and Eugene T. Ferraro have been appointed Director Sales and Director of Service, respectively, at Kearfott Co., Inc.

Dr. Lyman R. Fink has been appointed General Manager of the X-Ray Department, General Electric Co.

Dr. Victor B. Corey has assumed complete charge of Donner Scientific Company's marketing program.

Donald B. Otis will now serve as Director of Planning for IBM's Military Products Div.

George W. Hoffmeister has been named General Superintendent of Minneapolis - Honeywell Regulator Co.'s new plant at Fall River, Mass., which will produce electronic recording and controlling instruments for industrial use.

Frank J. Newman is now Marketing Manager for the Process Instruments Division, Beckman Instruments, Inc.


L. R. Fink


R. S. Mandelkorn


F. J. Newman


J. F. Nielsen

Rear Adm. Richard S. Mandelkorn, USN (Ret), has joined Philco Corp. as Manager of Operations for the Lansdale Tube Co.

Roy E. Wendahl has been named to the newly created post of Vice President of Sales at Hughes Aircraft.

John F. Nielsen heads the new Electronic Components Division of ESC Corp. Mr. Nielsen was formerly associated with A. B. DuMont Laboratories.

James B. Williams has been appointed Director of Weapon System Engineering, Philco G & I Division; **Herman A. Affel** becomes Director of Computer and Control Engineering; and, **John Colocousis,** Chief Mechanical Engineer.

Quentin G. Turner is now Assistant Manager for Organization at Motorola's Western Electronics Center.

Engineer Shortage

(*Continued from page* 107)

hundreds of hitherto ignored technician jobs.

"4. A nationwide series of 'Conferences on Utilization' now underway is driving home to industry leaders the potential value of technicians in solving their technological manpower problems.

"5. Enrollment and graduation statistics of the Nation's technical colleges and institutes are to be included in the U. S. Office of Education's annual survey, affording a more realistic picture of manpower resources.

"6. The United States Employment Service is helping to find qualified teachers for technical institutes, a prime problem facing such schools."

Circle 50 on Inquiry Card, page 101

 Circle 71 on Inquiry Card, page 101

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ups
and downs?

. . . if they involve Wire Wound Resistors

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All Dalohm products are carefully designed and skillfully made to assure you of supreme quality and dependability, plus the widest versatility of application.

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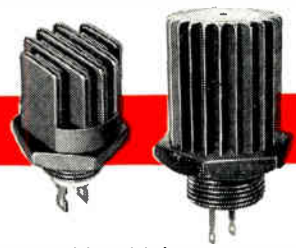
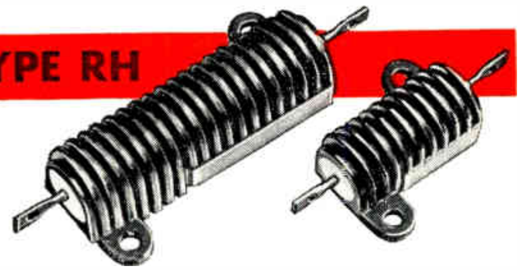


These Dalohm resistors combine high power rating with sub-miniature design. High heat dissipation and protective covering are achieved with vertical-finned black anodized aluminum housings. Vertical single hole panel mounting is provided by integral threaded base and lock nut. Ruggedized construction assures dependability under the most extreme conditions.

- Completely welded construction from terminal to terminal
- Silicone sealed for absolute protection against moisture, shock and salt spray
- Three wattages and sizes: PH-25, 25 watts; PH-50, 50 watts; PH-100, 100 watts
- Resistance values from 0.1 ohm to 60K ohms, depending on type
- Tolerances from 0.05% to 3%

Ask for Bulletin R-33

TYPE RH



Another Dalohm resistor that resolves power and space problems in tight specifications. Black anodized finned housing provides protection and maximum heat dissipation. Mounting lugs provided for horizontal mounting.

- Completely welded construction from terminal to terminal
- Silicone sealed for absolute protection against moisture, shock and salt spray
- Three wattages and sizes: RH-25, 25 watts; RH-50, 50 watts; RH-250, 250 watts
- Resistance values from 0.1 ohm to 100K ohms, depending on type
- Tolerances from 0.05% to 3%

Ask for Bulletin R-21C

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Circle 51 on Inquiry Card, page 101

100-VOLT TRANSISTOR...
New high power type available

Typical Characteristics at 25° C	DT100
Maximum Collector Current	13 amps
Collector Voltage, Emitter Open	100 volts
Saturation Voltage (12 amps)	0.7 volts
Power Dissipation	55 watts
Thermal Gradient from Junction to Mounting Base	1.2° °C/watt
Nominal Base Current I_B (V_{EC} = —2 volts, I_C = —1.2 amp.)	-19 ma
Distortion (Class A_1, 10 watts)	5%

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The electronics industry asked for a transistor to handle higher voltage—and here it is—Delco Radio's DT100 with maximum collector diode voltage of 100 volts. This is the highest yet, and it paves the way for a wide range of new applications. The new DT100 is an alloy junction germanium PNP transistor—normalized to retain its performance characteristics regardless of age. You can depend on the uniformity, reliability and high current handling capacity of the DT100, just as you have in the past on all of Delco Radio's High Power transistors. Write today for complete engineering data.

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Kokomo, Indiana

 Circle 72 on Inquiry Card, page 101

DOW CORNING CORPORATION

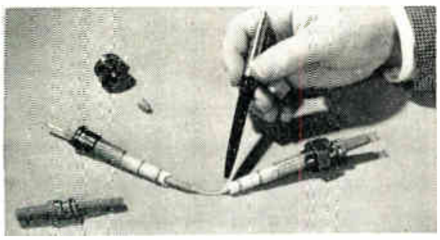
Silicone Dielectrics

ELECTRICAL AND ELECTRONIC NEWS No. 14

Silastic Withstands Heat and High Voltage on Spark Plug Lead

Selecting a rubbery insulating material that would withstand up to 15,000 volts at 400 F in aircraft spark plug lead assemblies posed no problem for design engineers at Scintilla Division, Bendix Aviation Corporation, Sidney, New York. Already familiar with Silastic*, the Dow Corning silicone rubber, they knew it has excellent resistance to moisture and retains good mechanical and dielectric properties even after prolonged exposure to heat and high voltages.

Actually, Scintilla uses Silastic in four different areas on the new Bendix lead: for the inner and outer layers of the cable; for the molded terminal insulators; and as an interlayer to separate the three courses of



braided metal sheathing. Interlaying the braided sheathing with Silastic not only keeps moisture out, but protects the sheathing against vibration to give it longer life.

The new Silastic insulated lead is now standard for the Wright turbo compound 18 cylinder, 3350 hp engine that powers the DC 7, the Super Constellation and various military aircraft. *No. 54*

*T. M. REG. U. S. PAT. OFF.

Dow Corning Silicone Lubricants, including oils and greases, are described in a new, illustrated 8-page brochure that gives their properties, lists their applications, and cites factors which contribute to obtaining longer life. *No. 55*

NEW SILICONE INSULATING RESINS FLOW FREELY WITHOUT SOLVENTS

Two new free-flowing, solventless silicone electrical resins are now available from Dow Corning in commercial quantities. Identified as R-7501 and R-7521, these 100% silicone resins are ideal for impregnating or encapsulating miniature and subminiature motors, transformers and other electrical and electronic assemblies.

Since both new resins pour freely, they quickly saturate and fill all voids in even the most complex assemblies, thus eliminating the problem of insulation punctures caused by escaping solvent gases. As shown in the photo, Dow Corning R-7521 is more fluid at room temperature and penetrates much deeper into 20-40 mesh sand than a conventional epoxy resin.

Both of the new resins cure to a strong, bubble-free mass having excellent dielectric properties, good thermal conductivity and high moisture resistance. When cured, they readily withstand continuous service at 400 F ambients and intermittent exposure to temperatures up to 500 F.

At room temperature the viscosity of R-7501 is 2500 centistokes and the viscosity of R-7521 is 100 centistokes. Either resin may be thinned by warming to 175 F. If desired, the resins can be blended together to obtain any intermediate viscosity.

The resins are cured by adding a peroxide catalyst and heating at temperatures up to 390 F. Shelf life of the uncatalyzed resins is well over a year; pot life of the catalyzed resins at room temperature is over six months. Dow Corning R-7501 and R-7521 can be used as received or combined with a wide range of inorganic fillers. *No. 53*

Silicone Insulated Motor Still on Test after 66,080 Hours at 240C

At 10 A. M., June 3, 1946, a silicone insulated 5 hp motor was generator loaded to operate at its test temperature of 240 C in Dow Corning's motor test labs. Every 500 hours since the test began, the motor has been shut down and exposed to 100% relative humidity for 24 hours. As of 11 A. M. August 1, 1957, this motor was still on test after 66,080 hours at an average copper temperature of 240 C! That's equivalent to 404 years operation at the Class H temperature of 180 C. *No. 56*

Silicone Materials in Appliance Design, a recent article in ELECTRICAL MANUFACTURING, lists a variety of applications for several different silicones in appliances; describes how silicones have made possible design changes heretofore impractical, and how they extend service life and dependability. To receive your copy, circle *No. 57*

Parts and components made with Dow Corning Silicone Molding Compounds are lightweight, show excellent resistance to heat, and have good structural and electrical properties. Used as brush holders, collector rings, terminal boards, multiple lead connectors, heat dams for turbine driven alternator bearings, and aircraft brake shoe backing. *No. 58*

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ANTENNAS, PROPAGATION

An Interferometer for Radio Astronomy with a Single-Lobed Radiation Pattern, A. E. Covington, and N. W. Broten. "IRE Trans. PGAP." July 1957. 9 pp.

Statistical Data for Microwave Propagation Measurements on Two Oversea Paths in Denmark, P. Gudmandsen, and B. F. Larsen. "IRE Trans. PGAP." July 1957. 5 pp.

Some Observations of Antenna-Beam Distortion in Trans-Horizon Propagation, A. T. Waterman, Jr., et al. "IRE Trans. PGAP." July 1957. 7 pp.

Back-Scattering Cross Section of a Thin, Dielectric, Spherical Shell, Mogens, G. Andreasen. "IRE Trans. PGAP." July 1957. 4 pp. The back-scattering cross section of a think, dielectric, spherical shell is calculated on the basis of simplified boundary conditions at the shell.

Serrated Waveguide—Part I: Theory, K. C. Kelly, and R. S. Elliott. "IRE Trans. PGAP." July 1957. 14 pp.

A Technique for Controlling the Radiation from Dielectric Rod Waveguides, J. W. Duncan, and R. H. DuHamel. "IRE Trans. PGAP." July 1957. 6 pp.

A Circularly-Polarized Corner Reflector Antenna, O. M. Woodward, Jr. "IRE Trans. PGAP." July 1957. 8 pp.

The Propagation of Electro-Magnetic Waves, G. Piefke. "Arc. El. Uber." Vol. 11. Issue 2. February 1957. 10½ pp. A disc line is a wave guide consisting of a stack of round copper discs and insulated from each other. The insulation is very lossy in order to strongly attenuate the radial waves. The propagation for various modes is evaluated and propagation constants are given.

Advances in the Field of Ionospheric Research and Propagation of Waves in the Troposhere, B. Beckmann. "Nach. Z." August 1957. 8 pp.

Posing the Problem in Periscope-Antenna Theory, B. E. Kinber, and A. M. Pokras. "Radiotek." July 1957. 11 pp. The paper examines certain problems which are involved in the solution of the direct and converse problems of periscope-antenna theory. Rational parameters are introduced, and the possibility of using geometric optics in the region occupied by the reradiator is demonstrated.

Terminated Circular Loop Aerial, S. Balaram. "E. & R. Eng." September 1957. 4 pp. The radiation field at any point in space due to a terminated circular loop aerial of any radius is derived for free space conditions, assuming an unattenuated traveling wave along the loop. The theoretical relative field intensity pattern in the plane of the loop has been verified experimentally for cases where the circumference of the loop is less than a wavelength.

> * Those articles marked with an asterisk are available as reprints to EI readers. Requests should be sent, on company letterhead, to Sources Editors, Electronic Industries, Chestnut & 56th Sts., Philadelphia 39, Pa.

A Method of Estimating the Power Radiated Directly at the Feed of a Dielectric-Rod Aerial, R. H. Clarke. "Proc. BIEE." September 1957. 4 pp. The present paper illustrated this representation in the case of a waveguide-fed dielectric-rod aerial of uniform rectangular cross-section for use at 3 cm wavelengths and shows its application to finding the fraction of the total power supplied to the aerial which is radiated at the feed. This fraction was found to be 23% when the dielectric rod had a rectangular cross-section of 0.9 in. x 0.4 in.

Tests with a Large Rhombic Antenna at the Transoceanic Radio Receiving Station Eschborn, J. Kronjager, E. Mark, and K. Vogt. "Nach. Z." August 1957. 3 pp. During the last years an improvement in quality of transoceanic radio services has been obtained by the use of large rhombic antennas. With the aid of simultaneous measurements with large rhombic antennas of normal size the actual advantages of large scale antennas are illustrated.

A Versatile Multiport Biconical Antenna, R. C. Honey, and E. M. T. Jones. "Proc. IRE." October 1957. 10 pp. A novel antenna system has been developed which can be used as a new type of direction finder or as a multiplexer at microwave frequencies.

AUDIO

***Reducing Magnetic Tape Print-Through, Frank Radocy.** "El. Ind." November 1957. 3 pp. Print-through, the layer-to-layer signal transfer of spooled magnetic tape, has placed a practical upper limit to tape sensitivity. Now however, improved production and quality control techniques make possible much lower print-through, with no sacrifice in other characteristics.

Transistorized RC Phase-Shift Power Oscillator, L. J. Giacoletto. "IRE Trans. PGA." May-June 1957. 4 pp.

Some Augmented Cathode Follower Circuits, J. R. MacDonald. "IRE Trans. PGA." May-June 1957. 8 pp.

Emitted Bypassing in Transistor Circuits, R. P. Murray. "IRE Trans. PGA." May-June 1957. 2 pp.

CIRCUITS

Certain Probl ms of Applying Fourpole Theory to the Design of Transistor Circuits, Kh. I. Cherne. "Radiotek." July 1957. 10 pp. Relationships are derived which simplify the utilization of the derivations and formulas of general fourpole theory in the design of

REGULARLY REVIEWED

AEG Prog. AEG Progress
Aero. Eng. Rev. Aeronautical Engineering Review
Ann. de Radio. Annales de Radioelectricite
Arc. El Uber. Archiv der elektrischen Ubertragung
ASTM Bul. ASTM Bulletin
Auto. Con. Automatic Control
Auto. El. The Automatic Electric Technical Journal
Avto. i Tel. Avtomatika i Telemakhanika
AWA Tech. Rev. AWA Technical Review
BBC Mono. BBC Engineering Monographs
Bell Rec. Bell Laboratories Record
Bell J. Bell System Technical Journal
Bul. Fr. El. Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Comp. Computers and Automation
Con. Eng. Control Engineering
E. & R. Eng. Electronic & Radio Engineer
Elek. Elektrichestvo
El. Electronics
El. & Comm. Electronics and Communications
El. Des. Electronic Design
El. Energy. Electrical Energy
El. Eng. Electronic Engineering
El. Eq. Electronic Equipment
El. Ind. ELECTRONIC INDUSTRIES & Tele-Tech
El. Mfg. Electrical Manufacturing
El. Rund. Electronische Rundschau
Eric. Rev. Ericsson Review
Freq. Frequenz
GE Rev. General Electric Review
Hochfreq. Hochfrequenz-technik und Electroakustik
IBM J. IBM Journal
Insul. Insulation
IRE Trans. IRE Transactions of Prof. Groups
Iz. Akad. Izvestia Akademii Nauk SSSR
J. BIRE. Journal of the British Institution of Radio Engineers
J. ITE. Journal of The Institution of Telecommunication Engineers
J. IT&T. Electrical Communication
J. UIT. Journal of the International Telecommunication Union
Nach. Z. Nachrichtentechnische Zeitschrift
NBS Bull. NBS Technical News Bulletin
NBS J. Journal of Research of the NBS
NRL. Report of NRL Progress
Onde. L'Onde Electrique
Phil. Tech. Philips Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers
Proc. BIEE. Proceedings of the Institution of Electrical Engineers
Proc. IRE. Proceedings of the Institute of Radio Engineers
Radiotek. Radiotekhnika
Radio Rev. La Radio Revue
RCA. RCA Review
Rev. Sci. Review of Scientific Instruments
Rev. Tech. Revue Technique
Syl. Tech. The Sylvania Technologist
Tech. Haus. Technische Hausmitteilungen
Tech. Rev. Western Union Technical Review
Telonde. Telonde
Toute R. Toute la Radio
Vak. Tech. Vakuum-Technik
Vide. Le Vide
Vestnik. Vestnik Svyazy
Wire. Wld. Wireless World

For more information, contact the respective publishers directly. Names and addresses of publishers may be obtained upon request by writing to "Electronic Sources" Editors, ELECTRONIC INDUSTRIES & Tele-Tech, Chestnut & 56th Sts., Philadelphia 39, Pa.

transistor circuits. Specific examples of design procedure and computation are given.

Duplexer for High Power, L. Milosewic. "Vide." Vol. 12. No. 67. 1957. 7½ pp. Described is the design of a duplexer for the 10 cm band which was tested with peak powers of up to 30 megawatts, and an average power output of 10 kw.

Interconnection of Two N-Terminal Networks, W. Ruppel. "Arc. El. Uber." Vol. 11. Issue 1. January 1957. 2 pp. It is shown how a scattering matrix of two N-terminal networks made up of two parts can be determined if the matrices of the two partial N-terminal networks are known.

Exponential Pulse-Time Converters, A. I. Novikov. "Avt. i Tel." August 1957. 7 pp. The basic relationships which govern exponential pulse-time converters are analyzed. Descriptions are given for converter circuits and for a multi-channel pulse telemetering system with exponential converters and no commutator.

Low-Noise Stabilized D. C. Supplies, D. W. W. Rogers. "E. & R. Eng." September 1957. 7 pp. The special precautions and wiring are described which are necessary to eliminate the various forms of hum injection into power-unit feedback amplifiers, and a representative type is explained having very low hum and drift. A novel three-valve stabilized supply is also described.

Calculation of Current Distribution in the Linear Network, J. Vratsanos. "Arc El. Uber." Vol. 11. Issue 2. January 1957. 4½ pp. analyzed is the current flowing through a linear network with a terminal impedance.

A Discussion of Crystal Oscillators, G. Becker. "Arc. El. Uber." Vol. 11, Issue 1. January 1957. 7 pp. Most crystal oscillators can be reduced to two basic arrangements; namely, the series resonant, and the parallel resonant respectively. The conditions for obtaining resonance are analyzed.

Oscillators Unaffected by Local Impedance, W. Herzog, and E. Frische. "Nach. Z." August 1957. 1 pp. Oscillator circuits are investigated the frequency of which is not affected by load impedances. Amongst other details such circuits without requiring transformers and with grounded cathodes as well as grounded loads are mentioned. Measurements have revealed that the frequency pullings in the order of 0.1% of any capacity, inductive or resistive loading on the oscillator.

Certain Properties of Thermistor Circuits, G. K. Nechaev. "Avto. i Tel." August 1957. 9 pp. An analysis is made of the temperature dependence of the conductance and resistance of two-terminal networks which contain thermistors. Derivations are made of the conditions governing the attainment of these functions in a linear approximation. A method is given for computing the temperature compensator required for linear resistances.

The Utilization of Step Filters for Correcting the Transient Response of Linear Systems, V. I. Gukov. "Radiotek." July 1957. 12 pp. The paper examines analytical and graphical methods for designing linear corrective networks—step filters—which are based upon the utilization of lag elements. The cascade connection of a step filter and a linear system which can be described by an equation of arbitrary order makes it possible to eliminate transients within a specified time interval.

Designing Transistor Circuits — Sinusoidal Transistor Oscillators, Part I, R. B. Hurley. "El. Eq." September 1957. 6 pp.

Magnetic Switching Circuits for the Representation of Logical Relationships, H. Gillert. "Nach. Z." August 1957. Magnetic switching circuits are described which can be used for producing logical relationships by superpositions of positive and negative magnetic fields of different amplitudes. The known "and" and "or" operations are special cases of a multitude of possible operations. The number of magnetic cores in a circuit and the number as well as type of turns on the individual cores for a given circuit function are derived from general design principles. A minimizing method leads from a given circuit reported method are investigated and stated. The results of a systematic investigation for a circuit function containing 2 and subtracting network is given as an example.

Audio Amplifiers with Single-Ended Push-Pull Output, J. Rodrigues de Miranda. "Phil. Tech." August 24, 1957. 9 pp. This article deals with a new transformerless circuit for the last two stages of audio-frequency amplifiers which differs appreciably from the conventional one and can satisfy far higher demands. No expensive components are required to replace the transformer.

Transient Response of "Comb" Filters, M. I. Finkelshtein. "Radiotek." July 1957. 7 pp. The paper examines the effect of a unit-step harmonic voltage upon a system of "comb" filters. A method is proposed for determining the shape of the transient and the time required for a steady state to be reached. It is proven that the initial slope of the transient is directly proportional to the number of filters.

An Improved High-Gain Panel Light Amplifier, B. Kazan. "Proc. IRE." October 1957. 7 pp. This paper reports on some substantial improvements that have been made since the first experimental model was announced two years ago.

Parametric Excitation Using Barrier Capacitance of Semi-Conductor, Kiyasu Zen'iti, et al. "J. IECE. of Japan." February 1957. 8 pp. In this paper, several characteristics of the parametron using the barrier capacitance of semi-conductor in place of inductive reactance are described, especially in the case of germanium junction diode. In this case, the operating frequency range can be improved and consuming power may be reduced.

The Design of Circuits for Shaping Rectangular Pulses, P. N. Matkhanov. "Radiotek." July 1957. 7 pp. Design computations are given for a circuit which shapes rectangular pulses. The computation is based upon synthesizing the circuits from time functions. An approximation is made in the complex frequency domain by representing hyperbolic functions in terms of the first factors of infinite products. The method of computation is simple and takes the load capacitance into account. Results of an experimental investigation of the shaping circuit are given.

RC and LC Resonance Filters and their Application in Selective Amplifiers, H. H. Rabben. "El. Rund." September 1957. 4 pp. In the development of a narrow band amplifier with a resonance frequency of appr. 200 cps investigations have been carried out into the suitability of various type filters. To ease the selection of appropriate band filter circuits a summary of the results of this investigation is given. The various filter circuits and their data are specified and compared; applications of RC filters in resonance or narrow band amplifier is considered in detail.

Calculation Directions for Flip-Flops, G. Thiele. "El. Rund." September 1957. 3 pp. In the present conclusion of the article the various kinds of triggering are considered. As practical examples complete calculations are given for a rectangular pulse generator and a frequency-dividing stage.

Approximation of the Transfer Characteristic of the Parallel-T RC Network, Minoru Higashiguchi. "J. IECE of Japan." May 1957. 5 pp. This paper presents an approximation method for the analysis of the network.

Slow-Wave Circuit of Cascaded Annular Discs, Kiyoshi Morita, et al. "J. IECE. of Japan." April 1957. This paper describes the theoretical study on the phase constant and the impedance parameter of this circuit and about the experiments with results.

COMMUNICATIONS

***VHF Propagation by Ionized Meteor Trails,** W. R. Vincent, et. al. "El. Ind." November 1957. 7 pp. Part one of this report summarized basic data for the design of a successful Meteor Burst System. Now, in part two the authors describe the 820-mile VHF line operating between Bozeman, Montana, and Palo Alto, Calif. The over-all teletype and voice systems are described together with the special system components developed for this type of communication.

***A Guide to Radio Station Design,** Adron Miller, and Paul A. Greenmeyer. "El. Ind. Ops. Sect." November 1957. 5 pp. A new kind of radio broadcasting has evolved during recent years, and with it have come new studies and equipment designed for the modern, fast-moving radio broadcasting format. The present resurgence of radio lends special significance to the "optimized" studio designs presented here.

***Line Amplifiers with ACC,** A. A. McGee, Jr. "El. Ind. Ops. Sect." November 1957. Operations Section. 3 pp. Now with an automatic level control amplifier preceding your limiting amplifier gain riding becomes an occasional adjustment.

Single Sideband Links Canadian Traders, S. G. L. Horner, et. al. "El." October 1957. 3 pp. Radiotelephone network connects isolated fur-trading posts located throughout northern Canada.

Tape Recorder Selects Radio Announcements, D. V. R. Drenner. "El." October 1957. 2 pp.

A History of Some Foundations of Modern Radio-Electronic Technology, J. H. Hammond, Jr. and E. S. Purington. "Proc. IRE." September 1957. 18 pp. The authors describe for the first time important pioneering work carried out in the Hammond Laboratories during the period 1912-1928 which, because of its military nature, has not previously been disclosed. This work, which began with radio-controlled torpedoes and ships, let to a number of notable original developments in the realm of control and homing devices, nondetector applications of the triode, intermediate-frequency type systems and FM and related circuitries, which in retrospect could be viewed as the precursors of many of our modern radio-electronic techniques.

The Digital Answer to Data Telemetering, E. A. Ragland, and D. E. Wassall. "Con. Eng." August 1957. 7 pp. The characteristics and requirements of digital data transmission systems are discussed in this article from the vantage-point of long experience.

You Can Communicate More Skillfully, C. A. Church. "G.E. Rev." September 1957. 3 pp. To effectively gain cooperation of people, put yourself in their place. Then orient your message to their needs and interest, making your pitch short and to the point by appropriate techniques.

Scatter Propagation in Thunderstorm Conditions, W. S. Ament, et al. "NRL." August 1957. 9 pp.

The Stereosonic Recording and Reproducing System, H. A. M. Clark, et. al. "Proc. BIEE." September 1957. 16 pp. The paper reviews briefly the history of stereophonic reproduction. The principal basic systems with their underlying ideas are described and compared. Some account is given of the supposed mechanism of natural binaural listening from the viewpoint of direction localization.

Single-Side Band Communication in Aeronautics, M. Marquis. "Onde." Vol. 36. No. 363. June 1957. 3 pp. An airborne SSB transmitter-receiver equipment is described with only 10 watt transmitter power. The equipment provides reliable communication over several hundred kilometers. Details on operation and performance are given.

Characteristics of H. F. Signals, A. F. Wilkins, and F. Kift. "E. & R. Eng." September 1957. 7 pp. Measurements at various daytime periods between October 1952 and January 1954 of the angles of elevation of (a) both pulse and telegraph signals from Negombo, Ceylon, and Kirkee, India, and (b) telegraph signals only from New Delhi, India, showed that on frequencies lying between 15 and 19 Mc/s the energy was received most strongly.

Observation of Forward Scatter at 50 MC, K. Bibl, H. A. Hess, K. Rawer. "Arc. El. Uber." Vol. 11. Issue 2. January 1957. 4 pp. Field strength measurements of a 51.3 mc 10 kw cw transmitter were recorded at distances of 50 km and 1,000 km. The medium propagation loss was 90 to 100 db. Short bursts of high field strength were caused by meteor trails.

Delays in Exchanges with Storage Facilities, G. O. Zimmermann. "Nach. Z." August 1957. 5 pp. Explanations of the special problems in traffic through exchanges with storage facilities are followed by investigations of the delays for various designs of exchanges. These delays are divided into statistically given basic delays and additional delays which depend upon exchange designs. The delays for urgent signals are briefly discussed.

Compatible SSB, K. B. Booth. "Aviation Age." September 1957. 3 pp.

"Recorded Carrier" System for High-Speed Data Transmission, R. M. Gryb. "Bell Rec." September 1957. 5 pp. Newly developed equipment has a transmission speed of 800 words per minute in teletypewriter code (600 bits per second) and uses magnetic tape for recording data messages. The tape is speeded up for transmission over voice channels.

The Choice of Systems in the Crossbar Switch Technique, A. Mehlis. "Nach. Z." August 1957. 12 pp. The technique with these switches permits the design of various systems similar to the technique with selectros, like in the latter, systems with direct and with indirect dialling can be designed with switches. This principle is illustrated by an example of a direct dialling system with switches manufactured by Standard Electric AG and by an example of an indirect dialling system with switches manufactured by Western Electric Co.

The Electrification of Precipitation and Thunderstorms, R. Gunn. "Proc. IRE." October 1957. 28 pp. The discussion discloses new facts as well as reviewing old ones in what is probably the most complete and authoritative explanation of the generation of atmospheric electricity that has yet been published.

Radio Propagation Above 40 MC Over Irregular Terrain, J. J. Egli. "Proc. IRE." October 1957. 9 pp. In this paper the author analyzes a large number of propagation measurements, made in the past by various organizations, in an effort to derive empirically relations for terrain effects versus frequency, antenna height, polarization and distance.

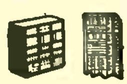
New Microwave Radio Relay Equipment, Tadasu Fukami, et al. "J. IECE. of Japan." February 1957. 6 pp. This paper describes on a new microwave radio relay equipment in which a TWT is used in common for an amplifier and a beating oscillator. The merits of this system are that only one microwave tube is used in the equipment and that the beating frequency is stabilized by means of high Q cavity resonator in the feed back circuit of TWT oscillator. It is expected that the equipment is simplified and that the maintenance cost may be cut down considerably.

Effect of Interference on Transmission Quality in International Radiotelephone Circuits, Yutaka Tsuruoka, and Masayuki Ito. "J. IECE. of Japan." February 1957. 4 pp. In this paper, the effect of the interference on the transmission quality was studied in terms of the syllable articulation and conversation intelligibility. For the experiment, a 3 wave, the wave used for the frequency inversion privacy system, a 1 wave, and F 1 wave were chosen from the waves to be used for the international radiotelephone circuits, as the frequency of occurrance of the interference was fairly high in the above chosen waves.

COMPONENTS

***A Report on Developments in Printed Microwave Components, D. R. J. White.** "El. Ind." November 1957. 5 pp. Housing and connecting problems are eliminated as the printed microwave components described in this article make a complete line practical. Some, not feasible in transmission lines, are realizable.

Miniaturization of Electronic Equipment, D. A. Findlay. "El." October 1957. 28 pp. A report on progress to date.



COMPUTERS

"Languages" of Digital Computers, A. W. Horton, Jr., "Bell Rec." September 1957. 4 pp.

Code Rings and Their Utilization in Remote-Control Devices, A. N. Radchenko. "Avto. i Tel.," August 1957. 8 pp. A new method is proposed for representing a complete set of codes; this method makes it possible to present the same information in a more compact form. Principles of ring coding are elaborated which make it possible to considerably simplify existing pulse-code devices for telemetering and remote control.

Computing Applications Where Analogue Methods Appear to be Superior to Digital, R. J. Gomperts. "J. BIRE." August 1957. 8 pp. Some advantages of analogue machines are quoted and three particular problems are studied for which analogue methods appear to be superior, namely the computation of non-linear heat flow, noise analysis, and the Monte Carlo method for solving neutron collision problems.

An Analogue Computer for Nuclear Power Studies, G. J. R. MacLusky. "Proc. BIEE." September 1957. 10 pp. The paper describes a new analogue computer which has been constructed at the Atomic Energy Research Establishment. It is to be used for nuclear power studies and comprises three main sections, namely the reactor-kinetics section, the control-system section and the thermal-system section. The design of these sections and their inter-connection is described in detail, and brief reference is made to some of the problems which will be studied with this new computer.

High Speed Analogue-To-Digital Converters, G. J. Herring, and D. Lamb. "J. BIRE." August 1957. 14 pp. Some control and computing problems are discussed in which advantage may be gained by encoding analogue quantities into digital form for subsequent processing. A voltage-to-digital converter has been designed for use with an electronic analogue computer in order to combine analogue and digital computation techniques. The system is basically a servo with a digital-to-voltage converter as a non-linear feedback element.

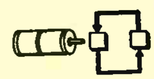
Pulse Transformer Design Chart, R. Lee. "El. Eq." September 1957. 5 pp.

Making Your Analogue Computing Facility Mobile, O. J. Sullivan. "Auto. Con." August 1957. 2 pp. Here are some of the general techniques which were employed in setting up a mobile computer at Chance Vought.

A Non-Destructive Readout of Ferrolectric Memory Devices Using Barium Titanate Single Crystal, Kazuo Hushimi, and Keishuke Kataoka. "J. IECE. of Japan." April 1957. 6 pp. The piezoelectric characteristics of Barium Titanate are determined by its domain structure. With these properties, the method to readout the information which is stored as residual polarization are described.

The Noise Problem in a Coincident-Current Core Memory, F. McNamara. "IRE Trans. PGI." June 1957. 4 pp.

Wide-Band Magnetic Tape Recorder, J. D. Rosenberg. "El. Eq." September 1957. 4 pp.



CONTROLS

The Design of Sampling Servomechanisms, S. Demczynski. "El. Energy." September 1957. 5 pp. In the present article the methods applicable for the analysis and synthesis of linear sampling servomechanisms are briefly reviewed, and references are quoted where more detailed information can be found. It is shown that the above techniques are essentially those of conventional analysis modified for applications to the design of linear, sampling servos. The use of the digital computer as a circuit element is also indicated.

Optimal Design of Devices Requiring Positioning, R. N. Auger. and R. J. Herman. "Auto. Con." August 1957. 4 pp. A systematic, if simplified analysis is provided up to the point where design and production parameters influence the calculations.

Phase Angle Analogues in Out-of-Sight Control Instrumentation, C. L. Parish. "IRE trans. PGI." June 1957. 7 pp.

Servo Modulators—I, B. T. Barber. "Con. Eng." August 1957. 7 pp. The first article tells how modulators work, discusses the six broad classes of control system applications, and tabulates the important performance specifications of the various types of servo modulators.

The Right Relay for Standard Machine Tools, E. J. Loeffler. "Auto. Con." August 1957. 2 pp. Here are some application notes for user and builder of relays for standard machine tools. Utilizing them will help you achieve the development of smaller, more reliable units.

Certain Methods for Stabilizing and Controlling Small Amounts of Working-Liquid Consumption in Hydraulic Automatic Systems, I. N. Kichin. "Avto. i Tel.," August 1957. 14 pp. The paper analyzes the phenomenon of obliteration (obstruction) of small flow cross-sections in hydraulic automatic systems and proposes mechanical hydraulic methods for eliminating this phenomenon. The effectiveness of the indicated methods is established, and it is shown that these methods facilitate the attainment of controllable stable consumptions in the restrictor units of hydraulic automatic systems.

Electronic Steering of Model Vehicle on Predetermined Course, A. Hoops. "El. Rund." September 1957. 3 pp. A model car displayed at the Great German Radion, Television and

Phono Exhibition in Frankfurt a.M. travels along an elliptic course. On both sides of the course lines are mounted which are fed by a 9.8 kc voltage. The field intensity varies in traverse direction. It produces the controlling signal for the automatic side steerage of the model car by means of sensing coils which (with inductive reception of the controlling frequency) feed a transistorized amplifier. Control relays for fine and rough turn are controlled by the transistorized amplifier and a special surge amplifier in such a way that right or left pulses can be fed to a servo motor actuating the steerage.

Electronic Heating and Automation, M. T. Elvy. "J. BIRE." August 1957. 20 pp. The principal methods of applying r.f. induction and dielectric heating are recalled, with particular reference to the employment of the electronic heater in conjunction with special purpose mechanical handling equipment. Work coil, electrode, and associated handling equipment design are discussed. Aspects of the design of suitable electronic generators are outlined. Some of the commercial applications of electronic heating in the electronic valve, metalworking, woodworking, plastics, and food industries are described.

Integration of Computers with Factory Processes, A. H. Cooper. "J. BIRE." August 1957. 10 pp. This application of computers involves more transfers of information than in a mathematical or business computer, but the speed at which the information must flow is much slower. Hence, the preferred basis and form of the computer are unusual. The paper describes typical computers for this class of application and the manner in which they fit into the requirements.

Transistorized-Core Memory, R. E. McMahon. "IRE Trans. PGI." June 1957. 4 pp.

A Barometric Pressure to Current Transducer, F. A. Lapinski. "IRE Trans. PGI." June 1957. 5 pp.

Ferrite Transducers for Electromechanical Filters, G. S. Hipskind. "El. Des." September 1, 1957. 6 pp.

Symbol Displays, W. A. Farrand. "IRE Trans. PGI." June 1957. 3 pp.

A New High Stability Micromicroammeter, J. Praglin. "IRE Trans. PGI." June 1957. 4 pp.

The Application of Miniature Saturable Reactors to Electronic Instruments, R. S. Melsheimer. "IRE Trans. PGI." June 1957. 5 pp.

A Liquid Level Switch Using a Radioactive Source, R. W. Wheeler, and B. V. Fowler. "IRE Trans. PGI." June 1957. 5 pp.

The Growth of Sonics in Industry, R. L. Rod. "El. & Comm." August 1957. 2 pp.

High-Frequency, High-G Calibration, E. I. Feder, and A. M. Gillen. "IRE Trans. PGI." June 1957. 7 pp.

Use of the Compensated Hot Thermopile Principle in Industrial Instrumentation, C. E. Hastings, and R. T. Doyle. "IRE Trans. PGI." June 1957. 8 pp.

INDUSTRIAL ELECTRONICS

***Ultrasonics—The New Electronic Art, John E. Hickey, Jr.** "El. Ind." November 1957. 6 pp. After a brief apprenticeship as a cleaning and soldering tool ultrasonics has now branched out into a wide variety of slicing, machining, measuring, drilling and burglar alarm applications. How the ultrasonic motion is applied, and how to choose the right transducers and generators for a given operation, are described in this article.

Computer Inventories Oil in Refinery Tanks, D. J. Gimpel, and H. O. Barton. "El." October 1957. 5 pp.

Ultrasonic Iron Solders Aluminum, Thomas J. Scarpa. "El." October 1957. 2 pp.

INFORMATION

The Relationship of Sequential Filter Theory to Information Theory and its Application to the Detection of Signals in Noise by Bernoulli Trials, H. Blasbalg. "IRE Trans. PGIT." June 1957. 10 pp. In this paper the problem of detecting signals in noise by the method of sequential filtering is formulated. A slicing operator for converting a given random variable into a Bernoulli random variable is defined. A method for choosing an optimum slicing operator in a certain prescribed sense is given.

A Theory of Weighted Smoothing, L. A. Ule. "IRE Trans. PGIT." June 1957. 5 pp. The problem attached in this paper is that of a system with a stationary random error input, a nonrandom signal input and a nonrandom error input.

The Response of a Phase-Locked Loop to a Sinusoid Plus Noise, S. G. Margolis. "IRE Trans. PGIT." June 1957. 7 pp. This paper presents a perturbation method which reduces the inherently nonlinear servo analysis problem to the analysis of a series of linear systems.

Teleprinted Code For The Hindi Alphabets, N. N. Biswas. "J. ITE" June 1957. 7 pp. In this paper the author has proposed a 5-unit teleprinted code for the Hindi alphabets. A study has been made regarding the frequency of occurrence of Hindi alphabets in the language. A new symbol has been coined, by means of which all the Hindi words can be written with the help of eight matras and only twenty-three letters.

MATERIALS

Testing in the Environment of Time, E. F. Peacox. "Environmental Quarterly." Third Quarter 1957. 3 pp. This article describes the basic life-test technique, suggests two ways for shortening testing time, and shows a simple technique for estimating the probability of survival for any given period of time.

The Utilization of Tungsten for High Purity Applications, R. C. Nelson. "Syl. Tech." July 1957. 6 pp. The effects of various impurities designated in tungsten concentrate purchase specifications are discussed from the standpoint of their effect on wire for use in incandescent lamps and on process control of metal powder for use in the carbide industry.

The Mechanical and Electrical Properties of Polymers An Elementary Molecular Approach, J. D. Hoffman. "IRE Trans. PGCP." June 1957. 28 pp. The mechanical and electrical properties of polymers are discussed in terms of the properties of individual polymer molecules in such a way as to bring out principles and generalizations which may be of use to persons interested in applying polymeric materials in electronic devices.

MEASURING & TESTING

***Microwave High-Power Simulator, Harold Heins.** "El. Ind." November 1957. 4 pp. By periodically injecting energy from a directional coupler into a waveguide cavity made in the form of a closed loop much higher power levels can be achieved than are available from microwave power generators. Energy is stored in a circulating or traveling wave.

Probability Computer for Noise Measurements, A. W. Sullivan, and J. D. Wells. "El." October 1957. 2 pp.

Test Equipment for Transistor Production, A. B. Jacobsen, and C. G. Tinsley. "El." October 1957. 4 pp.

Infrared Detector Aids Medical Diagnosis, W. E. Osborne. "El." October 1957. 3 pp. A technique has been applied to electroencephalography for study of the brain and as diagnostic detector for local inflammations in body.

Strain Gage System for Aircraft Telemetering, W. O. Brooks, and D. L. Stephenson. "El." October 1957. 4 pp.

Compliance Meter Tests Phono Cartridges, A. R. Kopp. "El." October 1957. 2 pp.

Selecting the Mode of Operation and Computing the Parameters of Electronic Voltage Stabilizers, L. I. Baida, V. K. Zakharov. "Avto. i Tel.," August 1957. 16 pp. An analysis is made of compensated electronic voltage stabilizers. An engineering method is proposed for computing such circuit and for selecting the elements for various sections of the stabilizer. For the purposes of illustration a description is given of the circuits and parameters of two types of currently manufactured voltage stabilizers.

Double Modulation System for Narrowing Electron Resonance Absorption Lines, R. R. Unterberge, et. al. "Rev. Sci." August 1957. 4 pp. A method is presented for observing electron resonance absorption on an oscilloscope screen by using both a magnetic field modulation and a klystron frequency modulation.

Measurement and Evaluation of Shot Noise in the Video Band, E. Sennhenn. "El. Rund." September 1957. 4 pp. From the Gaussian probability distribution law it is shown that the noise-peak voltage of the video frequency band is related to the effective noise voltage by a constant factor. The noise-peak voltage as $\sqrt{\Delta f}$ exactly as does the effective voltage. Curves of measurement results show the decrease of eye sensitivity towards high noise frequencies. Screen pictures taken at constant shot noise but in different noise bands show the disturbance effect.

Design of Electrostatic Cages for Airborne Antenna Research, A. Weissfloch and C. Ancona. "Onde." Vol. 36. No. 363. June 1957. 6 pp. The author covers the basic principles of electrostatic cages as applied to mock-up testing of antennas in radio direction finder system. Various improvements are described. The system has been extended to the testing of antennas operating in the radio frequency range of 2 to 20 mc.

Phase Distortion Due to Ground Inhomogeneities, K. Baur. "Nach. Z." August 1957. 3 pp. Investigation of the direction-finding site is taking up most of the work performed in preparation of setting D. F. equipment. Special attention must be paid to any latent characteristics of the ground surface which express themselves in local fluctuations of the ground conductivity and of the dielectric constants. This condition is causing a local phase deviation from the nominal value and thus false D. V. results will be obtained. Formulae have been derived in this report which permit a definition of the ground quality for D. F. purposes and thus a criterion for selecting the D. F.-site.

Low-Field Nuclear Magnetic Resonance Spectrometer, R. W. Mitchell, and M. Eisner. "Rev. Sci." August 1957. 5 pp. A nuclear magnetic resonance spectrometer has been constructed and its performance at 12 and 43 gauss is discussed.

Measurements of Efficiency of Bolometer and Thermistor Mounts by Impedance Methods, J. A. Lane. "Proc. BIEE." September 1957. 2 pp. Methods requiring only measurements of impedance are used to investigate the efficiency of resistance-type milliwattmeters at frequencies of 9.2 Gc/s and 3 Gc/s (wavelengths of 3.26 cm and 10.0 cm).

VTVM Survey—II, Sol Prensky. "El. Des." September 1, 1957. 4 pp.

The Measurement of Thermal and Similar Radiations at Millimeter Wavelengths, G. R. Nicoll. "Proc. BIEE." September 1957. 9 pp. The measurement of thermal and similar noise radiations at millimeter wavelengths is discussed. It is shown how this type of measurement is applied to radiation from gas discharges, flames and crystal diodes, and how it is used in certain studies of the atmosphere. Two types of measuring instruments are compared.

A Cyclotron for Medical Research, J. W. Gallop, et. al. "Proc. BIEE." September 1957. 12 pp. The paper describes the design and construction of the Medical Research Council fixed-frequency cyclotron, which is to be used for research in radiotherapy and radiobiology and for the production of radioactive isotopes for diagnostic, therapeutic and medical research purposes.

Tachometer Noise Reduction, J. C. West. "E. & R. Eng." September 1957. 3 pp.

Use of High Frequency Ultrasound for Determining the Elastic Moduli of Small Specimens, H. J. McSkimin. "IRE Trans. PGUE." August 1957. 19 pp. A description of the experimental methods and of the apparatus used is given, including the construction of units suitable for measurements over a temperature range. Illustrative results for single-crystal indium antimonide are presented.

On the Detection of Stochastic Signals in Additive Normal Noise—Part I, D. Middleton. "IRE Trans. PGIT." June 1957. 36 pp. Optimum detector structures for signal processes with rational intensity spectra are determined for the white noise case, and particular attention is paid to optimum receiver design in terms of physically realizable elements. Suboptimum receiver structure and performance are considered briefly, as well as a number of limiting cases of more special interest

Testing Metals "On-the-Fly" with Eddy Currents, R. Hochschild. "Con. Eng." August 1957. 7 pp. Accumulating experience with eddy-current testing shows it is applicable to automatic, continuous inspection.

Reliability—Design Technique for Complex Systems, H. E. Blanton. "El. Des." September 1957. 5 pp. Success-definition, the construction of reliability diagrams, and reliability formulas are presented in this article.

Errors in the Noise Spectrum Analyzer of Heterodyne Type, Yasuo Taki, et al. "J. IECE of Japan." April 1957. 6 pp.

Precision Calibration of Ultrasonic Fields by Thermoelectric Probes, F. Dunn, and W. J. Fry. "IRE Trans. PGUE." August 1957. 7 pp.

The Principles and Application of Radioisotopes to Noncontact Measurements for Continuous Processes, O. Bauschinger, Y. M. Chen, and F. H. London. "IRE trans. PGI." June 1957. 6 pp.

Trends in Acceleration Measurement, A. W. Orlacchio, and G. Hieber. "IRE Trans. PGI." June 1957. 6 pp.

Current Developments in Ultrasonic Equipment for Medical Diagnosis, J. M. Reid, and J. J. Wild. "IRE Trans. PGUE." August 1957. 15 pp.

Spectroheliometer for Continuously Monitoring Solar Radiation in Five Wavelength Bands, Y. T. Sihvonen. "Rev. Sci." August 1957. 7 pp.

Transducer Indicator System, W. C. Vaughan. "E. & R. Eng." August 1957. 5 pp.

A 12 KW Pulse Transmitter for Propagation Tests in Band 4, P. Mallach. "Rundfunk"—Jahrg. 1 No. 3 June 1957. 4 pp. The paper sets out to describe the principal factors affecting the design of the pulse transmitter for investigating the propagation in band 4, and highlights the special features of the equipment necessary for the extreme short duration of the pulses. Depending on the directional characteristics of the aerial, the effective peak pulse power of 12 to 18 KW has an effective radiated power of 7 KW at a pulse duration of .03 to .1 microsecond, and a repetition rate of 15,625 pulses per second. The behavior of the equipment, which was developed by the RTI, is discussed, and preliminary results of tests are given.

Maser Shows Promise, Some Drawbacks, Dr. R. W. Damon. "Aviation Week." August 19, 1957. 3 pp. Newer ferromagnetic amplifiers have operational characteristics which in many ways resemble those of Masers and both will be covered in this discussion.

Maser Potential Rests on Further Work, Dr. R. W. Damon. "Aviation Week." August 26, 1957. 5 pp.

Statistical Investigation into the Quality of Reception of Amplitude Modulated Sound Broadcasting, F. VonRautenfeld and P. Thiessen. "Rundfunk"—Jahrg. 1. No. 3. June 1957. 12 pp. From the listener's point of view, it is the quality of reception that is of importance, not the received field strength. Propagation-distortion may be subjectively appraised by means of several observers or objectively determined by measuring the distortion factor. A comparison between the figure of merit from the audience with the distortion factor provides a numerical comparison of different reception conditions.

Surface Temperature Transducer Systems, G. E. Reis. "Auto. Con." July 1957. 4 pp. Severe problems produced by need for temperature measurements at rocket velocities calls for a review of all possible techniques. Here is a summary of instrumentation setups in use and under development.

Semi-Automatic Test Set for Varistors, H. F. Dienel. "Bell Rec." August 1957. 4 pp. A semiautomatic test set has been designed to measure and plot rapidly varistor potentials from a few millivolts to several hundred volts and the tests are performed with currents ranging from a few microamperes to hundreds of milliamperes.

Self-Timing Regenerative Repeaters, E. D. Sunde. "Bell J." July 1957. 48 pp. The timing principles are discussed here for a particular type of self-timed regenerative repeater invented by Wrathall, in which a timing wave derived from either the received or the regenerated pulse train is combined in a particular way with the received pulse train.

Measurements Undertaken by the EBU for the Study of Space Wave Propagation on Long Waves and Standard Broadcast Frequencies, H. Ehlers and R. Dobiasch "Rundfunk"—Jahrg. 1. No. 3. June 1957. 10½ pp. This paper is a detailed report of working party B of the EBU technical committee which investigates the space wave propagation for the European area. It also reports on the experiments to find the correlation of the field strength with ionospheric and terrestrial-magnetic parameters.

A Capacitance Monitor for Plastic Insulated Wire, M. D. Birkeborn and R. A. Kempf. "Bell Rec." August 1957. 4 pp.

Infrared Solutions To Five Process Problems, L. E. Maley. "ISA Journal" August 1957. 5 pp. A correct solution to sampling problems seems the determining factor between success and failure with in-plant stream analyzers. Here is a "front-line" report on how infrared analyzer samplers were modified to solve five tricky industrial analysis problems.

Measurements of Flicker Made on Low-Tension Networks, A. Dejou and P. Gaussens. "Bul. Fr. El." Vol. 7. No. 77. May 1957. 10 pp. This paper describes the instruments which were used for determining power line variations and brightness fluctuations of incandescent and fluorescent lamps. Results of the measurements are given, including oscilloscope recordings.

Determination of the Service Area of Amplitude-Modulated Sound Broadcasting Transmitters, P. Thiessen. "Rundfunk"—Jahrg. 1. No. 3. June 1957. 8 pp. The inevitable difference in audio frequency and radio frequency propagation times not only gives rise to considerable distortion when the carrier is weakened by overmodulation, but also when side band asymmetry occurs. The paper examines the distribution for constant and fluctuating field strength, fluctuating phase displacement, and gives qualitative evaluation of the relation between a subjective appraisal of quality, protection ratio, and field strength fluctuations.

Nondestructive Testing of Nuclear Reactor Components, J. N. Wilson. "ISA Journal" August 1957. 4 pp. In nuclear processes, the hazards created by component failure require even more exacting tests of all fallible parts than are now used for conventional power, petroleum and chemical plants. Here is information on the special instruments and techniques developed for such testing under contract with AEC—information until very recently hidden by security regulations.

Electric Actuators: Examination and Evaluation, W. H. Brand, and E. F. Holben. "ISA Journal" August 1957. 6 pp. Here is a searching reappraisal of the basic function of power devices, and a revealing comparison of amplification factors as between electric-to-air, electro-hydraulic, and all-electric positioners.

The Accuracy of a Method for Measuring Series Capacities and Inductances, H. Rühl. "Nach. Z"—Jahrg. 10. Issue 6. June 1957. 6 pp. Investigations concerning the accuracy which can be obtained from a method developed by Herzog for measuring the series capacity and inductance of crystals have been carried out. A modified version of his method which leads to a simple formula for the determination of the series capacity is explained.

Initial Missile Data Via Drag Cable, D. K. Huzel. "ISA Journal" August 1957. 2 pp. During the first moments of missile flight, from 60 to 80% of engine failures occur. The drag cable provides the extra channels, with the high frequency-response and timing accuracy, that is required to analyze engine data through this critical initial period.

Method for the Determination of Reliability, K. E. Portz and H. R. Smith. "IRE Trans. PGRQC" August 1957. 9 pp.

A Study of the Flicker Caused by Periodic and Aperiodic Loads of Low-Tension Power Lines, P. Ailleret. "Bul. Fr. El." Vol. 7. No. 77. May 1957. 6 pp. Three types of disturbances may plague the customer of an electric power line: complete interruption, reduced voltage, or rapid variations in the supply voltage. The article deals in great detail with the last-mentioned failure, which may cause fluctuations in the brightness of fluorescent and incandescent lamps.

Cold Measuring Methods for Magnetron Quality, W. Schmidt. "El. Rund." August 1957. 7 pp. The cold measuring methods facilitate judgment, surveillance and correction of possible defects of circular and coupling properties of magnetrons prior to their final assembly and evacuation. The different measuring methods are divided into three groups. One method derived from each group is discussed. Comparing these methods their fields of economical application are considered.

The Double Meaning of Reliability, A. Mehlis. "Nach. Z."—Jahrg. 10. Issue 6. June 1957. 3 pp. The article outlines the various points which must be considered when establishing reliability of telephone system, i.e. from the standpoint of the consumer and the standpoint of the company.

Fluid Density Measurements by Means of Gamma Ray Absorption, R. Y. Parry, and A. E. M. Hodgson. "J. BIRE." July 1957. 4 pp. The paper discusses the phenomena involved and the parameters controlling the usefulness of a method of measuring the specific gravity of liquids flowing in a pipe (during manufacturing processes), and of detecting the interface between liquids having different specific gravities, e.g. petroleum products.

Computing Missile Trajectories in Three Dimensions, C. Bowie. "Auto. Con." July 1957. 3 pp.

On The Measurement of Component Reliability. I. K. Munson. "IRE Trans. PGRQC" August 1957. 7 pp.

Ionospheric Studies in India During the International Geophysical Year, K. R. Ramanathan. "J. ITE" June 1957. 5 pp.

Automatic Counting Techniques Applied To Comparison Measurement, C. C. H. Washtell. "J. BIRE." July 1957. 6 pp. The paper discusses the repetitive counting of independent pulse sources which are required to be measured in ration form, and for which the results are presented as a paper record. Examples in X-ray diffraction, tachometry and meter-testing are given to illustrate the technique.

A New Approach to Horizontal Deflection Tube Testing, G. M. Lankard. "Syl. Tech." July 1957. 4 pp. Static methods of testing horizontal deflection tubes have become inadequate, and are being replaced by more significant methods of dynamic testing.

Hydrothermal Synthesis of Electronically-Active Solids, A. Kremheller and A. K. Levine. "Syl. Tech." July 1957. 5 pp. The hydrothermal preparation of inorganic, phosphors and photoconductors is described. This new method of material synthesis makes it possible to produce solids which are superior in some properties when compared with those prepared by the conventional techniques.

RADAR, NAVIGATION

The Accuracy of RANA—The Hecto-Metric Navigational Aid, J. Aubry. "Onde." Vol. 36. No. 363. June 1957. 14½ pp. RANA—hectometric radio navigation system operates on the principle of phase comparison. Ground absorption and phase displacement due to ground irregularities affect the precision of the system. The analysis of these interferences provides certain conclusions for RANA network calibration. System accuracy can be assessed directly from continuous receiver readings.

Doppler Navigators Use Many Techniques, J. Holahan. "Aviation Age." September 1957. 5 pp. Pros and cons of the various Doppler radar techniques.

How Inertial Navigation Works, C. F. O'Donnell. "El. Eq." September 1957. 10 pp.

A Frequency-Modulated Altimeter, G. Collette and R. Labrousse. "Onde." Vol. 36. No. 363. June 1957. 10 pp. Described is the AM 210 altimeter, developed by the Société Francaise Radioelectrique now manufactured in quantities. Characteristics and performance of the equipment are given.

Air-Ground Circuit for Airlines, N. Monk. "Bell Rec." September 1957. 5 pp.

Direct Vision Type Direction Finder for High Frequency, Ken-ichi Miya, et al. "J. IECE. of Japan." April 1957. 8 pp. This paper describes on a direct vision type direction finder for high frequency, which is more sensitive than the one heretofore in use and by which multiple signals or scattering signals can also be measured. The working principle of the finder is not a minimum method but a so-called differential output method which is realized by using an electrical time division system.

TACAN—System for Air Traffic Control, H. de Lanouvelle. "Onde." Vol. 36. No. 363. June 1957. 9 pp. The article describes the methods developed for air traffic control, and shows the advantages of a single system for navigation, landing approach, and glide-path control, as well as communication.

Airborne Electronic Navigation Aids, M. Charot. "Onde." Vol. 36. No. 363. June 1957. 10½ pp. The article reviews the various developments of airborne navigation aids. In the first part of this article the author discusses the essential characteristics of radio telephone equipment, including single-side band transmission for long distances. The second part deals with such navigational aids such as VOR, Tacan, glide-path, ILS, and others. The third part envisions such developments as fuel consumption indicators, constant engine speed control mechanism, etc.

Electroluminescence and Image Intensification, G. Diemer, H. A. Klasens, and P. Zalm. "Phil. Tech." 27 July 1957. 11 pp. A mechanism accounting for the more important details of the complicated phenomenon of electroluminescence is presented in this article. A brief account is given of the employment of the phenomena in solid-state image intensifiers (amplifiers) which may well find important applications in radar, X-ray fluorescopy, etc.

Fundamentals of Magnetic Tape Recording of Radar Images, W. H. Schonfeld and H. Gillmann. "El. Rund." Vol. 11. Issue 6. June 1957. 3 pp. The article discusses requirements which must be fulfilled by magnetic recording system for radar image displays which can be reproduced on a P.P.I. screen. Emphasized are bandwidth, signal-to-noise ratio, stability of recording unit, and precision of synchronization. Test results obtained with experimental equipment are given.

Analysis of an Electrical Flight-Control System for Interceptor-Type Aircraft, E. Price and R. Westerwick. "Aero. Eng. Rev." August 1957. 5 pp.

Principles of Self-Contained Navigation, H. H. Bailey. "Aero. Eng. Rev." August 1957. 6 pp. A discussion of the methods and difficulties involved in self-navigation, a field of growing importance.

Electronic Flash Approach Systems for Airports, "El. Rund." Vol. 11. Issue 6. June 1957. 2 pp. The article describes the installation and operation of airports equipped with electronic flash approach systems developed by Sylvania.

Common System Standards, H. K. Morgan. "IRE Trans. PGANE." June 1957. 3 pp. Suggest the method of producing standards so as to release the development laboratories on actual equipment design to utilize signals to be radiated or received on aircraft and on the ground in the manner best suited to the particular application at hand.

Requirements for a New Universal Air Traffic Control Simulator, S. M. Berkowitz and R. S. Gubmeyer. "IRE Trans. PGANE." June 1957. 6 pp. This paper summarizes the role of dynamic simulation to date in helping solve current and future air-traffic control and navigation problems, and in evaluating proposed system concepts, control philosophies, procedures and equipments.

Military Weapon Systems Complex and the Professor Factor, D. E. Noble. "IRE Trans. PGRQC" August 1957. 11 pp.

Radar Beacon System Performance, S. Thaler and D. L. Ashcroft. "IRE Trans. PGANE." June 1957. 7 pp. Conservatively sufficient conditions are found for satisfactory operation of many ground and airborne beacon sets in a relatively small area. Necessary conditions must be found in some more tedious manner, since several simplifying assumptions are made in the method described here. However, application of the method often allows a short paper analysis to suffice for showing system practicability. The methods suggested for adjusting the sets to allow for desired system performance are easily applied. An example of the application of the method is given in order to make the ideas presented clearer.

Is an Airborne System for Collision Avoidance Operationally and Technically Feasible, F. C. White. "IRE Trans. PGANE." June 1957. 3 pp. Two years ago, the scheduled airline industry presented an analysis of the midair collision problem and asked the electronic manufacturing industry to help solve the problem. This paper is a brief status report on the progress to date.

Self-Contained Navigation Aids and the Common System of Air Traffic Control, N. Braverman. "IRE Trans. PGANE." June 1957. 5 pp. The relationship of self-contained aids to other navigation aids, to communications, and to the other elements of the common air traffic control system is treated in this paper. Also discussed are some of the problems involved in the integration of this technique in the over-all system.

Multiple-Track Tape Recorders in Air Traffic Control (ATC), K. Heidelauf. "Nach. Z." July 1957. 5 pp. Radio-telephone and telephone conservations in ATC should be registered for documentation. Tape recording and play-back equipment can be used for this purpose.

Physical Aspects of Collision Avoidance, J. S. Morrel. "IRE Trans. PGANE." June 1957. 7 pp. The purpose of this paper is to present some aspects of the problem and some of the conclusions drawn from them.

SEMICONDUCTORS

***Systematic Design of Transistor Bias Circuits,** Ray P. Murray. "El. Ind." November 1957. 4 pp. Proper design of transistor amplifiers requires special attention to operating point stability. Professor Murray defines a practical stability factor, and derives design formulas for bias components. These bias concepts can be readily extended beyond the examples given.

The Gauss Effect of Various Semi-Conductors Measured at 10, 300, and 600 MC, P. Rama, M. J. O. Strutt, F. K. von Willisen. "Arc. El. Uber." Vol. 11. Issue 1. January 1957. 7 pp. A review of the theoretical results obtained concerning the frequency dependence of the galvo-magnetic effects showed that corresponding formulas do not hold for semi-conductors. Measurements of semi-conductor pellets such as indium-arsenid, indium-antimonid, and germanium reveal that the galvano-magnetic effects decrease when the frequency is increased progressively to 10, 300, and 600 mc. The testing methods and error limits are discussed.

Characteristics of Silicon Junction Diodes as Precision Voltage Reference Devices, K. Enslein. "IRE Trans. PGI." June 1957. 14 pp.

Design Theory for Depletion Layer Transistors, W. W. Gartner. "Proc. IRE." October 1957. 9 pp. This paper takes a theoretical excursion into the design of this new type of transistor, presenting valuable information on the behavior of one form of the device and suggesting other forms and modes of operation for future study.

Development of the Transistor Inverter at 20 KC Using Power Transistors, W. A. Martin. "IRE Trans. PGI." June 1957. 5 pp.

Transistors In Speech Equipment, H. J. Albrecht. "QST." September 1957. 4 pp.

Silicon-Germanium Transistors, J. J. Bowe. "El. Eq." September 1957. 3 pp.

The Junction Transistor As A Network Element At Low Frequencies, I. Characteristics and h Parameters, J. P. Beijersbergen, M. Beun and J. te Winkel. "Phil. Tech." 27 July 1957. 11 pp.

Theory and Operation of Crystal Diodes as Mixers, G. C. Messenger and C. T. McCoy. "Proc. IRE." September 1957. 15 pp. The electrical parameters (barrier resistance, barrier capacity, and spreading resistance) of a crystal diode are quantitatively related to its fundamental physical properties and geometrical construction.

Carrier Generation and Recombination in P-N Junctions and P-N Junction Characteristics, Chih-Tang Sah, R. N. Noyce, and W. Shockley. "Proc. IRE." September 1957. 16 pp. It is the purpose of this paper to show that the current due to generation and recombination of carriers from generation-recombination centers in the space charge region of a p-n junction accounts for the observed characteristics. This phenomenon dominates in semiconductors with large energy gap, low lifetimes, and low resistivity.

Stabilization of Current-Operated Transistor Switching Circuits, N. W. Morgalla. "ATE J." July 1957. 9 pp. When a junction transistor is used in the current mode of operation the defined switching states depend to a large extent on the device parameters, and are influenced by variations in leakage current and saturated collector voltage. It is, however, possible to compensate for these effects by simple circuitry. A method is suggested and ways of practical evaluation are given.

The Transistor As A Speech-Path Switch, R. C. N. Münch. "ATE J." July 1957. 9 pp. This article describes some methods of using transistors as speech-path switches, and details some investigations into their suitability for this purpose. A description of a method of calling a wanted subscriber is also given which, while not actually dealing with part of the speech circuits, solves a problem arising from the use of transistor- and transformer-coupled speech paths.

TELEVISION

Mobile Monitor Covers TV Stations for FCC. R. L. Day. "El." October 1957. 3 pp.

Defects in Picture Quality of Image Orthicon TV Camera Tubes, R. Theile, F. Pilz. "Arc. El. Uber." Vol. 11. Issue 1. January 1957. 16 pp. The article discusses the characteristic defects in the picture quality of image orthicon tubes; especially when televising high contrast scenes. Analyzed are spurious signals which appear as white borderlines, loss of definition on horizontal white to black transients, and blooming. It was found that the effects are due to capacitive coupling of adjacent picture elements, and additional deflection of the scanning electrons caused by the potential pattern of the stored charges.

Designing an Amplitude Selector for a Television Receiver, A. Ia. Kornienko. "Radiotek." July 1957. 8 pp. The paper examines the simplest circuits for diode amplitude selectors and amplifier-tube selectors; the basic relationships are derived for selecting the elements of amplitude selector circuits.

New Developments of Closed Circuit Television, E. F. Speigel. "El. Rund." September 1957. 3 pp. In the new miniature model of the vidicon a miniature camera has been created opening like the infrared sensitive vidicon new fields of application of tv. Appropriately modified techniques might be used for production rationalization. For contact-free width measurement the pulses supplied by the tv camera are employed for the control of sheet rolling mill lines as automatic production implements they are used for the control of the correct register of the work unit.

Development and Operation of a TV Camera with Non-Linear Characteristics, W. Dillenburger. "El. Rund." Vol. 11. Issue 6. June 1957. 5 pp. This article is the second part of a paper describing in detail the design of a TV camera with gamma control. Operation of the unit as pick-up camera as well as film camera is discussed.

Colour Television Transmission, K. Teer. "E. & R. Eng." August 1957. 7 pp. In recent years a color-television transmission system using two sub-carriers for the transmission of the chrominance information has been developed. Practical results were demonstrated to Study Group XI of the C.C.I.R. in 1955 and 1956. The principles and evolution of the system have been described and discussed in previous articles. In this article the technical aspects are considered in more detail and data are given about modifications and improvements which have since been introduced.

THEORY

***Designing Low-Noise Microwave Receivers,** C. T. McCoy. "El. Ind." November 1957. 5 pp. A reliable microwave receiver with noise figure in the 6-db range can be designed on the basis of theory and practical suggestions resulting from low noise research studies over the past few years. The author includes experimental data on microwave crystal mixers.

Improving the Static Characteristic of a Pneumatic Relay by Utilizing Restrictors with Constant Pressure Differentials, V. N. Dmitriev. "Avto. i Tel." August 1957. 13 pp. The paper investigates the possibilities of improving the static characteristic of a pneumatic relay by installing restrictors with constant pressure differentials. Equations are derived for the static characteristics of such relays, and detailed experimental results are provided.

A High-Performance Magnetostriction-Sonic Delay Line, H. Epstein, and O. B. Stram. "IRE Trans. PGUE." August 1957. 24 pp. A simplified theory of operation is discussed, and a laboratory model incorporating the features of the delay line is described.

Certain Problems Associated with the Theory of Magnetic Amplifiers and Magnetically Modulated Probes of the "Second Harmonic" Type, V. N. Mikhailovsky, Iu. I. Spektor. "Avto. i Tel." August 1957. 8 pp. A no-load analysis is made of the operation of magnetic amplifiers and magnetically modulated probes of the "second Harmonic" type when a sinusoidal exciting current is used. Hysteresis and eddy current losses are taken into account. It is proven that the presence of losses gives rise to the dependence of the phase of the output voltage upon the intensity of the measured magnetic field.

The Attenuation of a Single-Wire Helical Delay Line, G. Schiefer. "Arc. El. Uber." Vol. 11. Issue 1. January 1957. 6 pp. The helical line is thought of as an inhomogeneous delay line along which an infinite number of partial modes propagates. For the two limiting cases, namely a narrow and a wide helix, the attenuation constants are calculated by taking into account all partial modes. The solutions are discussed and reference to measurements are made.

Electrical Simulators for Computing Electromagnetic Systems, S. A. Aleskerov. "Acto. i Tel." August 1957. 9 pp. The paper describes a method of electrical simulation which can be used to solve problems involving the magnetic field distribution in electromagnetic systems in cases where these problems reduce to the external Dirichlet problem. The proposed method makes it possible to solve problems involving a magnetic circuit of any arbitrary shape with any arbitrary distribution of potentials along the boundary surfaces of the field. It is proven that, having determined the magnetic potential distribution at various points of the field, it is possible to use known methods to compute the permeance of the space occupied by the field of the electromagnetic mechanism.

A Microwave Hohlraum, A. E. Lilley. "NRL." August 1957. 5 pp. A new device suitable for the calibration of microwave receivers has been constructed and preliminary tests are reported. Because of an analogy to a black radiation cavity, the device is called a microwave hohlraum. Its basic feature is the complete surrounding of a microwave antenna feed system with a gaseous discharge medium which acts as well as a well-matched hot load.

A Note on Numerical Transform Calculus, R. Boxer. "Proc. IRE." October 1957. 6 pp. This paper modifies and extends previous methods by overcoming the difficulty of including the initial conditions in the working of the problem and by increasing the accuracy of the solution.

The Mode Conversion Phenomena of Multi-Layer Laminated Transmission Lines and the Resulting Attenuation on Single and Multi-Section Conductors, Horst-Edgar Martin. I Part: "Arc. El. Uber." Vol. 11. Issue 1. January 1957. 10 pp. II Part: "Arc. El. Uber." Vol. 11. Issue 2. February 1957. 15½ pp. The concept of multi-layer laminated transmission line is explained. When two multi-layer transmission lines are interconnected via a coaxial cable, mode conversion phenomena appear. The amount of power transmitted from one transmission medium to the other is solved with the aid of eigenfunctions or eigenwave expansions. An arrangement consisting of many tandem-connected multi-layer lines is investigated. The specific attenuation of the sections, the transition loss, the input and output coupling losses, and reflection factors are investigated.

Distortion Produced in a Noise Modulated FM Signal by Nonlinear Attenuation and Phase Shift, S. O. Rice. "Bell J." July 1957. 11 pp. An expression is given for the FM distortion introduced by a transducer whose attenuation and phase shift depend upon the frequency in an arbitrary way.

Pressure Effects on the Ultraviolet Absorption Spectra of Some Aromatic Hydrocarbons, W. W. Robertson, O. E. Weigang, Jr., and F. A. Matsen. "Journal of Molecular Spectroscope" July 1957. 10 pp. There is presented a study of the dependence of the frequency of an electronic absorption band of a chromophore on change in the surrounding medium. Changes in the medium have been effected not by choosing different solvents, but by varying the density of one solvent, n-pentane, through the application of pressures up to 5500 bars. Several transitions could be observed in each of the aromatic hydrocarbons chosen as chromophores.

Coincidences in Poisson Patterns, E. N. Gilbert and H. O. Pollak. "Bell J." July 1957. 30 pp. A number of practical problems, including questions about reliability of Geiger counters and short-circuits in electric cables, reduce to the mathematical problem of coincidences in Poisson patterns. This paper presents the probability of no coincidences as well as asympatotic formulas and simple bounds for that probability under a variety of circumstances.

On the Nature of the Electron, J. L. Salpeter. "Proc. AIRE." June 1957. 11 pp. In this paper the concept of the electron as a fundamental particle of modern physics is discussed in relation to Pauli's exclusion principle, wave mechanics, the uncertainty principle and relativity.

The Behavior of Modulators, Feeding Complex and Selective Terminals, J. Gensel. "Freq." Vol. 11. No. 6. June 1957. 10 pp. A detailed, thorough mathematical analysis is made of modulators feeding four terminal networks.

TUBES

***Understanding the Traveling-Wave Tube.** Donald A. Dunn. "El. Ind." November 1957. 4 pp. An explanation based on Kompfer's original theoretical approach to traveling-wave amplification. Although more elegant methods of analysis have since been devised, this early theory leads to an answer after a series of logical steps, each of which represents an easily visualized physical occurrence.

Design of a 4,000 MC Triode with an L-Cathode and Its Application, K. Rodenhuis. "Vide." Vol. 12. No. 67. 1957. 8½ pp. Described is the construction of the EC56 and EC57 disc-sealed triodes which have a cathode current density of 375 ma/cm² and 250 ma/cm² respectively. The electrical characteristics of the tubes are given in connection with applications as amplifier in the output stages of a microwave repeater operating in the 4,000 mc band. Operating as input amplifiers in receivers the noise figure at 400 mc is 4 db, and 900 mc it is 7 db. Other applications include the use as oscillator tube, high-level mixers, and frequency multipliers. In one particular case, an output of a few milliwatts was obtained at 24,000 mc.

Developmental Position and Method of Operation of Microwave Tubes II, R. Muller, and W. Stetter. "El. Rund." September 1957. 3 pp. The present conclusion of the 2nd part of the series deals with the various methods of beam focusing (convergent beam emission into the operational space, Brillouin focusing, electrostatic focusing). Futhermore the tube noise of microwave tubes is entered upon.

Stroboscopic Operation of Photomultiplier Tubes, C. F. Hendee, and W. B. Brown. "Phil. Tech." August 24, 1957. 9 pp. By applying pulse voltages instead of the usual D. C. voltages to the electrodes of a photomultiplier tube, such a tube is made to operate as a light shutter capable of shutter times of fractions of a microsecond. An interesting method for the analysis of very weak light flashes and for "time-resolved spectroscopy" is based on this type of operation. The behavior of the pulsed photomultiplier tube is in several respects different from that under D. C. operation.

Some Technological Aspects of UHF Triode Design, A. G. Dorgelo. "Vide." Vol. 12. No. 67. 1957. 6 pp. Design parameters are given for the construction of UHF triodes with an operating range up to 1,000 mc.

Method of Obtaining Pressure and Temperature Insensitive Microwave Cavity Resonators, C. M. Crain, and C. E. Williams. "Rev. Sci." August 1957. 4 pp. This paper describes a method of fabricating cavity resonators having very low temperature frequency dependence and also describes a means of building pressure insensitive cavity resonators.

Growth of Anode-to-Grid Capacitance in Low-Voltage Receiving Valves, F. H. Reynolds, et al. "Proc. BIEE." September 1957. 6 pp. The capacitance between the anode and the control grid of a certain type of receiving pentode has been found to increase with life, the rate of growth being dependent on the operating conditions of the valve and on the material and processing schedule of the anode. It is shown that the phenomenon is due to the transfer of impurity carbon from the anode to the mica insulators.

U. S. GOVERNMENT

Research reports designated (LC) after the PB number are available from the Library of Congress. They are photostat (ph) or microfilm (mi), as indicated by the notation preceding the price. Prepayment is required. Use complete title and PB number of each report ordered. Make check or money order payable to "Chief, Photoduplication Service, Library of Congress," and address to Library of Congress, Photoduplication Service, Publications Board Service, Washington 25, D. C.

Orders for reports designated (OTS) should be addressed to Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Make check or money order payable to "OTS, Department of Commerce." OTS reports may also be ordered through Department of Commerce field offices.

Heater-Cathode Leakage Investigations, P. E. Carroll, J. Cohen, P. Cutler, and J. V. Florio, Sylvania Electric Products, Inc. Aug. 1956. 31 pp. Mi $3.00, ph $6.30. (PB 124715, LC). The purpose of the present experimental program is three-fold: 1. To obtain a phenomenological description of heater-cathode leakage under typical life test conditions of military tube types. 2. To determine the nature and relative importance of mechanisms responsible for heater-cathode leakage and to investigate the physical and chemical parameters governing the important heater-cathode leakage mechanisms. 3. To utilize the experimental findings through specific recommendations concerning (a) the use of improved materials, (b) the use of improved processing and aging, and (c) the use of operating conditions to minimize the detrimental effects of heater-cathode leakage.

Common-Base Transistor Equivalent Circuits for Wideband Application, J. M. Mathias, Stanford University. Dec. 1955. 50 pp. $1.25. (PB 121752, OTS). The problem of choosing a transistor equivalent circuit of practical usefulness for wideband, low-pass (video) amplifiers is studied experimentally. The calculated response of several equivalent circuits of varying complexities are compared with the actual measured response. Approximate formulas are found which enable the cutoff frequency of such an amplifier to be calculated for all values of source and load resistance. An instrument was developed to measure accurately the phase response of the transistor amplifier. This resulted in a device, with a high input impedance, that could measure the relative phase shift between a reference signal and the low-level collector signal at frequencies from the audio range up to 10 MC.

Field Electron Emission, R. D. Young and E. C. Copper, Pennsylvania State University. July 1956. 91 pp. Mi $4.80, ph $13.80. (PB 123961, LC). Boron is found to be strongly bonded to the tungsten substrate as indicated by activation energies of 2.8 electron volts for surface migration and 6.2 electron volts for disappearance. The activation energy of pure molybdenum for surface migration is 3.1 electron volts and for the silicon deposit 2.5 electron volts for surface migration and about 4.0 electron volts for evaporation.

Circularly Polarized Antenna for 350 to 1000 Megacycle Frequency Range, M. Heusinkveld, U. S. Naval Research Laboratory. March 1956. 21 pp. Mi $2.70, ph $4.80. (PB 120716, LC).

Conductor Heating Losses in Strip Transmissions Lines with Rectangular Inner Conductors, R. L. Pease, Tufts College. December 1954. 23 pp. Mi $2.70, ph $4.80. (PB 122378, LC). Two expressions are derived for the a-c resistance per unit length due to conductor heating losses in a microwave strip transmission line with rectangular inner conductor of arbitrary dimensions.

Demountable Diode for Cathode Studies, A. Eichenbaum and H. Farber, Polytechnic Institute of Brooklyn. March 1955. 23 pp. Mi $2.70, ph $4.80. (PB 119937, LC). A demountable planar diode with a movable anode is described. This tube can be used for carrying out a variety of cathode studies. It has been used to confirm an experimental method for determining the motional transconductance of a diode. It has also been used to compare two distinctly different methods for measuring the conductivity of oxide coated cathodes.

Methods of Analysing Fading Records from Spaced Receivers, Including Preliminary Analysis of Such Data at 75 Kc/S, R. B. Banerji, Pennsylvania State University. January 1956. 56 pp. Mi $3.60, ph $9.30. (PB 120225, LC). The statistics of the fading of radio waves from spaced receivers has been reconsidered to interrelate the existing methods of drift measurement and compare their effectiveness.

Model for Non-Thermal Radio Source Spectra, N. G. Roman and F. T. Haddock, U. S. Naval Research Laboratory. March 1956. 8 pp. 50 cents. (PB 111710, OTS). A model is presented to explain the observed radio spectrum of Cassiopeia A on the assumption that the underlying non-thermal emission process has an intrinsic spectrum.

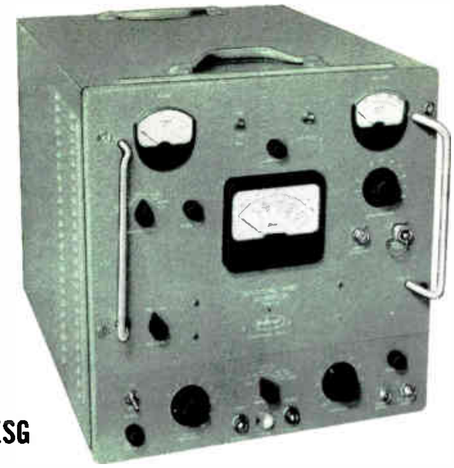
Modification of Indicator Group OA-184/CPN-18, J. J. Bogart, Wright Air Development Center. March 1955. 23 pp. Mi $2.70, ph $4.80. (PB 120415, LC). Investigation of improving the stability and accuracy of the AN/CPN-19 indicator for displaying a PPI presentation required in a traffic control system was initiated. Extensive modifications recommended.

Multiple Mode Excitation of the Trimode Turnstile Waveguide Junction, R. S. Potter, U. S. Naval Research Laboratory. August 1956. 18 pp. 50 cents. (PB 121040, OTS). The microwave junction whose study is extended in this report is a seven port variation of a turnstile waveguide junction with a coavial arm avially opposing the circular waveguide.

Noise Generation in High-Power Microwave Gas Discharges, R. C. Jones and W. J. Graham, U. S. Naval Research Laboratory. August 1956. 28 pp. 75 cents. (PB 121338, OTS). Experimental measurements were made on noise output, electron temperature, and electron density of rare gas discharges excited by up to 300 watts cw at 1850 MC. The general objective of the study was to determine what noise amplitudes and bandwidths are feasible; a specific objective was to determine if a nose level of the order of 1 milliwatt/MC could be generated over a band 200 MC wide in the S-band region. Probe studies were made of electron temperature and density.

Power Handling Capacity of Strip Transmission Lines Having Rectangular Inner Conductors with Semi-Circularly Rounded Edges, R. L. Pease, Tufts College. March 1955. 14 pp. Mi $2.40, ph $3.30. (PB 122377, LC). An expression is obtained for the maximum power which can be carried by a strip transmission line having an inner conductor with rounded edges without breakdown.

Some Proposals for Improving Aircraft Radio Systems, F. E. Boyd, K. L. Huntrey and P. D. Shups, U. S. Naval Research Laboratory. June 1946. 13 pp. Mi $2.40, Ph $3.30. (PB 120778, LC). In the course of the work carried on by the Systems Operational Survey Group of the Naval Research Laboratory, a number of ideas for improving aircraft radio and electronic systems have been originated. Many of these suggestions have been presented in reports on the individual problems.



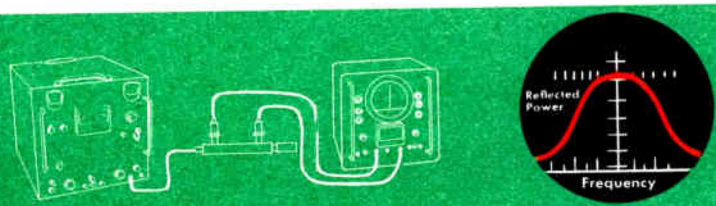
Model ESG

All Electronic

MICROWAVE SWEEP GENERATOR

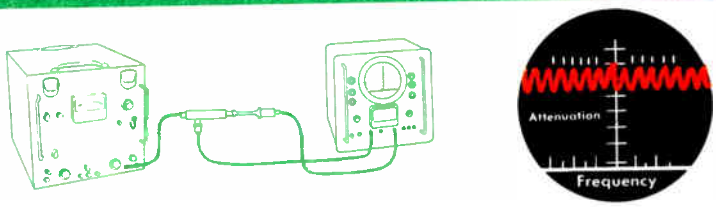
- Dynamic Measurements, Rapidly
- High Power Source

1,000 to 15,000 mc



MEASUREMENT OF VSWR OR PERCENT POWER REFLECTION

By employing an ESG along with a Rapid Scan Ratio-Scope (Model VS-1) in a reflectometer system set-up, accuracies equivalent to those obtained with the use of a slotted line can be achieved, by an untrained technician, in a fraction of the time formerly required. A two-to-one frequency range is provided. 7 interchangeable microwave oscillator units enable measurements to be made at microwave frequencies of 1000 to 15,000 mc.

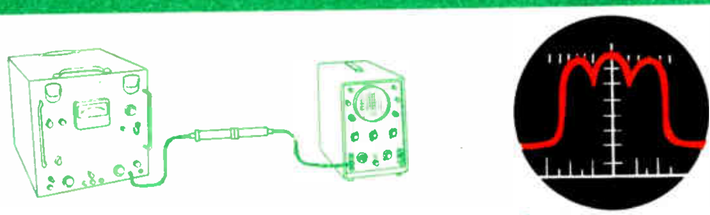


ATTENUATION MEASUREMENT

Broadband attenuation measurements are easily made with an ESG and Rapid Scan Ratio-Scope (Model VS-1). Attenuation of the unit under test is read directly on the ratio-scope indicator. Attenuation measurements can be made either at single frequency or over a band of frequencies (ESG sweeps its full frequency range).

MEASUREMENTS OF Q

The use of a Model ESG enables rapid visual instantaneous measurement of high and low Q. This cuts down engineering man hours when compared with laborious point-to-point Q measurements. The diagram shows a typical set-up utilizing a standard oscilloscope.



FILTER ALIGNMENT AND BANDPASS MEASUREMENTS

Because of the ESG's rapid sweep, the complete characteristics of a filter can be observed and measured instantaneously, utilizing a standard oscilloscope. The ESG's high power output enables determination of the filter's offband response. Dynamic measurements across the entire frequency range of the filters are possible because the stable backward wave oscillator in the ESG sweeps the full frequency range of the filter.

ANTENNA PATTERN MEASUREMENTS

By using an ESG to feed an antenna under test, accurate pattern measurements can be obtained over long distances and over a wide frequency range. This because of the ESG's high stable power output from 10 milliwatts to 1 watt. Provision is made in the instrument for amplitude modulation from external source and internal 1000 cps and 456 kc square wave modulation is provided.

POLARAD *IN ACTION*

PROVEN RELIABILITY

POLARAD ELECTRONICS CORPORATION

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REPRESENTATIVES: Abington, Albany, Atlanta, Baltimore, Boeing Field, Chicago, Cleveland, Dayton, Denver, Detroit, Englewood, Fort Worth, Kansas City, Los Angeles, Orlando, Portland, Rochester, St. Louis, Stamford, Sunnyvale, Syracuse, Washington, D.C., Westbury, Westwood, Wichita, Winston-Salem, Canada: Arnprior, Ontario. Resident Representatives in Principal Foreign Cities.

Polarad Model ESG Microwave Sweep Generator utilizes stable backward wave oscillators to make possible rapid dynamic tests of broadband and narrowband microwave systems and components. This instrument covers the frequency range from 1000 to 15,000 mc by use of 7 interchangeable microwave oscillator units, each of which can be purchased separately. The ESG can be externally modulated, providing a pulse rise time less than 0.15 microsecond.

Contact Polarad or your nearest Polarad representative for complete details.

Polarad Model VS-1 Rapid Scan Ratio-Scope is available to provide visual presentation of VSWR and attenuation.

SPECIFICATIONS: Basic Unit: Model E-B

INTERCHANGEABLE PLUG-IN UNITS

MODEL	FREQUENCY RANGE	POWER OUTPUT	MODEL	FREQUENCY RANGE	POWER OUTPUT
Model E-L1	1,000 to 2,000 mc	80 to 1,000 mw	Model E-C2	4,800 to 9,600 mc	20 to 150 mw
Model E-L2	1,600 to 3,200 mc	80 to 1,000 mw	Model E-X1	6,500 to 11,000 mc	20 to 100 mw
Model E-S1	2,000 to 4,000 mc	80 to 800 mw	Model E-X2	7,500 to 15,000 mc	15 to 40 mw
Model E-C1	3,600 to 7,200 mc	25 to 400 mw			

CODE MODULATED MULTIPLE-PULSE MICROWAVE SIGNAL GENERATOR

950-10,750 mc

An integrated mobile instrument. Generates multi-pulse modulated carrier for missiles, beacons, radar, DME, Tacan, Loran... provides 5 independently adjustable pulse channels. Variable pulse width, delay and repetition rate; and pulse time modulation.

SPECIFICATIONS:

Frequency Range:
Band 1: 950 to 2400 mc.
Band 2: 2150 to 4600 mc.
Band 3: 4450 to 8000 mc
Band 4: 7850 to 10,750 mc

Frequency Accuracy: ±1%

RF Power Output: 1 milliwatt (0 DBM)

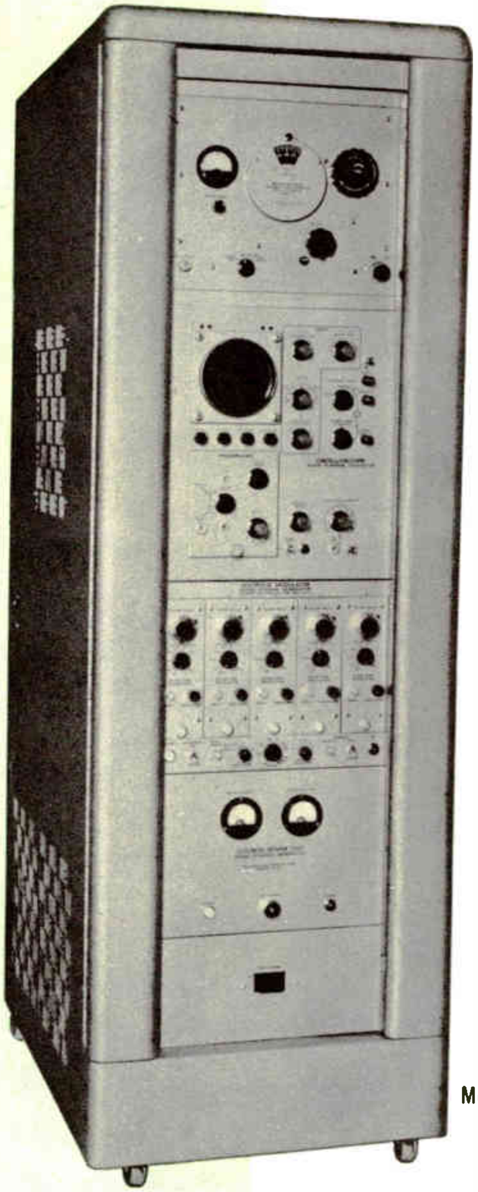
Attenuator:
Output Range: 0 to —127 DBM
Output Accuracy: ±2 db
Output Impedance: 50 ohms nominal

RF Pulse Characteristics:
a. Rise Time: Better than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the initial rise.
b. Decay Time: Less than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the final decay.
c. Overshoot: Less than 10% of maximum amplitude of the initial rise.

Internal Pulse Modulation:
No. of Channels: 1 to 5 independently on or off
Repetition Rate: 40 to 4000 cps.
Pulse Width: 0.2 to 2.0 microseconds
Pulse Delay: 0 to 30 microseconds
Accuracy of Pulse Setting: 0.1 microsecond
Minimum Pulse Separation: 0.3 microsecond
Initial Channel Delay: 2 microseconds from sync. pulse
Internal Square Wave: 40-4000 pps (separate output)

Pulse Time Modulation:
Frequency: 40-400 cps any or all channels
Required Ext. Mod.: 1 volt rms min.
Maximum deviation: ±0.5 microsecond

Power Input (built-in power supply) 105/125 v. 60 cps 1200 watts.



Model B

FOUR INTERCHANGEABLE MICROWAVE OSCILLATOR UNITS—all stored in the instrument . . . each with UNI-DIAL control . . . precision power monitor circuit to maintain 1 mw power output reference level . . . keying circuit to assure rapid rise time of modulated r-f output . . . non-contacting chokes.

PRECISION OSCILLOSCOPE WITH BUILT-IN WIDE BAND RF DETECTOR for viewing the modulation envelope and accurately calibrating the r-f pulse width, delay, and group repetition rate. Equipped with built-in calibration markers.

FIVE INDEPENDENTLY ADJUSTABLE PULSE CHANNELS—each channel features variable pulse width and delay; has provisions for external pulse-time modulation. Repetition rate for each group of pulses can be varied.

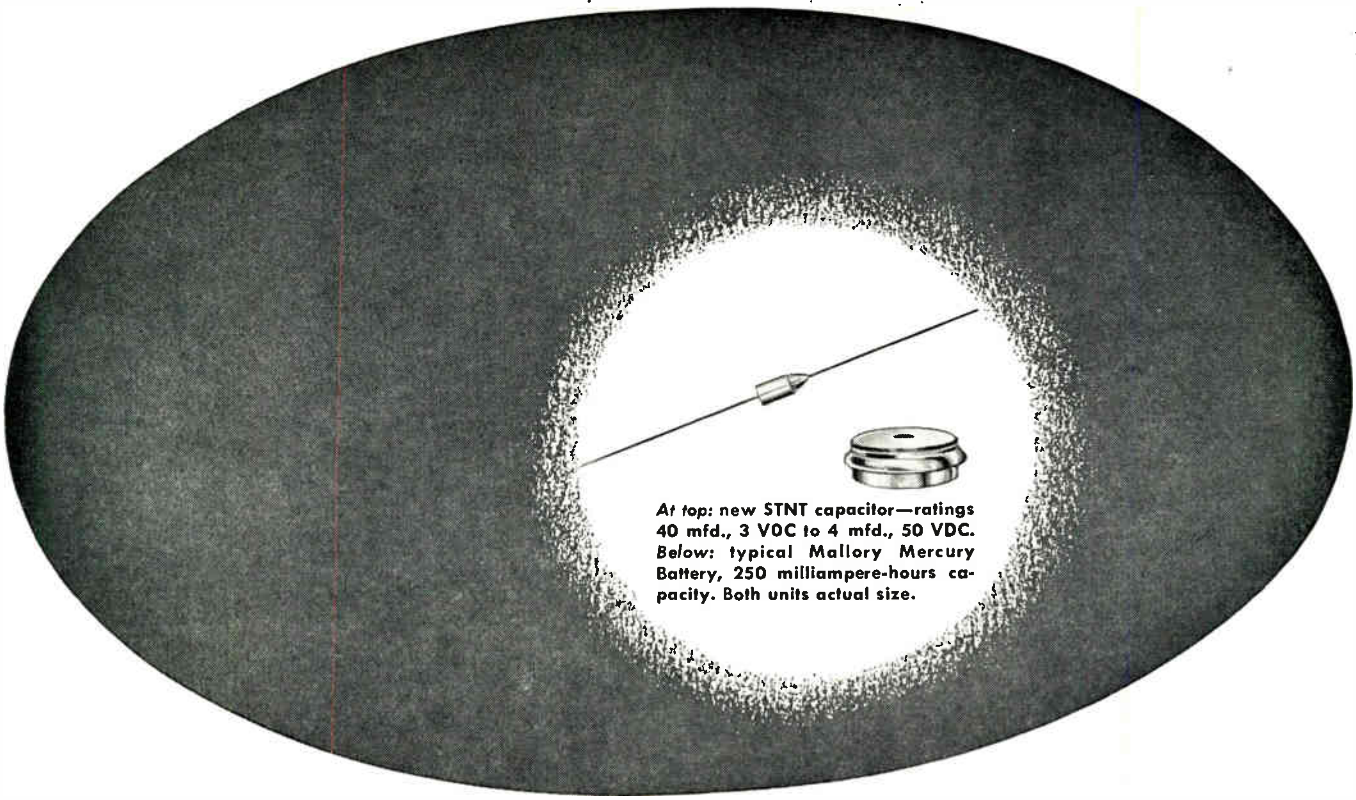
SELF-CONTAINED POWER SUPPLIES—Model B operates directly from an AC line through an internal voltage regulator. The coded multipulse generator is equipped with an electronically regulated low voltage DC supply. Klystron power unit adjusts to proper voltage automatically for each interchangeable tuning unit.

Contact your Polarad representative or write to the factory for detailed information.

POLARAD ELECTRONICS CORPORATION
43-20 34th Street, Long Island City 1, New York

POLARAD PROVEN RELIABILITY **IN ACTION**

REPRESENTATIVES: Abington, Albany, Atlanta, Baltimore, Boeing Field, Chicago, Cleveland, Dayton, Denver, Detroit, Englewood, Fort Worth, Kansas City, Los Angeles, Portland, Rochester, St. Louis, Stamford, Sunnyvale, Syracuse, Washington, D. C., Westbury, Westwood, Wichita, Winston-Salem, Canada: Arnprior, Ontario. Resident Representatives in Principal Foreign Cities.



At top: new STNT capacitor—ratings 40 mfd., 3 VDC to 4 mfd., 50 VDC. *Below:* typical Mallory Mercury Battery, 250 milliampere-hours capacity. Both units actual size.

Big Performance in Subminiature Size —for your Transistor Circuits

The new transistorized products that you are designing can be engineered to even smaller size, and to even higher standards of performance, by using Mallory subminiature batteries and capacitors.

Mercury Batteries, pioneered and developed by Mallory are outstanding for high milliampere-hour capacity in extremely compact size. The unique combination of the electrochemical cell system and structure used in Mallory Mercury Batteries gives a constant energy discharge that offers the ideal power source for transistors. They last for several years on the shelf, and need no recuperative periods between use. They withstand extremes of temperature and humidity far beyond conventional batteries.

Mallory Subminiature Capacitors cover a complete range of sizes and characteristics to match your applications. Newest and smallest is the STNT—only 0.145″ in diameter and 0.250″ long; available in ratings from 40 mfd., 3 VDC to 4 mfd., 50 VDC. Other models include: ultra-miniature TAW tantalum capacitors in 1 to 6 mfd. ratings; TAP tantalum capacitors for −55 to +85° C, rated 2 mfd./90 VDC to 30 mfd./6 VDC; TNT tantalum capacitors with double the capacity of STNT, in slightly larger case size; and type TT miniature aluminum electrolytics.

Mallory application engineers can give you valuable assistance not only in selecting the subminiature components for your application, but also in coordinating circuit designs for peak over-all performance. Write today for technical data and for a consultation.

Expect more . . . get more from

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

Serving Industry with These Products:

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

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

Circle 69 on Inquiry Card, page 101

New Tech Data for Engineers

Ceramics

The Coors Porcelain Co., Golden, Colo., has issued two 2-color brochures, "Standard Terminal Insulators" and "High Strength Ceramics." These two bulletins describe ceramic components and ceramic insulators. Booklets are both complete with photographs, specifications, suggested uses, and cables.

Circle 160 on Inquiry Card, page 101

Automatic Quality Control

A new 2-color brochure describes Supertester which may be used to automatically test electronic subassemblies for continuity, leakage, dc voltage, ac voltage, resistance, and impedance. Unit can make all types of complex tests rapidly. Brochure contains photographs, block diagrams, and specifications. California Technical Industries, Belmont, Calif.

Circle 161 on Inquiry Card, page 101

Components & Accessories

Handy size, 2-color, 50-page booklet has been issued by Ardente Acoustic Laboratories, Ltd., 8/12 Minerba Rd., London, N.W. 10, England, describing their complete line of earphones, switches, transformers, and potentiometers. Booklet is complete with photographs, line drawings, graphs, charts, mechanical and electrical specifications.

Circle 162 on Inquiry Card, page 101

Optical Coating

The Optical Coating Laboratory, Inc., 1035 Sebastopol Rd., Santa Rosa, Calif., has issued two bulletins, TB-200 and TB-500, describing their optical coating processes.

Circle 163 on Inquiry Card, page 101

Oscilloscopes and Accessories

Tektronix, Inc., P. O. Box 831, Portland 7, Ore., has just issued an 8-page short form catalog on their oscilloscopes and accessories. Brochure is complete with photographs, electrical and mechanical specifications on all types of oscilloscopes, plug-in preamplifiers, and other accessories.

Circle 164 on Inquiry Card, page 101

Automatic Torque Tester

A 6-page, 2-color brochure describes an automatic torque tester for instrument ball bearings. It is a continuous-rotation tester which may be used for production and research. The Fafnir Bearing Co., New Britain, Conn.

Circle 165 on Inquiry Card, page 101

Strip-Chart Recorder

An 8-page brochure describes the Model G-11A strip chart recorder. Brochure is complete with photographs, drawings, and complete electrical and mechanical specifications. Also included is information on the B1 attenuator-type input chassis. Varian Associates, Instrument Div., 611 Hansen Way, Palo Alto, Calif.

Circle 166 on Inquiry Card, page 101

Power Supplies

Bulletin No. 56 is a 2-color, 12-page bulletin issued by Oregon Electronics Mfg. Co., 2105 S.E. Sixth Ave., Portland 14, Ore., describing their complete line of power supplies for all uses. It contains photographs, graphs, complete electrical and mechanical specifications for a variety of power supplies.

Circle 167 on Inquiry Card, page 101

Instrument Directory

Neely Enterprises, 3939 Lankershim Blvd., North Hollywood, Calif., have issued a 2-color, 70-page spiralex bound instrument directory. Directory contains complete information on such things as: laboratory electronic instruments for field and factory applications; impedance and comparison bridges and accessories; high accuracy rheostats and potentiometers; decade resistance and capacitance units; signal generators; frequency counters; oscillators; voltmeters; oscilloscopes; test equipment; highly regulated dc power supplies; dc amplifiers; VTVM's; industrial and broadcast TV camera and monitor systems; oscillograph recorders, klystron and microwave tubes; strip-charts and accessory items. Booklet also contains handy cross index.

Circle 168 on Inquiry Card, page 101

Transistor Chart

A new transistor replacement chart issued by Bendix Semiconductor Products, 201 Westwood Ave., Long Branch, N. J., lists the correct Bendix transistor to use to replace weak and burned out transistors with Bendix units.

Circle 169 on Inquiry Card, page 101

Emergency Showers

Immediate first aid for eye, face and body contamination for industrial use is described in a brochure issued by Haws Drinking Faucet Co., 4th & Page Sts., Berkeley 10, Calif. Emergency eye, face and body fountains permit instant washing of affected areas with controlled streams of water.

Circle 170 on Inquiry Card, page 101

SSB Tubes

A new bulletin describes the 4CX1000A ceramic power tetrode tube which was designed for single side band usage. The brochure contains photographs, graphs, drawings, complete electrical and mechanical specifications and typical operating conditions. Eitel-McCullough, Inc., San Bruno, Calif.

Circle 171 on Inquiry Card, page 101

D-C Power Supplies

GEA-6690, 6 pages, describes tailor-made dc power supply systems for computer, aircraft, military, and special applications. Publication discusses typical applications and provides chart citing relative characteristics of various power supplies. Included are basic electrical and mechanical details of dc power units. General Electric Co., Schenectady 5, N. Y.

Circle 172 on Inquiry Card, page 101

Automation System

Features of the new Univac II Data Automation System are described fully in an attractive, fully illustrated 79-page manual issued by Remington Rand Univac, 315 Fourth Ave., New York 10, N. Y. Bulletin U-23 is a complete guide for Univac II system and is designed for the needs of both the computer specialist and the layman. The manual contains 5 sections.

Circle 173 on Inquiry Card, page 101

Silicon Rectifiers

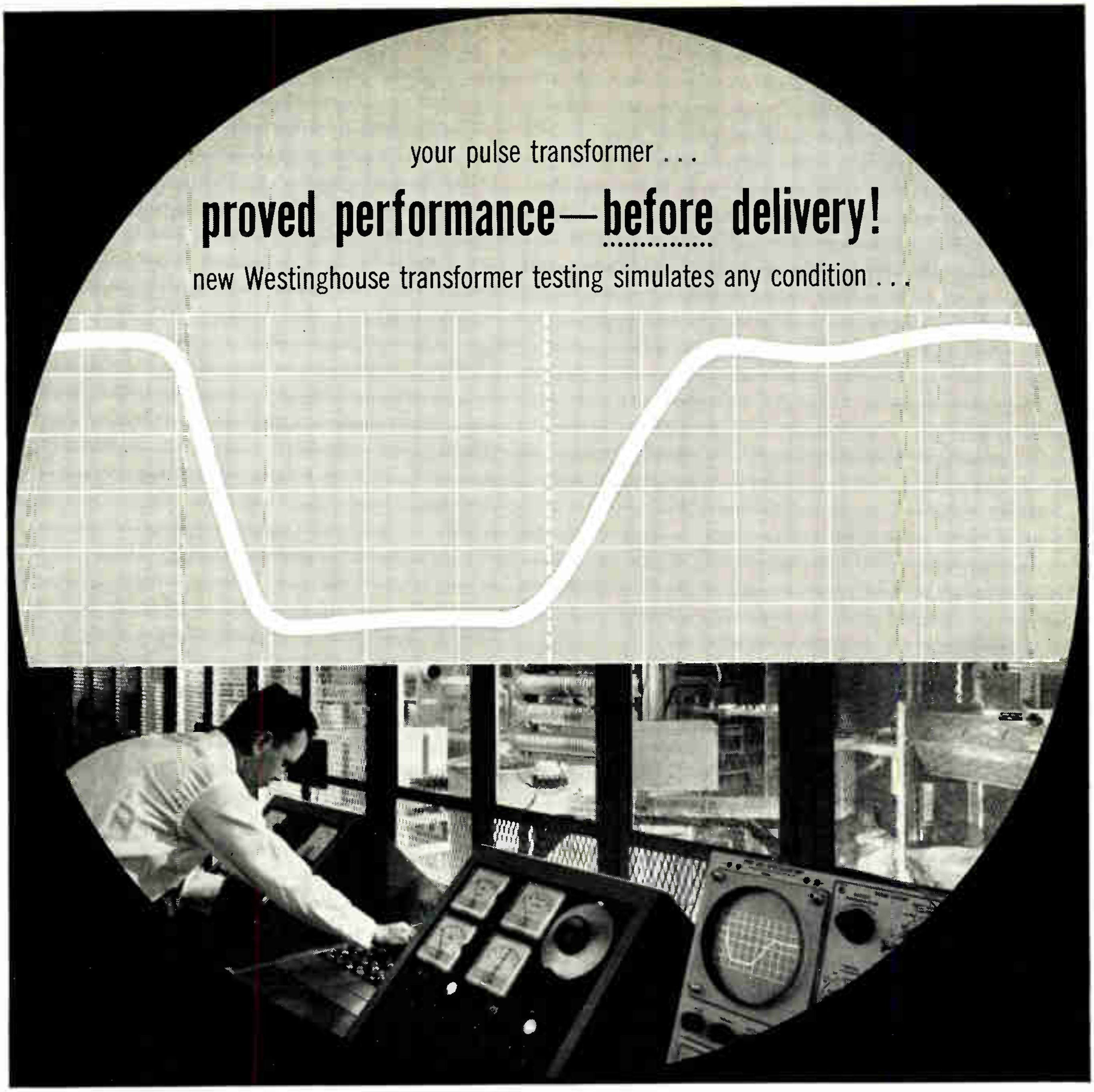
Bulletins 20, 21, and 22 describe fully three types of full wave silicon rectifiers manufactured by Sarkes Tarzian, Inc., 415 N. College Ave., Bloomington, Ind. These 3-color bulletins contain photographs, line drawings, complete electrical and mechanical specifications along with graphs.

Circle 174 on Inquiry Card, page 101

Research and Development

A new booklet entitled "Product Research and Development" has been issued by The Franklin Institute Laboratories, Benjamin Franklin Pkwy at 20th, Philadelphia 3, Pa. describing services offered by the laboratories in this field. The 20-page illustrated brochure lists specific areas in which the laboratories is staffed and equipped to perform research and development. Projects already completed or underway are mentioned to illustrate the extent of their services.

Circle 175 on Inquiry Card, page 101



Howard Jessup, Westinghouse Design Engineer, testing relatively high power interstage pulse transformers on the new line-type pulse modulator designed by Mansom Laboratories Incorporated, Stamford, Connecticut.

shows pulse shape, predicts performance in your circuit

Westinghouse has revolutionized pulse transformer testing. Now, complete performance in your circuit is proved—before delivery. *Even pulse shape predictions are now possible.* This means faster delivery of ready-to-use components, eliminates the expense of proving transformer performance in your plant.

Using a new line-type pulse modulator in conjunction with low power pulse testing, these tests will simulate any condition. Tests are applied both in development—level of insulation systems and components, life testing, temperature rise measurement—and in production—core characteristics, dielectric tests, pulse shape determinations.

Although rated at 30 megawatts peak power and 60 kilowatts average power, transformers having ratings up to 50 megawatts peak and 200 kilowatts average power can be tested by deviating from specification impedence or repetition rating. Tests can be made under full load or with no load.

This complete testing—before delivery—is your assurance of specified performance. Call your Westinghouse representative for information on the wide line of fully tested Westinghouse pulse transformers . . . or write Specialty Transformer Department, Westinghouse Electric Corporation, P. O. Box 231, Greenville, Pennsylvania.

J-70822

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

Circle 68 on Inquiry Card, page 101

New Tech Data for Engineers

Wire Wound Resistors

A new brochure describes adjustable precision wire wound resistors. The 2-color brochure is issued by Eastern Precision Resistor Corp., 675 Barbey St., Brooklyn 7, N. Y.

Circle 176 on Inquiry Card, page 101

Metal Film Resistors

A new kind of precision resistor, the Riteohm Series 77 metal film resistor is described in a bulletin just released by the Ohmite Mfg. Co., 3661 Howard St., Skokie, Ill. Outlined in full detail are the complete characteristics compared with MIL specifications, resistance range, dimensions, and other important data.

Circle 177 on Inquiry Card, page 101

Parts Catalog

Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill., have just released their 1958 general catalog. The new 404-page catalog lists over 27,000 items. All types of electronic parts are described and listed.

Circle 178 on Inquiry Card, page 101

Capacitors

Gudeman Co., 340 W. Huron St., Chicago 10, Ill., has just released a catalog on their line of high reliability capacitors. Catalog XR-461 describes completely these new capacitors.

Circle 179 on Inquiry Card, page 101

Industrial Tubes

Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y., has just issued a booklet, "Industrial Tubes," describing the general characteristics of vacuum power tubes, beam power tubes, rectifiers, thyratrons, magnetrons, mercury vapor rectifiers and ignitrons. It also lists the maximum ratings of these tubes. In addition, there are sections devoted to reliable and ruggedized tubes.

Circle 180 on Inquiry Card, page 101

Noise Systems

A 6-page, 2-color brochure issued by Radio Corporation of America, Commercial Electronic Products, Bldg. 15-1, Camden, N. J., describes their high intensity noise systems. The system is primarily designed for the testing of electronic components and assemblies at extremely high noise levels. Brochure is complete with photographs, graphs, curves, and specifications.

Circle 181 on Inquiry Card, page 101

Panel Instruments

A bulletin covering the group of long scale panel meters for special applications has just been issued by the Weston Electrical Instrument Corp., Newark 12, N. J. Complete electrical and mechanical specifications of these meters are included along with applications.

Circle 182 on Inquiry Card, page 101

Silicon Power Transistors

Texas Instruments Incorporated, P. O. Box 312, Dallas, Tex., has just issued two new brochures, describing their type 2N424 n-p-n and type 2N389 n-p-n diffused junction silicon power transistors. Brochures contain photographs, drawings, graphs, and complete electrical specifications.

Circle 183 on Inquiry Card, page 101

Printed Circuit Connector

A new illustrated technical bulletin gives specifications, diagrams and general information on a new printed circuit connector for computer application. Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 184 on Inquiry Card, page 101

Transistor Transformer Design

Audio Development Co., 2839 13th Ave. So., Minneapolis 7, Minn., has just issued a new catalog describing their facilities for all types of transformer design.

Circle 185 on Inquiry Card, page 101

Electrical Equipment

Western Gear Corp., Lynwood, Calif., has just released their engineering catalog No. 5721. This catalog illustrates more than 70 different types of miniature motors, gear motors, motor generator sets, fans and blowers designed and manufactured by this company. Engineering drawings, performance curves and other detailed information is provided for the engineer.

Circle 186 on Inquiry Card, page 101

Printed Circuit Soldering

A 12-page technical brochure titled "Printed Circuit Soldering" is available from Kester Solder Co., 4201 Wrightwood Ave., Chicago 39, Ill. The booklet describes the types of fluxes suitable for printed circuit soldering and also covers such matters as temperatures, procedures, alloys and contaminations.

Circle 187 on Inquiry Card, page 101

Precision Machining

A new 2-color brochure issued by Research Development Manufacturer, Inc., 429 E. Collom St., Philadelphia 44, Pa., describes fully, with photographs, their facilities for manufacturing any precision mechanical part.

Circle 188 on Inquiry Card, page 101

Scaler

A new bulletin issued by Radiation Instrument Development Laboratory, 5737 Halstead St., Chicago 21, Ill., describes their Model 210 Versatile Scaler. Scaler permits counting rates of a million per second. Complete specifications are included.

Circle 189 on Inquiry Card, page 101

Laboratory Equipment

Precision Equipment Co., 4411C Ravenswood, Chicago 40, Ill., have just issued a 16-page booklet describing countless kinds of standard office, laboratory, factory, warehouse and maintenance equipment. Catalog is complete with photographs, specifications and prices.

Circle 190 on Inquiry Card, page 101

Relays

A 36-page catalog lists thousands of relays made by all leading relay manufacturers. Prices and model numbers are included for easy ordering. Complete electrical and mechanical specifications are included. Relay Sales, Box 186-EV, West Chicago, Ill.

Circle 191 on Inquiry Card, page 101

Instrumentation Recording

"Magnetic Tape Instrumentation" is a 16-page, 2-color booklet issued by the Ampex Corp., 934 Charter St., Redwood City, Calif. The booklet describes how to become a tape recording expert and sets forth the functional capabilities of tape recorders and describes a number of useful applications. Complete with photographs, tables and drawings.

Circle 192 on Inquiry Card, page 101

Ceramic HF Parts

Stettner & Co., Lauf/Nürnberg, Western Germany, has just issued a new catalog describing their complete line of ceramic capacitors and parts for high frequency usage. Complete information is included in catalog along with photographs.

Circle 193 on Inquiry Card, page 101

MODEL 372 SLIDING COAXIAL TERMINATIONS

This equipment, available only from Narda, provides the most convenient means for evaluating the residual VSWR of coaxial slotted lines. VSWR of the element is 1.05 or less; covers range from 2000 to 12,400 mc.

N Connector, male or female **$110** C Connector, male or female **$116**

MODEL 371 FIXED COAXIAL TERMINATION

This Narda coaxial termination is the first and only to cover the entire frequency range from S to X band. Same range and element VSWR as above.

N Connector, male or female **$55** C Connector, male or female **$58**

3, 6, 10 and 20 DB

40 DB HIGH POWER

HIGH DIRECTIVITY COUPLERS

The 40 db High Power Coupler is another exclusive Narda product. Similar to standard types, except that coupling irises are in the narrow wall, it may be used at full rated power of the waveguide size. Nominal coupling value is 40 db; directivity 40 db. Directivity for 3, 6, 10 and 20 db couplers is also 40 db. Standard cover flanges on primary line; low VSWR termination and standard cover flange on secondary. All bands covering frequencies from 2600 to 18,000 mc.

STANDARD REFLECTIONS

Narda offers five values of reflections for each of six different waveguide sizes . . the most complete choice we know of! Provides calibrated reflections or VSWR's for use in standardizing reflectometers or calibrating slotted line impedance meters.

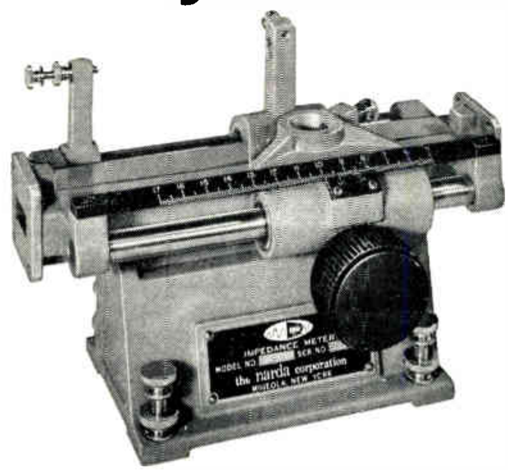
SPECIFICATIONS

Reflection Coefficient	0.00	0.05	0.10	0.15	0.20
Accuracy	0.002	0.0025	0.0035	0.0045	0.007
VSWR Equivalent	1.00	1.105	1.222	1.353	1.50

Models for 2.60 to 18.0 kmc, from $125 to $300

***Microwave engineers*–**

Where can you use these exclusive features offered by narda?



Waveguide and Coaxial IMPEDANCE METERS

Exclusively in Narda Waveguide and Coaxial Impedance Meters, the carriage mounting and drive mechanism are integral with the precisely machined transmission line casting. This insures permanent accuracy and freedom from slope errors—no more tedious adjustment or possibility of misalignment.

Other features include angle-mounted scale and vernier for optimum visibility; readily removable supporting pedestal; and smooth carriage travel action. Waveguide models, accurate for VSWR's of 1.01, are available for complete coverage from 2600 to 18,000 mc; N or C Connector coaxial models, from 1500 to 12,400 mc.

WAVEGUIDE IMPEDANCE METERS

Frequency (kmc)	Narda Model	Residual VSWR	Price
2.6 — 3.95	224		$425
3.95— 5.85	223		350
5.3 — 8.2	222	1.01	325
7.05—10.0	221		270
8.2 —12.4	220		250
12.4 —18.0	219		270

COAXIAL IMPEDANCE METERS

Frequency (kmc)	Connectors (One Male, One Female)	Narda Model	Price
1.5 to 12.4	Series N	231	$360
1.5 to 12.4	Series C	232	390

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

DIRECTIONAL COUPLERS
TERMINATIONS
FREQUENCY METERS
HORNS
TUNERS
ECHO BOXES
SLOTTED LINES
BENDS
ATTENUATORS
STANDARD REFLECTIONS
BOLOMETERS
THERMISTORS

the narda microwave corporation

160 HERRICKS ROAD, MINEOLA, N. Y. • PIONEER 6-4650

MAIL COUPON TODAY FOR FREE CATALOG AND NAME OF NEAREST REPRESENTATIVE

The Narda Microwave Corporation
160 Herricks Road
Mineola, N. Y.
Dept. EI-1

NAME ______

COMPANY ______

ADDRESS ______

CITY ______ ZONE ______ STATE ______

Circle 66 on Inquiry Card, page 101

Does specialized business publication advertising pay?

No one is in a better position to give a hard-boiled, practical answer to this question than the men who spend their working lives on the sales front ...the men the ads are supposed to help... the men who sell.

Here are the statements of salesmen who know what advertising does for them when it appears in the industrial, trade or professional publications that serve the specialized markets to which they sell:

Bill Kramer
Monsanto Chemical Co.
sells to industry

says Mr. Kramer:

"We make many different chemicals, mostly standardized products that don't have trade names. Many of our chemicals are purchased in small quantities direct and through distributors. So you might think that all I have to sell is price. That's not true. Thanks to our advertising in business papers the name '*Monsanto*' is known to stand for quality products and service.

"We have so many small customers I can't call on all of them, so advertising must carry a large part of the load for the small orders we get from such people which add up to a great deal of tonnage. Advertising also gets across the fact that we warehouse standard chemicals right here in the city and can give prompt service.

"We have such a long list of chemicals that I wouldn't do much of a sales job if I just read the list of chemicals we make on each sales call. So again our company uses advertising to let the people know all the different chemicals we are prepared to deliver. Then we salesmen can concentrate on the individual prospect's immediate requirement.

"Of course you don't always know exactly what chemicals are required by a particular prospect because a company can go into a new product, or a variant of an old one, almost overnight and come up with a need for a chemical he'd never used before. So it's pretty important for our advertising to remind all buyers just what lines we have.

"Although many of our chemicals don't have trade names, we have one silica product that has become known to the trade as '*Santocel*'. Very few people in the trade call this by its proper chemical name — they refer to it as '*Santocel*'. Advertising in the trade papers has created this new name and made it stick. These are just some of the ways I know advertising is working for me — calling on people I can't get to see and calling more often than I can possibly do in person, and suggesting new uses for our products."

Harold Robus
Shuron Optical Company
sells to wholesalers

says Mr. Robus:

"My direct customers are wholesalers—distributors with optical laboratories who sell to and fill prescriptions for optometrists, ophthalmologists and opticians. These men in turn are my secondary, though nonetheless important, customers. I do a lot of so-called missionary work with them, and I also write. a lot of orders that are billed, of course, through the wholesaler of their choice.

"My company's trade advertising in professional journals is directed to these men who examine eyes and dispense eyewear. It has several purposes. First, it sells the company and its policies. Then we use it to introduce new products and all important specifications such as styles, colors, sizes and availability. Another aim of our advertising is to keep the 'retailer' sold on products that he has ordered from me or from his wholesaler.

"I know our advertising does a job when I hear constant references to 'the SHURON ad I saw recently' or 'that new frame I saw in your ad.'

"It has been my experience that all three types of advertising are important, but that keeping the 'retailer' sold on SHURON products is the most vital. It helps bolster his confidence in his own judgment and cuts down my competitors' chances of selling him between my calls.

"Yes, I list advertising as No. 2 in importance in selling our products. When I put it in second position I put it ahead of salesmen. Here's the way I see it. Number one — you have to have a good product. Number two — you have to have a good advertising campaign. Number three—you have to have good men to follow up the advertising.

"That's my opinion."

Glen Chase
Yarnall-Waring Company
sells to industry

says Mr. Chase:

"I have been selling *Yarway* products for over seven years, and I'll have to admit that I've taken the trade paper advertising for granted. But when I stop to think I realize it's out there working for me all the time.

"For instance, I never have to tell my prospects who YARNALL-WARING is, or what they make. Often I don't even have to tell them why they should see me and find out what I've got to offer. The advertising has done much of the *who*, *what*, and *why* of selling before I make my contact.

"Here's an example: I recently had a phone call from a potential customer that I'd never even called on. He was having trouble with a competitive product. He'd seen our ads and wanted to try my product. That's one time when my sale consisted merely of writing the order. Advertising really made the sale.

"The advertising has given people a good impression of our company, too. This is surprising, when you stop to think about it, because we are a relatively small organization.

"Our company name is YARNALL-WARING but a great many people say '*Yarway*'. I believe this use of our trade-mark may be due to the wide use of the company trade-mark in our trade paper advertisements, on our product name plates, shipping cartons and stationery."

Ask your own salesmen what your company's business publication advertising does for them. If their answers are generally favorable, you can be sure that your business publication advertising is really helping them sell. If too many answers are negative, it could well pay you to review your advertising objectives — and to make sure the publications that carry your advertising are read by the men who must be sold.

How salesmen use their companies' advertising to get more business

Here's a useful and effective package of ideas for the sales manager, advertising manager or agency man who would like to get more horsepower out of his advertising. Send for a free copy of the pocket size booklet entitled, "How Salesmen Use Business Publication Advertising in Their Selling," which reports the successful methods employed by eleven salesmen who tell how they get more value out of their companies' advertising.

You'll find represented many interesting variations in how they do this. Some are very ingenious; all are effective. You can be sure that more of your salesmen will use your advertising after they read how others get business through these simple methods.

The coupon is for your convenience in sending for your free copy. Then, if you decide you want to provide your salesmen with additional copies, they are available from NBP Headquarters in Washington, at twenty-five cents each. Or if you choose you can reprint the material yourself and distribute it as widely as you please. But first, send for your free copy.

NATIONAL BUSINESS PUBLICATIONS, INC.

NBP ...each of which serves a specialized market in a specific industry, trade or profession.

NATIONAL BUSINESS PUBLICATIONS, INC.
Department 5A
1413 K Street, N. W.
Washington 5, D. C. STerling 3-7533

Please send me a free copy of the NBP booklet "How Salesmen Use Business Publication Advertising in Their Selling."

Name ____________________
Title ____________________
Company ____________________
Street Address ____________________
City ________ Zone ________ State ________

 Circle 70 on Inquiry Card, page 101

Ultrasonics (*Continued from page* 62)

welding members. The vibratory energy is briefly introduced.

Under ordinary circumstances ultrasonic welding is accomplished from 0.5 to 1.5 seconds per weld. Some work has been done with times as short as 0.10 seconds and as long as 3.0 seconds. The result is a solid-state metallurgical bond, made in a short time, with low clamping load, low deformation and no fusion.

This method of welding does not make use of heat normally associated with pressure or resistance type welding. It is believed that the welding is accomplished, at least partly, as a result of deformation at the inner face being welded. This deformation results from stresses introduced into the weld zone by the static force applied to the welding clamps, on which are superimposed oscillating stresses associated with the delivery of the elastic vibratory energy. The process achieves considerable deformation at the inner face being welded, with relatively little deformation at the surface where the static force and the elastic vibratory are applied. Inspection of numerous micro sections reveals internal deformations amount to as high as 80% while the external deformation is less than 5%.

Welding Transducer

The transducer used is usually a magnetostrictive type which operates in the frequency range of 4,000 to 40,000 cps. Power requirements range from 200 watts to 4,000 watts, with power usually in higher regions. The transducer is mounted as shown in Fig. 13.

Mounting the transducer at right angles to the force isolates the transducer itself from any pressures which may tend to dampen its vibratory motion or cause the housing requirements, as far as strength goes, to be increased. It is also the direction which gives efficient welding. The vibratory motion at the tip is in a lateral direction. The transducer is a rectangular shape built up of "A" nickel laminations wrapped with insulated wire.

Ultrasonic welding was developed to weld metals of the thickness of foil and sheet (0.00015 to 0.080 in.). These foils may be welded however to another piece of material which may be 1 in. thick. Just about any combination of metals may be joined together with this type of welding. This process has also been useful in welding objects almost too small to be seen with the naked eye.

Ultrasonic welding is not practical for such things as welding ships, or heavy plate where normal types of electric welding are still utilized. Continuous seam welding utilizing ultrasonics is presently under development.

Medical Ultrasonics

The application of ultrasonics to the medical field has been the subject of a great deal of experimental work. Experiments in brain surgery, diagnostic applications, dentistry, therapeutic applications and mappings of the body are taking place. Equipment in this field operates in a frequency range between 1 and 15 MC.

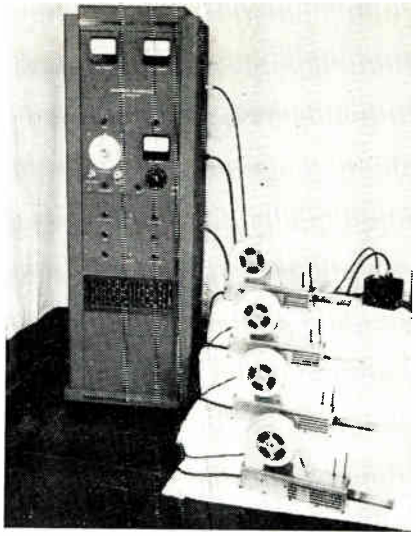


Fig. 14: Four ultrasonic soldering heads for continuous strip coating operating on one 600 w generator.

Photo—Sonobond Corp.

While complex brain surgery apparatus is ready for hospital use and ultrasonic dental drills operating at 30 KC are available, the most widely known use of ultrasonics is in the therapeutic field. A leading manufacturer of electronic medical equipment says that over 10,000 of their ultrasonic therapeutic devices are being used daily in treating muscular and bone disorders.

This equipment usually consists of a modified Hartley oscillator, a full wave rectifier power supply and a quartz crystal transducer that operates at 1 MC. The power output is often continuously variable from zero to 6 watts per square centimeter at the transducer.

The quartz crystal is held in close contact with a half-wave length metallic coupling plate that forms the front of the head. This transmits the vibrations with very little attenuation and has the advantage of protecting the quartz and providing a smooth rounded contact face.

The transducer shell is made of a nonferrous material and the whole unit is hermetically sealed. The crystal section of the applicator has a measured amount of special oil surrounding the quartz element for cooling and insulating purposes.

There are specially shaped adapters made for treatment such as inside the mouth. Sometimes a thin rubber container filled with water is placed in front of the applicator. The opposite face of the rubber can then adapt itself to the outline of whatever part of the body it is held against and allow treatment of sharply curved parts.

Experimentations are being conducted along the lines of pulsing the oscillator as opposed to continuous free running operation. The advantage claimed for this technique is that temperature rise of treated parts will be lower for a given intensity of other ultrasonic effects. Modulation of ac on the output stage has also been adopted in some cases.

The Applicator

The ultrasonic applicator is kept small so that it may be readily held in the hand. The person holding

(*Continued on page* 151)

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Latest Microwave Literature for Engineers

Microwave Oscillators

A new brochure describes a line of stable microwave oscillators and introduces a new instrument, Model 815, which covers the frequency range of 9000 to 10,500 mc. Bulletin 814 contains complete specifications and block diagrams and photographs. Laboratory for Electronics, Inc., 75 Pitt St., Boston 14, Mass.

Circle 219 on Inquiry Card, page 101

Duplexer

Budelman Radio Corp., 375 Fairfield Ave., Stamford, Conn., has issued a 2-color bulletin describing their radio frequency duplexer which is a tuned cavity network designed to provide for coupling a transmitter and receiver operating in the 450 to 900 mc bands to the same antenna and transmission line. The bulletin contains complete specifications, outline drawings and photograph.

Circle 220 on Inquiry Card, page 101

Test Equipment

A new brochure issued by the Cubic Corp., 5575 Kearny Villa Rd., San Diego 11, Calif., describes 10 completely transistorized instruments including waveform generator, pulse generator, frequency meter, transistor curve tracer, and 30 mc generator. Two power-measuring devices are also listed. Brochure is complete with photographs and specifications.

Circle 221 on Inquiry Card, page 101

Bolometer Preamplifier

A 2-color bulletin issued by Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md., describes a new amplifier which is used with the bolometer for microwave measurements. Brochure is complete with block diagrams, mechanical and electrical specifications.

Circle 222 on Inquiry Card, page 101

Design & Development

A 2-color bulletin issued by Radiation, Inc., Melbourne, Fla., describes their facilities for designing and developing microwave equipment. Brochure is complete with photographs.

Circle 223 on Inquiry Card, page 101

Coaxial Rotary Joint

A bulletin describing the Model 8701 coaxial rotary joint is being issued by Radiation, Inc., Melbourne, Fla. Bulletin contains photograph, complete electrical and mechanical specifications.

Circle 224 on Inquiry Card, page 101

Microwave Test Equipment

A new 96-page illustrated catalog is available showing a complete line of microwave instruments covering the frequency range 2600 to 90,000 mc. Complete electrical and mechanical data is presented including numerous data, charts, curves and photographs. Waveline Inc., Caldwell, N. J.

Circle 225 on Inquiry Card, page 101

Silicon Diode

A brochure describes a new silicon diode which simplifies microwave power measurements. The MA-424 diode is described fully in the bulletin which also contains graphs and curves showing its operation and electrical characteristics. Microwave Associates, Inc., Burlington, Mass.

Circle 226 on Inquiry Card, page 101

R-F Equipment

New 2-color brochure lists an extensive line of transmitters, modulators, power supplies, and accessories for applications in radar, communications, and tube development. Twenty-odd products are illustrated but a data tabulation covers these and more, to a total of 37 types. Levinthal Electronic Products, Inc., Stanford Industrial Park, Palo Alto, Calif.

Circle 227 on Inquiry Card, page 101

Microwave Equipment

The Radio Corporation of America, Engineering Products Div., Camden 2, N. J., has issued a new bulletin describing their complete line of microwave equipment and its application to pipeline companies, electric utilities, common carriers, state and municipal governments, and other users. The RCA microwave brochure is complete with photographs, drawings, and other interesting information.

Circle 228 on Inquiry Card, page 101

Frequency Measurements

Data File 111 describes frequency measurements and how to make them. This 16-page booklet covers such things as measurement of low to UHF frequencies, rotational velocity, flow, pressure, temperature and strain. It also covers telemetry and setting up a secondary standard of frequency. Complete with graphs and charts, this is a definitive discussion of the topic. Dept. 7220, Beckman/Berkeley, 2200 Wright Ave., Richmond 3, Calif.

Circle 229 on Inquiry Card, page 101

Test Equipment

Hewlett-Packard Co., Palo Alto, Calif., has issued a 12-page, 2-color booklet describing their complete line of test equipment and accessories. Booklet contains photographs, specifications, and tables which list primary uses, frequency ranges, the output and price of each piece of equipment. Booklet is punched for notebook insertion.

Circle 230 on Inquiry Card, page 101

Traveling Wave Tubes

A 2-color brochure issued by Huggins Laboratories Inc., 711 Hamilton Ave., Menlo Park, Calif., describes in table form their various tubes such as backward wave amplifiers, forward wave amplifiers, backward wave oscillators, and special purpose tubes. Brochure is in easy-to-read table style with necessary information about the tubes.

Circle 231 on Inquiry Card, page 101

Parabolic Reflectors

Bulletin No. 8438 describes parabolic reflectors constructed of heavy gauge aluminum. Bulletin contains photograph, physical dimensions and price of these reflectors. Andrew Corp., 363 E. 75th St., Chicago 19, Ill.

Circle 232 on Inquiry Card, page 101

Microwave Tubes

A 32-page, 2-color catalog issued by Varian Associates, 611 Hansen Way, Palo Alto, Calif., describes their line of microwave tubes. Booklet contains photographs, cut away drawings, complete specifications, both electrical and physical and the frequency of operation of tubes. The first few pages describe, with cutaway views, the various types of tubes available and also contains a chart which makes it easy to locate a particular tube for a definite function.

Circle 233 on Inquiry Card, page 101

UHF Triode

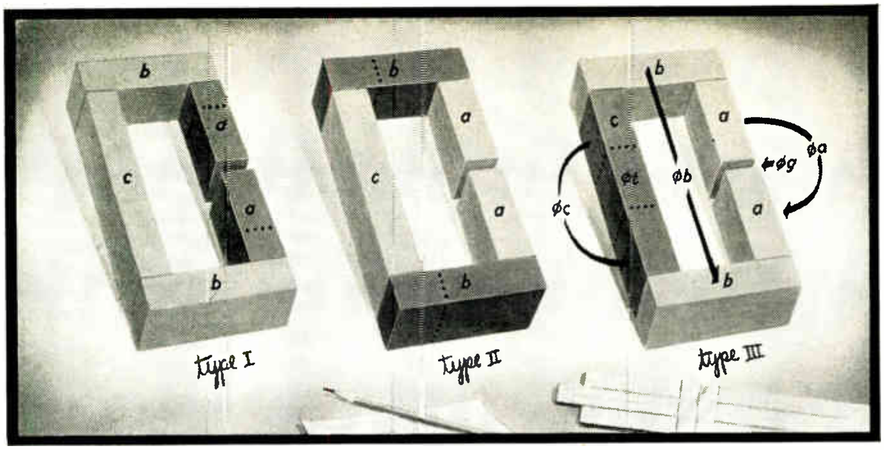
Eitel-McCullough, Inc., San Bruno, Calif., has issued a bulletin describing their new 3CX100A which supersedes the 2C39 group. Bulletin is complete with electrical and mechanical specifications, photograph, outline drawing and characteristic table.

Circle 234 on Inquiry Card, page 101

High Power Termination

A bulletin has been issued by The Narda Corp., 160 Herricks Rd., Mineola, N. Y. describing their Model 369 high power coaxial termination. Complete specifications and prices are included.

Circle 235 on Inquiry Card, page 101



How You Can Save Time Estimating Leakage Factors for Magnetic Circuits

Computing even approximate values for leakage flux in magnetic circuits is a time consuming job. The research department of Indiana Steel recently undertook a series of studies, supported by the U.S. Air Force, to simplify these computations. Dr. R. K. Tenzer reported the results of this work, which reduce the time in computing leakage flux up to 90% by diminishing the number of mathematical operations necessary.

The investigations were done on circuits with permanent magnets; the results were also found applicable to unsaturated electromagnetic circuits when the coil-covered parts were treated as permanent magnet parts.

After checking values obtained by this method with actual measured values for many Type I, II, and III magnetic circuits, deviations were found to be less than ± 10%.

Leakage Flux, Leakage Factor

Because of magnetic leakage, only a part of the total flux through the neutral zone of the permanent magnet is found in the air gap. The difference between these two values is known as leakage flux. Mathematically this is:

$$\phi_L = \phi_t - \phi_g. \qquad (1)$$

In practical design, leakage is best considered as a factor stated thus:

$$\sigma = \frac{\phi_t}{\phi_g} = 1 + \frac{\phi_L}{\phi_g}. \qquad (2)$$

For simplification, the flux can be assumed to follow three basic, probable paths: ϕ_a between parts a, ϕ_b between parts b, and ϕ_c along part c. The equation above then becomes:

$$\sigma = 1 + \frac{\phi_a + \phi_b + \phi_c}{\phi_g}. \qquad (3)$$

With $\phi = mmf \times P$, this formula can be written:

$$\sigma = 1 + \frac{1}{P_g}\left(\frac{mmf_a}{mmf_g} P_a + \frac{mmf_b}{mmf_g} P_b + \frac{mmf_c}{mmf_g} P_c\right). \qquad (4)$$

Letting the mmf ratios be denoted by K,

$$\sigma = 1 + \frac{1}{P_g}\left(K_a P_a + K_b P_b + K_c P_c\right). \qquad (5)$$

This becomes the basic equation for numerical calculations of leakage factors after introducing simple expressions for leakage permeances and mmf ratios.

Simplified Leakage Permeances

The following formulas have been found satisfactory for leakage permeances between soft steel parts:

$$P_a = 1.7 \times U_a \times \frac{a}{a + L_g} \qquad (6)$$

where U is cross-section perimeter;

$$P_b = 1.4 \times b \times \sqrt{\frac{U_b}{c} + .25} \qquad (7)$$

where U_b/c is greater than .25 and less than 4. The total length of part b is used.

Since permanent magnets have a neutral zone which does not contribute to leakage, the value of 2/3 of the magnet's total length is used when computing leakage permeances—this is the effective length a' and b' to compute P'; thus the two equations above become:

$$P'_a = 1.7\, U_a \frac{.67a}{.67a + L_g} \qquad (6a)$$

and

$$P'_b = 1.4 \times .67b \sqrt{\frac{U_b}{c} + .25} = .67\, P_b. \qquad (7a)$$

When part c consists of a permanent magnet (Type III) its permeance can be calculated as:

$$P_c = .5\, U_c. \qquad (8)$$

The permeance of the air gap itself is

$$P_g = A_g / L_g. \qquad (9)$$

Simplified MMF Ratios

Simplifying the mmf ratios is done by neglecting the reluctance in *soft steel parts;* so

$$mmf_a = mmf_b = mmf_g \text{ or } K_a = K_b = 1 \; (mmf_c = 0 \text{ so } K_c = 0). \qquad (10)$$

Since the mmf *along permanent magnet parts* is not constant, integral values ($\overline{mmf}$) are used. Experiments showed that 2/3 of the mmf_g was the effective mmf for leakage flux between permanent magnet parts; thus

$$\overline{mmf_a} = \overline{mmf_b} = \overline{mmf_c} = 2/3\; mmf_g$$

or

$$K_a = K_b = K_c = 2/3. \qquad (11)$$

Basic Formulas

By inserting the permeances for soft steel into equation (5), the general formula becomes:

$$\sigma = 1 + \frac{L_g}{A_g}\left(K_a \times 1.7\, U_a \frac{a}{a + L_g} + K_b \times 1.4\, b \sqrt{\frac{U_b}{c} + .25} + K_c \times .5\, U_c\right). \qquad (12)$$

This formula contains only constants and dimensions; and by the two following rules this can be modified into the three basic equations for the Type I, Type II, and Type III circuits.

Rules: (1) For leakage flux paths between soft steel parts, use total lengths and constant K of 1. (2) For leakage flux paths between permanent magnet parts, use 2/3 of lengths and K of .67.

The following provide the leakage factors for the three types of circuits:

Type I:

$$\sigma = 1 + \frac{L_g}{A_g} \times .67 \times 1.7\, U_a \frac{.67a}{.67a + L_g}$$

Type II:

$$\sigma = 1 + \frac{L_g}{A_g}\left(1.7\, U_a \frac{a}{a + L_g} + .67 \times .67 \times 1.4b \sqrt{\frac{U_b}{c} + .25}\right)$$

Type III:

$$\sigma = 1 + \frac{L_g}{A_g}\left(1.7\, U_a \frac{a}{a + L_g} + 1.4b \sqrt{\frac{U_b}{c} + .25} + .67 \times .5\, U_c\right)$$

For variations on these basic formulas, write today for the April-June issue of *Applied Magnetics* which also shows examples of the formulas in use.

Traveling Wave

(*Continued from page 69*)

the beam. Since it is possible to make a TW tube with much greater coupling between circuit and beam than between bunches in the beam, the energy processes involved in the space-charge storage of energy cannot be essential to the process of gain. Although there is no energy transfer from circuit to beam in producing bunching, there is a perfectly real energy transfer from the bunched beam to the circuit in inducing a field on the circuit.

In terms of the picture of the beam passing through a series of interconnected gaps, the beam delivers power to each gap in the same fashion that the bunched beam in a klystron delivers power to the load of the catcher gap. Here the load is the characteristic impedance of the transmission line that constitutes the TWT circuit, and the power delivered at each infinitesimal gap propagates down the circuit in both directions from the point at which it was induced. At each stage of bunching, then, no energy is transferred; but in setting up each field wave, secondary, tertiary, etc., the beam transmits energy to the circuit.

"Total Wave" Analysis

It is also possible to view the energy-transfer process from the point of view of the total wave, which is the sum of all the induced waves plus the original applied wave. As stated previously, this wave may be shown to increase exponentially with distance. The total field wave is traveling slower than the beam and the original wave, since it is composed of induced wave components, each of which lags the previously induced component by 90°. Thus, energy is ultimately transferred from the beam to a wave traveling slower than the beam. It may be shown from very elementary considerations that a beam must be traveling faster than a growing wave in order to transfer energy to it.[3]

References

1. R. Kompfner, "The traveling-wave tube," *Wireless Eng.*, 24: 255-266 (1947).
2. R. Kompfner, bid., n. 1.
3. J. R. Pierce and L. M. Field, "Traveling-wave tubes," *Proc. IRE*, 35: 108-111 (1947).

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Printed Microwave

(*Continued from page 66*)

An analysis of corresponding mixer performance has not yet been completed. By connecting two of these mounts to two arms and feeding opposite arms of a ring circuit from two r-f signal sources, a compact balanced mixer is readily realized.

System Applications

From an application point of view requiring miniaturization, reproducibility, and cost reduction, consideration for a proposed system realization should include PMC techniques. This is particularly emphasized for most airborne applications. Above K-Band, however, advantages of PMC over waveguide become marginal, although fabrication is still simpler and cheaper.

By printing the entire r-f circuitry in one operation rather than connecting individual components together, the connectors on each component are obviated—further reducing cost, size, and improving electrical performance.

Fig. 6 depicts a complete S-Band front-end receiver. The front end contains a Microdot antenna input connector and transition, balanced mixer, variable attenuator, local oscillator, crystal meter and switch. The remainder of the receiver includes a low-noise Wallman circuit, four-stage i-f amplifier, second detector, video amplifier, and cathode follower output. This unit is currently being developed and will have an antenna input-to-cathode follower output gain of about 130 db. Using 1N369A crystals, the expected noise figure is about 10 db.

Packaged in 30 cu. in., the complete S-band unit, Fig. 6, weighs approx. 20 oz. The printed microwave circuitry occupies only 2 cu. in. By using a smaller klystron (when available) and employing the recently announced VHF germanium tetrode transistors in the i-f amplifier, the size and weight may be further reduced by about 20%. Virtually the entire r-f circuitry and the i-f and video wiring can be printed in one operation. The unit cost of quantity numbers

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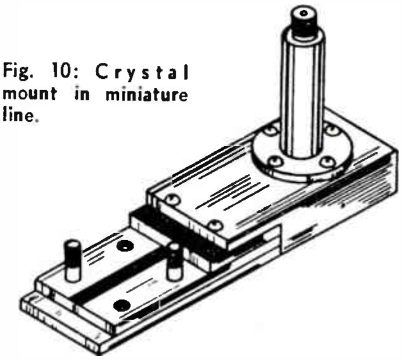
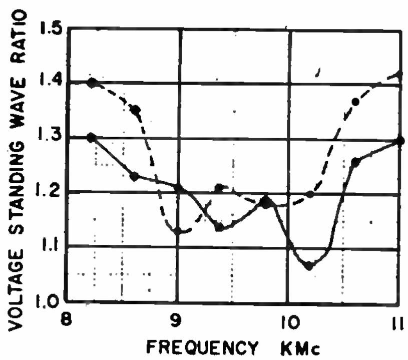
permits throw-away maintenance of subsections.

Ruggedness and compact size of this type construction augurs well for proximity fuze and missile applications. Passive PMC duplexers for beacons permit substantial reduction in cost and complexity of fabrication. In general, aircraft radar, countermeasures, and an-

Fig. 10: Crystal mount in miniature line.





tenna systems are afforded further degrees of freedom in design by the advantages offered in using printed microwave lines and components.

Conclusions

Until recently the applications of PMC have been limited because of inadequate housing and connectors. Universal connectors make a complete line of PMC practical in the same sense as coaxial or waveguide components, and offer additional advantages. Some components, either not feasible or practical in other transmission lines, are realizable in PMC. Finally, the greatest advantage of PMC is obtained when entire microwave wiring and components are printed and fabricated in one single unit.

The author extends his gratitude to Messrs. Diehl, Mills, and Ranck for their support in measurements and data reduction.

Transistor Bias Circuits

(*Continued from page* 77)

stabilizing circuits. The price paid for stabilization in this circuit is additional components and higher battery drain. Reduced impedance levels and reduced gain also result, but these factors can usually be kept within reasonable bounds.

In analyzing this circuit, let us first consider R_S to be absent. We may then consider the voltage source for the base bias current as $V_{CC}-I_ER_E$. Should I_C increase due to a temperature rise, the emitter current rise increases the voltage across R_E. Thus the voltage source for the base bias current decreases and the reduced base bias current tends to restore I_C to its original value. The circuit is stabilized even without R_S, but the amount of stabilization is limited by the voltage variation across R_B as the bias current changes. This voltage variation may be stabilized by the bleeder action of R_S. In addition, R_S permits a reversal of bias which may be required at high temperatures.

We will now determine the stability factor of this circuit. Neglecting the base-emitter voltage, a solution of the circuit yields

$$I_C = \frac{\dfrac{\beta V_{CC}}{R_B} + I_{CL}\left(1 + \dfrac{R_E}{R_B} + \dfrac{R_E}{R_S}\right)}{1 + (\beta + 1)\left(\dfrac{R_E}{R_B} + \dfrac{R_E}{R_S}\right)} \qquad (11)$$

and

$$J_s = \frac{dI_C}{dT} = \frac{1 + \dfrac{R_E}{R_B} + \dfrac{R_E}{R_S}}{1 + (\beta + 1)\left(\dfrac{R_E}{R_B} + \dfrac{R_E}{R_S}\right)} \frac{dI_{CL}}{dT} \qquad (12)$$

the stability factor is

$$S = \frac{\beta}{\beta + 1 + \dfrac{1}{\dfrac{R_E}{R_B} + \dfrac{R_E}{R_S}}} \qquad (13)$$

For good stabilization, R_E should be large and R_B and R_S small. However, small values of R_B and R_S load the input circuit and increase the battery drain. Generally R_E is chosen as high as can be tolerated considering such factors as V_{CC}, R_C, the required stabilization and the operating point. Then the loading effect of R_B and R_S will be minimum for a given requirement of stabilization. The actual values of R_B and R_S may be computed from the equations of stabilization and base current. Ignoring V_B.

$$I_B = \frac{\dfrac{V_{CC}}{R_B} - I_C\left(\dfrac{R_E}{R_B} + \dfrac{R_E}{R_S}\right)}{1 + \dfrac{R_E}{R_B} + \dfrac{R_E}{R_S}} \qquad (14)$$

Then from Eqs. 14 and 15,

$$R_B = \frac{V_{CC}\,[\beta\,(1 - S) - S]}{\beta\,(1 - S)\,I_B + SI_C} \qquad (15)$$

and for R_S in terms of R_B.

(*Continued on page* 148)

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$$R_S = \frac{1}{\dfrac{S}{R_E\,[\beta - S\,(\beta + 1)]} - \dfrac{1}{R_B}} \qquad (16)$$

By equivalent circuit analysis it can be shown that the capacitance of the emitter by-pass capacitor should reduce the impedance in the emitter circuit to approximately

$$Z_E = \frac{1}{2}\left(r_e + \frac{r_b + R_g}{\beta + 1}\right) \qquad (17)$$

at the lowest frequency of interest. r_e and r_b are equivalent circuit properties of the transistor and R_g is the resistance seen by the transistor looking back from base to ground. If, for example, the input is from another amplifier, then R_g is approximately the parallel resistance of R_C for the previous stage, R_B and R_S. Usually R_E is quite high and the low reactance of C_E must be depended upon to keep the degeneration to a minimum.

Example 3
Stabilized Amplifier

Given: Amplifier circuit of Fig. 4.
Characteristic curves of Fig. 5.

Supply Voltage:	V_{CC}	=	12 v.
Operating Point:	V_C	=	3 v.
	I_B	=	5 μa.
	I_C	=	1.2 μa.
	β	=	75
	R_L	=	500 ohms
Required Stability:	S	=	0.90
Lowest Frequency:	f	=	30 cps
	r_e	=	25 ohms
	r_b	=	1500 ohms
	R_C	=	5000 ohms (for previous stage)

Solution: Neglecting the base component of the emitter current, the sum of R_E and R_C will be

$$R_E + R_C = \frac{V_{CC} - V_C}{I_C} = 7500 \text{ ohms}$$

The amount of resistance that can be assigned to R_E will depend upon R_L, since the current gain will be reduced if R_C is not considerably larger than R_L. Let us assign 2700 ohms out of the 7500 ohms to R_E.

$$R_E = 2700 \text{ ohms}$$
$$R_C = 4800 \text{ ohms}$$

Then from Eqs. 16, 17, and 18

$$R_B = 70{,}800 \text{ ohms}$$
$$R_S = 27{,}500 \text{ ohms}$$
$$Z_E = 48.7 \text{ ohms}$$

Since R_E is much higher than Z_E, the reactance of C_E should be about 48.7 ohms at 30 cps, giving a capacitance requirement of 109 μf.

Summary

We have defined a stability factor that indicates the improvement of the operating point stability over an unstabilized amplifier and have derived design formulas for bias components in terms of the stability factor and desired operating point. Although these concepts were applied to a limited number of circuits, they may be readily extended to other bias arrangements.

Sputnik (*Continued from page 74*)

the satellite on its axis. The detector will have a field of view of approximately 120° and will be located on the equator so that the solar signal will exist for approximately one third of each spin period, slowly approaching a maximum when the detector is directed toward the sun.

Also associated with the solar Lyman alpha experiment will be a silicon solar cell to be used for obtaining information on the aspect of the satellite with respect to the sun. The system is designed to obtain values for instantaneous output of the Lyman alpha dector and solar aspect cell with an accuracy of a few percent and with good time resolution to permit time coordination between the two signal sources.

Radio Data

A single radio transmitter in the satellite serves the dual purpose of transmitting telemetering signals to the ground receiving station and providing signals to be used in the Minitrack radio tracking system. Minitrack uses radio-interferometry to establish two direction angles needed to determine the direction in space from the receiving station to the satellite.

Measurement of angular positions will be made by comparing the electrical phase difference between signals received by pairs of antennas located a known distance apart. This phase difference contains information regarding the difference in path length between the satellite and the pairs of antennas. With an appropriate array of antennas, the two-direction angles can be calculated uniquely.

Electrical manipulation of the incoming 108-megacycle signal from the satellite permits ultimate determination of the required angles by comparison of electrical phase of signals at 500 cps. Modulation of the satellite transmitter for telemetering purposes must avoid frequency components in the range from this 500-cps reference frequency through its fifth harmonic at 2.5 kc to prevent introduction of excessive errors in angular position. Transmitted power will be 100 mw peak.

Ground Stations

Since the U. S. satellites in their proposed orbits are expected to traverse nearly two thirds of the total surface of the earth, it was completely impractical to provide adequate number of ground receiving stations to continuously receive signals from the satellite. Satellite receiving stations are therefore located so as to receive and record signals at least once each orbit with a small group of additional stations which will occasionally provide more closely spaced telemetry records.

On group of stations is located roughly in a north-south line along the east coast of the United States and extending southward along the west coast of South America from Washington, D. C., to Santiago, Chile. One such station in the West Indies should provide early information as the satellite is being launched. An additional station in California will provide additional information with less than full orbit separation. Ten stations have been installed and

(*Continued on page* 150)

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are operating as a part of the Project Vanguard earth satellite program. Technical information has been given to universities, foreign governments, and advanced amateurs so they could install stations to receive and record this telemetered data.

Each ground station has an array of high gain antennas viewing the satellite in its path approximately 30° each side of zenith. This antenna system can provide a recording interval of from three quarters of a minute to fifteen minutes duration for each transit of the satellite, depending upon the height above the earth. Longer recording intervals at greater radio transmission distances will provide an opportunity to use statistical methods for obtaining improved data reliability during unfavorable signal-to-noise ratio operating conditions.

A sensitive receiver, with this high gain antenna array, provides signals to an instrumentation-type magnetic tape recorder for making permanent records of telemetered data. Two receiver outputs are provided, one conventionally detected for favorable conditions and the second a linearly detected output which essentially contains all information in the receiver i-f section for use in extracting data under poor signal-to-noise ratio conditions.

The tape recorder gives seven channels on ½-inch wide magnetic tape moving at 30 ips. Other tape speeds up to 60 ips are available for special needs of experiments in subsequent satellites. In use with the first U. S. satellite, three channels will be used for recording telemetered data, three for timing information, and one spare.

Telemetered data channels will record the conventionally and linearly detected receiver output by direct recording methods, while the third channel will utilize special pulse width recording to permit accurate reproduction of telemetered signals where favorable signal-to-noise ratios exist. Timing channels will record a precision standard frequency for use in accurate pulse width measurements, a recording in code of the time of day at which recording was made, and a "speed-lock" channel used for correct synchronization of playback speeds.

Satellite conditions leave much to be desired in signal-to-noise ratios. Low transmitted power and long transmission distances result in low received signal levels. High gain antennas combined with sensitive receivers contribute to high noise levels, particularly in the southern hemisphere where hot spots in galactic noise exist, the sun coinciding with these hot spots, and a simultaneous maximum altitude transit. The telemetering signal must thus be one offering maximum readability in the presence of noise.

The telemetering system must accept information from many types of input devices. The first U. S. satellite telemetering system handles information supplied in the form of variable resistances (thermistors and pressure transducers), low values of electrical current (electrometer tubes), high currents (silicon solar cells), and voltages (battery voltage monitors).

1. Based on data presented before AIEE by Whitney Matthews, Head, Applications Group, Solid State Division, NRL.

Ultrasonics (*Continued from page* 138)

the applicator does not derive any benefits or detrimental effects from this. Coupling to the patient is made using either water or oil. In a normal operation no sounds of any nature are heard from the applicator.

Failure of treatment is quite often caused by not holding the head flatly against the skin, improper coupling media, and deficiencies in the ultrasonic generator. If the treatment head is moved too slowly during massage technique, a burning sensation may be experienced by the patient but no burns under the skin or other tissues have resulted to date.

There is still quite a bit of controversy in this field over how ultrasonics actually works. There are those that believe the ultrasonic generator is nothing more than a glorified heating pad or sunlamp. While others believe the mechanical action is the useful effect.

As with every new form of therapy, the ultrasonic energy was, in its beginning, applied in a somewhat haphazard trial-and-error manner. This caused it to be viewed as a quack-type device in many circles. The haphazard methods have been recently replaced by serious clinical studies and careful measurements of physical properties.

We would like to state again that practically all the applications of ultrasonics in the medical field are still in fairly early stages of development. One of the problems confronting this field is the apparent poor commercial possibilities. (*Part* 2 *next month*).

 (*Continued from page 57*)

version loss, and t is the time average of the noise temperature of the crystal diode itself.

Under the influence of the local oscillator and bias the crystal diode acts as a time-varying resistance. Each instantanteous value of this resistance has a corresponding noise temperature. It has the value unity when no crystal current is flowing but increases rapidly with crystal current.

With no local oscillator injection, and for slight values of forward bias, t can theoretically be given by

$$\bar{t} = \frac{19}{\alpha} \qquad (6)$$

As seen earlier, α can have the maximum value of 40, so t can theoretically be as low as ½ at room temperature. The weaker the necessary local oscillator drive, the better the noise temperature t. The better the mixer crystal, the higher its α will be, and thereby the weaker need be the local oscillator voltage V as seen in Fig. 6.

Although the time average noise temperature t increases with local oscillator injection, conversion loss decreases only up to a certain point. A compromise must be made, for Eq. 5 shows the mixer noise temperature t_x reduced as conversion loss L_0 approaches its theoretical minimum of 2.

If conversion loss is given its minimum value of 3.1 as seen from the curve of Fig. 6, and t takes its minimum value of one-half, Eq. 5 gives a value of 0.85 as the theoretical minimum for broadband mixer t_x. In practice, the best silicon crystals average about 1.3 for t_x, and for the germanium 1N263 the average broadband t_x is about 1.15.

As might be expected, the portion of the crystal diode noise that appears at the i-f terminals is affected by the image termination in narrowband mixing. For "image open" the mixer noise temperature is always higher, and for "image short" the mixer noise temperature is always lower, than for the broadband mixing conditions.

Fig. 9b shows the variation for a germanium mixer diode. It would be similar for approximately zero bias for the best silicon crystal. The highest i-f conductance at the right portion of the graphs of Fig. 9 represents image short condition, and the extreme left side of the graph represents "image open" operation. Fig. 9c again shows image-open conversion to be considerably lower than image-short conversion.

Of course, the signal termination has been rematched for each point of the chart. If we refer to Eq. 3, we see that for high values of F_{if}, the over-all receiver noise figure F_r will be minimized for the conditions which minimize the conversion loss L_x. Fig. 9a shows that even for a good i-f noise figure of 1.3 (1.14 db), the conversion loss is still the dominant dependency. The receiver noise figure F_r is minimized near the "image open" mixing condition.

Thus for low-noise crystals, the mixer design influences the desired values of i-f noise figure to be achieved. For broadband mixers, and in UHF TV tuners where practicality and simplicity dictate image short mixing, the i-f noise figure is generally so much higher than the mixer noise temperature that the receiver noise figure can be improved in exact proportion to the improvement of the i-f noise figure.

Vacuum Tubes

The over-all noise figure of an i-f amplifier can be analyzed and measured in terms of the noise figure and gain of the cascade stages as related by Eq. 1.

If the available gain of the first stage G_1 is large enough, and the noise figure F_2 of the second and successive stages is small enough,

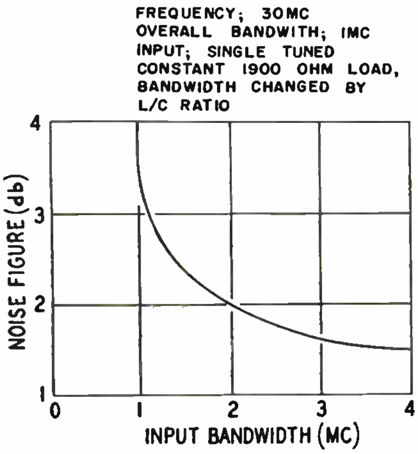

Fig. 10: Receiver noise figure vs input network bandwidth (experimental results at 30 mc).

the over-all noise figure $F_{1\text{-}n}$ will reduce to the F_1 of the first stage alone. Triodes are the lowest noise tube type, so that by cascading two in a Wallman[4] circuit, the over-all amplifier noise figure can be that of the first tube.

Choice of I-F Tube

Now it is possible to study the tube parameters of a triode which determine its noise figure capability. The best noise figure possible from a tube, F_{opt} has been derived to be

$$F_{opt} - 1 = \left[\frac{\rho G_i \theta}{g_m}\right]^{1/2}; \qquad (7)$$

requiring the optimum source conductance

(*Continued on page* 154)

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$G_{s,\,opt}$ to be

$$G_{s,\,opt} = \left[\frac{\rho G_i g_m}{\theta}\right]^{1/2} \quad (8)$$

where g_m is the conventional term for tube transconductance, G_i is its input conductance, ρ is the noise temperature of the input conductance and θ is the effective noisiness of the transconductance g_m — ρ and θ are constants that are affected only slightly by tube design, both having values between 2 and 4.

G_i and g_m are drastically affected by tube design. G_i is dependent on g_m, increasing as g_m increases, but it is the mark of a low-noise tube to have a low ratio of G_i to g_m. When nothing else is known, high g_m is required for low noise, not only because of Eq. 7, but because Eq. 8 shows it reduces optimum source conductance $G_{s,\,opt}$. The lower $G_{s,\,opt}$, the less will be the noise figure degradation from inadequate bandwidth as discussed in Section 3 below.

Choice of I-F Frequency

The excess i-f noise figure $(F_{if} - 1)$ and excess mixer noise temperature $(t_x - 1)$ in Eq. 3 are i-f-frequency-dependent, but not the conversion loss L_x. There will be some i-f frequency for which the value in the brackets, and therefore receiver noise figure F_r, diminishes. This is made clearer by rewriting Eq. 3

$$F_r = L_x[(t_x - 1) + (F_{if} - 1) + 1] \quad (9)$$

Tube noise theory [5] shows G_i of Eq. 7 to be proportional to frequency squared. Thus excess noise figure is proportional to i-f frequency, which has been experimentally verified. Crystal physics shows that the excess noise temperature $(t_x - 1)$ is inversely proportional to frequency to an exponent m with a value between 0 and 1 depending on diode design. These relations can be expressed by:

$$t_x - 1 = \frac{k_1}{A_o^m} \quad (10)$$

$$F_{if} - 1 = k_2 A_o \quad (11)$$

where k_1 is a calculated or measured value for $(t_x - 1)$ at 30 MC, k_2 is the same for $(F_{if} - 1)$, A_0 is frequency-normalized to 30 MC (for example: $A_0 = 1.5$ for 45 MC), and M is the exponent. For silicon diodes for i-f between 10 and 90 MC, m has been measured to have values between 0.3 and 0.7 but it is constant for any one crystal. The value in the bracket of Eq. 9 will minimize for the normalized frequency A_{om} given by

$$A_{om} = \left[\frac{mk_1}{k_2}\right]^{1/(m+1)} \quad (12)$$

For example, a good 5702 30-MC i-f has a 1.5-db noise figure, making $k_2 = 0.42$, and the 1N263 has a 30-MC broadband noise temperature t_x of 1.15, making $k_2 = 0.15$; then, assuming an average value of ½ for m, Eq. 12 gives A_{om} to be 0.315, or about 10 MC for optimum i-f.

Eq. 12 clearly shows that the larger the excess i-f noise figure (k_2) compared to excess mixer noise temperature (k_1), the lower will the optimum i-f be. As crystals improve the $t_x - 1$ spectrum will approach white noise, meaning m in Eq. 10 approaches 0. Thus the better the crystal, the lower the optimum i-f, and the better the i-f noise figure, the higher the optimum i-f.

(*Continued next month*)

Table 1

EFFECT OF IMAGE TERMINATIONS

Philco Germanium Experimental Crystal #405 at I_{dc} = 1.2 ma, 0.1V forward bias Frequency 840 mc.		Conversion(1) Loss L_x	Noise(1) Temp t_x	IF(1) Resistance R_{if}	Receiver(2) Noise Figure F_r
Fundamental	Second Harmonic	(db)	(times)	(ohms)	(db)
Open	Open	4.0	1.3	560	6.8
	Short	6.6	1.0	270	8.7
Short	Open	6.1	1.08	270	8.4
	Short	7.5	1.00	120	9.5

Note 1 Measured parameters.
Note 2 Calculated for 2-db IF Noise Figure.

Microwave Simulator

Continued from Page 81)

a very critical dependence between circuit loss and maximum power multiplication, particularly for losses less than a few tenths of a db.

Under operating conditions of less than maximum gain, the loop loss can be precisely determined from the difference between the incident power and that in the primary line load. The measurement of loss in this fashion is considerably more convenient than many procedures involving the measurement of VSWR. Another important application is the precision measurement of loss where the loss is a function of power level such as in a large variety of gas-switching tubes.

References

1. Traveling Wave Resonators by L. Milosevic and R. Vautey, *Revue Technique C. F. T. H. No. 21,* December 1955, pp. 63-68.
2. Traveling Wave Resonator by P. J. Sferrazza, *Tele-Tech,* November 1955, p. 84.
3. F. J. Tischer, Resonance Properties of Ring Circuits, *IRE Trans.,* Vol. MTT-5, No. 1, January 1957, pp. 51-56.

Fosdic II

(*Continued from Page* 83)

times faster than mechanical card handling machines.

The input to FOSDIC II is 16-mm microfilm. Each 100-foot roll contains up to 13,000 images of punched cards. Although the present equipment is designed for the 80-column, rectangular-hole card, it could be modified to work equally well for the 90-column, round-hole card. The film is currently prepared in a special microfilm camera designed and built at the Bureau of the Census. This camera films the cards against a background scale which provides the indexing for the columns on the card. While the nominal reduction ratio is 24:1, a considerable tolerance exists because the scale is included on the film. The reduction ratio is made greater by a factor of two in the short dimension of the card by an anamorphic lens attachment in the camera. The rectangular punched holes on the card thus appear as squares on the film, and can be read just as easily by the machine.

EE Views Industry

(*Continued from page* 109)

It should be noted, also, that 91% of the 3433 respondents were seniors. Many of the comments that follow therefore are based on the assumption that the opinions adduced from the data represent the opinions of seniors. The respondents by age groups, as of May, 1956, were as follows: 21 yrs. og age, 27%; 22 yrs., 22%; 23 to 25 yrs., 23%; and more than 26 yrs., 28%.

Technical Opportunities

In this inquiry the kinds of organizations—industrial, government, or educational—were listed and the student was asked to give his opinion on each one as to whether the technical opportunities for electrical engineers in that kind of organization are "Good," "Average," or "Poor." The results are shown in Fig. 1.

A most interesting point, which is characteristic of the whole survey, is that the number of respondents who failed to express an opinion is quite small—less than 6% on practically all questions. Modern American education is being criticized for many things; it appears, however, that when men become seniors in electrical engineering they not only have opinions, they are willing to express them.

Supplemental comments entered on the questionnaires indicated that many of the colleges and also employers have provided little information for the students regarding the kinds of work and the opportunities in certain businesses. This lack of information may be largely responsible for the poor opinions of several lines of employment.

There is in the answers to this inquiry a whole series of challenges to the profession of electrical engineering. These challenges can be put in the form of questions, of which some are the following:

If a large fraction of graduates wants to work on computers, solid-state devices, information theory, control, and all the other new areas under the tent of electronics, how can undergraduate students be educated to prepare them for this work? If more of the basic aspects of these subjects are put into the curricula of our schools, what will be removed to make room for them? How are the students to be educated to prepare them simultaneously to become good citizens and professional engineers?

What are the utilities—not just power, but others as well—to do in order to find personnel who can solve the formidable technical problems they face?

Is the trend of opinion represented by these data temporary in nature or will it proceed further in the direction it seems to have taken in the past 25 yrs.?

What will be the actions of professional-technical societies in electrical engineering to meet the needs of their members, who are becoming active in many diverse and highly technical endeavors?

What is the responsibility of the colleges and employers to correct the difficulties in training the college students, informing them of the work that they may expect, and properly placing them as employees?

Tentative answers to some of these questions have been offered and are being tried. Failure to analyze questions like these, and failure to act soon can have major effects on the profession of electrical engineering in the next 10 to 20 yrs.

Factors Influencing Choice

The respondents were asked to list, in descending order of importance to them, a group of factors that had influenced their selection of employer or would probably influence their choice if they had not yet accepted a job. The composite results are shown in Fig. 2. The data were evaluated by assigning numerical ratings, such that the highest numerical rating represents a combination of a large number of votes and high relative placement in the list.

The students chose 3 things which they consider most important: good opportunities for personal and professional development, work in fields of special interest to them, and work in a geographical location they like.

(*Continued on page 158*)

(*Continued from page* 157)

Jobs Accepted—Areas of Work

Those who had accepted positions when they submitted questionnaires described the areas in which they will work as tabulated in Fig. 3. These data show clearly that there are opportunities for employment that generally satisfy the desires of the entire group.

Development, design, planning and application, and research represent the vast majority of work in which the new graduates will be engaged. The total for these categories, from Fig. 3 is 81%. However, many students indicated that they would be engaged in at least two of the occupations. Allowing for these multiple answers, it is estimated that at least two-thirds of the graduates will be employed in these four areas of work.

Starting Salaries

For those who had accepted jobs the starting salaries were listed, with the kind of employer. Fig. 4 lists the average monthly salary for each kind of employer for which there were 15 or more individuals already offered employment.

The average monthly starting salary is $442. A breakdown by age and academic degree, Table 1, is interesting. There is a marked increase in salaries listed in the 1956 survey over salaries listed in the 1955 survey.

Table 1

Degree	Average Salary (dollars per month)
B. S. (all respondents)	$440
B. S. (23 years old, or less)	426
M. S.	491
Ph. D.*	591

* The number is small: 10.

Additional Data

Many other interesting statistics and comments were revealed by the survey. Some of these are summarized in the following paragraphs.

Many students expressed a desire for summer work, cooperative work and study programs, or other means of obtaining some practical experience in their chosen profession. Seemingly in many parts of the country there is little opportunity for such employment. The result—many students very close to graduation with no knowledge of what awaits them as electrical engineers.

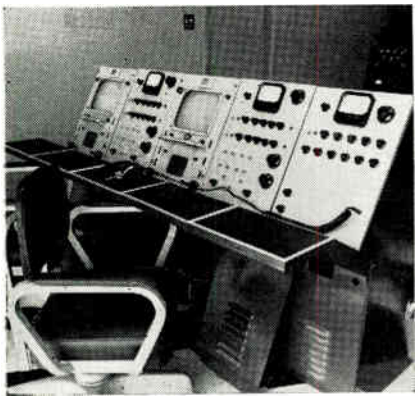
Those who answered the questionnaire were given the opportunity to add their own comments; they did, with a vengeance. These personal comments cannot be treated either summarily or statistically. They range far and wide in subject and opinion. They are often critical — of educational methods, of personnel practices in industry, of the status of engineering as a profession; yet they show understanding of some of the things that lie at the root of that which they criticize.

Perhaps it is in order to conclude in a lighter vein. One student, taking advantage of the request for individual comments, stated that he expected to be awarded his Ph. D. in June 1957, and that he would seek "a job to exercise my creative abilities in a leisurely manner at a high salary in a good location." Et tu, Brute!!

References

1 *Employment Plans of Electrical Engineering Graduates,* Stanford Research Institute, Menlo Park, California, September 1955, prepared for Eta Kappa Nu Association.
2 "The Personnel Problem of the Public Utilities in the Colleges," by J. D. Ryder, Michigan State University, *The Bridge of Eta Kappa Nu,* Winter Issue, 1956.
3 *Opinions of Electrical Engineering Graduates Regarding Employment Opportunities,* Stanford Research Institute, Menlo Park, California, 1956, prepared for Eta Kappa Nu Association.

BARTLESVILLE BOARD



Equipment for the closed circuit cable system going into operation at Bartlesville, Okla. is being supplied by General Precision Labs. This is the control board. A special system permits showing wide-screen film.

News of Reps

Reps Wanted

A leading manufacturer of **precision microwave cavities, and pass filters** wants representation in Maryland, Washington, Virginia and the Carolinas. (Ask for R11-1.)

A manufacturer of **constant current equipment** desires representation in the Illinois, Indiana area as well as the Eastern Pennsylvania, Southern New Jersey area. (Ask for R11-2.)

Industrial Components Corp., North Wilbraham, Mass. has been named reps in New England and New York state for Magnetic Controls Co. of Minneapolis.

G. S. Marshall Co., San Marino, Calif. has announced the appointment of Bill Olbrich as a rep in the firm's instrument division.

MOBILE REPS

The new Mobilab is owned and operated by Technical Instruments, Inc. The equipment in the lab is ready-to-operate. The vehicle is presently touring the Northeast.

Lester P. Creaser has been added to the sales staff of Ray Perron & Co., New England sales reps.

D. R. Bittan Co., 103 S. Central Ave., Valley Stream, L. I., N. Y. are celebrating their 35th anniversary as reps this month.

F. D. Marcy Assoc., 1922 Raymond Commerce Bldg., Newark, N. J. have been named reps for the Transistor Devices, Inc. in New York City area, Southern Connecticut, Eastern Pennsylvania, Delaware, Maryland, New Jersey, and part of Virginia.

(Continued on page 162)

ELECTRONIC INDUSTRIES & Tele-Tech Advertisers—Nov. 1957

* In Operations Edition Only.

News of Reps

(*Continued from page* 160)

A new service is available to both reps and manufacturers. The **Manufacturers' Agents Div. of The Metal Products Sales Co., 10 N. Main St., West Hartford 7, Conn.** has been established to help qualified representatives and top-notch manufacturers find each other, when the need exists. Free information is available by contacting them.

Jack Logan, 256 Magellan Ave., San Francisco, Calif. is the name of a new rep firm just formed which is covering the Northern California territory.

Don V. Hamilton and Co., Minneapolis, Minn. has just received the first annual award from the General Transistor Co. for their outstanding record of sales.

R. G. Sidnell & Co., 1229 Westlake Ave., Cleveland 7, Ohio are now technical sales reps in the state of Ohio for the Measurements Corp.

R. L. Pflieger Co. have been appointed sales engineering reps for Beckman/Berkeley Div. of the Beckman Instruments, Inc.

Don C. Wallace & William H. Wallace have added **Jack Cudahy** to its sales staff. The Los Angeles rep firm was made reps for Stromberg-Carlson Co. in California, Nevada and Arizona.

E. V. Roberts & Associates have opened a branch in New Mexico. **William A. Bains** has been made manager.

Benz Sales Co., P. O. Box 486, Riverside sta., Miami 35, Fla. have just formed a new rep firm. Their territory covers the state of Florida, and the islands of Cuba and Puerto Rico.

David H. Ross Co., 534 El Camino Real, San Carlos, Calif. has just added **Elton H. Bell** to its industrial staff.

LeRoy & McGuire, Inc., R. D. No. 1, Phelps, N. Y. has been appointed distributor sales reps for semiconductor products of Radio Receptor Co., Inc., in all of New York state north of Rockland and Westchester counties.

Henry Dubois has joined **Westron Sales & Engineering,** 7407 Melrose Ave., Los Angeles 46, Calif. as a rep.

Grady Duckett, 26 E. Andrews Dr., N.E., Atlanta, Ga. is now southern rep for Fairchild Recording Equipment Co.

Rockbar Corp., 650 Halstead Ave., Mamaroneck, N. Y. are now reps for American Electronic Labs., Inc.

Abbett & Hustis, 16A Eaton Sq., Needham 92, Mass., are now reps for Cornell-Dubilier in the New England area.

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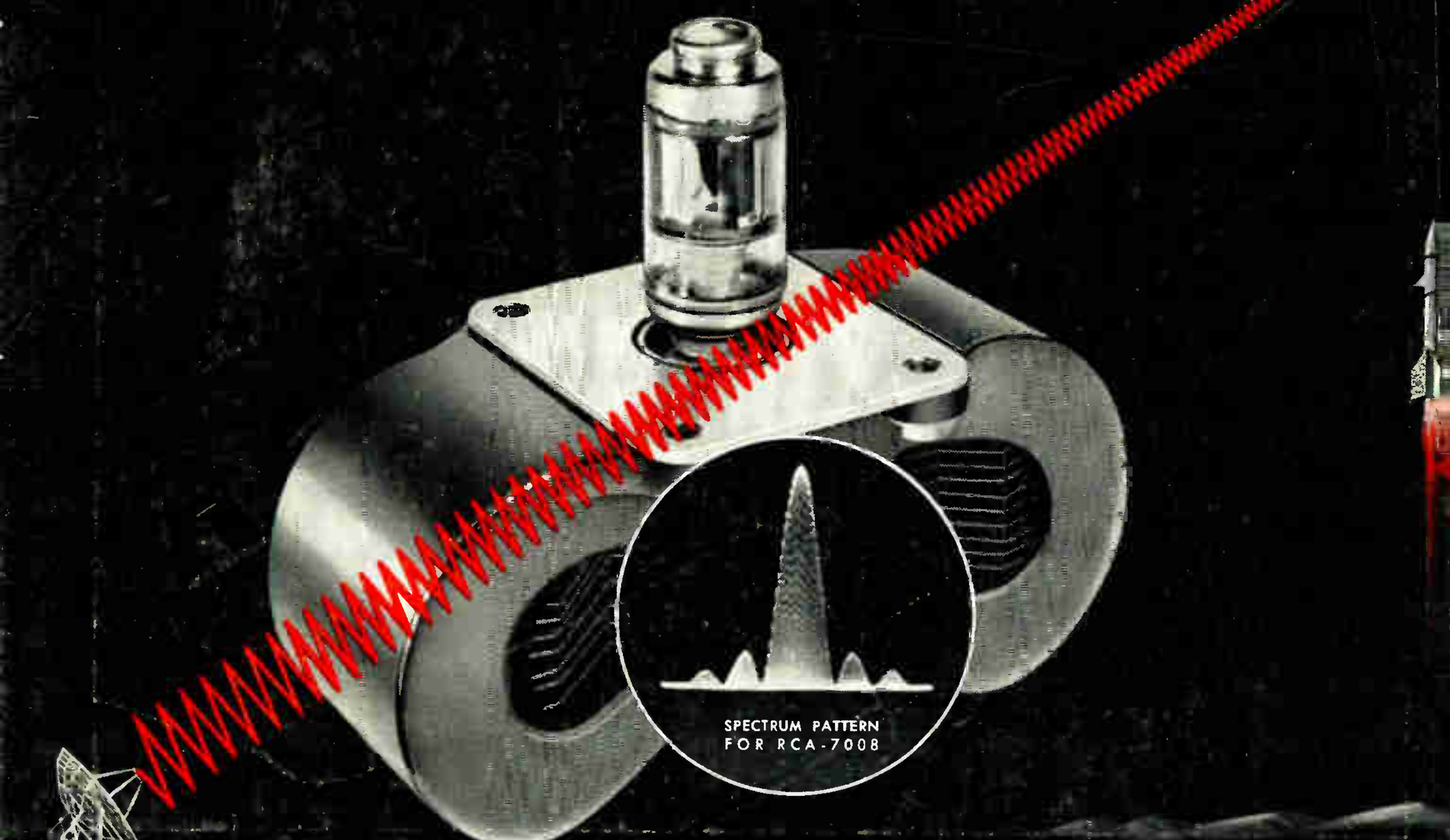

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Stability at Max. Rate-of-Rise of Voltage	less than 0.1%	less than 0.1%	less than 0.1%
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