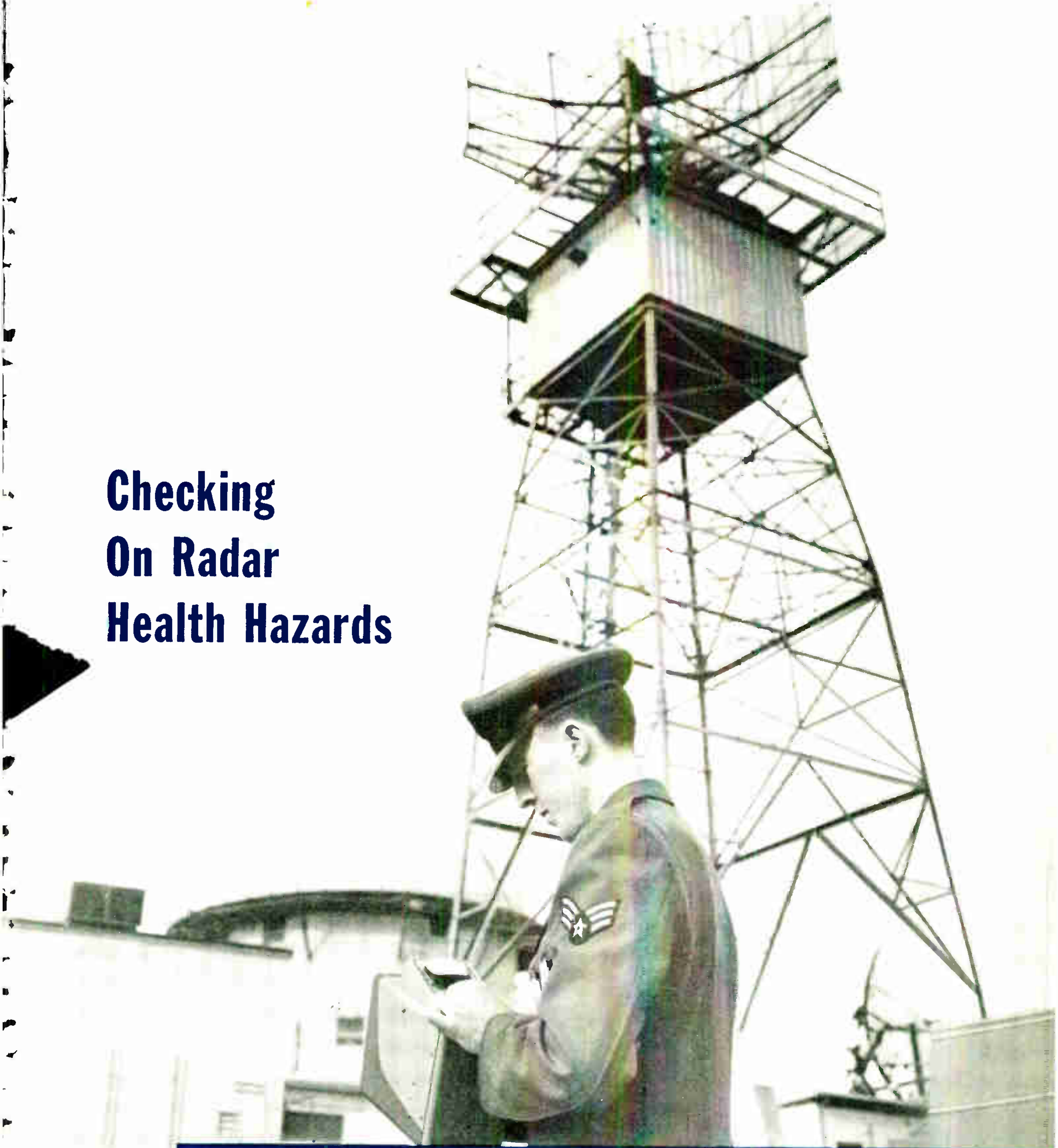
FEBRUARY 20, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 8 PRICE SEVENTY-FIVE CENTS

Checking On Radar Health Hazards



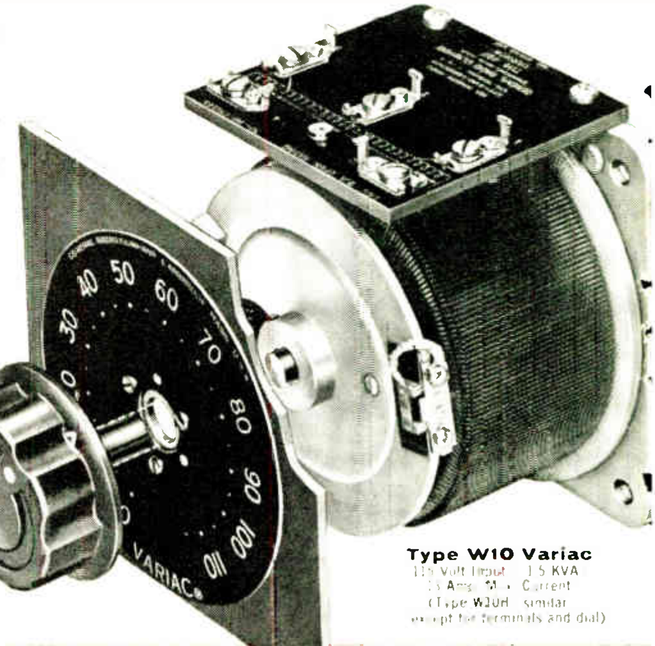
Chain-Stores Sponsor Computer Research

Another NEW Variac® 10-Ampere Type W10

These new Type W10 VARIACs complete the modernization of the entire VARIAC line so that all units are of the "W" type. Improvements include wrought metallic parts, better heat transfer between coil and base, and brush and radiator; improved insulation, disc radiators and generally improved mechanical design. ALL VARIACS have exclusive DURATRAK contact surfaces for longer life.

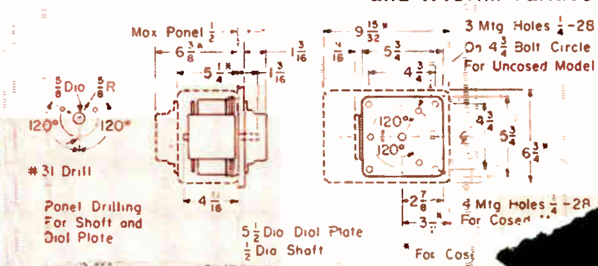
	W10 Uncased	W10M Cased	W10MT Portable (2-wire cord)	W10MT3 Portable (3-wire cord)	W10H Uncased	W10HM Cased	W10HMT Portable (2-wire cord)	W10HMT3 Portable (3-wire cord)
Input Voltage	115	115	115	115	230	230	230	230
Load Rating (kva)	1.5	1.5	1.5	1.5	1.2	1.2	1.2	1.2
Output Voltage	0-135	0-135	0-135	0-135	0-270	0-270	0-270	0-270
Rated Current (amp.)	10	10	10	10	4	4	4	4
Maximum Current (amp)*	13	13	13	13	5.2	5.2	5.2	5.2
No Load Loss at 60c (W)	17	17	17	17	17	17	17	17
Dial Calibrations	0-115 0-135	0-115 0-135	0-135	0-135	0-230 0-270	0-230 0-270	0-270	0-27
Angle of Rotation (deg.)	320	320	320	320	320	320	320	320
No. Turns on Winding	212	212	212	212	430	430	430	430
D-C Resistance of Winding (Ω)	0.63	0.63	0.63	0.63	4.73	4.73	4.73	4.73
Driving Torque (oz. in.)	30-60	30-60	30-60	30-60	30-60	30-60	30-60	30-60
Net Weight (lbs.)	12½	15	16	16	12	14	15	15
Code Word	DOGAL	DOGER	DOGIC	DOGOM	LUTAL	LUTER	LUTIC	LUTOM
Price	**$31.00**	**$44.00**	**$48.00**	**$51.00**	**$33.00**	**$46.00**	**$50.00**	**$53.00**

Replacement Brushes

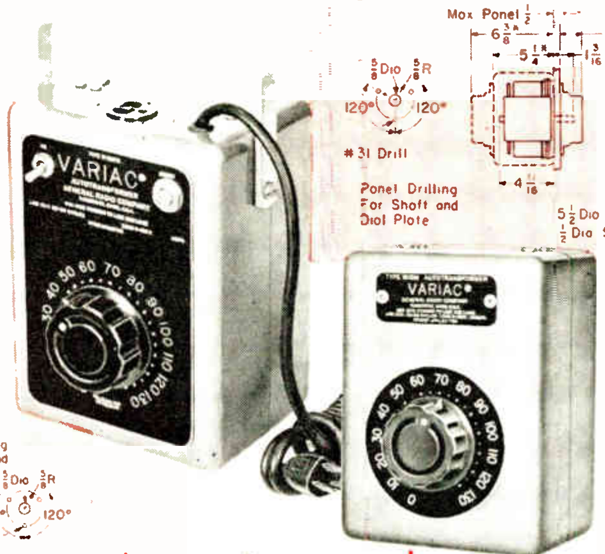


Type W10 Variac
115 Volt Input 1.5 KVA
15 Amps. Max. Current
(Type W10H similar except for terminals and dial)

Essential Dimensions Types W10, W10M, W10H and W10HM Variacs

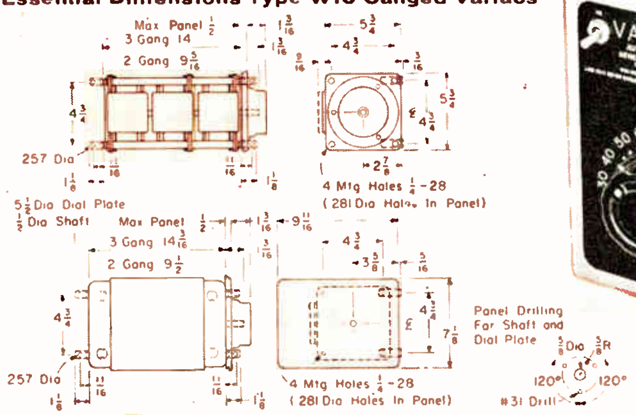


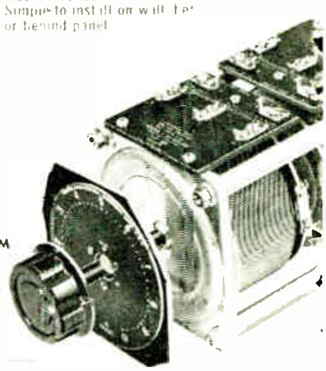
Type W10MT3
Portable model, cased, 3-wire output receptacle, ON-OFF switch, overload breaker and heavy duty 3-wire line cord and plug. Available in 2- and 3-wire models for either 115 or 230 volt lines.



Type W10M
Cased model in gray enamel. Two knockouts on end and side for conduit or armored. Simple to install on wall, bench or behind panel.

Essential Dimensions Type W10 Ganged Variacs





Type W10G2 Variac
2 Gang Type W10
(W10HG2 similar except for terminals and dial)

	2-gang W10G2 Uncased			W10G2M Cased	3-gang W10G3 Uncased		W10G3M Cased	2-gang W10HG2 Uncased			W10HG2M Cased	W10HG3 Uncased		W10HG3M Cased
Input Voltage	115	115	230	Same as W10G2	115	230	Same as W10G3	230	230	460	Same as W10HG2	230	460	Same as W10HG3
Load Rating kva	3 (Parallel)	2.6 (Delta)	3 (Series)	Same as W10G2	4.5 (Parallel)	5.2 (Y)	Same as W10G3	2.4 (Parallel)	2.1 (Delta)	2.4 (Series)	Same as W10HG2	3.6 (Parallel)	4.1 (Y)	Same as W10HG3
Dial Calibrations	0-10			0-10	0-10		0-10	0-10			0-10	0-10		0-10
Driving Torque (oz. in.)	60-120			60-120	90-180		90-180	60-120			60-120	90-180		90-180
Net Weight (lbs.)	26½			30½	39½		43½	25			24	37		42
Code Word	GOGAL GANDU			GOGAL BONDU	GOGAL GANTY		GOGAL BONTY	LUTAL GANDU			LUTAL BONDU	LUTAL GANTU		LUTAL BONTY
Price	**$72.00**			**$93.00**	**$105.00**		**$128.00**	**$76.00**			**$97.00**	**$111.00**		**$134.00**

ANY TYPE W10 Variac or Variac gang can be supplied with ball bearings. Add suffix "BB" to type number and following surcharge to prices:
Single unit **$8.00** — 2 gang **$10.00** — 3 gang **$12.00**

electronics FEBRUARY 20, 1959

Issue at a Glance

A McGRAW-HILL PUBLICATION
Vol. 32 No. 8

BUSINESS

ENGINEERING

DEPARTMENTS

FREQUENCY STANDARDS

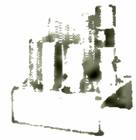
PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*

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

*3⅛" high
400 - 1000 cy.

FREQUENCY STANDARD
TYPE 50L



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

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

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*

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

*3½" high
400 to 500 cy.
optional

FREQUENCY STANDARD
TYPE 2005

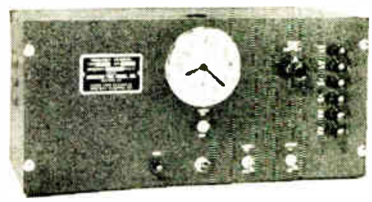
Size, 8" x 8" x 7¼" High
Weight, 14 lbs.

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

FREQUENCY STANDARD
TYPE 2007-6 **NEW**

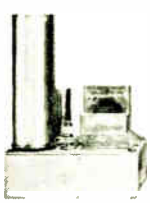
TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.
Frequencies: 400 — 500 or 1000 cycles
Accuracies:
2007-6 (± .02% at —50° to +85°C)
R2007-6 (±.002% at +15° to +35°C)
W2007-6 (±.005% at —65° to +125°C)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD
TYPE 2121A



Size
8¾" x 19" panel
Weight, 25 lbs.
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)

FREQUENCY STANDARD
TYPE 2001-2



Size 3¾" x 4½" x 6" H., Wght. 26 oz.

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

FREQUENCY STANDARD
TYPE 2111C

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.
Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.

ACCESSORY UNITS
for TYPE 2001-2

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

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

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.

Watch Master
Timing Systems

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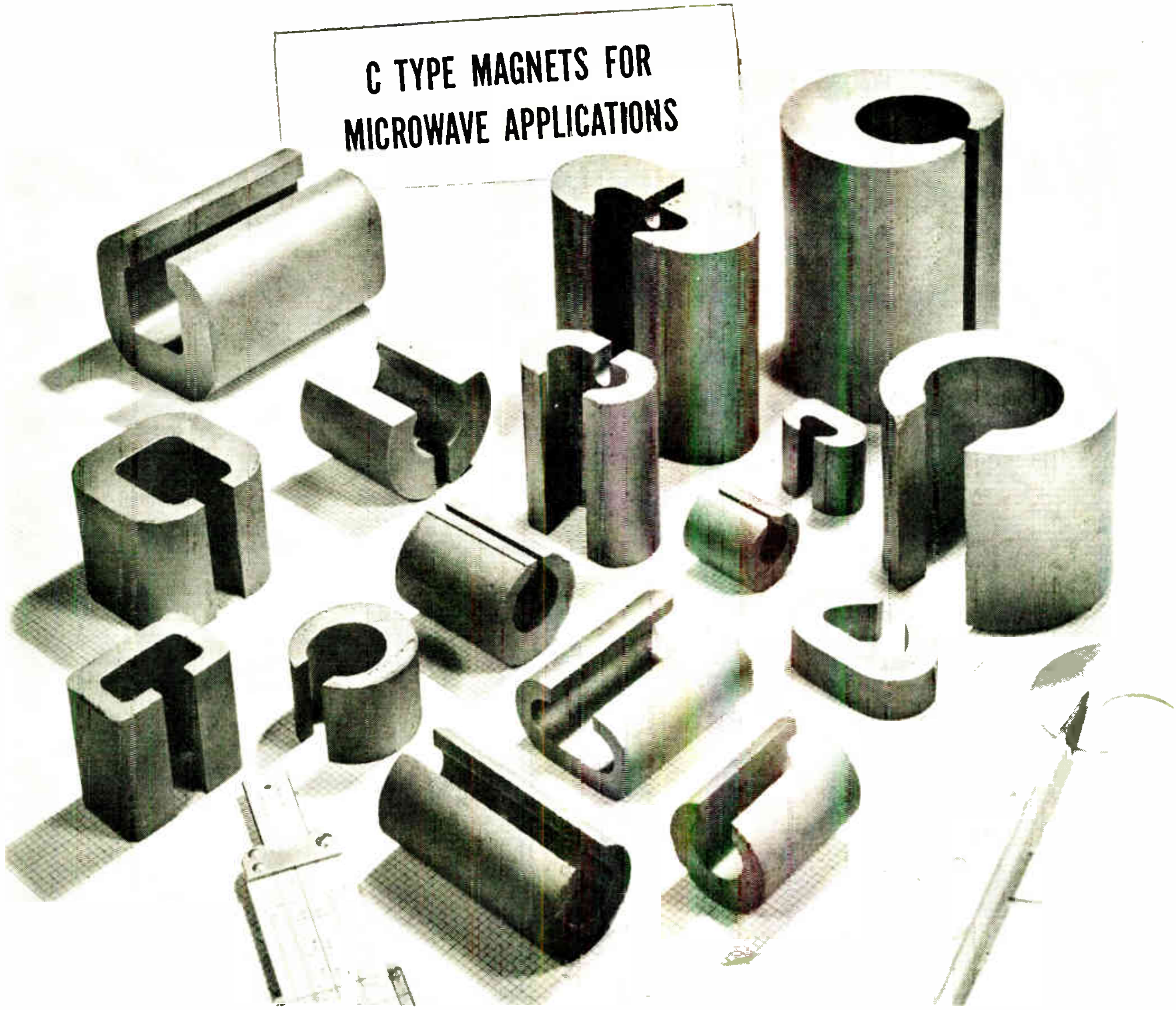
580 Fifth Ave., New York 36, N. Y.

CIRCLE 1 READERS SERVICE CARD



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When used in transverse field isolators, Arnold C Magnets supply the magnetizing field to bias the ferrite into the region of resonance, thus preventing interaction between microwave networks and isolating the receiver from the transmitter. These magnets are also used in differential phase shifters and duplexers, and Arnold is prepared to design and supply tubular magnets to provide axial fields in circular wave guides.

A feature of all Arnold C Magnets is the excellent field uniformity along the length of the magnet. Versatility in design may be realized by using multiple lengths of the same size magnet stacked to accomplish the needs of your magnetic structure.

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CIRCLE 2 READERS SERVICE CARD

electronics

Feb. 20, 1959 Vol. 32, No. 8

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SHOPTALK . . .

GLASS CAPACITORS. During a recent trip to Corning Glass Works' new components plant in Bradford, Pa., Associate Editor Sideris obtained the first detailed description of how capacitors are made from metal foil and a glass ribbon only 1 mil thick.

The whole manufacturing story is in Sideris' department, "Production Techniques," this week.

Gathering material for his department, Sideris visited nearly 50 plants last year. Roughly half of them were out of town. In addition, ELECTRONICS field editors in Boston, Chicago and Los Angeles pitched in, reporting new manufacturing techniques in their territories.

Sideris joined ELECTRONICS in 1956. Before that he had studied engineering in a Naval officers' training program, then moved into journalism and covered industrial and commercial developments for a metropolitan-area daily newspaper. His other electronics interests include new materials for the industry, industrial control applications and atomic-energy instrumentation.

SMALL BUSINESS. Of the 4,000-odd companies in the electronics industry—assemblers, parts manufacturers and suppliers—by far the majority fall into somebody's category of "small business".

Indeed, these small engineer-run companies comprise one of the great strengths of our industry. The diversity of specialized products and services they offer, in the aggregate, could not economically be provided by larger business organizations.

An important problem to small electronics firms has been how to get a bigger share of the more profitable government business. Some small firms enter into government work through subcontracting from larger prime contractors. Others have formed teams with other companies. Now comes a new plan: A corporation jointly owned by several small manufacturers that can bring their collective abilities to bear on government contract work. In his story, "New Look for Small Companies," on p 40, Associate Editor Emma goes into this and other news of interest to small businessmen.

Coming In Our February 27 Issue . . .

SOLIONS. A device which is assuming greater importance as research uncovers more applications for it is the solion, so-called because the mechanism of conduction it employs involves ions in solution.

R. N. Lane of Texas Research Associates and D. B. Cameron of National Carbon Company describe how these interesting new devices can be used as control elements to perform such functions as integration and amplification. A circuit using a solion as a noise dosimeter is included.

AMPLITUDE WINDOW. In statistical studies of signals and noise, probability amplitude density functions are the subject of intensive investigation. In such studies, a circuit is required which yields a rectangular output pulse with a width proportional to the time spent by the input between specified voltage levels.

T. A. Bickart of Johns Hopkins University describes a modified form of Schmitt trigger which obtains desired output without excessive circuitry.

ECONOMY TV SOUND. Ratio-detector systems contain expensive components and have low output, according to R. B. Dome of GE in Syracuse. In an effort to overcome these shortcomings, development of the delta sound system for tv receivers was undertaken. Features are a-m compression from 12 to 24 db, high a-f output and cancellation of the fundamental component of undesired a-m.

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Maximum Collector Current	15	15	15	15	15	15	15	15	15	15 amps
Maximum Collector Voltage (Emitter Open)	100	80	80	80	60	50	40	60	50	40 volts
Saturation Resistance	.02	.02	.02	.02	.03	.03	.03	.03	.03	.03 ohms
Thermal Gradient (Max.) (Junction to Mounting Base)	.8	.8	.8	.8	.8	1.0	1.0	1.0	1.0	1.0 °C/watt
Base Current I_B (V_{EC} = 2 volts, I_C = 5 amps)	135	100	135	135	100	100	100	150	150	150 ma
Collector to Emitter Voltage (Min.) Shorted Base (I_C = .3 amps)	80	70	70	70	50	45	40	50	45	40 volts
Collector to Emitter Voltage Open Base (I_C = .3 amps)	70	60	60	60	50	45	40	55	45	40 volts

*Designed to meet MIL-T-19500/13A (Jan) 8 January 1958 †Formerly DT100 ‡Formerly DT80

Check your requirements against the *new, improved* characteristics of Delco High Power transistors. You will find improved collector-to-emitter voltage . . . higher maximum current ratings—15 amperes, and extremely low saturation resistance. Also, note the new solid pin terminal design.

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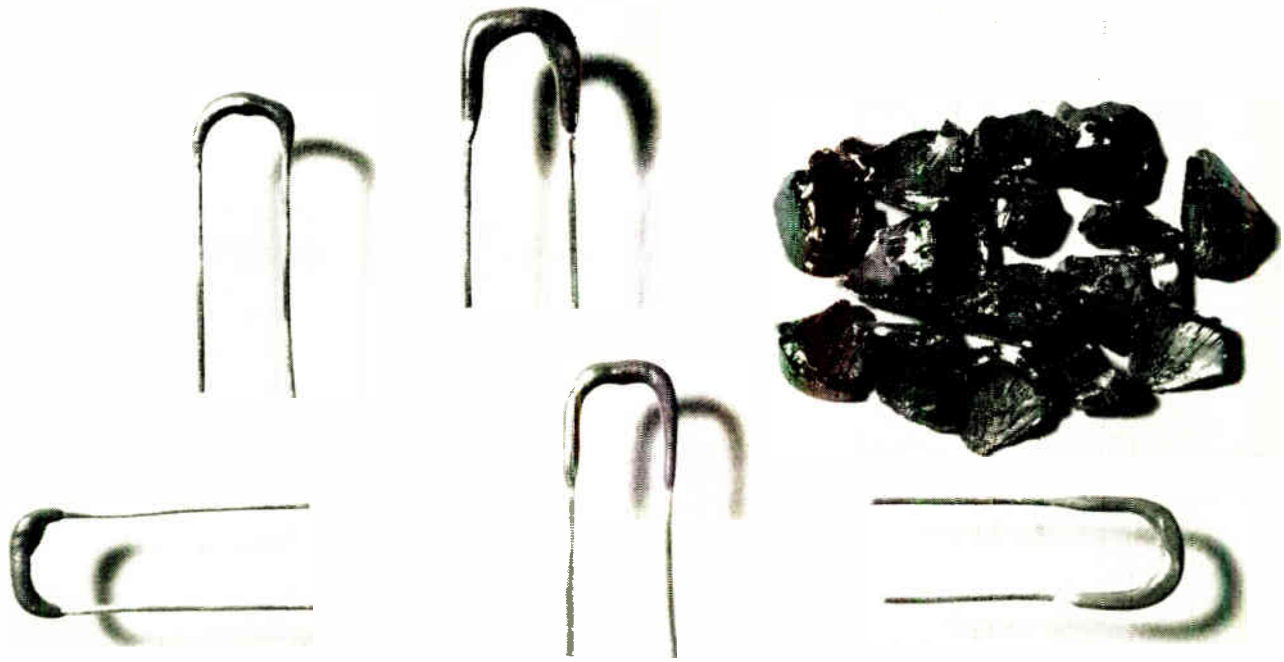

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*Abstract No. 116, Journal of The Electrochemical Society, August, 1958.

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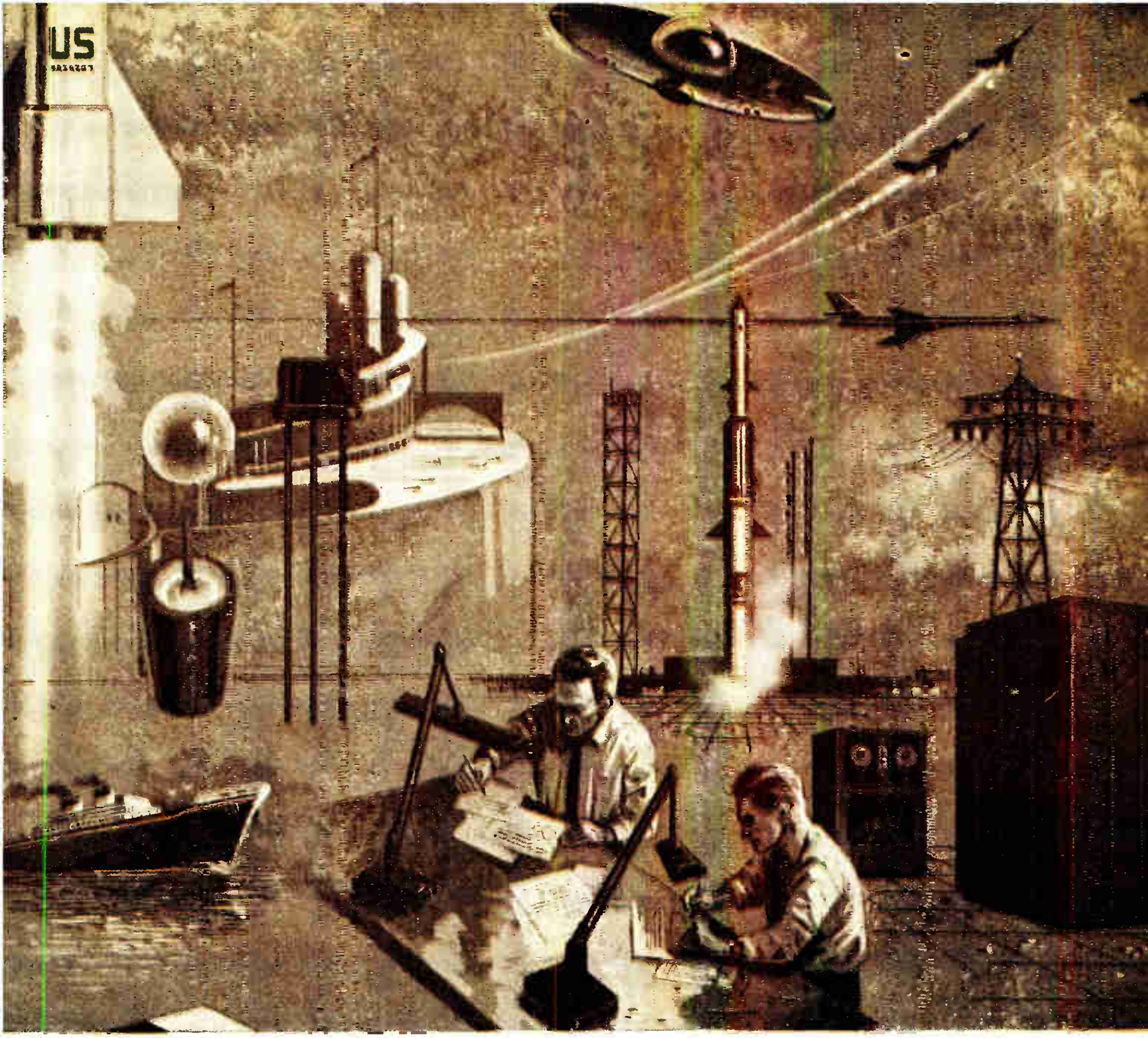

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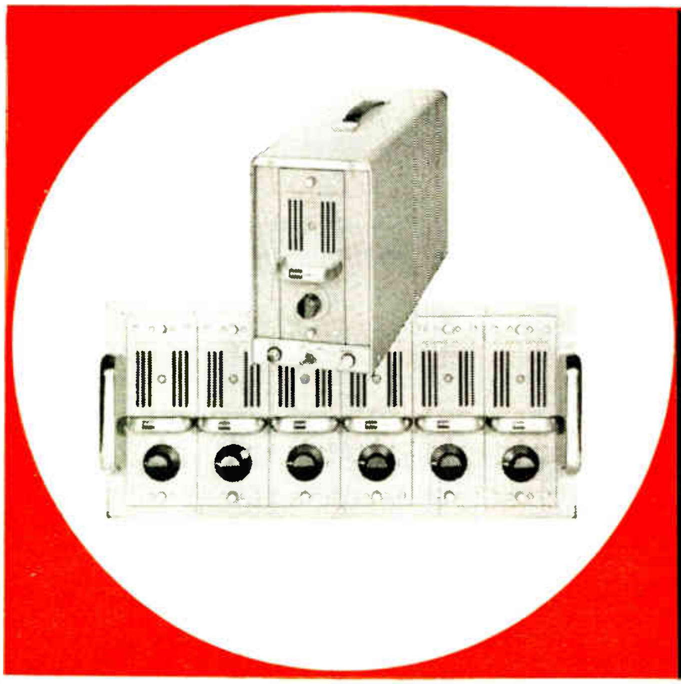


NEW...TRUE DIFFERENTIAL DC AMPLIFIERS ELIMINATE GROUND LOOP PROBLEMS...RESCUE MICROVOLT SIGNALS FROM VOLTS OF NOISE

160 db DC, 120 db 60 cycle common mode rejection with balanced or unbalanced input ■ Input completely isolated from output ■ Input and output differential and floating ■ 5 microvolt stability for thousands of hours ■ 0.05% linearity, 0.1% gain stability ■ Gain of 10 to 1000 in five steps ■ >5 megohms input, <2 ohms output impedance ■ 10 volt at 10 ma output ■ 120 cycle bandwidth ■ Integral power supply

Ideal for thermocouple amplification, the Model 114A differential DC amplifier eliminates ground loops; allows the use of a common transducer power supply; drives grounded, ungrounded or balanced loads; permits longer cable runs; and can be used inverting or non-inverting. The 114A can be mounted in either single amplifier cabinets or six amplifier 19″ rack adapter modules. Price: 114A – $775; six amplifier module – $200; single amplifier cabinet – $125.

WIDEBAND, SINGLE ENDED DC AMPLIFIERS AMPLIFY DATA SIGNALS FROM DC TO 40 KC WITH 2 MICROVOLT STABILITY

±2 microvolt stability ■ <5 microvolt noise ■ 40 kc bandwidth ■ 100 KΩ input, <1 ohm output impedance ■ Gain of 20 to 1000 in ten steps with continuous 1 to 2 times variation of each step ■ ±45 V, ±40 ma output ■ 1.0% gain accuracy ■ 0.1% gain stability and linearity ■ Integral power supply

Millions of cumulative hours of operation have proved KIN TEL Model 111 series DC amplifiers to be the basic component for all data transmission, allowing simple, reliable measurement of strain, temperature and other phenomena. DC instrumentation systems – with their inherently greater accuracy, simplicity, and reliability than AC or carrier systems – are made entirely practical by the excellent dynamic performance, stability, and accuracy of KIN TEL DC amplifiers. Price: 111BF–$575; six amplifier module–$200; single amplifier cabinet – $125.

5725 Kearny Villa Road, San Diego 11, California

KIN TEL

A Division of Cohu Electronics Inc.

ELECTRONICS NEWSLETTER

AUTOMATIC LANDING SYSTEM said to function in zero-zero visibility without need for pilot seeing runway has landed various commercial and military craft more than 2,000 times in development and evaluation tests. Bell Aircraft Corp., the developer, says system could eliminate accidents such as the Electra crash in New York's East River. All-weather system reportedly locates plane by radar, takes control from pilot 2 to 4 miles from end of runway and then operates automatic pilot by radio to guide it to a landing. Bell says system was developed for carriers, expects both Navy and Air Force to buy it for operational use this year.

AIR WEAPONS CONTROL SYSTEM 212 L, which will combine base air defense and tactical air control, looks like a large and continuing project. Intended to solve air defense problems for overseas bases and areas in much the same way that SAGE operates in the U. S., it consists of three subsystems: radar, communications and data-processing. GE, responsible for data-processing, has starter contract topping $12.7 million.

BALLOON-LOFTED RADAR GONDOLA is expected to extend knowledge of radar characteristics at stratospheric altitudes through photographs of ppi displays. Photos were recently taken at 100,000 ft on first of three unmanned flights undertaken by Goodyear Aircraft Co. and Winzen Research Corp., under ARDC contract. Pictures are correlated with regular aerial photographs taken by external camera synchronized with ppi camera.

High-speed weather chart transmission system is being designed for the Air Force Cambridge Research Center by Philadelphia-Tele-Dynamics Inc. Firm says its technique relies on coding methods based on information theory.

AIRPORT RUNWAY AND TAXIING CONTROLS will be installed this year at the Atlantic City, N. J., experimental facility of FAA. RCA, as subcontractor, will supply 300 detector circuits and accessory gear for one 10,000-ft runway and 20,000 feet of taxiways. General Railway Signal Co., the contractor, will provide controller's display panel and associated equipment. As plane passes over buried loops, a signal will be generated, received by detector, and then used to show position of craft on control panel. System requires no airborne gear and will accommodate landing speeds up to 175 mph, or taxiing speed up to 65 mph; 20 planes may be traced at once. Future system might use computer to preschedule landing and taxi routes for incoming craft.

HAWK PRODUCTION PLANS for 1959 and '60 are firm for fixed and mobile combat requirements. So said Raytheon President C. F. Adams in denying report of a possible cutback. He told Boston security analysts that '61 production schedule awaits Army decision on fixed installation needs.

USE OF A COMPUTER in developing an advanced airways control system starts this month in Atlantic City, N. J. Unit is an RW-300 at the National Aviation Facilities Experimental Center (NAFEC). The Thompson-Ramo-Wooldridge Products Co., manufacturer, is also supplying special input and output equipment and technical aid. Federal Aviation Agency's R&D bureau will simulate complex traffic control problems by means of mathematical models of proposed systems. Built-in analog input-output permits communicating for simulation purposes with existing traffic control devices.

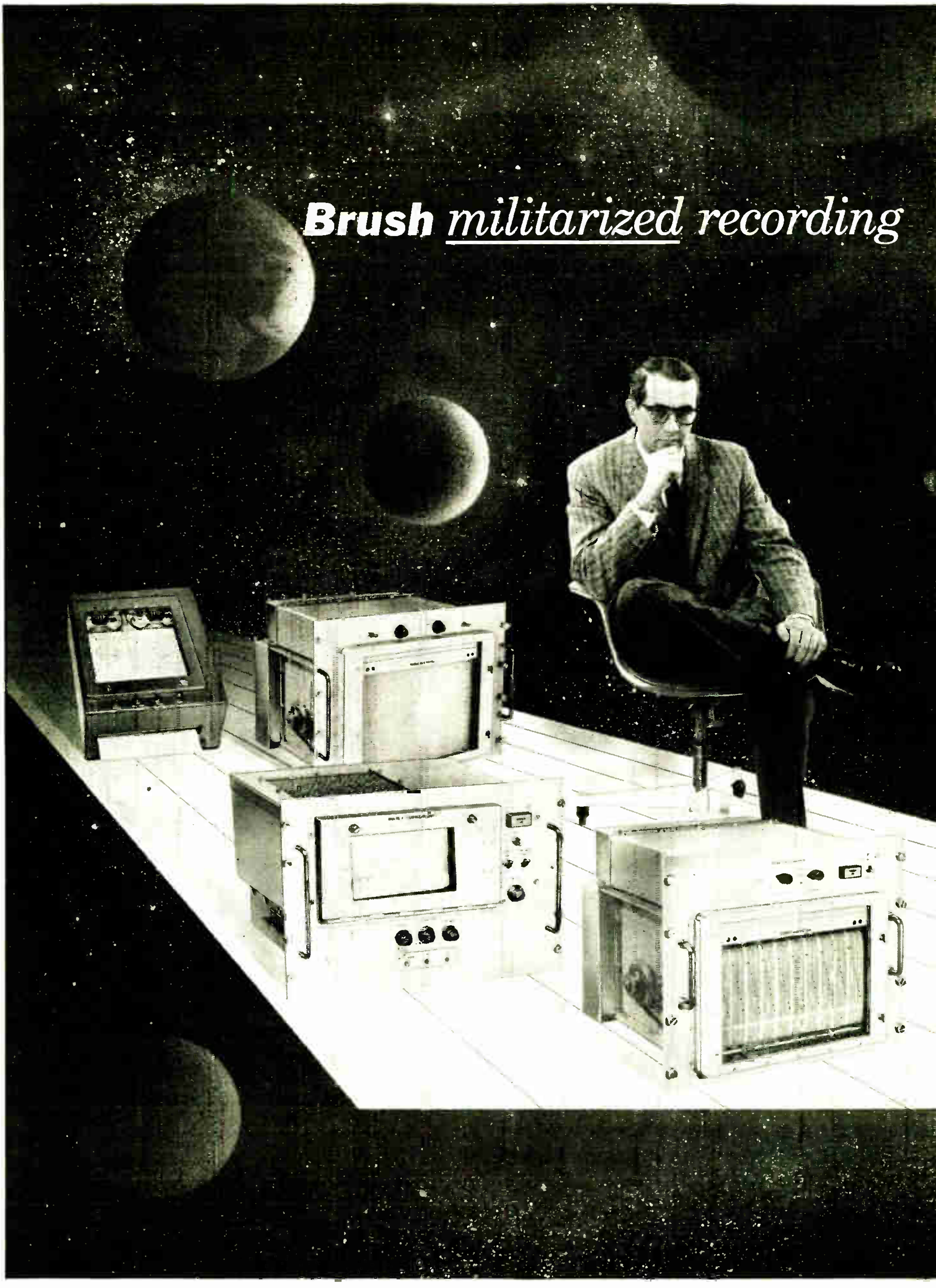
Two klystrons designed by Ferranti of Britain will now be made by Raytheon. UK firm sold for $250,000 the knowhow for the low-noise tubes used in Doppler radar systems.

TERMINAL GUIDANCE METHODS for space vehicles will be studied at ITT Laboratories in Fort Wayne, Ind., under a contract awarded by Air Research and Development Command. Research problems include initial condition accuracies, adverse physical phenomena, required vehicle performance, environment, sensor characteristics and reliability. Program objective: to initiate studies to define guidance systems, techniques and designs.

AUTOMATIC DRILL for bearing jewels has been developed by Carl Zeiss, Oberkochen, West Germany. Electron beam is concentrated on jewel center in a vacuum; released heat energy results in smelting and evaporation of the material. Tempering beam keeps jewel at high temperature for some time after drilling. New jewel is automatically fed to drilling position every 6 seconds.

Army Signal Corps has contracted for three mobile, transistorized Sylvania Mobidic computers, making four so far ordered by the Army at a total funding of $6.5 million.

MISSILE DEFENSE requires more data on reentry phenomena. Carl F. J. Overhage, director of MIT's Lincoln Laboratory, declared recently that reentry observations at the far end of missile test range add up to a slow and expensive program. To speed an active defense posture, he reported, lab experiments are exploring means of anticipating possible enemy techniques such as decoys, jamming and defense saturation by closely-spaced small warheads.


Brush militarized recording

WASHINGTON OUTLOOK

SEARCH by Congress into almost every facet of the defense program already suggests some likely effects: (1) a beefed-up military appropriation, (2) some changes in defense procurement policy, and (3) the glare of publicity on details of ballistic missile program management.

An atmosphere conducive to defense budget boosts is being whipped up by three major committee investigations of missile and space projects.

Committees are the Senate Military Preparedness and Space Committee under Majority Leader Lyndon Johnson; the House Space Committee under Rep. Overton Brooks (D., La.); and the House Armed Services Committee under Rep. Carl Vinson (D., Ga.).

The probes are being made against a backdrop of serious charges that (1) USSR leads the U. S. in missile production and space exploration, and that (2) the fiscal 1960 budget sent to Congress last month is inadequate to overcome the Soviet lead.

Secy. McElroy has stated that U. S. defense is based on the assumption that for some time to come the USSR will out produce us in ICBM's. This plays into the hands of Democratic critics. McElroy argues that the U. S. maintains "superiority" with a more "diversified" arsenal of nuclear striking power, and that this will deter Soviet aggression.

However, strong rebuttal has come in the form of: (1) Maj. Gen. Schriever's assertion that ICBM production schedules should be hiked and that capacity is already available to handle heavier production rates; and (2) charges from both military and civilian space officials that budget restrictions will delay key projects.

Summing up: The current investigations provide a major sounding-board for critics of administration policies. They are likely to cause new pressures to hike spending despite the administration's determination to hold the line on military expenditures.

- **On the military procurement side,** the House Armed Services investigating subcommittee under Rep. F. Edward Hebert (D., La.), will probe: (1) the trend toward weapon system management; and (2) the growing volume of negotiated contracts and the decline in formal open-bid procurement.

  Also in an investigating mood are the Senate and House Small Business Committees. Both have plans for new inquiries into the often-raised question: Why don't smaller firms get more defense business?

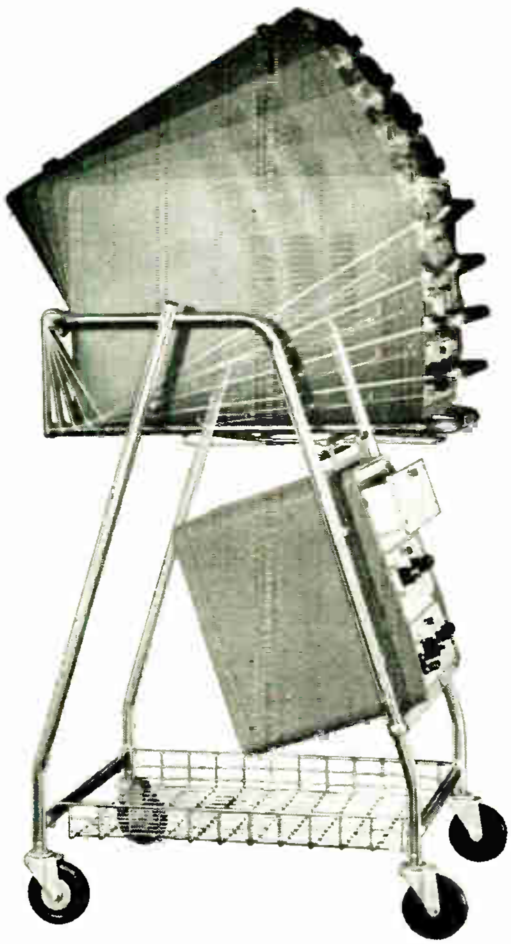
  The weapon system concept is also under fire from the House Military Operations subcommittee, headed by Rep. Chet Holifield (D., Calif.).

  He has begun to look into "organization and management concepts" of the ballistic missile program.

- **Basic changes** in government policies on patent and copyright law may come from Congress this year. A Senate Judiciary subcommittee is now investigating patent practices and policies of 19 government agencies, including the military services. The committee is expected to recommend that Congress make patent policy uniform.

  Subcommittee has already found, for example, that the National Science Foundation allows its inventors to obtain patent titles, with the government given royalty-free, nonexclusive rights. Other government agencies, on the other hand, take title to patents but make them available to industry on a royalty-free basis.

No stoop, no squint, no painful nagging backache*



Buy this Testmobile and tilt your 'scope so you can read it!

Obsoleting all previous concepts in one brilliant breakthrough, -*hp*- engineers have achieved the *ultimate device*—the revolutionary 115A Oscilloscope Testmobile. Employing the radical Supermarket Cart principle (first described 1906 by A. and P.) -*hp*- 115A *actually tilts an oscilloscope so you can read it, and lets you push it from place to place!* Scope may be tilted up to 30° in 7½° increments; heavy chromed tube steel construction; big, locking, rubber-tired wheels; removable bottom basket; size 40" high x 23" wide x 29" deep, folds for shipment or storage; lightweight, only 28 lbs., $80.

*with thanks to our friends at Philco and Anacin

Still further probing the Unknown, -*hp*- engineers achieved the -*hp*- 116A Storage Unit and 117A Storage Drawers. The 116A is a sophisticated cube known as a "box." It holds up to 3 plug-in units for -*hp*- 150A/AR 'scopes; prevents dust and elbows in the circuitry. Yours for $22.50. The 116A also holds up to three 117A drawers which in turn hold tools, solder, components and bubble gum. -*hp*- 117A, a modest $10.

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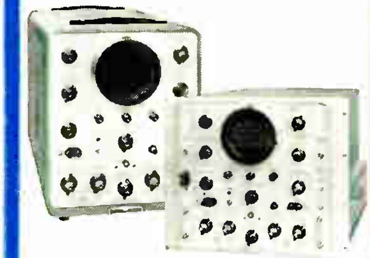
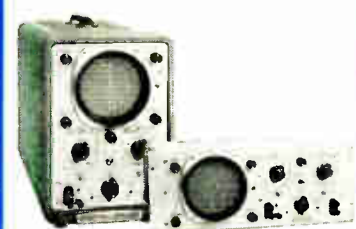


-*hp*- 150A/AR - to 10 MC
Automatic trigger, direct-reading; plug-ins providing dual trace or differential input; or high amplification. -*hp*- 150AR (rack) $1,200. -*hp*- 150A (cabinets) $1,100.

-*hp*- 130B/BR - to 300 KC
1 mv sensitivity, similar X/Y amplifiers, direct reading, automatic trigger, X5 magnifier, balanced on 6 most sensitive ranges. -*hp*- 130B (cabinet) or 130BR (rack), $650.



-*hp*- 120A/AR - to 200 KC
Sweeps 1 μsec/cm to 0.5 sec/cm; X5 sweep magnifier, automatic trigger, high sensitivity calibrated vertical amplifiers, regulated power supplies. -*hp*- 120AR (rack mount, 7" high) or 120A (cabinet) $435.

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

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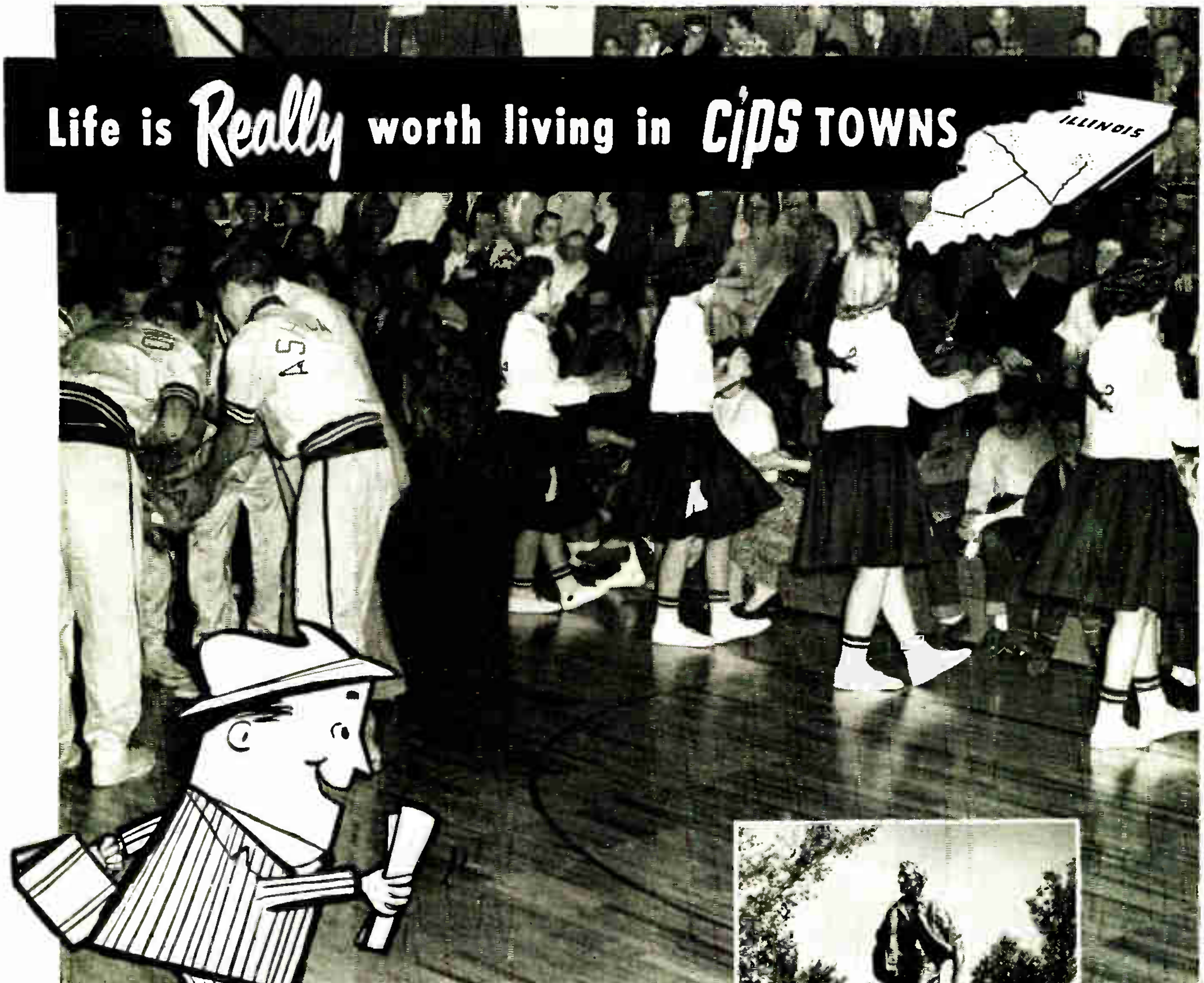

Historic Lincoln shrines dot the countryside . . . and offer inspiration to the people of CIPStowns.

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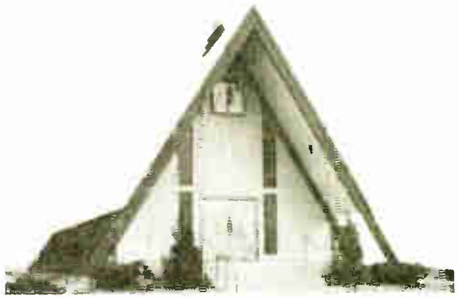
For information on available plant sites, write, wire or call our Industrial Manager. He'll serve as your confidential assistant.



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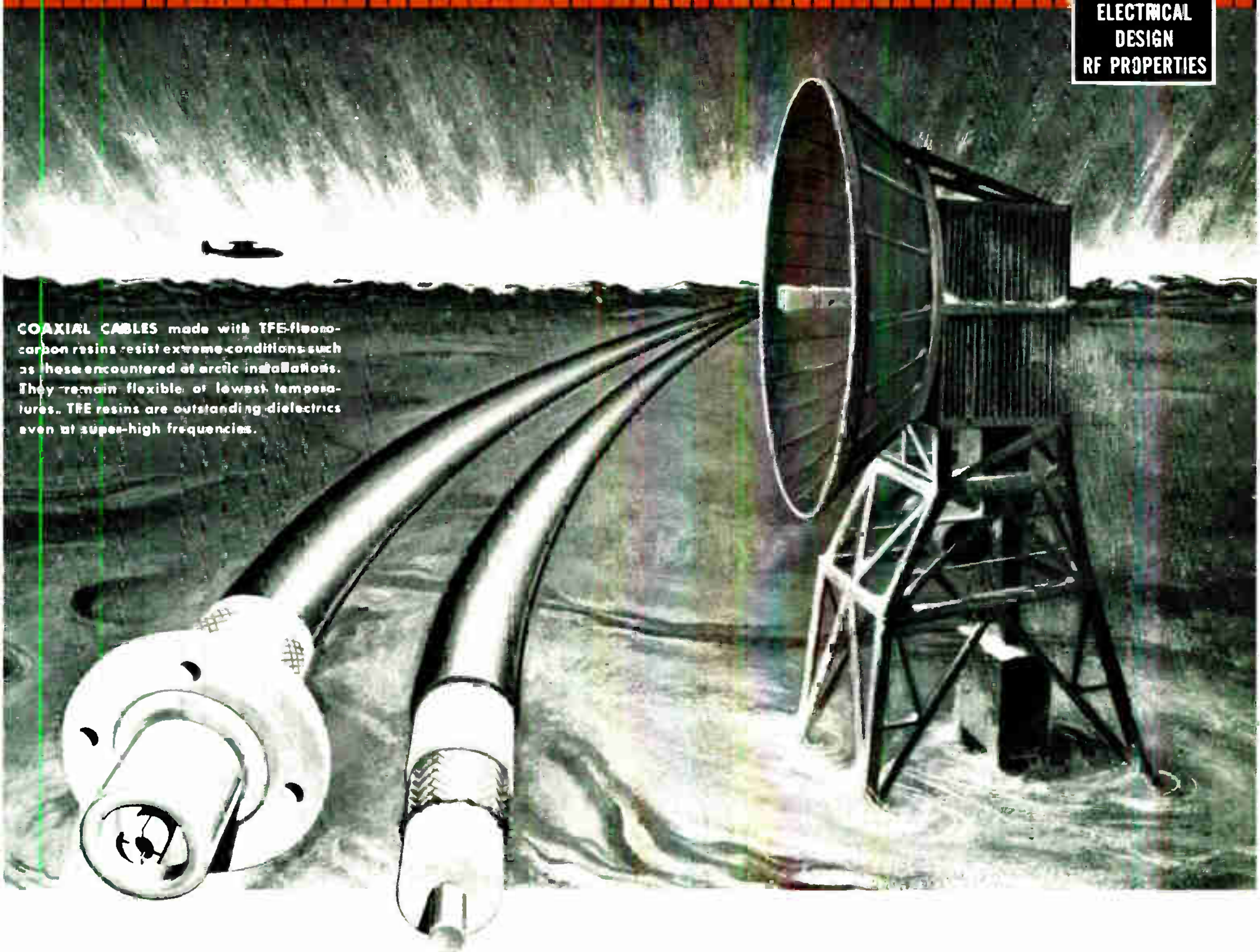
ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

NUMBER 1
IN A SERIES:
ELECTRICAL DESIGN
RF PROPERTIES



COAXIAL CABLES made with TFE-fluorocarbon resins resist extreme conditions such as those encountered at arctic installations. They remain flexible at lowest temperatures. TFE resins are outstanding dielectrics even at super-high frequencies.

Microwave components of TFE resins withstand severe operating conditions . . . provide low losses

TEFLON TFE-fluorocarbon resins provide extremely low dielectric losses and high dielectric strength. In addition, they offer almost unlimited life under severe environmental conditions. Recognition of these features has led to the rapid adoption of TFE resins for microwave and other radio-frequency applications. More than a decade of outdoor testing has proven the complete resistance of TFE resins to weathering—to sunlight, moisture, tropical heat and arctic cold. Applications demanding years of contact with the most violent corrosives have demonstrated the resistance of TFE resins to virtually all chemicals. The resins also have excellent mechanical properties—resilience, impact strength, flex life, low coefficient of friction, anti-stick properties. With all these characteristics, it is clear why TFE resins are often considered ideal insulators, especially for crucial RF applications. In radar, aviation, guided missiles, TFE resins have become indispensable. This issue of "Engineering Facts" will describe some of the RF properties of TFE resins and their applications.

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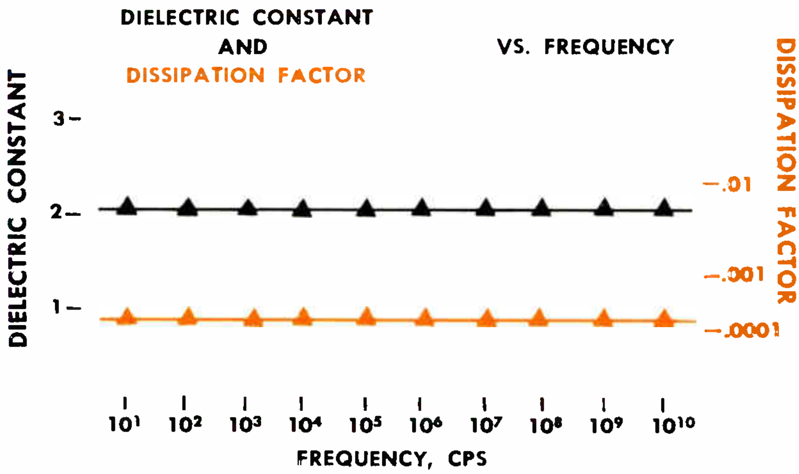
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

OVER

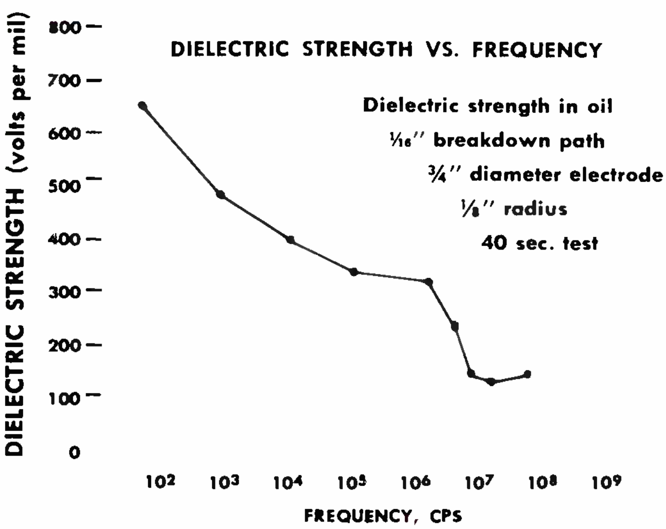
Properties of TFE resins are
dielectric components used



TFE resins provide exceptionally low attenuation . . . low dielectric constant

No solid exists which provides lower losses at high fre-quencies than TEFLON TFE-fluorocarbon resins. A uniqu feature is that these losses do not vary with frequency— or with temperature.

Better radio and microwave designs are made possibl by the dependably low losses of TFE resins under al conditions. The low dielectric constant of TFE resin makes possible designs with low attenuation and low VSWR. Dielectric constant, too, does not vary with frequency or temperature, considerably simplifying de-sign problems. In fact, the electrical characteristics o TFE resins are essentially invariant from low audio fre-quencies to the highest microwave frequencies, and from the lowest temperatures attained by liquefied gases to above 260°C.

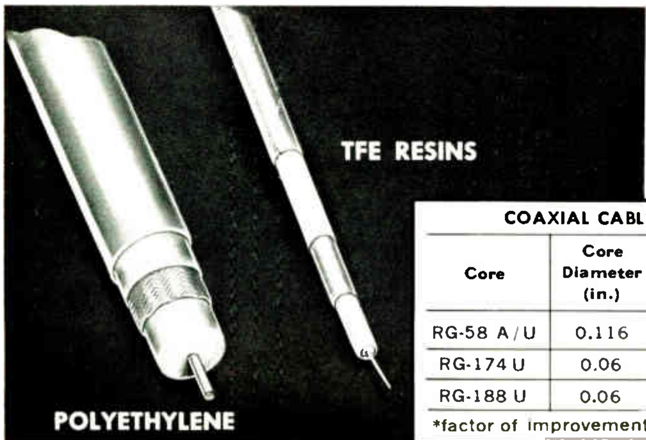


TFE resins have good high-frequency dielect strength . . . permit higher RF voltages

The dielectric strength of TFE resins drops off less wit increase in frequency than for any other material teste to date. Published data show that at 100 megacycles is 130 volts per mil. Ordinary glass has a dielectric strengt of only 20 volts per mil at 100 mc; and polystyrene dro to below 5% of its 60 cps value. Low RF heating due t low loss factor is thought to be the basis of the superi performance of TFE resins . . . all materials have *co tinuous* voltage stress ratings below their short-term *d electric-strength* values to avoid the erosive action corona. High-voltage operation is practical with an low-loss material like TFE resins, provided volt-per-m stress is below corona initiation. The chemical-therm properties of TFE resins give them longer life at voltag of any frequency, in absence of corona, than oth materials. Their high-frequency dielectric strength su gests TFE resins need not be derated as much as oth plastics at high frequencies.

TFE resins make possible miniaturization . . . space and weight savings

Because of the high dielectric strength and heat resist-ance of TFE resins, center conductors can operate at higher temperatures and carry much more power for the same cross section. For example, at room temperatur the substitution of a coaxial cable with a core of a TFE resin permits a 4-to-1 weight saving and an 8-to-1 space saving for equivalent power over a polyethylene core. The resins als solve the problem of getting more ampere turns into a winding. Finer wire can be used so that miniaturized coils are possible. Othe electronic components benefit in the same way. Thus, a complete electronic chassi can be reduced in size and weight by th use of TFE resins.

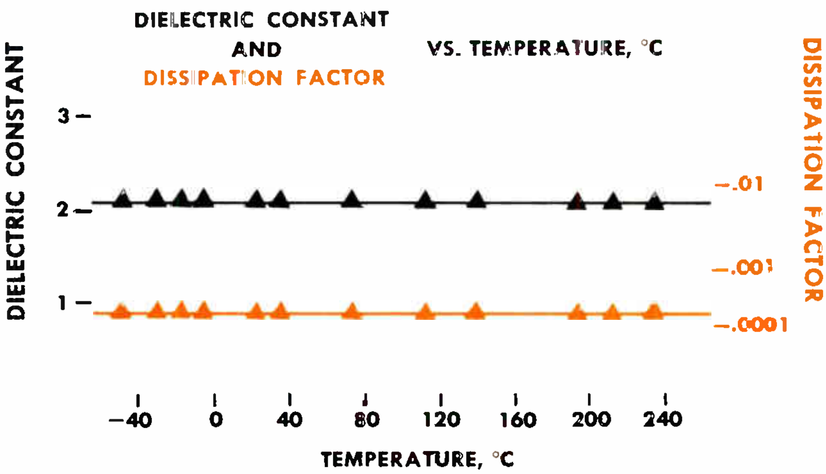


COAXIAL CABLE SIZE COMPARISON

Core	Core Diameter (in.)	Core Material	Relative Power Rating
RG-58 A/U	0.116	Polyethylene	2
RG-174 U	0.06	Polyethylene	1
RG-188 U	0.06	TFE resins	4*

*factor of improvement higher above 2000 MC

unsurpassed for making
from low to microwave frequencies



TFE resins are rated for operation at extreme temperatures

TFE resins provide the best performance of any plastic at both very low and very high temperatures. Impact strength of the TFE resins even at liquefied gas temperatures is good. The resins are elastic and can be used at -70°C. in services where they undergo constant flexing. They are rated for continuous operation at 260°C. The resistance of TFE resins to high temperatures makes them particularly suitable for use at high power levels. Heat aging, which results in the cracking and embrittlement of most other high-grade insulations, is completely eliminated at temperatures to at least 260°C. TFE resins are among the few insulators that remain effective at microwave frequencies under severe conditions of climatic and mechanical shock. This is especially useful in designing airborne components.

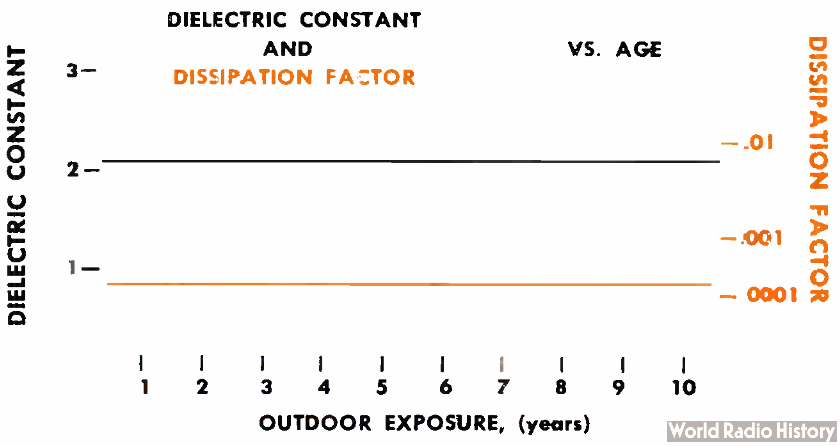
TFE resins can be compounded with inorganic materials (glass fibers, quartz, mica, graphite, copper, aluminum, etc.) to increase mechanical properties as follows:

INCREASE IN MECHANICAL PROPERTIES BY USE OF FILLERS

PROPERTY	FACTOR OF IMPROVEMENT
Resistance to creep	2 to 6
Resistance to initial deformation under load	1.25 to 4
Stiffness	2 to 3
Thermal conductivity	5
Resistance to wear by rotating shafts	up to 500

TFE resins simplify assembly of components for high-frequency use

TFE resins can withstand continuous application of a soldering iron or dip soldering. This facilitates assembly especially in densely wired equipment or where shielded wiring or thin-walled insulation is required. In thicker sections, parts made of TFE resins are relatively stiff. For RF applications where extreme rigidity is required, the use of special fillers such as quartz or a glass is possible with some loss in electrical properties. The elasticity of the resins is also useful in assembly; feed-through insulators can be snapped into place in slightly undersized drill holes. Complex microwave parts can be machined from basic shapes such as rods, sheets and tubes. A variety of special processes is available for bonding TFE resins (normally non-adhesive) to other materials. One heat-bonding resin has electrical properties like those of TFE resin. Additional information is available on request.

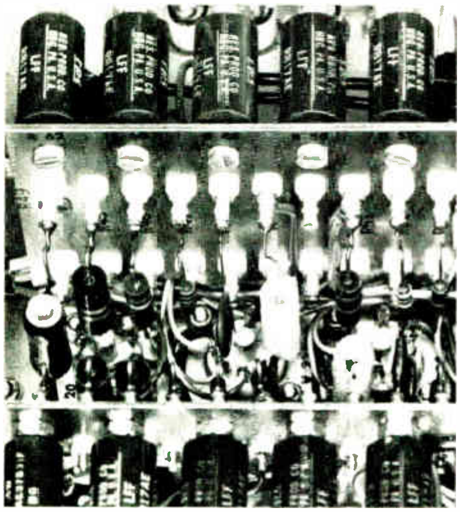


TFE resins have practically unlimited resistance to aging and weathering

TFE resins, unlike most other plastics, are completely unaffected by weather. After 12 years of Florida exposure, no deterioration in properties could be detected. Water does not wet a clean surface of TFE resin. Thus, standoff insulators do not short out. No water is absorbed, so that volume and surface resistivities remain at their normal, extremely high level—well beyond the measurable range of ordinary instruments. Freezing cold, ultraviolet rays and salt spray are harmless to TFE resins. They are unaffected by microorganisms and soil chemicals of any nature. Heat aging at 250° C. showed no effect. Their resistance to aging makes TFE resins useful in applications such as environmental test chambers for component testing.

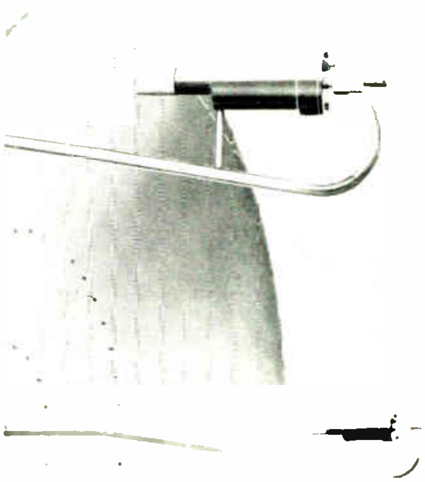
OVER

Insulators of TFE resins save costs . . . increase compactness and safety of equipment



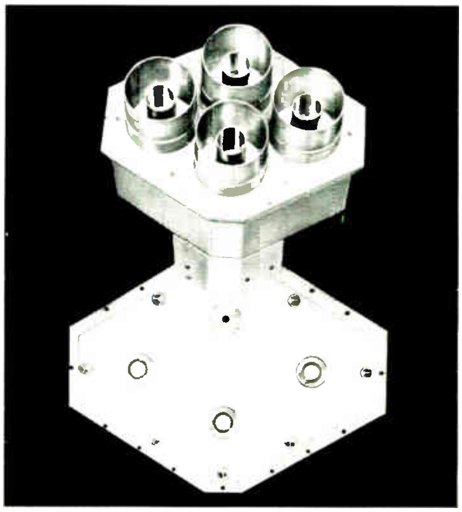
(Photo courtesy of Dressen-Barnes Corp.)

STANDOFF INSULATORS of TFE resins replace component mounting boards because they snap into metal chassis. Low leakage of the resins even in moist air and use of grounded metallic terminal board prevent cross talk and stop leakage currents from reaching adjacent circuits. Especially useful in low-level, high-impedance circuits, chassis design costs no more, permits ease of fabrication.



(Photo courtesy of Diamond Antenna & Microwave Corp.)

RADOME for K-band antenna matches impedance of feed horn to space and provides protection against weather. Wave-guide impedances at input and output of ferromagnetic rotator in the feed are matched with minimum insertion loss by internal cones of TFE resins. Since the resins do not absorb moisture, the low dielectric constant remains stable.



(Photo courtesy of Thompson Ramo-Wooldridge, Inc.)

TV TRANSMITTER SWITCH used with 3⅛" rigid coaxial line handles 55 KW in the UHF band with very low loss. Both high frequency rating and high temperature performance are made possible by use of TFE resins. They end the problem of impact cracking of the dielectric and eliminate maintenance. Insulating layer is machined from a sheet of TFE resin.

WEIGHT SAVINGS AND ECONOMIES are possible with TFE resins in industries such as the aircraft industry. For example, the dollar savings per foot of cable made possible by the higher power-to-weight ratio of TFE resins becomes vital in aircraft and missiles where every pound of load requires several pounds of air frame and engine to carry it. Another area of savings results from the ready soldering of cable to connector, since TFE resins will not melt, shrink back or be sliced through by heated conductors during soldering. Furthermore, in high-speed aircraft where skin temperatures sometimes exceed 200°C. and ambient temperatures in electronic devices run very high, the savings in refrigeration equipment can be substantial. Components can be made much smaller and lighter with TFE resins with no sacrifice in performance.

Dielectrics that do the job safely and reliably are the least costly in the long run. TFE-fluorocarbon resins are the most dependable organic insulating materials known. They simplify assembly operations and lessen their cost. They minimize rejections. They reduce or may entirely eliminate maintenance costs. TFE resins help engineers meet the most stringent MIL specifications.

Typical RF Uses of TEFLON TFE-fluorocarbon resins

Coax, RF connectors • Flush antennas • Antenna horns, radomes • Microwave printed circuits • Rotary RF joints • RF switches • Duplexers and other waveguide components • Standoffs, feedthrough bushings, spacers

SEND FOR INFORMATION

Discover how Du Pont TFE-fluorocarbon resins can help you improve your products both electrically and structurally. For property, design and end-use information, contact a processor of fluorocarbon resins (listed in the Yellow Pages under "Plastics") or write to: E. I. **du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 2524, Nemours Building, Wilmington 98, Delaware.**

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

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

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TFE-FLUOROCARBON RESINS

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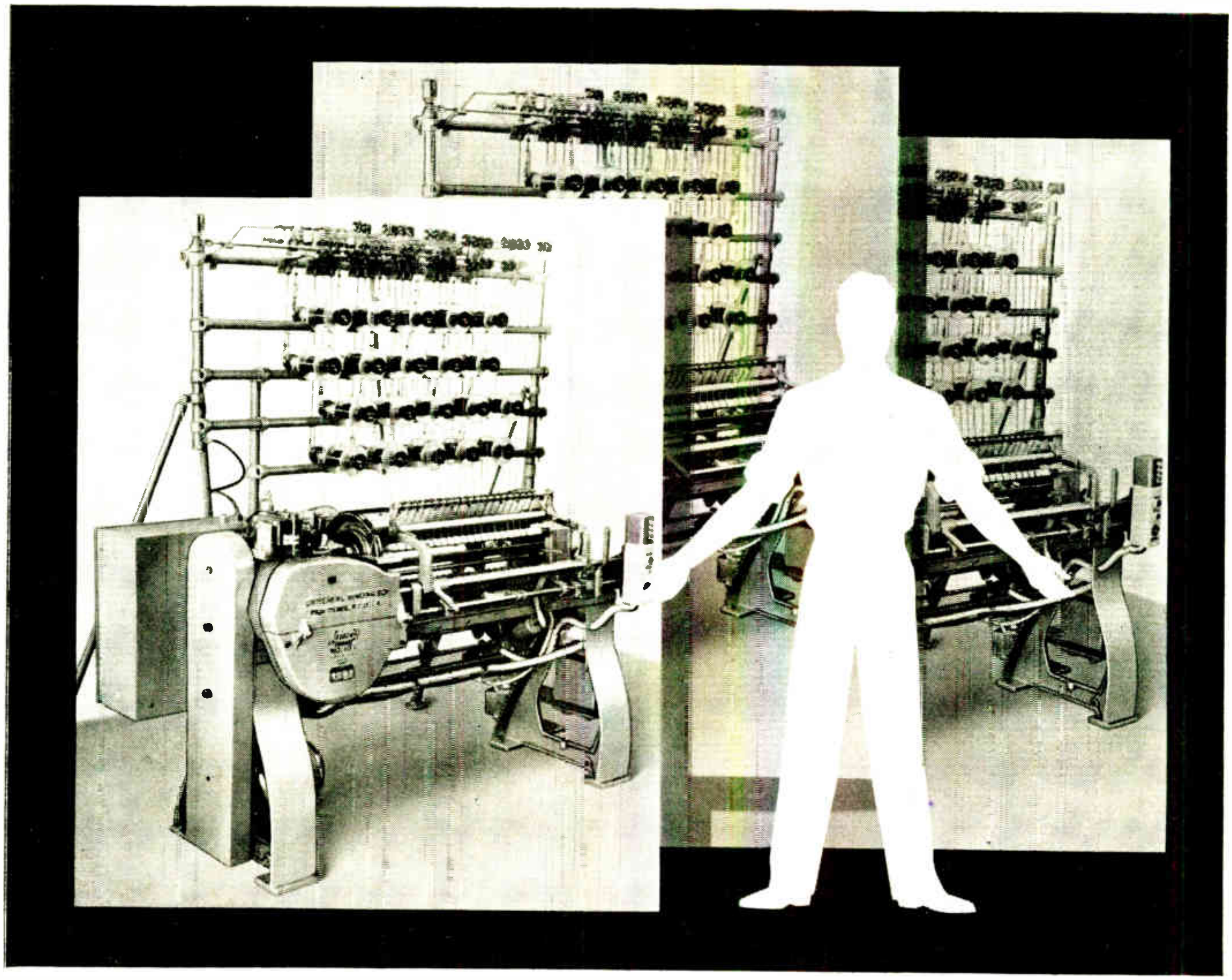

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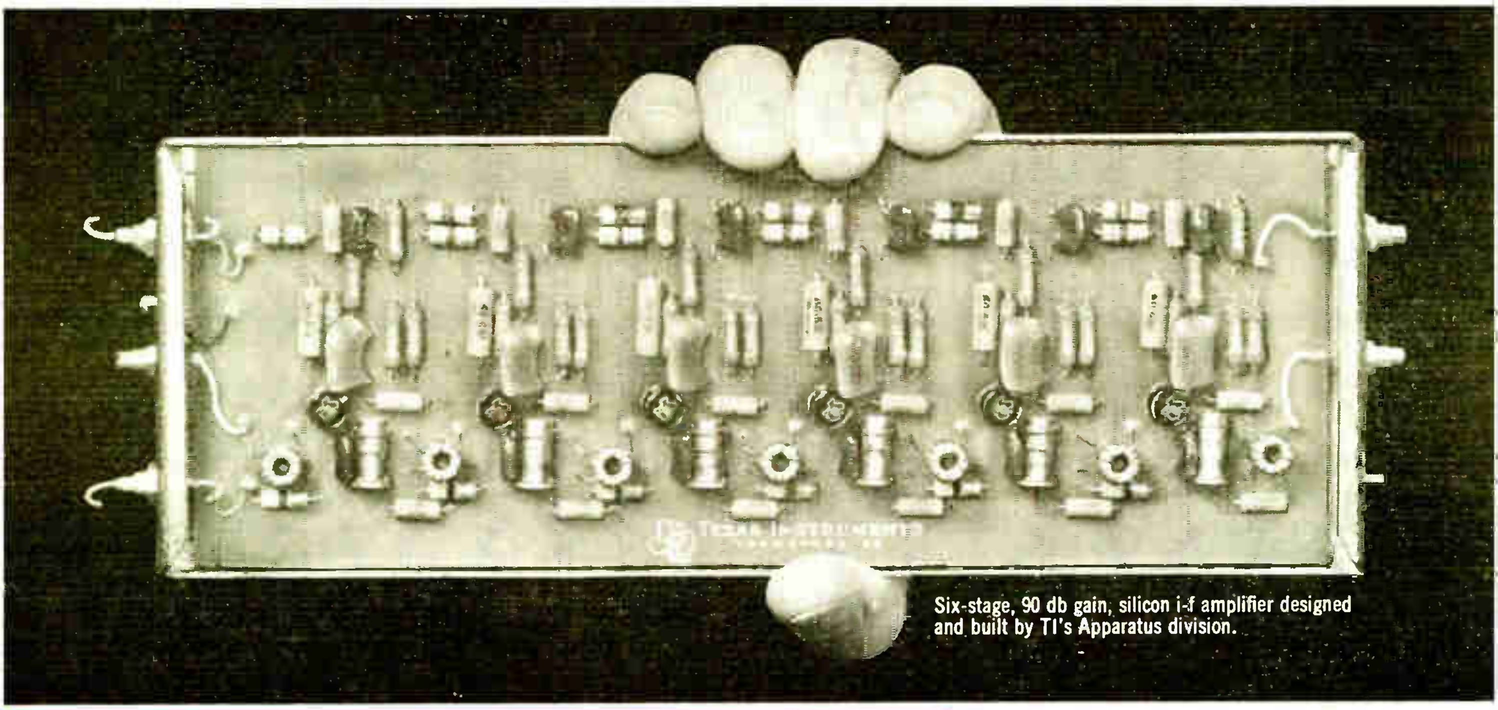
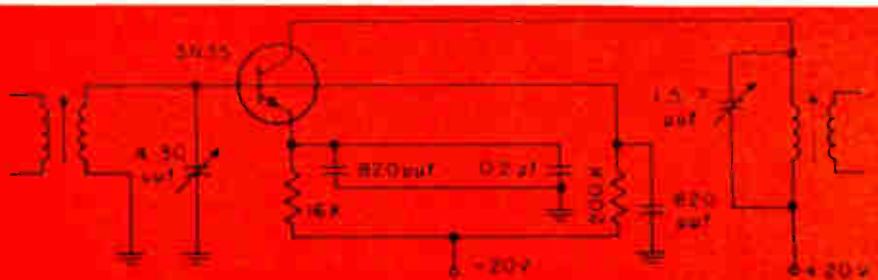
105 db gain in 60 mc I-F strip



Six-stage, 90 db gain, silicon i-f amplifier designed and built by TI's Apparatus division.



One stage of 105 db gain, eight stage, 60 mc I-F strip

Write on your company letterhead for 105 db gain, eight stage, 60-mc i-f amplifier applications brochure.

...with TI 3N35 silicon transistors

Actual Size

105 db I-F STRIP CHARACTERISTICS

Bandwidth: 20 mc at 3-db down

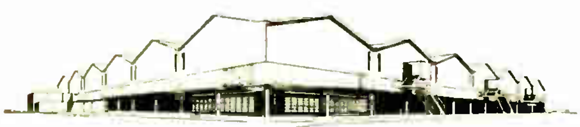
Center Frequency: 60 mc

No neutralization required

The high gain of TI 3N35 transistors at high frequencies permits mismatch in the interstage coupling networks to eliminate complicated neutralizing circuitry. You save extra component costs, design with ease and gain added reliability . . . because the mismatch in this application sacrifices only 2.55 db gain per stage!

Designed for your high frequency oscillators, i-f, r-f, and video amplifier circuits, the TI 3N35 features . . . 20-db power gain at 70 mc . . . typical 150-mc alpha cutoff . . . operation to 150°C. These characteristics make transistorization feasible for radar, communications, missile, and other high reliability military applications.

In commercial production at TI for two years, the 3N35 has a product-proved record of high performance and high reliability. These units are *in stock now!* For *immediate delivery*, contact your nearby TI distributor for 1-249 quantities at factory prices . . . or call on your nearest TI sales office for production quantities.



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Firms Announce Mergers

MERGERS, ACQUISITIONS and other amalgamations are proceeding at a brisk pace during this year's first quarter. Latest check on announced combinings includes the following:

• Terms have been agreed to by **Ling Electronics**, Richardson, Tex., and **Altec Companies, Inc.**, Anaheim, Calif., for the acquisition of Altec stocks by Ling on a share-per-share exchange of common stock. On completion of the transaction, which is now pending before the Securities and Exchange Commission, Altec Companies, Inc., and its subsidiary, Altec Lansing, will both operate as subsidiaries of Ling. Altec Service Co. will function as a division of Altec Companies, Inc.

• Stockholders of **Cessna Aircraft Co.**, Wichita, Kan., and **Aircraft Radio Corp.**, Boonton, N. J., have approved merger plans providing for exchange of two shares of Cessna stock for three shares of ARC. Final signing of the agreement took place last week at Boonton. Company officials say the specialized facilities under which ARC produces navigation and communication gear for small aircraft make the firm a logical acquisition for Cessna.

• Combined operations between **Varian Associates**, Palo Alto, Calif., and **Bomac Laboratories Inc.**, Beverly, Mass., will come about through an exchange of common stock. Varian will acquire 80 percent interest in Bomac and have an option to acquire the balance of outstanding Bomac common stock. Negotiations, which were completed late last month, are awaiting final settlement of legal and accounting matters.

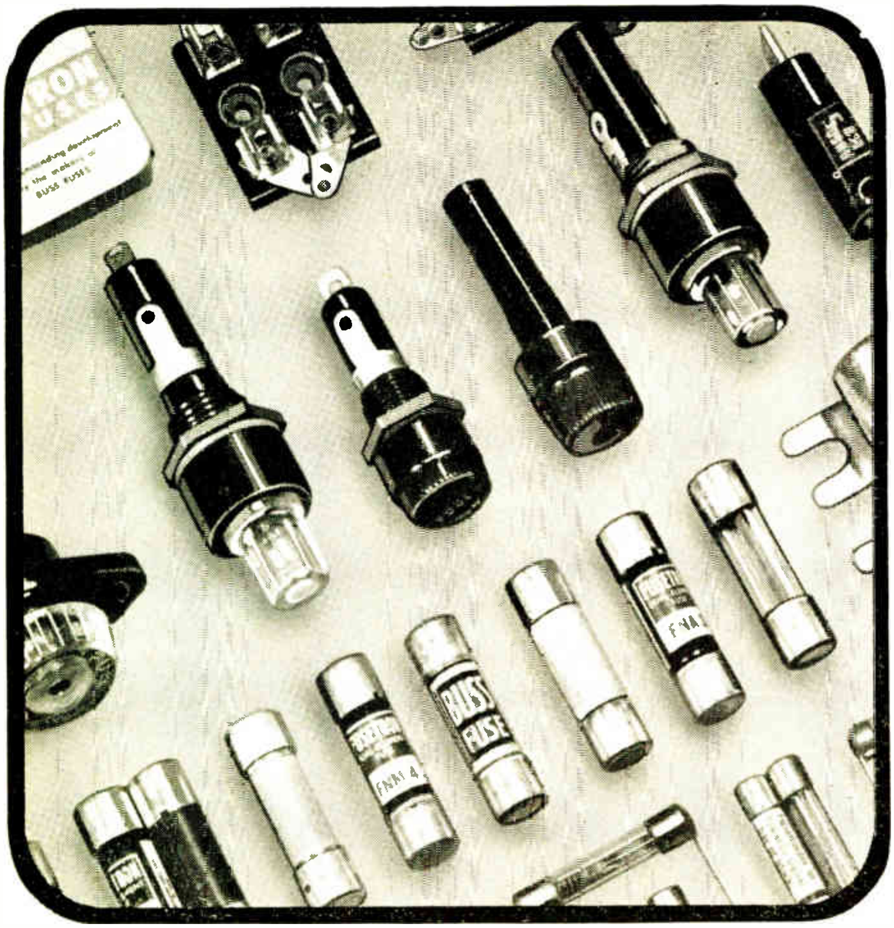
• Announcement of merger has been made by officials of **Eastern Air Devices Inc.**, Dover, N. H., and **Norbute Corporation**, industrial division of Crescent Petroleum Corp., New York. Consideration for which Norbute acquired EAD was not disclosed. It was revealed that the exchange involved transfer of stock as well as cash.

• **Sprague Electric Co.**, North Adams, Mass., has purchased the magnetic component and filter product lines of the **Hycor Division of International Resistance Co.**, Philadelphia, according to a joint announcement of both firms. Sprague will take over the manufacture of Hycor lines which were formerly made by the IRC division at its Sylmar, Calif., plant.

OVER THE COUNTER

1958 BIDS LOW	1958 BIDS HIGH	COMMON STOCKS	WEEK ENDING Jan. 30 BID	WEEK ENDING Feb. 6 BID	WEEK ENDING Feb. 6 ASKED
3¾	20½	Acoustica Assocs	20¾	22½	27¾
1⅝	3	Advance Industries	3¾	3⅜	4¼
3⅛	6⅝	Aerovox	7⅝	7½	8⅜
20½	33	Amer Res & Dev	37¾	38¼	40½
16¾	24¼	AMP Inc	23¼	24½	26¾
5½	15	Appl'd Sci Princet	9	9¼	11¼
1⅛	8⅞	Avien, A	9¾	8¼	10½
6¾	24	Baird-Atomic	25¼	26¼	29⅛
9¾	13⅜	Burndy	14	14	15¾
6¾	9	Cohu Electronics	7¼	7¾	8⅜
11	22½	Collins Radio, A	23	23¾	25⅞
10¼	22¼	Collins Radio, B	23	23¼	25⅝
4	7	Craig Systems	7⅝	7½	8½
30	50½	Dictaphone	47½	46	50⅞
17⅝	25⅜	Eastern Industries	20¼	20¼	22½
10½	21	Electro Instr	24¼	23½	26¼
34	49	Electronic Assocs	48	48	53½
5	11	Electronic Res'rch	12	12¼	13¾
8½	12¾	Electronic Spec Co	13	13⅛	14⅞
15¼	49½	Epsco, Inc	40½	36	42
5½	9⅜	Erie Resistor	10½	10	11½
10	17½	Fischer & Porter	15½	15¾	17¼
36¾	50	Foxboro	49	49½	54
5½	10½	G-L Electronics	13½	13¾	16¼
12	27	Giannini	28	26½	32
30	39½	Hewlett-Packard	40½	39	43
23¼	48	High Voltage Eng	54	54½	59
1¾	3	Hycon Mfg	3⅜	3¼	3⅞
1⅛	5⅛	Industro Trans'tor	2½	2¾	3⅞
1½	4¼	Jerrold	4¾	4⅞	5½
21	30	D. S. Kennedy	32½	36¼	44
3¾	29	Lab For El'tronics	25¼	26½	30⅛
19¼	28	Leeds & Northrup	30¼	29¼	32½
2	3⅛	Leetronics	2	2⅛	2⅝
5	18¾	Ling Electronics	18½	18	19⅞
16	20½	Machlett Labs	24½	25	28⅞
3¼	8¼	Magnetic Amplifiers	7¾	7½	8¼
2⅞	4½	Magnetics, Inc	3⅜	3⅝	4⅛
4⅝	12	W. L. Maxson	13⅝	13⅞	15¼
10⅝	29	Microwave Assocs	33½	34	37¾
5¼	11¼	Midwestern Instr	12⅞	13⅝	15⅜
1⅛	7	Monogram Precis'n	8⅝	8⅝	9¼
3½	7¼	Narda Microwave	7⅛	7¼	8⅝
9¾	16	National Company	18½	18½	21½
14¼	56	Nuclear Chicago	28½	30½	34⅝
14½	29¼	Orradio Industries	29	29¼	32½
4½	7⅜	Pacific Mercury, A	9⅛	9¾	11
10⅛	27½	Packard-Bell	31	31	35⅜
4¼	9⅜	Panellit, Inc	6⅞	6¾	7⅞
21	53¾	Perkin-Elmer	47	46½	50⅞
11⅜	19½	Radiation, A	18	18¾	21½
2⅛	7⅜	Reeves Soundcraft	7⅝	6⅝	8⅝
13	32½	Sanders Associates	32	30	35⅝
7	12	SoundScriber	18	18¾	20⅝
22¾	40	Sprague Electric	41½	41	44⅞
26	35	Taylor Instruments	33	32¾	35⅝
5½	15	Technical Operat'ns	16¾	16¼	18⅜
5½	15¾	Telechrome Mfg	18	18	20⅜
3¼	7¾	Telecomputing	8¼	7½	8¾
1⅛	2¾	Tel-Instrument	2¾	2¾	3½
8¾	16¼	Topp Industries	14¼	14¾	16¾
3¾	10¾	Tracerlab	11¼	10¼	12⅝
1⅛	3⅜	Universal Trans'tor	1	1	1½
14¼	40	Varian Associates	42	43	47¾
12½	18½	Vitro Corp. Amer	16¾	15⅞	17⅜

The above "bid" and "asked" prices prepared by the NATIONAL ASSOCIATION OF SECURITIES DEALERS, INC., do not represent actual transactions. They are a guide to the range within which these securities could have been sold (the "BID" price) or bought (the "ASKED" price) during preceding week.



For Every Fuse Application . .

there's a safe and dependable
BUSS or FUSETRON Fuse

The complete BUSS and FUSETRON fuse line includes:

Single-element fuses for circuits where quick-blowing is needed; — or single-element fuses for normal circuit protection; — or dual-element, slow-blowing fuses for circuits where harmless current surges occur; — or indicating fuses for circuits where signals must be given when fuses open. Fuses range in sizes from 1/500 amperes up — and there's a companion line of fuse clips, blocks and holders.

Each fuse electrically tested to assure you dependability

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

You get the safest, most modern protection possible when you specify BUSS or FUSETRON fuses. You'll save time and trouble too, by using this one source for all your fuse needs.

For more information, write for bulletin SFB.

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259

Tell us your requirements and we'll have a fuse to match, for example:

For fuses that abolish needless blows . . *specify* . . **Fusetron fuses**

¼ x 1¼ inch.
Glass tube.

dual-element — slow blowing type

These fuses avoid needless blows from starting currents or surges. Yet protection is afforded against short-circuits or continued overloads.

Test specifications carry 110%, open at 135% within 1 hour.

Voltage	Amperes
250 or less	up to 2
125 or less	up to 7
32 or less	up to 30

For Signal or Visual indicating fuses . . . *specify* . . . **Fusetron FNA fuses**

13/32 x 1½ inch.

Fusetron fuse with indicating pin which extends when fuse is blown. Can be used in BUSS fuseholders to give visual signal or, if desired, pin can be used to actuate a light or audible signal by using fuses in BUSS Signal fuse block.

0 to 2½ ampere sizes and 12 to 15 ampere sizes listed as approved by Underwriters' Laboratories.

Voltage	Amperes
250 or less	1/10 to 30.

For fast acting fuses for protection of instruments *specify* **BUSS AGC fuses**

¼ x 1¼ inch.
Glass tube.

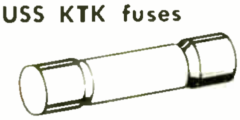
In sizes up to 2 ampere, for circuits of 250 volts or less, they provide high speed action necessary to protect sensitive instruments or delicate apparatus.

Listed as approved by Underwriters' Laboratories.

Test specifications carry 110%, open at 135% in 1 hour or less. 1/500 to 2 ampere sizes also will open at 200% load in 5 seconds or less.

For high interrupting capacity fuses . . . *specify* . . **BUSS KTK fuses**

13/32 x 1½ inch.



Capable of safely interrupting 68,000 amperes at voltages of 500 or less, AC or DC.

Test specifications — Carry 110%, open at 135% in 1 hour or less.

Voltage	Amperes
500 or less.	1/10 to 30.

BUSS fuses are made to protect,—not to blow, needlessly.
BUSS makes a complete line of fuses for home, farm, commercial, electronic, automotive and industrial use.

FUSETRON — TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION — BUSS
McGRAW-EDISON

Two portables with

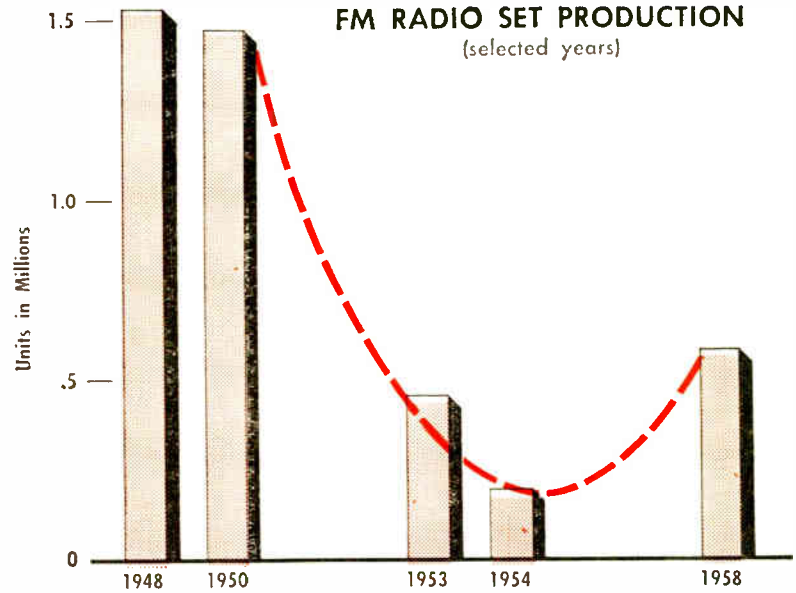
WIDE RANGE COVERAGE

Traditional Weston quality alone would keep these famous model 904 portable instruments '*way in the lead*. But their exceptionally broad range coverage, plus other exclusive features which distinguish this comprehensive instrument line such as . . . unequalled scale visibility . . . wrap-around windows . . . hand calibrated mirror scales and knife-edged pointers . . . convenient terminal locations . . . efficient shielding . . . rated accuracy of 0.5% . . . make them *standouts* for laboratory or shop portable needs. Other instruments in this broad line include D-C Voltmeters, Volt-Ammeters, Ammeters, Milliammeters; A-C Voltmeters, Ammeters, Milliammeters; and A-C and D-C single-phase Wattmeters. For complete information see your local Weston representative or write for literature . . . WESTON INSTRUMENTS, Division of DAYSTROM, Inc., 614 Frelinghuysen Avenue, Newark 12, New Jersey.

A DAYSTROM UNIT

WESTON *Instruments*

Visit us at Booths 8102, 1901, Radio Engineering Show, N. Y. Coliseum, Mar. 23-26



F-M Radio Set Output Rising

F-M RADIO set reports show production is on the way up.

Some 576,00 sets were produced last year, including 376,000 American-made and 200,000 foreign imports. Figures include f-m and a-m/f-m radios and a-m/f-m radio-phonograph combinations but exclude f-m tuners.

Indications are that 1959 output will be still higher. Reasonably close forecasts are not available, but those familiar with the market feel there is no question that production will continue to increase.

Despite effects of recent recession, production in 1958 is believed to have been somewhat higher than 1957. It is difficult to measure precisely the gain over 1957 because of changes in methods of reporting figures.

Major radio set makers have increased production to keep up with resurgent demand, National Association of Broadcasters says. One manufacturer reports his sales of f-m table models have doubled in the last five years.

Upward trend stands out in relation to 1954 f-m set output, the recent low-point. In that year production totaled a scant 189,000 units. Previous high in f-m output was reached in 1948 when American factories turned out more than one and a half million receivers. Production in 1950 remained high—1,472,000 units. Dropoff became noticeable in 1953 when domestic production totaled 456,000 sets.

Foreign f-m manufacturers have recently exhibited vigorous activity. A leading exporter of f-m sets is West Germany. Its output has been heavy since 1955. Japan is now reported entering the market.

High fidelity has been one of the most significant factors in f-m gains. A healthy segment of radio listeners are interested in the quality reception which hi-fi can provide via f-m. Stereo, too, will have a salutary effect upon f-m production and sales, says NAB, but it is still too early to determine the extent of stereo's influence.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Jan. 30, 1959	Jan. 2, 1959	Change From One Year Ago
Television sets	129,745	61,007	+ 8.3%
Radio sets (ex. auto)	295,036	192,562	+ 20.0%
Auto sets	95,323	79,228	+ 19.3%

STOCK PRICE AVERAGES

(Standard & Poor's)	Feb. 4, 1959	Jan. 7, 1959	Change From One Year Ago
Electronics mfrs.	72.74	72.84	+ 33.7%
Radio & tv mfrs.	79.03	79.79	+ 68.5%
Broadcasters	81.08	78.22	+ 35.9%

LATEST MONTHLY SALES TOTALS

(Add 000)	Dec. 1958	Nov. 1958	Change From One Year Ago
Transistors, value	$16,596	$12,442	+ 150.7%
Transistors, units	5,628	5,441	+ 102.9%
Rec. tubes, value	$25,[illegible]23	$29,854	+ 1.0%
Rec. tubes, units	28,504	[illegible]5,640	+ 2.8%
Pic. tubes, value	$12,644	$15,008	—2.5%
Pic. tubes, units	649	789	+ 0.8%

the right capacitor for the application...

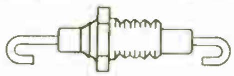
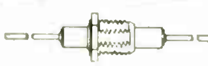
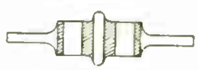
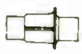
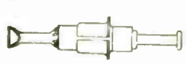
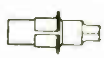
your job...and Centralab's

choose from TEN TYPES of Centralab FEED-THRU CAPACITORS

in a wide range of values, voltage ratings, tolerances and physical sizes

Wherever you need a feed-thru capacitor, you can be sure that CENTRALAB can meet your needs. The table below shows the many varieties that make up the most complete line in the industry—and you get the added benefit of CENTRALAB'S unequalled experience in the design and manufacture of ceramic capacitors. Whether it's for high frequency, filtering, bypass, or coupling, you'll find the unit you need in this group.

CENTRALAB Engineering Bulletins (FT Group) give you all the details. Write for your copies today.

TYPE	ACTUAL SIZE ILLUSTRATION †	CAP. RANGE mmf	RATING VDCW	RATING VDCT	APPLICATIONS
Bushing type DA-717		10-4000	500	1000	High frequency filtering, bypass, etc. ± 5% tolerance in lower values
Bushing type DA-720	 †	10-5000	500-1500	1000-3000	
Step type DA-728		10-1500	500	1000	Med. freq. use, bypass, TV tuners, etc. ± 10% tolerance below 200 mmf.
Step type DA-729		10-1500	500	1000	
Ring type DA-740*		10-1000	500	900-1300	Symmetrical design. Inserts from either end . . . ideal for automatic insertion
Ring type DA-741*		10-1000	500	900-1300	
Eyelet type DA-784		25-1000	500	1000	For high frequency filtering and bypass, where size is important
Eyelet type DA-785		25-1000	500	1000	
Eyelet type DA-787		25-1000	500	1000	
Resistor-Capacitor type 732		470 gmv. .3 to 1.0 meg. only	1000	**	Resistor-Capacitor in parallel. ** 1500 VAC test when immersed in Silicone oil cooled with dry ice.

*patents pending

†Units marked † are ½ actual size

Centralab D-5913

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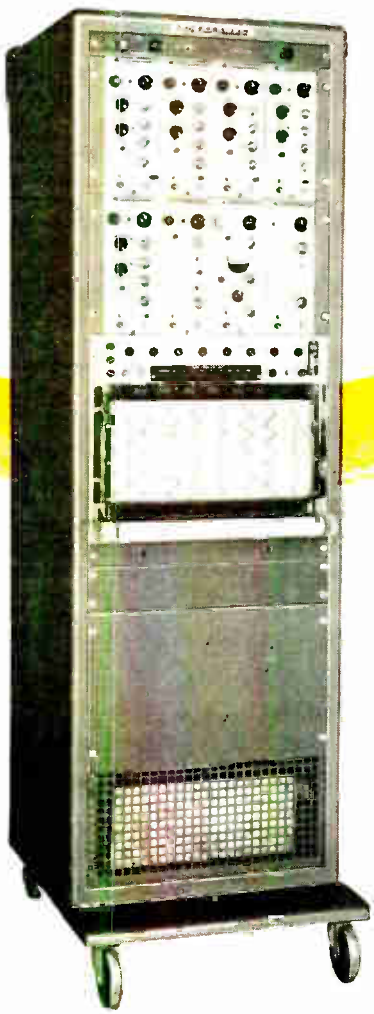
- **Galvanometer** natural frequency 55 cps
- **Hysteresis less than ± 0.1 div.**
- **True velocity damping** for galvanometer at all times — limiting ahead of output stage
- **Current feedback power amplifiers** eliminate effect of galvanometer resistance changes due to temperature
- **Linearity 0.2 div.** over entire 50 div. chart width
- **Gain stability** better than 1%
- **Base line drift less than 0.2 div.** over 20°C. changes
- **Automatic stylus heat control**
- **Inkless recording** in true rectangular coordinates

PERFORMANCE

is the best proof of SANBORN "350" System Quality



8-CHANNEL SANBORN "350"
Direct Writing Oscillographic Recording System . . .
also available with 6 channels

Only the Sanborn "350" oscillographic recording system offers *both* superior performance *and* operating versatility. You can interchange the plug-in preamplifiers — or use them separately with their own power supplies to drive a scope, meter, or optical oscillograph. The compact recorder ($17\frac{1}{2}$ inches tall), complete with transistorized power amplifiers and power supply, may also be used separately (sensitivity 0.1 volt/chart division). That's real versatility!

Recorder features include built-in paper footage indicator, paper take-up, 8" of visible record, simple paper loading from the front. Nine electrically controlled chart speeds are selected by pushbuttons, and have provision for remote control. Connections are also provided for output monitoring.

All these features — plus well-known Sanborn reliability — are yours in the Sanborn "350" system. Ask your local Sanborn Industrial Sales-Engineering Representative for complete facts — or write the Industrial Division in Waltham.

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SANBORN COMPANY
175 Wyman Street, Waltham 54, Mass.

CIRCLE 24 READERS SERVICE CARD

Specialized registers like this represent one approach to solution of a difficult problem in retail selling

Retailers Seek Input Devices

Electronics manufacturers and merchandise retailers are working closely to develop equipment that will speed up big-store operations by collecting and scanning sales information for computer processing

STRONG INDICATIONS have come to light this month that retailers are following the lead of bankers in pushing development of equipment that can "read" printed information to supply computer input data.

Unlike bankers, however, retailers are seeking systems that will use conventional ink as a basis, instead of magnetic-ink techniques which have been used in processing checks.

Equipment development, from the retailers' point of view, is proceeding at two levels—equipment to collect data, and equipment to read the collected information.

Manufacturers are working at three levels to accomplish the first aim of data collection. One method being pondered is the use of a modified cash register which will supply information in punched-tape or dot-code form.

A second approach being considered is a reader that will be incorporated in a chassis separate from the cash register, but still be used at the point of sale. This approach might require initial input information of a fairly sophisticated type.

Expanded Imprinter

The third approach relies on a manually operated imprinter similar to the type now used to place credit card information on sales slips. The imprinter would be expanded to contain a specially prepared merchandise tag as well as a charge card.

In use, the sales clerk places both documents in the imprinter and obtains a third form which is routed to the accounting department, the inventory control section, or other destination for reading by special scanners.

Retailers operating on a scale large enough to warrant use of character-recognition equipment will require data collectors in great numbers. Therefore, a basic requirement for data collectors is that they be inexpensive.

Another requirement will be ease of operation. Personnel operating the data collectors are basically interested in selling, not data collection. Any collector device will thus have to be no more complicated to operate than a cash register.

As to the actual form in which the collected information will appear, retailers will probably choose among devices which supply punched tape, conventional ink characters, or dot-code patterns printed in conventional ink.

Retailers have been working closely with equipment manufacturers for almost three years to develop what the research director of the National Retail Merchants Association calls "a common language," as well as collectors that will translate sales information into that common language, and scanners that will read the common language and convert it into computer input form.

Forums on these topics have been held by NRMA, and more are slated for later in the month. Almost a dozen equipment manufacturers have participated in the talks.

Some Results

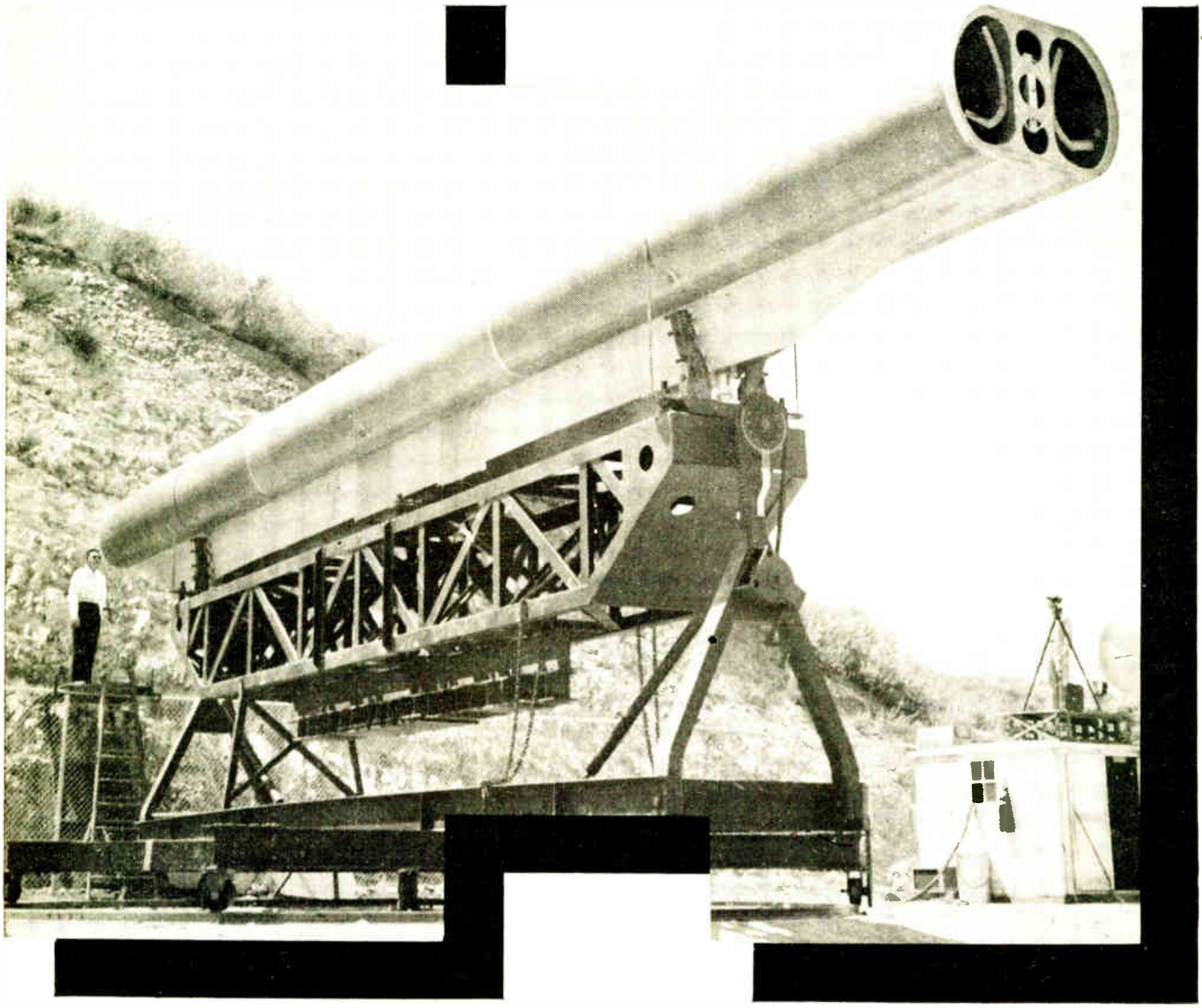
In Washington, D. C., Woodward & Lothrop have begun using a device called the Salestronic made by National Cash Register. Directions are flashed in sequence as the sales clerk operates it. Input information is collected on punched tape and delivered periodically during the day to the store's computer room.

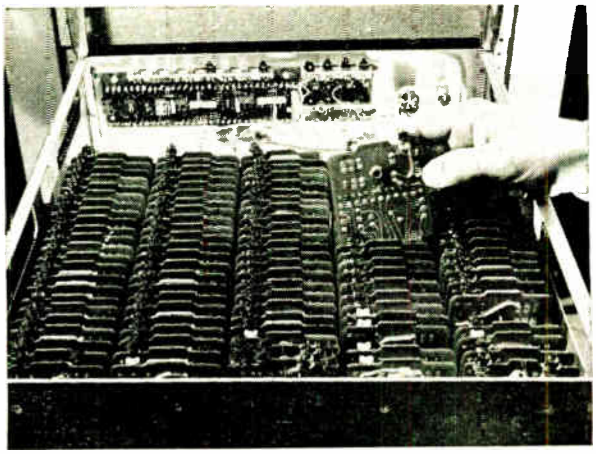
A punched-tape collector soon slated for pilot operation is a modified cash register made by Sweda Cash Register Inc. of Chicago (see photo).

Also being readied for pilot use is a line of imprinters made by Addressograph-Multigraph Corp. These devices are said to meet the price requirement of data collectors, as well as the requirement of easy operation. They provide information in dot code and in Roman alphabet and Arabic numeral characters simultaneously. They are predicated on the use of embossed credit cards. The firm has also developed readers which process information obtained from data collectors and provide direct computer input, punched cards or tape, or magnetic tape.

Working on data collectors and readers for retailers, NRMA sources say, are firms such as Burroughs, IBM, General Electric and Pitney Bowes. Intelligent Machines Research Corp., Alexandria, Va., has a number of prototype readers and imprinters in pilot operation.

The new long look





Test Equipment *designed and built by Hughes El Segundo is as sophisticated as the Hughes Electronic Armament Systems which it tests.*

His lab is the cockpit. *Wherever Hughes systems and missiles are employed, Hughes Field Engineers are on hand to work directly with squadron personnel.*

in sky scanning

A totally new idea in reconnaisance radar. SIGHTSEER *(at left)* is a side-looking, microwave search antenna within a completely self contained detachable pod. Carried under the Convair B-58 Supersonic Bomber as a 58-foot package, SIGHTSEER has all hardware and black boxes built-in. It is roll stabilized—when the aircraft changes flight attitude, the antenna maintains its normal axis.

SIGHTSEER was designed and developed by the Microwave Laboratory of Hughes. This Microwave Laboratory is presently engaged in every field of electronics for airborne, missile, communication, and ground and ship-based radar systems—with operational ranges from 50 to 70,000 megacycles.

The "systems orientation" represented by the new SIGHTSEER reflects Hughes philosophy of integration. The Microwave Laboratories, for example, support the Systems Development Laboratories as well as the Hughes Ground Systems Group in Fullerton.

Advanced Research and Development at Hughes creates stimulating opportunities for creative engineers in Airborne Electronics Systems, Space Vehicles, Plastics, Nuclear Electronics, Global and Spatial Communications, Ballistic Missiles and many others.

Similar opportunities exist at Hughes Products, where basic Hughes developments are translated into commercial products—semiconductors, specialized electron tubes, and industrial systems and controls.

From basic research through final application, Hughes offers a unique opportunity for personal and professional growth.

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

Digital Computer Engr.	Communications
Microwaves	Radar
Semiconductors	Circuit Design
Field Engineering	Systems Analysis
Microwave & Storage Tubes	Reliability Engineering

Write in confidence, to Mr. Tom Stewart, Hughes General Offices, Bldg.6-D2, Culver City, California.

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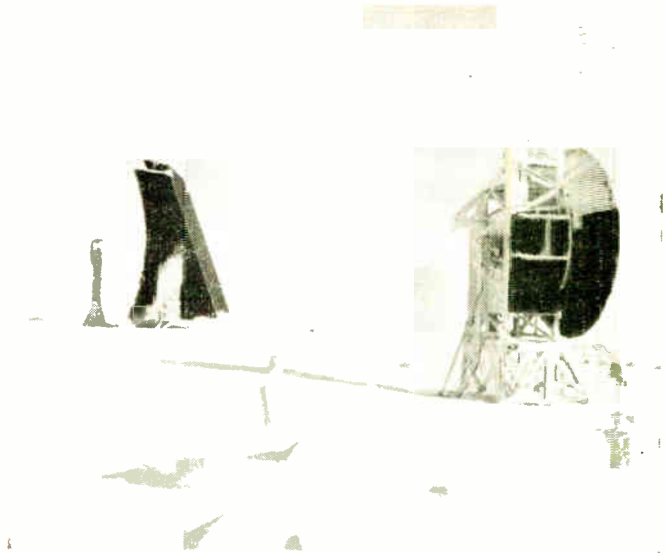
HUGHES

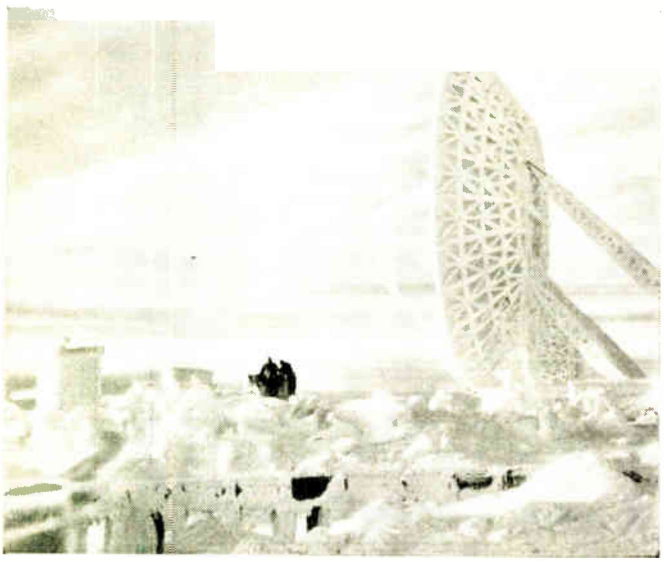
HUGHES AIRCRAFT COMPANY
*Culver City, El Segundo, Fullerton and Los Angeles, California
Tucson, Arizona*

WHITE ALICE

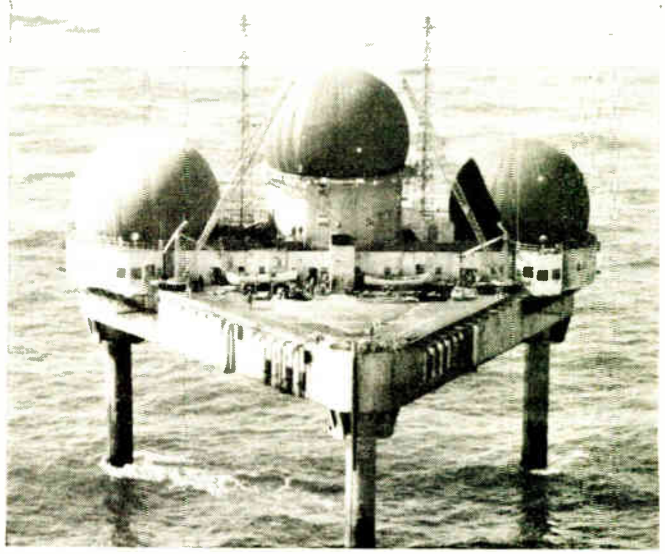
WESTERN ELECTRIC PHOTO



DEW LINE



POLE VAULT



TEXAS TOWERS

OFFICIAL U.S. AIR FORCE PHOTO

EIMAC KLYSTRONS performance proved in original Tropo-Scatter systems

Eimac klystrons are used in nearly every major military and commercial tropo-scatter system in the world. The list is impressive: Pole Vault, Texas Towers, Dew Line, White Alice, SAGE, NATO, Florida-Cuba TV, and numerous commercial networks. They have been selected for systems from Norway to North Africa, from the Arctic Circle to the Andes, from the United States to the Far East.

In most of these systems Eimac klystrons are used exclusively. The reason is simple: Eimac-pioneered external-cavity klystrons make it possible to generate high power at ultra-high frequencies simply, reliably and at low cost. With the Eimac external-cavity system, tuning cavities, couplers and magnetic circuitry are all external to and separate from the tube. This permits exceptionally wide tuning range and simplifies equipment design. Cost is lowered because this external circuitry is a permanent part of the transmitter and is not repurchased when tubes are replaced.

The reliability of these high-performance devices is exceptional. Some of the original Eimac klystrons installed in Project Pole Vault—the first major tropo-scatter network ever established—are still going strong with more than 25,000 hours of air time logged to their credit.

Eimac manufactures a complete line of amplifier and pulse klystrons covering the most important areas of the UHF spectrum. Write our Application Engineering Department for specific information.

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SAN CARLOS, CALIFORNIA

Eimac First with ceramic tubes that can take it

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How SAC Communicates

Big push now is to complete a single-sideband network. One company alone has a $20-million order for airborne radio gear

OFFUTT AFB, NEB.—STRATEGIC AIR COMMAND's 3,000 planes flying from 70 bases spread across four continents are welded into a single striking arm by a gigantic complex of electronic communications and data-processing systems.

Center of this network lies some 45 feet below ground here. In case of enemy attack, SAC's immediate retaliation would be directed and controlled entirely from this post ("SAC Prepares for Missiles," p 30, Feb. 13).

Facilities here include a communications center, global weather central (ELECTRONICS, p 26, Jan. 16), computer room and a control room 140 ft long, 39 ft high. Lining one wall, the length of the control room, giant panels are constantly updated to show all information needed to direct global war.

For quick internal visual communications, two RCA TK-41 color tv cameras, with remote control and focus capabilities, are installed in the operations room on a 106-ft track opposite the map panels. Two more cameras, with electronic viewfinders, are mounted on movable studio pedestals. A TK-45 3-vidicon color tv camera is in the weather briefing room.

In addition to color tv, a monochrome RCA ITV-6 camera monitors entrance to the map room and control area. Black-and-white tv also connects the control room with North American Air Defense Command in Colorado Springs, Colo.

Future tv plans include connecting the control room with USAF headquarters in Washington. ITT has a development contract for such a system to be transmitted in code over low-frequency telephone wires. Later, tv will connect all SAC bases in the U. S.

Sixty telephone lines leased from AT&T are available in the control room for alerting SAC bases individually or all at once. Receiving end has a loudspeaker, automatic tape recorder and individual telephone receivers.

A separate private telephone system is used for control of daily aircraft movements.

Teleprinter communication equipment is used to back up the telephone voice messages. The system includes multiple lines operated by USAF and Army, and commercial lines leased from AT&T. Cable service to England is backed up by RCA's radiotelephone service.

Single-sideband radiotelephone backs up the telephone service and reaches all SAC planes flying anywhere in the world.

At present there are 23 fixed ground-to-ground ssb stations, broadcasting on 11 mc, 14 mc and 20 mc. The equipment used, according to SAC, includes Collins KWT-6, KWS-1, 75A4 and RCA's SSB-1. Using 500-watt pep (peak envelop power), world-wide coverage is maintained under good atmospheric conditions. Automatic radio relay switches, however, can bypass poor conditions.

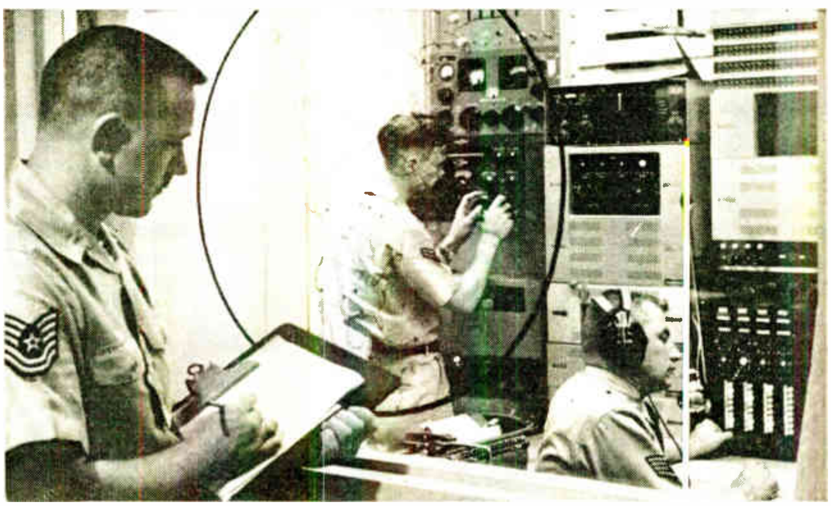
Air-to-air and air-to-ground ssb equipment, transmitting at from 4 mc to 25 mc, will be operational in all SAC planes by mid-1960. RCA has recently delivered $3.5-million worth of airborne equipment for SAC and is under contract for $20 million more.

Airborne receiver/transmitters used include RCA's AN/ARC-65 (modified ARC-21's) and Collins' AN/ARC-58. Both are automatically controlled. The ARC-65 operates in 500-cycle steps, providing a total of 44,000 crystal-controlled channels. The units are used for ssb and a-m voice.

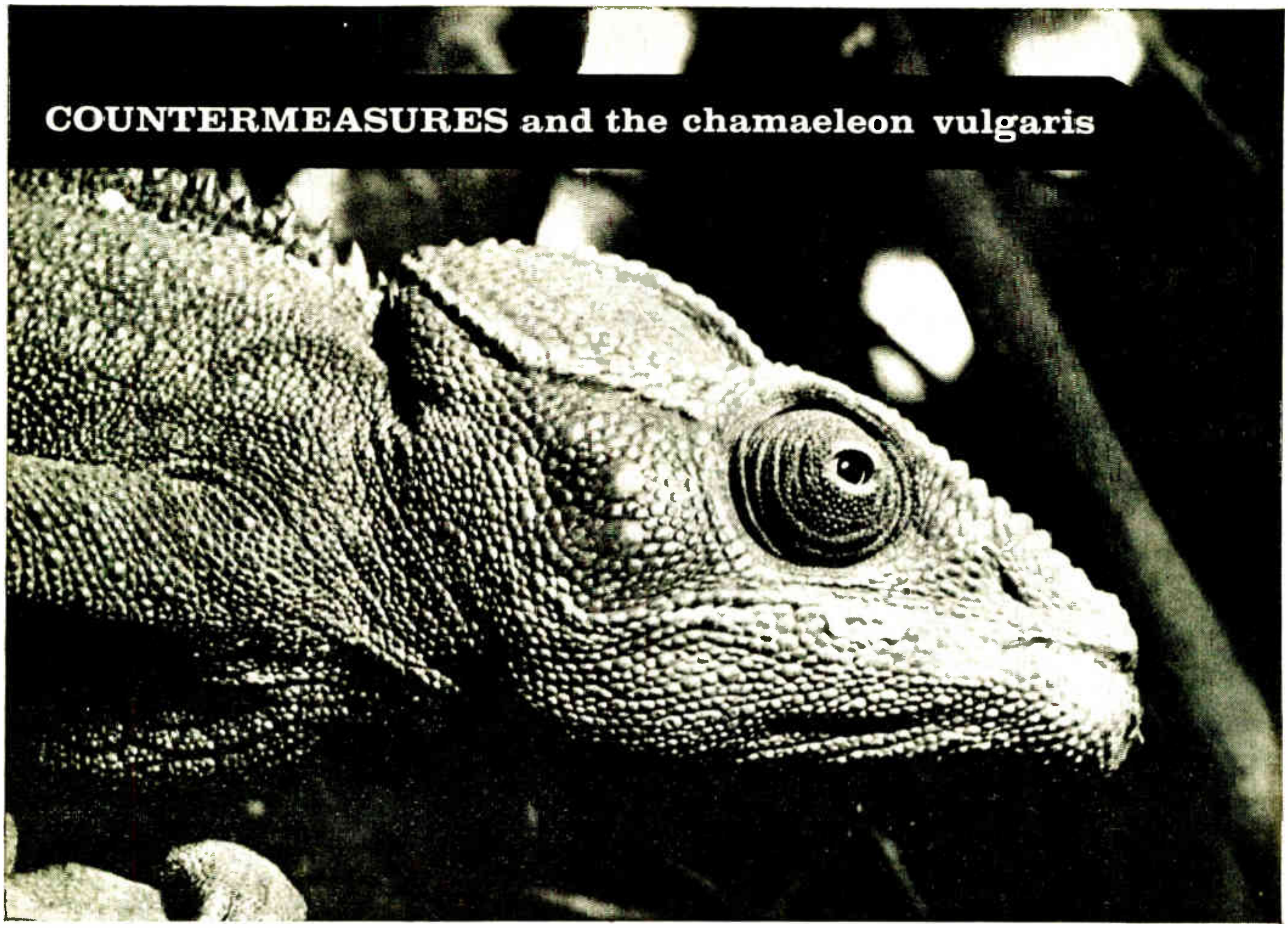
Some SAC planes carry RCA's ARC-34 uhf, remote-controlled, line-of-sight, command communications set. It can be preset to any 20 operating frequency channels of 1,750 available frequencies from 225 mc to 399.9 mc. Successor to the ARC-34 will be the ARC-62.

Four ground stations for the air/ground network are now under construction. Active contractors for ground equipment, according to Air Materiel Command, include Westinghouse with a $½-million contract, Collins for KWT-6 transmitters, receivers and controllers ($4 million), and Eldico Electronics div. of Radio Engineering Labs for 2 mc to 30 mc 100-watt pep transmitters, receivers, control units and power supply ($525,000).

(Part III of this series will describe how SAC's electronic data-processing equipment would direct a global offensive.)



Four communication systems, including single-sideband radiotelephone (above), weld the Strategic Air Command into a single striking force



DECEPTION IS A FORM OF COUNTERMEASURE

and at this the chameleon must be considered an expert.

The approach to the problem of survival through countermeasures has been neatly solved by this handsome little fellow. By simply changing his color to match the surroundings the chameleon may take on the appearance of a brown twig, a green leaf or so completely blend into the immediate area that his enemy is hopelessly confused. This, in effect, is countermeasure in the truest sense.

To confuse or mislead the enemy is often the problem faced by the military. Not to be outdone by the chameleon, electronic countermeasures have been developed which effectively confuse the presentations as seen on radar scopes. Defensive action is thereby delayed until too late. In this field, as well as many other forms of countermeasures, Instruments for Industry can apply exacting know-how and skill. The high degree of success achieved by IFI is proof of ability.

Only one target is a true target.
The big question . . . which one?

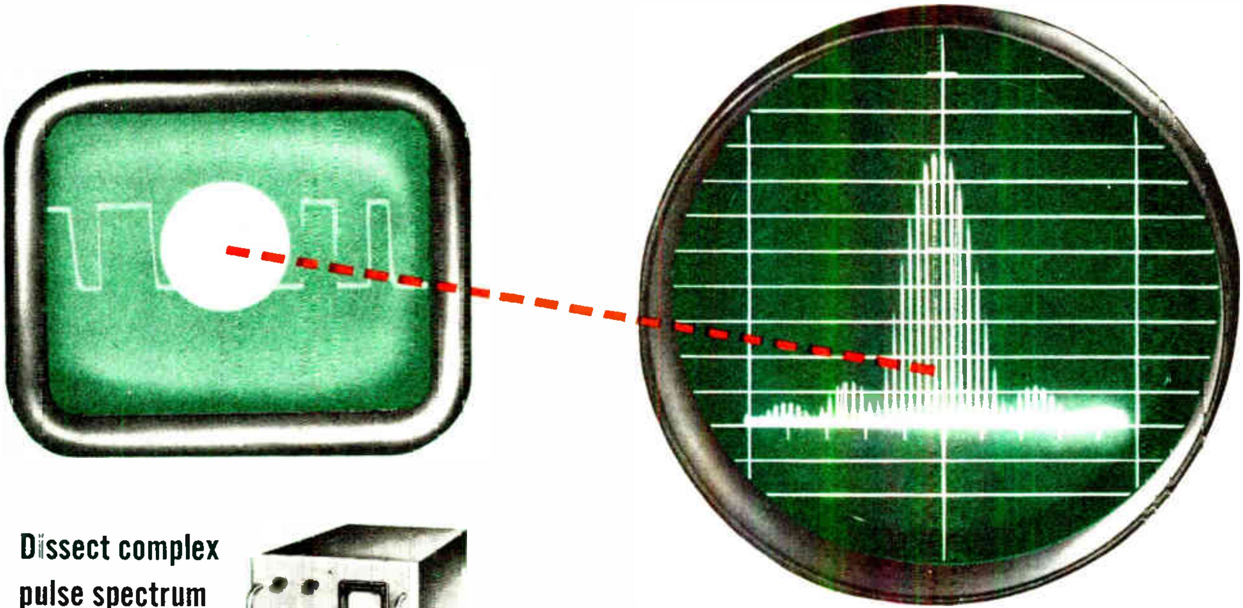
MILITARY INSTRUMENTS ifi INC. FOR INDUSTRY ELECTRONICS

INSTRUMENTS FOR INDUSTRY, Inc.
101 New South Road, Hicksville, L. I., N.Y.

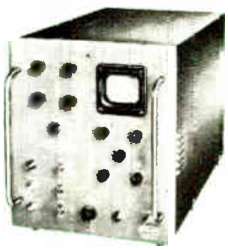
Graduate engineers with two or more years of circuit application in the fields of electronics or physics are invited to meet with Mr. John Hicks in an informal interview or send complete resume to: Dir. Personnel, IFI, 101 New South Road, Hicksville, New York.

VISUAL MICROWAVE ANALYSIS—10 to 44,000 mc

COMPLEX SPECTRUM DECODING



Dissect complex pulse spectrum visually by means of Polarad Model SD-1



MULTI-PULSE SPECTRUM SELECTOR

Used with any Polarad analyzer, this Model SD-1 Spectrum Selector permits complete analysis of any complex pulse modulated microwave signals. The unit decodes and isolates any segment of a complex pulse train and permits corresponding spectrum analysis of that segment.

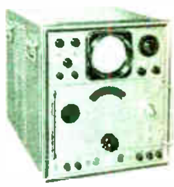
Model SD-1 Spectrum Selector displays pulse groups up to 180 microseconds duration (Model SD-1X: 350 microseconds).

Applications:

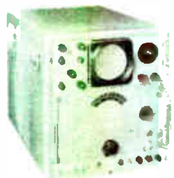
Design and operation of radar, telemetry equipment, IFF systems and beacons.

Analyze complex spectrum visually using any of Polarad's wide band

MICROWAVE ANALYZERS



Model TSA Spectrum Analyzer — 25 kc resolution. 400 kc to 25 mc dispersion. 5 sensitive plug in tuning units.



Model TSA-S Combination Synchroscope-Spectrum Analyzer — Displays pulse waveform or frequency spectrum. 5 kc to 5 mc adjustable bandwidth. 400 kc to 25 mc dispersion. 5 sensitive plug-in tuning units.

Model TSA-W Wide Dispersion Spectrum Analyzer — 100 kc to 70 mc dispersion. 7 kc and 50 kc resolution. Logarithmic amplitude display. 5 sensitive plug-in tuning units.

Model SA-84 Multi-band Spectrum Analyzer — 10 to 40,880 mc in a single unit. 25 kc resolution, 400 kc to 25 mc dispersion. Simple band switch, slide-rule dial. Military approved.

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Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Handbook of Spectrum Analyzer Techniques" and "Notes on Microwave Measurements"

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Representatives in principal cities

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Please send me information and specifications on:

- ☐ Model SD-1 Multi-Pulse Spectrum Selector
- ☐ Microwave Spectrum Analyzers
- ☐ Model B Microwave Code Generator (see reverse side of this page)

My application is: ____________

Name ____________

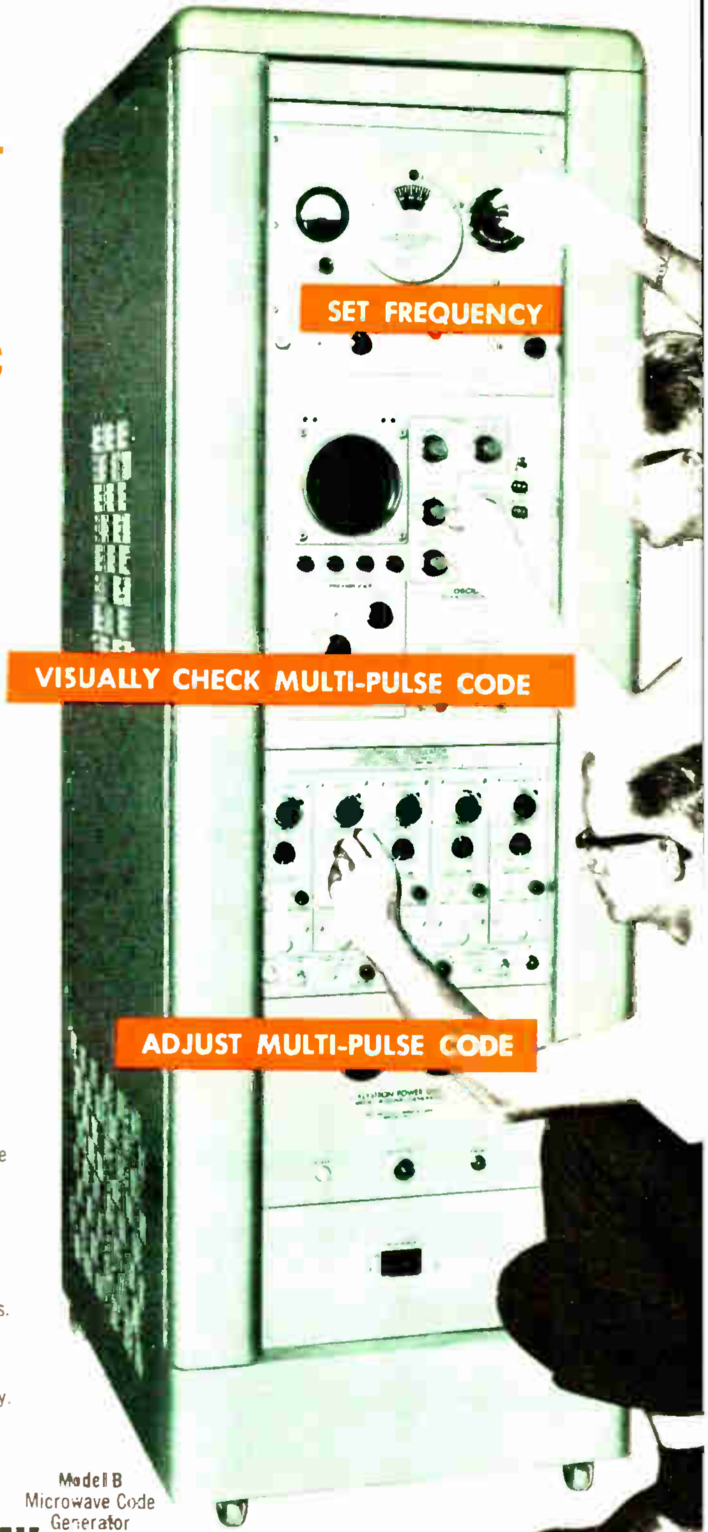
Title ____________ Dept. ____________

Company ____________

Address ____________

City ____________ Zone ____ State ____________

COMPLETE FACILITIES– CODED MICROWAVE SIGNALS 950 to 10,750 mc



Model B
Microwave Code
Generator

APPLICATIONS:

One integrated instrument:

Provides a complete system for simulating and testing missile and telemetry systems, IFF and radar, microwave beacons, direction finding and navigational equipment and microwave relay links.

Performs general purpose signal generator and oscilloscope measurements, multi pulse testing and analysis.

SET FREQUENCY

Frequency range 950 to 10,750 mc is covered by four interchangeable microwave oscillator units, all stored in the instrument. Each has UNI-DIAL control, precision power monitor circuit to maintain 1 milliwatt power output reference level, and non-contacting short type chokes to assure long life.

VISUALLY CHECK MULTI-PULSE CODE

Calibration of r-f pulse width, delay and group repetition rate is simplified by ability to view pulse train on a precision oscilloscope with a built-in wide band r-f detector.

ADJUST MULTI PULSE CODE

Code modulation is achieved with five independently adjustable pulse channels providing: **pulse repetition rate** variable, 10-10,000 pps; **width** variable 0.2 to 2 microseconds; **delay** variable 0-300 microseconds. **Pulse rise and decay**, 0.1 microsecond.

NO ADJUSTMENT NECESSARY on self contained power supplies. Klystron power unit adjusts to proper voltage automatically for each interchangeable tuning unit. Built-in AC regulator. Equipped with an electronically regulated low-voltage DC supply.

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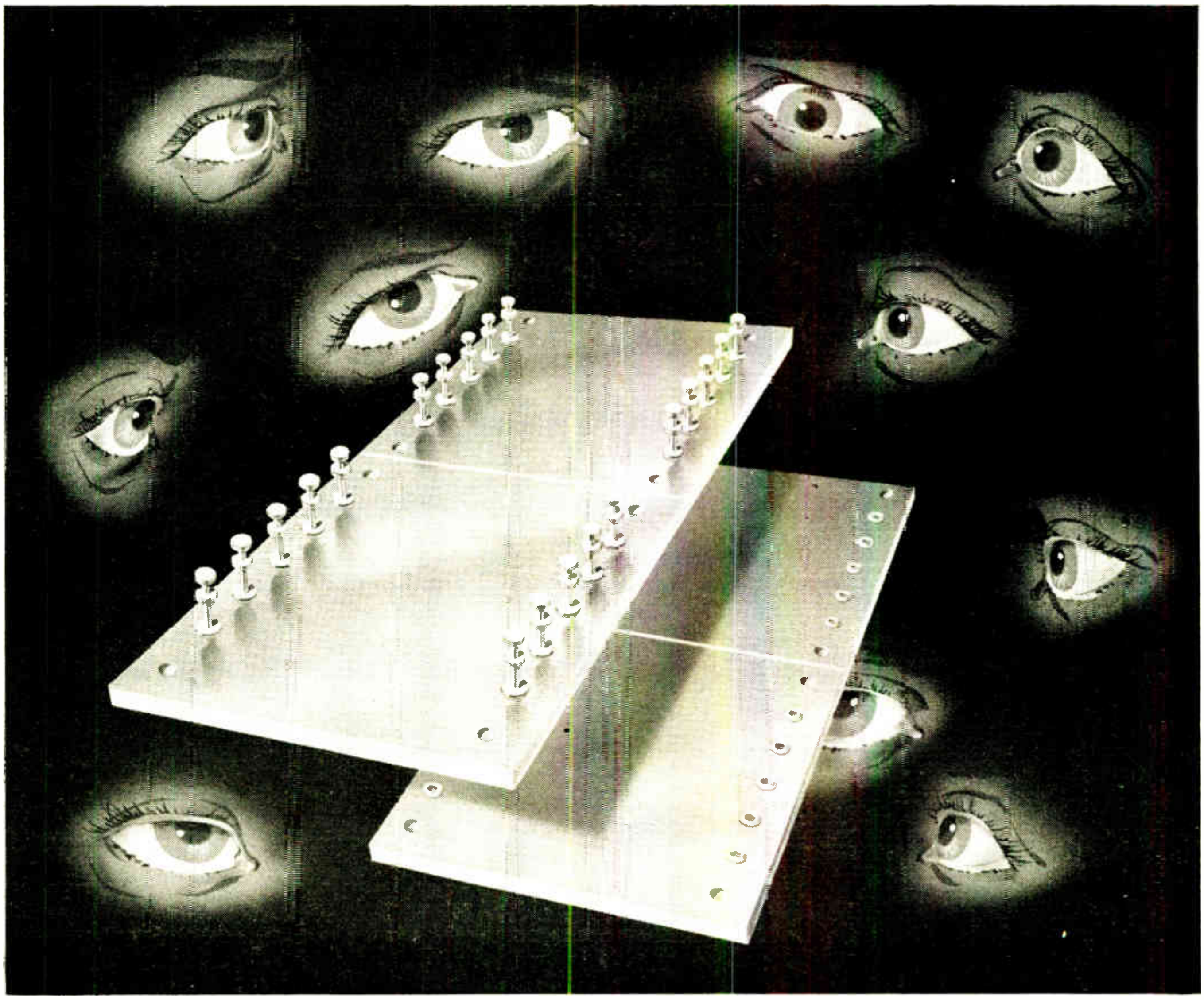
for detailed specifications
Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements"

FREE LIFETIME SERVICE ON ALL POLARAD INSTRUMENTS

POLARAD ELECTRONICS CORPORATION
43-20 34th Street, Long Island City 1, N. Y.
Representatives in principal cities



CAMBION terminal boards are available in standard all-set, miniature all-set, standard ceramic and custom-made types. Materials include paper, cloth, nylon or glass laminates, bonded with phenolic, epoxy, melamine or silicone resins. Boards are moisture-proofed and fungus-proofed. Standard or special components are assembled as required.

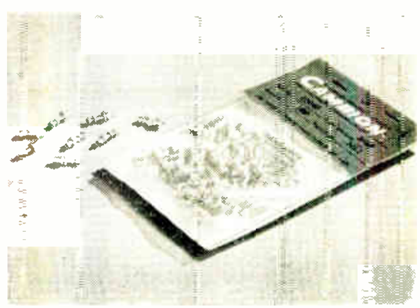
Our "private eyes" protect you from delinquents

You won't find a single weak spot in any CAMBION® terminal board. We've already made sure there are no cracks in board or terminals; no strain, chips or sunbursts; no insecurely mounted terminals. In fact, such defects are the rarest discoveries, even in our own thorough inspections. That's because the stock used in CAMBION boards is *certified* top grade . . . CAMBION tooling is specially engineered to prevent product damage . . . and CAMBION workmanship is true craftsmanship.

Quality control like this is standard in every step of CAMBION production — in any quantity. That's why you can count on the complete CAMBION line — terminal boards, solder terminals, insulated terminals, coils, coil forms, capacitors, swagers, hardware — for the trouble-free performance you expect and need. And every CAMBION component is *guaranteed.*

Available locally through authorized CAMBION distributors. Or write to Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Massachusetts. On the West Coast: E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles, California. In Canada: Cambridge Thermionic of Canada, Limited, Montreal, P. Q.

CAMBION solder terminals are made of silver plated brass, coated with water dip lacquer. There are 65 different types available in bulk in unlimited quantity or in individual packages of 100. Mounting information and CAMBION tools required are listed on the package.



CAMBRIDGE THERMIONIC CORPORATION

CAMBION®

The guaranteed electronic components

New Look for Small

'Coalition concept' being proposed by investment firm aims to place small firms on equal footing with big ones in major contract bidding

A MEETING held yesterday in Long Island, and an announcement made by a New York investment banking firm earlier this month, may have some far-reaching consequences for small electronics firms.

The New York announcement was made by Hayden Stone & Co, in the form of a proposal to organize a corporation made up of about 10 electronics firms. They would bid for large contracts on the same basis as big companies, under the name of Decco Electronics Corp.

Each of the member companies would own Decco, but would not be required to give up its identity and interest in "personal" work.

Financial Details

Initial capitalization would be $250,000, made up of 10 shares of common stock with a par value of $1 per share, and 10 shares of preferred stock to be priced according to market levels. Each member firm would hold equal shares, one common and one preferred.

The investment banking company has declined to name firms being considered for membership in Decco, since the group is not yet chartered.

A spokesman for Hayden Stone says his firm is "still looking." A hint on possible final composition of the group is that initial formation will probably be aimed at obtaining of military contracts.

How Plan Works

The "coalition concept," as one manufacturer has dubbed the newly announced system, has excited considerable interest in Long Island, where a number of small electronics firms have recently felt the pinch of reduction in aircraft construction activity in the area.

Most of the Long Island firms are familiar with the two main ways in which small companies share in major contracts—getting subcontracts and forming teams.

The team idea differs from the coalition concept in duration as well as structure. Team member firms do not remain united once the task at hand is completed, while Decco-type firms would remain incorporated the same way as presently incorporated large firms.

One Long Island group already in operation is Electrodyne. This name is applied to a pool of four companies headed by Republic Electronic Industries Corp., Farmingdale, L. I. Three non-electronic firms have joined with Electrodyne to add mechanical engineering skills to the combine. The pool has been in operation for almost a year.

One component manufacturer located not far from Electrodyne looks at the pool concept with some reservations. "It might be poor judgment to bid in competition with customers of long standing, especially if a member of a pool firm is liable to be eligible for subcontract work, should the big company get the contract being bid on."

Met Yesterday

On the other hand, several firms indicate keen interest in the new plan and say that it may be "just what the doctor ordered" as a way of improving their business prospects.

The general problem of how to increase the volume of business of Long Island firms was the subject of discussions conducted yesterday under the auspices of the Long Island Association.

On the panel were representatives of the electronics industry, members of the Long Island Electronic Manufacturers Council, an affiliate of LIA.

The group heard talks by regional representatives on state and

Companies

national levels, as well as by military procurement officials and industry procurement spokesmen.

Purpose of the meeting was to give L. I. firms the latest information on procurement methods. In panel discussions held in the afternoon, topics included talks on ways of obtaining financial aid.

Radio Telescope Being Readied

UNIVERSITY OF MICHIGAN'S 85-ft-wide steerable radio telescope is nearing completion this week.

The 10-story antenna will be used to pick up radio signals from the sun and outer space.

By Spring, the receiver portion of the lookout station will be ready for operation.

Total cost of the facility, atop Peach Mountain 16 miles west of Ann Arbor, will amount to \$300,000. Most of the funds are being supplied by the Office of Naval Research. When completed, the dish will stand nearly 1,100 feet above sea level.

The new antenna was developed by the equipment division of the Blaw-Knox Steel Co., Pittsburgh.

Missile Detector?

New experimental high-power search radar, designed by MIT's Lincoln Laboratory, is operating in North Andover, Mass. Radar reportedly has frequency of 400 mc with peak power of 5 megawatts. Reflector: 120 ft wide, 30 ft high

United States	Completed in 1958 No.	Kw	Cont. in Operation No.	Kw	Under Construction No.	Kw	Under Dev. or Planned No.	Kw[b]	Total No.
Power	1	200E	7	79,700E	8	695,700E	9	446,500E	25
Power Experiments	1	—	2	—	2	—	1	—	6
Naval Reactors	5	—	4	—	41	—	—	—	50
Materials Testing	2	50,000T	2	215,000T	6	231,000T	3	80,000T	13
Research > 50 KW	5	71,100T	18	45,650T	9	14,200T	9	—	41
Research < 50 KW	15	—	20	—	8	—	31	—	74
Critical Facilities	13	—	36	—	2	—	3	—	54
Aircraft and Rocket	1	—	1	—	—	—	—	—	2
SOLD ABROAD BY US FIRMS									
Power	—	—	—	—	1	11,500E	9	538,000E	10
Materials Testing	—	—	—	—	3	75,000T	—	—	3
Research > 50 KW	2	8,000T	—	—	15	36,100T			17
Research < 50 KW	5	—	3	—	3	—	1	—	12

T—thermal kilowatts E—electrical kilowatts

a Includes 1 merchant ship reactor rated at 74,000 tkw

b Ekw rating for 1 power reactor and 5 large research reactors is unspecified

Latest reactor construction box score shows 37 units were completed in 1958, as . . .

A-Power Gear Market Grows

Nuclear instrumentation sales area is now 180 reactors, including 51 for subs and ships

UNITED STATES manufacturers, institutions and government agencies completed the construction of 37 nuclear reactors in this country and abroad during 1958, according to the Atomic Industrial Forum's latest box score.

The number and size of reactors now under construction or being designed strengthen earlier predictions of a steadily increasing reactor instrumentation market, estimated at $15 million for 1958 (ELECTRONICS, p 21, May 16, 1958).

The eight big power plants under construction will be ready in 1960. Nine others are being designed or planned. Another 19 are under study.

Ship reactors are well underway. Atomic engines were completed in 1958 for the submarines *Swordfish* and *Sargo*. A prototype for the radar picket sub *Triton* and a dual reactor prototype for a large surface vessel were also built.

Start 13 Sub Reactors

Construction began last year on 13 submarine reactors and two destroyer engines. The submarine reactors include five power plants for ballistic and guided missile subs. Construction was continued on 15 submarine reactors—including four guided missile subs—eight engines for the carrier *Enterprise* and two for the cruiser *Long Beach*.

AIF previously has estimated total military reactor construction, largely for the Navy, will go well over 200,000 electrical kilowatts in each of the years 1960-1968. Construction in 1957 was 62,000 kw and in 1958, an estimated 87,000 kw.

Work continued on the NS *Savannah* merchant ship reactors and design studies have begun on two more merchant ship reactors. At least one aircraft propulsion reactor prototype is in operation and one rocket reactor prototype is about ready for tests.

Of 144 research reactors in operation, under construction or planned, 28 are for U. S. educational institutions and 12 for foreign institutions.

A bind in space available for reactor materials testing was alleviated by completion of two powerful reactors. Six others will be ready by the end of 1960.

Accelerator Sales Lively

In the subsidiary field of electron particle accelerators, manufacturers' sales were lively. One firm delivered 35 machines valued at $5.75 million. Another delivered four worth $850,000 and has five others, worth $3.2 million, under construction.

Universities and private institutions bought 17 accelerators, industry purchased nine and government agencies bought six. Foreign sales included eight accelerators for universities and four for government agencies.

MEETINGS AHEAD

Feb. 16-20: Western Audio Convention, Audio Eng. Soc., Biltmore Hotel, Los Angeles.

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

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

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

Mar. 23-25: Flight Testing Conf., ARS, Daytona Beach, Fla.

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

Mar. 24-25: Institute of Printed Circuits, Annual Meeting, New York City.

Mar. 26: Quality Control Clinic, ASQC, Univ. of Rochester, Rochester, N. Y.

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

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

Apr. 6-7: Astronautics Symposium, Air Force Office of Scientific Research, Sheraton-Park Hotel, Washington, D. C.

Apr. 6-9: British Radio and Electronic Components Show, Great Hall, Grosvenor House, Park Lane, London W.1.

Apr. 13-15: Protective Relay Conf., Texas A & M College, College Station, Tex.

Apr. 14-15: Industrial Instrumentation and Control Conf., PGIE of IRE, Armour Research Foundation, Illinois Inst. of Tech., Chicago.

Apr. 16-18: Southwestern IRE Conf. and Electronics Show, SWIRECO, Dallas Memorial Aud. & Baker Hotel, Dallas.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 86.

. . . WHERE THERE'S A GROWTH SITE FOR YOUR ELECTRONICS PLANT

This is the hand of a Virginia worker painting an electric circuit 1/10,000 of an inch thick. More than 30,000 such trainable men and women swell Virginia's potential working force each year. Home-rooted, conservative people . . . the kind who've helped make this state's record of labor-management harmony *five times better* than the national average.

That's one reason why the electronics industry is growing far faster in Virginia than in the U. S. as a whole. Your new plant, too, can find a profitable and congenial home in this land of mild climate, pleasant living and thrifty, friendly government.

Write, telegraph or telephone for more facts or confidential site-finding help in Virginia . . . where you'll enjoy southern production advantages as close as you can get them to the great northeast and mid-west markets.

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CIRCLE 39 READERS SERVICE CARD CIRCLE 40 READERS SERVICE CARD

INTERNATIONAL RECTIFIER CORPORATION

A WORLD OF DIFFERENCE THROUGH RESEARCH

RECTIFIER NEWS

64 Zener Diode Types Offer Advantages to Every Voltage Regulator Circuit

As compared to other voltage reference elements, the silicon diode regulator has a longer life expectancy because of its mechanical ruggedness. It does not deteriorate under storage nor age during its operating life. Small size and light weight make its use in airborne or portable equipment especially desirable from many standpoints.

International Rectifier Corporation now offers an extensive line of zener types numbering 64 in seven basic styles. From the miniature type rated at 750 milliwatts to the precision 1N430 reference element types, all are manufactured to meet the most rigid military requirements. *See how these all-welded, hermetically sealed diodes can improve your circuit design. . . .*

CIRCLE READER SERVICE CARD NO. 115

HZ Series Silicon Zener Voltage Regulators Replace Vacuum Tubes — Streamline Circuitry — Take Only Half The Space!

Semiconductor equivalents eliminate components and circuitry required by tube counterparts to overcome plasma oscillation and high firing potential.

Voltage regulation circuits can be simplified and the reliability increased by using silicon zener voltage regulators in place of conventional gas tube regulators such as the 0A2, 0A3, 0B2, 0C3, 1B46 and the 991.

The International Rectifier HZ series, provides a substantially lower dynamic resistance than do comparable tube types — and over a much broader temperature range (—65°C to +165°C). This feature, and the unusually high zener reference voltage, stem from the unique construction of these units. Mechanical ruggedness of this package leads to longer term reliability than can be expected from tubes.

Other regulators restrict the engineer to a few specific voltages within a very limited current range. Not so with the HZ series. You may select the *exact* zener voltage your circuit requires within a range of from 24 to 160 volts — over a wide range of current values. This opportunity to select in discreet voltage steps obviates additional corrective circuitry . . . saves time!

If you are developing a voltage regulation circuit, write or call us today. We will be happy to provide whatever assistance you need to improve your circuit with silicon zener regulators.

For Bulletin SR-253 describing the HZ series in technical detail . . .

CIRCLE READER SERVICE CARD NO. 117

ZENIAC Provides a Shortcut to the Application of Silicon Zener Diodes

A flip of the Zeniac selector switch quickly tells you the exact diode required in complex breadboard circuitry. This unique innovation — the first semiconductor substitution box in history — has been designed specifically to aid system design groups by saving valuable lab time in the application of zener diodes. The eleven component diodes of Zeniac are rated at 1 watt and range in voltage from 3.6 to 30 volts. Zeniac is available at your local International Rectifier Industrial Distributor. For details on this time saver . . .

CIRCLE READER SERVICE CARD 116

Technical Service Provides XY Plot of Reverse Breakdown Characteristics of Each Diode in all Prototype Orders

To eliminate guesswork and tedious testing on your part, every zener diode sent on prototype orders will be accompanied by a specially plotted XY recording of its exact breakdown voltage point! This permanent record can come in mighty handy when it's time to match diodes or reorder to the same specs. This is just one of the many application engineering services we are prepared to extend to you at all times!

Write on your letterhead *for Bulletin SR-250-A, a four page technical article describing the characteristics of zener diodes, how to select them, and application data with circuit schematics.*

FOR SAME DAY SERVICE ON PRODUCT INFORMATION DESCRIBED ABOVE, SEND REQUEST ON YOUR COMPANY'S LETTERHEAD

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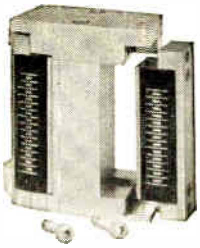
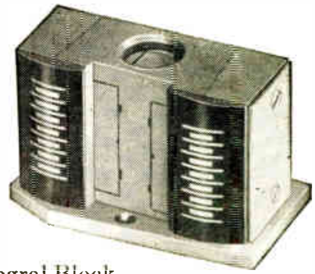


"Gap-Mounted."*



Integral Block Interlace.

Magnetic Heads for Digital Recording

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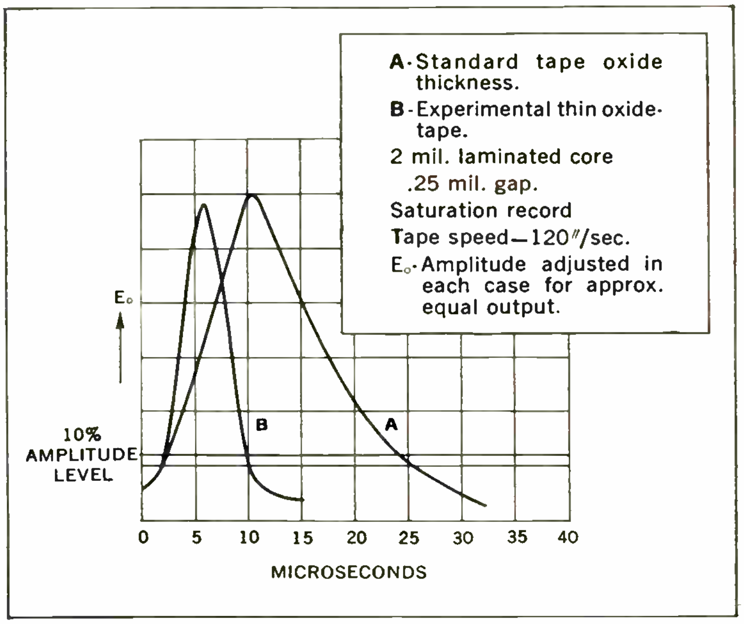
Why settle for less than the best magnetic head —the "heart" of your digital recording system? Whether your digital recorder is in the design stage, on order or in use now, Clevite "Brush" magnetic head specialists can improve your system at low cost. Write for prompt quotations on replacement or "modernization" heads for any existing transport, or specials including flux-responsive or high resolution heads. Write for Clevite Digital Recording Bulletin for complete information.



Pulse width comparison—standard and thin oxide tape.

CAPACITY— Five series of Clevite "Brush" multichannel heads give channel format variety for standard tape widths from 1/4" to 2". A single block will handle up to 16 channels per inch of media width—an interlaced block up to 32 per inch. Clevite heads read pulse widths down to 1½ mils recorded to saturation on 0.3 mil coating instrumentation tape—approximately 600 pulses per inch with self-erasing saturation recording. More than 300 ppi packing is possible on 1 mil coated drums, operating 0.2 mils out of contact with a 3 mil pulse width on the drum.

ACCESS—Careful choice of material plus unique design and construction techniques enable Clevite "Brush" heads to provide uniform performance at very high processing rates. The heads themselves respond to wave lengths down to .15 mils (1.5 MC at 240 IPS) but standard instrumentation tapes and transports usually reduce the practical repetition rate of saturated recording to approximately 30 KC and 15 KC for RTZ and NRTZ respectively.

RELIABILITY— Clevite "Brush" tape and drum heads hold track width and location to ± 0.001-inch tolerance. Azimuth, contact angle and gap perpendicularity are true ± 0 deg., 5 min. and can be held even closer when required. "Gap-mounted" head (see photo) has lapped bracket and cartridge surfaces for fast replacement without critical adjustment. Redundant and interlaced (see photo) designs provide immediate checking of recorded data and higher output per channel respectively. All multichannel heads available in epoxy or full metal face (to reduce oxide pickup) at no extra charge.

* Patent Pending

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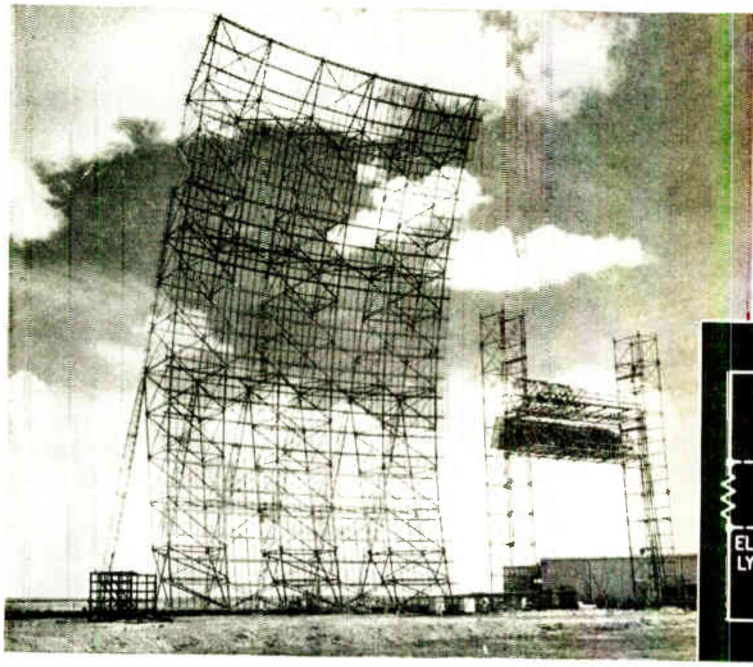


Power levels in front of antennas like this AN/FPS-17 near Laredo, Tex., can be hazardous to health. Research is now finding out what r-f energy does to animal tissue

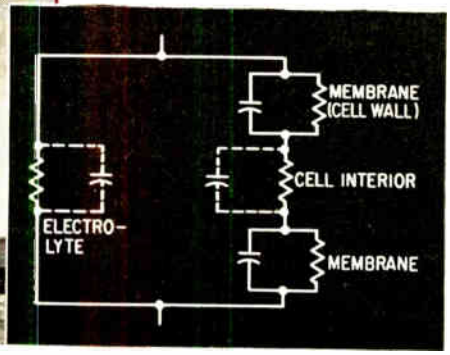


FIG. 1—Equivalent electrical circuit of animal tissue. Values of capacitance and resistance are functions of cell shape, radius, and volume concentration

Researching Microwave Health Hazards

High power levels in new radar, scatter gear, call for caution, understanding, and new measuring devices. Here is where we stand today

By FRANK LEARY, Associate Editor

HIGH-POWERED radar, radio and countermeasures transmitters now being designed, built and tested present an element of hazard to health.

New Air Force scatter systems will put out 100 kw of average power. The torus scanner for the ballistic missile early-warning system will beam 600 kw average, with peak power in the 10-megawatt region. Radars of the Millstone Hill type, used to track and analyze missile and satellite debris, will also produce an average of 600 kw.

The hazard resulting from focused concentrations of such energy, like any hazard, can be rendered relatively harmless by understanding and precaution.

Until five years ago, understanding of the effects of r-f energy on living animal tissue was limited to a handful of experiments performed on rats and dogs, and a small body of experience with microwave diathermy. Results from experiments on small fur-bearing animals were not necessarily applicable to human beings: these animals have high coefficients of heat absorption, small body surfaces and relatively poor heat-regulating systems. The human body, by comparison, has one of the best regulating systems. Adequate physiological function can be maintained at 240 F for periods as long as 20 minutes if humidity is low. One subject has been exposed to 400 F for as much as a minute

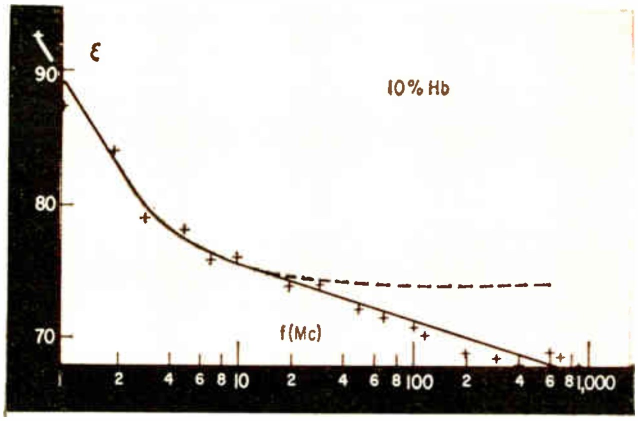


FIG. 2—Dielectric dispersion of 10-percent hemoglobin solution in water. Dashed curve indicates theoretically predicted behavior; points are empirically derived

without incurring injury to the tissue.

Within the last two years, a massive research program has attempted to enlarge our understanding of the biological effects of microwave exposure. The program is sponsored by the Defense Department, and is coordinated at USAF's Occupational Health Research Laboratory at Cape Canaveral by Col. George M. Knauf, staff surgeon of the Air Force Missile Test Center.

Some of the results emerging from this program point up criteria for safety throughout the electronics industry and indicate several paths for additional research.

R-F IN TISSUE—Animal tissue reacts to r-f energy like the parallel resistive-capacitive circuit shown in Fig. 1 on the preceding page. At low frequencies, current tends to bypass the relatively high capacitance of the cell through the conductance of the electrolyte which surrounds it. As the capacitive reactance drops at higher frequencies, the current passes into the cell. At microwave frequencies, reactance drops to the point where animal tissue presents the electrical appearance of a protein solution—a suspension of individual proteins and protein lipid complexes in an electrolyte.

As frequency rises, the dielectric constant of the cell materials drops due to dispersion. In muscle tissue, one drop centers at about 100 cps. A second and major drop, due to cell structure, centers at about 100 kc. A third major drop falls in the microwave spectrum at 10,000 to 30,000 mc, and is caused in part by the properties of biological macromolecules and in part by the water content of tissue. Water is known to display a dispersion near 20,000 mc.

The form and orientation of the protein molecules in tissue introduces a complicating parameter, according to researcher Herman P. Schwan at the University of Pennsylvania. The protein constituents appear to leave "dielectric holes" in the electrical path formed by the electrolyte. Fig. 2 illustrates this phenomenon in a 10-percent solution of hemoglobin in water.

The sharp fall-off in dielectric constant in the 1-10 mc range is part of a major dispersion discontinuity centered around 1 mc. If the behavior of the material were completely described by the 1-mc dispersion, the dielectric constant would assume the constant level indicated by the dotted line in Fig. 2. However, the dielectric constant is observed to follow a fairly linear decline as indicated by the measurement points surrounding the solid line.

Hydration of protein molecules can explain this behavior. Figure 3 shows the frequency dependence of the dielectric constants of ice and free water, with the curve hypothetically adduced by Schwan for the bound water that hydrates protein molecules. Ice and water have been thoroughly investigated and are known to undergo dispersion at 1-10 kc and 20,000 mc respectively. A dispersion curve for bound water near 300 mc would explain the uhf-dispersion phenomena observed in protein molecules.

LIVING ORGANISMS—The seriousness of the possible effects of r-f energy on living animals depends on several factors. One is the size of the animal: for any significant effect, the animal or animal part must be at least a tenth the wavelength in size. Radio-frequency energy generally penetrates between a tenth and a hundredth of its wavelength into living tissue.

Power Brings Problems

The problem of microwave radiation hazards can be neatly summarized in the words of USAF Col. George M. Knauf, who has coordinated the government's research:

"We established arbitrarily a maximum safe exposure level of 0.01 w/cm² . . . The most powerful radar set in operation today cannot produce this power level at 500 ft, even in the axis of the main beam . . .

"The levels at which we are conducting our probing exposures are many times greater than the capability of present-day equipment . . .

"In the new series of equipment on the drawingboard . . . we can be certain that we will attain power levels equal to our safe exposure level over a much wider area. Such levels will not be restricted to the main beam. Because of the peculiar configuration of this equipment, it will be necessary for certain technical personnel to spend varying periods of time in areas where the ambient power level will exceed 0.01 w/cm². The upward tilt of the beam will still offer protection to the casual passerby.

"The problem of accidental exposure to this higher power becomes a possibility. The need for protective clothing to cope with operating and maintenance problems appears inevitable, as does the need for more attention to shielding for buildings and passageways in the operational areas.

"Even here there does not appear to be any need for concern about any hazardous situation outside of the immediate vicinity of the equipment . . . "

The amount of power absorbed by the body is also frequency-dependent. At frequencies below 400 mc and above 3,000 mc, the body absorbs about half the incident power or less. The rest passes through (lower frequencies) or is reflected at the skin's surface (higher frequencies). At frequencies below 1.5 mc the human body ceases to be a significant fraction of wavelength.

Between 1,000 and 3,000 mc, the percentage of absorbed radiation can approach 100 percent, depending on thickness of skin and of subcutaneous layers of fat.

Below 1,000 mc, most radiant energy is translated into heat in the deep tissues (at 300 mc, for example, much of the heat would tend to develop three or four inches inside the body). Above 3,000 mc, the result is mostly surface heating. Intolerable temperature rises are therefore more likely below 1,000 mc.

The interface effect is an important factor in the biological effect of r-f energy. Every time the energy passes from one material to another, the discontinuity reorients the power. Power is reflected, and a standing wave results near the interface.

Early experiments with a 2,450-mc diathermy machine showed that a layer of red meat was heated to higher temperature when a layer of lard was placed on top of it than when exposed alone. Furthermore, the lard melted at the interface, not on top.

HEAT EFFECTS—Since animal tissue converts into heat most of the electromagnetic energy it absorbs, the thermal effects are the most serious recorded thus far. Thermal effects of microwave energy are directly related to average power levels.

The eye and the testis are the two organs most seriously affected by heat. The eye is easily damaged because it has an inefficient vascular (blood-transfer) system for the exchange of heat to surrounding tissue. Research also suggests that certain enzymes in the eye are characteristically sensitive to alteration due to temperature increases.

The seminiferous tubules of the testis are easily damaged by heat. Indeed, temporary partial sterility can even be induced by the wearing of tight undergarments, since the normal temperature of the body is too high for these tubules.

Irreversible damage to the eye is far more common than irreversible damage to the testis. Although temporary sterility and tubular damage have been induced in animals, the situation has ultimately corrected itself. One researcher has commented that irreversible damage to a human testis due to hyperthermia would probably be preceded by death of the subject.

The eye, however, develops opacities of the lens (cataracts) due to overheating, and these can be irreversible. The avascular condition of the eye complex makes the removal of dead tissue difficult. The alterations in enzymes in the eye lens may cause these enzymes to change or cease their functional activity. If cellular metabolism stops, the tissues die; if it decreases, dysfunction may result.

Small opacities detected after one or a few exposures to r-f energy (in rabbits, whose eyes are closest in structure to human eyes) have frequently been observed to develop into major lesions without additional exposure.

Time and power thresholds for lens opacities at 12.3 cm range from 5 minutes at 0.59 w/cm² to 90 minutes at 0.29 w/cm². Exposure to sustained irradiation at 0.12 w/cm² for 4.5 hours caused no discernible opacity, which suggests that this power level is a threshold of safe exposure. The 12.3-cm spectrum (the region between 2,400 and 3,000 mc) has been found critical for the production of

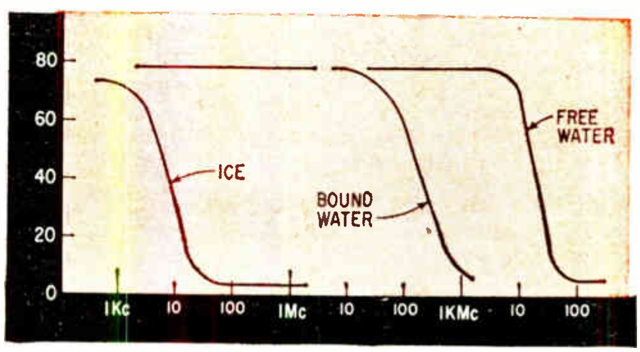
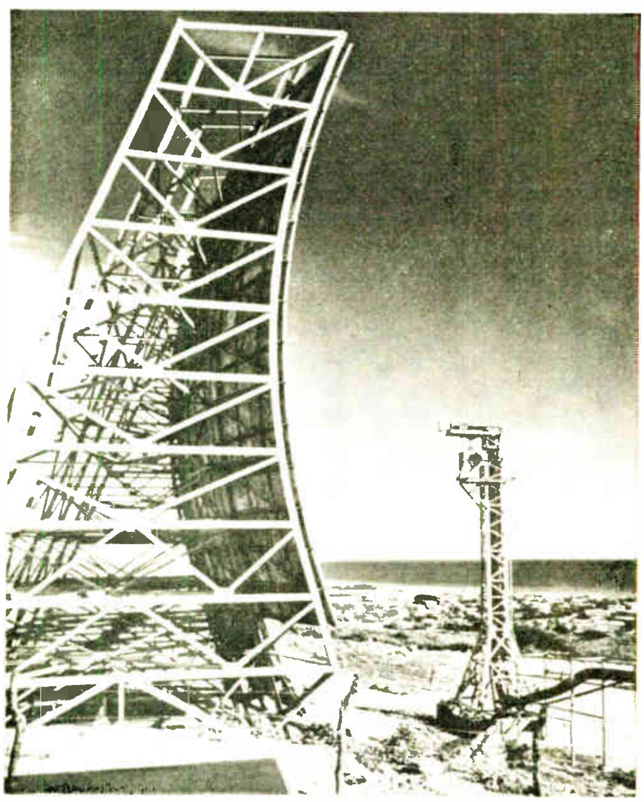


FIG. 3—Dielectric dispersion in ice and water. Curve for bound water explains dispersion of effective dielectric constant of hemoglobin molecules



This 60-ft reflector forms one end of ITT's Cuba-Florida scatter link. Antenna puts out 10 kw; new scatter systems will be 10 times as powerful cataracts, perhaps because of the distance below the surface of the eye of the highly sensitive suture of the lens, where most cataracts form.

WHOLE BODY—Exposure of the whole body is also serious, since there is no organism with which the blood can interchange heat if the whole body is heated.

One of the principal causes of internal damage due to fever (natural or induced) is anoxia, or lack of oxygen. This condition causes almost instant damage to certain sensitive cell groups in the brain, central nervous system, and internal organs, notably the kidney, liver and adrenal glands.

For every degree that the temperature of the body rises above normal, the rate of basal metabolism increases 5 to 14 percent, which requires a 50 to 100 percent increase in the supply of oxygen to tissues. But the presence of fever brings about a net reduction in the oxygen supply.

Heat causes the hemoglobin to lose some of its capacity to combine with oxygen. Increase in blood-flow rate reduces the time available in the lungs for oxygen transfer. Rapid breathing results, causing alkalosis (the dizziness you may experience from blowing up a balloon is caused by alkalosis), which increases the chemical stability of hemoglobin and interferes with the release of oxygen to the tissues.

The combination of these factors produces severe anoxia. Additional effort by the body to supply oxygen in needed quantities may cause hemorrhage, farther compounding the damage.

Sedatives and tranquilizers reduce the body's ability to withstand heat. Sedation interferes with the cellular utilization of such oxygen as is available, contributing further to the anoxic condition.

Safety Standards

Army training areas have certain characteristics in common with industry testing grounds. The army has established these criteria for its training areas:

Hard stand areas (concrete, asphalt, etc.) are limited to immediate vicinity of the set.

Surfaces between are soft and absorbent, preferably grass.

Sets are separated by distances which reduce searchlighting exposures to less than 0.01 w/cm².

Training areas near acquisition-type radars are screened in the direction of the beam.

Rest areas are provided where power densities are 0.001 w/cm² or less.

No other unassociated training is done in the vicinity of the radar training areas.

General Electric has been observing these safety standards since June 1, 1954:

Prevent exposure to direct beams, especially of the eyes.

Limit direct or reflected intensity in all areas to which people require access to 0.001 w/cm².

GE feels it necessary to monitor at 0.001 w/cm² to make allowance for harmonics and spurious waves

The functioning of the hypothalmus, the body's thermostat control, is impaired by high temperatures; as a result, the nervous system cannot efficiently establish sweating or adequate peripheral circulation. High body temperatures also cause a reduction in the efficiency and number of thrombocytes, the blood constituents which cause coagulation. As a result, clotting time is increased.

DIMENSIONAL RESONANCE—Since the body and its parts are conductive, they resonate at critical frequencies and can build up standing waves. Some of the effects noted by researchers in the hollow cavities of the body and in bone marrow appear to have been caused by concentrations of thermal energy that may have been produced by resonance.

In more than one case, internal lesions caused by microwave exposure were undoubtedly produced by reflections from fat-muscle or muscle-bone interfaces, which produced standing waves nearby.

A couple of experiments with small animals have shown partial or complete loss of control over motor functions under relatively mild exposure, with immediate recovery after removal of power. This effect could result from resonance in the cranial cavity or along the spinal column, which might create a strong enough field to beat against and cancel the normal signals in the motor network. The nerve transmission system could thus temporarily be rendered inoperative.

NONTHERMAL EFFECTS—Nonthermal effects have been demonstrated by some of the researchers. Nonthermal effects, however, are hard to trace in animal experiments, since no thermostatic device exists which can keep body temperatures constant and thus eliminate thermal effects. The variability of animal responses also makes it difficult to establish an exact relationship between dose and effect.

Molecular response characteristics of protein molecules and protein lipid complexes may be responsible for nonthermal effects. These responses result from the movement, orientation and polarization of the molecular constituents: side groups and main protein body. Each of the side groups, as well as the main body, may be electrically polar. High r-f field strengths can orient the side groups and cause dielectric saturation. When all side groups are completely oriented, the bonds between them and the main protein body may be snapped by a small increase in field strength.

Denaturation of living tissue in this manner, one possible nonthermal effect, is most likely to occur in the 100-300 mc range. The likelihood decreases sharply above 1,000 mc. The effect need not have a significant thermal counterpart, since it can be brought about by high peak powers whose average value is not great enough to produce heating.

Nonthermal components have been noted in the production of cataracts, and in variations in blood-clotting time. Research at Tufts University has produced cataracts at subcritical temperatures by exposure to high peak values of power. This may be the result of molecular responses in the sensitive enzymes mentioned above. Increase in blood-clotting time may result from similar responses in the thrombocyte platelets.

A clearly nonthermal phenomenon noted by researchers is the formation of pearl chains in living fatty tissue, in solutions of erythrocytes, in solutions of milk and blood, and—most recently—in lymph. Upon exposure to microwave energy, the suspended solids form into chains of round aggregations, similar in appearance to tiny strings of pearls, oriented in the direction of the r-f beam.

If such a phenomenon occurs on the molecular level, the natural distribution of tissue components may be disturbed, which could have profound biological significance.

INSTRUMENTS—The nature of the problem of biological effects is such that new instruments are needed.

Most areas in which the more serious possibilities for damage arise are in the Fresnel zone just forward of a microwave reflector, and in backlobes, and from spurious reflections. In the Fresnel-Fraunhofer crossover and within the Fresnel zone itself, the point-to-point variations in power density are such as to require measurement rather than calculation. Similarly, reflections from buildings and terrain features require measurement, as do backlobes and transmission-line leaks.

Sperry Gyroscope has produced a series of light, portable, battery-operated radiometers (or power density meters). Each meter (see cover) covers one segment of the microwave spectrum. The block diagram of this simple instrument is given in Fig. 5.

A second needed piece of equipment is a dosimeter for personal use by people exposed to microwave exposure. The Richardson dosimeter (picture), developed by Alfred W. Richardson at St. Louis University's School of Medicine, is one such device.

The hand-held dosimeter contains a broadband transducing material—a small mass of gelatin, simulating an avascular body structure—which absorbs microwave energy and translates it into heat; and a thermistor to translate the heat into a meter reading. The instrument as presently designed is highly sensitive to ambient temperature: when moved from indoors to outdoors, from tabletop to hand, or from one pocket to another, it produces a larger change in reading than that caused by a biologically significant r-f field. For this reason it can be rendered ineffectual in field use.

Richardson dosimeter measures heat analog of r-f energy, with blob of gelatin as transducer

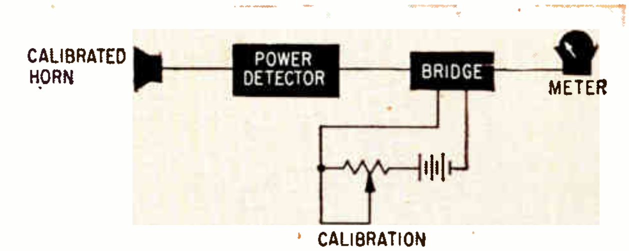


FIG. 4—Black diagram of Sperry Gyroscope microwave power-density meter. Meter reads directly in mw/cm^2 and in db relative to 0.01 w/cm^2

The dosimeter has a "fast" component due to r-f pickup in the wiring, which is converted to heat in the thermistor; and a "slow" component resulting from the conversion of r-f energy to heat in the gelatin. In practice, these result in "rate" and "dose" readings. The thermal time constant of the gelatin is about 6 minutes, which is within the range of biological significance.

Protective clothing to absorb or reflect r-f energy is also needed. Design of such clothing is within the scope of present technology; technicians working on BMEWS radars will wear such clothing.

Of especial importance is protective headgear that adequately protects the eyes. Glasses may cause more trouble than they prevent, especially if they are prescription lenses. By reflecting and focusing r-f energy, they might cause the build-up of nodes and standing waves just where they can do the most harm.

An efficient head covering would have to block out all access to the rear aspect of prescription-type spectacles, and would of necessity include a planar eyepiece of transparent material for users who do not wear spectacles.

ACKNOWLEDGMENT

Much of the material in this article concerning the effects of r-f energy in tissue, and the data in Figs. 1–4, is based on work done by Herman P. Schwan, professor of electrical engineering in the electromedical division of the Moore School of Electrical Engineering, University of Pennsylvania.

Telemetry Demodulator

Input circuit to pulse-position telemetry demodulator is a modified two-input semiconductor diode AND gate. A quasifeedback-type link between transmitting and receiving equipments compensates variation parameters

By **LLOYD WEISMAN,** Ford Instrument Co., Division of Sperry Rand, Long Island City, N. Y.

DESIGN REQUIREMENTS for pulse-position telemetry systems specify rugged, miniature and lightweight equipment which uses few components and is reliable over a wide range of operating conditions. A block diagram showing such a ppm telemetry transmitter with its associated input signals is shown in Fig. 1. Also shown are ground units consisting of pulse-shaping and synchronizing circuits, ten demodulator channels and a quasifeedback-type link between the transmitter and receiver. The feedback compensates any variations of parameters in the transmitter other than d-c data inputs.

Transmission

A brief description of the transmitting part of the telemetry system will be given.[1]

At point *A* in Fig. 2 negative pulses at the required prf are applied to the variable-width pulse generator, a monostable multivibrator, which then produces positive gate outputs, shown at point *B*. These gates are differentiated to produce positive and negative spikes. The negative spike is used to cut off the first stage of the two-stage amplifier, a normally saturated tube. This provides a positive gate output, whose leading edge is coincident in time with the trailing edge of the monostable multivibrator output. This leading edge triggers a pulse shaper to provide the negative output pulse, shown at *C*. This negative pulse is similar in shape and amplitude to the input waveform at *A* but separated from it in time by the width of the pulse generator output gate. Both the input and output pulses of negative polarity are then used in the receiver as input signals. The leading edge of the first pulse is also used to multiplex a single-pole, ten-position electronic switch which operates ten clamping circuits and provides the system with ten independent channels.

The input to each channel is a d-c voltage of from 0 and 5 v. which is superimposed on the fixed grid bias of the variable-width pulse generator tube. This tube is normally biased to cutoff by the clamping circuits. Variation in grid bias changes the width of the multivibrator output waveform. The width is directly proportional to each multiplexed d-c input voltage of each of the ten telemetry channels.

In the receiver, provision is made for inversion and shaping of the negative transmitted pulses. They are fed, properly synchronized with the transmitter synchronizing pulses, into the demodulator.

Demodulator

For a telemetry system to be useful, it must have a linearity of one percent or better. This linearity must be preserved in the demodulator. The circuits and components utilized in this unit were designed to meet or exceed this requirement.

A block diagram, schematic and waveforms of the demodulator are shown in Fig. 3.

Input circuit to the demodulator is a modified two-input semiconductor diode AND gate. The two positive pulses, occurring at the prf rate, are applied to one leg of the circuit, shown at *A*, while a wide positive gate, occurring at one-tenth the prf rate and obtainable from a ten position electronic switch, is applied to the other input leg, *B*. The switch is similar to the one in the transmitter, and is located in the synchronizer portion of the ground equipment. Normally, because of the finite forward re-

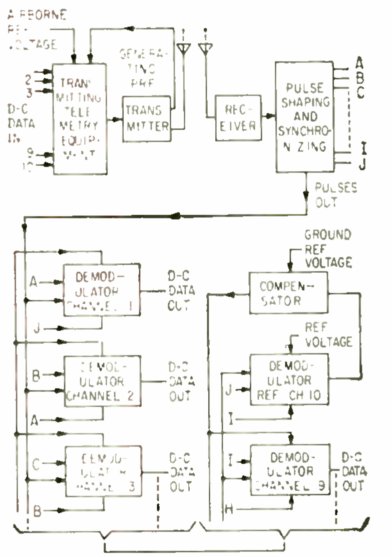
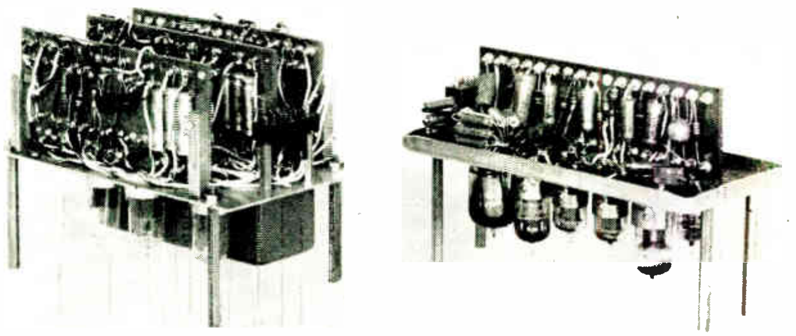


FIG. 1—Overall block diagram of pulse-position telemetry system

Using Modified AND Gate



Pulse-position demodulator (left) and decommutator (right) are packaged in modular form to facilitate plug-in use

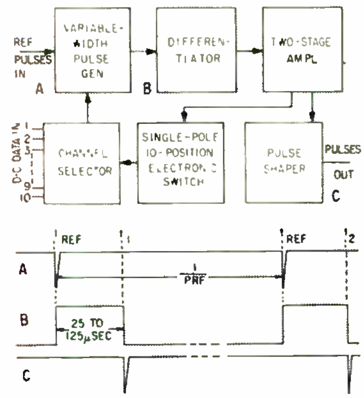


FIG. 2—Simplified block diagram of telemetry transmitting system

sistance of the crystal diodes and impedance of the source generators, some small amount of input signal on either leg of an AND circuit will appear in the output in addition to the required output waveform. In the present application, however, since output of the AND circuit feeds the bases of a transistorized bistable multivibrator, the waveform must be free of noise signals. As shown in Fig. 3, the d-c output voltage level of the AND circuit is normally higher than the amplitude of any expected noise pulses so that diode D_3 will not conduct until the required signal pulses are applied to diode D_1.

Symmetrical Triggering

The AND circuit output pulses shown at C are applied to the bistable multivibrator which uses symmetrical triggering. This circuit employs two *pnp* 2N496 high-speed silicon switching transistors. Silicon is used for stable operation over the required temperature range and the high cutoff frequency is required for fast rise time and for good system linearity. The output stage, Q_2, of the multivibrator is normally saturated and the input stage, Q_1, is normally cut off. The voltage across D_2 is approximately zero, while D_1 is highly reverse biased because the collector of Q_1 is at -6 v. When the first of the two positive pulses is applied to the common triggering point of the multivibrator, D_2 conducts almost immediately, cutting off Q_2 and reverse biasing D_2, while circuit action then causes Q_1 to become saturated. This stable state remains in effect until the second of the two positive pulses is applied. Since voltage across D_1 is now approximately zero, it conducts and cuts off Q_1, thus returning the circuit to its original stable state. The output gate from the multivibrator is negative and equal in width to the spacing between the two input pulses, as shown at point D.

The bistable multivibrator has been designed to minimize timing delays. If a transistor were to be driven too far into saturation, there would be a time delay between the application of the input pulse and initiation of circuit action. The amount of such a delay is limited by system linearity requirements and should ideally be nearly zero.

Modified Bootstrap

The multivibrator output gate is then applied to the switching stage of a highly linear modified bootstrap sweep circuit. This linearity is accomplished by providing a constant current source to charge up a capacitor for a period of time determined by the input signal. Advantage is taken of the constant current charging of the capacitor to provide a peak voltage directly proportional to the duration of the input signal.

Switching stage Q_3 is composed of an ST32 silicon *npn* transistor, which is normally saturated and drawing full collector current through R_2 from the supply voltage. Capacitor C_4 is assumed to be discharged. Under these conditions, the collector of Q_3 is several volts negative and keeps diode D_7 in its reverse biased and cutoff state. Thus a charge is prevented from accumulating on C_4.

When the negative gate from the multivibrator reduces Q_3 to its cutoff state, its collector tends to rise towards the supply voltage.

However, when the voltage at the anode of diode D_7 exceeds that at its cathode by some small amount, it is forward biased and allows capacitor C_4 to charge from the supply voltage through R_1. Charging continues for the duration of the negative multivibrator output waveform. When this waveform ends, transistor Q_3 again saturates and its collector voltage drops to some small negative value reverse biasing diode D. Thus C_4 cannot discharge rapidly through the saturation resistance of transistor Q, which happens in conventional sweep circuits.

When C_4 begins to charge, the resultant waveform is amplified through Darlington emitter-follower stage Q_5-Q_6 and fed back by bootstrap action to resistor R_1 through blocking capacitor C_7. Since diode D_6 is normally conducting, the voltage at this point is equal to the supply voltage. However, when the charging voltage from the emitter of Q_3 is superimposed on this d-c level, diode D_6 is reversed biased and linear charging of capacitor C_6 is accomplished through resistor R_1 and diode D_7. This resultant constant current charges C_6 and provides a linear sweep voltage.

Composite Emitter Follower

The output of the demodulator channels must be in the form of a d-c level equal, within the allowable system linearity requirements, to the d-c input signal level applied to the same channel in the transmitting equipment.

To obtain a d-c level from the linear sweep voltage, the peak value of this waveform must be maintained for at least ten times the prf period. To establish an r-c discharge time constant equal to about ten times the period of the resultant wave, an emitter follower must be used whose input impedance approaches tens of megohms. Composite emitter follower Q_5-Q_6 is used for this purpose. The input impedance of this stage is given approximately by:[2]

$$Z_{in} \approx r_{c1} R_{L2}/[r_{c1} + R_{L2} + r_{e1}(1 - \alpha_1)]$$

where the subscript 1 refers to the parameters of Q_5 and the subscript 2 refers to those of Q_6.

Capacitor C_6 must be discharged prior to its next charging period otherwise it would iteratively charge to some large value of voltage and no longer be able to respond linearly to the input waveform. A positive gate, shown at point E, is applied to Q_4 just prior to the charging period of capacitor C_6 and effectively discharges C_6 to permit it to start charging from its initial discharged condition at the start of each cycle. This procedure allows the linear sweep voltage to be directly proportional to the spacing of the two transmitted pulses. Thus a linearity for the entire telemetry system of better than 1 percent is achieved.

During the exceptionally long discharge period of C_6, any resistance in parallel with the high input impedance of the composite emitter follower will reduce the R-C discharge time constant. Since a crystal diode, D_7, and a transistor, Q_4, are both connected in this manner, both their reverse saturation currents will tend to reduce the R-C discharge time constant. To reduce this effect to a minimum, silicon is used for both units and each is selected for its low reverse saturation current. The diode is a 1N459 and the transistor an ST32.

The resultant waveform, existing at F in Fig. 3, has an amplitude that is linearly variable with the input pulse spacing. This signal is then filtered by the three L-section filters and results in a d-c level corresponding to the d-c input signal applied to the same channel in the transmitting equipment.

Because the linearity of the telemetry system must be held to better than one percent, no variations in parameters may be allowed whose total summation adds up to more than this figure. Channel number ten of the demodulator, the reference channel, in conjunction with circuitry which includes an operational amplifier, is used to reduce any variations in parameters, other than the d-c data voltage inputs, to a value which is small compared with the allowable system deviation from linearity. As shown in the schematic diagram in Fig. 4, the input to the compensator (operational amplifier) is derived from the d-c output voltage from the reference channel of the demodulator.

The reference channel, which is similar in design to the nine other demodulator information channels,

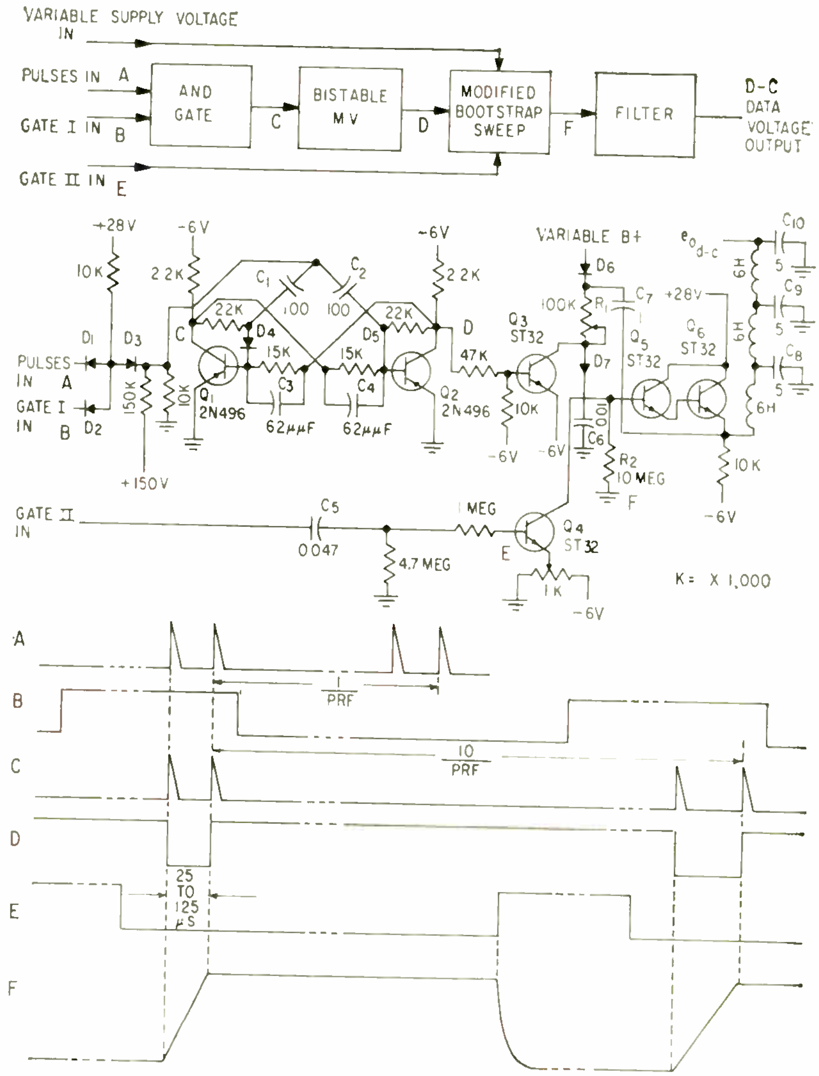


FIG. 3—Block diagram, schematic and waveforms of the demodulator

is initially set by adjustable resistors, so that the 152-μsec spacing of the reference pulses fed into this channel will correspond to a 20-v d-c output voltage. This d-c voltage level is then fed to the operational amplifier whose overall gain is approximately 25. The plate voltage for this amplifier is plus 300 v, and the circuit parameters are chosen to give a 150-v drop through the plate load resistor. The plus 150-v d-c level at the plate of the pentode is then applied through a cathode follower to the sweep charging circuit in each of the nine information channels of the demodulator. The cathode follower supplies the power to the charging R-C circuits and the sweep voltages are developed across the individual capacitors.

Pulse Spacing

During operation of the transmitting equipment, variations in parameters such as battery terminal voltage variations, changes in resistance values with temperature and age, tube ageing, and variations in power supplies will normally occur. This means that the reference pulse spacing will change from the nominal value of 152 μsec. Similarly the information pulse spacing of the other information channels will change and erroneous intelligence will be received by the ground equipment.

However, if the d-c level output voltage of the demodulator channels can be compensated to revert to the levels which would have prevailed if the parameters had not changed in value, correct information will be contained in the demodulator output although incorrect information is being fed to the ground telemetry receiver system.

To explain the operation of the compensating circuits, let the d-c input signal to the operational amplifier decrease as a result of the pulse spacing decrease from the nominal 152 μsec. The plate current will also decrease. This will increase the plate voltage which in turn is used to charge the capacitors across which the sweep voltages are developed.

Therefore when the reference pulse spacing decreases from 152 μsec, the decreased charging time

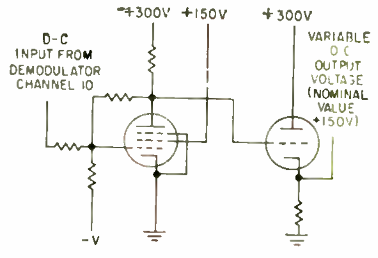


FIG. 4—Compensator for variation of parameters in the transmitting equipment

is, ideally, compensated for exactly by having the capacitor charge from a higher source voltage. The system has been checked out and can maintain its 1 percent linearity over a range of 152 μsec plus or minus a 20-μsec variation into the demodulator reference channel.

In the demodulator channels, the bootstrap sweep circuits theoretically operate as described above. In practice, however, certain complications arise because the subsequent circuitry is required to produce an average *d-c* waveform.

This situation means that charging capacitor, C_6, must not be allowed to discharge rapidly as in a normal bootstrap sweep circuit. A large resistor is added so the capacitor can discharge slowly and maintain its peak charging voltage for the duration of the period of the wave. That is, the R-C time constant is much greater than ten times the prf period.

Since C_6 is also included in the charging time constant of the circuit, the discharge resistance is the only simple means of determining the discharge time constant. However, as is shown in Fig. 5A, the input impedance of an emitter follower is directly in parallel with the large value of the discharge resistor, R_2. Since the r_c of the transistor is the maximum asymptotic value of the input impedance, and for a normal low-power transistor this value may be in the order of 100,000 ohms, the discharge resistance can have a maximum value of 100,000 ohms. A practical value, however, is above several megohms. Therefore a simple emitter follower stage is impractical in this circuit.

In Fig. 5B, a Darlington composite emitter-follower circuit replaces the simple emitter-follower stage in the bootstrap circuit. The input impedance of this circuit, shown with no compensation of any kind and in its simplest form, can be as high as several megohms and even as high as several hundred megohms.[3] This type circuit is satisfactory over a restricted temperature range.

A tube version, shown in Fig. 5C, covers a larger temperature range. However, a large grid-leak resistor is used and an appreciable negative voltage drop could occur across it as a result of grid-leak current.

The authors acknowledge the suggestions received from J. V. D'Onofrio, J. Sarzin, C. Valavanis, and I. Steinberg. This project was sponsored by the Signal Corps and the authors thank Mr. P. Maresca for his constant encouragement.

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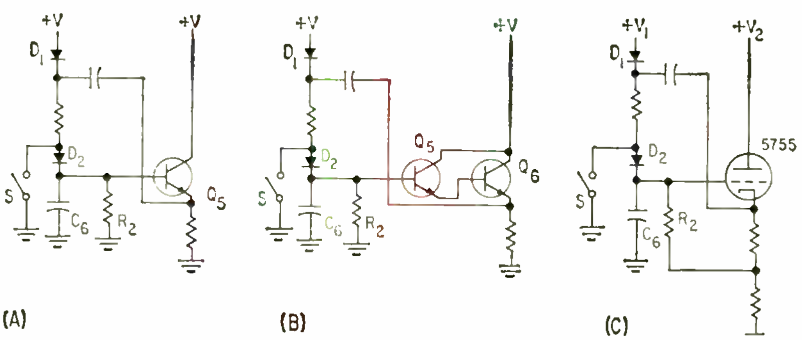


FIG. 5—Emitter follower used for bootstrap sweep circuit (A); composite emitter follower for high input impedance (3); and electron-tube version which covers larger temperature range

Aluminum Finishes

Finishes for aluminum will protect it against corrosion, alter its resistivity, improve its solderability or change its color

By **WALTER E. POCOCK,** Development Engineer, Allied Research Products, Inc., Baltimore, Md.

FINISHES are given aluminum used in electronics applications to improve the metal's appearance, corrosion resistance, surface conductivity, solderability and wear resistance. Some of the finishes of interest to electronics engineers are identified and described in Tables I and II.

TABLE II—Specifications for Coatings in Table I

I	MIL-A-8625A
II	MIL-C-5541
III	ASTM B-253-53 (electroplating on aluminum); MIL-G-19788, FCS114 (gold); QQ-S-365 (silver); QQ-P-416 (cadmium); QQ-Z-325 (zinc); QQ-N-290 (nickel); QQ-C-320 (chromium); MIL-C-14436 ("gray" chromium)
IV	MIL-C-15328A (wash primer); MIL-P-6889A (zinc chromate primer, air dry); MIL-E-5558A (wrinkle enamel); MIL-E-15090B (light gray equipment enamel); TT-E-489B, MIL-E-7729A (gloss enamel); TT-E-527 (lusterless enamel); MIL-L-6806 (clear lacquer)

TABLE III—D-C Resistance of Coated and Uncoated Aluminum

Aluminum Treatment	Average Resistance (microohm-in²) Before Salt Spray (Average of 75 readings)	After 64 hrs Salt Spray (Average of 60 readings)
Clean Aluminum	96	6.09×10^6
Yellow Chromate Conversion Coat	2,020	3,370

ANODIZING—An abrasion-resistant aluminum oxide coating of high electrical resistance is formed when aluminum is the anode in an electrolytic bath. Baths operated below room temperature produce hard coatings. Dyed coatings are decorative as well as protective.

CHROMATE—Chromate (chemical dip) conversion coatings also protect, but are electrically conductive as shown in Table III and Fig. 1. Indications are that they perform better as pretreatments for organic finishes than anodic oxides. Differing treatments can also be applied to zinc, cadmium and silver plated over aluminum.

ELECTROPLATING—Plating other metals on aluminum will increase solderability, abrasion resistance or improve appearance. Galvanic corrosion of aluminum in contact with cadmium or zinc-plated steel can be reduced, for example, by plating the aluminum with cadmium or zinc. A simpler procedure is to chromate coat the aluminum, cadmium plate the steel and chromate coat the cadmium. The aluminum-cadmium potential is low.

ORGANIC—Organic coatings are many and varied. Some of the more common types are listed in Table I. Cost and conditions of application, such as time and temperature for curing, are of interest as well as performance.

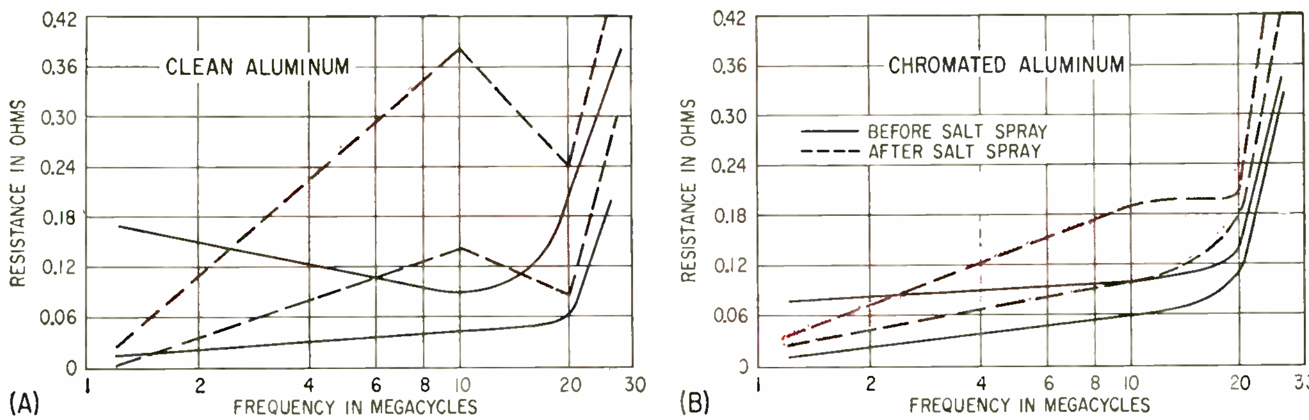


FIG. 1—R-f resistance of aluminum. Maximums and minimums before salt spray exposure are shown by black lines. Ranges after 64-hour salt spray are shown by red shading

for use in Electronics

TABLE I—Production Methods and Application Data for Aluminum Finishes Used in Electronics

TYPE OF FINISH AND PROCESS DETAILS	PROPERTIES, ADVANTAGES, DISADVANTAGES	TYPICAL APPLICATIONS IN ELECTRONICS
I ANODIZING (1) Vapor degrease when heavy oils and grease are present (2) Rinse (3) Alkaline clean (4) Rinse (5) Acid dip optional depending on alloy (6) Rinse (7) Anodize 10–60 minutes in sulfuric, chromic, oxalic acid, etc., electrolyte Refrigeration required in some cases (8) Rinse (9) Seal, hot water or dichromate (10) Rinse (11) Dry	Hard, abrasion-resistant, corrosion-resistant, resistant to organic solvents, acids and alkalies Electrically insulating. Breakdown voltages of 100–1,000 volts have been reported, depending on coating thicknesses and process conditions Good base for organic coatings Partial or multicolor dyeing process adaptable for lettering, etc. Heat-resistant, but subject to crazing at high temperatures Brittle, susceptible to galvanic corrosion if coating flakes or is scratched off	For abrasion resistance and corrosion resistance when conductivity is not required; housings on small control motors As a dielectric on capacitor plates and foil Panels and other exposed parts, for appearance; black and other colors; dials and name plates As pretreatment for organic finishes
II CHROMATE CONVERSION TREATMENTS (Iridite Type) Steps (1) to (6) under anodizing (7) Chromate dip 10 seconds to 5 minutes immersion in acid chromate solution at room temperature (8) Rinse (9) Dry Can be colored by dip in dye solutions following step (8)	Extremely thin, about 0.01 mil Resistant to corrosion, resistant to organic solvents, mild acids and alkalies Electrically conductive. See Table 2 and Fig. 1 Good base for bonding and organic coatings; flexible, weldable; simple to process Relatively low in abrasion resistance; heat-resistant, but subject to loss of corrosion resistance when heated above 200 F; dyeable, but dyes have low light fastness	Parts requiring corrosion resistance and conductivity, chassis, wave guides As pretreatments for organic finishes, particularly where exterior is to be painted and grounding is required on interior Color-coding washers, connectors and other parts To give additional galvanic corrosion protection to plated aluminum in contact with other metals
III ELECTROPLATING Steps (1) to (6) under anodizing (7) Immerse 30–60 seconds in zincate (alkaline zinc) solution (8) Rinse (9) Electroplate in conventional bath (10) Rinse (11) Chromate conversion dip (for cadmium, zinc and silver only) (12) Rinse (13) Dry	Copper-silver-gold: tarnish and corrosion-resistant; retains high degree of solderability Copper-silver: solderable, conductive; with chromate conversion coating (Iridite 18-P, Allied Research Products), has reduced susceptibility to tarnishing, retains solderability Cadmium or zinc with chromate conversion coating: corrosion-resistant and conductive Cadmium with clear conversion coating: retains solderability and conductivity Chromium: abrasion-resistant, conductive	Copper-silver-gold and copper-silver: parts requiring high conductivity and solderability, chassis, waveguides, connectors Cadmium and zinc: see text Copper-nickel-chromium: surfaces requiring abrasion resistance and conductivity, telescoping antennae; for appearance hardware Copper-nickel: for appearance
IV ORGANIC FINISHES Cleaning by solvents or by steps (1) to (4) under anodizing are usually the minimum pretreatment required Anodizing or chromate conversion treatments are advisable as pretreatments, to give maximum corrosion resistance of the organic coatings	Protection against corrosion; electrically insulating; varying resistance to organic solvents, acids, alkalies and thermal decomposition Clear lacquers: enhance corrosion resistance and give moderate abrasion resistance; useful for protecting lettering on panels, chassis, etc. Wash primers and conventional zinc chromate primers: improve corrosion resistance and bonding of topcoats	For appearance and corrosion resistance where conductivity is not required; structural parts, panels, cabinets and hardware

Four Transistor Inverter

Direct-current motors used in low-pressure or explosive environments can be replaced with induction motors by employing transistors as controlled switches to provide two-phase square-wave output from single d-c source. Inverter is also applicable to hysteresis-synchronous motors in situations where constant speed under load is required

By W. HOWARD CARD,
Dept. of Electrical Engineering, L. C. Smith College of Engineering, Syracuse University, Syracuse, N. Y.

CONVENTIONAL D-C MOTORS are undesirable in some applications where only a d-c source is available. In low-pressure environments, brushes wear rapidly, while brush sparking presents a fire hazard in explosive atmospheres. For such applications a two-phase induction motor driven by the experimental transistor inverter to be described can be used instead.

The two-phase inverter is comprised of two almost identical single-phase square-wave-output inverters as shown in Fig. 1.[1,2] The two-single phase circuits are phase locked to operate in synchronism and phase quadrature, with each inverter driving one motor phase. Source voltage E_s determines the inverter frequency and motor phase voltages that control motor speed and torque. Since frequency and voltage vary together, the motor operates at nearly constant magnetic flux density regardless of source voltage.

Components

Feedback transformers T_1 and T_2 are toroidally wound on 1-mil tape Deltamax cores, with the turns ratio chosen to switch the transisistors either on or off.

Cut 4-mil tape-wound C-cores are used in output transformers T_3 and T_4. Though autotransformer connections are shown, the motor phases may be connected to separate secondaries. To match the ratings of the motor used, one motor phase is connected across half the turns of T_4.

There must be close coupling between N_1 and N'_1 of T_3 and T_4 since energy stored in the transformer leakage reactance is mostly dissipated in the transistor when it is turned off. To improve coupling N_1 and N'_1 are wound simultaneously by feeding wire off two spools.

Switching Effects

Inductive loads such as motors usually require diodes connected across the transistors as shown, to carry the inductive load current during switching. In this way, stored energy in the motor magnetic field is not dissipated in the transistor, but instead, is returned to the source. The motor phases cannot be tuned with capacitors as this prevents the transistors from switching rapidly and greatly increases transistor average-power dissipation.

Operation at the rated motor frequency of 400 cps with a 23-v source results in a 46-v peak collector-to-emitter voltage that is within the transistor ratings. Neglecting losses, the voltage across N_1, N'_1 is a 46-v square wave, which has a fundamental component of (46) $(4/\pi)$ (0.707) = 41.5 v rms.

Both output voltage e_{o1} and feedback-transformer voltage e_{f1} are square waves.

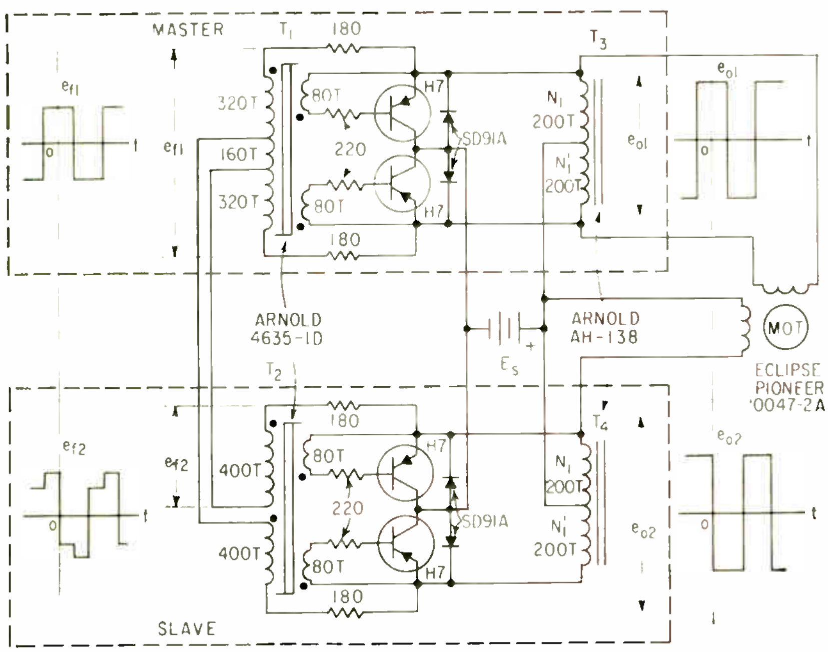
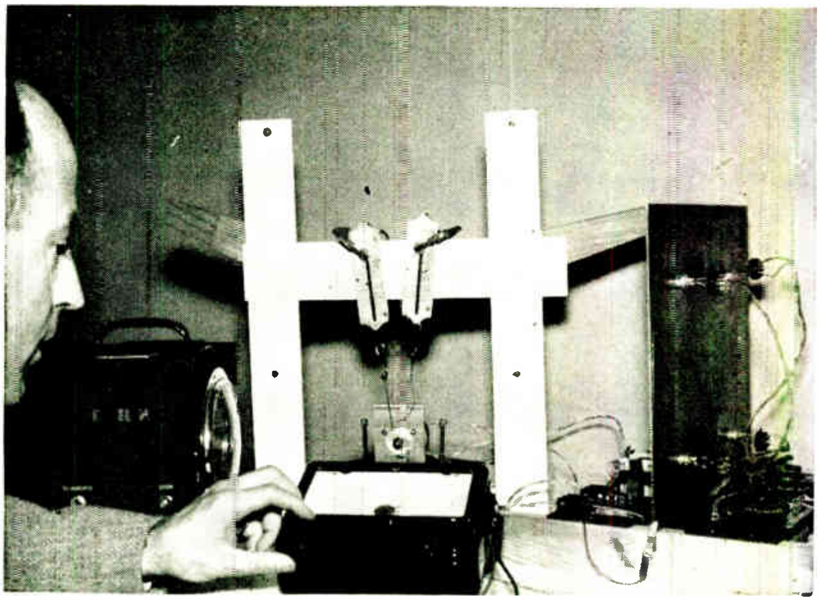


FIG. 1—Two-phase square-wave inverter drives two-phase induction motor

Drives Induction Motor



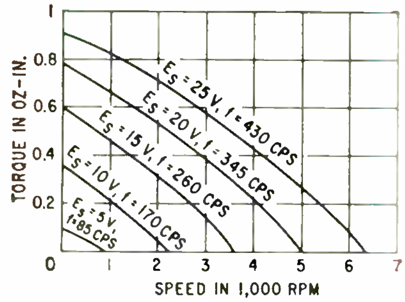


FIG. 2—Measured torque as a function of speed for driven inverter servo motor. Supply voltage E_S sets inverter frequency and determines motor speed and torque

Setup measures motor torque with spring scales and motor speed with Strobotac. Experimental two-phase transistor inverter is at right

The slave inverter is the same as the master inverter that sets the system frequency, except that a fraction of the master voltage is added into the slave feedback-transformer circuit. Slave inverter output voltage e_{o2} is a square wave, but the slave feedback-transformer voltage has the stepped waveform e_{f2} as shown.

With the two inverters operating in synchronism and quadrature, the average voltage applied to the slave feedback transformer is the same as for the master. Since the two feedback transformers have identical cores and equal total turns, the conditions for synchronous and quadrature operation are fulfilled.

Phase-Locking Scheme

Operation in phase quadrature is self-stabilizing. If the slave inverter tends to run ahead, the phase angle between master and slave changes to lower the average voltage applied to the slave feedback transformer. Thus the slave slows down. Similarly, if the slave inverter runs slowly, its feedback voltage is boosted to speed it up.

To obtain good quadrature operation over a wide range of source voltage, the square-loop-core feedback transformers should be closely balanced so that they have the same volt-second areas.

With the circuit values shown, the system will not operate with a source voltage less than 5 v because the feedback is not sufficient to switch the transistors thereby producing the output square wave.

Performance

Figure 2 shows the speed-torque curves obtained when the inverter drives a small two-phase drag-cup servo motor. Both no-load speed and stall torque are nearly linear functions of the d-c source voltage, hence behavior somewhat resembles that of a separately excited d-c motor.

Square-wave drive has some disadvantages for driving an induction motor[3]. The fifth and ninth harmonics of the square wave help the fundamental produce forward torque, but the third, seventh, eleventh harmonics contribute reverse torque. The net result is at most a 11.5-percent decrease in output torque compared with that obtainable using the fundamental frequency alone.

Another detrimental factor is that the square-wave voltage harmonics contribute to extra motor heating, amounting at most to 22 percent. Because of this reduced torque and increased heating, a motor must be derated by a given small amount when used with square-wave rather than sinusoidal drive.

Results

All the experimental results were obtained using a high rotor-resistance induction motor (servo motor). The drive should also be useful for low-rotor-resistance induction motors and hysteresis-synchronous motors when nearly constant speed under load is desired.

The author gratefully acknowledges the support for this research received from the National Research Council of Canada, The University of Toronto and Syracuse University.

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Tv Sound Detector

Drift-transistor slope detector operating in an oscillating mode gives superior performance compared with passive detector in a-m rejection, audio recovery and linearity at low signal levels. At larger signal levels, performance equivalent to a passive detector is obtained

By **MARVIN METH***, Member Technical Staff, RCA Laboratories Div., Industry Service Laboratory, New York, N. Y.

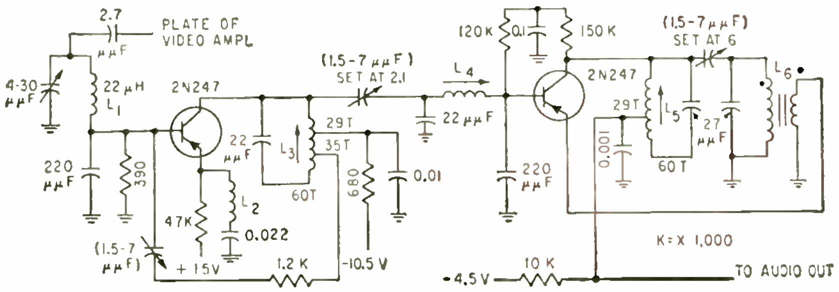


FIG. 1—Experimental f-m detector intercarrier-sound circuits

DESIGN of a transistorized tv receiver requires an efficient, low-cost sound strip. The circuitry described uses an efficient, highly sensitive oscillating linear-slope detector, injection locked by a one-stage sound driver. The combination of sound driver and detector is capable of overdriving the output audio amplifier when driven from the first video amplifier.

By operating in an oscillating mode, detector threshold level is reduced, a-m rejection is uniformly high over the full detector bandwidth and audio output is maintained at a constant level independent of carrier strength.

Detector

A 2N247 drift transistor functions as a slope detector in an oscillating mode. Oscillations are maintained by collector-to-emitter feedback through an overcoupled double-tuned circuit as shown in the right half of Fig. 1. The oscillator is injection locked to the sound signal which is applied to the base electrode by the driver stage through an impedance-matching network. Detected audio appears across the 10,000-ohm collector resistor and is obtained at r-f ground of the primary winding. Required forward bias is obtained by bleeding current from the collector into the base through two series-connected resistors bypassed at their junction to prevent audio and r-f degeneration.

Collector characteristics of drift transistors differ from conventional bipolar transistors, as shown in Fig. 2. Note that for negative collector voltages, the zero-bias characteristic of the drift transistor is similar to that of conventional units. For positive voltages applied to the collector of a *pnp* transistor, the collector acts as an emitter and the emitter as a collector. The applied voltage is a reverse voltage for the emitter junction.

Symmetrical Breakdown

Grading of the base layer of drift transistors is in such a sense as to produce breakdown of the emitter junction for relatively low voltages. Three to five volts is a typical value. Breakdown of the emitter junction is reflected in the collector as a large increase in current. The low breakdown voltage shown in the first quadrant of Fig. 2 will be referred to as symmetrical breakdown.

Positive peaks of the collector voltage are clamped at the symmetrical breakdown level. Time constant of the clamp, which is in the decoupling network, corresponds to at least 20 r-f cycles. Collector current adjusts to maintain a sinusoidal voltage waveform at the collector electrode. Positive excursions of the collector waveform are held at the symmetrical breakdown level. Negative excursions are limited by the available collector voltage.

Driving Impedance

The average collector current and oscillator amplitude are a function of the collector-circuit impedance and the coupling coefficient of the transformer. The link is a convenient means for obtaining a sufficiently low driving impedance for efficient coupling between the collector and the emitter.

The double-tuned coupling arrangement restricts oscillator operation to either the positive or negative slope of the impedance characteristics of the collector tank circuit. This action prevents excessive distortion which would arise from a slope reversal. Assume that the collector and emitter

* Now with Department of Electrical Engineering, City College of New York

Uses Drift Transistor

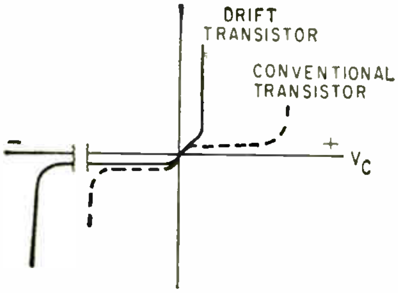


FIG. 2—Zero-bias characteristics for a drift and conventional pnp transistor

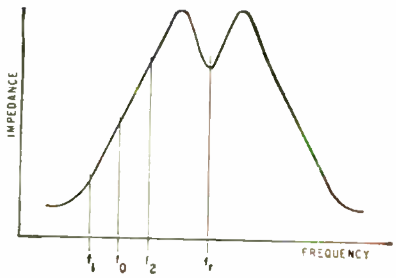


FIG. 3—Impedance of the collector tank where f_1 and f_2 are synchronizing range

tank circuits are resonant at the same frequency f_r. A signal of frequency f_r would experience a 90-deg phase shift in passing through the coupling network. The direction of phase shift, either lead or lag, is dependent on the link polarity.

Injection Locking

The oscillator is injection locked to the sound signal which is applied to the base electrode. Natural frequency of the oscillator f_o is set equal to the carrier frequency. Deviations of the signal about the carrier frequency are followed by the oscillator.

The oscillator will assume the frequency of the injected signal if two conditions are met. First, the circuital phase requirement for self-oscillation at the injected frequency must be satisfied. Second, the injected power level must be greater than a minimum. The synchronizing range is restricted to those frequencies for which the coupling network introduces less than 90 deg of additional phase shift relative to the shift at the natural oscillating frequency. The synchronizing range is restricted to either the positive or the negative slope.

Figure 3 shows the collector tank impedance for a circuit where the link polarity corresponds to synchronization on the positive slope. Frequencies f_1 and f_2 are the limits of the synchronizing range for a given injected power level.

Two restrictions are imposed on the collector voltage swing. Positive peaks are clamped at the symmetrical breakdown level. The average value is set by the effective collector voltage. The clamping time constant—approximately 10 μsec—is made fast enough to follow the amplitude variations encountered in the application. As a result, the dynamic and static limiting characteristics can be considered similar.

Ability of the detector to reject amplitude variations is not dependent on the injected signal providing the injection is of sufficient level to lock the oscillator for full carrier deviation. If the injection is below this threshold, the a-m rejection will be maintained only over the synchronizing range. Beyond this range, the output contains the beat between the injected and the oscillator signal. Also, for signals in excess of the threshold level, the audio output is maintained constant independent of carrier level.

Driver Stage

Maximum power transfer between the sound takeoff and the detector stage is provided by the driver for signals below the limiting threshold. Signals that would otherwise overload the detector are limited symmetrically to maintain a constant injection into the detector. Limiting action is rapid enough

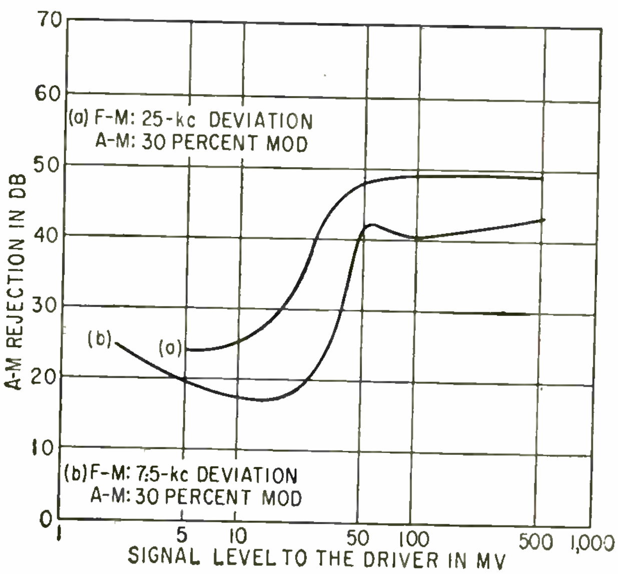


FIG. 4—A-m rejection as a function of signal level to the driver

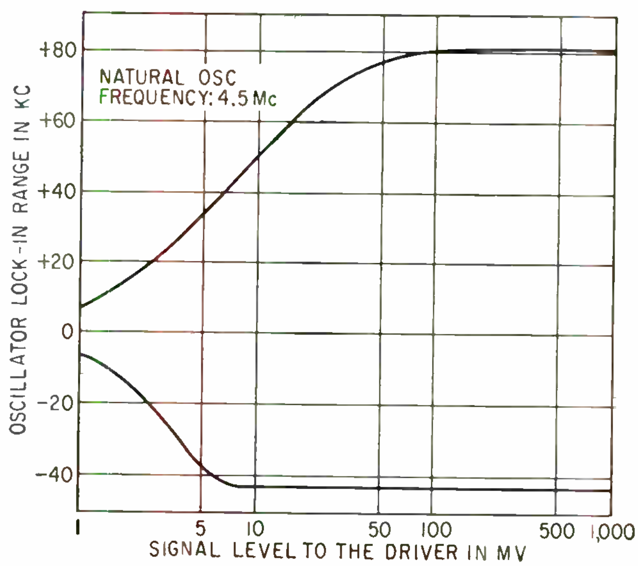


FIG. 5—Oscillator pull-in characteristics

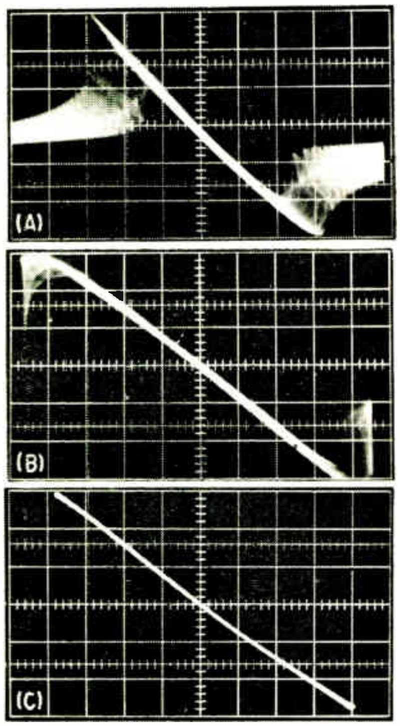


FIG. 6—Performance oscillograms (top to bottom)—signal level to driver, 1.5 mv, 10 mv and 30 mv; f-m, 25 kc at 50 cps, 50 kc at 50 cps and 50 kc at 50 cps; a-m, 30 percent at 400 cps for all three

to respond to the video modulation of the sound carrier.

A double-tuned critically coupled circuit matches the driver and detector stages. The primary is tapped to provide an impedance match for the neutralized driver stage. A signal of opposite phase to the collector signal is available at the second tap. It is used for neutralization of the transition capacity in a conventional feedback arrangement.

Biasing

A highly degenerative biasing scheme fix-biases the transistor at a high g_m point. The emitter current is set predominantly by the emitter resistor, bypassed to ground for signal frequencies, and by the positive supply voltage. Collector voltage is determined by the negative supply voltage and the decoupling resistor.

For large positive swings at the base of the driver, the transistor cuts off. For large negative swings, the transistor is driven into collector-voltage saturation. Quiescent conditions are proportioned for these effects to occur for equal positive and negative swings. This arrangement provides the desired symmetrical clipping of the input waveform.

The transistor has an exponential transfer characteristic and produces a rectified component of emitter current, reducing the forward bias of the emitter junction. For large input signal amplitudes, highly modulated by the video information, the driver stage can be cut off during the sync interval. This condition will occur only if the emitter circuit cannot respond rapidly to the required shift of the quiescent operating point. This effect may be reduced greatly by using a larger emitter resistance. As a result, rectification efficiency of the emitter junction is reduced.

Another technique is to limit the maximum emitter time constant to a value that permits bias adjustments at a horizontal line rate. A 4,700-ohm emitter resistor bypassed with a 0.022-μf disk capacitor with leads cut and coiled for resonance at 4.3 mc is a satisfactory compromise. Incomplete emitter bypassing introduces 0.6 db of negative feedback at 4.5 mc. The driver stage can follow deep modulation of the sound signal.

Circuit Details

The schematic diagram of the sound strip installed in a commercial chassis is shown in Fig. 1. This circuit shows high-side capacitance coupling. But mutual, or a combination of mutual and high-side coupling, may be substituted.

Detection linearity and a-m rejection, Fig. 4, are dependent on the coefficient of coupling in the double-tuned coupling arrangement of the oscillator loop. A coupling factor of 1.5 times critical coupling gives good a-m rejection and reasonably good linearity. Larger values of coupling distort the detection characteristic S curve; smaller values of coupling reduce the amplitude-modulation rejection.

Base and emitter networks are designed to suppress spurious oscillations arising from input-circuit feedback due to high input capacitance of the transistor. Driving-point impedances of these networks have been designed so that for all frequencies for which the base reactance is positive, the emitter reactance is also positive. Consequently, feedback from emitter to base is degenerative for all frequencies and stable operation results.

The detector operates in an oscillating mode over the full range of input signals provided by the driver. The holding, or lock-in, range is a function of signal level. Lower limit of the holding range, Fig. 5, corresponds to frequencies for which the tank impedance is too low to support oscillations. Theoretically, the oscillator can follow positive deviations up to the tank resonant frequency. Practically, these limits are dependent on the maximum power capability of the driver.

Performance Results

Overall performance is illustrated best with the oscillograms of Fig. 6. They were obtained by passing a carrier that is simultaneously amplitude- and frequency-modulated through the sound strip and displaying the detected output with the f-m as a time base. These oscillograms indicate that a-m rejection is not critical to center tuning. A-m rejection characteristics are given for 30- and 100-percent f-m where 100-percent modulation corresponds to 25-kc deviation.

At low signal levels the a-m rejection is 20 db, which is the inherent a-m rejection of the detector. This rejection increases as the driver limits. For input signals of less than two mv, a-m rejection is still high.

Audio recovery is 75 mv per kc of deviation, independent of carrier level. For 100-percent modulation, the detector develops an open-circuit output of 1.3-v rms. Maximum power transferred by the detector into an audio load is 10 dbm and is maintained over a wide range of loading centered about 4,000 ohms.

As loading varies from 500 to 25,000 ohms, output is maintained within three db of the maximum level.

For 25-kc deviation, the audio output contained from 2.5 to 3.5 percent of rms harmonic distortion depending on center tuning and on signal level. As the deviation was increased to 50 kc, rms harmonic distortion increased in the range of four to five percent.

Resistances of Dry Cells

Internal resistance of dry cells depends upon conditions of use. Tables give resistances of typical cells, as measured by new method

NATIONAL BUREAU OF STANDARDS has developed a rapid, nondestructive technique for measuring the true internal resistance of dry cells. It determines how internal resistance changes as the cell is discharged under various conditions.

Test results, such as those given in the tables, show that increases in internal resistance depend on the type of discharge, cell size and variations in manufacture. Test results are averaged for each group of cells. Some groups did not survive the life tests.

PROCEDURE—To test, a pulse generator, a resistor of known value and the test cell are connected in series. Leads of a cro are connected to the cell terminals. As a train of pulses is applied to the cell, the instantaneous internal resistance drop is recorded at the trailing edge of the pulse on the oscilloscope.

Next, the oscilloscope is connected across the resistor, the internal resistance drop is noted and the current through the resistor is calculated from Ohm's law. With the pulse current known, the cell's resistance is calculated by applying Ohm's law to the resistance drop in the cell in the first measurement.

Internal resistances obtained by this method do not include other impedance components. Variations in current direction, current, frequency and length of the pulse have no effect on the measured internal resistance.

Life tests show no general relation between internal resistance at the beginning and end of any particular test. Short circuit current increases as internal resistance decreases. Internal resistance increases on discharge. Internal resistance has a slight tendency to increase at the highest momentary current drains.

LIFE—The Bureau is investigating whether internal resistance measurements can be used to determine dry cell life expectancy. Variations in cell resistances between manufacturers do not permit a general formula, according to the Bureau. However, specific groups of cells may be calibrated.

The test method was developed by R. J. Brodd, of the Bureau's electrochemistry laboratory. Test results are considered more accurate than those obtained through previously used methods. There is no NBS standard for internal resistance of dry cells.—G.S.

TABLE I—Internal Resistance of Fresh, Undischarged D, C, AA and No. 6 Size Cells

Cell Groups	Initial Resistance (ohms)	Open Circuit Voltage (volts)	Short Circuit Current (amp)
D 1	0.146	1.58	8.6
D 2	0.147	1.6	8.7
D 3	0.152	1.58	7
D 4	0.153	1.61	7.7
D 5	0.178	1.59	6.9
D 6	0.18	1.57	6.7
D 7	0.186	1.64	6.8
D 8	0.196	1.61	6.1
C 1	0.196	1.59	6.3
C 2	0.271	1.61	5
C 3	0.353	1.62	3.7
AA 1	0.167	1.64	4.1
AA 2	0.192	1.56	5.2
AA 3	0.232	1.57	4.7
AA 4	0.379	1.58	3.2
6–1	0.0465	1.64	27.4
6–2	0.0318	1.65	30.3
6–3	0.0389	1.59	32.9

TABLE II—Results of General Purpose Life Tests on Cells Described in Table I

Cells	2.25-Ohm Test Time (min)	2.25-Ohm Test Final Resistance (ohms)	4-Ohm Intermittent Time (min)	4-Ohm Intermittent Final Resistance (ohms)
D 1	581	0.7	805	0.5
D 2	486	1	807	—
D 3	420	1.6	618	—
D 4	518	—	873	—
D 5	631	1.5	1014	1
D 6	323	0.8	575	—
D 7	173	0.7	808	0.9
D 8	647	—	931	1.2
C 1			407	1.2
C 2			468	0.9
C 3			405	1
AA 1			146	0.5
AA 2			127	0.6
AA 3			117	0.8
AA 4			136	0.6

TABLE III—Effect of Momentary Current Drain on Internal Resistance (R_i) of D, C and AA Cells

D Size Cells Drain (ma)	D Size Cells R_i (ohms)	C Size Cells Drain (ma)	C Size Cells R_i (ohms)	AA Size Cells Drain (ma)	AA Size Cells R_i (ohms)
0	0.18	0	0.22	0	0.274
1.54	0.18	1.52	0.22	1.42	0.273
15.4	0.18	15.1	0.22	14.1	0.273
32.4	0.178	32	0.22	29.6	0.272
149	0.18	146	0.221	133	0.276
508	0.18	480	0.225	426	0.282
1,156	0.186	1,141	0.23		

Coincidence Diodes Gate

Transistorized electronic switch for radar indicators uses coincidence diode circuits to switch six channels in each coordinate axis of a scope presentation. Amplitude capability is 120 v with an accuracy of 0.3 percent. Device operates over wide range of pulse repetition frequencies

By **JOHN B. BEACH,** Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y.

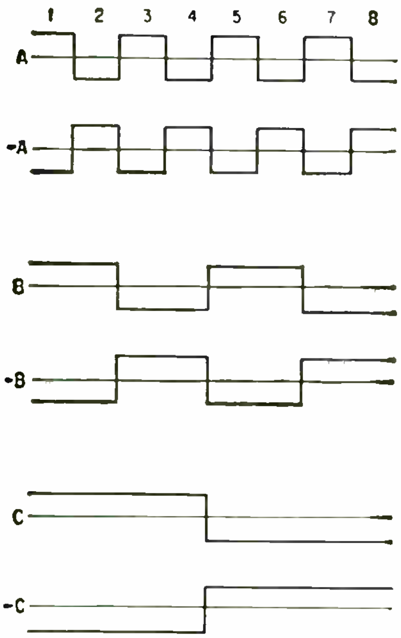


FIG. 1—Waveforms of the three binary switching voltages required to switch 8 channels are periodic with frequencies 4f, 2f and f, respectively

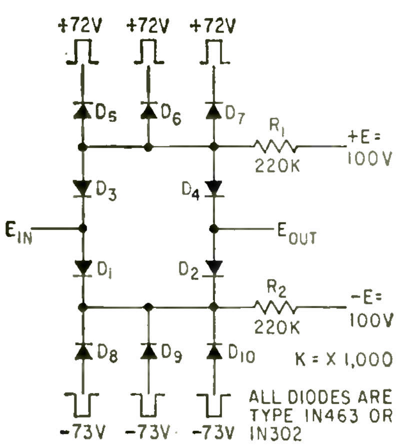


FIG. 2—Schematic of one channel of coincidence circuit using diodes

AN ELECTRONIC SWITCH can be used to present markers for aircraft identification on a radar plan position indicator. The switch should have high accuracy, sufficient voltage swing for full scale deflection, and capability of operation over a wide range of radar pulse repetition frequencies. A switch having these characteristics has been constructed on printed circuit boards using transistors and diodes.

Coincidence of binary voltages supplies gating signals for the switch. This method of switching provides 2^n channels where n is the number of gating voltages having a relationship f, 2f . . . $2^{n-1}f$ where f represents the lowest frequency square wave voltage. For certain applications the gating voltages need not be periodic and for generality will be referred to as binary voltages.

Diode Gate

Combinations of n binary voltages lead to $2n$ possible conditions. The binary voltages can be applied to a four-diode gate[1] through coincidence circuits. The result will be one channel of a switch which operates for only one of 2^n possible combinations of binary voltages. With $n = 3$, binary voltages A, B and C (assumed periodic with frequencies $4f$, $2f$ and f for convenience) appear as shown in Fig. 1.

One channel of the switch has the circuit of Fig. 2. If all binary voltages applied to diodes D_5, D_6 and D_7 are positive, these diodes experience reverse polarity and do not conduct.

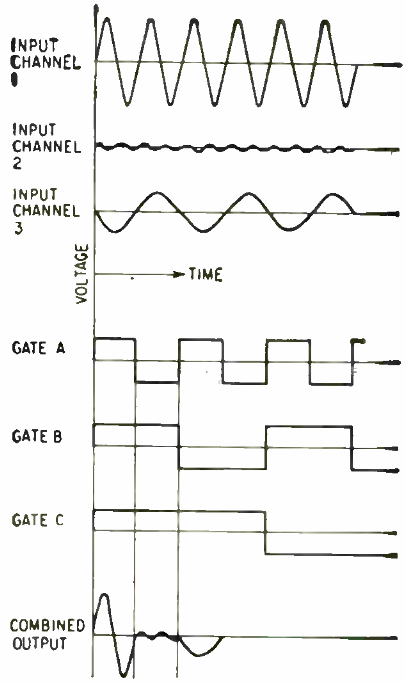


FIG. 3—Waveforms show how binary voltages gate switch for three input signals. When gates A, B and C are positive, channel 1 is closed. Channel 2 conducts when A reverses polarity. All possible logical combinations result in eight channels

Likewise, if negative polarity voltages are applied to D_8, D_9 and D_{10}, these diodes do not conduct. Under these conditions, D_1, D_2, D_3, and D_4 conduct and the switch presents a closed circuit.

If all binary voltages applied to diodes D_5, D_6 and D_7 are not positive and all binary voltages applied to diodes D_8, D_9 and D_{10} are not negative, one or more diodes in each group conduct and consequently diodes D_1, D_2, D_3 and D_4 experience reverse polarity. In this case, the

Electronic Switch

Printed circuit switch assembly shown mounted on ppi equipment

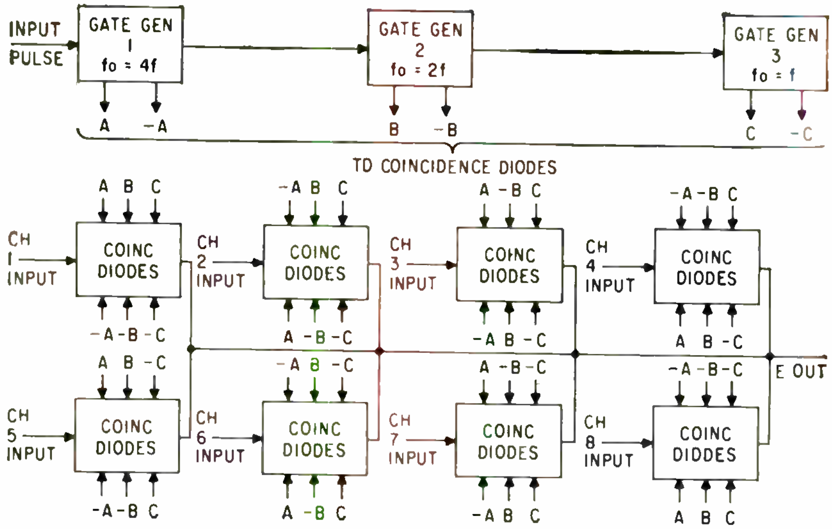


FIG. 4—Block diagram of eight-channel switch showing logic arrangement. Gate generators are scale-of-two bistable circuits

switch presents an open circuit.

Input voltages, binary voltages and the output are plotted as functions of time in Fig. 3. Eight different combinations of voltages *A*, *B* and *C* are possible, each condition corresponding to a conducting channel.

A block diagram showing the logical design of the switching circuit is shown in Fig. 4. Each binary gate generator supplies binary voltages to the coincidence diodes and also drives the following binary gate generator. The binary gate generators consist of scale-of-two bistable circuits followed by amplifiers.

Voltage Swing

The voltage swing available from the binary gate generators must be greater than the highest voltage swing the switch is required to pass. The radar indicator for which this switch was designed required +60 v to −60 v for full scale deflection. To provide a gating voltage safety factor the amplifiers provide 145-v peak-to-peak.

A circuit diagram of the amplifier-multivibrator chain which produces the gate pulses is shown in Fig. 5. Type 953 transistors were used in the amplifiers because of their high-voltage capability. Transistor Q_1 operating in common-emitter connection is driven to saturation by the input signal from

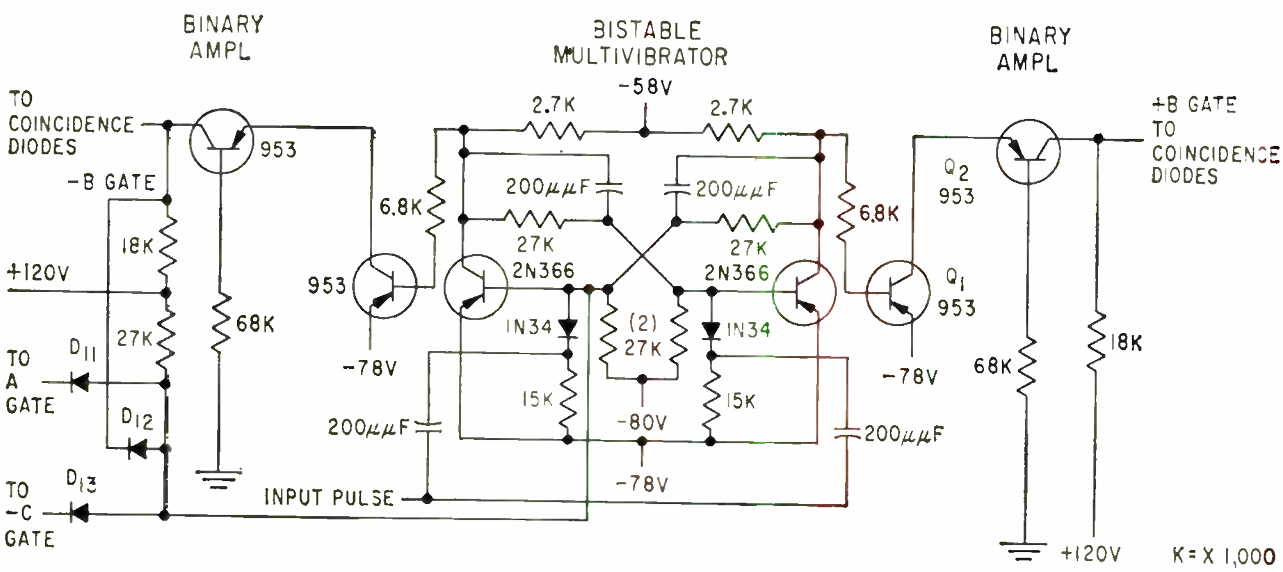


FIG. 5—Schematic of one channel of the six-channel switch. Forced recycling of the switch through diodes D_{11}, D_{12} and D_{13} triggers switch back to channel 1 after channel 6 is reached

the multivibrator. Q_1 in turn drives transistor Q_2 to saturation. Under this condition a small voltage drop exists across each transistor and −73 v is obtained at the output. When the phase of the input signal reverses, both transistors Q_1 and Q_2 are cut off.

Transistor Q_1 has 75 v between emitter and collector with the collector at approximately −3 v. Transistor Q_2 also has 75 v from emitter to collector with the collector at approximately +72 v. The result is a gating voltage of approximately 145 v peak to peak. Half this voltage appears across each transistor. Maximum current through both transistors is about 20 ma. Power dissipation is well within maximum rating.

Switching Channnels

The number of switching channels can be reduced from 2^n by applying a recycling pulse to an appropriate bistable circuit at the

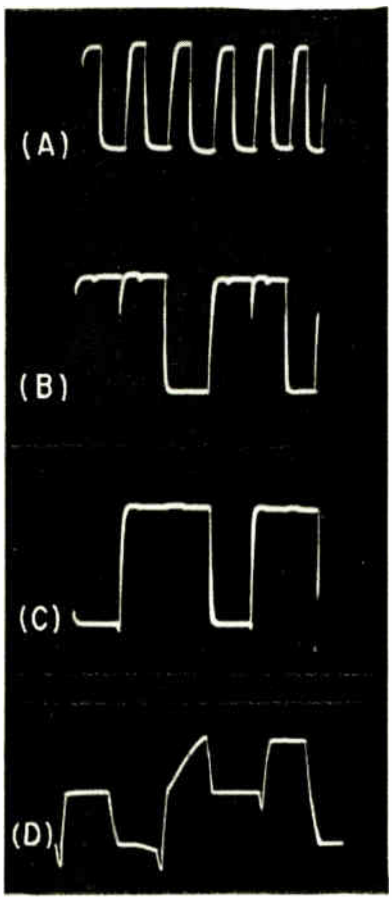
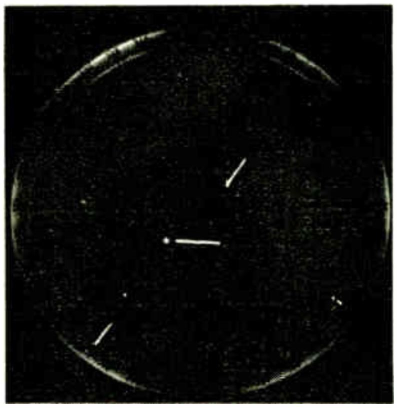


FIG. 6—Oscillograms of gating voltages for six channel switch are shown in (A), (B) and (C) while (D) shows switch output with input from marker generator



Appearance of markers on ppi scope. Markers along edge indicate direction. Markers with dot and tail represent direction and position of aircraft

beginning of the first channel to be eliminated.

For example, to reduce eight channels to seven channels, the combination of binary voltages which corresponds to channel 8 is selected. According to Fig. 4. this combination is $-A$, $-B$ and $-C$. These signals are applied to a coincidence circuit. The combination of binary voltages necessary to gate channel 1 is A, B and C. Comparison of these two combinations reveals that all binary voltages corresponding to channel 8 must be reversed in polarity to produce the combination corresponding to channel 1. To accomplish this, the output of the coincidence circuit is applied to binary generator 1 and the chain of binary generators is cycled to the combination corresponding to channel 1 when channel 8 is reached.

Coincidence Circuit

To produce a six-channel capacity, binary voltages A, $-B$ and $-C$ corresponding to the seventh channel are selected and applied to a coincidence circuit. From Fig. 4 note that the A binary voltage is the same polarity for channels 1 and 7. The output of the coincidence circuit is therefore applied to binary gate generator 2 reversing the polarity of outputs of binary generators 2 and 3 when channel seven is reached.

Diodes D_{11}, D_{12} and D_{13} in Fig. 5 form a coincidence circuit which triggers the switch back to the combination corresponding to channel 1 when the switch is stepped from channel 6. If these three diodes are eliminated, the binary gating generators will supply gating signals for eight switching channels.

Oscillograms of the gating voltages are shown in Fig. 6. Note that the B and C binary voltages are similar but shifted in phase. Forced recycling at the end of the sixth channel extends the B binary signal ½ cycle and shortens the C binary signal ¼ cycle. The results as shown are two nonsymmetrical voltages differing in phase. The recycling transient appears as a spike on the B signal.

Markers

An oscillogram of the y-axis output of the switch with inputs obtained from a marker generator is shown in Fig. 6D. Each marker occupies 300 μsec. One hundred μsec are blanked to allow transients to die out in the display equipment. The indicator is intensified during the remaining 200 μsec. The second and third markers shown consist of sweep voltages which appear as short lines on the radar indicator. The second sweep voltage is delayed in order to produce a dot marking position at the head of the marker. Five markers in all are shown. Several normal radar sweep periods occur while the switch is on the sixth channel. This channel has its inputs grounded to prevent noise pickup during radar sweep cycles. Synchronizing circuitry operated by a pulse received from the coincidence circuit used for forced recycling insures that the sixth channel will occur during radar sweeps.

Prototype switch accuracy was within ±0.3 percent over the operating range. Diodes D_1, D_2, D_3 and D_4 of Fig. 2 were selected to have equal forward resistances. If nonselected diodes are used and high accuracy is desired, a 1,000-ohm potentiometer should be connected between D_1 and D_3 to balance their resistances with the input on the adjustable tap.

Accuracy of the switch is also dependent on the accuracy of voltages $+E$ and $-E$ (Fig. 2) and upon precision of resistors R_1 and R_2. If the power supply for $+E$ and −E is isolated from ground, it need not be well regulated and R_1 and R_2 can be replaced by a single resistor.

Crosley Communications For.... Today's Armed Forces

Years of experience in communications have made Crosley a name that is respected for both commercial and defense business. Crosley's latest contribution to communications is the VRC-12, designed for use in communicating with practically every type vehicle used by the Armed Services, including tanks, jeeps, ducks, airplanes, helicopters and command cars.

The VRC-12 Ground Communications system provides narrow-band FM communications over 920 channels. The unit is transistorized and miniaturized in a package that is both rugged and light in weight.

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Maser Sensitivity Curves

Recent interest and development of masers and low-noise amplifiers make these useful receiver sensitivity and noise figure relationships revealing

By A. BRODZINSKY and A. C. MACPHERSON, Naval Research Laboratories, Washington, D. C.

IN EVALUATING a communication or radar system, it is desirable to arrive at a convenient indication of the sensitivity of the receiving system to a narrow-band signal imbedded in white noise as a function of the noise figure of the receiver and the noise temperature, T, of the signal source. The accompanying graph furnishes this information.

Noise figure, F describes the noise parameter of a linear receiver compared to a noiseless system for which $F = 1$. Recent emphasis on the development and use of super low-noise amplifiers whose noise figures are close to unity, has made important the evaluation of such amplifiers under various operating conditions. The system designer is fundamentally more interested in overall system sensitivity, S, than in the receiver noise figure.

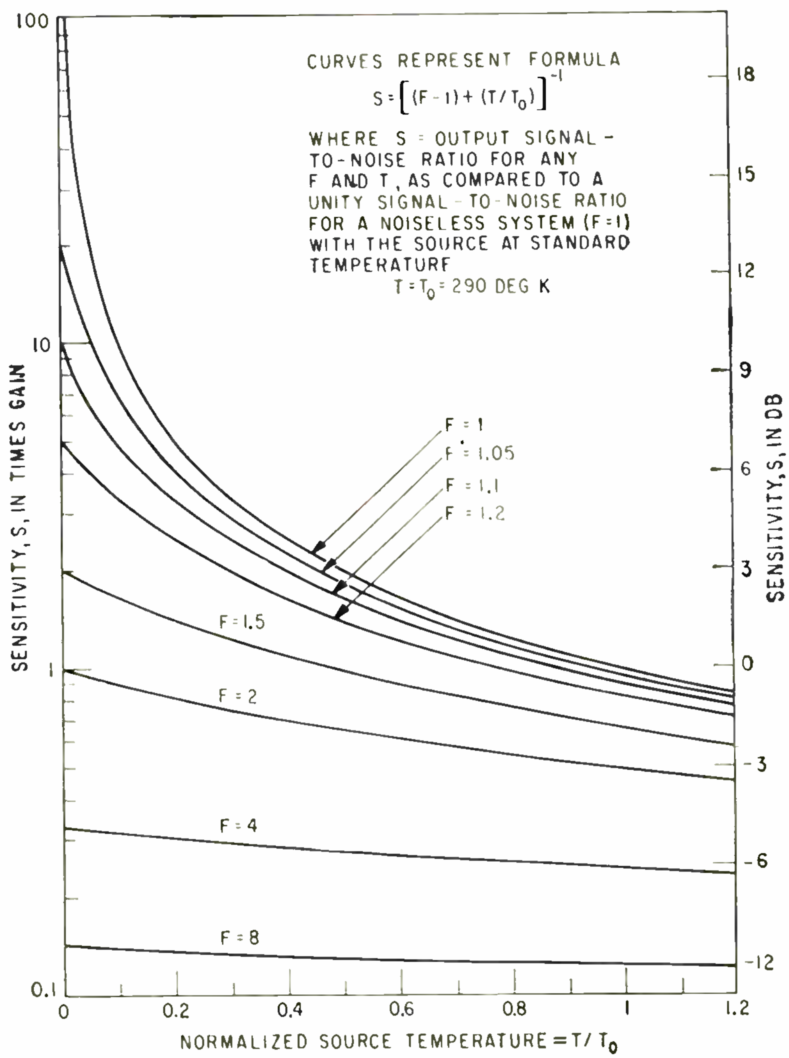
Curves shown in the accompanying graph represent the formula $S = [(F - 1) + (T/T_0)]^{-1}$ explained on the chart.

However these curves do not apply to a radioastronomy system when the signal is itself of a white-noise-like character.

Application

In particular, the graph shows that any receiving system whose signal source is operating near or above room temperature, $T/T_0 \geq 1$, has a limited potential gain in sensitivity.

For example, if a 3,000-mc surface search radar system ($T/T_0 = 1$) has a receiver noise figure of 4, then a gain of 4 times, or 6 db, in sensitivity is the most that can be expected by going to a super-low noise preamplifier ($F = 1.01$).

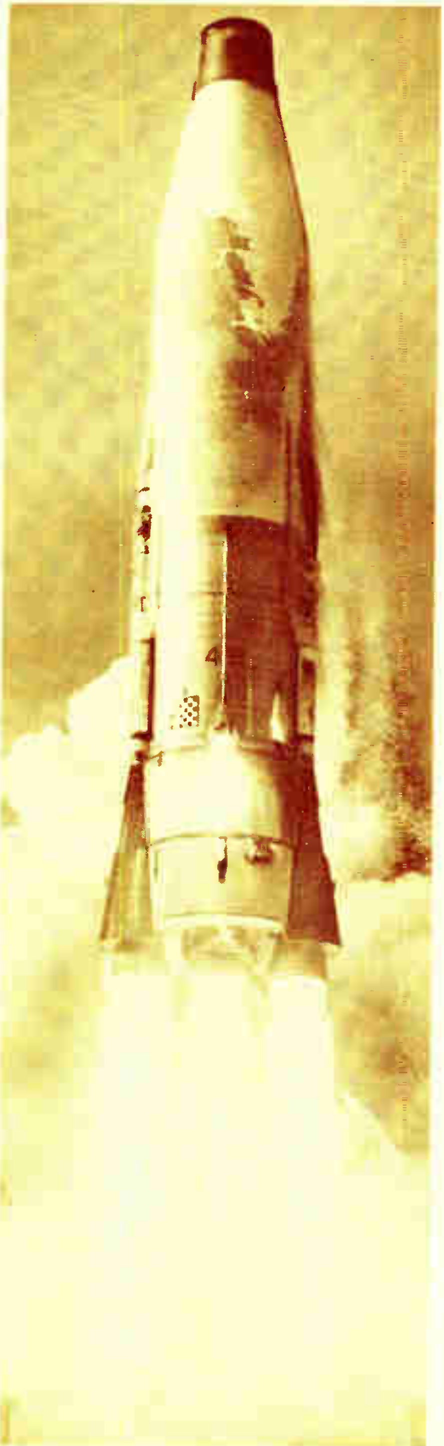


GENERAL ELECTRIC

TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY

Five-Star 6829's Help Guide Atlas ICBMs to Target 6,325 Miles Distant And into Earth-Circling Orbit!



High reliability of General Electric's 6829 twin triode was a factor in the historic full-range test flight of Convair's U.S. Air Force Atlas missile November 28—the nose-cone dropping well within the target area.

Ground radio-command guidance for the range shot used 6829's both in computer sockets, and for general-purpose triode functions such as cathode-follower, coincidence, pulse-generator or amplifier, and gating.

In the Atlas satellite shot, Type 6829 was used for many ground-base sockets because of its dependability. DC and pulse life tests of hundreds of 6829's show 1,350,000 tube hours with no defectives.

With high perveance, mu, and transconductance, plus uniform, controlled cut-off, the 6829 is a military tube having wide usefulness. Ask any General Electric tube office on the next page for circuit applications!

Six 7077 Ceramic Triodes Used in RF Stage of Collins ARC-52 Military Communications System

Low noise, high gain, exceptionally small size—these qualities of General Electric's 7077 were responsible for Collins Radio Company's choice of the tube for RF amplifier and mixer sockets in their new military airborne communications equipment.

Now in production, Collins' advanced system meets the needs of the newest, fastest planes because of its communications range, compact size, and ability to stand up in hard service. The tough metal-ceramic construction of Type 7077 contributes to the ARC-52's ruggedness.

This actual-size picture of the G-E 7077 shows the triode's small dimensions—only .44" long by .48" wide. Extreme compactness was one reason Collins specified Type 7077.

New 5-Star 6688 Amplifier Pentode Features High G_m-to-Cap. Ratio!

Developed for use in broad-band IF amplifiers, General Electric's new high-reliability 6688 has a transconductance of 180 micromhos per microfarad of tube capacitance (G_m over $2\pi\sqrt{C_{in} \times C_{out}}$), or approximately twice that of Type 5654/6AK5. Double the gain bandwidth product of the 5654 may therefore be anticipated from the new tube.

Also the frame-grid design of the new 6688 makes possible a very high G_m-to-cathode-current ratio. This helps produce an exceptionally low-noise grid-cathode structure. See next page for information on the performance of General Electric's 6688 when the tube is triode-connected!

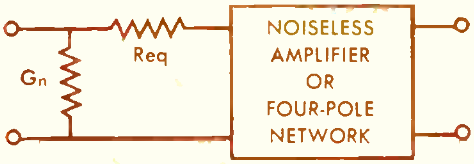
Tear off and keep this sheet for reference. It contains useful tube-application data.

New Parameters Help Pinpoint Tube RF Noise Characteristics!

Designer's Choice of Correct Type Made Easier by Curves That Show R_{eq} and G_n as Functions of Tube Operating Frequency!

The curves at right enable the circuit designer to analyze, in advance, the noise characteristics of a triode at different frequencies of operation. Type 6688, triode-connected, has been chosen for this example.

The equivalent parameters employed—R_{eq} and G_n—are based on recent work* on the specification of tubes at high frequencies. The fundamental circuit is:



(R_{eq} is the equivalent series shot-noise resistance. G_n is the equivalent shunt noise conductance.)

The value R_{eq} already is familiar as the term for shot-noise resistance, and describes the relative amount of shot-noise voltage present in the tube. G_n is a comparatively new term. G_n may be assumed to be equal to five times transit-time conductance, a familiar value.

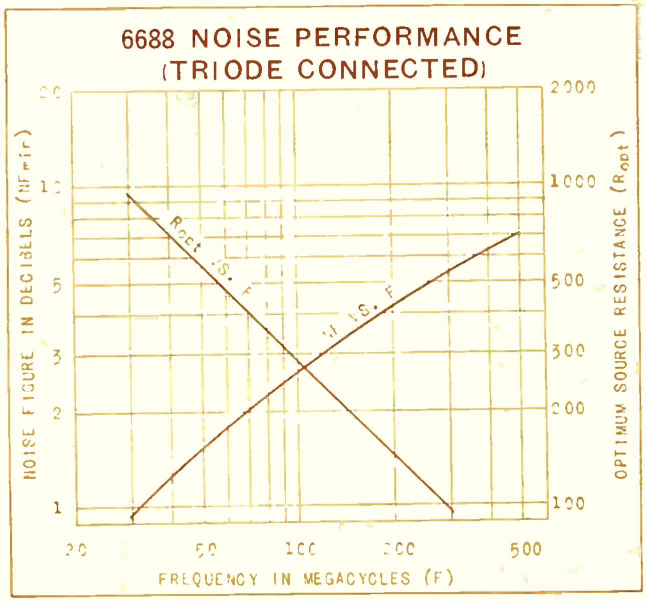
R_{eq} is essentially constant over a tube's useful frequency range, while G_n varies directly with frequency squared. In the light of these facts, simple equations can be written for minimum noise figure and optimum source resistance:

$$NF_{min} = 1 + 2\frac{f_x}{f_o}\sqrt{R_{eq}G_n} \qquad R_{opt} = \frac{f_o}{f_x}\sqrt{\frac{R_{eq}}{G_n}}$$

—where fx is frequency at which noise figure and optimum source resistance are desired, and fo is frequency at which the value of G_n has been measured.

At lower right are values of R_{eq} and G_n, as measured on commercially available samples, for most of the popular high-frequency tube types. From these values, the noise characteristics of any type listed can easily be determined and charted. Ask any General Electric receiving-tube office listed below for additional facts!

* Rothe, H., and Dahlke, W., "Theory of Noisy Fourpoles", PROCEEDINGS OF THE I.R.E., Vol. 44 (June, 1956) pp 811-818.



MEASURED VALUES OF R_{eq} AND G_n

Tube type	R_{eq} (ohms)	G_n at 90 mc (micromhos)
Military and Industrial:		
6201	600	320
6688	120	1160
7077	350	140
Entertainment:		
6AM4	260	600
6AN4	250	550
6BC4	260	540
6BC8	600	320
6BK7-A	240	520
6BN4	420	390
6BQ7-A	435	290
6BZ7	490	350
6CE5	650	1200
2CY5	525	640
PC86	170	710

NOTE: pentodes are connected as triodes.

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

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

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

WESTERN REGION
11840 West Olympic Boulevard
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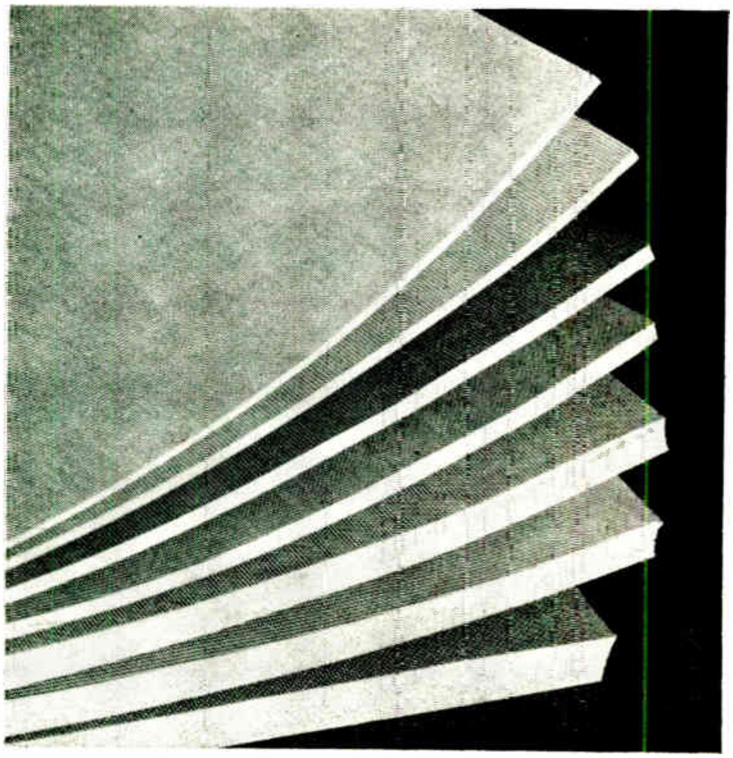

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remains flexible at extreme temperatures
−100° F to 500° F

COHRlastic R-10470 silicone sponge rubber has a dense, uniform, non-absorbing closed cell structure, highly suitable for soft gasketing, vibration dampening, fairing strips, seals, pads, bumpers, dynamic cushions and other applications where resiliency at extreme temperatures is required. It has superior compression set resistance, excellent dielectric properties, immunity to aging, ozone and weather hardening and good chemical resistance — non-sticking, odorless, non-corrosive.

COHRlastic R-10470 can be bonded to metals, plastics, fabrics or silicone rubber. Sheets 24″ x 24″ and in thicknesses 1/16″ through 1/2″ are available from stock. Larger sizes up to 30″ x 30″ and special molded and extruded shapes are made to order. CHR silicone sponge rubber is sold nationally through distributors.

FREE SAMPLES and folder — write, phone or use inquiry service.

CHR

COHRlastic R-10470
Silicone Sponge Rubber

SPECIFICATIONS:
COHRlastic R-10470 meets many specifications. Some are listed below:

- AMS 3195
- AMS 3196
- MIL-R-6130A type 2
- Boeing BMS 1-23
- Martin MC1 4546
- Martin MB 6130
- Bendix ES 0709
- Douglas DMS 1597
- Lockheed LAC 1-924

PROPERTIES	Range of typical properties COHRlastic R-10470	Typical accepted standards
Tensile	50-130 psi	40 psi, min.
Elongation	175-225%	125% min.
Water absorption (Immersion 24 hrs. @ 75°F.)	3-6%	10% max.
Density, lbs./cu. in.	.020-.030 (firm)	.030 max.
	.013-.018 (medium)	.020 max.
Low temperature brittleness (5 hrs. @ −100°F., bend flat)	No cracking	No cracking
Compression deflection (compressed to 75% of original thickness)		
Room temperature		
Type firm	12-18 psi range[1]	12 min.-20 max. psi
Type medium	8-14 psi range[1]	6 min.-14 max. psi
−65°F. pct. difference	−10% to +15%[1]	
212°F. pct. difference	+5% to +10%[1]	
Compression set (compressed to 50% of original thickness)		
22 hrs. @ 70°F	0-5% (firm)[1]	10% max.
	5-30% (medium)[1]	40% max.
22 hrs. @ −65°F	0-5% (firm)[1]	10% max.
	5-30% (medium)[1]	40% max.
22 hrs. @ 212°F	10-25% (firm)[1]	30% max.
	20-50% (medium)[1]	60% max.

1 ASTM D 1056-56T

CHR products include:

COHRlastic Aircraft Products — *Airframe and engine seals, firewall seals, coated fabrics and ducts*

COHRlastic Silicone Rubber Products — *Silicone rubber moldings and extrusions, silicone rubber sheets, silicone sponge rubber*

Temp-R-Tapes — *Pressure sensitive, thermal curing Teflon and silicone tapes*

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CIRCLE 45 READERS SERVICE CARD

Recorder Finds Heart Faults

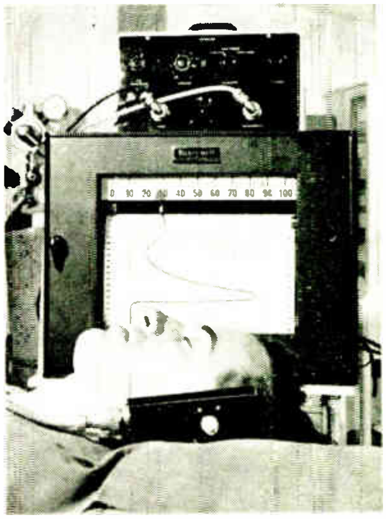
SMALL OPERATING theater at the National Heart Hospital, London, is equipped to examine a patient rapidly for a variety of heart defects. Key to the diagnosis is an industrial strip-chart recorder.

Success of the tests depends on tracing a fast-changing variable over a period of a few seconds. Emphasis in the measuring system is on accuracy and speed of response without overshoot. The high-speed recorder, which operates on the continuous-balance potentiometer principle, is designed to register full-scale travel (one millivolt) in one second. A special amplifier provides sufficiently fast response, and overshoot is reduced by an adjustable damping circuit.

The system records continuously concentration of injected dye as it circulates through the bloodstream. As well as providing a measure of cardiac output in litres per minute, the curves on the recorder, supplied by Honeywell Controls Ltd., give specialists vital information at a glance.

Dye is injected in the patient's arm and carried around the bloodstream until it becomes so diluted that the dye concentration reaches a uniform low level. During dilution, which lasts about 12 sec, dye concentration is continuously monitored. This is done by passing a beam of filtered light through the lobe of the patient's ear to a photoelectric cell. Variations in dye present in arterial blood cause changes in cell output. This voltage is fed to the recorder.

When a quantitative analysis is required, the same principle is used, but the earpiece is replaced by a cuvette, which draws arterial blood from the upper arm through a transparent tube. Blood through the tube is monitored as before, and the cell voltage recorded.



Circulatory defects in the heart are quickly diagnosed by monitoring and recording dye concentration injected in the patient's bloodstream

Normal Reaction

About seven seconds after the injection, a wave front of high dye concentration passes the measuring point, causing a sudden large rise in the recorder reading. The peak dies away rapidly and is followed by a second smaller peak when the wave front, now much diluted, passes through the ear a second time. The dye concentration then decreases slowly to a low constant value. This sequence of events provides a characteristic and instantly recognizable normal curve.

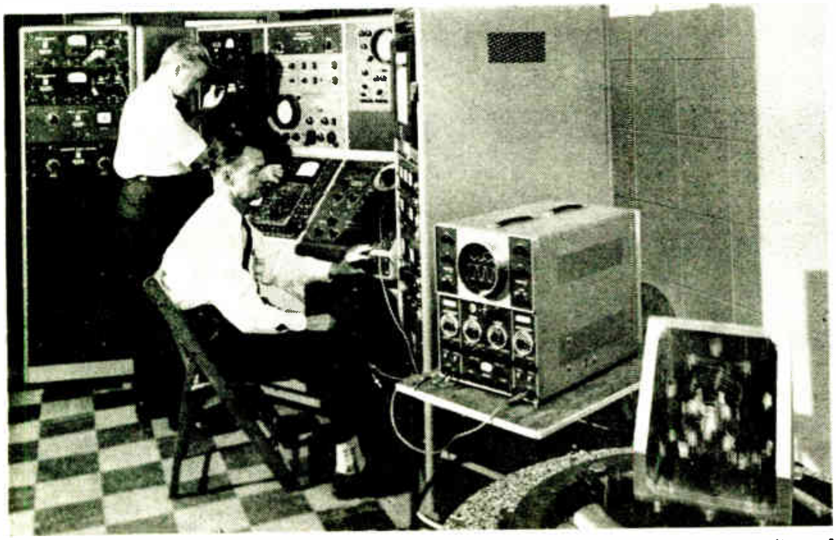
Abnormal Reaction

If the patient has a shunt (abnormal flow of blood through a hole in the septum separating the left and right auricles), some blood continually circulates to the lungs and back to the heart without reaching the main circulation. When the dye is injected, only part of it is pumped out into the aorta.

Consequently, the record shows a slightly lower initial peak. Then, as blood passing through the heart continues to pick up dye from the blood circulating to the lungs, the dye concentration at the measuring point fails to die away properly. The disappearance curve is markedly longer and shallower in slope than that for a normal patient.

A variety of other abnormalities show equally characteristic curves.

Shaker Tests Space Parts



U. S. Army Signal Research and Development Laboratory engineers study feasibility of random vibration test system for evaluating components for future space vehicles. Du Mont dual-beam oscilloscope provides visual indication to pinpoint instant random noise frequencies begin to affect component's structure. Shaker at right is operated from tape-recorded random noise

Transistor Amplifier Design Method

By VICTOR R. LATORRE Applied Research Lab, University of Arizona, Tucson, Arizona

SIMPLIFIED procedure for designing bandpass transistor amplifiers operating up to 50 mc uses an ef-

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Here is a super-refined, highly versatile ceramic grain that gives electronic component designers real creative latitude. With its superior electrical and mechanical properties to work with, even the most advanced design concepts can be translated into practical products efficiently and economically.

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For example, ALUNDUM grain combined with epoxy resins or silicone compounds makes possible superior potting, encapsulating, and sealing agents. Again, used as a basic ingredient in ceramic type mixes or in insulating powders, it readily lends itself to casting, molding or extruding of sleeves, shells, tubes, collars, etc. And in every case, it makes design easier . . . processing more profitable.

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fective equivalent circuit. Design is exactly that used for vacuum-tube amplifiers.

Common-emitter hybrid-parameter equivalent circuit of a junction transistor is shown in Fig. 1.

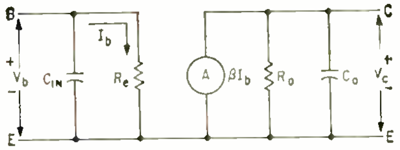


FIG. 1—Equivalent circuit of junction transistor

The hybrid parameters are: $r_b + a_{11}$ is input resistance with collector shorted to emitter; a_{22} is output admittance with base open; a_{12} is voltage feedback factor with base open; β is ratio of collector to base current with collector shorted to emitter; r_b is base-spreading resistance; C_{in} is input capacitance; and C_o is output capacitance.

C_{in} is equal to $C_{be} + C_{bc} + (1 + A_v)$.

For an amplifier with single-tuned output, an inductance is placed in parallel with the collector and emitter terminals. Since a_{12} may be neglected for small signals, expressions for gain and center frequency are obvious.

Multiple Stages

For more than one stage, accounting for the input circuit of the following stage greatly complicates the above expressions. The pole-zero diagram of a one-stage amplifier (Fig. 2) shows that design procedure would be greatly simplified if the real pole could be neglected. An effective equivalent circuit makes this possible.

All circuit impedances are as-

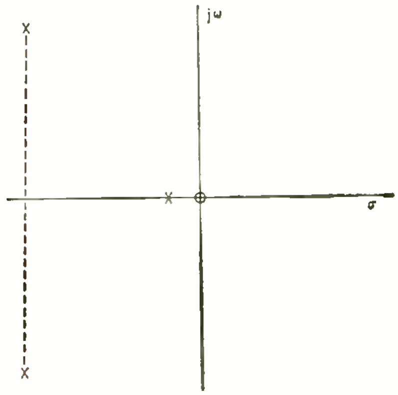


FIG. 2—Pole-zero diagram of one-stage amplifier using 2N384 transistor

sumed to be in parallel. Since the real pole is no longer present, the circuit is analogous to that for vacuum tubes. Base-spreading resistance r_s is not being neglected in the equivalent circuit in Fig. 3.

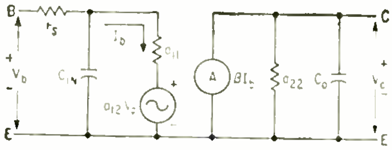


FIG. 3—Effective equivalent circuit of grounded-emitter amplifier

Parameters of the effective equivalent circuit were determined in the following manner. The output circuit was broadbanded (R_L very small), and a coil whose inductance and resistance are accurately known shunt the transistor input circuit.

By varying signal frequency, maximum voltage across the input terminals is found. The maximum occurs at input circuit resonance. Bandwidth of the input circuit is found by varying frequency on either side of resonance.

Input capacitance is then given by $C_{in} = 1/(\omega_n^2 L)$. Input resistance is calculated from $R = 1/(2\pi BC_t)$, where $C_t = C_{in}$ and $R = (R_{11} R_{ar})/(R_{11} + R_{ar})$. R_{ar} is the parallel resistance of the coil at ω_n.

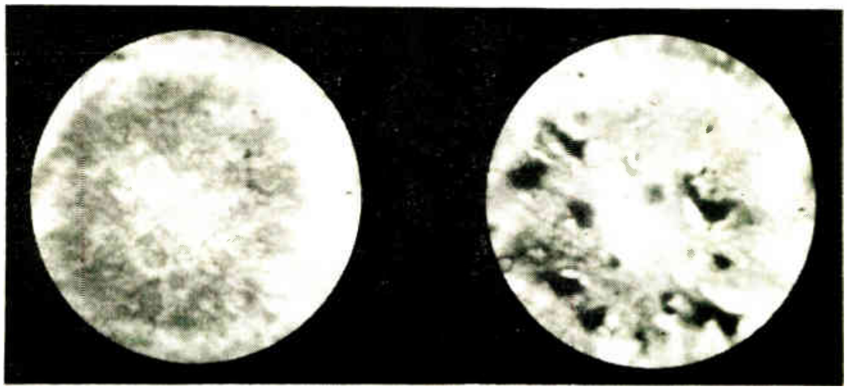
This method was used and actual characteristics of the amplifiers were within 5 percent of theoretical values.

Analog Tester Speeds Missile, Aircraft Checks

Electronic device called ASCAT (Analog Self-Checking Automatic Tester) made by Bell Aircraft tests electrical, hydraulic and pneumatic systems of missiles and aircraft. Single technician can in two minutes make same checkouts formerly requiring an hour by 10 men. Tester supplies unit being checked with predetermined sequence of d-c signals. Returned signals are compared with preset standards

Ultraviolet Image-Converter Tube

INVISIBLE ultraviolet images of specimens are converted into visible pictures by a new tube called the Ultrascope. Developed by RCA, the new tube is intended to replace the regular eyepiece of a microscope adapted for ultraviolet viewing. A commercial model of an ultraviolet photo-microscope incorporating the new tube will be available shortly from Bausch and Lomb Optical Company.



Left photomicrograph shows unstained section of human brain as seen in visible white light. At right, the same specimen is shown as viewed in ultraviolet light with aid of new tube. Irregular black spots are nerve cells

Accessory Viewer

The ultraviolet accessory viewer, Fig. 1, consists of two units—the Ultrascope and eyepiece and a compact power supply. Invisible rays from an ultraviolet lamp pass through the specimen under observation and through an ultraviolet objective lens. On the faceplate of the image-converter tube an invisible ultraviolet image of the specimen is formed. The faceplate transmits ultraviolet rays. On the inner surface of the faceplate a photosensitive material converts the ultraviolet image into a corresponding pattern of electrons. The pattern is focused on the fluorescent viewing screen at the opposite end of the tube. The image of the specimen is observed on the viewing screen through a lens of the desired magnification.

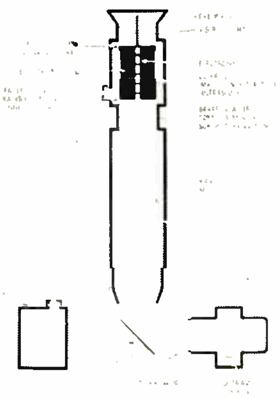


FIG. 1—Functional drawing of ultraviolet accessory viewer

Applications

Microscope applications are expected to be found in the fields of pathology and cytology. As a clinical instrument, it will be useful for tissue cell screening, bone marrow observation and determination of hemoglobin in liver.

It may be possible in future extensions of the principle involved to develop special glasses that would enable the viewer to see in high ultraviolet light areas.

Stereo Pickup Uses Push-Pull Coils

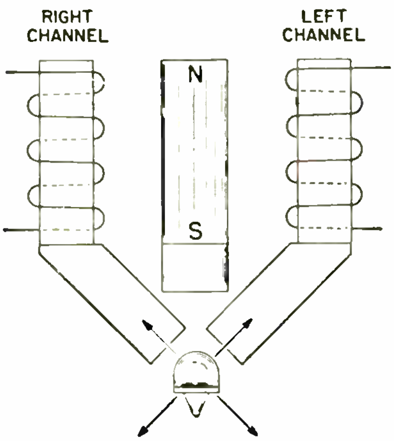


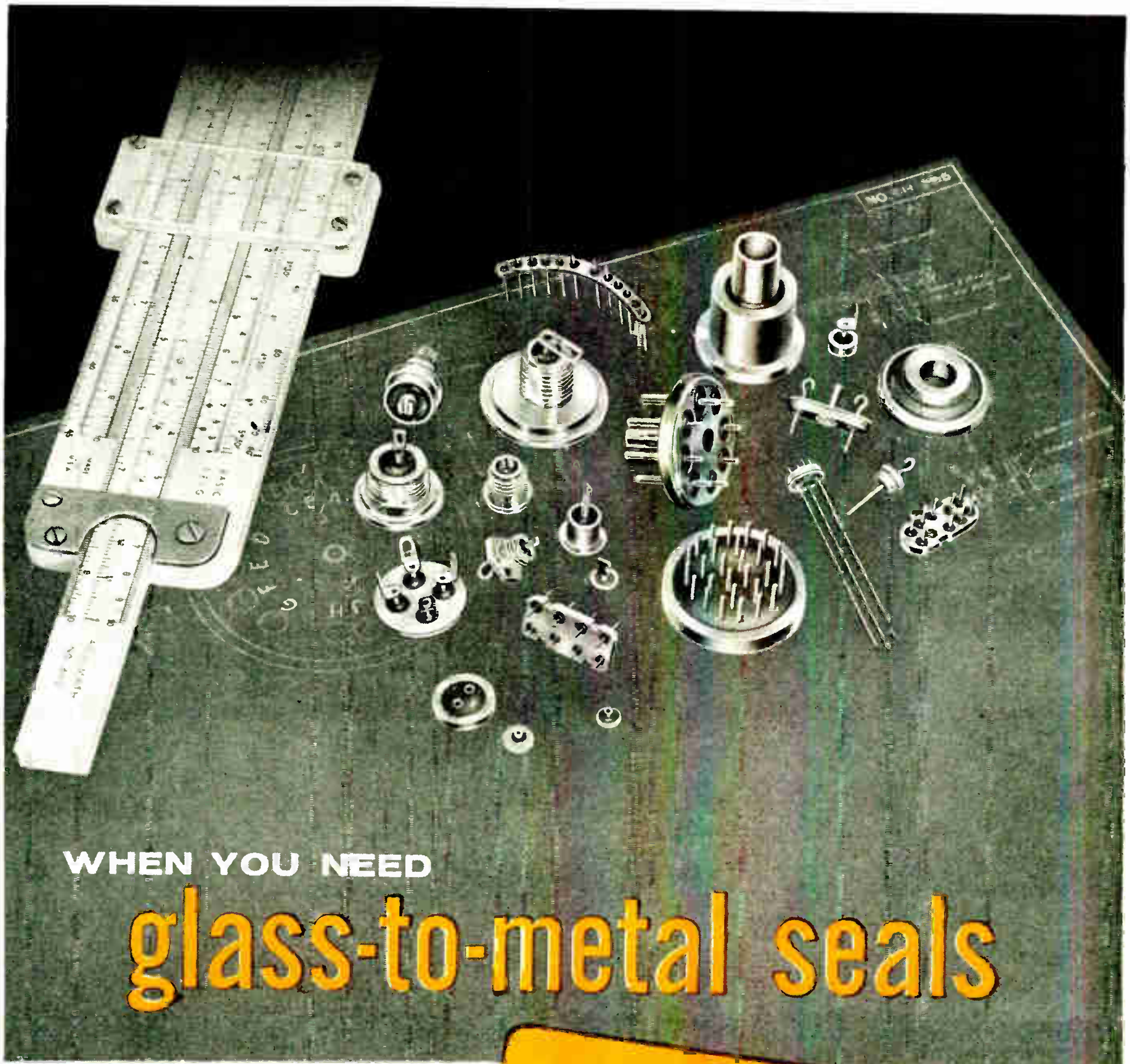
FIG. 1—Basic configuration of stereo pickup design. Magnet is located behind plane of the drawing

IN PAST ISSUES (p 78, Feb. 13, 1959 and p 102, Sept. 26, 1958), several stereo pickups have been described, each different in design from the other. Still another design is used in the Pickering unit described in a recent paper[1].

Basic functional configuration of the design is shown in Fig. 1. This is a front view of the pickup along a line parallel to the record surface and shows the front end of the armature with the stylus attached. The armature is free to move in any direction in the plane of the drawing. The magnet is behind the drawing plane and located centrally between the two separate branches of the magnetic circuit. Extensions of the magnetic polepieces come down at 45 deg to the record surface as shown. The magnetic circuit is completed by the armature connecting the lower end of the magnet to the two cores inside the coils.

Motion of the stylus along the 45-deg line up to the left modulates the flux in the left-hand leg but not in the right-hand leg. And the reverse situation modulates the flux in the right but not the left leg. The two coils are separate electrically and provide the two electrical signals.

In actuality, a push-pull ar-



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rangement is used with four coils. Two are used for each channel as shown in Fig. 2. The magnet is located in the center between the four coils. The only moving part of the pickup is the armature—a single straight tube placed along the bottom of the structure parallel to the record surface.

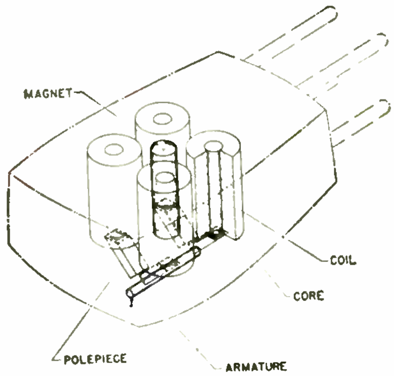


FIG. 2—Actual push-pull design

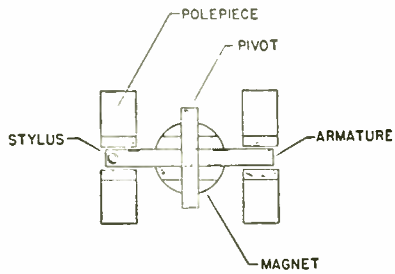


FIG. 3—Simplified bottom view of pickup

Figure 3 is a simplified bottom view of the pickup. The armature is pivoted at its center in a bearing allowing the stylus end-free motion in all directions in the plane perpendicular to the record surface. The front end of the armature is coupled to the magnetic circuit through the two 45-deg pole pieces at the front of the cartridge. The other end of the armature is also coupled to the magnetic circuit through two identical pole pieces at the rear of the cartridge.

As the armature moves, it modulates the magnetic circuit at the rear of the cartridge with an amplitude equal to the modulation at the front but 180 deg out of phase. Coils are phased so that the two signals in each channel are added. The push-pull arrangement gives higher signal level, minimum distortion, and dynamic mass reduction. It provides also hum-bucking against external magnetic fields.

The complete moving system is on an insert which the user can put in the pickup or remove easily. Two different inserts are available. One has a moving system with the maximum compliance usable on the best quality record changers. The other has the additional compliance which can be accommodated by a top quality manual arm.

Reference

1. W. O. Stanton, "The Development of a High Quality Stereophonic Pickup Cartridge", paper presented at the 1958 Annual Meeting of the Audio Engineering Society.

Switch Includes Thermal Tripper

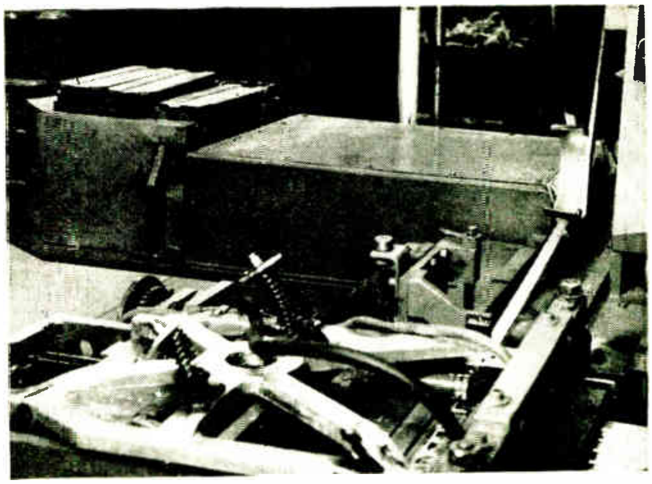
DEVELOPED by Allgemeine Elektrizitats-Gesellschaft of West Germany, a new switch contains a built-in thermal tripping device. The switch consists of a curved pretensioned bimetal strip held by two knife-edge supports which carry the current passing through the switch. The bimetal strip is welded at one end to another strip carrying an interrupting contact.

Switch Operation

When current through the switch becomes excessive, the bimetal strip combination bends upward, because of the heat, and opens the contact. The combination remains in the off position even after the strip has cooled down until the switch is actuated again by a push-button causing the bimetal strip to be depressed into its normal position. But the circuit is connected again only when the main switch is once again actuated to its on position.

According to the manufacturer, the new combination has several advantages compared to the conventional arrangement of separate main switch and thermal release. These include the fact that no damage can be done by clamping the excess-current (thermal) switch in the on position since the main switch is off. Also, no auxiliary push-button is required for switching on again after thermal tripping has taken place.

Ribbons of glass and foil electrodes are interleaved automatically cn compact machine



Pallet loading racks and pallet heating oven are seen in rear, electrode pickup carriage and bar are in foreground

Machine Stacks Glass Capacitors

GLASS RIBBON and metal foil are alternately stacked to form the basic structure of glass capacitors made at Corning Glass Works' electronic components plant, Bradford, Pa. The stacking operation is handled in high volume by machines.

The machine shown prepares 10 to 30 capacitor stacks in a single strip, which is later cut apart. The machine is unattended except for observation and loading of the coordinated feed systems which supply pallets, glass ribbon and foil.

Pallets are loaded in racks. An air-operated arm transfers pallets in train from the bottom of the vertical racks. The pallets pass through an oven to a belt moving from left to right. After each pallet is pushed onto the belt, a stud in the belt, behind the pallet, pushes it into the stacking bed.

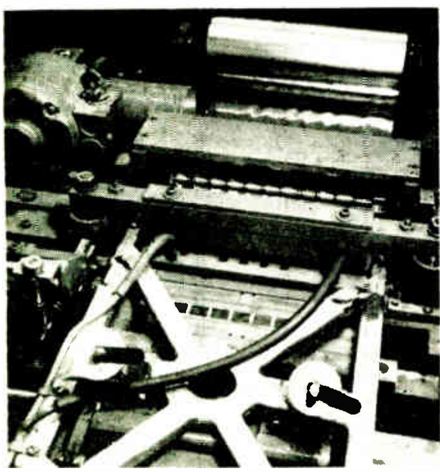
Heating

Heating the pallet facilitates stacking and subsequent handling of the strips. The glass ribbon is coated with a pure organic adhesive which melts at a temperature of 100 F. After stacking, the pallets are cooled, solidifying the adhesive and making the stacks rigid. The adhesive is completely evaporated during subsequent processing.

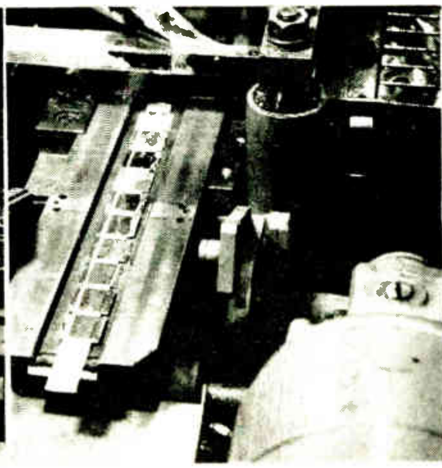
Glass ribbon is fed from a reel to a guide above the left end of the stacking bed. After the pallet is in position, a pickup arm grasps the ribbon end and pulls it the length of the pallet. The ribbon is cut at the guide and released by the arm so that it lays flat in the pallet. The glass is about 1 mil thick and sufficiently limp for machine handling.

Foil is supplied as rolled sheet the width of the strip. It is fed at right angles to the pallet. As the sheet unrolls, a roller die cuts it into tape, 1 tape for each capacitor in the strip. The tapes pass under a guillotine to a pickup platform.

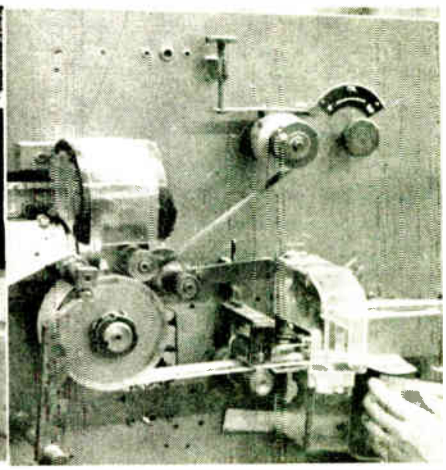
A bar picks up the ends of the tape as the guillotine cuts the tape ends into the rectangular electrodes of the capacitor. The pickup is made by vacuum, through holes in



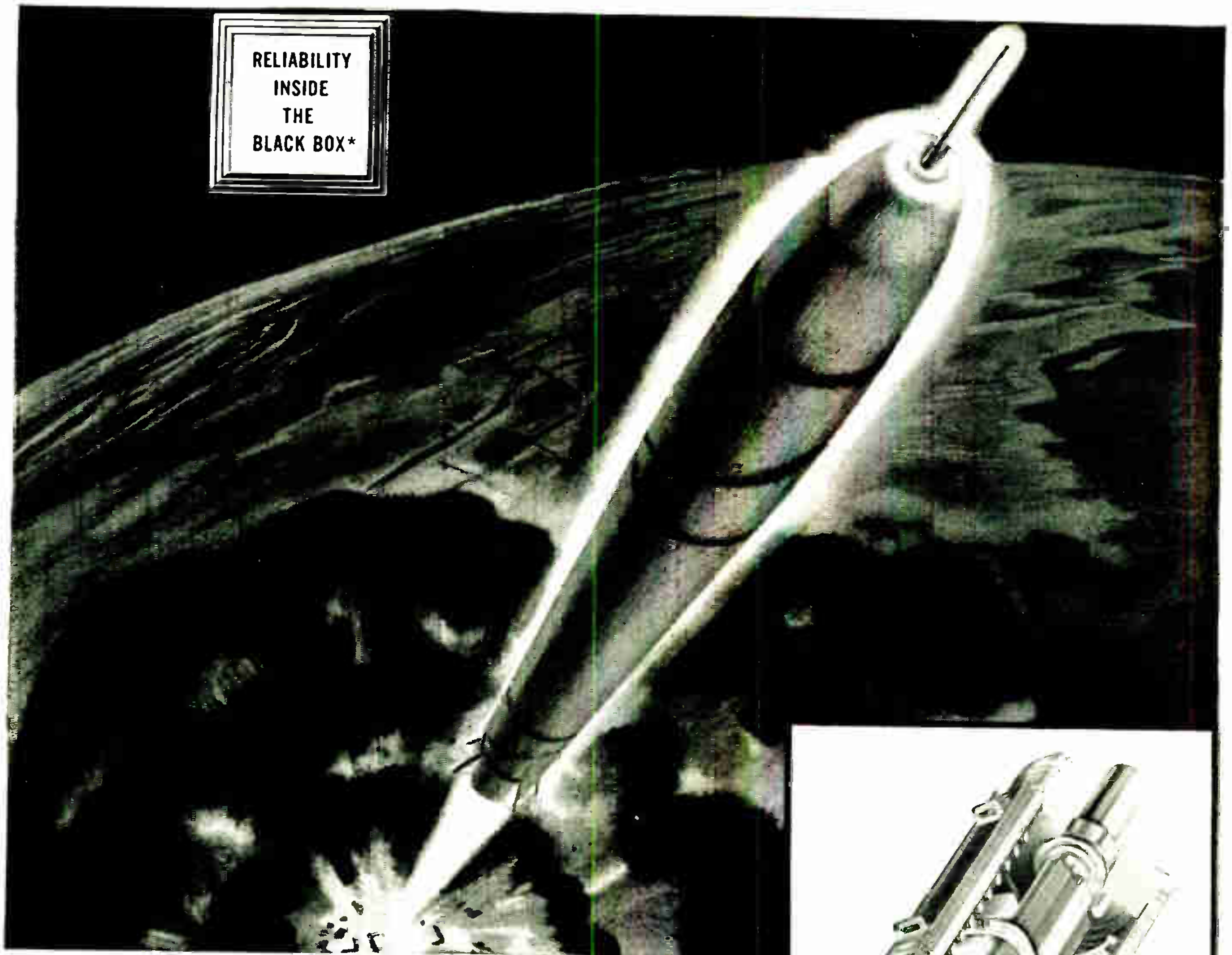
Electrode pickup and foil slitting roller die



Pallet is ejected onto refrigerated table



Small electrodes are prepared in combs



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This "pot" features a **unique mechanical wiper tab drive** perfected by Fairchild which is **separate** from the helical coil of resistance wire. This minimizes winding wear and electrical backlash thereby extending life and accuracy. Fairchild's design also offers tight linearity tolerance, high temperature performance, low noise levels and is available in resistance ranges between 1K ohms and 2 megohms, and in diameters of ⅞", 1" and 1-13/16".

The Fairchild potentiometer line is complete. It is the result of careful research and design, of rigid incoming materials inspection, of sub-assembly and final inspection plus performance testing and environmental testing to destruction of random samples.

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***Fairchild's Built-in SAFETY FACTORS Beyond the Specs for Reliability in Performance.**

THE PROBLEM: A small, multi-turn potentiometer was required for the "black box" in the Thor missile which had to withstand severe environmental conditions, and have characteristics of low noise with no discontinuity under vibration, shock and acceleration.

THE SOLUTION: A special high-reliability design of the Fairchild standard type 920, 10-turn potentiometer, a design demanding the closest tolerances, selected materials, and special assembly techniques. The result — a "pot" which delivered a safety factor beyond the specs that helps to assure reliability.

Environmental Tests	Contractors Specification	Fairchild Performance
Vibrations	2-2000 cps—15G	2-2000 cps—30G
Shock	100G	125G
Acceleration	Constant 17G	Constant 50G

In addition, the units were vibrated at resonant peaks between 2-2000 cps from 25G to 50G for 15 minutes without electrical or mechanical degradation.

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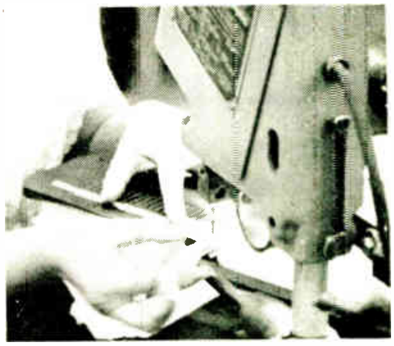
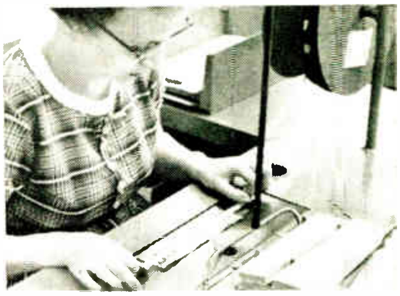
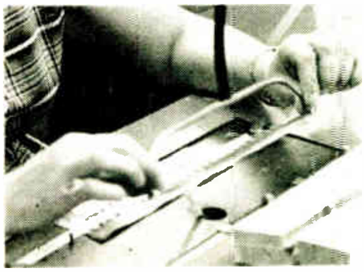
the underside of the hollow bar. The bar lifts, retracts and places the electrodes on the ribbon of glass. The vacuum is momentarily relieved as the electrodes drop in place.



Leads are spotwelded to capacitor strip



Stacking capacitor strip by hand



Assembler uses hand vacuum pickup to hold electrodes

Successive layers of glass and electrodes are built up. The carriage of the electrode pickup bar is cycled so that electrodes of one polarity project beyond 1 edge of the glass and electrodes of the opposite polarity project beyond the other edge.

The pallet is ejected on a refrigerated table, where the adhesive is cooled, and the machine repeats the stacking sequence.

Strips of capacitors are also stacked by hand. The foil is precut from tapes by machine and positioned on strips of paper. Electrodes for small capacitors are cut from foil tapes, but left joined at one edge so that the strip of elec-

Strip is placed in sawing fixture

Flip-top hand stamp paints code dots on capacitors

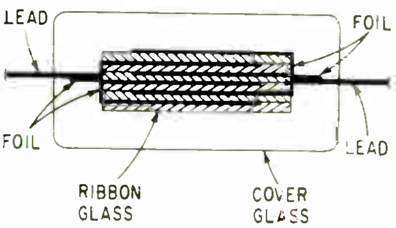


FIG. 1—Cross section of unfused capacitor in exaggerated vertical scale

trodes look like a comb. The excess is cut off after stacking.

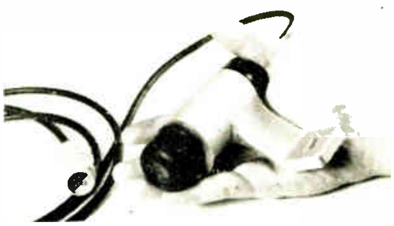
After strips are formed, leads are spotwelded to electrodes. Molded strips of cover glass are fitted around the strips as shown in Fig. 1. The cover provides support and, when fused, seals the capacitor against moisture and contamination. The covered strips are placed in a fixture and the glass is fused in a horizontal conveyor oven. A roller in the oven applies pressure to the fixture.

Diamond gang saws cut the strips into individual capacitors. Strips are held in fixtures with saw slots during sawing to ensure dimensional accuracy. After testing, the capacitors are color-coded with epoxy-base paint, applied with a hand stamp. The paint is cured and the leads are pretinned.

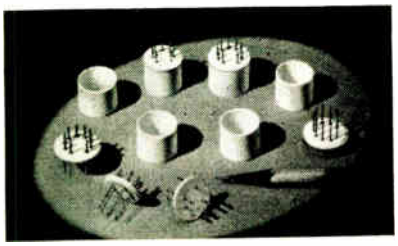
ON THE MARKET

Optical Transducer
rugged, reliable

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., 10201 Westheimer, Houston, Texas, has introduced the TL-2 optical transducer for use in conjunction with electronic tachometers such as the ET-series units. The TL-2 is a rugged, completely reliable transducer which



can measure rotational speeds over 1,000,000 rpm. It contains a phototransistor, a light source and a lens system. It detects, by optical reflection, graduated lines placed on the moving surface of which the rotational or linear speed is to be measured. Mylar film with lines printed on it and with a pressure-sensitive adhesive backing is supplied for application to shafts, couplings or surfaces, eliminating shaft loading. **Circle 200 on Reader Service Card.**

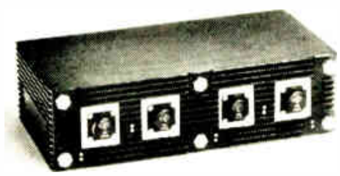


Sealed Headers
7- and 9-pin

AMERICAN LAVA CORP., Manufacturers Road, Chattanooga 5, Tenn. Tantalum pins with nickel braze alloy, combined in a strong hermetic seal with an AlSiMag alumina ceramic base and envelope for vacuum tube use, are announced. These headers allow higher bake-out temperatures during subsequent assembly to the envelope. The materials have been selected for their low vapor pressure characteristics. **Circle 201 on Reader Service Card.**

Power Supply
large output

MASTER SPECIALTIES CO., 956 E. 108th St., Los Angeles 59, Calif. The P N 380-100 power supply was designed to supply three separate, closely regulated output voltages,



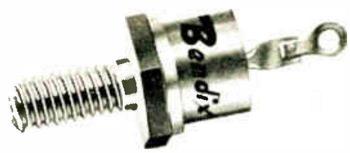
(+ 150 v at 630 ma, – 150 v at 100 ma, and –300 v at 40 ma), for airborne use. Output is very large for the size and weight of the unit. Unit will operate at +85 C at full output rating, and is completely transistorized. **Circle 202 on Reader Service Card.**

Frequency Calibrator
harmonics to 25 kmc

MICRO-NOW INSTRUMENT CO., 6340 N. Tripp Ave., Chicago 46, Ill. Harmonics up to 25 kmc can be generated with a new microwave frequency calibrator model 101. The 450-mc crystal controlled signal is designed to feed directly into a waveguide or coaxial crystal holder. A 5-mc fundamental crystal provides a convenient means of calibrating the instrument against WWV. Lower intensity markers at 150 and 50 mc are present for wavemeter or receiver calibration. **Circle 203 on Reader Service Card.**

Silicon Rectifiers
diffused junction

BENDIX AVIATION CORP., Red Bank Division, Long Branch, N. J., has available a series of new diffused junction silicon rectifiers. They



have piv ratings ranging from 50 to 600 v and can deliver 5 amperes of rectified current. Operating temperature extends from –65 C to +175 C. The rectifier package is in conformance with the latest JETEC proposed standards. Units are

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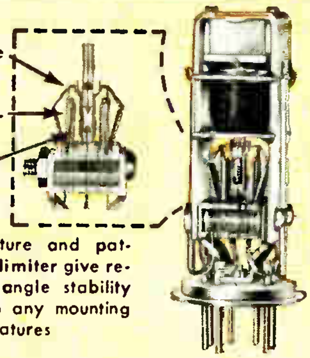
Guide to Oak Choppers



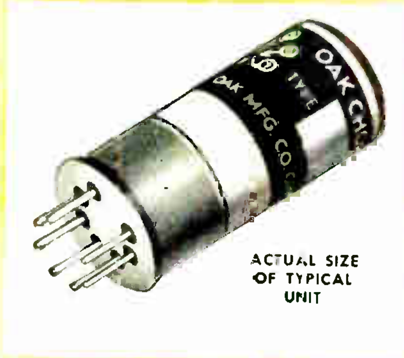
Lightweight side contacts

Leaf spring damping members

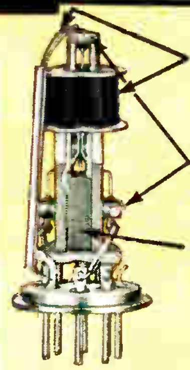
Side contact snubbers

Lightweight armature and patented amplitude limiter give remarkable phase angle stability and adjustment in any mounting and at low temperatures

MINIATURE SERIES 600—MOST STABLE IN ITS CLASS



ACTUAL SIZE OF TYPICAL UNIT



No organic materials other than Teflon are used in switch unit

All contact insulation and supports are metal-to-glass construction

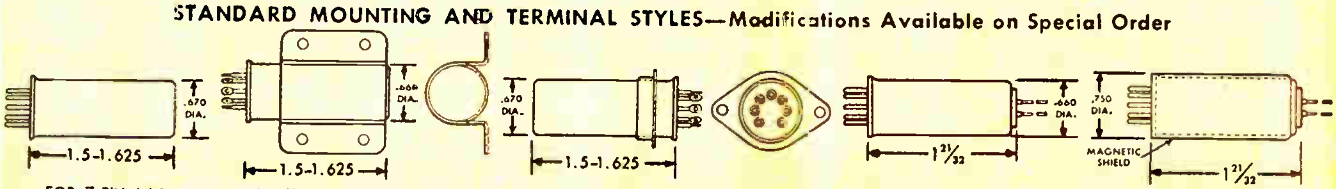
Oriented ceramic magnet (patented design) eliminates parts, gives remarkable simplicity and ruggedness

MINIATURE SERIES M—SMALLEST, MOST RUGGED IN ITS CLASS

METICULOUS ENGINEERING combined with exhaustive testing provides a line of SPDT choppers which exhibit unusual stability and low noise. While the specifications shown here are necessarily abbreviated, they will help you make a preliminary appraisal. For complete details on any unit, send us the type number and a description of your application with its circuitry.

SERIES 600—MIL C4856, Class B, Type 1. Capacity between switch terminals and ground, 15 uuf average. Contact symmetry, within 10°. Weight, less than 1 oz.
SERIES M—MIL C4856, Class B, Type 1, Grade 2. Capacity between switch terminals and ground, 3-5 uuf. Contact symmetry: 0-500 cps, within 10°; at 1000 cps, within 20°. Weight, less than ¾ oz.

STANDARD MOUNTING AND TERMINAL STYLES—Modifications Available on Special Order



FOR 7-PIN MIN. ELECTRON TUBE SOCKET — WITH BRACKET FOR PARALLEL-TO-SURFACE MOUNTING — WITH COLLAR FOR PERPENDICULAR-TO-SURFACE MOUNTING — FOR 7-PIN MIN. ELECTRON TUBE SOCKET — FOR 7-PIN MIN. ELECTRON TUBE SOCKET

	SERIES 600						SERIES M For Shock and Vibration Conditions
	Types 607, NC-600, 602, 603	Type 610	Type 604	Type 612	Type 605	Types 608, 609, NC-600A	Types M5-1, M5-2, M5-3
Nominal Drive Freq. and Voltage	400 ±20 cps at 6.3 v	400 ±20 cps at 6.3 v	380-500 cps at 6.3 v	400 ±20 cps at 6.3 v	400 ±20 cps at 6.3 v	60 ±5 cps at 6.3 v Aperiodic from 10-100 cps	4-8 Volts, 10-1000 cps. Aperiodic. Coil Current 60 ma at 400 cps Coil Res. 85 Ohms
Phase Lag at Nominal Drive Freq. and Voltage	65° ±5° at 400 cps (25° C)	65° ±5° at 400 cps (25° C)	75° ±10° at 400 cps (25° C)	90° ±10° at 400 cps (25° C)	180° +10° −0° at 400 cps (25° C)	20° ±5° at 60 cps (25° C)	10 cps: 10° ±5° 60 cps: 15° ±5° 400 cps: 55° } +10° 1000 cps: 110° } −0° (25° C)
Contact Dwell Time at Nominal Drive Freq. and Voltage	150° min (25° C)	140° max (25° C)	150° min (25° C)	150° min (25° C)	160° ±10° (25° C)	165° to 170° at 60 cps	160° to 170° (25 °C)
Contact Rating Into Resistive Load (Maximum)	CONTINUOUS: 10 v at 2 ma INTERMITTENT: 15 v at 2 ma	CONTINUOUS: 50 v at 2 ma INTERMITTENT: 100 v at 2 ma	CONTINUOUS: 10 v at 2 ma INTERMITTENT: 15 v at 2 ma	CONTINUOUS: 10 v at 2 ma INTERMITTENT: 15 v at 2 ma	CONTINUOUS: 50 v at 2 ma INTERMITTENT: 100 v at 2 ma	CONTINUOUS: 15 v at 2 ma INTERMITTENT: 50 v at 2 ma	CONTINUOUS: 10 v at 1 ma INTERMITTENT: 12 v at 2 ma
Life Expectancy (Optimum Conditions)	Up to 5000 hours	Up to 1000 hours	Up to 5000 hours	Up to 5000 hours	Up to 5000 hours	Up to 10,000 hours	Up to 10,000 hours
Switching Speed With DC in Coil	Less than 1 Millisecond	Less than 1 Millisecond	Less than 1 Millisecond	Less than 1 Millisecond	Less than 1 Millisecond	Less than 800 Microseconds	Less than 200 Microseconds

OAK MFG. CO.

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Phone: MOhawk 4-2222

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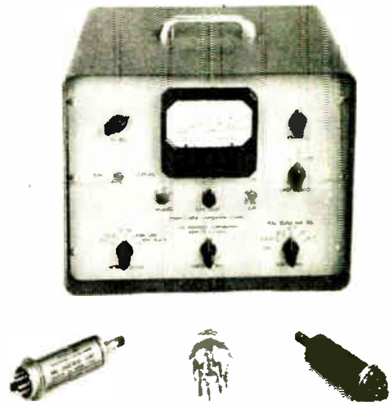
ROTARY SOLENOIDS TUNERS
PACKAGED CIRCUITRY

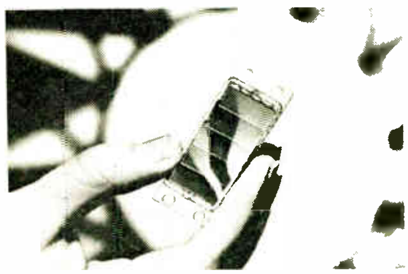
CIRCLE 55 READERS SERVICE CARD

designated 1N1612 through 1N1616. **Circle 204 on Reader Service Card.**



Gage Control
high vacuum type

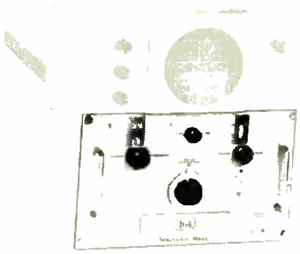
NRC EQUIPMENT CORP., 160 Charlemont St., Newton 61, Mass. A new high vacuum thermocouple ionization gage control, which covers the range from 1 to $1 \times 10^{-}$[illegible] mm. Hg., the model 710-B offers the reliability and precision which make it suitable for most laboratory and production floor high vacuum installations. A quick-acting protective relay, which operates when the pressure increases to $1\frac{1}{2}$-2 times the scale to which the control is set, guards the ionization gage against burn-out due to pressure surges. **Circle 205 on Reader Service Card.**



Silicon Solar Module
rugged, shockproof

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., announces high efficiency silicon solar converter modules that will supply 100 w of power per 14 sq ft of cell area. The building block modules are assemblies of series and parallel con-

nected silicon solar cells with specially processed, ruggedized contact strips that assure optimum conversion efficiency. Each module contains five series-connected 1 cm by 2 cm solar cells embedded in an epoxy mold. **Circle 206 on Reader Service Card.**



R-F Head direct-reading

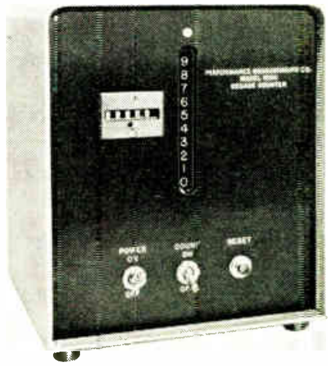
ITEK CORP., 1609 Trapelo Road, Waltham 54, Mass. Model 30X5 r-f head is designed for use with the model SA30 microwave spectrum analyzer to cover the 8,500 to 9,700 mc range of the X band. With direct reading frequency dial, this unit is accurate to 0.05 percent or better. It features automatically tracked reflector voltage for constant display centering and a precision 80 db r-f input attenuator. **Circle 207 on Reader Service Card.**

Digital Voltmeter automatic reading

HEWLETT-PACKARD CO., 275 Page Mill Road, Palo Alto, Calif. Model 405AR d-c digital voltmeter reads positive and negative voltages from 100 mv to 999 v with an automatic selection of range and polarity. Voltages are displayed in three significant figures and the decimal point is automatically placed. Unit has an accuracy of

CIRCLE 59 READERS SERVICE CARD

±0.2 percent of the reading ±1 count. Special features include a floating input, electronic analog-to-digital conversion, digital recorder output and a "hold" control which permits manual positioning of the decimal. Price is $825. **Circle 208 on Reader Service Card.**

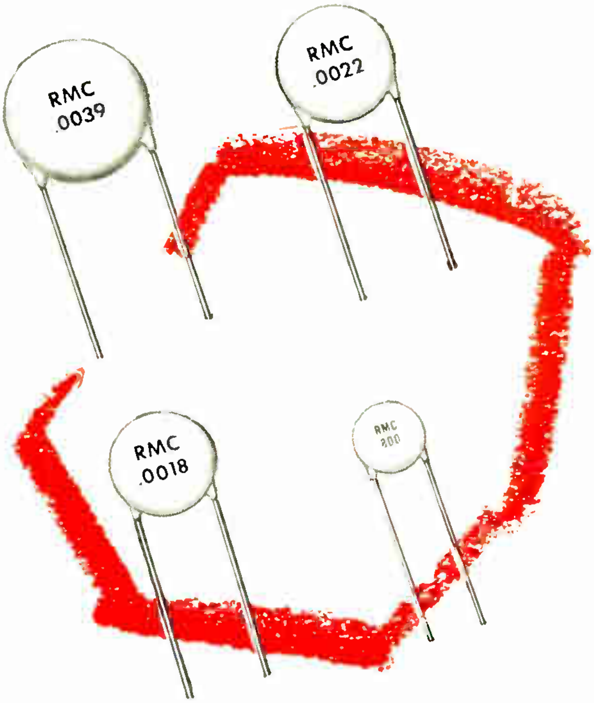


Portable Counter reads to 12,000 cpm

PERFORMANCE MEASUREMENTS CO., 15301 W. McNichols, Detroit 35, Mich. Model 1000-B portable electronic counter is capable of counting speeds to 12,000 counts per minute. It combines a plug-in electronic decade with a five-digit mechanical register. Unit meets a variety of laboratory, production and process counting needs. It fills the gap between slower electromechanical counters and elaborate, high-speed multi-decade units. Counting pulses may be from photoelectric cells, magnetic pickups or contact closures. Input signals can be sinusoidal, rectangular or slow-rising. **Circle 209 on Reader Service Card.**

Power Oscillator ultra-precise

ELECTRONICS INTERNATIONAL CO., 145 W. Magnolia Blvd., Burbank, Calif., has produced an ultra-precise power oscillator for airborne



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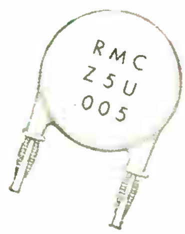
EXTENDED TEMPERATURE RANGE...

CLOSE TOLERANCE

NEW



FIN-LOCK LEADS...

for printed wire circuits

Fin-Lock leads provide an absolute lock into printed circuit boards and permit either automatic or hand assembly. Crimping of leads is eliminated and stand up position is assured. Designed for holes from .040 to .052, Fin-Lock leads are stopped in holes over .052 by the unique shoulder design. These new leads are available on all DISCAPS of standard voltage, rating and spacing at no increase in price.

Where application calls for ceramic capacitors with great stability over an extended temperature range, type JL DISCAPS should be specified. Between −55°C and +110°C JL DISCAPS show a capacity change of only ±7.5% at 25°C. Type JL DISCAPS are a quality replacement for paper or general purpose mica capacitors at a savings in cost.

Your inquiry is invited.

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CERAMIC
CAPACITORS

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GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors

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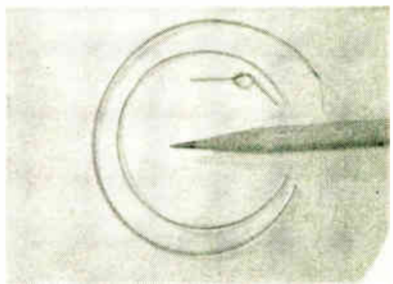
applications. The DK1-102A is essentially a 2-w output power oscillator designed for shock-mounted installation in aircraft and missiles for control equipment, gyros, synchros and servos. It is also readily used in electronic ground support systems and is particularly adaptable due to the input source of from 50 to 800 cycles, 115 v a-c. The entire unit is designed to meet or exceed specifications under MIL-E-4158A. **Circle 210 on Reader Service Card.**

Phototube head-on type

RADIO CORP. OF AMERICA, Harrison, N. J. The 7326 is a new 10-stage, head-on type multiplier phototube having a new and improved photocathode. This photocathode is characterized by broad response range, high sensitivity, low thermionic dark current, and high conductivity even at low temperatures. The 7326 is well suited for use in applications such as flying-spot scanning and photometry which require low dark current as well as high sensitivity over the entire visible spectrum. It is also useful in scintillation counters. **Circle 211 on Reader Service Card.**



Thermocouples subminiaturized

PYRO-ELECTRIC, INC., 228 E. James St., Barrington, Ill. Need for lighter, faster responding temperature sensing devices is met with new subminiature thermocouples. They are fully metal clad

J. B. WASSALL, DIRECTOR OF ENGINEERING, WITH LOCKHEED SINCE 1937

A message of importance to career-minded engineers:

"Lockheed aircraft continue to blaze new trails for manned flight. The new Electra is America's first prop-jet airliner. A Navy version of the Electra will be the country's first turbine-powered submarine hunter.

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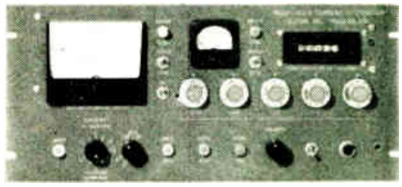
ENGINEERS: *Write Mr. Des Lauriers for your copy of a paper on "Airborne Early Warning in the Missile Age" presented by Robert A. Bailey, Chief Engineer, California Division, Lockheed Aircraft Corporation, at the 6th USAF World Wide Weapons Meet.*

THE CALIFORNIA DIVISION OF LOCKHEED AIRCRAFT CORPORATION • BURBANK, CALIFORNIA and ceramic-insulated from the high-temperature sheath. They are rugged and resist corrosion, abrasion and erosion as readily as their larger counterparts, yet are readily formed. The wide range of subminiature diameters, from 0.020 in. o-d, 2-wire to 0.040 in. o-d 2-wire, complements a complete line of thermocouple and electrical conductors in metal sheaths ranging up to 0.500 in. o-d 6-wire units. **Circle 212 on Reader Service Card.**



Current Integrator versatile unit

ELCOR, INC., 1225 West Broad St., Falls Church, Va. Primary application of the A309 current integrator relates to high-voltage particle accelerators, but the instrument is useful in many other applications as well. As a sensitive current indicating instrument, it also will measure the total charge collected in a given length of time. Notable for high accuracy, the integrator contains an internal calibrating current source that enables the accuracy and performance to be conveniently checked. The instrument's panel switch includes one which allows ready adaptation for measuring current of either polarity. **Circle 213 on Reader Service Card.**

Protective Coating for components

COLUMBIA TECHNICAL CORP., 16-02 Thirty-First Ave., Woodside 77, N. Y. A new, humidity-proofing coating, specifically developed for fast air drying at room temperatures, is announced. Known as HumiSeal type 1F12, it has infinite pot life and shelf life. Its excellent adhesion characteristics enable its use on a great variety of materials including glass, ceramic, plastic and metal. The coating may be applied

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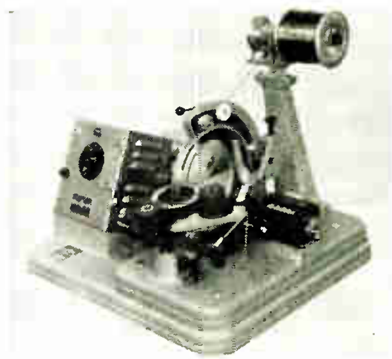
either by dip, spray or brush. It is recommended for application on components to withstand temperatures from —60 C to 150 C and subject to reasonable abrasion. **Circle 214 on Reader Service Card.**



Toroidal Winder simple, accurate

UNIVERSAL MFG. CO., INC., 1168 Grove St., Irvington, N. J. Model L-7 laboratory toroidal coil winding machine measures 20 in. by 18½ in. by 17 in. high. It is equipped with: Variac speed control for 1/6 h-p d-c motor, 0-575 rpm; self-releasing shuttle to magazine loading lock; wire guiding device for uniform wire distribution in magazine; and high-speed geared predetermining counter. Price is $1,250. **Circle 215 on Reader Service Card.**

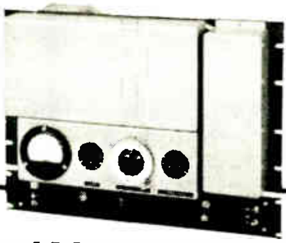
Pulse Generator series string type

KINGSTON ELECTRONIC CORP., Medfield, Mass., has developed a new model AC-1 series string pulse generator for use with Kingston absorption analyzers to simplify the location of open filaments in series string receivers. The battery-powered unit is a transistorized pulse type generator which injects a signal into the receiver under test through the line cord

PRODUCTS

FREQUENCY STANDARD

For your most precise laboratory measurements, the JK Sulzer Frequency Standard with output frequencies of 1 mc and 100 kc, with stability better than 1 part in 10^9 per day. Frequency is variable over a range of 0.9 cycles or more at 1 mc, and capable of being reset to 5 parts in 10^{10}. Write for complete data.



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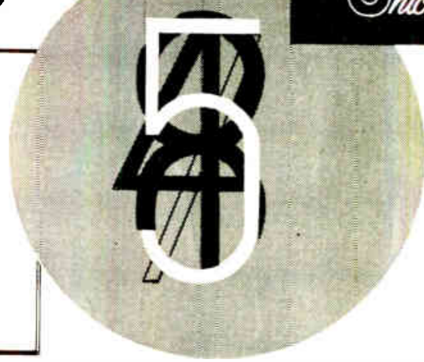

Actual Size of the New "Inditron" NUP102

FOR NEW OR REPLACEMENT APPLICATIONS

This new digital readout "Inditron" is offered at a cost far below previous models. A new engineering approach makes this reduction possible without sacrificing the National Union tradition for highest quality and rugged construction. You get longer life, distinct presentation and lower voltage (150 V. DC) performance in this compact design. Investigate the replacement possibilities of *this new "Inditron."*

Write for information on the new NUP102 and National Union's extensive line of presentation and glow devices.

Let us help you with your visual display problems.

NU

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ELECTRONICS DIVISION
Developers and Manufacturers of Special Purpose Electron Tubes
BLOOMINGTON, ILLINOIS

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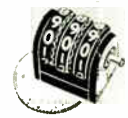
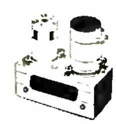


PRECISION GEARHEADS AND SPEED REDUCERS

PRECISION SERVO PACKAGES



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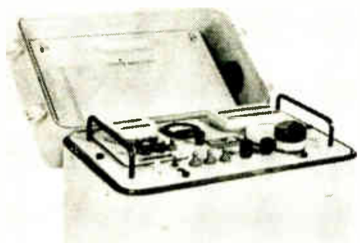
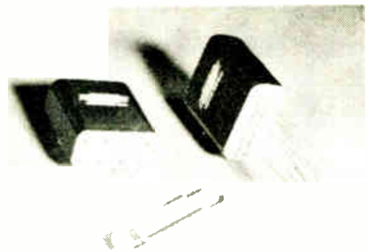
receptacle. This signal can then be followed to the defective stage, from the top side, by using the absorption analyzer's electrostatic probe at the successive stages in the series string. **Circle 216 on Reader Service Card.**



Beacon Simulator portable unit

HOFFMAN LABORATORIES DIVISION, Hoffman Electronics Corp., 3740 S. Grand Ave., Los Angeles 7, Calif. The HLI-119 simulates the operation of the TACAN ground beacon by generating a standard TACAN signal on any two of the 126 TACAN channels. It makes possible checks of range and bearing operation, coding and decoding and operating frequency, and enables the user to measure peak power and receiver sensitivity of the airborne equipment. Unit can function as an accurate signal source in a laboratory or as a go-no-go checkout device on the flight line. **Circle 217 on Reader Service Card.**



Crystal Can Relay four pole

BRANSON CORP., 41 So. Jefferson Road, Whippany, N. J. Type AR four pole crystal can relay is now available. It withstands 125 C temperature and 2,000 cycles vibration. With header leads arranged on a 0.1 in. grid and several case styles available, the type AR is compatible with printed circuits, miniature packaging and micromodular construction. Dry circuit to 2 ampere contact rating plus nominal operating voltages up to 115 v d-c, make it a versatile space and weight saving device. **Circle 218 on Reader Service Card.**

Logic Circuits transistorized

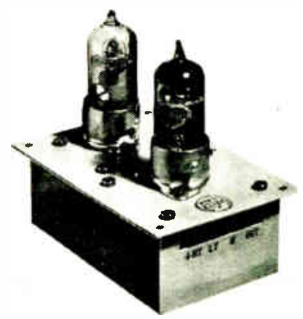
The Erie Resistor Corp., Erie, Pa., has developed a line of high speed transistorized plug-in modules for digital equipment and system construction based primarily upon the "NOR" logic. These units are designed to work at speeds in excess of 2 mc under typical loading conditions. The module is designed to fit a standard 7 pin-inline subminiature tube socket. Up to 144 units may be mounted on a standard $3\frac{1}{2}$ in. by 19 in. rack panel. Each module measures 0.750 in. high, 0.687 in. wide and 0.297 in. thick. **Circle 219 on Reader Service Card.**

Accelerometer subminiaturized

Humphrey, Inc., 2805 Canon St., San Diego, Calif. A new subminiature accelerometer with potentiometer pickoff is now in production. The LA29-0100 series is only 1 in. in diameter and less than $1\frac{1}{2}$ in. long. It is ideal for precision inertial sensing in minimum space. The accelerometer employs a unique integral weight and dry-gas damper combination. Simplified design with minimum number of parts reduces cost and improves reliability. It is available in a variety of acceleration ranges and potentiometer characteristics to fit various requirements. **Circle 220 on Reader Service Card.**

Aluminum Oxide high purity

GULTON INDUSTRIES, INC., 212 Durham Ave., Metuchen, N. J., is now marketing aluminum oxide as well as formed aluminum oxide shapes. It is being offered at a guaranteed purity of 99.96 percent with average particle size measuring 0.2 and 0.3 micron. Some of its applications include vacuum tube cases, radomes, antennas and high temperature electronic components. **Circle 221 on Reader Service Card.**

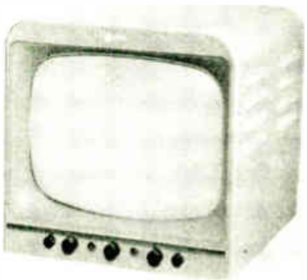


Crystal Oscillator has zero warm-up

MARCONI INSTRUMENTS, 111 Cedar Lane, Englewood, N. J. A new crystal oscillator has stability of ±5 parts per million over the range −20 C to +70 C with aging characteristic of less than ±0.2 part per million. Any frequency in the range 4 mc to 16 mc can be supplied and multiple frequency units are also available. Rugged compact construction weighs only 9 oz and is tested to withstand accelerations to 10 g. **Circle 222 on Reader Service Card.**

Counters transistorized

VAN DER HEEM, LTD., P.O.B. 1060, The Hague, Holland, announces a line of transistorized counters. By using semiconductor devices (transistors and diodes) and printed circuits the dimensions have been reduced to 12 × 9 × 6.5 in. and the weight to about 12 lb. The instruments count up to 999,999 with a maximum counting speed of 1,000,000 per sec. Frequencies up to 1 million per sec can be measured. Time intervals can be determined in units of 1 μsec to 10 sec. **Circle 223 on Reader Service Card.**



Video Monitor
17-in. screen

MIRATEL INC., 1080 Dionne St., St. Paul, Minn., announces a new low cost video monitor designed for the educational, industrial and broadcast fields. Model L59B features a 90-deg aluminized kine. Unit gives better than 500 line resolution with stable vertical hold circuitry for use with industrial cameras. Video input is high impedance looping for signal levels of 0.5 to 1.5 v. Price is $189. **Circle 224 on Reader Service Card.**

Hook-Up Wire
three types

AMERICAN SUPER-TEMPERATURE WIRES, INC., 2 W. Canal St., Winooski, Vt., is producing types B, C, and D extruded polyvinyl chloride hook-up wire to conform to MIL-W-16878B (Navy). Temperature rating is −55 C to +105 C continuous operation. Type B wire, rated at 600 v is being produced in Awg sizes 32 through 16. Type C, rated at 1,000 v, is available in Awg sizes 24 through 14. Type D, rated at 3,000 v, is produced in Awg sizes 24 through 6. Colors conform to MIL-STD 104 and spiral striped insulation may be had with one or two tracers on a background color. **Circle 225 on Reader Service Card.**

Literature of the Week

MATERIALS

Silicones. Dow Corning Corp., Midland, Mich. The 1959 reference guide to the company's silicone products describes what silicones can best meet the needs of a variety of problems ranging from adhesives to release agents, resins to rubbers, dielectrics to water repellents. **Circle 250 on Reader Service Card.**

COMPONENTS

Miniature Transformers. Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y. A short form catalog lists complete specifications on the company's miniature, subminiature, transistor, MIL-T-27A and industrial transformers. **Circle 251 on Reader Service Card.**

Synchro Coupling. Theta Instrument Corp., 48 Pine St., East Paterson, N. J. Discussed in a new technical bulletin are the special problems associated with coupling a synchro under test to a precision agular divider. **Circle 252 on Reader Card.**

LVDT's. Schaevitz Engineering, Route 130 & Schaevitz Blvd., Pennsauken, N. J., has made available new literature on the applications of linear variable differential transformers. **Circle 253 on Reader Service Card.**

Magnetic Amplifiers. Vickers, Inc., 1815 Locust St., St. Louis, Mo. Bulletin E PD 1296-5 gives full specifications on the new 1290 series Super Power gapless core magnetic amplifiers. **Circle 254 on Reader Service Card.**

Pulse Transformers. PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif. A 24-page catalog covers a brief history of low-level pulse transformers, their measurements, specifications, ap-

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plications, interchangeability, dielectric ratings, manufacturing, and other data. Circle 255 on Reader Service Card.

Printed Wiring Design. Rowe Engravers, 262 E. 16th St., Paterson 4, N. J. Printed wiring design criteria are featured in an illustrated catalog, E-11. Standardized definitions and military design standards are presented. Catalog is available on letterhead request.

EQUIPMENT

Digital Shaft Angle Encoder. Dychro Corp., 12 Centre Ave., Newton 58, Mass. A four-page folder describes the design, operation and applications of the Dychroverter digital shaft angle encoder. **Circle 256 on Reader Service Card.**

Sweeping Oscillator. Kay Electric Co., Maple Ave., Pine Brook, N. J., A recent mailing piece describes the Magna-Sweep, an all electronic 1,000 mc sweeping oscillator. **Circle 257 on Reader Service Card.**

Tv Monitoring Equipment. Visual Electronics Corp., 342 W. 40th St., New York 18, N. Y. A new catalog contains information on a complete line of picture monitors, a waveform monitor and a tv tuner. **Circle 258 on Reader Service Card.**

Antenna Pattern Analyzer. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md. Bulletin 141 illustrates and describes the model BA-7 antenna pattern analyzer. **Circle 259 on Reader Service Card.**

FACILITIES

Digital Instrumentation. Franklin Electronics Inc., Bridgeport, Pa., has published literature offering a complete digital instrumentation engineering service for the electronic and missile industries. **Circle 260 on Reader Service Card.**

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NEW BOOKS

Traveling-Wave Tubes Part II, of Einfuhrung in die Mikrowellen-Elektronik

By W. KELLEN and K. POSCHL

S. Hirzel Verlag, Stuttgart, Germany, 1958, 192 *p*, *DM* 28.

THE tube engineer who reads or can manage to understand technical German will find himself rewarded by this volume on traveling-wave tubes by Prof. Kleen and Dr. Poschl.

The mathematical and physical background for microwave electronics is developed in the first volume, which was not available to this reviewer; the second volume, however may be read independently, assuming a general familiarity with the theory of interaction between electron beams and electromagnetic fields.

TWT Small-Signal Theory—After a brief qualitative survey, the small-signal theory of the traveling-wave tube is developed. The development is in terms of field theory and the results are presented in numerous curves for various values of the pertinent parameters. This treatment should be very useful to the designer of traveling-wave tubes.

The third chapter deals with noise in traveling-wave tubes, the calculation of noises figure and the design of minimum noise figure tubes. Nonlinear behavior is the subject of the fourth chapter in which the work of Rowe and Tien and Cutler are reported and compared. The final chapter in this first half discusses measurements and applications of traveling wave tubes; specific examples of tubes are reported and some of the practical problems of matching and attenuation are discussed.

Special Types—The second half of the book is devoted to special types of traveling-wave tubes.

Chapter six deals with backward-wave oscillators in various geometries. Chapter seven discusses electron-wave tubes and chapter eight treats the resistive-wall amplifier. The last chapter discusses special forms of traveling-wave tubes, the transverse field tube, the transverse electron tube and a Cerenkov radiation tube.

Two appendices deal with the helix as a periodic structure and beam focusing with axially symmetric magnetic fields. — MORRIS ETTENBERG, *Polytechnic Institute of Brooklyn, Brooklyn, N. Y.*

Transform Method in Linear System Analysis

By JOHN A. ASELTINE

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

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

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

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

Trio Labs Expands Fourfold

TRIO LABORATORIES, INC., designers and manufacturers of miniature precision electronic instruments, recently moved to new and larger quarters at Plainview, L. I., N. Y. The building comprises 16,000 sq ft of space and represents over a fourfold expansion of facilities.

Founded in 1953 by three engineers who were among pioneers in designing miniaturized, precision electronic instruments—especially for panel-mounting or integration into operational equipment as well as test systems and consoles—the company has enjoyed a steady controlled growth. This is the fourth move in its five-year history.

Company has developed a substantial line of products in the test and instrumentation fields. They include vtvm's, phase meters, null meters, auxiliary power supplies and many other special units in the measuring/monitoring field, most all of which embody the principle of build-in applications.

Nearly half the new building's area is sound conditioned and divided into work areas for product engineering, R&D and general office operations. New environmental test facilities are included to perform tests during product development.

The manufacturing area is organized for efficient production flow. Segregated machine shop and dust-controlled meter areas are on opposite sides of the mechanical and electrical assembly sections, along with separate calibration, aging and final inspection areas, resulting in rapid, efficient production of quality products.

The new building, on a 2-acre site, offers ample expansion area for all phases of growing operation.

Vitro Readjusts Management

FRANK B. JEWETT, JR., has been elected executive vice-president of Vitro Corp. of America, New York City. A Vitro vice-president for three years, he succeeds Albert G. Noble, who, as a vice president of the corporation, will devote his efforts to Vitro's R&D in the field of national defense, and the establishment of a weapon systems group of Vitro companies.

At the same time William B. Hall was made a vice-president of the corporation. He has been president of Vitro Uranium Co., and will now assume charge of the Vitro companies engaged in chemical and metallurgical operations, which include Vitro Uranium, Vitro Rare Metals Co., Vitro Mfg. Co., Berkshire Chemicals, Inc. and Heavy Minerals Co. He will remain vice-president of Vitro Minerals Corp.

Behringer Joins General Time

THE newly created position of manager of market development, General Time Laboratories, N. Y. C., was recently occupied by Robert W. Behringer. In this post he will be responsible for General Time Corporation's Incremag program.

Behringer was formerly associated with Ebasco Services Inc.

Maher Advances At Philco Plant

WILLIAM F. MAHER was recently appointed manager, military and industrial sales, for the Lansdale Tube Co., division of Philco Corp., Philadelphia, Pa.

He has been associated with Philco since 1948, when he joined the company's engineering department. In 1951 he was transferred to Philco's Government and Industrial sales with responsibility for Government contract administration and negotiation. He joined Lansdale Tube Co. in 1953, taking charge of military tube sales, and became manager of Government sales for tubes and semiconductors in 1955.

Elect Lewis To Top Post

RECENTLY elected president of Sylvania Electric Products Inc. is Robert E. Lewis. He was previously a senior vice president of the company.

As president, Lewis succeeds Don G. Mitchell, who will continue as chairman of the board.

RCA Names Bain Vice President

ELECTION of Walter G. Bain as vice president, Washington Office, Defense Electronic Products, RCA, is announced.

In his new position, he will have

TANTALUM

Started At Fansteel....

DR. CLARENCE W. BALKE holds a replica of his first tantalum ingot. This was the basic discovery that made tantalum capacitors possible. For his pioneer work in tantalum he received many awards, among them, the Perkin Medal.

THE TENS OF MILLIONS of tantalum capacitors put into service since 1949 pay tribute to the man who made tantalum possible.

The late Dr. Clarence W. Balke, Fansteel's Director of Research, produced in 1922 the first tantalum "ingot" ductile and malleable enough to be rolled into sheet or drawn into wire.

Dr. Balke, with his research group, then began to look closer at the unique properties of tantalum, to discover new uses. One of his experiments with current flow between tantalum plates immersed in an electrolyte resulted in the development of the tantalum-lead (Balkite) rectifier. In his laboratory log entry dated December 1, 1922, Dr. Balke wrote: "... In addition to functioning directly as a rectifier ... apparatus built along similar principles may be used for electrolytic condensers ..."

Thus emerged the first tantalum capacitors and Fansteel had them on the market by 1930—principally, in telephone service. One model used electrodes of crimped tantalum sheet in a cell about the size of a pint fruit jar, providing 800 mfd. at 24 volts. Another used coiled electrodes welded to tantalum rods. The tantalum capacitor did a good job in those days, but it was unwieldy and expensive. Fansteel scientists later developed a way to eliminate expensive sheet metal and still retain large capacity characteristics, stability, and extremely long life of the tantalum capacitor.

Porous tantalum electrodes, made from powder, compacted around tantalum wires, resulted in an anode which exposed a great amount of surface to the electrolyte. This type capacitor first operated as a railway signal surge arrester. Single high-peak voltage surges, caused by lightning, momentarily break down the tantalum oxide film, but as soon as the surge voltage disappears, the oxide film heals and re-forms immediately.

ENTER THE TRANSISTOR

Shortly after World War II the Bell Telephone Laboratories introduced the transistor which started the age of miniaturization in electronic components. In 1949 we were asked to produce a Tantalum Capacitor of 4 mfd., 60 wvdc to occupy a space of less than one-tenth cubic inch and with a life expectancy of 30 years. Commercial production began that same year.

The result of this development was the Fansteel "PP" Type Tantalum Capacitor now made in a wide range of sizes and ratings. As this is written, more than twelve million capacitors of this type have been put into service.

Along with this major development, Fansteel metallurgists created the first tantalum made especially for capacitor use—Fansteel Capacitor Grade Tantalum.

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responsibility for maintaining relations with U. S. defense agencies, assisting in major defense contract negotiations and directing the activities of Defense Electronic Products unit's Washington office.

Since 1954, Bain has been vice president and general manager of Republic Aviation Corp., Farmingdale, L. I., N. Y.

Palo Alto Firm Hires Teichner

APPOINTMENT of Robert W. Teichner to the technical staff of Shockley Transistor Corp., Palo Alto, Calif., is announced. His initial responsibilities will include the development of precision techniques for semiconductor devices which are closely related to printed circuit techniques found in other branches of electronics.

Teichner was formerly with the Mergenthaler Linotype Co. as chief chemist of the lithographic chemistry department.

Airpax Changes Company Name

THE board of directors of The Airpax Products Co. has announced that the new corporate name of the company will be Airpax Electronics Inc. Firm is located in Cambridge, Md., and Ft. Lauderdale, Fla.

Stavid Appoints Engineering Mgr.

ROBERT E. WILLIAMS has been named manager of the airborne electronics department at Stavid Engineering, Inc., Plainfield, N. J. He was formerly project manager in the same department.

From 1946 to 1954 Williams was a project engineer at the Naval Ordnance Plant, Indianapolis, where he received the Naval Civilian Meritorious Service Award for his work in the development and modification of various types of radar equipments. Later he was head of radar and fire control projects at the Magnavox Co., and joined Stavid in 1957 as project manager of a major bombing radar system.

News of Reps

Mid-Eastern Electronics, Inc., Springfield, N. J., has appointed **Michael S. Coldwell, Inc.**, of Hartford, Conn., representative for its line of ultrahigh-resistance measuring instruments, power supplies and special test equipment in all of New England.

Continental Mfg., Inc., Omaha, Nebraska, has appointed two new reps:

Bray & Carter, Los Angeles, cover southern California and Arizona.

Robert C. Hammond of Hopkins, Minn., will handle the territory of Minnesota, North and South Dakota, and western Wisconsin.

Lindly & Co., Mineola, N. Y., names **Arthur T. Hatton & Co.** of West Hartford, Conn., and Newtonville, Mass., to handle its equipment in Maine, New Hampshire, Massachusetts, Connecticut, Vermont and Rhode Island.

Radiation Counter Laboratories, Inc., Skokie, Ill., names **M. J. Seavy & Sons**, New York City, as reps for its complete line of radiation counters, instruments and analyzers for New York, New Jersey, Delaware, eastern Pennsylvania, and Fairfield County, Conn.

Menlo Park Engineering, Menlo Park, Calif., manufacturer of microwave instrumentation, announces appointment of the **Airep Engineering Co.** of Dallas, Texas, as its sales reps in the Texas, Oklahoma, Arkansas and Louisiana area.

COMMENT

Design for Ham's Nirvana

A critical study of developments in the communications field shows one parameter in the design of new equipment that is being neglected. Papers at recent IRE symposiums show no consideration of this problem; recent R&D contracts indicate no thought on the Pentagon's part. Yet this is a matter of vital concern to us all.

I refer to the conversion of communications equipment to ham use when it becomes surplus. Surely we have enough experience by now to make us realize this a major oversight on the part of design engineers.

I think it is mandatory that all receivers be immediately convertible to ham-band-only use. Conversion should be accomplished by the flick of a switch, located preferably on the front panel. Under no circumstances should it be necessary to remove the chassis from the case.

Transmitters, mobile or fixed, should also be readily convertible. Use in all bands from 160 to 2 meters should require no more than the substitution of a dial. Two power outputs should be available: 74 and 999 watts. Automatic control should be provided to prevent California kilowatts.

With the advent of jet aircraft, there arises a pressing requirement for a prop-pitch motor for use as an antenna rotor. This problem is not wholly the electronic engineer's responsibility; the manufacturer of jet engines must help figure out a way to put the equivalent of a prop-pitch motor somewhere in his engine. The idea that such a piece of equipment may not be necessary is not to be tolerated; design problems can be overcome with suitable ingenuity.

These suggestions are offered to ensure that suitable surplus equipment will result from today's and tomorrow's designs.

Are the Russians to be first again?

STEPHEN W. GIBSON

FAIRFAX, VA.

May we add a suggestion? Designers of helical antennas should

consider incorporating the facility for quick conversion to a hula hoop. And just think how much labor and money might be saved if some of the big tropo reflectors could quickly and easily be converted to curved screens for drive-in theaters. It's a whole new field: conversion engineering. Reason totters!

Flashing Lights

We have read with great interest your recent article "Instruments: Key to Missile Programs" (Jan. 16, p 47), and would like to think that the "intense flashing lights" referred to are ours. ("Highly accurate ballistic plate cameras . . . record the image of an intense flashing light aboard the missile against the background of star trails," p 50.)

JAMES V. DANIELS
KEMLITE LABORATORIES
CHICAGO

Opaque Airfoil

B-mews this a while: what if the Russians come up with a radar-opaque airfoil?

M. KIGAN
NEW YORK

We feel that reader Kigan means a radar-transparent airfoil, since only such a foil would be nonreflective. And such things already exist: we have a missile and some other aircraft which are made of materials that do not reflect r-f energy. The thought, in fine, does not b-mews us at all.

Satellites

My note may not have been too clear (see Comment "Global Girdles," p 130, Jan. 16), but—Tesla's proposed satellite was to be a colossal globe-encircling Saturnian ring, and Fermi's suggested global synchrotron was to use the earth's tremendous *radius* (not its radial velocity) to get particles up to Mach 1 speed, in spite of its weak magnetic field.

TED POWELL
GLEN OAKS, N. Y.

We goofed. Sorry.

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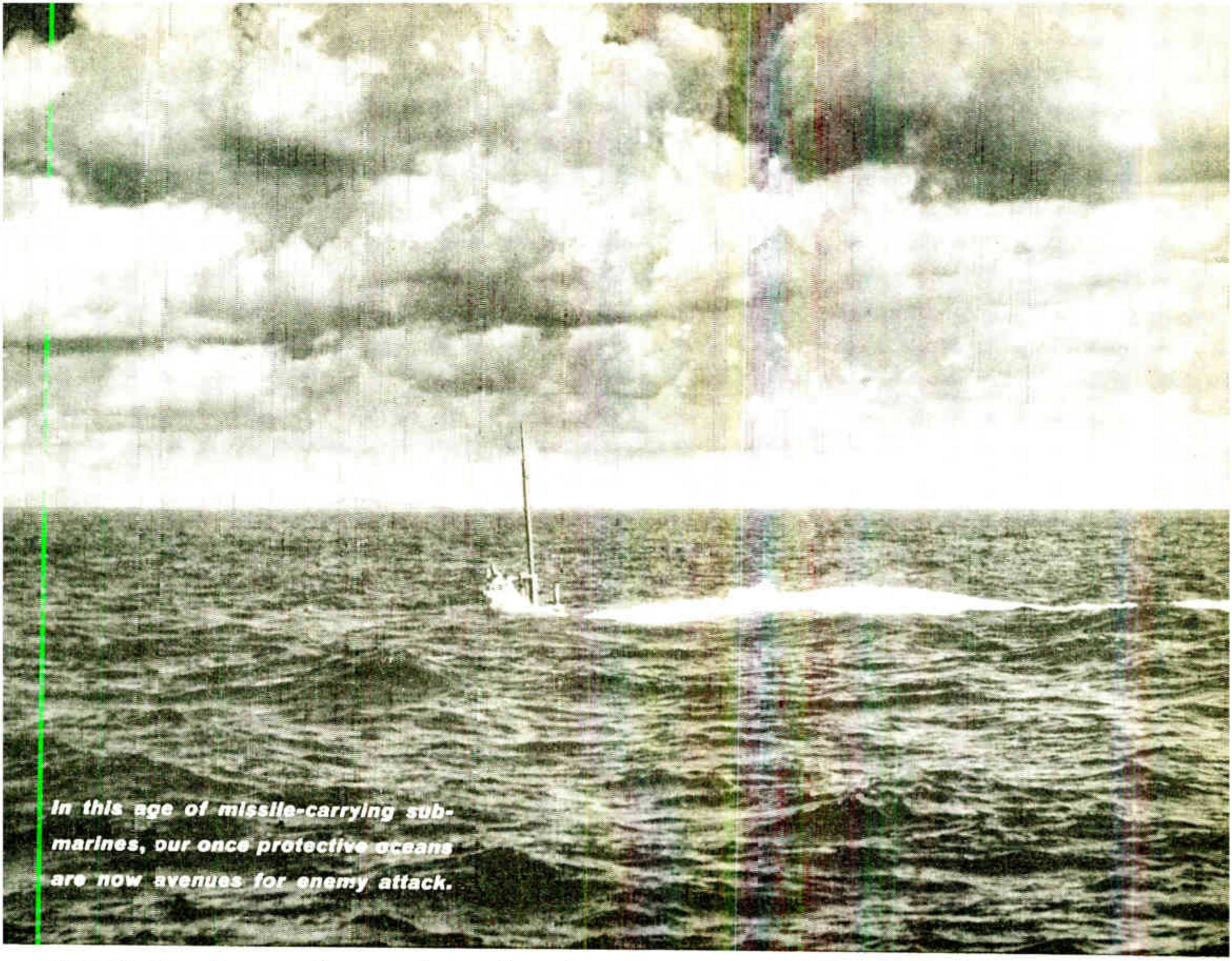

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AN/MPN-1A (GCA) Ground Control Approach Radar, 30 ft trailer with 3cm precision and 10cm Search Radars as used by C.A.A. Full desc. Vol. 11 MIT Rad Lab Series Sec. 8.13.

WEATHER RADAR 275 kw. 10cm. Compact wt. 488 lbs. rotating yoke PPI 4, 20, 80 mile ranges, ideal for weather forecasting. Lab. Brand new. FCC approved $950.

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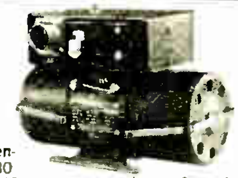

DMF3506M Continental Electric 24-30 volts input; 5.5-45 amps; cont. duty. Output: 115 volts; 44 amps 400 cyc; 1 phase; pf 1.0; 50 watts $39.50

12116-2-A Bendix
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12117 Bendix
Output: 24 volts; 400 cycle, 6 volt amperes, 1 phase. Input: 24 VDC; 1 amp $15.00

12121 Bendix
Input: 24 volt D.C. 18 amp. 12000 r.p.m. Output: 115 volts, 400 cycle, 3-phase, 250 volt amp, 7 pf. $49.50

12123 Bendix
Output: 115 V; 3 phase; 400 cycle; amps. .5; Input: 24 VDC; 12 amp. $49.50

12126-2-A Bendix
Output: 26 volts; 3 phase; 400 cycle; 10 VA; 6 PF. Input: 27.5 volts DC: 1.25 amps. $24.50

12142-1-A Bendix
Output: 115 volts, 3 phase, 400 cycle, 250 VA. Input: 27.5 VDC, 22 amps. Voltage and frequency regulated. $99.50

12147-1 Pioneer
Output: 115 VAC, 400 cycles; single phase. Input: 24-30 VDC; 8 amps. $19.95 each

10285 Leland
Output: 115 volts AC; 750 VA, 3 phase, 400 cycle, .90 pf and 26 volts. 50 VA single phase, 400 cycle, .40 pf. Input: 27.5 VDC, 60 amps. cont. duty. 6000 rpm. Voltage and frequency regulated. $59.50

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Output: 115 VAC; 400 cycle, 3-phase; 115 VA; 75 pf. Input: 28.5 VDC; 12 amps. $25.00

PE109 Leland
Output: 115 VAC, 400 cycle single phase; 1.53 amp.; 8000 rpm. Input: 13.5 VDC; 29 amp. $50.00

PE218 Leland
Output: 115 VAC; single phase pf. 90; 380/500 cycle; 1500 VA. Input: 25-28 VDC; 92 amps.; 8000 rpm. $30.00

AN 3499 Eicor, Class "A"
Input: 27.5 volts at 9.2 amps. AC. Output: 115 volts, 400 cycles; 3 phase, 100 voltamp; continuous duty. Price $39.50 each

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Part #653265. Motor 115 volts, 3 phase, 400 cycle, 8 watts, 20,000 RPM. 3-minute runup, synchro pickoffs, roll 360°, pitch 85°. Synchro excitation 26 volts, 400 cycle, 150 m.a. Vertical accuracy ±½°. Weight 3½ lbs. Approx. dim. 5¾" L, 4½" W., 4½" H. Price $35.00

400 CYCLE, 3 PHASE GENERATOR

BY MASTER ELECTRIC

Type AG, frame 364Y, 7.5 kw, 3428 rpm, pf .95. Star connected 120/208 3 phase 22 amps. Delta connected 120 volt single phase 66 amps. Self excited. Complete with control box, voltage regulator, AC voltmeter and frequency meter. Shaft 1" dia., 2" long overall dim. of unit: 21"x18"x 20". Price $395.00 each

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1CT cont. Trans 90/55V 60 cy.	$34.50
1DG Diff. Gen. 90/90V 60 cy.	34.50
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5SDG Diff. Gen. 90/90V 400 cy.	12.50
6DG Diff. Gen. 90/90V 60 cy.	25.00
6G Syn. Gen. 115/90VAC 60 cy.	34.50
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C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C76165 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
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FPE-25-11 Diehl Servo 75 115 v 60 cy.	12.50
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FPE-43-1 Resolver 400 cy.	19.50
FJE-43-9 Resolver 115V 400 cy.	15.00
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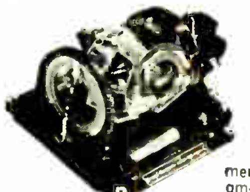
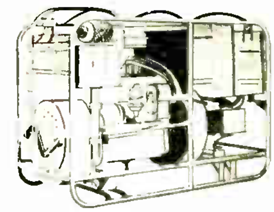
R220-1 Kearfott Receiver	20.00
R235-1A Kearfott Resolver	20.00

HONEYWELL VERTICAL GYRO MODEL JG7003A-1



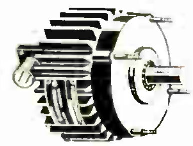
115 volts, 400 cycles, single phase, 35 watts. Pitch and roll Potentiometer pickoffs 890 ohms, 40 volts max. AC or DC. Speed 20,000 rpm, ang. momentum 12,500,000 gm-cm²/sec. Erection system 27 VAC, 400 cycles, time 5 min. to ½°. Weight 5.5 lbs. Price $35.00 each

POWER UNIT PU-104/U



5 KW 120/208 volt AC single or 3-phase permanent magnet type 400 cycle alternator. Alternator is driven by Hercules model ZX3 4-cylinder 4-cycle "L" head liquid cooled gas line engine. This unit is complete with a control panel. Price $495.00

400 CYCLE PM GENERATOR



115/200 volts A.C. 1- or 3-phase, 200 watts. 4,000 r.p.m. Approx. dimensions: 4¾" dia.; 3" long; ½" shaft, AN connector. $75.00

400 CYCLE 1/3 PHASE GENERATOR

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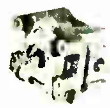
Mod. 8K63AC. 115 volts, 400 cps, 3 phase, 40 watts. Has settable induction pick-off. $10.00

VARIABLE SPEED BALL DISC INTEGRATORS

No. 145

Forward & Reverse 2¼-0-2¼. Input shaft spline gear 12 teeth 9/32" dia. 3/8" long. Output shaft 15/64" dia. x 15/32" long. Control shaft 11/32" x 3/8" long. Cast aluminum construction. Approx. size 3" x 3" x 2¾".

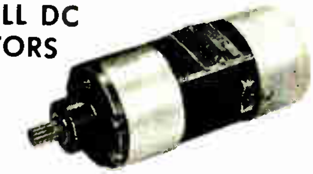
No. 146



Forward & Reverse 4-0-4. Input shaft 5/16" dia. x ¾" long. Output shaft 15/64" dia. x 9/16" long. Control shaft 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4½" x 4½" x 4". (All Shafts Ball Bearing Supported)

$17.50 ea.

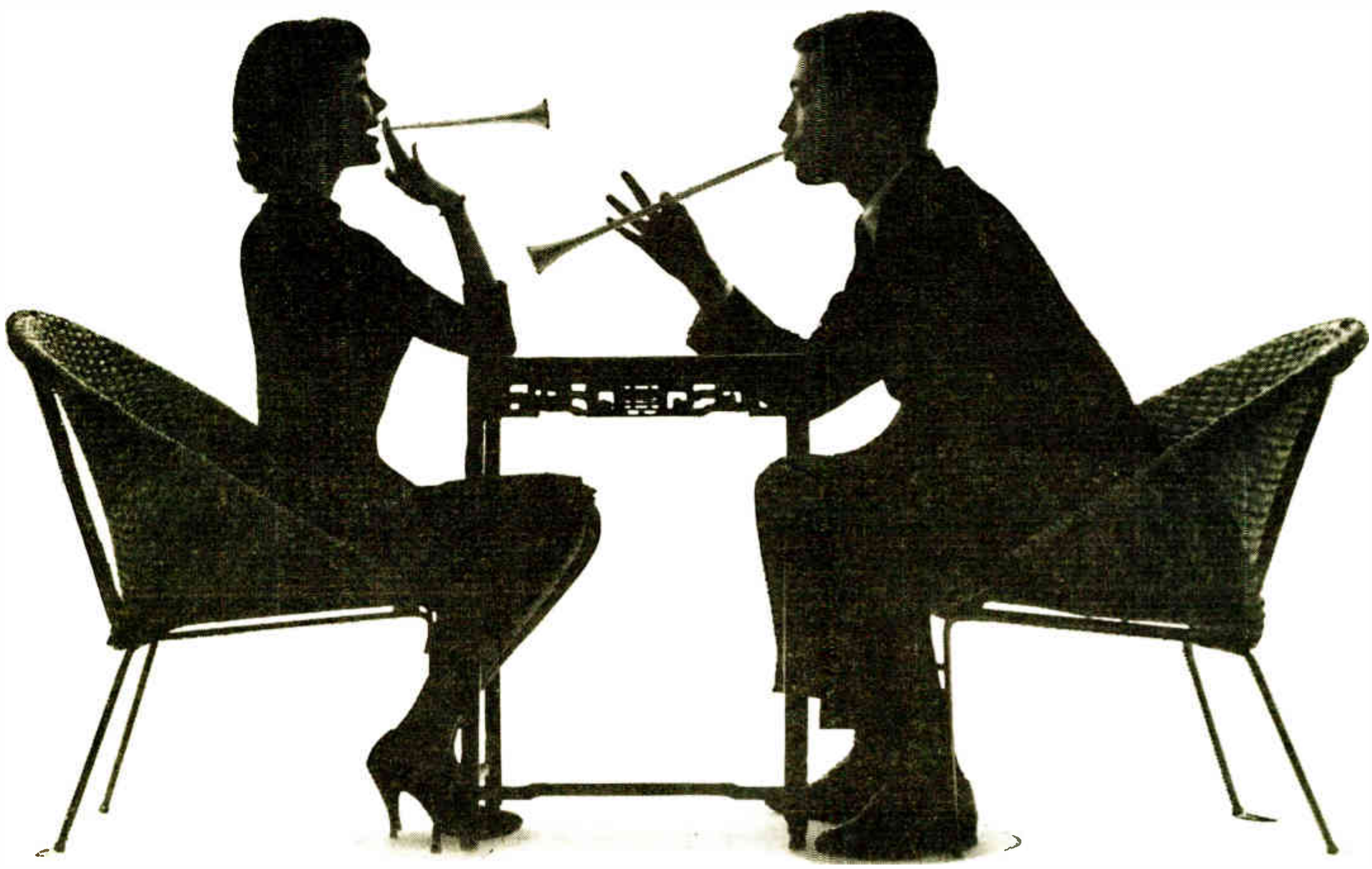
SMALL DC MOTORS



(approx. size overall 3¾" x 1¼" dia.:)

5067043 Delco 12 VDC PM 1" x 1" x 2", 10,000 rpm.	$7.50
5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled	15.00 ea.
5069600 Delco PM 27.5 VDC 250 rpm	12.50
5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w. brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled	15.00 ea.
5072735 Delco 27 VDC 200 rpm governor controlled.	15.00
5BA10A118 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
5BA10AJ50, G.E., 12 VDC, 140 rpm	15.00
5BA10FJ401B, G.E. 28 VDC, 215 rpm, 10 oz. in., .7 amp, contains brake	15.00
5BA10FJ421, G.E. 26 VDC, 4 rpm, reversible, 6 oz. in., .65 amp	15.00
S. S. FD6-21 Diehl 24 VDC PM 10,000 rpm. 1" x 1" x 2".	4.00

MUSIC MATES!



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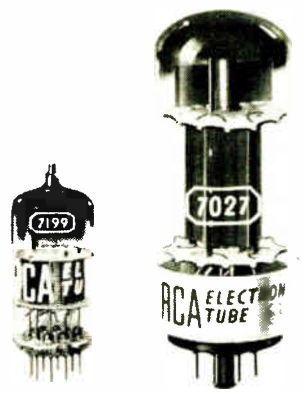
Offer them a "top" note. Send your "deepest" bass. Blast your "fullest" fortissimo at them. Never fear the outcome if your high-fidelity amplifier is designed around this "perfect pair"...RCA-7199, medium-mu triode sharp-cutoff pentode and RCA-7027, beam power tube.

Study the sensitivity of the high g_m pentode unit of the RCA-7199...wonderful for use in a low-noise low-hum amplifier; consider the medium-mu triode unit...ideally suited for use in a phase splitter. On the masculine side of the table is the other "mate", RCA-7027, developed specifically to reproduce the "big sounds". A pair of 7027's in a push-pull class AB_1 circuit utilizing feedback and driven by a 7199 with an input signal of 1 volt can deliver a power output of 50 watts with total harmonic distortion of less than 0.5% and hum and noise of 85 db below 50 watts.

Ask your RCA Field Representative for the details on the High-Fidelity "Music Mates"...RCA-7199 and RCA-7027. For technical bulletins, write RCA Commercial Engineering, Section B-19-DE-3, Harrison, N. J.

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



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