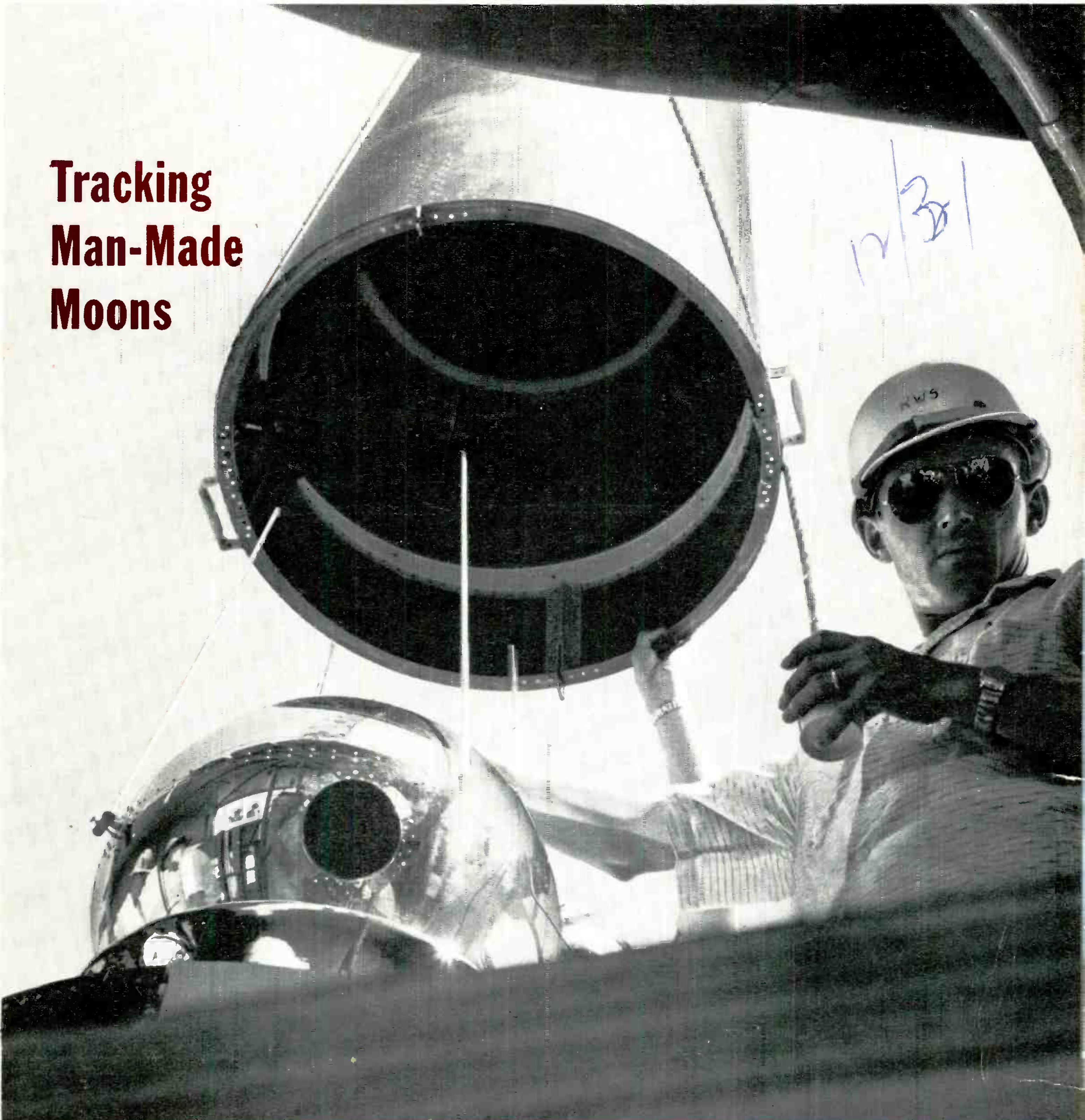
JANUARY 2, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 1 PRICE SEVENTY-FIVE CENTS

Tracking Man-Made Moons



Can Computers Design Electronic Equipment?

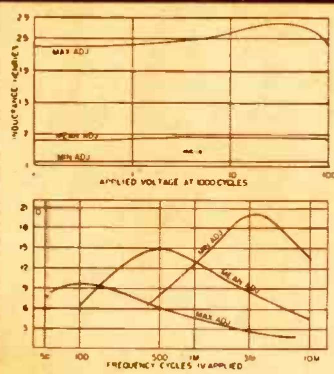
Hi-Q Inductors . . . . FROM STOCK

As largest producers in this field for over two decades, UTC inductors cover virtually every need for both fixed and variable units of exceptional stability. Hermetic units have been proved to MIL-T-27A, eliminating costs and delays of initial MIL-T-27A testing.

For complete listing of our 700 stock items (300 hermetic) write for catalog.

HVC Hermetic Variable Inductors

A step forward from our long established VIC series. Hermetically sealed to MIL-T-27A . . . extremely compact . . . wider inductance range . . . higher Q . . . lower and higher frequencies . . . superior voltage and temperature stability. Case 25/32 x 1⅛ x 1 7/32, 2 oz.

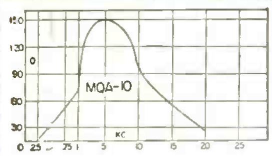


Type No.	Min. Hys.	Mean Hys.	Max. Hys.
HVC-1	.002	.006	.02
HVC-2	.005	.015	.05
HVC-3	.011	.040	.11
HVC-4	.03	.1	.3
HVC-5	.07	.25	.7
HVC-6	.2	.6	2
HVC-7	.5	1.5	5
HVC-8	1.1	4.0	11
HVC-9	3.0	10	30
HVC-10	7.0	25	70
HVC-11	20	60	200
HVC-12	50	150	500

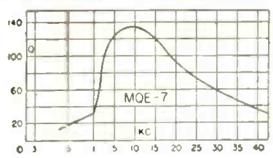
HVC

MQ drawn case structure

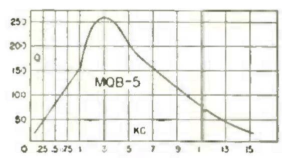
	Length	Width	Height	Oz.
MQE	1/2	1-1/16	1-7/32	1.5
MQA, MQD	11/16	1-9/32	1-23/32	4
MQB	1-5/16	2-9/16	2-13/16	14



MQA
19 stock values from 7 Mhy. to 22 Hy.



MQE
15 stock values from 7 Mhy. to 2.8 Hy.



MQB
12 stock values from 10 Mhy. to 25 Hy.

MQD

New extreme stability inductors for 12KC to 130KC range. Typical Q is 170 @ 50KC. 6 stock values from 2 mhy. to 20 mhy.

MQ Series Compact Hermetic Toroid Inductors

The MQ permalloy dust toroids combine the highest Q in their class with minimum size. Stability is excellent under varying voltage, temperature, frequency and vibration conditions. High permeability case plus uniform winding affords shielding of approximately 80 db.

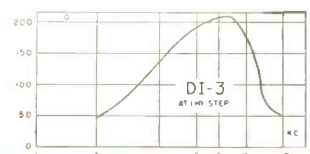
MQL Low Frequency High Q Coils

The MQL series of high Q coils employ special laminated Hipermalloy cores to provide very high Q at low frequencies with exceptional stability for changes of voltage, frequency and temperature. Two identical windings permit series, parallel, or transformer type connections. 1-13/16 dia. x 2½" H.

MQL-0	.25/1 Hys.
MQL-1	2.5/10 Hys.
MQL-2	5/20 Hys.
MQL-3	50/200 Hys.
MQL-4	100/400 Hys.
MQL-5	625/2500 Hys.

DI Inductance Decades

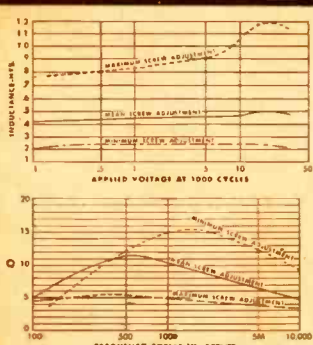
These decades set new standards of Q, stability, frequency range and convenience. Inductance values laboratory adjusted to better than 1%. Units housed in a compact die cast case with sloping panel ideal for laboratory use . . . 4½ x 4⅜ x 2⅜ high.



DI-1	Ten 10 Mhy. steps.
DI-2	Ten 100 Mhy. steps.
DI-3	Ten 1 Hy. steps.
DI-4	Ten 10 Hy. steps.

VIC case structure

Length	Width	Height	Oz.
1-1/4	1-11/32	1-7/16	5-1/2



Type	Mean Hys.	Type	Mean Hys.
VIC-1	.0085	VIC-12	1.3
VIC-2	.013	VIC-13	2.2
VIC-3	.021	VIC-14	3.4
VIC-4	.034	VIC-15	5.4
VIC-5	.053	VIC-16	8.5
VIC-6	.084	VIC-17	13.
VIC-7	.13	VIC-18	21.
VIC-8	.21	VIC-19	33.
VIC-9	.34	VIC-20	52.
VIC-10	.54	VIC-21	83.
VIC-11	.85	VIC-22	130.

VIC Variable Inductors

The VIC Inductors have represented an ideal solution to the problem of tuned audio circuits. A set screw in the side of the case permits adjustment of the inductance from +85% to −45% of the mean value. Setting is positive.

Curves shown indicate effective Q and L with varying frequency and applied AC voltage.

SPECIAL UNITS TO YOUR NEEDS
Send your specifications for prices.

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Issue at a Glance

BUSINESS

ENGINEERING

DEPARTMENTS

Ucinite Magnetron Connectors

Ucinite manufactures a variety of special connectors for the heater and heater-cathode terminals of magnetrons. Many of these have been adapted for special applications as to size and function to meet the sealing and mounting requirements of high temperature and high altitude operation and other special conditions.

Connectors are coaxial in construction and can be supplied with built-in capacitors for added protection. Connecting leads of any length can be furnished to customer's specifications.

With an experienced staff of design engineers, plus complete facilities for volume production, Ucinite is capable of supplying practically any need for metal or metal-and-plastics assemblies. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.

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RADIO AND AUTOMOTIVE

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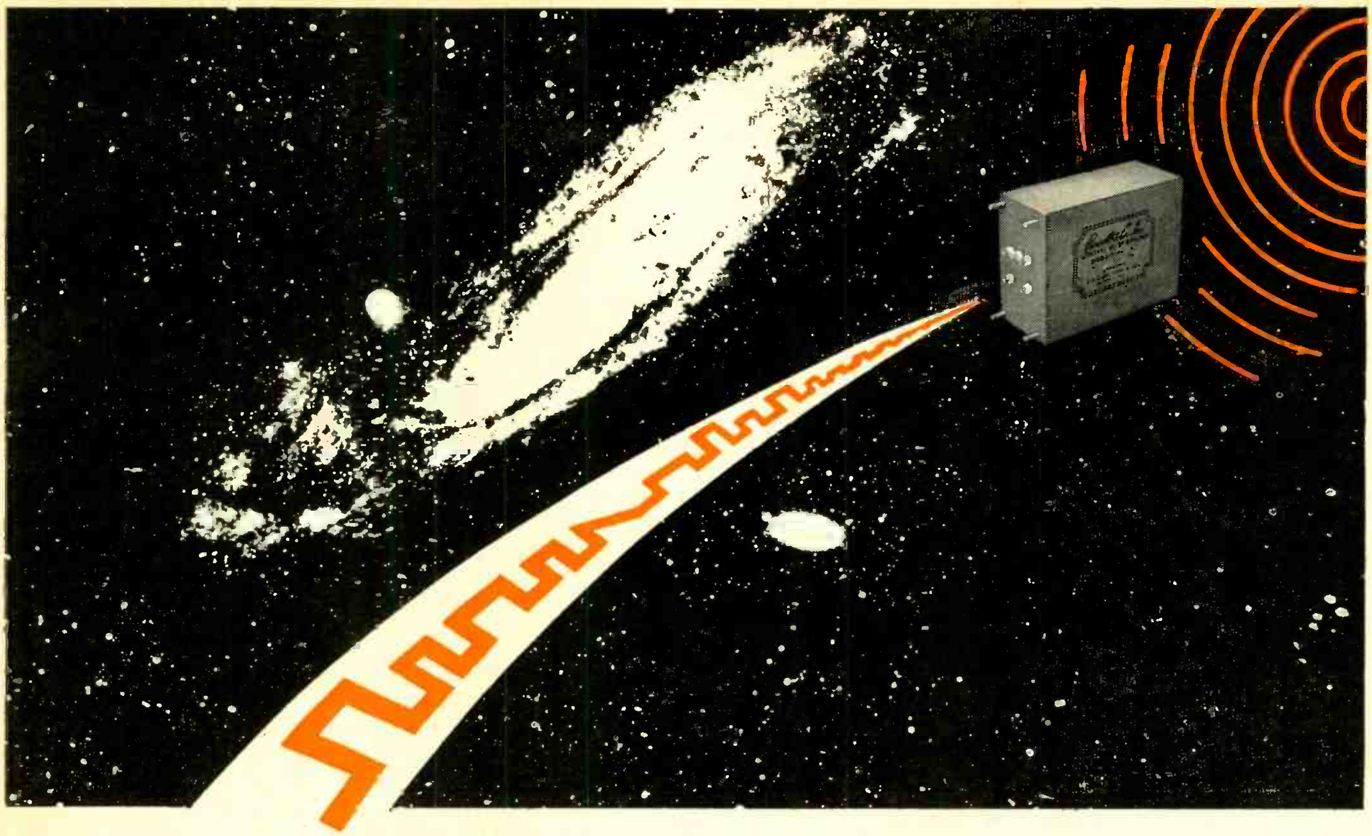


MAXIMUM TELEMETERED RESPONSE THROUGH FLAT AMPLITUDE AND CONSTANT DELAY

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

Amplitude and Phase Necessary

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

Combination Achieved

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

Write for Bulletin CD 051

TECHNICAL DATA

FOR ± 7½% PASS BAND
1 Flat within 3 db over pass band
2 21 db at ± 15% of center freq.
3 40 db at ± 22% of center freq.
4 Time delay over the pass band, constant to ± 5%

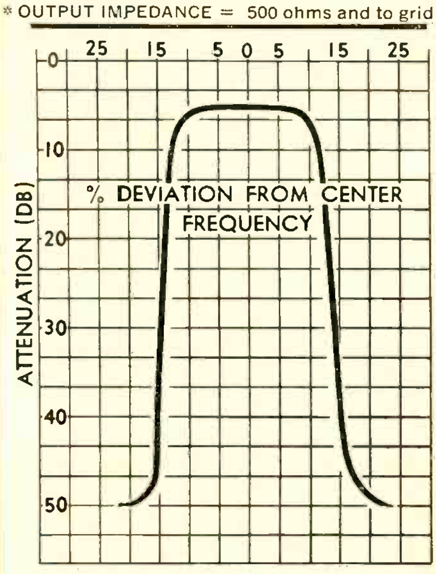
FOR ± 15% PASS BAND
1 Flat to 3 db over pass band
2 23 db at ± 30% of center freq.
3 40 db at ± 44% of center freq.
4 Time delay over pass band constant to ± 7%

Input impedance — 500 ohms
*Output impedance — 500 ohms and high impedance for operation to a grid
*optional impedance available on special order.

CONSTANT DELAY BAND PASS

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

CASE SIZE—2" x 3½" x 4 13/16"
* INPUT IMPEDANCE = 500 ohms
* OUTPUT IMPEDANCE = 500 ohms and to grid



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Member ABP and ABC

Shoptalk . . .

DESIGN AUTOMATION—Will the engineer ever wind up replacing himself with a computer?

This is most unlikely. But engineers are learning how to make computers do many routine, time-consuming jobs in designing electronic equipment. Right now computers can digest specifications and print out block diagrams—even making corrections where the engineer's logic is faulty. Next step: to print out complete schematic diagrams.

Associate Editor Leary's story on p 20 will bring you up to date in a part of the automation business that may someday change every design engineer's method of operation.

TABULAR ARTICLES—Many of ELECTRONICS' most widely quoted engineering articles have included tabulated design data. In our repackaged format, the editors have taken steps to insure that every weekly issue carries some of this extremely popular material.

On p 42, Associate Editor Sideris lists some two dozen kinds of tape and film insulation, their physical and chemical characteristics, and their specific uses in electronic equipment.

On p 49, T. L. Greenwood, of the Army Ballistic Missile Agency, enumerates four types of electronic liquid-level detectors, their characteristics, where and how to use them.

AIRCRAFT EARLY WARNING—News of USSR's 9,000-mi ballistic missile is forcing another crash program. If the Soviet news is true, the U. S. is vulnerable throughout a 270-deg sector instead of the 90-deg polar sector presently covered by Ballistic Missile Early Warning System (BMEWS) radars in Alaska, Greenland and, possibly soon, in Scotland.

Plans to meet the 9,000-mi missile challenge include greatly augmented offshore patrol by long-range aircraft equipped with high-power radar. Proposals are streaming into Washington from firms anxious for a crack at a program that will reportedly cost more than $½ billion. Associate Editor Mason rounds out the picture on p 26.

Coming In Our January 9 Issue . . .

VOICE DATA LINK. In aircraft intercept operations, the necessity to automatically process radar data, and accurately and swiftly compute intercept paths, has resulted in rapid rates of data generation, according to C. W. Poppe and P. J. Suhr of Fairchild Camera & Instrument Corp. in Syosset, N. Y.

The authors describe a system which accepts the outputs of data-processing equipment and automatically converts them into a verbal message. The system avoids errors of human judgment and fatigue.

F-M CAPTURE. In conventional f-m reception, the weaker of two signals is normally suppressed, while the stronger signal is demodulated. In some instances the weaker signal may be the desired one.

E. J. Baghdady and G. J. Rubissow of Massachusetts Institute of Technology have devised a system in which a stronger and undesirable f-m signal is tracked and attenuated. The system permits reliable communication, may provide more efficient use of the spectrum.

High capacitance for low voltage circuits . . .

NEW TANTAPAK CAPACITORS*

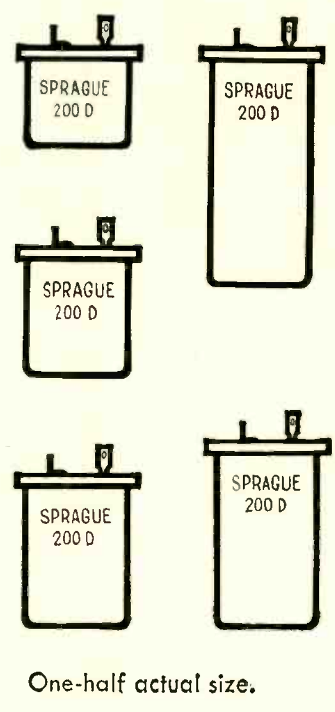
SPRAGUE'S TANTAPAKS are the newest members of the Tantalex* family of tantalum electrolytic capacitors. TANTAPAKS have as much as 2400 μf at 10 volts d-c or as little as 140 μf at 75 volts d-c. Five case sizes—ranging from less than a cubic inch to a mere 3½ cubic inches—are identical to Type CP-90 paper capacitors. Standard footed and spade-lug brackets simplify mounting. All units are dual-voltage rated for operation at both 85°C and 125°C under 2000 hour life tests.

The construction of TANTAPAK Type 200D capacitors assures excellent shock and vibration resistance. Glass-to-metal solder-seal terminals provide positive hermetic sealing. There are no electrolyte leakage problems.

Porous tantalum anodes give better leakage and temperature coefficient characteristics than foil-type capacitor sections of comparable ratings. In addition, the impedance and equivalent series resistance of Type 200D are superior to foil units at high temperatures and frequencies.

Get complete information by writing for Engineering Bulletin No. 3705. Address request to Technical Literature Section, Sprague Electric Co., 35 Marshall Street, North Adams, Massachusetts.

*Trademark



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Newest

HONEYWELL MINIATURE RATE GYROS

Typical M Series Gyro undergoes 20 G Linear Vibration Test with no deterioration of performance.

Rugged enough to withstand 100 G shock

Model M-1
shown actual size

Sensitive enough to detect 0.005° per second

Honeywell's newest miniature rate gyros, Type M Series, are rugged enough to withstand repeated shocks and linear accelerations up to 100 G yet sensitive enough to detect turn rates of only 0.005 degrees per second. A damping ratio variation of 2 to 1 or better is maintained without heaters by a unique fluid damped, temperature compensated system that assures reliable operation over the entire operating temperature range.

Type M Series Gyros are specifically designed for autopilot damping, radar antenna stabilization and fire control applications. Their small size, high performance and ruggedness suit them particularly for high performance military aircraft and guided missile applications. Write for Bulletin M to Minneapolis-Honeywell, Boston Division, Dept. 7, 40 Life Street, Boston 35, Mass.

DESCRIPTIVE DATA

FULL SCALE RANGE: to 400 degrees per second

THRESHOLD-RESOLUTION: 0.005 degrees per second

LINEARITY: 0.1 % to 2 % depending on range

DAMPING: 2 to 1 (or better)

TEMPERATURE RANGE: −65 to +200 and +250°F

SHOCK AND ACCELERATION: 100 G

VIBRATION: 20 G to 2000 cps

PICKOFF: Variable Reluctance type providing infinite resolution and high signal-to-noise ratio

MOTOR EXCITATION: 26 volts, 400 cps (standard) 2 phase and 3 phase

SIZE: 1″ diameter, 2 ¾″ long

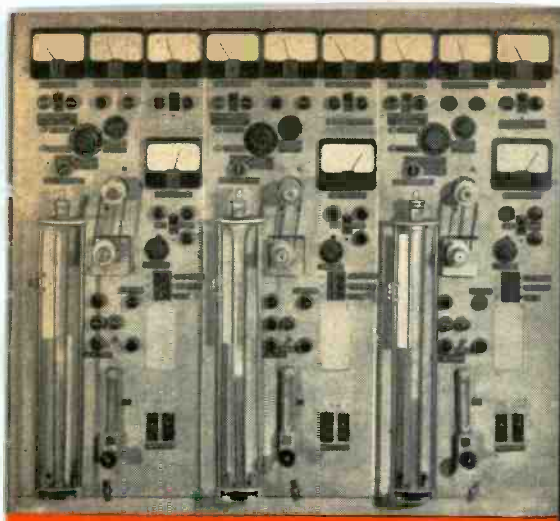
WEIGHT: 4.5 ounces

Honeywell

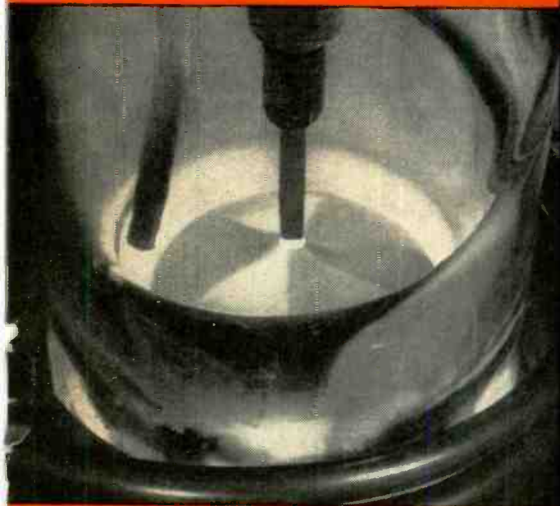
H HONEYWELL Military Products Group

CIRCLE 4 READERS SERVICE CARD

CIRCLE 5 READERS SERVICE CARD →



Trancoa's unique automated process assures product uniformity.



Rigid cleanliness test requires three-sixteenths inch clearance between test crystal and crucible.

TRANCOA SILICON... *Key to increased yields!*

Multiple Zone Refining of every lot permits accurate boron content measurement.

Three characterization crystals are grown from each lot — one for resistivity, type and lifetime determination; another for cleanliness; a third for boron content.

Higher quality silicon can improve your semiconductor device yields. *Trancoa* offers this higher quality at no increase in price!

Grade for grade, the superior quality of Trancoa Silicon is assured by our unique process and exacting specifications. In addition to the standard tests for resistivity, lifetime and base boron level — every lot of Trancoa Silicon must also meet two other important requirements:

Cleanliness — the vital factor directly affecting your crystal yield! Trancoa specifications require that a doped single crystal be drawn with only three-sixteenths of an inch clearance between crystal and crucible. Any fuming, dross, or wetting of the quartz is cause for internal rejection.

Resistivity Ratio — resistivity uniformity of doped crystals is improved perpendicular and parallel to the growing axis. Furthermore, the occurrence of P-N junctions is eliminated. Ratio of the resistivities at the 10% and 60% points on the test crystal may not exceed 3:1.

This combination of a new improved process plus added quality standards assures you of receiving better silicon, thus better yields, at no increase in cost.

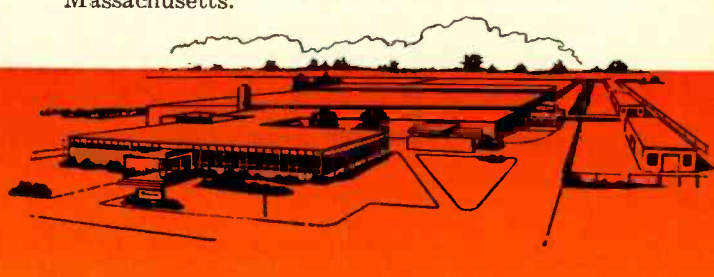
PRODUCT SPECIFICATIONS

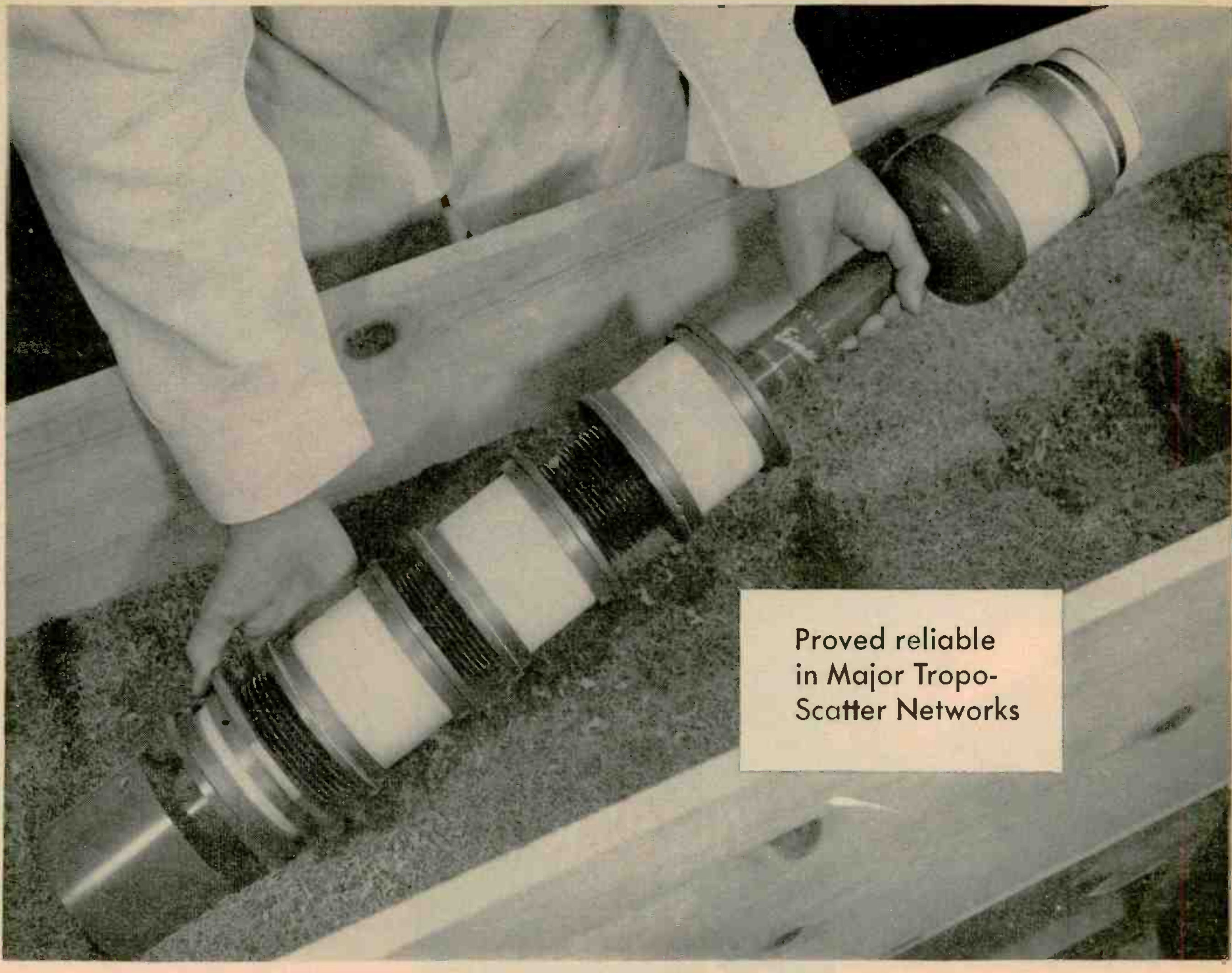
Grade	Resistivity P-Type	Resistivity N-Type	Max. Resistivity Ratio for 10% & 60% Points	Max. Boron Content (ppb)
IA	500	250	3:1	0.5
I	100	50	3:1	0.5
II	50	20	3:1	1.0
III	25	10	3:1	2.0
IV	2.5	1.0	3:1	4.0

For complete information write for brochure, *Trancoa Methods for Evaluating Silicon*, Trancoa Chemical Corporation, Dept. E-1, 312-326 Ash Street, Reading, Massachusetts.

Trancoa® chemical corporation

312-326 Ash Street, Reading, Massachusetts, Tel: REading 2-3900





Field experience indicates

15,000 hours from now, this Eimac 2KW KLYSTRON will still be in service

After three years of widespread service in such tropo-scatter systems as Dew Line, White Alice and Texas Towers, typical life of Eimac 3K3000LQ klystrons is nearing 15,000 hours and still increasing. Experience with Eimac klystrons in these and other tropo-scatter systems indicates that the 3K3000LQ will easily exceed 15,000 hours typical life. This exceptional record of long life and high performance is the result of Eimac's conservative design and advanced manufacturing techniques.

The Eimac 3K3000LQ is a 2 kilowatt klystron covering the frequency range of 610 to 985 megacycles. It will tune over the entire frequency range with one set of external cavities and is capable of meeting the bandwidth requirements of modern tropo-scatter systems.

Eimac's external-cavity design permits this wide tuning range and bandwidth, and also eliminates problems inherent in flexible vacuum seals. Systems' operating costs are significantly lowered since tuning circuitry need not be repurchased when tubes are replaced.

The 3K3000LQ is typical of the Eimac family of 1 and 2 kilowatt klystrons. Other tubes in this family, such as the 3KM3000LA, 4KM3000LQ, 3K2500LX and 3K2500SG, cover virtually all the frequencies from 375 to 2400 megacycles. For complete technical data on these exceptional power amplifier klystrons, write the Eimac Application Engineering Department.

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Eimac First with ceramic tubes that can take it

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ELECTRONICS NEWSLETTER

ATLAS MISSILE SATELLITE fired into orbit last month carried a communications system developed by U. S. Army Signal Research and Development Laboratory, Ft. Monmouth, N. J. Instrument package and receivers were developed with several electronics firms, including RCA's Astro-electronics division and Convair Astronautics division. System was designed to receive transmissions from the ground and later relay them with a transmitting power of 8 w on 132.435 and 132.905 mc directly back to earth or from storage on command; it handles one voice or seven teletypewriter messages. Two beacon transmitters operating on 107.938 and 107.97 are used for tracking. Total payload of 150 pounds includes two 35-pound packages, each containing a communications transmitter, recorder using erasable magnetic tape, zinc-silver battery and other components. GE gear takes care of tracking, measuring and ground-to-missile data transmission. Burroughs is responsible for ground-based computer which figures trajectory and determines commands for steering vehicle into orbit.

ARMY has ordered a solid-state computer of modular design for use by the U. S. Continental Army Command in simulated war games. IBM Military Products division, the developer, says the system will be transportable via truck and will permit participants representing many different units to take part at once in a simulated combat situation.

AIR FORCE CANCELLATION last month of diversionary surface-to-surface Goose missile was attributed to rapidly changing operational concepts. However, some observers see economy as an equally compelling reason. They think the air-launched Quail may do the same decoy job without the need for costly ground sites. Thompson Ramo Wooldridge, responsible for ecm on Goose, is also responsible for Quail's ecm.

FEDERAL AVIATION AGENCY is taking over the CAA Technical Development Center at Indianapolis and is transferring its activities to Atlantic City, N. J. There, all airways modernization R&D is being consolidated in FAA's National Aviation Facilities Experimental Center (NAFEC). As of yesterday, all CAA functions are part of FAA.

Gold-doped germanium cube under study by General Bronze looms as a possible infrared eye for the Sentry reconnaissance satellite. Placed in microwave cavity it detunes balanced bridge when illuminated.

REVISED PHYSICS INSTRUCTION in many U.S. colleges requires more and better types of electronic training apparatus. American Institute of Physics says a survey reveals need for: apparatus to illustrate recent developments in physics; apparatus to illustrate classical physics by use of improved techniques; and gear for physics demonstrations to large classes.

IGY 300-MILE ALTITUDE RESEARCH ROCKET was successfully fired last month by the Air Research and Development Command. Rocket reached height of 260 mi. with an overweight payload. Telemetered data indicated that the system design requirement—flight with a 50-pound payload to 300 mi.—had been achieved. Scientists said the "Spaerobee" rocket, which combines an Aerobee-Hi propellant rocket with a second-stage solid propellant Navy Sparrow, provides a "relatively inexpensive vehicle" to push beyond 100-mi. ceiling of previously-fired IGY rockets.

Soviet scientists claim to have achieved a 4-million C temperature in plasma, possible advance toward generating controlled thermonuclear power. How they did it is not revealed yet.

SOME 258 VORTAC STATIONS will be installed and ready for operation by June 30 at civil airfields all over the country. That's the report from International Telephone and Telegraph Corp. which announced a contract signing last month. ITT's service arm, Federal Electric Corp., will provide 40 teams of electronics experts to install and test the gear as it's delivered. So far, nine of the short-range navigation systems have been commissioned, with 26 operating on test.

BRITISH FIRM EMI Electronics, reported entering the U.S. industrial electronics market with a giant, high-speed computer (ELECTRONICS, p 7, Dec. 5, 1958), now says it's pushing into Canada too. EMI is joining forces with another British firm, A. C. Cossor, which already has a Canadian subsidiary making and selling defense, communications and technical instrumentation, radar and radio gear. EMI plans to finance expansion of the subsidiary, which it will control and rename EMI-Cossor Ltd.

NEW PARAMETRON COMPUTER is just reported developed at Japan's Tohoku University. Nippon Electric Co. worked with the university to overcome the nine-digit limitation of earlier computers using the Japanese magnetic devices. New unit handles figures containing up to 12 digits and can take 200 different instructions.

TWO HAWK MISSILE CONTRACTS totaling $35.4 million was awarded Raytheon Manufacturing Co. Army's Boston Ordnance District awarded a $14.8-million contract for Hawk production, a $20.6-million contract for production of ground support equipment for the Hawk program.

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SONIC ENERGY CLEANING

CIRCLE 7 READERS SERVICE CARD

WASHINGTON OUTLOOK

INDUSTRY INTEREST in the Air Force's proposal for a third ballistic missile early warning system (BMEWS) site has been rekindled by reports from London that United States and British scientists are "discussing plans for a powerful radar station in north Scotland to warn against possible missile attacks."

Earlier this year, the Pentagon had shelved plans for a third BMEWS installation near Prestwick, Scotland, and approved work on only two sites—at Thule, Greenland, and near Fairbanks, Alaska—at a total cost of $800 million. About half this sum will be spent on development, manufacture, and installation of electronic equipment.

The apparent resumption of planning for the Scotland BMEWS site, however, does not necessarily mean work orders for the project are imminent. The Defense budget for fiscal 1960 won't even include requests from Congress for a construction authorization or a construction appropriation —two requisites before work on the bases can begin.

But the Pentagon needs no such specific approval from Congress to begin procurement of the additional electronic equipment for the third BMEWS installation.

Upcoming budget, therefore, will not necessarily provide a tip-off on whether the third BMEWS base has now been approved by the Pentagon.

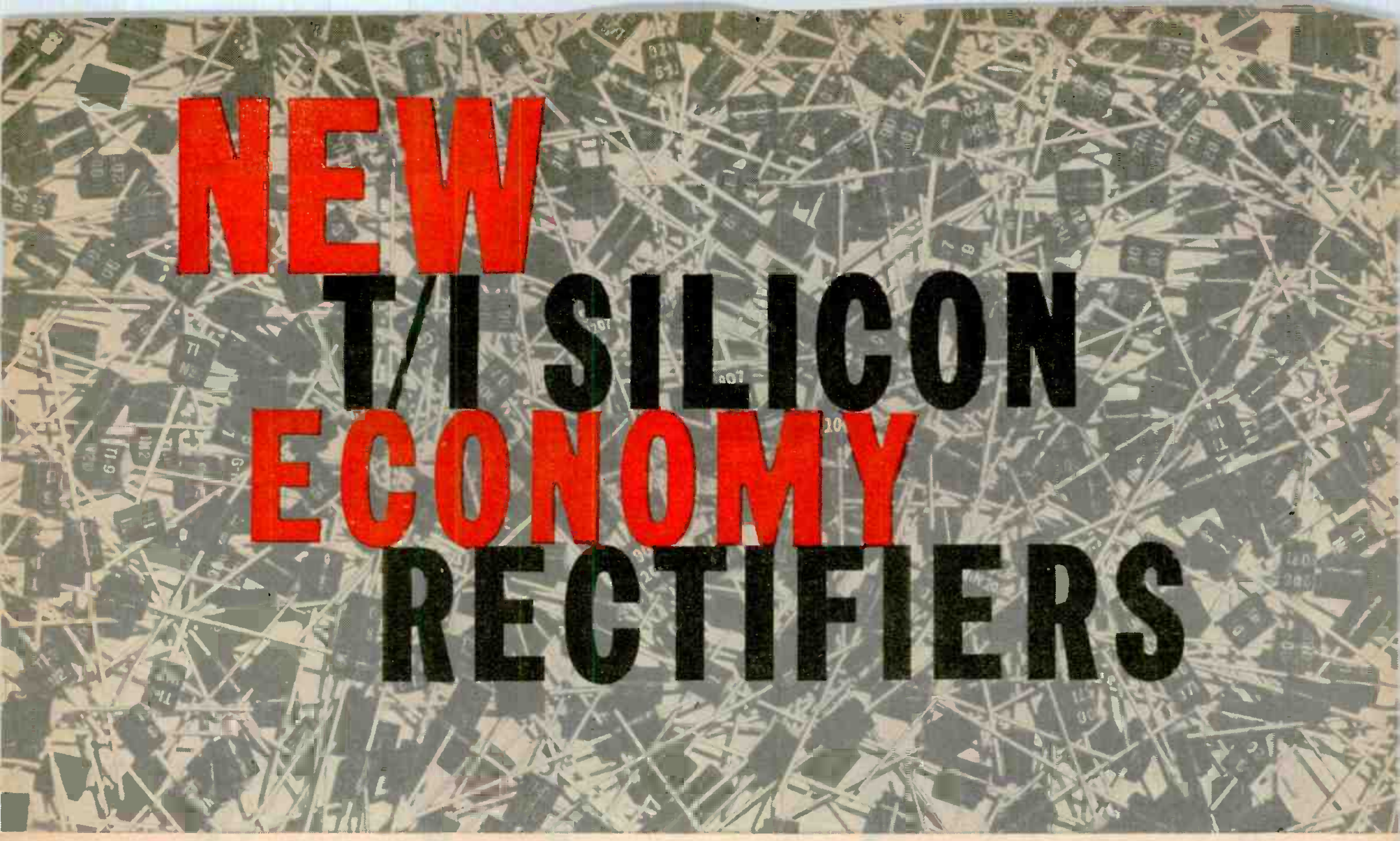
RCA holds the Air Force's prime contract as system manager for the BMEWS program. Major subcontractors are GE, Goodyear Aircraft, Sylvania, and Western Electric.

- **Electronics companies** once more dominate the Pentagon's latest listing of the 500 leading industrial prime contractors for military research and development work.

  New listing covers contracts awarded in fiscal 1958, which ended last June 30. With just a handful of exceptions, the top 50 companies are either electronics producers, aircraft companies or firms in other hard-goods industries which have diversified into electronic work.

  For the second straight year, GE tops the list. During fiscal 1958 its prime military R&D contract awards amounted to $302 million. Following in the contract ranking: North American Aviation, $288.3 million; General Dynamics, $256 million; Boeing, $245.3 million; Lockheed, $181.1 million; Martin, $168.9 million; Westinghouse, $163.4 million; Sperry Rand, $139.3 million; Douglas Aircraft, $136.8 million; and Hughes Aircraft, $132.2 million. The sums for companies like NAA and General Dynamics, of course, include electronic work.

  Other leading electronics R&D contractors: Western Electric, $116.7 million; Raytheon, $65.6 million; RCA, $60.8 million; Ramo Wooldridge, $44.5 million; American Bosch Arma, $44.3 million; Bendix, $31.2 million; IBM, $28.5 million; Burroughs, $25.2 million; Sylvania, $19.8 million; Minneapolis-Honeywell, $17.3 million; Collins Radio, $17 million; ITT, $16 million; Motorola, $14.7 million; Philco, $13.8 million; Melpar, $13.6 million; Aeronutronic Systems, $10.3 million; Litton Industries, $9.4 million; Hallicrafters, $8.6 million.



ACTUAL SIZE PHOTO

. . . give you 750 mA at 200, 400 and 600 PIV

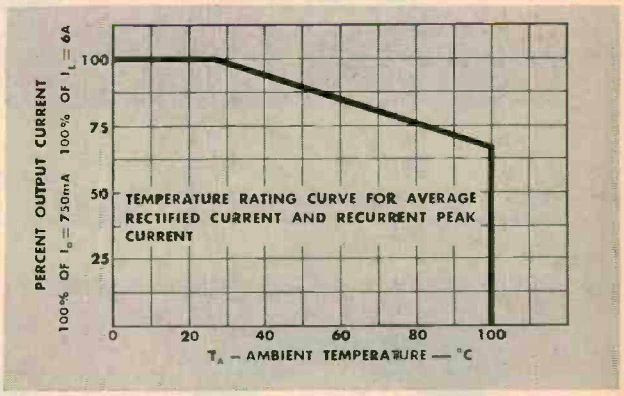
IMMEDIATE DELIVERY! You get the inherent high reliability of silicon with new TI silicon economy rectifiers *now available in commercial production quantities!*

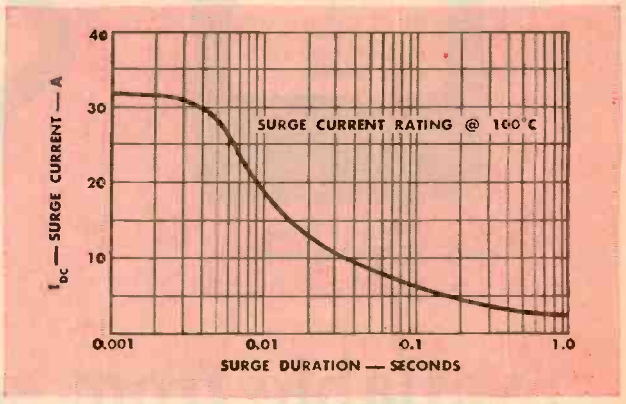
These newest TI rectifiers withstand a surge current of 32 amps up to one millisecond and operate at temperatures up to + 100°C. Miniature nylon-epoxy case, 0.25 inch long and 0.20 inch in diameter, meets the rugged environments of MIL-STD-202A.

Priced competitively with selenium and germanium rectifiers, the new TI series is ideal for use in your low current power supplies, computer circuits . . . for your large volume applications where small size, reliability and *low cost* demand important consideration.

Check the specifications below for the unit most suited to your particular requirements.

Quantities to meet your immediate needs are now in stock at TI distributors or through your nearest TI sales office.



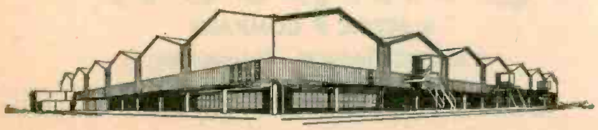


Max Ratings at 25°C

		1N2069	1N2070	1N2071	
PIV	Peak Inverse Voltage	200	400	600	V
Vrms	RMS Voltage	140	280	420	V
I_o	Average Rectified Forward Current	750	750	750	mA
i_f	Recurrent Peak Current	6	6	6	A
T_A	Operating Temperature	————	to +100	————	°C

Electrical Specs at 100°C

	1N2069	1N2070	1N2071	
Maximum Dynamic Reverse Current	.2	.2	.2	mA
Maximum Dynamic Forward Voltage Drop	.6	.6	.6	V



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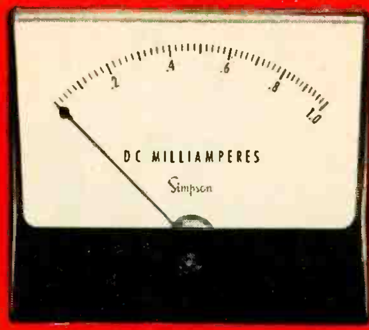
CIRCLE 8 READERS SERVICE CARD

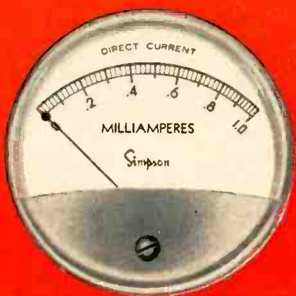
Meter Relays: 2" and 3"; AC and DC

Edgewise: Vertical, DC

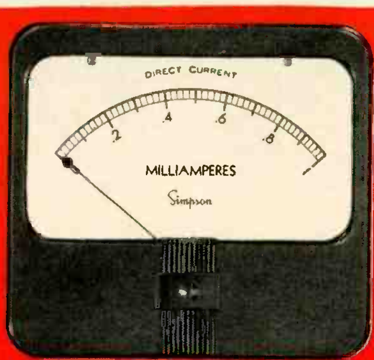


Wide-Vue: 2½", 3½", 4½"; AC and DC

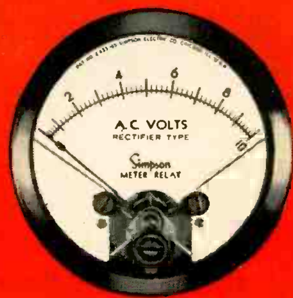
These are Simpson panel instruments...



Round: 3", DC



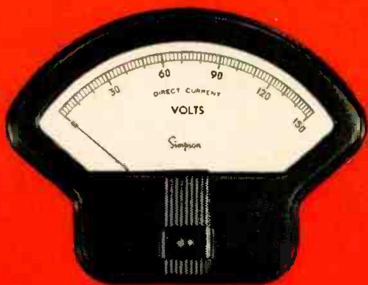
Rectangular: 4", 4½", 5½", AC or DC, RF; 7" and 9", DC or RF



Front Adjust Relay: 2½", 3½", 4½"; DC. Rectangular also.

engineered and built to stay accurate...

Elapsed Time: 3½"; 60-cycle AC



Fan Shape: 4½", AC or DC

Modernistic: 2½", 3½", 4½", 5½"; AC, DC, RF

available from stock or custom-built

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Sylvania-GT Vote Feb. 11

SYLVANIA AND GENERAL TELEPHONE stockholders will vote Feb. 11 on proposed merger of the two firms. If approved, merger will become effective early in March. For merger details see ELECTRONICS, p. 6, Nov. 28, 1958.

• **Stock splits** wax popular among electronics firms. Latest announcement comes from **ITT**, which plans a 2-for-1 split. **Nuclear-Chicago** and **Lockheed Aircraft** also recently arranged for 2-for-1 splits of their stocks. Splits increase number of shares held by stockholders but leave their percent of ownership interest unchanged. Splits are common in

Arnold Malkan, a director of the firm and formerly board chairman of **General Transistor**, has agreed to purchase all of remaining shares if 100,000-share minimum subscription figure is reached. Organized last Oct., firm intends to make silicon power transistors and silicon diodes. Proceeds will be used to purchase manufacturing and test equipment and for working capital.


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WITH
ATR
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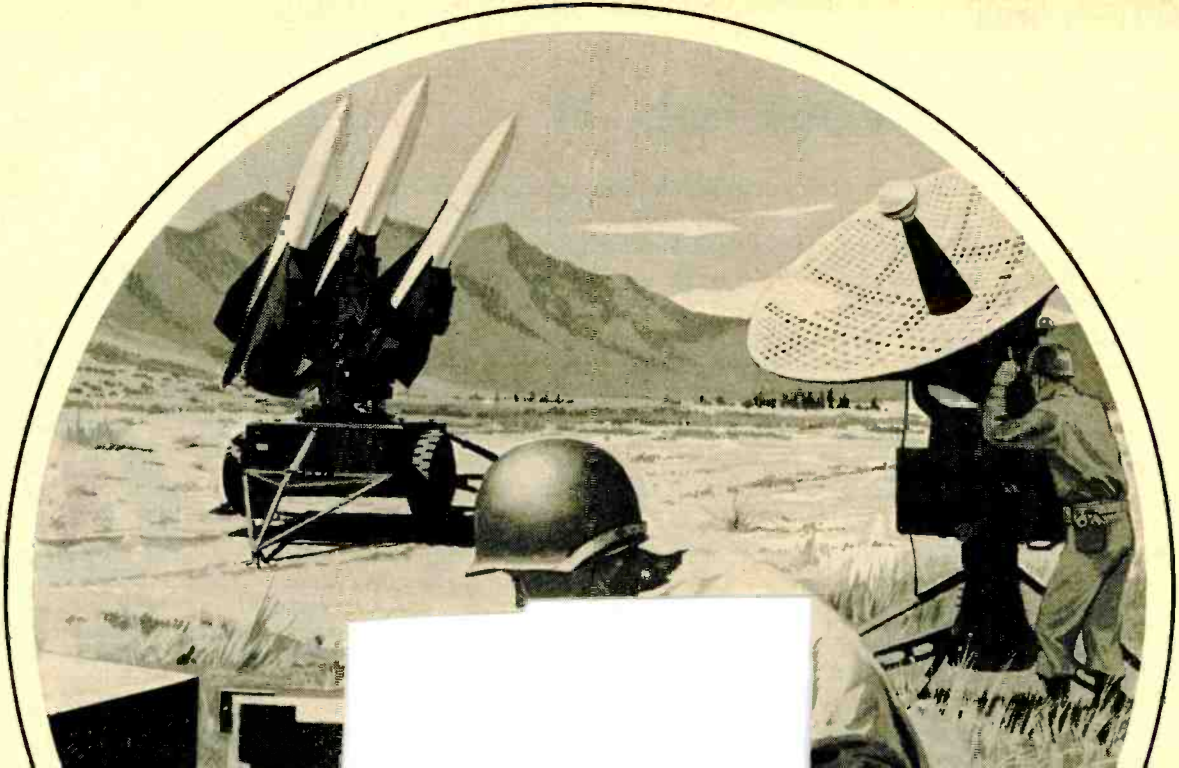

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WIDEST VARIETY of Alumina materials available from any source. Vitrified or porous compositions . . . 85% and higher. Industry approved . . . accurately controlled. Greater freedom for designers who can usually find in our special purpose AlSiMag Alumina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

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

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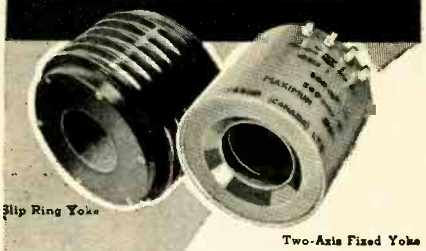
PRECISION DEFLECTION WITH COSSOR YOKES



Component Development Engineering at its BEST!

- ADVANCED ELECTRICAL DESIGN
- PRECISION MECHANICAL DESIGN
- ACCURATE PRODUCTION METHODS

Custom Built to the most Exacting Specifications by Cossor Engineers

In Mumetal Cores for Optimum Geometry
In Ferrite Cores for Speed and Sensitivity
In Non-magnetic Cores for Perfection of Response

Any of Cossor's Three Core Types can be made in single or double axis with single or push-pull windings, and encapsulated for fixed or slip ring (rotating) use.

Normal characteristics of yokes for 1-1/2 in. neck tubes are:

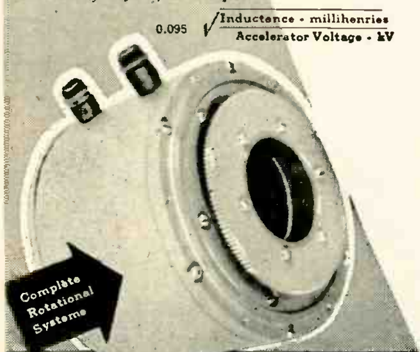
Positional accuracy - the spot position will conform to the yoke current co-ordinates within 0.25% of tube diameter. For deflection angles less than ± 25° better accuracy can easily be achieved.

Memory - 0.5% max. without overswing; 0.1% or less with controlled overswing.

Complete encapsulation in epoxy (stycast) or silicone resins is standard for all Cossor deflection yokes, and is done with special moulding tools ensuring accurate alignment of the yoke axis. When slip rings are added, solid silver rings are mounted in encapsulating resin. The finished slip ring yoke is precision turned to centre bore, and can include bearing mounting surfaces with dimensional tolerances approaching those associable with high quality metal parts.

Settling Time (Micro sec.) = 120 √Inductance in Henries

Sensitivity degrees/ milliamperes = 0.095 √(Inductance - millihenries / Accelerator Voltage - kV)



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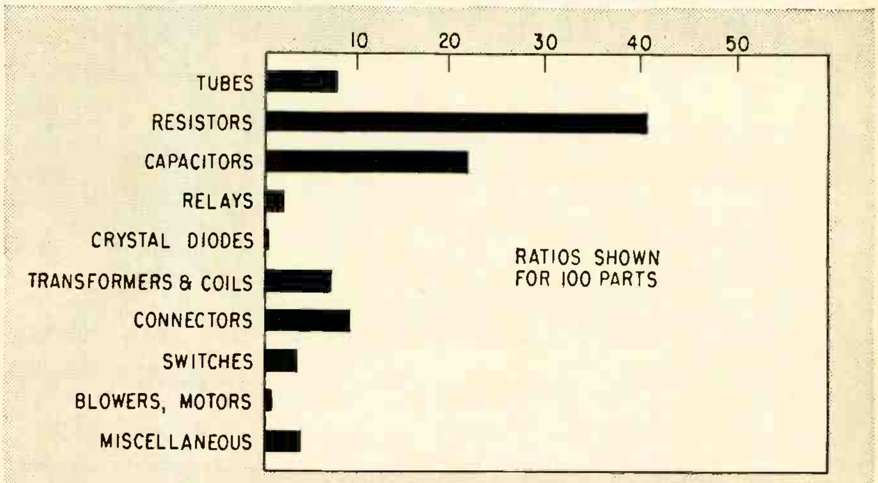
CIRCLE 13 READERS SERVICE CARD

Survey Gives Parts Ratios



RELATIVE NUMBER OF COMPONENTS IN NONTRANSISTORIZED MILITARY COMMUNICATIONS SETS-1958

RECENT BREAKDOWN of components in military sets gives component-makers one yardstick for production. These manufacturers often try to relate their projected output to probable electron-tube production.

In the graph above are shown relative numbers of circuit components in more than a dozen of the latest declassified military radar, direction finding and communications sets not using transistors. These particular sets probably represent the highest degree of nontransistorized, nonhybridized circuitry which will be employed for radar and communications sets.

The bars show how many parts per one hundred components of all types will be electron tubes, how many capacitors, resistors, etc. Converting the parts per 100 to simple ratios per electron tube provides the following: Resistors, 5.0; capacitors, 2.8; relays, 0.26; crystal diodes, 0.09; transformers and coils, 0.93; connectors, 1.2; switches, 0.49; blowers and motors, 0.1; miscellaneous, 0.52.

• **Government spending** is going to continue growing far into the future, although our industrial and consumer markets will also become increasingly larger. Military spending is seen providing the market for about half of all electronic end products for many years ahead.

Despite a poor showing in the first half of 1958, sales for the year were up from 1957's totals. Sales by major categories were: Military, $4.5 billion; industrial, $1.37 billion; and home entertainment, $1.3 billion.

These totals exclude sales of replacement parts, broadcast time and talent, service and distribution income. Comparable figures for 1959 will probably be: $5 billion, $1.5 billion, and $1.5 billion respectively.

Electronics' share of both aircraft and missile expenditures is increasing rapidly. Likewise it seems certain that military expenditures for fiscal 1960 will be considerably higher than present budget estimates.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Dec. 12 1958	Nov. 14, 1958	Change From One Year Ago
Television sets	97,172	112,202	—16.4%
Radio sets (ex. auto)	318,894	364,943	—14.6%
Auto sets	122,914	113,309	+ 3.9%

STOCK PRICE AVERAGES

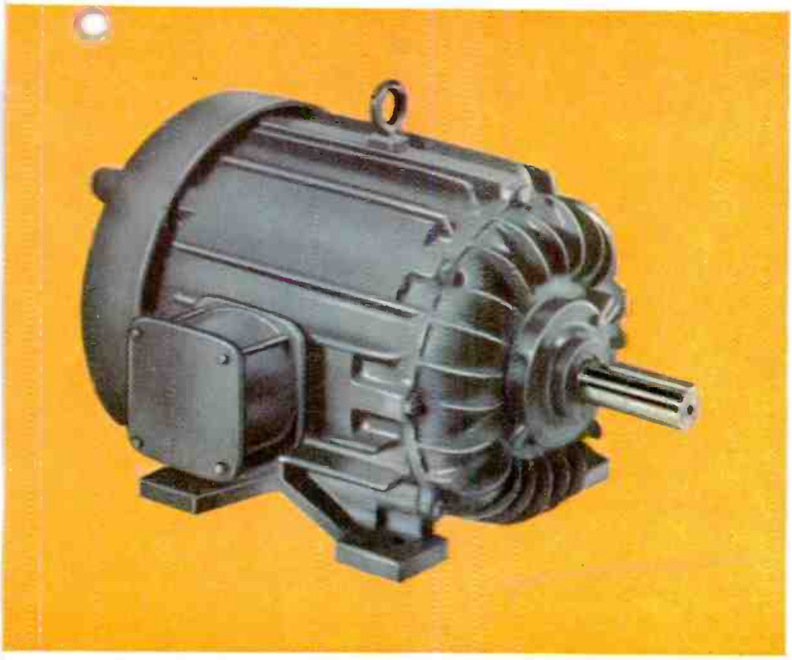
(Standard & Poor's)	Dec. 17, 1958	Nov. 19, 1958	Change From One Year Ago
Electronics mfrs.	71.05	66.64	+41.3%
Radio & tv mfrs.	80.16	69.18	+99.9%
Broadcasters	77.98	75.67	+55.7%

LATEST MONTHLY SALES TOTALS

(Add 000)	Oct. 1958	Sept. 1958	Change From One Year Ago
Transistors, value	$13,462	$10,811	+90.3%
Transistors, units	5,595	5,076	+57.9%
Rec. tubes, value	$34,362	$33,951	—10.6%
Rec. tubes, units	41,540	40,061	—11.8%
Pic. tubes, value	$19,352	$17,704	— 0.7%
Pic. tubes, units	957	892	— 3.9%

CIRCLE 14 READERS SERVICE CARD →

EPOXY–Anaconda Magnet Wire for outstanding compatibility at high temperature



Epoxy's unique combination of dependable characteristics makes it suited to use in such equipment as totally enclosed motors, above; hermetically sealed relays, encapsulated dry-type transformers, below.

Anaconda Epoxy Magnet Wire is particularly well suited to use in oil-filled transformers. Epoxy's excellent behavior in transformer oils is but one of its many outstanding chemical characteristics.

The compatibility, chemical stability, and thermal stability, of Anaconda Epoxy have been proved by some three years of actual field experience, plus seven years of research and development, in both military and civilian applications.

Anaconda Epoxy (130°C AIEE Class B) magnet wire is compatible with most well known insulations. It offers excellent resistance to moisture, transformer oils, acids, and alkalies. Tests of Anaconda Epoxy magnet wire with all impregnating varnishes tried to date have resulted in chemically compatible systems—with no thermal deterioration of the Epoxy film.

Epoxy's unique combination of dependable characteristics makes it suited to a wide variety of difficult applications. Its outstanding dielectric strength, its heat-shock, adherence, and flexibility properties make it an "all around" magnet wire for use up to 130°C in either open or closed systems.

ROUND, SQUARE AND RECTANGULAR. Anaconda Epoxy magnet wire is available in the full range of round, square and rectangular sizes. It can also be furnished in combination with glass servings.

If you have a difficult Class B application or a troublesome job at lower temperature that might benefit from some other characteristic of Epoxy, see the Man from Anaconda. Or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N.Y.

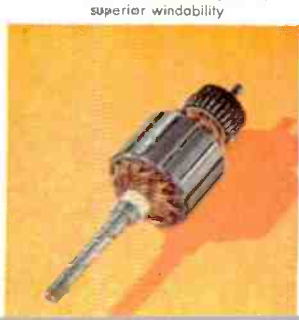
58365

ASK THE MAN FROM **ANACONDA®** *about* **EPOXY MAGNET WIRE**

For more details on Anaconda Epoxy's unique combination of useful characteristics, please turn the page—

ANATHERM 155°C (AIEE Class F)
high temperature resistance

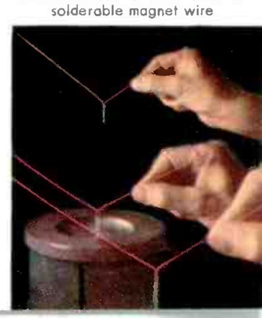
NYFORM 105°C (AIEE Class A)
superior windability

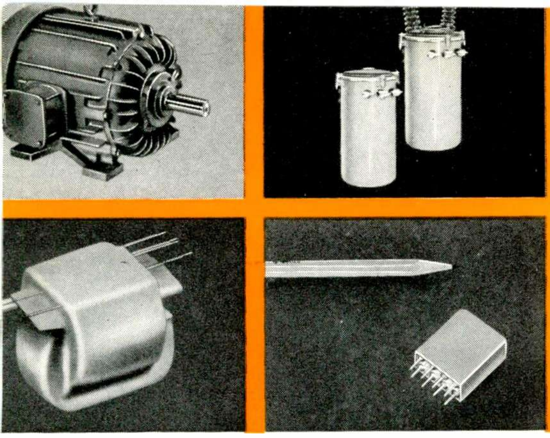


VITROTEX 130°C (AIEE Class B)
glass-insulated, high heat resistance

FORMVAR 105°C (AIEE Class A)
proven dependability

ANALAC 105°C (AIEE Class A)
solderable magnet wire





MAGNET WIRE DATA SHEET

from

Anaconda Wire & Cable Co.

TEAR OUT FOR YOUR FILE

IMPORTANT FACTS FOR YOUR WORK...

...about Anaconda Epoxy 130°C (AIEE Class B) Magnet Wire

Anaconda Epoxy film-coated magnet wire is suitable for use in 130°C (Class B) hottest spot operation. It meets MIL-W-19583 requirements. Epoxy is compatible with other insulations and performs excellently in oils. It offers unusual resistance to moisture and has a higher resistance to heat shock than other Class B wires. This unique combination of properties makes it applicable to a wide variety of difficult applications.

SUGGESTED APPLICATIONS

Oil filled transformers • Air conditioning systems where moisture is a problem • Refrigeration machines for operation with fluorinated hydrocarbon refrigerants • Totally enclosed motors, transformers, alternators • Encapsulated windings of virtually any type.

MECHANICAL PROPERTIES

Epoxy offers outstanding adherence and flexibility. It meets the exacting demands of abrasion resistance called for in high-speed winding machines.

ELECTRICAL PROPERTIES

Epoxy magnet wires exhibit high dielectric strength—a minimum of 2000 volts per mil under dry test conditions. The following are dielectric constant and dissipation factor measurements at 25°C and 50% RH:

Frequency Cycles per Second	Dissipation Factor %	Dielectric Constant
60	0.37	4.63
1,000	0.48	4.60
10,000	0.96	4.55
100,000	1.95	4.45

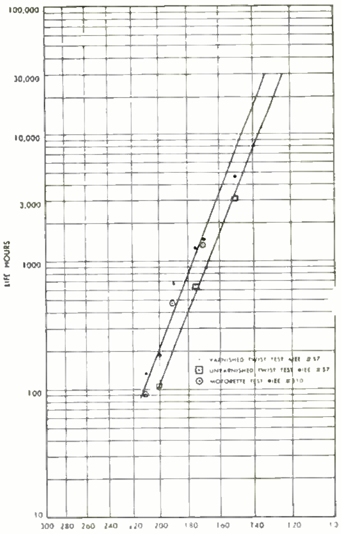
CHEMICAL PROPERTIES

Epoxy offers outstanding chemical characteristics. The Epoxy resins are characterized by their resistance to attack by compounds they may come into contact with when used in electrical apparatus. Epoxy shows exceptional resistance to 5% potassium hydroxide, 5% sulphuric acid, VM&P naphtha, ethyl alcohol, xylol, toluol. Epoxy wire has given excellent results in test programs designed to determine the effects of fluorinated hydrocarbon refrigerants. Scrape abrasion resistance is high under Freon. Freon 22 does not blister and attack the coating. Epoxy does not hydrolize in closed systems.

Epoxy is outstanding in its behavior in transformer oils. It will also withstand the action of lubricating oils at high temperature. In fact, such oils sealed in glass tubes with Epoxy wire and heated to 150°C do not damage the insulation, even when the oils have been contaminated by long use.

THERMAL PROPERTIES

Epoxy is a 130°C (Class B) magnet wire. This rating is based on AIEE test procedures. The wire is also intended for use at lower temperatures where the choice may be made to take advantage of some other characteristic. It also can be used at higher temperatures for shorter life or in some special applications. Please refer to the thermal stability chart.



Thermal stability, Epoxy round magnet wire

THERMOPLASTIC FLOW. Epoxy magnet wire meets the 200°C minimum requirement of Specification MIL-W-19583 for 130°C systems.

RETENTION OF FLEXIBILITY. Epoxy magnet wire can be heated for 168 hours at 125°C and then wound on its own diameter without cracking.

HEAT SHOCK. Epoxy magnet wire offers outstanding heat shock characteristics, as indicated by the following table (Wires are stretched or not stretched, then wound on mandrels having X times the diameter of the wire and placed in an oven at 155°C for one hour):

Prestretch %	1X	3X	5X	10X
0	Pass	Pass	Pass	Pass
10	Fail	Pass	Pass	Pass
15	Fail	Pass	Pass	Pass
20	Fail	Pass	Pass	Pass
25	Fail	Fail	Pass	Pass

MOISTURE RESISTANCE

Epoxy magnet wire can be used when sealed in electrical apparatus where water is contained in other materials. Small coils in water at room temperature for 18.000 hours (2.1 years) maintained a very high insulation resistance between the copper and water. Epoxy wires sealed in glass tubes with a small amount of water can be heated for a month at 150°C without destruction of the enamel coating.

All-Epoxy insulation systems. Materials are now available to make possible complete Epoxy systems that offer superior thermal and chemical stability and maximum environmental protection. Detailed information available on request.

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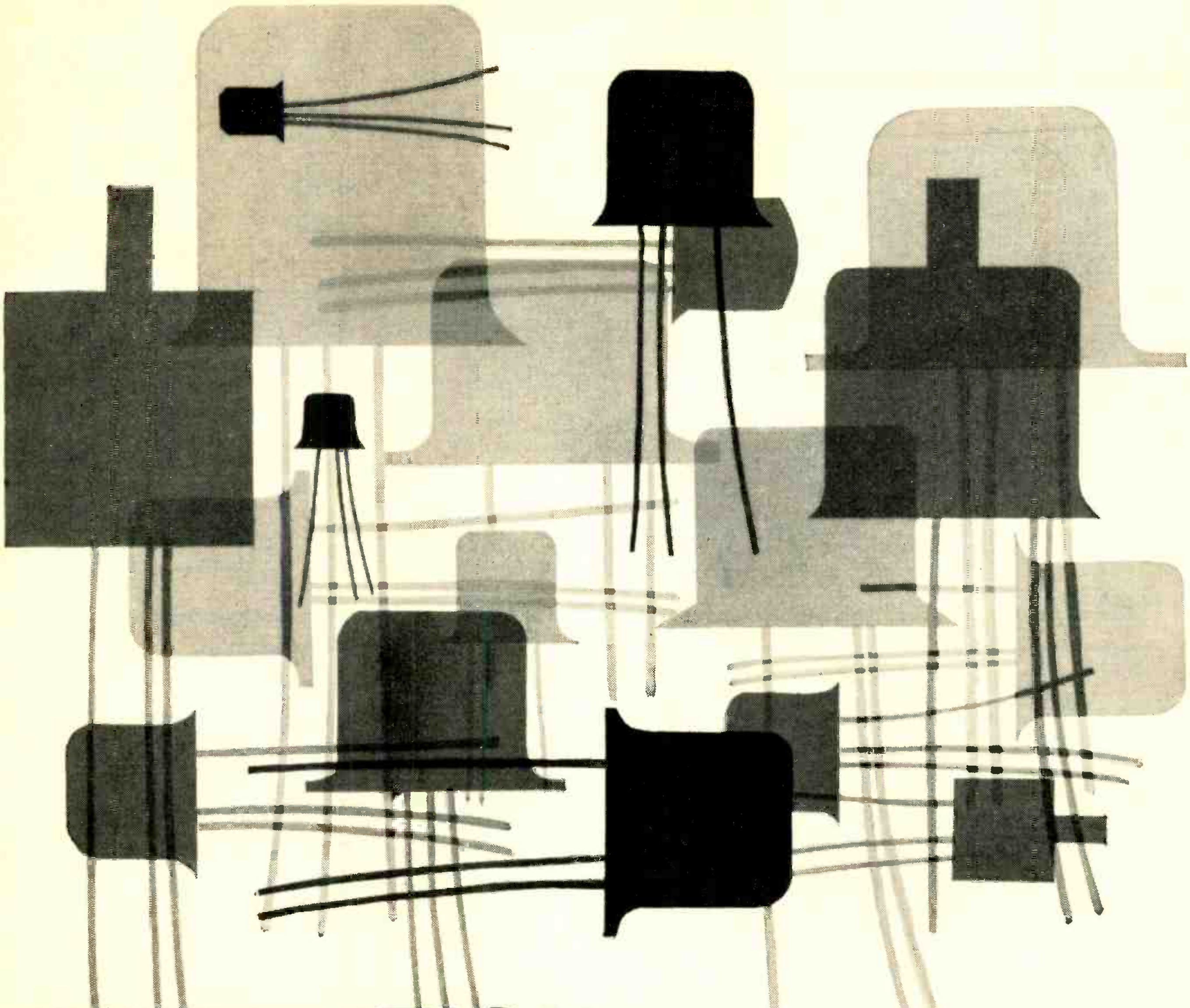

INSPIRATION IN RADIO ELECTRONICS

Think big has always been the order of the day in radio electronics. Galvani, Marconi and you either have changed or can change the world with a thought or an idea unheard of before. Seeing all that's new at the 1959 IRE SHOW can spark your new idea—can be your inspiration. Big in number of manufacturers and suppliers exhibiting, big in number of top radio electronics experts, big in number of important developments on display—that summarizes this year's CONVENTION and SHOW. Don't miss this once-a-year opportunity for man-to-man talk with the thinkers, planners and doers in your field of specialty.

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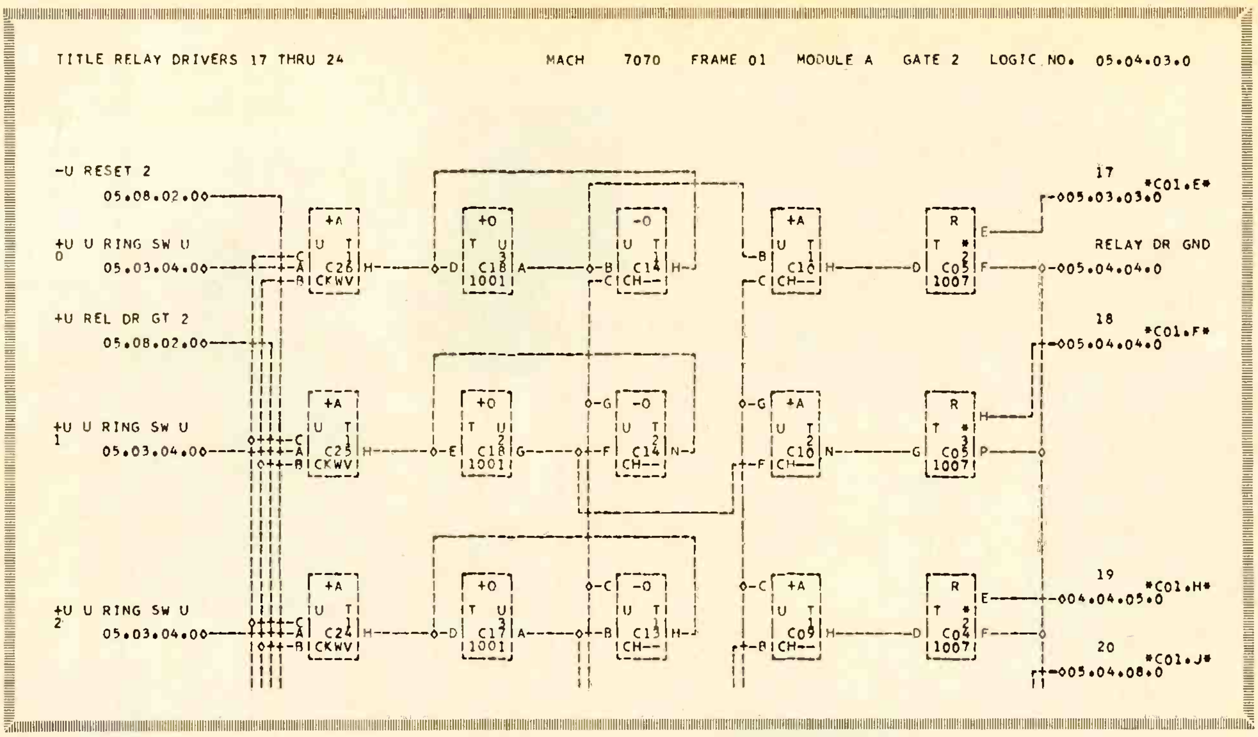


From an engineer's rough logic sketch, IBM computer produces a finished drawing. Diamonds are connection points

In Go Specs—Out Come Plans

Having built up the data-processing technology, it figured that engineers would get around to using it. All across the country, computermen are learning how computers can be used to do engineering design

COMPUTER laboratories all over the country are investigating the feasibility of assigning electronic circuit design work to computers.

Development results from pressure of steadily increasing demand for engineering. Complicating this is the prospect of a steadily diminishing supply of engineers: engineer enrollments in colleges dropped 7 percent this year.

At the moment, computers can work efficiently at technological levels that require strong engineering background. But it's not creative engineering.

Many engineers spend too much time buried under routine operations, chasing electrons through circuits. Such stickwork, involving control of engineering data, can efficiently be performed by a computer.

Print Diagrams

The machine has to work with standard elements. IBM's current programs, for instance, required the standardization of several score "building blocks"—AND and OR circuits, amplifiers, inverters, delays, and so forth.

Not too far off are programs that will work directly with basic components, while the engineer merely specifies input, output and such basic parameters. In these near-future programs, the computer will design to order, for maximum reliability, or for optimum cost or reliability. To help such programs along, there are already in existence machines which can print and typeset schematic diagrams (see ELECTRONICS, p 122, Dec. 5 '58, "Machine Composes Schematics").

Engineering with computer help is not new, although its extension to circuit design has come about only recently. Analog computers have been used for analysis of electrical networks for years, and mechanical design of gears and flanges was undertaken on digital data-processing systems as long ago as 1953. The *Nautilus'* steam system was also computer-designed.

In 1956 and 1957, computer-makers began solving the simpler design problems on computers. Backboard wiring layout, optimum connection systems and so forth were worked out by Boolean techniques. Logical designers also began "test-flying" advanced systems designs on older computers, saving hundreds of hours of laboratory and breadboard experimentation. Second generation of computers now emerging from the labs reflects this work.

Designs Circuits

Crash programs triggered the increase in interest in this work. IBM designed many of the circuits for its new solid-state 7070 system on the 704. RCA, speeding the design of the complex ballistic-missile early-warning system, developed programs which produced circuit drawings ready for the assembly department. Burroughs and Remington Rand are working with similar engineer-aid programs.

IBM's present programs were developed to be run on the 704 or 705 systems, and are used in both its data-processing and military products departments. The programs can attack the design problem from any of several points. In commonest usage, the engineer starts with his barrel of logical circuit elements and the overall logical design—the master plan—of the system. He roughs the elements into a block diagram representing the logical design of the particular circuit. The computer checks the design sketch, adds amplifiers or driver stages where needed to keep signal levels up or reshape pulses, and makes all the routes and connections between basic elements. A modified printer draws the final diagram with all connections specified (see cut).

The program also determines whether or not specific connections require coax or twisted pair. By-product of the program is the wire routing list.

The computer does not use Boolean techniques in checking and implementing the logic sketch. It essentially applies ideal engineer rules and tests the sketch against these rules. The program uses rat-in-a-maze techniques to select optimum routes and connections. If it finds that the circuit, as sketched by the engineer, contains unsatisfactory logical or electrical situations, it prints out the errors.

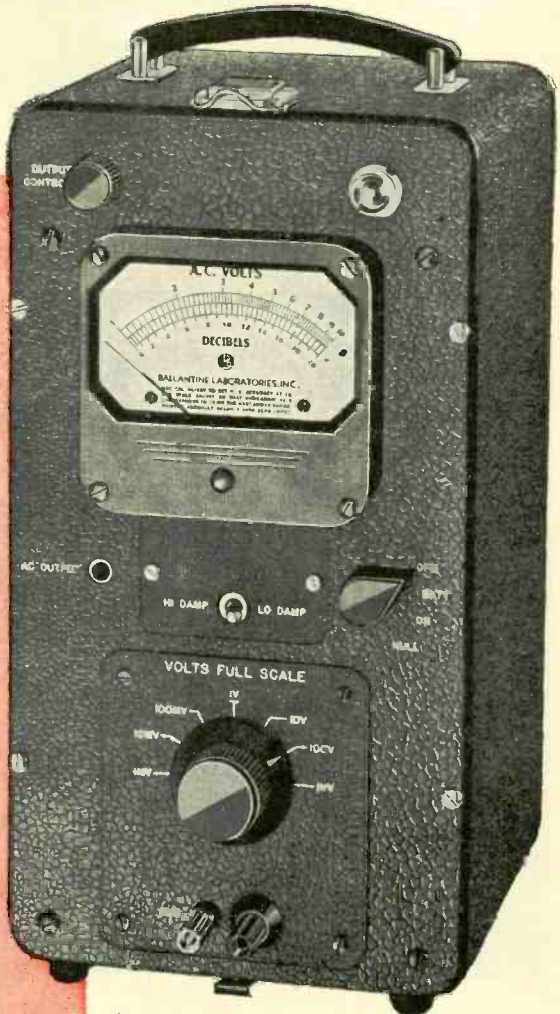
Specifies Connections

In the design of the backboard wiring for the Livermore Atomic Research Computer, Remington Rand's programmers also let their computer figure out which connections should be twisted-pair. Starting only with the layout of the printed-circuit cards for each circuit type, and the logical diagram of the system, the computer specified each of the hundred-thousand-odd connections, produced transistor classification sheets, parts inventories and similar production documents as byproducts.

Experience thus far indicates that, although many engineers don't trust the results at first, they're quickly converted. Relief from wearisome tasks is the principal converting factor.

Ballantine SENSITIVE ELECTRONIC VOLTMETER

Battery Operated



VOLTAGE RANGE: 100 microvolts to 1000 volts rms of a sine wave in 7 decade ranges.

INPUT IMPEDANCE: 2 megohms shunted by 10 mmfd on high ranges and 25 mmfd on low ranges.

FREQUENCY RANGE: 2 cps to 150,000 cps.

ACCURACY: 3% except 5% below 5 cps and above 100,000 cps and *for any point on meter scale.*

MODEL 302C—Price $245.

- Available accessories increase the voltage range from 20 microvolts to 10,000 volts.
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Right—*Kenneth J. Carlson*, Director of Manufacturing, and his men transform theories and designs into physical realities, utilizing the skills of all three departments to meet every production requirement—*on schedule!*

Mechanical Division teamwork plays a vital role in *all* our current activities, including: *Search and Track Systems* (infrared optics, visual optics, radar, antennas, slave platforms) *Guidance and Navigation Systems* (computers, and inertial or navigational platforms) *Underwater Ordnance Weapons* (torpedoes, depth charges and related mechanisms) and *Missile Sub-Systems* (mechanical, electro-mechanical or electronic controls). *For complete details, address inquiries to: Dept. AW-12,*

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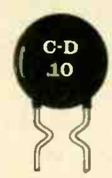
Ideal for limited space and low-voltage requirements of portable radios and a variety of other miniature battery-powered and line-powered equipment. Excellent for bypass and coupling. Tough phenolic coating affords excellent insulation while protecting against severe humidity and vibration. For further information, write for Bulletin SEB-2 to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.



Crimped and Straight-Cut Leads for Automation. These units are available in 600 and 1000 VDCW units on types C, JA, JB, JC, BYA and other General Purpose capacitors. Crimped-lead units prevent bottoming on the printed wiring board assuring positive contact for soldering. Straight-cut leads save height off the board and may be inserted to circumference of disc.

Controlled phenolic dip avoids "rundown" of the phenolic on straight-cut leads. Assures always-uniform soldering connections.

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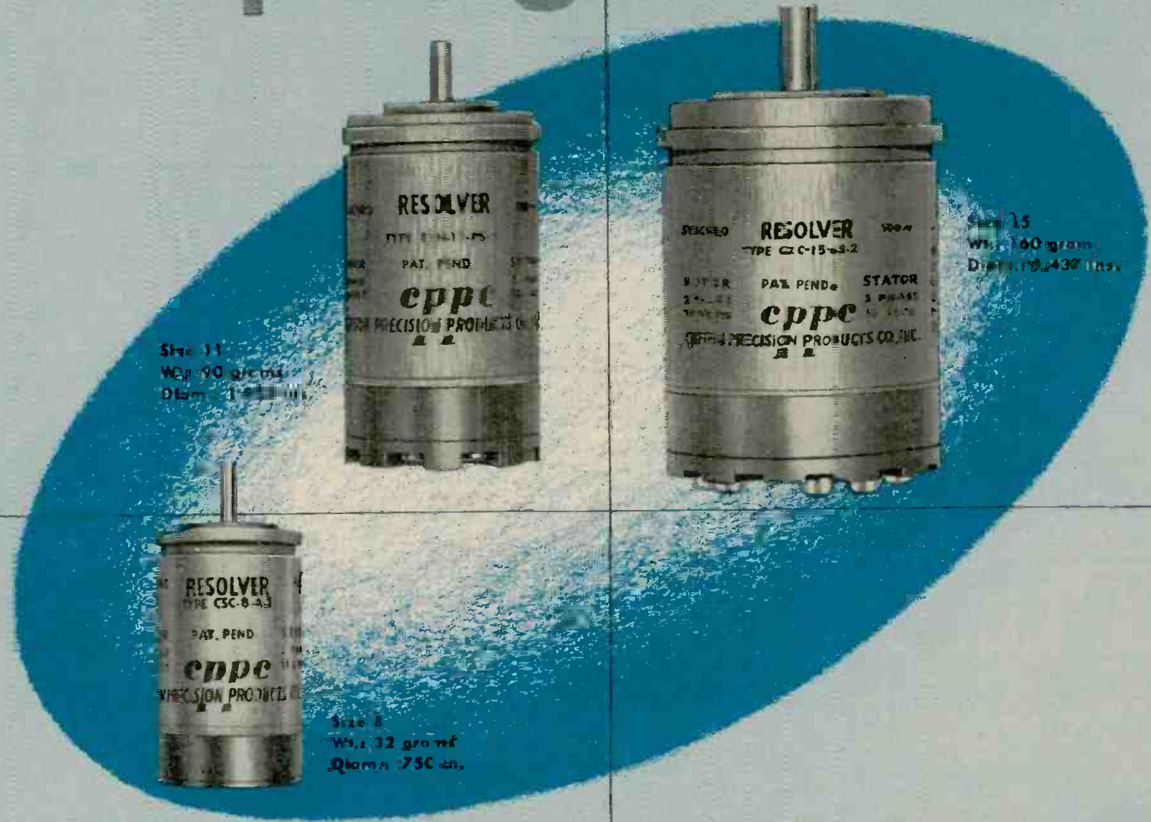
Precision Computing Resolvers



ACCURACY

Highest accuracy in rotating components is a CPPC fundamental. Our Precision Computing Resolvers are no exception. Without compensation, a recent production run of resolvers showed functional errors of .06% *or less*. Perpendicularity of axes was ±3′ in 360°. Due to extreme symmetry of rotor and stator, nulls are excellent in these resolvers. Low phase shifts are also a feature.

VERSATILITY

CPPC Precision Computing Resolvers can be had with any of the following features: corrosion resistant construction, stainless steel or aluminum housing. Units to resist temperatures up to 450° F. The following compensation is available in any or all units: resistive, feedback winding, thermistor. Types available for transistor circuitry. Pin or screw terminals or lead wires. BuOrd type shafts and BuOrd MK 4 Mod 0 brush block obtainable.

PRICE AND DELIVERY

We ask you to review what you are paying for precision computing resolvers. In the past CPPC has been able to lower traditional prices of rotary components.

We are already tooled for many types of these resolvers and can make quick delivery in quantity or short run. Whenever you need *any* rotary component, think of CPPC.

Call or write Sales Department, HIlltop 9-1200 (Suburban Philadelphia) or our Representatives.

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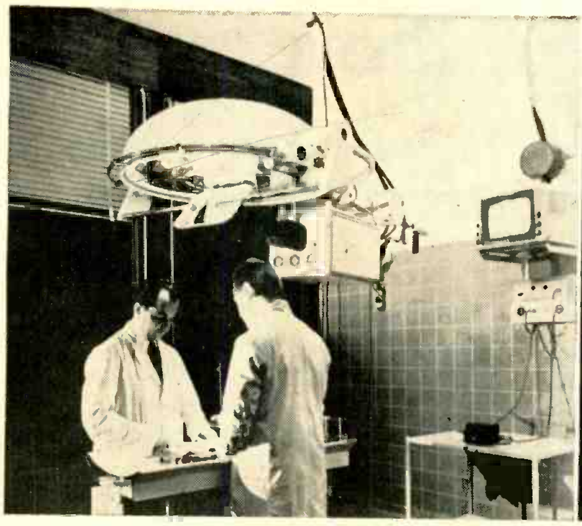


Details picked up by camera focused on tilting mirror above operating table are displayed on screen by three-barrel projector

Projection Color Tv Grows

Medical groups are paying increased attention to large-screen projection color tv as a way of studying experts in surgery and diagnosis

PROJECTION color tv is gaining new enthusiasts this Winter as medical firms step up their programming.

New advances in projection color tv are coming from abroad. One example of this is the Norelco system supplied to Smith Kline & French Laboratories (see photo above), by North American Philips Inc. Unit costs about $30,000.

Uses Mirror

The Philips system uses a three-vidicon camera clamped in a stationary position above the operating table. The camera focuses on a movable mirror. This is done to avoid the difficulty of moving the heavy camera to follow the surgeon's activity. The camera has a remote-controlled lens turret.

The projector contains three Schmidt optical boxes arranged side-by-side, each using 5-in. projection tubes having a red, green and blue phosphor respectively. The tube anodes operate at 50 kv.

Picture dimension is 9 by 12 ft when projected on a screen 25 ft away. Resolution of the picture is 500 lines with 1:30 contrast ratio. Highlight brightness is 5.6 ft-lamberts on a screen with a gain of 2.5. System operates on U. S. or European (CCIR) standards.

The three images provided by the projection tubes are superimposed on screen, giving color variations.

System Shown

The Philips projector system was introduced in America recently at the American Medical Association's meeting in Minneapolis. An older model of the system is installed permanently at the Faculte de Medecine et de Pharmacie, at Marseilles. The system purchased by Smith Kline & French forms part of the firm's mobile unit which travels some 25,000 miles annually.

A second imported unit (photo, below) is the Swiss-made Eidophor recently purchased by CIBA, Summit, N. J., pharmaceutical firm. Its debut date was Dec. 27 at the Washington meeting of the American Association for the Advancement of Science. Projector equipment was made by Dr. Edgar Gretener Ag., Zurich, a CIBA subsidiary. Model costs about $16,500.

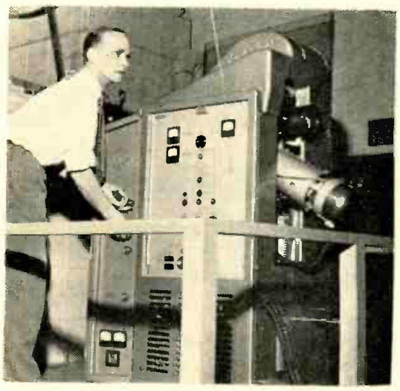
The Eidophor uses the field sequential system in combination with a control layer process devised eleven years ago. In this process, light passes through an oil film and then through a special grating.

In Mobile Unit

The CIBA color projector produces a picture 12 by 16 ft in size using a 2,000-w xenon lamp. The 800-lb unit is about 5 ft high, 2 ft wide and 4 ft deep. It is part of a mobile unit containing one more Eidophor, 4 tv cameras, a public address system, and control gear.

Among American manufacturers, GE is planning to produce a color tv projector. Firm says it expects to have a product on the market by "early 1959," but is not giving any further details now.

Two versions of a color projector have been produced by RCA, but company officials say that since initial market attempts several years ago, there has not been sufficient demand to warrant RCA's getting into full-scale production on color projectors at this time.



Single-barrel projector displays pictures in Swiss-made system

AN INVITATION TO JOIN ORO

Pioneer In Operations Research

Operations Research is a young science, earning recognition rapidly as a significant aid to decision-making. It employs the services of mathematicians, physicists, economists, engineers, political scientists, psychologists, and others working on teams to synthesize all phases of a problem.

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No other Operations Research organization has the broad experience of ORO. Founded in 1948 by Dr. Ellis A. Johnson, pioneer of U. S. Opsearch, ORO's research findings have influenced decision-making on the highest military levels.

ORO's professional atmosphere encourages those with initiative and imagination to broaden their scientific capabilities. For example, staff members are taught to "program" their own material for the Univac computer so that they can use its services at any time they so desire.

ORO starting salaries are competitive with those of industry and other private research organizations. Promotions are based solely on merit. The "fringe" benefits offered are ahead of those given by many companies.

The cultural and historical features which attract visitors to Washington, D. C. are but a short drive from the pleasant Bethesda suburb in which ORO is located. Attractive homes and apartments are within walking distance and readily available in all price ranges. Schools are excellent.

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$\$\frac{1}{2}$ Billion for New

Airborne Early Warning project means new business for at least one prime and six major subs, hundreds of other subs and suppliers

MORE THAN $\$\frac{1}{2}$ billion will be spent on the new U. S. Airborne Early Warning and Control system. First contracts are due this month. The new project means added business for hundreds of firms in our industry.

Soviet announcement of the successful launching of an 8,700-mi-range ballistic missile has stimulated interest here in our east and west coast early warning facilities. BMEWS, our ballistic missile early warning system, which will watch the northern frontier from Alaska, Thule and Preswick for transpolar missile attacks, will be of no help against long-range missile fired west from the Caspian Depression or east from South China.

The horizons that must now be monitored have swung around to the south, coming close to a 270-degree arc. A few months ago the "danger area" was 90 degrees.

Directs Interceptors

Solution to the problem of east- and west-coast detection is being sought by the Air Force in a super airborne early warning and control system that will eventually replace the currently operational RC-121 plane. Besides detection, the new system will also be equipped to direct interceptors to the target as Sage does from the ground.

The new AEW planes will be a much-needed addition to our other defense facilities which now consist of three northern radar fences —Dew Line, Mid-Canada Line and Pine Tree Line; offshore and inshore radar picket ships; Texas towers; Navy blimps; gap filler radar along the coasts; and the current Air Force and Navy reconnaissance planes.

The new AEW project is expected to get off the ground when USAF selects a weapons system manager.

Six teams have submitted proposals to do the job. Heading up the teams are Douglas, Convair and Lockheed, who offer a 360-degree radar scan system; and Boeing, RCA and Hughes, who propose a "sidelooker" radar system.

Who's Doing What

Though most of the candidates for weapons systems manager were reluctant to divulge other team members, the following are known: Douglas has selected GE as electronic systems manager for its system. Aircraft will be a DC-7C. Convair's team consists of: GE for radar; RCA, communications; Hughes, communications; Autonetics div. of North American, navigation; and Canadair Ltd., aircraft.

Offering an Electra plane, Lockheed's team associates are: GE, radar; General Precision Equipment, navigation; Hazeltine, data processing and displays; Hughes, communications and data link; and Lockheed's missile Systems Division, automatic checkout equipment. (ELECTRONICS, p 26, Oct. 17, 1958).

Douglas, Convair and Lockheed have selected General Bronze's cross type SVE (Swept Volume Efficiency) antenna array for use with the search radar. Made of lightweight aluminum employing non-corrosive irridited aluminum supports and elements, the SVE weighs 500 lbs.

The SVE antenna consists of an array of end-fed directional radiators, each of which is made up of an active feed and a number of passive metal disks spaced along a supporting rod to guide the electromagnetic energy into space in a $7\frac{1}{2}$-degree beam width.

Boeing proposes using a KC-135, with Thompson Ramo Wooldridge as electronic systems manager.

On the overall matter of finances, Secretary of Defense McElroy has stated:

System

"The capital investment already made in our continental air defense during the last 4½ years exceeds $13 billion. The cost of operation is now almost $2 billion a year."

Suburbs Pose Hiring Problems

MANAGEMENT of electronics firms which require casual labor, young female clerical and production workers and unskilled male labor should investigate carefully these days before following trek to suburbs.

Warning emerges from study by Boston's Federal Reserve Bank of labor supply characteristics of Mass. Route 128 companies.

Relocation of 22 companies, 11 of them electronic, to Route 128 during 1955-57 revealed relatively high rate of loss of workers living in Boston.

Impact of increased commuting costs varies inversely with workers' level of income. Company aid in car pool arrangements played vital role in making labor available. Chartered bus service from downtown proved successful for only a brief period.

Survey shows relocation quits tend to be greater among experienced labor force.

Administrative, professional and "key" personnel were rarely lost by transfer to suburbs, since this group were likely to live in suburbs and to gain by relocation.

Generally, Route 128 locations definitely eased recruitment of engineering, professional and administrative staff, but neither helped nor hindered recruitment of skilled labor.

Recruiting difficulties arose when firms sought young female clerical workers, male unskilled workers, and seasonal workers.

For younger, unmarried female clerical workers, Route 128 locations offered definite disadvantages: lack of public transportation for a group with low car ownership, lack of shopping facilities, relative isolation during day.

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- customize both your test set-up and instruments
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- save time: at-a-glance sequential or continuous monitoring
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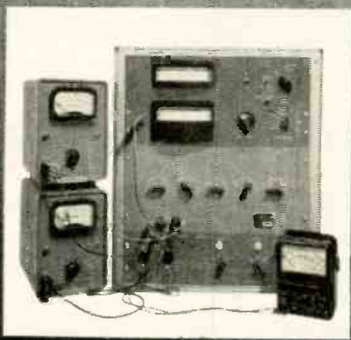
- make monitoring foolproof: read "go/no-go" by switching
- improve testing efficiency and system reliability
- increase overall design freedom



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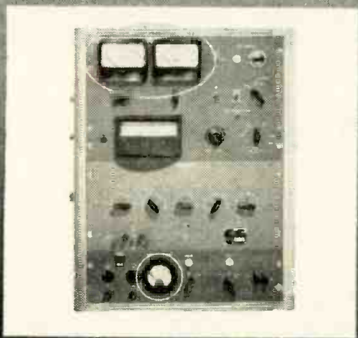

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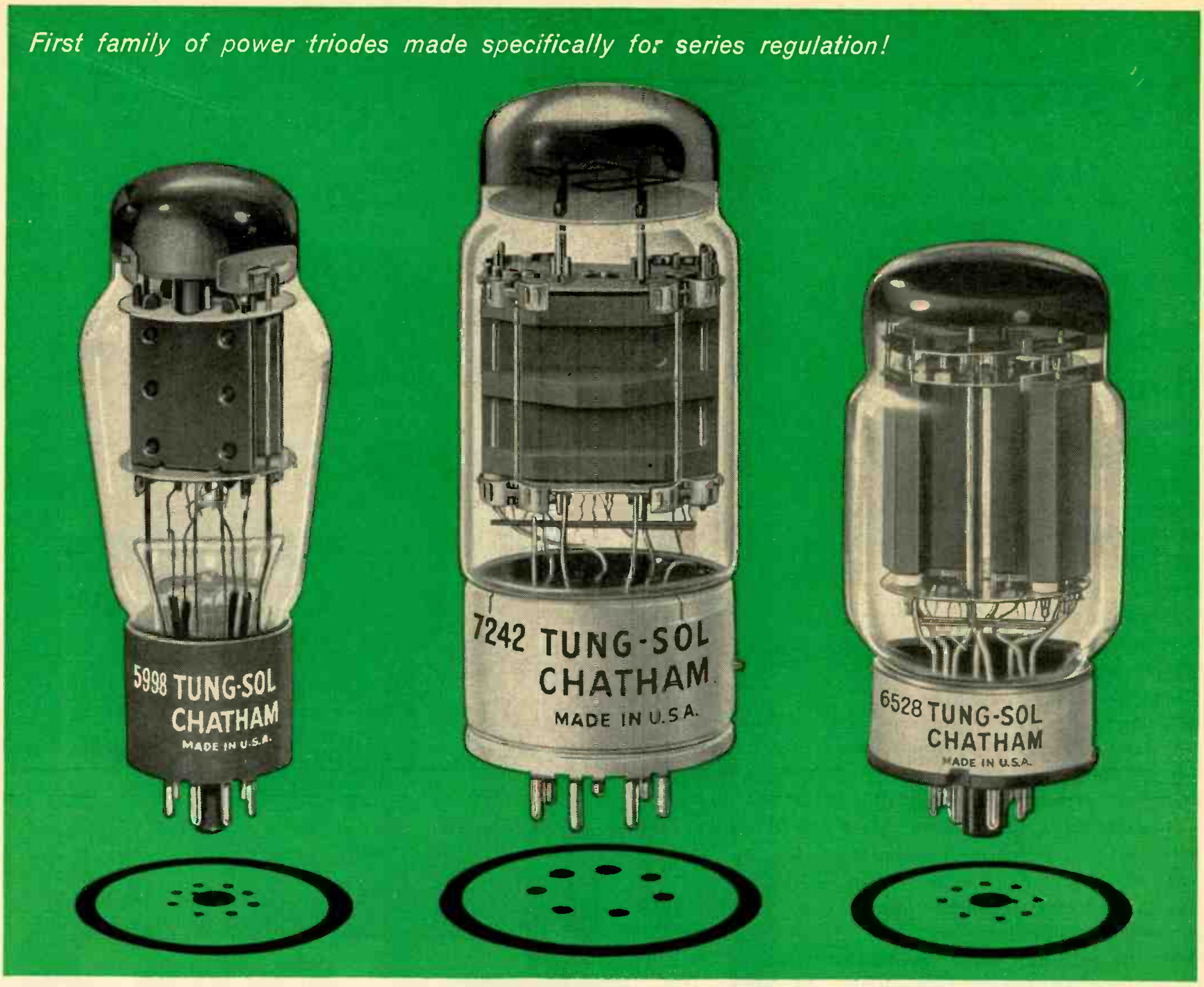

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Compare the ratings below against your particular application! If you desire complete data sheets . . . or you have a specific design problem, contact us today! We'll be glad to give whatever assistance we can. Just write: Tung-Sol Electric Inc., Newark 4, N. J., Commercial Engineering Offices: Bloomfield and Livingston, N. J., Culver City, Calif., Melrose Park, Ill.

TUNG-SOL®

TYPICAL VALUES

	Total Plate Current	Range of Tube Voltage Drop	Minimum Tube Drop	Grid Voltage Swing
5998	200 ma	80 v	45 v	20 v
6528	400	65	70	10
7242	600	80	70	13

PERTINENT CHARACTERISTICS PER TUBE

	Max. Plate Current	Max. Plate Voltage	MU	Gm
5998	280	275	5.5	28,000 umhos
6528	600	400	9.0	74,000 umhos
7242	900	400	9.0	111,000 umhos

TUBE TYPES BY PLATE DISSIPATION RATINGS

Total Plate Dissipation	26 to 30 W	60 W	100 W
Low Mu	6AS7G, 6082, 6080WA, 7105	6336A, 6394A	7241
Medium Mu	5998	6528	7242

"Here's how you'll handle that mountain of paper work," NCR's board chairman, Stanley Allyn, tells R. H. Macy president, Wheelock Bingham

Stores a Ripe Market?

Macy's purchase of $1-million electronic data processing system points way to future

BIG STEP on the road to electronic automation of department stores was taken recently when R. H. Macy & Co., Inc., world's largest department store, announced plans to install a million-dollar electronic data processing system.

Heart of the system, to be installed at Macy-New York in 1961, is a National Cash Register all-transistor 304 computer. Punched paper tape teller and adding machine peripheral equipment—about 40 machines in all—will feed data on 750,000 time payment and customer deposit accounts for recording and statement production.

Eyeing Future

Future plans call for store to use computer for analysis of merchandise statistics and for payroll and accounts payable processing. Store is also studying possibility of tieing computer in with point of sale recorders. The latter units are half cash register and half electronic media reader. They create computer input data at moment of sale.

Proposed installation is claimed to be the biggest automation program in department store history. Department stores are regarded as a big electronic market of the future, but to date only a handful of stores have gone electronic.

Retailers report that other department store computer installations include an RCA Bizmac at Higbie's in Cleveland, an IBM 305 Ramac at Dey's in Syracuse, N. Y., and a Royal McBee LGP at Filene's, Boston. Macy-New York also has a Remington-Rand Univac 120.

Commenting on reasons for the new installation, a top Macy executive said that electronic equipment has reached the point where it can handle masses of department store operating data quickly and economically. Statements will be prepared at rate of 50 a minute, 25 times faster than present speed. Record-keeping costs will be cut and shoppers will receive bills a week earlier.

"The growth in credit buying has created a rising mountain of paper work which could be solved only through a greater degree of automation," said Wheelock H. Bingham, president of R. H. Macy.

Serves Six Stores

The new system will service all six stores in Macy's New York division. Operating on a one-shift basis, the system is expected to handle seven million statements annually.

It's reported the system will process the division's 750,000 customer accounts with only one manual step required to prepare the mounds of Macy statements sent out year after year.

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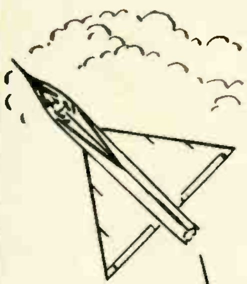

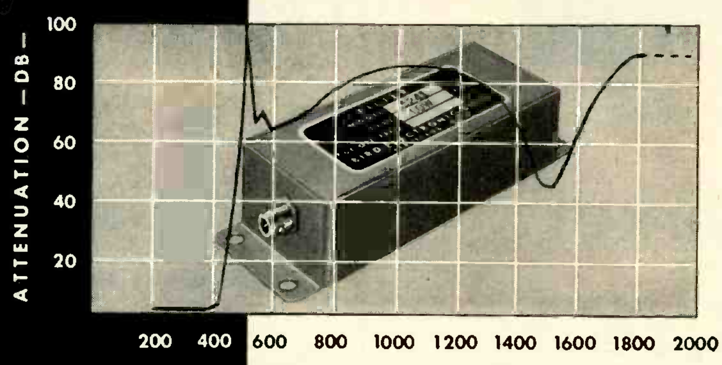

Model 524

DESIGNED TO REJECT INTERFERENCE IN "L" BAND

When size and weight are important factors in your rf filter selection, turn to Bird Electronic for your source of supply. Our engineers will design an rf filter to serve your exact requirements with particular attention to component density, accuracy, ease of application and long-life performance.

Our physical facilities to produce and deliver quantity orders dependably can be relied upon to meet your production schedules.

SPECIFICATIONS

Model 524I

SIZE: 4-¾" x ¾" x 1-¼"
WEIGHT: 5 ounces
PASS BAND: 225 to 400 mc
CUT-OFF FREQUENCY: 400 mc
POWER RATING: 50 watts
RF INPUT IMPEDANCE: 50-ohm nominal
ATTENUATION: Less than ½ in pass band; 80 db in stop band
VSWR: Insertion loss and VSWR are very low in pass band
CONNECTORS: Most miniature types

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MEETINGS AHEAD

Jan. 12: Medical Electronics Meeting, Detecting Unseen Cancer Cells, PGME of IRE, Inst. for Cancer Research, Philadelphia.

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

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

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

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

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

Feb. 1-6: American Institute of Electrical Engineers, Winter General Meeting, Statler Hotel, N. Y. C.

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

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

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

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

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

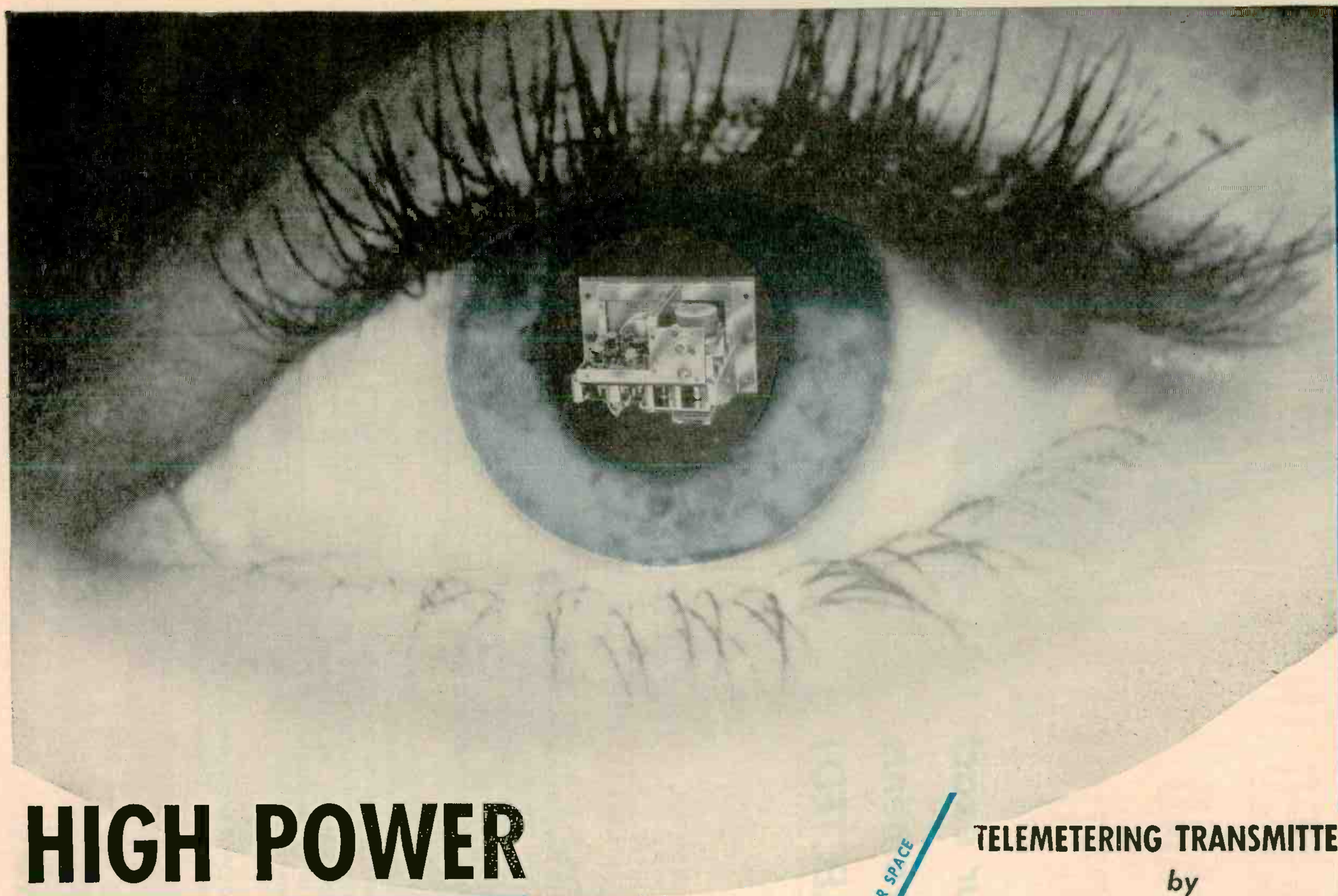
Mar. 15-18: National Assoc. of Broadcasters, Annual Convention, Conrad Hilton Hotel, Chicago.

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

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

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

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



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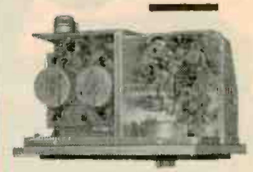

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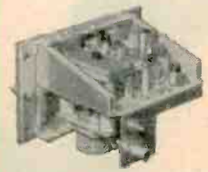

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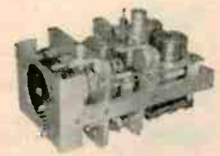

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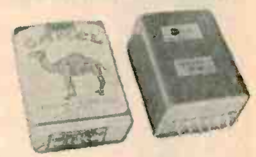

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2N501	Ultra high-speed switch typical t_r = 9 mμsec; (18 max.); t_s = 9 mμsec; (12 max.); t_f = 7 mμsec; (10 max.) in circuit with current gain of 10 and voltage turnoff.			
2N502†	800 mc	11 db at 200 mc		amplifier to 250 mc
2N503†	420 mc	12.5 db at 100 mc		amplifier to 175 mc
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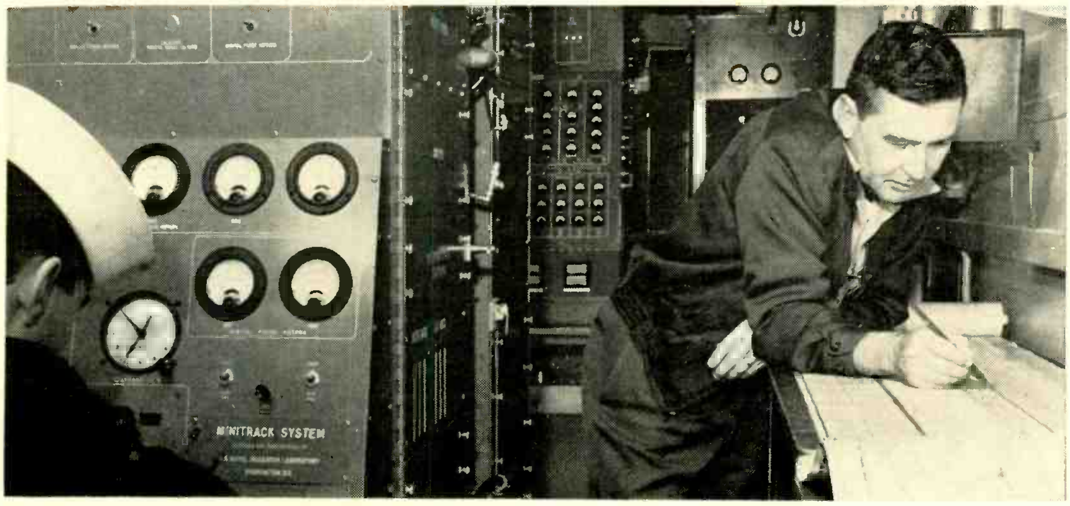


Naval scientist, left, checks data recording of a satellite which has just passed over the station. Sailor, right, at console checks system operation

Tracking Orbits of Man-made Moons

Radio network establishes satellite position in space at any time. Data is accurate within 20 seconds of arc and one millisecond time. Circuits measure wavelength differences from satellite to ground antennas

By C. A. SCHROEDER, C. H. LOONEY, JR. and H. E. CARPENTER, JR.
Radio Tracking Branch, Project Vanguard, U. S. Naval Research Lab., Washington, D. C.

TRACKING EARTH SATELLITES within 20 seconds of arc, and relating position in space to time accuracy of one millisecond, is the task assigned to the Vanguard Minitrack system.

Satellite data is gathered by eleven signal-receiving stations and coordinated at a central headquarters in Washington, D. C.

The system has tracked three Russian satellites and four United States satellites, the Explorers and Vanguard. Orbits of man-made moons are computed accurately and their position in space at any time is established exactly.

Antenna layout at each tracking site is shown in Fig. 1. Data provides the difference, measured in wavelengths, between the radio paths from the satellite to paired antennas at each ground station. The satellite is located in space by measuring the radio path difference between antenna pairs, as the satellite passes through the pattern of the receiving antennas.

Five signal-phase comparisons are made from antenna pairs that lie in north-south and east-west directions.

Actual measurements are made from the fine baselines, and the medium and coarse baselines are used for ambiguity resolution.

SATELLITE ANGLE — Angular relationship of

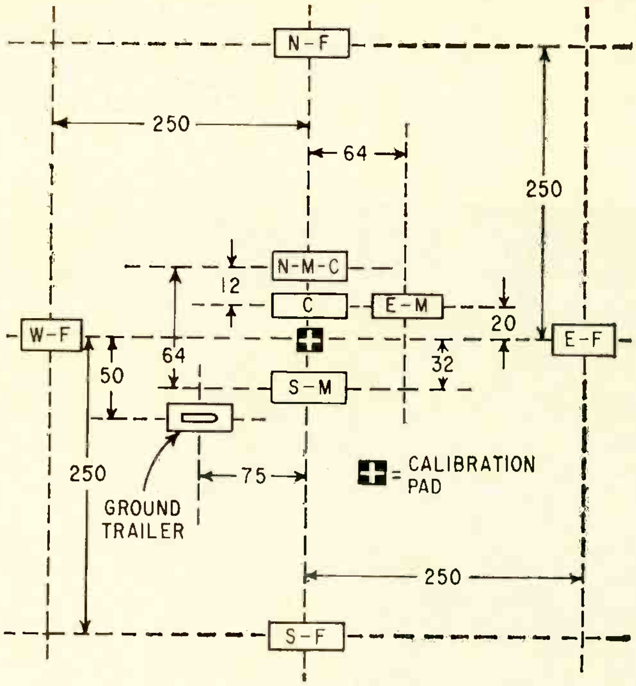


FIG. 1—Antenna field layout at each of eleven ground receiving stations located at widely scattered points on earth. Signal-phase comparisons are made from antenna pairs that lie in north-south and east-west directions

antenna pairs with respect to the satellite position is shown in Fig. 2. The phase angle of the signal received at one antenna is compared with that of the signal received on the other antenna.

The relative phase angle is zero whenever the radio path difference is an integral number of wavelengths, and will cycle from zero up for each part wavelength added to the path difference.

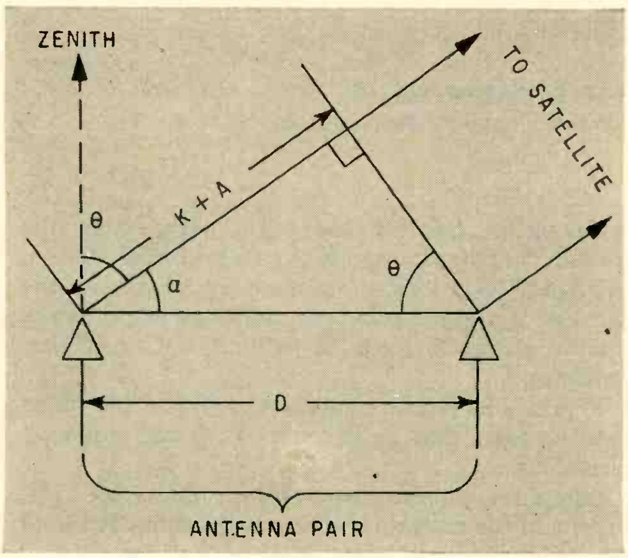


FIG. 2—Minitrack system angular relationship of antenna pairs with respect to satellite position

Operator, seated at console of the Minitrack data system, checks system operation

Quantity $K + A$ is the time difference between the arrival of a wave front at the two antennas, expressed in whole wavelengths K, while the actual phase-angle difference between the signals is expressed as a fraction of a wavelength A. Distance between the two antennas, D wavelengths, divided into $K + A$, gives the cosine of a, the direction cosine of the satellite position.

Block diagrams of the equipment at each ground station is shown in Figs. 3 and 4 along with the line connections to the phase meters, recorders and the time standard system.

Signals from antenna pairs are fed, after preamplification, to the mixers which are also supplied with two local oscillator signals. Converted to two i-f frequencies, separated by 500 cps, the two-antenna signals are fed to a common i-f amplifier that has a bandwidth broad enough to create a minimum differential phase shift between the two signal frequencies.

The phase angle between the 500-cps oscillator separation frequency and the 500-cps signal separation frequency is identical with the phase angle between the two antenna signals.

The local oscillator separation frequency, the reference signal, is phase-locked to a 500-cps standard frequency derived from WWV, to maintain time synchronization.

REFERENCE SIGNAL—The 500-cps reference is counted down, compared with, and adjusted to match the time standard. Digital information is recorded in three ten-level staircase analogs for the tenths hundredths and thousandths of full scale, using three recording channels for each fine baseline. The fine baselines use both analog and digital presentations. Digital presentation correlates data and time and provides a fast accurate readout.

The analog presentation shows the character of the data and acts as a backup for the digital system. Internal noise, less than 0.1 degree rms, does not influence the readings.

FILTER AND BUFFER—Receiver signals consist of a 500-cps component at a nominal amplitude of 10-v peak-to-peak, plus noise components to 8,000 cps depending upon the received signal strength.

Filter bandwidth between 3-db points is 10 cps, corresponding to an effective post-detection rectangular bandwidth of 8 cps.

The narrow-passband filter is shown in Fig. 5. The receiver signal, divided by eleven by R_1, R_2 keeps inductance change of L_1 small enough to neglect phase shift from amplitude variations.

The entire five-channel filter, oven-enclosed, is kept at about 125 F. Each inductor is triple-mu shielded to eliminate crosstalk between adjacent inductors. The filter output, nominally 0.5-v peak-to-peak, is fed directly to the grid of the amplifier stage in the buffer.

The buffer, Fig. 6, amplifies the filter output for the analog phase meters. There are five identical amplifiers and cathode followers.

The amplifier, with about 20-db feedback, has a closed-loop gain of about 100. The feedback amplifier provides stable gain, maintains linearity and minimizes noise distortion.

REFERENCE-PULSE GENERATOR—The 500-cps reference signal from the local oscillator, a sine wave of about 10-v peak-to-peak amplitude, is amplified to about 50-v peak-to-peak in V_{1A} of the reference pulse generator, Fig. 7. A single-stage amplifier with about 10 db of degeneration is used.

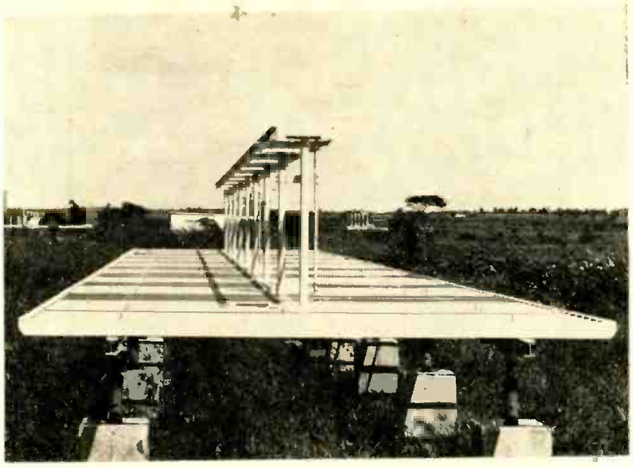
Output of V_{1A} is coupled through V_{1B} to R_1 and D_1, D_2.

The clipped sine wave is amplified by V_{2A} and V_{2B}. The output of V_{2B}, a clipped sine wave of 40-v peak-to-peak amplitude, with a rise time of about 6 μsec, is coupled through V_{3A}, to a second clamping stage. Tube V_{3A} prevents overloading of V_{2B}.

Diodes D_3 and D_4 are biased so that clamping occurs at one volt on either side of zero. This 2-v peak-to-peak square wave out of the clamper is amplified by V_{3B} with a gain of about 30. Amplitude distortions represent negligible shifts in the time of zero crossing.

The circuits of V_{4A} and V_{4B} comprise a series-triggered blocking oscillator. The square wave from V_{4A}, differentiated by C_3, R_3, provides a pulse trigger for the blocking oscillator. In addition, the built-up charge on C_1 during firing holds the blocking oscillator grid below firing potential until the danger of multiple firing is past. Grid bias of V_{4B} is adjusted by R_4 to fire the blocking oscillator in coincidence with the positive-going zero crossing of the 500-cps sinewave into the unit.

The negative 150-v one-μsec pulse at the plate of V_{4B} is inverted by T_1 and fed to V_{6A} and V_{5B}. Posi-



Closeup view of one of the Minitrack antennas located in Cuba. In the background is the ground-station trailer

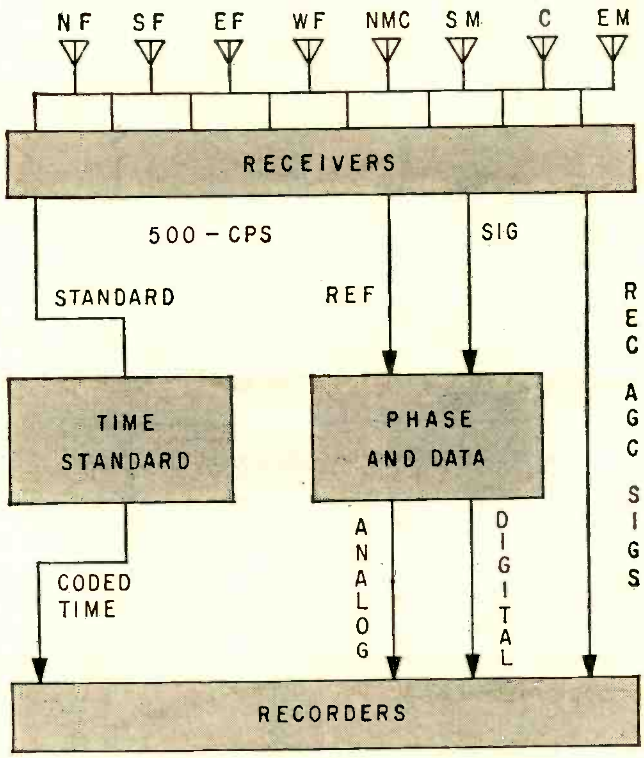


FIG. 3—Simplified block diagram of data and time system at each ground station

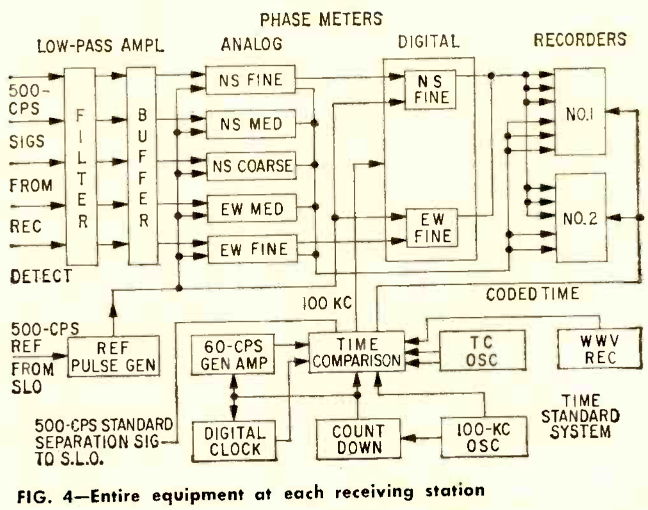


FIG. 4—Entire equipment at each receiving station

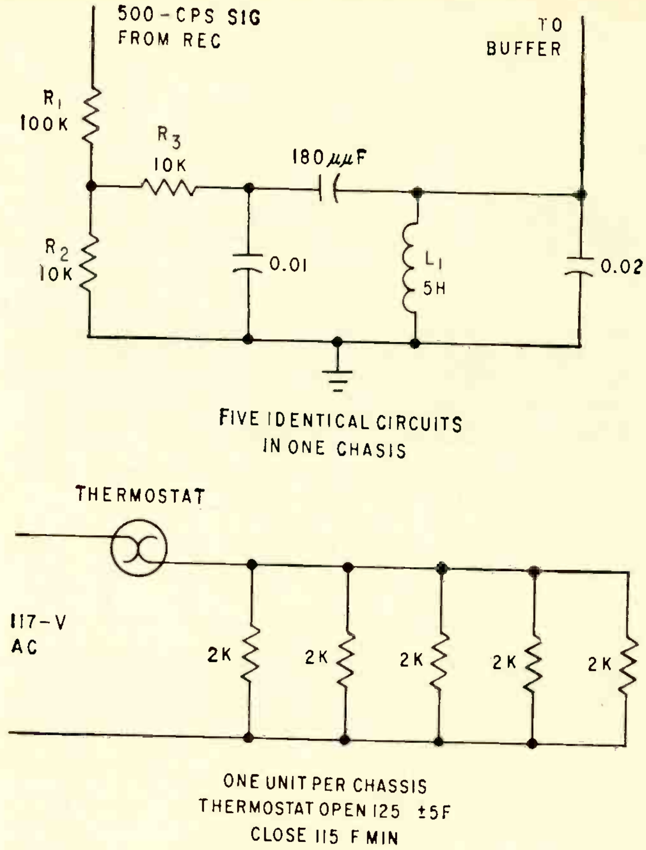


FIG. 5—Schematic of narrow-passband filter

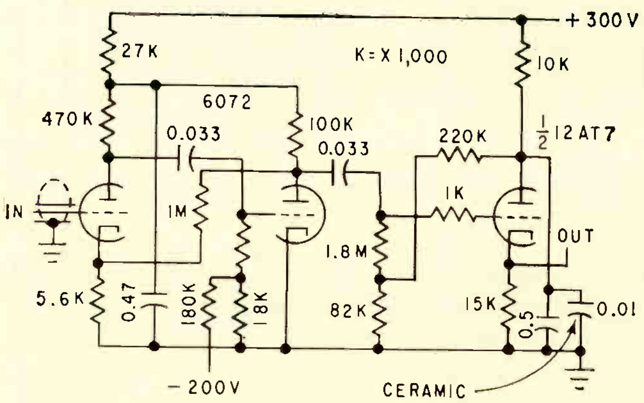


FIG. 6—Buffer circuit of the tracking system

tive-pulse inversion preserves the leading edge of the pulse.

The output of one of the cathode followers is distributed to three analog phase meters while the other goes to two analog phase meters and the digital phase meter.

DIGITAL PHASE METER—The phase angle between the signal and the reference is measured by the unit shown in Fig. 8. A bistable switch operates a gate which connects the 500-cps pulse train to a three-decade decimal counter during the time between a reference pulse and a signal pulse.

Two channels measure the phase angles of the north-south fine and east-west fine signals. Digital measurements obtain a resolution of 0.36 degree. Time is resolved to 0.1 millisec.

Output information is recorded on a direct-reading unit that has a frequency response flat to 20 cps and down 3 db at 60 cps. To obtain output within this band, the 500-cps reference-pulse train is divided down to 20 cps, and digital measurements are made at this frequency.

The train is divided by 25 by the two divide-by-five pairs V_{1A}, V_2 and V_{1B}, V_3. The positive train from the reference-pulse generator is applied to the suppressor grid of the first phantastron.

The square pulse of the second phantastron has a positive rise synchronous with every 25th reference pulse. This square pulse, differentiated by C_1, R_1, triggers a series-fed blocking oscillator, V_4. Tube V_{4A} isolates the driving circuit from the pulse on the grid winding of T_1.

The train of negative pulses that are generated at the plate trigger two bistable switches for gate operation. A train of positive 80-v pulses at the output of T_1 is coupled through V_5 to the time comparison unit.

A comparison is made between the 20-cps reference and the one-cps standard in the comparison unit. The phase angle of the reference is adjusted so that every 20th digital measurement coincides with the one-cps standard timing signal on the recorders.

The 500-kc multiplier utilizes V_6, driven by a 100-kc, 90-v peak-to-peak sine wave from the time

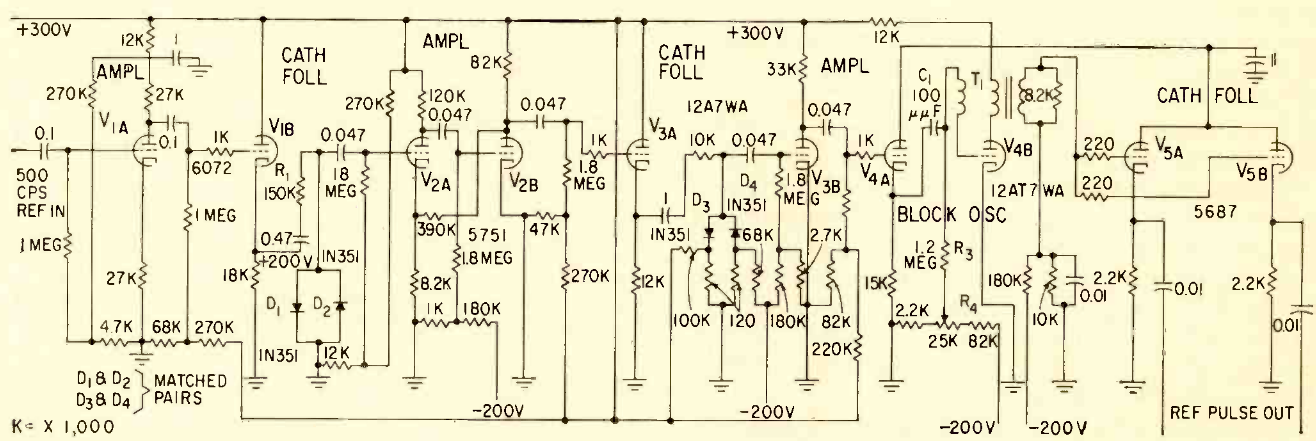


FIG. 7—Reference-pulse generator supplies a 500-cps reference pulse to the analog and digital phase meters

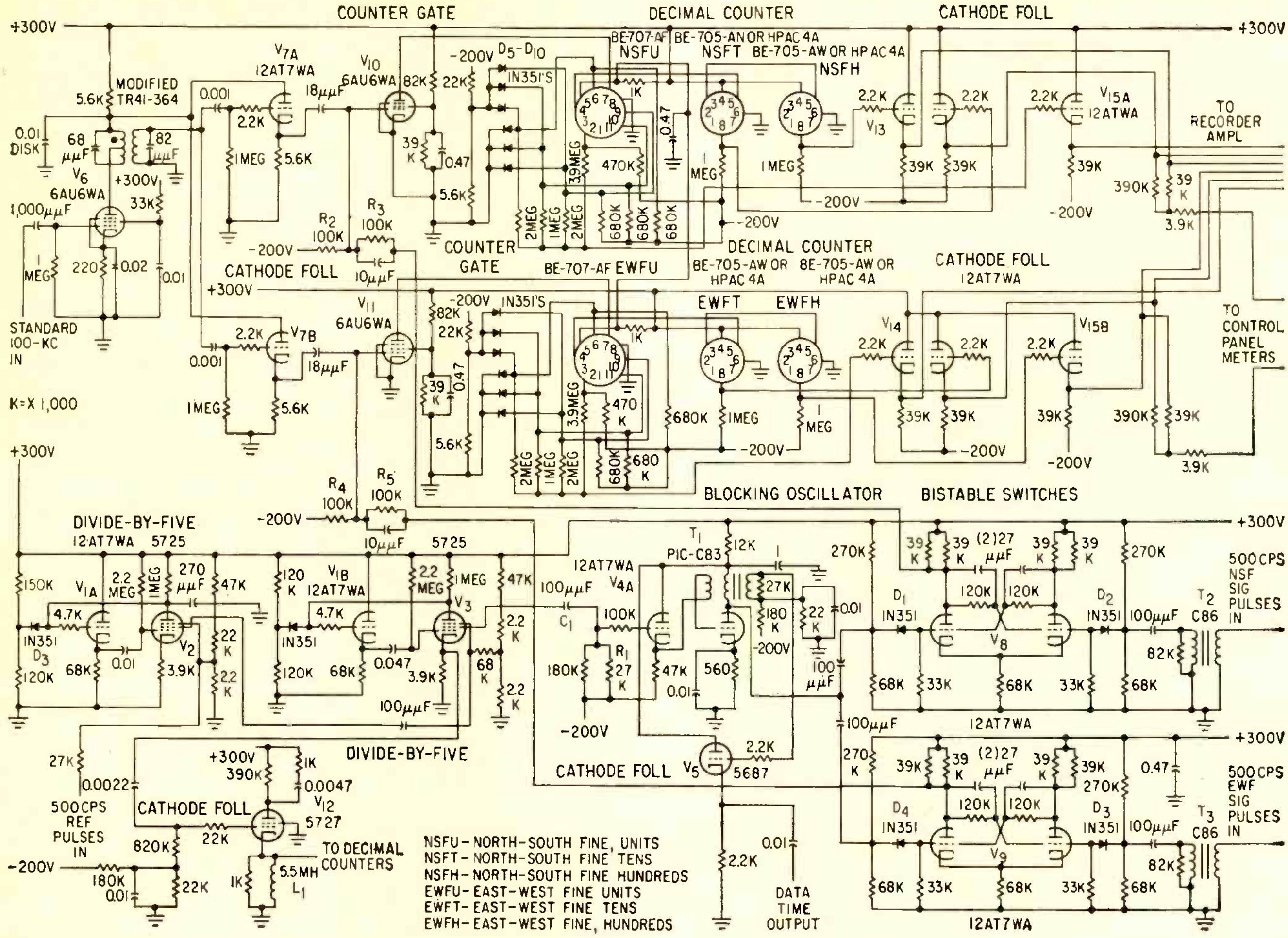


FIG. 8—Digital phase meter measures the phase angle between the signal and the reference pulse

standard. Tubes V_{7A} and V_{7B} clip the negative portion of the wave, thus forming 60-v pulses that go through the gates to the two decimal counters.

Switches V_8 and V_9; and two gates, V_{10} and V_{11}, connect the 500-kc pulse train to the counters.

The 20-cps reference pulse from the plate of blocking oscillator V_{4B} is coupled to the grids of switches V_8 and V_9 to turn them on. The 500-cps signal pulse train from the appropriate analog phase meter is inverted by T_2 or T_3 and fed to the remaining grid of the associated switch to turn it off.

Diode pairs, D_1, D_2, and D_3, D_4 decouple the driving circuits during the switch transients and clamp the positive overshoots of the triggering pulses to prevent triggering the pulse at the wrong time.

The level of the gate signal from the switch plates is lowered by dividers R_2, R_3 and R_4, R_5 so that the upper level of the signal to the grid of the counter gates V_{10} and V_{11} is at ground level, and the lower level drives the grid well below cut off. Thus, when the switch is on, the 500-kc pulses are coupled to the counters.

DECIMAL COUNTERS—Each of the two decimal counters is made up of one high-frequency Berkeley 707AF; and two medium-frequency Hewlett-Packard AC-4A packaged units.

All counters are reset by V_{12}, which is triggered by the positive rise of the cathode of V_3, about five millisec before a count is to be made.

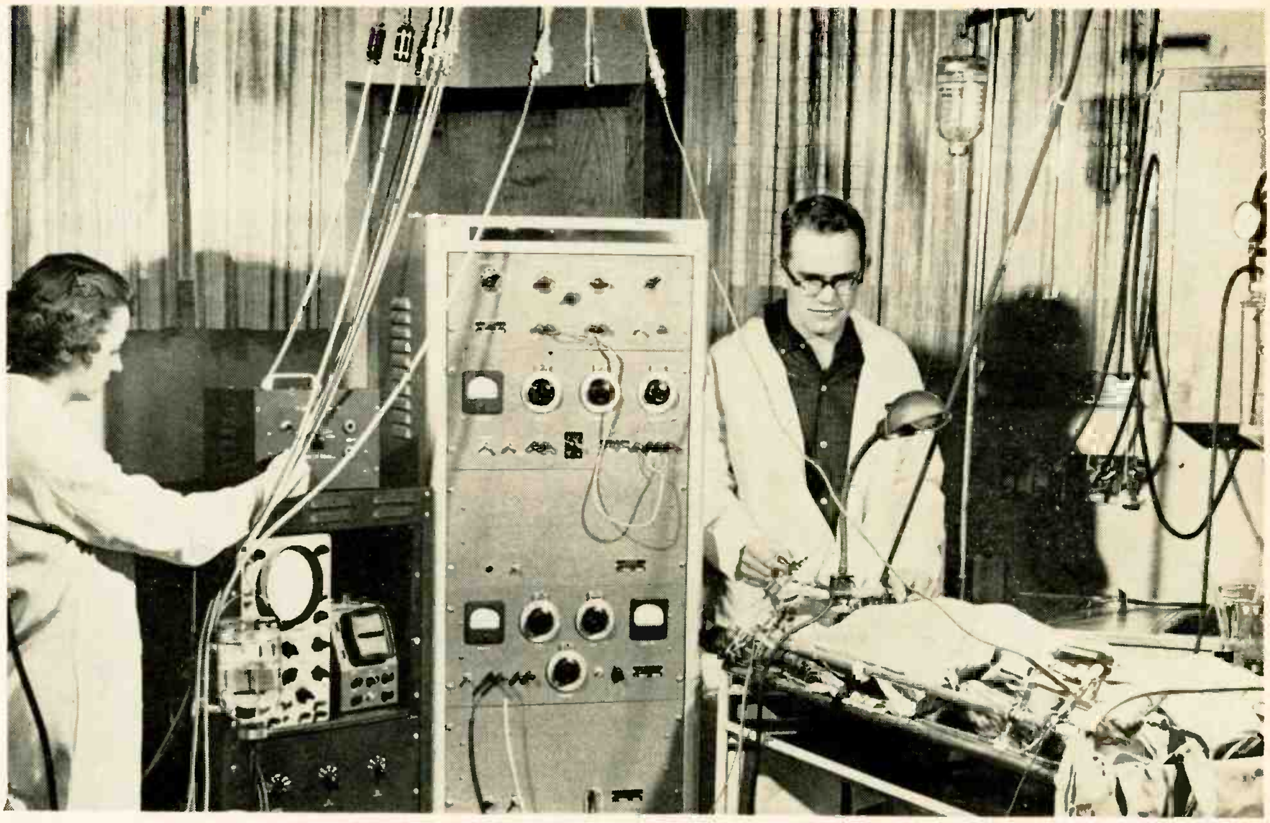
The resistor-diode matrix, connected to each of the two high-frequency counters, forms an analog representation of the counter signal digital output.

Tubes V_{13}, V_{14} and V_{15} provide analog voltages to the recorder as a three-digit number: 0 to 999. This number is a measure of the direction cosine of the angular position of the satellite, in terms of percentage of antenna baseline length. The tens and hundreds counter outputs are combined by a resistor matrix and fed to meters on the control panel.

Two Sanborn 158-5475 eight-channel recorders are used. Permanent records are obtained in rectilinear coordinates. The records have excellent line definition.

Time information is received from the time-standard system in the form of relay closures in coded time sequence and is used to energize the timing stylus in the margin of the record. The stylus records a 60-cps signal during the 50-millisec, on period of the time standard relay.

The authors acknowledge the contributions of members of the Radio Tracking Branch of Project Vanguard, in particular, E. J. Habib, J. Taube, W. M. Hocking and J. W. Ryan.



Prototype regulator, filling standard rack at center, successfully held blood pressure and pulse rate of dog on table at desired levels set on dials. Clamps on table hold pressure transducer that goes in artery and electrodes that make contact with nerves

Blood Pressure and

IT HAS LONG BEEN a dream of medical men to be able to control both heart rate (pulse rate) and blood pressure in a living animal over sustained periods of time. Especially was this need felt during experimental work on laboratory animals, where many factors affect the blood pressure of the animal being examined and the blood pressure and heart rate in turn affect other animal factors.

One of the major blood-pressure regulating mechanisms in the body is a small pressure detector in the neck which detects the actual pressure in the carotid sinus artery and converts this pressure into electrical impulses. These electrical impulses are fed through a system of nerves to the brain, as shown in Fig. 1. The brain then translates these impulses into other nerve impulses which act on muscles to control blood vessels throughout the body. If blood pressure rises too high, a signal is sent from the brain which causes the blood vessels and openings to expand, thereby allowing the pressure to decrease.

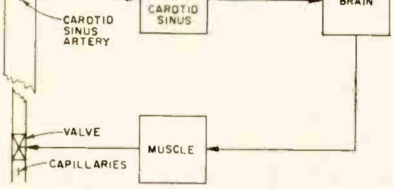


FIG. 1—Simplified diagram of blood pressure regulator system in animal

The nerves that control the impulses to the blood vessels can be externally stimulated by using electrical pulses in the range of 12 volts, with pulse width approximately 0.1 millisecond and frequency proportional to the desired pressure. The actual body pressure

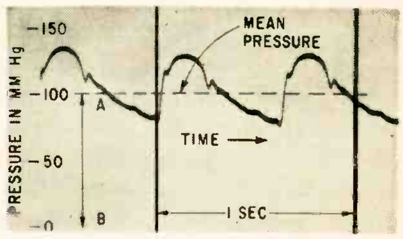


FIG. 2—Variation of blood pressure in aorta of medium-size dog

replaced by an electronic system.

The body heart rate is controlled by a similar mechanism. The heart rate is sensed by a transducer and impulses are fed onto appropriate nerves that control the heart muscles, these impulses being a function of the actual heart rate. Part of the body's own system can be replaced by an electronic system.

Getting Signals from Body

The first problem to be solved is that of providing a signal propor-

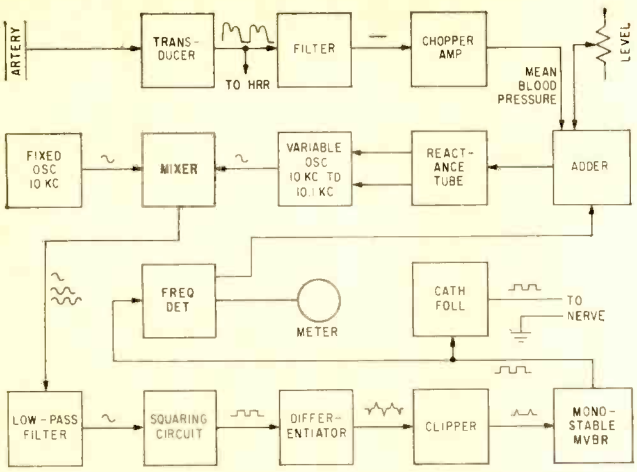


FIG. 3—Electronic blood pressure regulator senses arterial pressure and delivers controlling pulses to carotid sinus nerve

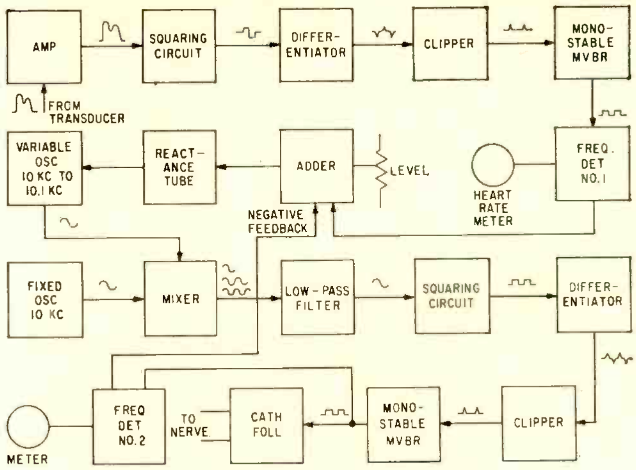


FIG. 4—Heart rate regulator similarly senses arterial pressure, but delivers pulses to vagus nerve that controls muscles of heart

Successful electronic control of dog's heart in laboratory experiments offers promise that patients with heart trouble may someday wear transistorized versions wired to nerves that control heart action. Patient could then turn knobs to adjust blood pressure and pulse rate, just as users of hearing aids adjust volume from time to time

By ROBERT L. SKINNER, DIETRICH K. GEHMLICH and FRANK W. LONGSON
ENSCO, Inc., Salt Lake City, Utah

Heart Rate Regulator

tional to the blood pressure and the heart rate of the body system. This is accomplished by inserting a needle or catheter into an artery and allowing the blood to come up the needle and make contact with a small pressure transducer that provides an output voltage proportional to the actual blood pressure. The arterial pressure consists of a series of pressure pulses (one for each time the heart beats) superimposed on a slowly varying mean pressure as in Fig. 2. The distance *A-B* represents the mean blood pressure in the body system. The output voltage of the pressure transducer is fed through filters which average out the arterial pressure pulses. The resultant voltage, proportional to the mean pressure of the system, is used to control the blood-pressure regulator.

The signal needed to control the heart-rate regulator should be a function of heart rate alone and not dependent on mean blood pressure. Differentiation of the arterial pressure signal eliminates the mean pressure and produces the required sharp spike at the beginning of each pressure pulse. These spikes are used to control the heart-rate regulator.

Blood Pressure Regulator

The voltage signal proportional to the mean pressure level in the artery is amplified by a drift-free chopper amplifier and fed into an adder circuit, as indicated in Fig. 3. The adder circuit sums the voltage representing the mean blood pressure and a voltage representing some preset desired pressure level. This voltage sum controls the rate generator.

Also fed into the adder is a negative feedback signal that is directly proportional to the output frequency of the rate generator. The adder then also performs the function of an error detector in an inner closed loop. This inner loop is designed to hold the output frequency directly proportional to the voltage sum of the mean blood pressure and some fixed level, independent of drift and fluctuations within the frequency source itself.

The frequency of the stimulating pulses to be applied to the nerve in the body to control blood pressure lies within the range of 0 to 100 cps, depending on the desired pressure. The rate generator beats two high-frequency oscillators together in the mixer to obtain this low-frequency output. One oscillator is fixed in frequency at 10,000 cps, while the other can be varied from 10,000 cps to 10,100 cps by use of a reactance-tube modulator which is controlled by the adder output.

The output of the mixer, which

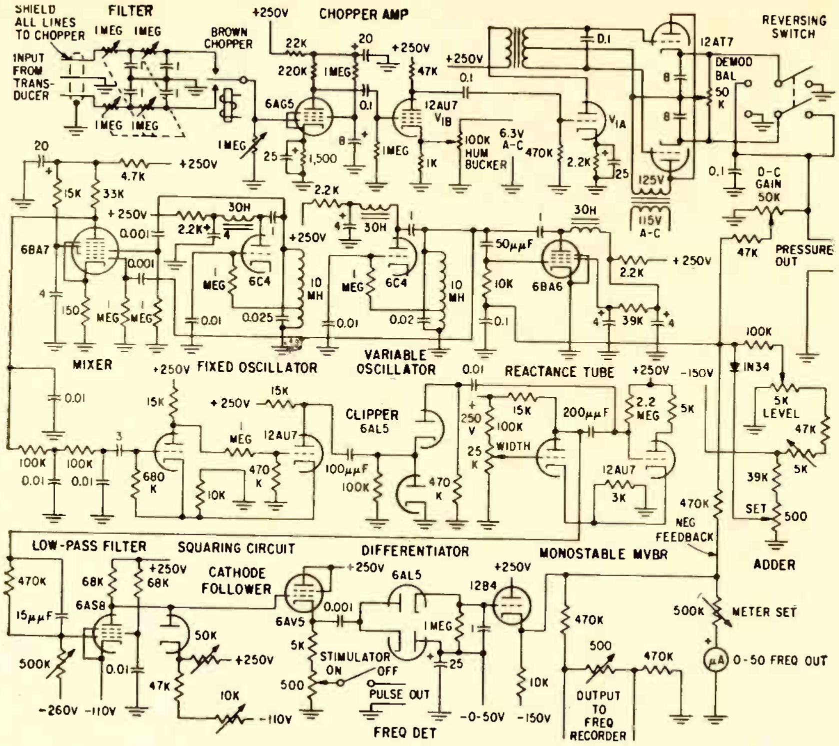


FIG. 5—Complete circuit diagram of blood pressure regulator. Power supplies are conventional, hence not shown

contains all sum and difference frequencies of both oscillators, is fed into a low-pass filter which removes the higher frequencies. The resulting sine-wave output of the rate generator, varying in frequency from 0 to 100 cps, is fed into squaring, differentiating and clipping circuits. The result is a positive pulse of the same frequency as the input sine wave. This pulse is used to trigger a monostable multivibrator which in turn supplies constant-width pulses to the output circuit at the frequency corresponding to the rate generator.

In the output circuit in Fig. 3 is a cathode follower which supplies the power to stimulate the carotid sinus nerve controlling blood pressure. The output is connected through suitable electrodes to the carotid sinus nerve in an exposed region of the neck.

The output circuit also contains a frequency detector which provides a d-c voltage proportional to the stimulus frequency. A voltmeter on the front panel is calibrated to indicate this stimulus frequency directly in cps. The d-c voltage is also fed back into the adder as negative feedback which stabilizes the rate generator against the possibility of internal frequency drift.

The level control circuit has a limiting control which may be preset to some safe value so that in normal use the mean blood pressure cannot be set to a harmful level.

Heart Rate Regulator

The operation of the heart rate regulator in Fig. 4 is identical with that of the blood pressure regulator except for the input circuit and the nerve to which the frequency output is attached. The voltage output from the same pressure transducer in the artery is amplified and applied to the squaring circuit.

Output of the squaring circuit is differentiated and clipped to give a sequence of pulses, each representing one heartbeat and appearing at a time corresponding to the rising edge of the arterial pressure pulse. These pulses are applied through a monostable multivibrator to frequency detector No. 1, to give a d-c voltage output that is directly proportional to the input frequency. This d-c voltage is in turn applied to the adding circuit. The rest of the operation is identical to that of the blood-pressure regulator circuit. Also included in the frequency detecting circuit is a meter that reads the d-c voltage which is proportional to the heart rate. The meter face is calibrated to read heart rate directly in pps.

The desired heart rate is fed into the regulator by adjusting the level set control. The unit then automatically sets the heart rate. The output stimulating pulses are applied to the vagus nerve which controls the muscles in the heart.

If this nerve fatigues and normal

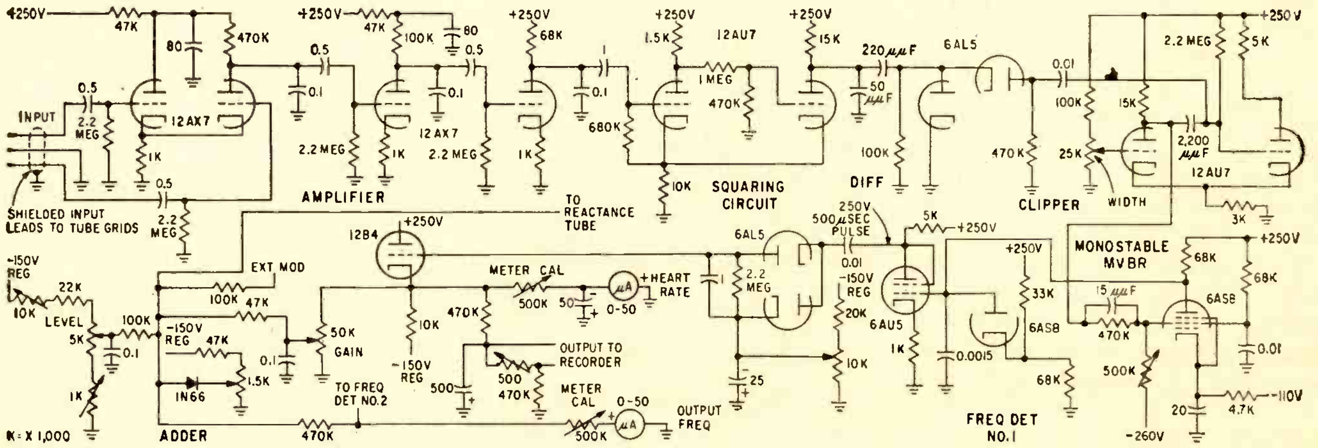


FIG. 6—Sections of heart rate regulator which use different circuits. Separate power supply is conventional

body control takes over, denervation of the vagus nerve helps to restore control to the electronic heart rate regulator.

Circuits

The complete circuit of the blood pressure regulator is given in Fig. 5, except for power supplies. Identification of stages corresponds to that of the block diagram in Fig. 3. The 6AG5, 12AU7 and 12AT7 tubes in the chopper amplifier serve to deliver to the adder a d-c voltage that is proportional to mean blood pressure, the polarity of which can be reversed by the reversing switch at the upper right.

Potentiometers in the adder circuit permit introducing negative voltages that correspond to the desired blood-pressure level and the maximum safe level. The remaining stages function essentially as described for the block diagram, with the frequency detector having an added output for driving a recorder.

The heart-rate regulator differs from the blood-pressure regulator principally in the input circuits, shown in Fig. 6. The stages are labelled to conform to the terminology of the block diagram in Fig. 4.

The blood pressure can be maintained constant over long periods of time with no detrimental effects to the patient or subject. Figure 7 shows a pressure recording taken on a dog over a period of 90 min. The electronic regulator was energized near the beginning of the trace and the mean pressure dropped to the desired level. This level was maintained over the 90-minute period, after which time the stimulus was removed. The body system immediately increased the pressure to its original level.

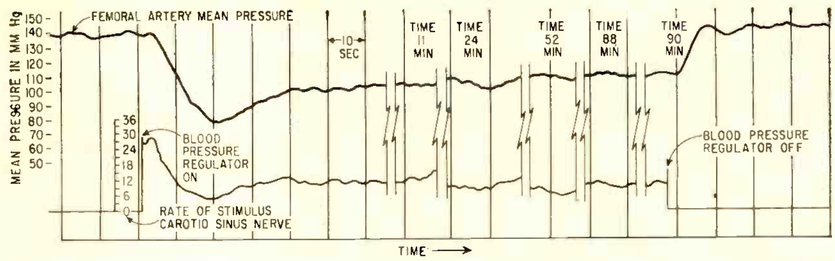


FIG. 7—Tracing of record showing regulation of pressure by stimulation of carotid sinus nerve with blood pressure regulator unit

In some cases where the blood pressure regulator does not completely override the subject's own regulator system, it is necessary to denervate the carotid sinus nerve.

Ability of the heart rate regulator to lower the heart rate is shown in Fig. 8. Here the output signals are fed to the vagus nerve. The decreased heart rate can be held constant at the preset level for long periods of time. A decrease in mean blood pressure is also obtained, as a result of decreased heart rate.

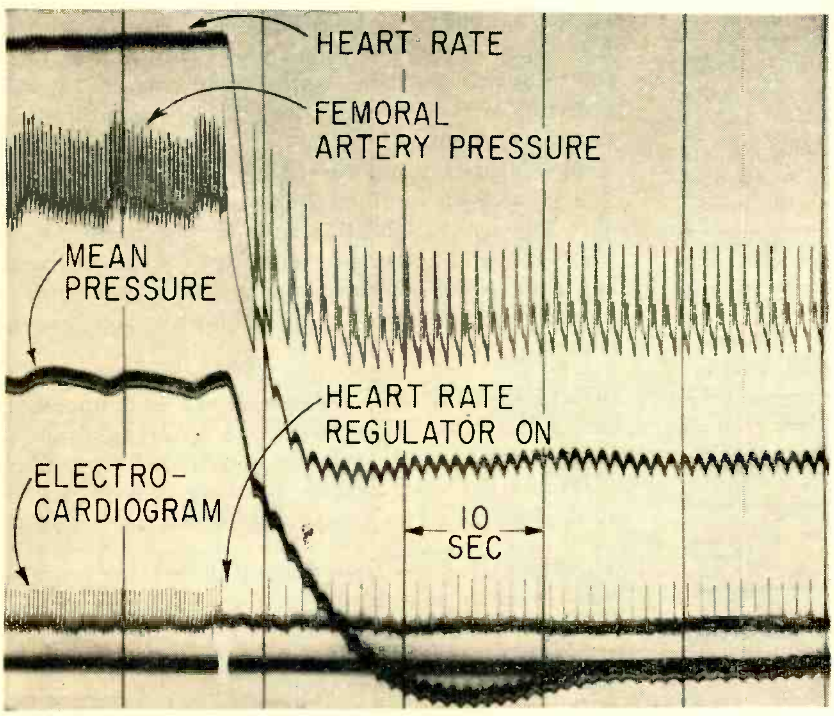


FIG. 8—Tracing of record showing decrease in heart rate and mean blood pressure as result of stimulation of vagus nerve by heart rate regulator unit

Future Possibilities

During laboratory experimentation on the cardiovascular system, the regulators may be used to eliminate the variables of heart rate and blood pressure and maintain them at any level as dictated by the experiment. These units may also be used to simulate different conditions of blood pressure and heart rate.

For instance, they allow studies of high blood pressure in which the actual high blood pressure is induced by the regulator. Also, studies can be made of the response of several body systems to variable heart rate. At all times, the experimenter or physician, has complete control of the variables.

Up until this time, the heart rate regulator and blood pressure regulator have not been applied to human patients. However, more research is under way and the possibilities for the future are rather intriguing. The possibility exists that these units may be miniaturized and further developed such that they may be applied to human beings to adjust or control blood pressure and heart rates over long periods of time. The ultimate is, of course, a possibility that a sufferer from high blood pressure, for instance, may be able to wear a miniaturized blood pressure regulator continually and adjust his high blood pressure much the same as wearers of hearing aids adjust their hearing level.

The medical facilities, testing, and background for the development of the blood pressure and heart rate regulators were furnished by Dr. H. R. Warner of the L.D.S. Hospital, Salt Lake City, under grants from the U. S. Health Service.

Tape and Film Insulation

High-temperature requirements of modern military equipment are bringing about use of new tape and film insulations that combine recently developed plastics with conventional materials such as glass, mica and asbestos

By GEORGE SIDERIS, Associate Editor

ACTIVE DEVELOPMENT of dielectric combinations in recent years have given electronics a wide choice of tapes and films.

There are scores of insulating papers available, in thicknesses ranging from one-fifth mil and up and in dielectric strengths ranging from 200 to 2,500 volts per mil thickness.

MICA—Better grades of mica, available in thicknesses of 1 and 2 mils, have dielectric strengths up to 3,000 volts per mil. One prepared form of mica consists of 1-mil sheets coated with silicone varnish and ground mica to provide a nonslip form about 2 mils thick.

Most designers are already familiar with tapes and films made of such plastics as vinyl, polyethylene and polyester. Polyester has rapidly become important as a capacitor dielectric and in pressure-sensitive tapes.

Table 1—Standard Service Temperature Ratings for Tape and Film Insulation

Class	Temperature	Basic Materials
O	90 C	Materials or combinations of materials such as cotton, silk and paper without impregnation
A	105 C	Materials or combinations of materials such as cotton, silk and paper when suitably impregnated or immersed in a dielectric liquid
B	130 C	Materials or combinations of materials such as mica, glass fiber, asbestos with suitable bonding substances
F	155 C	Class B-type materials with suitable binders
H	180 C	Class B-type materials and others such as silicone elastomers with binders such as silicone resins
C	220 C and up	Inorganic materials such as mica, porcelain, glass, quartz

Note: In all classes, other materials may be substituted if experience and accepted tests demonstrate that the material is suitable for the class

FLUOROCARBONS—Fluorocarbon resins, with their stability over a wide range of temperature and frequencies are expected to become more widely used. Films of tetrafluorethylene (TFE) are now commercially available as thin as $\frac{1}{4}$ mil and have been cast at $\frac{1}{10}$ mil. In some cases these can be used for class-C applications (see Table I). They are generally typed as class-H insulation. Thin film of tetrafluorethylene may be laminated to avoid pinholes without increasing bulk, or can be metallized for capacitor winding.

One plastics processor offers a TFE fluorocarbon which has been modified to improve its high-temperature physical capabilities with only a slight loss of high-frequency electrical qualities. A perfluorocarbon soon to be commercially available will perform like the polyesters, but in a higher temperature range.

POLYETHYLENE — Polyethylene's temperature rating has been raised to class A by irradiation, although it is not yet available in extremely thin films.

Irradiation also permits it to be heat-shrunk by 40 or 50 percent to create a form-fitting wrapping.

GLASS—Glass has been finding increasing applications recently as a flexible dielectric, chiefly as fiber cloth and bonded flakes. Thin glass films are used in capacitors but they lack flexibility for cold windings on coils and other applications.

for Electronic Equipment

Glass cloth is used in high-temperature tapes primarily to give resins greater physical strength. In the glass flake papers, the paper pulp is used to bond the flakes. The paper pulps may either be the common kraft paper pulp or glassine, a clear paper pulp. At least one firm is laying glass fibers lengthwise on thin asbestos paper to improve its strength.

Some of the newer types of flexible insulation systems use matted and felted resins and inorganics.

APPLICATIONS—A number of the insulating materials shown in Table II were originally developed for electrical applications, rather than for electronic use. The thinness of the tapes described testify to the efforts of insulation manufacturers to keep striving for insulations which take up less space.

As the maximum service temperature of electronic equipment is pushed up, glass, mica, reconstituted mica, silicones and the fluorocarbons will become more important. In using combinations of these materials, it must be remembered that the initial temperature rating of the insulating system is not so important as the ability of the system to withstand long-term high temperature.

Not shown in Table II are a host of natural and synthetic tape and film materials useful at temperatures below 105 C.

Table II—Physical and Electrical Properties and Applications of Representative Tape and Film Insulation

	Service Temp. Class (Table I)	Dielectric Strength volts/mil thickness	Tensile Strength lbs./in. width	Thickness (at values given)	Typical Applications in Electronic Equipment
Polyester	A	4,000	—	1	Capacitors, transformers and coils, insulate cores
Varnish-paper	A	2,000	—	1	Capacitor dielectric, coils, cable joints
Polyester-paper	A	1,350	100	6.5	Coil insulation, capacitor dielectric
Polyester-cloth	A	2,750	20	5	Transformer and coil wrapping
Acetate-cloth	A	2,000	50	3.5	Affixing yokes to coils
Irradiated polyethylene	A	2,750	—	5	R-f cable, heat-shrunk wrapping
Resin-glass	B	500	100	5	Small-motor slot insulation
Asbestos-polyester	B	1,200	—	5	" " " "
Polyester-rubber	B	2,200	20	2.5	Electronic components
Polyester-mica-glass	B	1,200	70	5	Spacers and other structural parts
Glass flake-glassine	B	1,000	15	5	In development
Glass-isocyanate	F	1,600	75	3	Spacers and other structural parts, wrappings
Asbestos-isocyanate	F	800	18	4	" " " " " "
Glass-polyester	F	1,700	—	—	" " " " " "
Glass-silicone	H	1,000	70	3	Small-motor wrapping, wire, transformer
Glass-silicone rubber	H	1,100	70	5	Cable wrapping, transformers
Glass-tetrafluorethylene	H	750	45	3	" " " , taping leads
Asbestos-silicone	H	800	7	3	Spacers and other structural parts
Mica-resin mat	H	700	15	5	Spacers and other structural parts, tubes
Mica-silicone-glass	H	325	70	6	" " " " " " , wire insulation
Tetra fluorethylene	H	3,200	—	1	Wire insulation, strip coils, capacitor dielectric
Asbestos-silicone	C	410	9.5	3	High-temperature power transformers
Glass paper	C	200	2.5	4	Transformer and small motor insulation
Mica-silicone	C	2,000	—	¾	High-temperature capacitor dielectric, power transformers
Glass-silicone	C	850	—	—	Transformers
Mica sheet	C	1,000	—	¾	Capacitor dielectric

Multiplier-phototube control circuit, traveling on machine lathe, automatically records dimensional measurements of printed circuits and photographic plates in increments of 0.0001 in. System employs opaque projector and electronic counter. Output is read as image length times magnification ratio

By **SHELDON ISAACSON**, Maryland Electronic Mfg. Corp., College Park, Maryland

Electronic Caliper

AUTOMATIC MICROMEASUREMENTS of dimensions of small objects are made by an electronic system that eliminates human error in taking repetitious readings.

Measurements are taken by a multiplier-phototube control circuit that travels on a precision lathe. Circuit output is fed to an electronic counter. A block diagram of the system is shown in Fig. 1, and the mechanical layout is seen in Fig. 2.

The object to be measured is placed on a rotary index table, located directly beneath the lens system of a projector. The lens casts a magnified image of the object, which is reflected from a front-surface mirror onto the plane scanned by the multiplier phototube.

System

A 931-A multiplier phototube, a 6AK5 amplifier and a mercury-relay switch with a relatively fast response time are mounted to the cross arm of the lathe. This arm travels down the ways of the lathe and when the phototube reaches the image-area region, the mercury relay switch with a relatively fast counter is triggered and the counting cycle begins. The relay is de-energized at the end of the image zone and counting stops. Recorded in counter readout is the image length times the magnification ratio.

Sealed-beam lights in the projector give high illumination efficiency. A voltage regulator insures a constant light source, independent of line-voltage fluctuation. A ventilating fan stabilizes the projector temperature.

Circuit

The multiplier-phototube circuit is shown in Fig. 3. The 931-A tube fulfills the needs of sensitivity, tube response time and low dark current to minimize fringe-lighting effects resulting from shadow diffraction around the image. The phototube also permits a high signal-to-noise ratio at low levels and response peaks correspond closely to the light source of the projector.

Photocathode sensitivity is 15 μa per lumen. At 100-v potential per stage, the average stage gain is 3.5 for a total gain of 60,000. With 125-v potential per stage, the gain will be 230,000, which is a 4 to 1 change in gain. If tube output is held at one percent, the regulation of the high-voltage supply should be 0.1 percent.

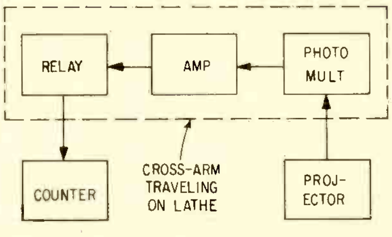


FIG. 1—Block diagram of electronic micrometer for printed circuit checking

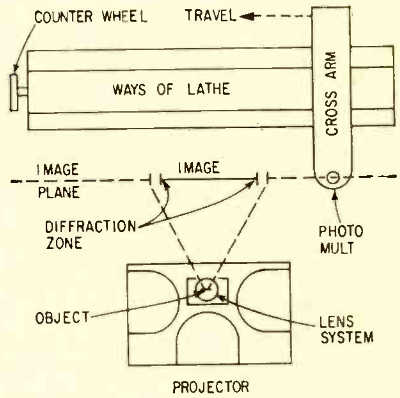
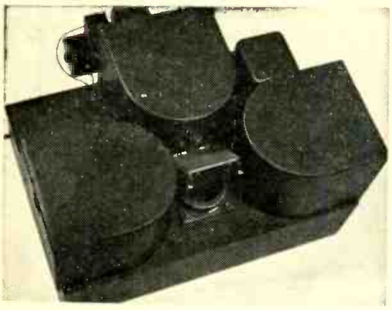


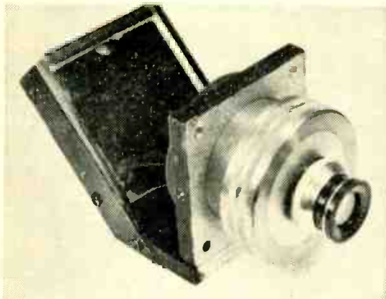
FIG. 2—Mechanical arrangement of the precision measuring machine. Image of object to be measured is scanned by phototube as arm travels down lathe

Dark current of the 931-A is 0.05 μa with 100 v per stage. A lightsource of 10^{-6} or 10^{-7} lumens is detected if the tube is operated with a gain of only 50,000. The aperture of the phototube is reduced by installing a limiter (dormer window) over a glass envelope, controlling overall sensitivity to some extent.

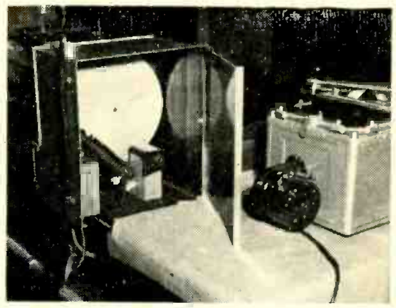
Response time for a typical 9-stage phototube is about 6×10^{-9} sec. Response is linear from zero illumination to values which cause saturation due to space-charge effects. If it takes 6 v to fire the next stage, then 6 μa is required from



The object to be measured is placed beneath lens of opaque projector, and casts image in plane parallel to lathe



Lens and front-surface mirror. Image from front-surface mirror is reflected on to plane scanned by phototube



Counter wheel is directly geared to the main screw of the lathe. Light beam, through holes, indicates lathe travel

Checks Printed Circuits

the phototube at maximum sensitivity.

Illumination sensitivity of the phototube is 800,000 μa per lumen, so that only 6/800,000 lumens will trigger the counter at full sensitivity. To further compensate for fringe lighting, the sensitivity control is cut down to 300,000 ohms, which requires 20 μa or 25 microlumens to trigger the counter.

Operation

A counter wheel with 125 holes, accurately indexed and drilled in its periphery, is geared directly to the main lead screw of the lathe. Each hole corresponds to 0.0001-in. cross-arm travel down the lathe.

The counter wheel interrupts a light-beam-phototube-transducer system which emits one output pulse per interruption, as the carriage, propelled by the lead screw, takes the cross-arm down the lathe.

The output pulse from the phototube is fed into an electronic counter which registers the total number of pulses.

Magnification ratio of object-to-image was determined within measuring accuracy of precision dial indicators.

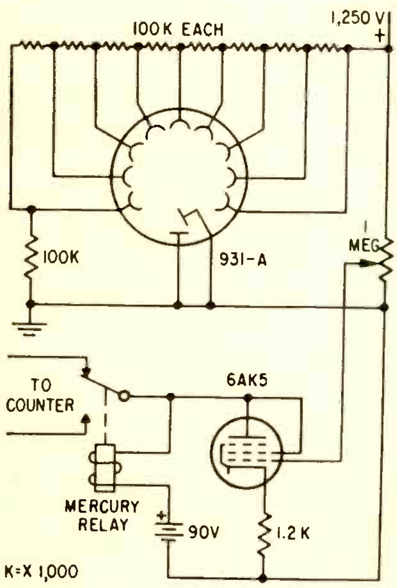


FIG. 3—Multiplier-phototube control circuit. The mercury relay controls the electronic counter

Measurement Parameters

With a magnification ratio of 100 to 1, measurements to one-millionth of an inch are possible in theory. However allowances must be made for shadow diffraction. The light-fringe surrounding the image was found to measure 0.0005 in. in the image plane.

A fair approximation allows 0.001 in. for total shadow diffraction. Also allowances are made for measurement tolerances to 10^{-4}. Considering these factors, measurements to 100 millionth of an inch are experienced. Repeated measurements on the same object indicate an accuracy to ± 10 counts or 10 ppm.

The electronic micrometer was designed to facilitate inspection of printed circuits and photographic plates, and has been used to measure metal stampings and three-dimensional parts. The machine is semiautomatic at present, the only manual operation required being object positioning. However its use could be extended for fully-automatic inspection.

Conveyor Control

An electronically controlled conveyer could be incorporated, so that objects would be positioned automatically to start and stop phototube scan. The stop-count control could be arranged to trigger a photoflash unit which would provide a photographic record of the electronic counter readout, then reset the counter and recycle the entire operation.

Fully automatic inspection would greatly complement the quality-control requirements of mass production.

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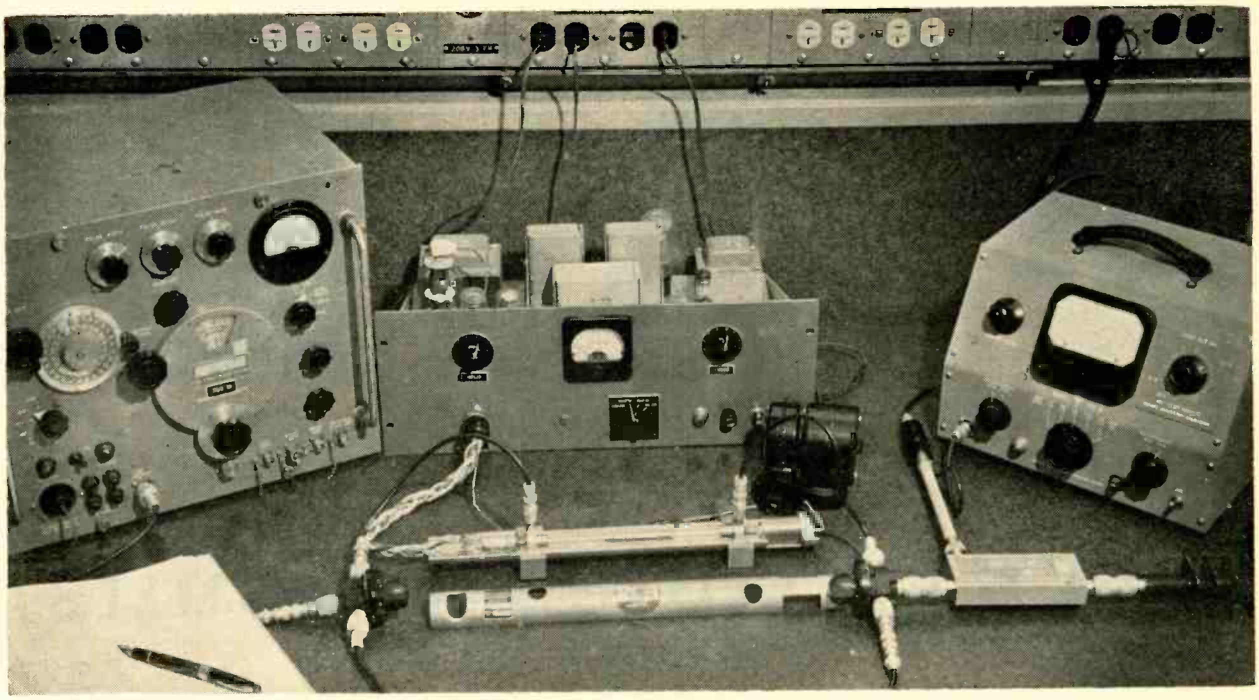


Estiatron encased in a thin shell is shown in typical bench setup prior to checking characteristics

Electrostatically Focused

Complete freedom from external focusing accessories is a feature of this new power traveling-wave device. Other advantages are lightweight, ruggedness, freedom from critical voltage adjustment and no ion oscillation problems

By D. J. BLATTNER and F. E. VACCARO, Electron Tube Div., Radio Corp. of America, Princeton, N. J.

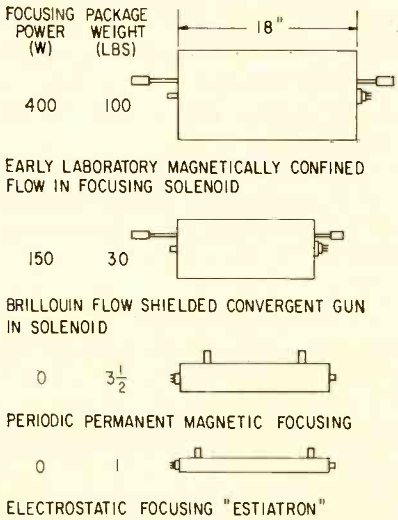


FIG. 1—Size and weight comparison for 10-w S-band traveling-wave amplifiers

BECAUSE of its large bandwidth and gain, the traveling-wave tube is useful in radio-relay systems requiring frequency diversification.

Acceptance of the tube in the field has been slow, however, partly because a heavy magnet is needed to focus the electron beam and because the tube must be aligned carefully within the magnet.

Size and Weight Reduction

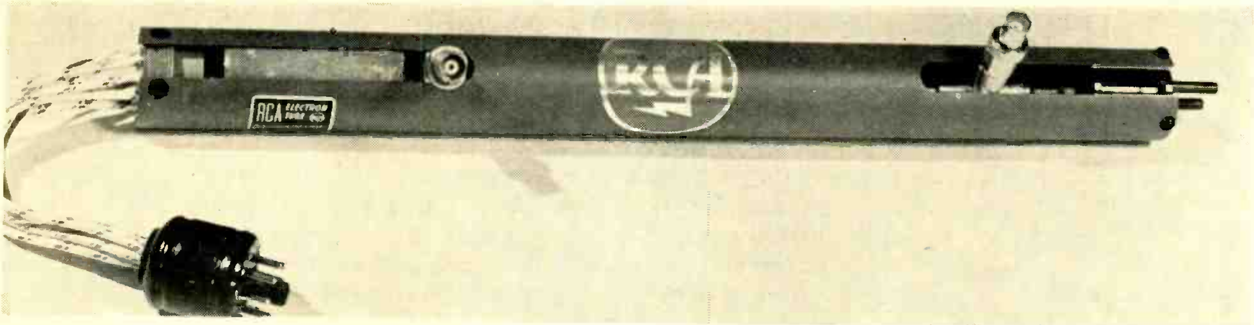
Figure 1 illustrates the progress made in reducing size and weight of traveling-wave tube packages. Early laboratory solenoids for confined-flow magnetic focusing weighed as much as 100 pounds. Size and weight were reduced by use of convergent-flow shielded guns and Brillouin-type electron flow.

These improvements, in turn, led to development of a periodic-permanent-magnet focusing which reduced package weight to 3½ pounds.

Several methods have also been proposed which employ a small magnet in the electron-gun region and electrostatic focusing of the beam. While these methods reduce weight of the tube, alignment within the magnetic field is still necessary.

At the bottom of Fig. 1, the further reduction in size and weight resulting from development of the Estiatron is indicated.

This new tube, to be described, uses electrostatic focusing rather



Closeup view of packaged traveling-wave device

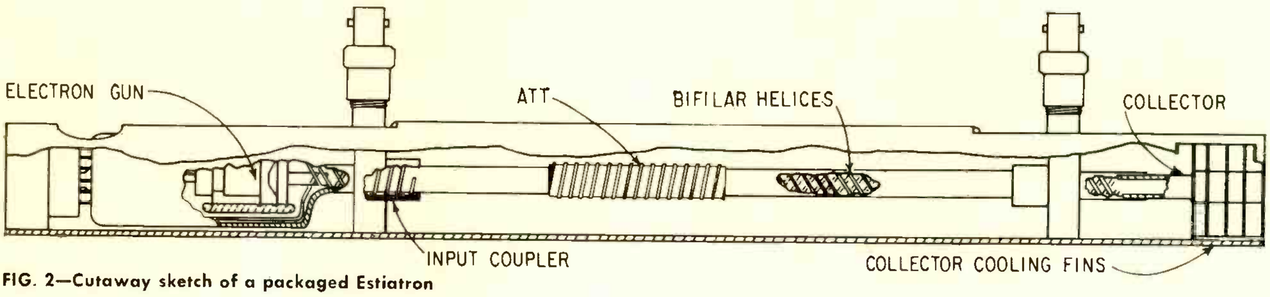


FIG. 2—Cutaway sketch of a packaged Estiatron

Traveling-Wave Tube

than magnetic and requires no magnet. No alignment is required.

R-f input and output are achieved with coupled helices external to the glass envelope which give a good match over an octave bandwidth. The attenuator uses a coupled helix with a lossy sleeve to provide a nominal cold insertion loss of 50 db.

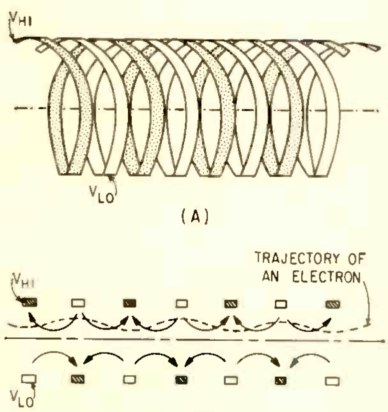


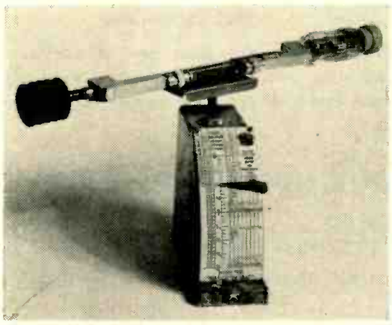
FIG. 3—Bifilar helices for electrostatic focusing. Bifilar helix structure (A) and forces exerted on an electron by the periodic electrostatic field and the trajectory of an electron (B)

Tube Construction

Figure 2 is a cut-away drawing of the packaged tube showing details of its assembly and construction. The Pierce-type convergent-flow electron gun, which has an oxide cathode operated at 60 ma/sq-cm, launches the beam into the bifilar helix.

The helix is supported firmly by flutes of the glass envelope shrunken onto each turn of the wires. The helix serves both as an r-f circuit and as an electrostatic focusing structure. The collector is a hollow cylinder, cooled by radiator fins.

Electrostatic-focusing method is shown in Fig. 3. As illustrated in Fig. 3A, one wire of the bifilar helix is at a high voltage, V_{HI}. The other is at a low voltage, V_{LO}. Average of the two voltages determines the average velocity of the electrons. This velocity must be synchronous with the electromagnetic wave traveling along the helices.



Additional advantage of light weight is shown by tube

The electrostatic field between successive turns of the helix exerts alternating forces on an electron, as shown in Fig. 3B.

For this reason, an electron moving along the outer edge of the beam travels slower in the region of the focusing field of the low-voltage helix than in the defocusing fields of the high-voltage helix. As a result, the beam is focused a greater percentage of the time than it is defocused. An iterated lens effect results that overcomes the

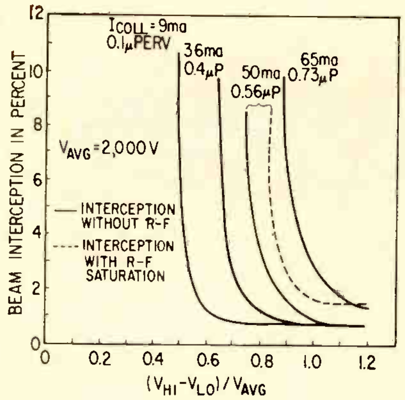


FIG. 4—Beam interception as a function of the ratio of voltage difference to average voltage

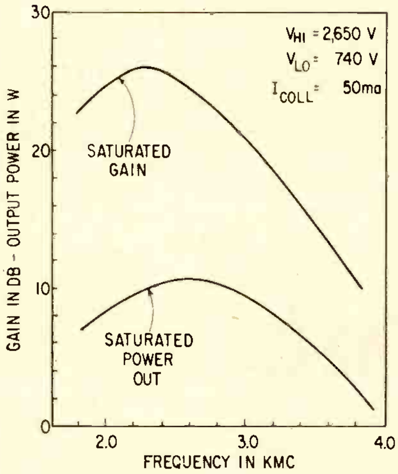


FIG. 5—Saturated gain and power output as a function of frequency. Voltages held fixed at optimum values for 3 kmc

defocusing forces of the space charge.

Practical performance of the focusing system is shown in Fig. 4. It shows how beam-current interception depends on the ratio of voltage difference between helices to average voltage. Operating minimum interception is less than one percent when no r-f signal is applied to the tube. Under saturated r-f conditions, minimum interception is only 1½ percent.

R-f Performance

The electrostatic field which focuses the electron beam also serves as an ion trap by draining the ions out of the beam at every turn of the low-voltage helix. In any application in which spurious signals caused by ion oscillation are a problem, the new tube can be used to advantage. Absence of ion bombardment prolongs the cathode life.

Typical r-f gain and power-output performance of the tube in constant-voltage operation are shown in Fig. 5. The voltages are fixed at the values which produce maximum output at 3,000 mc. The c-w power output is greater than eight watts over a 1,000-mc bandwidth. Saturated gain reaches a maximum of 25 db and has a half-power bandwidth of 1,000 mc. Low-level gain is always greater than the saturated gain by at least five db.

If the two helix voltages are set for optimum performance at some frequency lower than 3,000 mc, even higher output power and gain are achieved. Operation of the tube does not require closely regulated power supplies. Voltages can vary by several percent without material effect on r-f performance and without causing excessive interception.

Input-output characteristics of the tube are shown in Fig. 6. The c-w power output is plotted as a function of power input for three different frequencies keeping voltages fixed at each frequency. Low-level amplification is linear. At 1,900 mc, for example, gain is constant at 28 db up to a power output of 13 w. The tube then saturates with 23 db gain at a power output of 21 w.

Over-all efficiency of the tube depends upon the voltage on the collector. As the collector potential is reduced below that of the high-voltage helix, efficiency rises from 11 to 15 percent before interception becomes too great. Power output remains constant. See Fig. 7.

Noise figure of the particular tube described here is about 25 to 30 db. This is approximately the same value quoted for magnetically

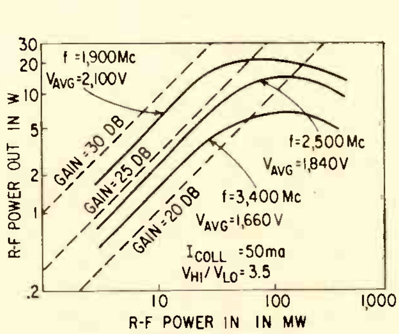


FIG. 6—R-f power output as a function of r-f power input

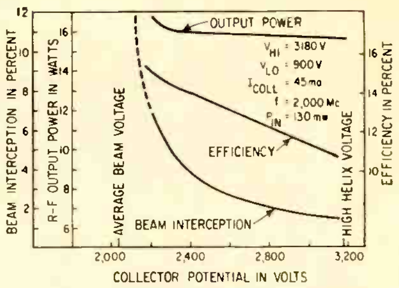


FIG. 7—Curves show variation of efficiency, with collector potential

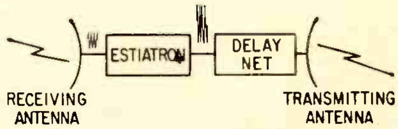


FIG. 8—Airborne countermeasures circuit is a typical application for new tube

focused traveling-wave tubes of the same power level. Low-noise tubes can be built with slight modification of the present design.

Principle of the tube is not limited to intermediate power levels. Conservative extrapolation of the design data indicates that a tube using electrostatic focusing by a bifilar helix can deliver more than half a kw of power at S-band at one-percent duty cycle. The design can be scaled up or down in frequency. The tubes can be used to best advantage at low frequencies at which conventional traveling-wave tubes are long and the required magnets heavy.

Applications

Because r-f performance of the new tube is equivalent to that of a conventional traveling-wave tube, it can be used in any application requiring high gain over wide bandwidth. The light weight and freedom from alignment of the device, however, makes it particularly suited for airborne applications. The block diagram in Fig. 8 shows an application in a countermeasures circuit designed to protect an airplane from target-seeking radar. The enemy's radar pulse is amplified and retransmitted after some time delay, thereby confusing his range determinations.

Development was sponsored in part by the Air Force Cambridge Research Center, ARDC.

Liquid Level Detectors

Four methods of measuring and recording discrete and continuous liquid level, as in flowmeter calibration and other phases of research, are tabulated

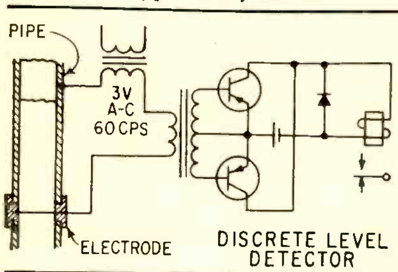
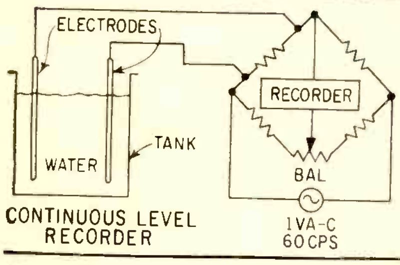
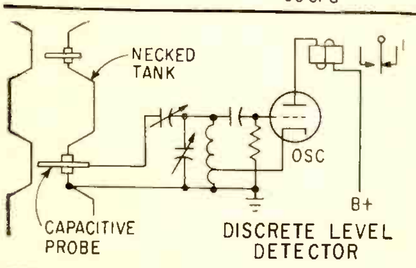
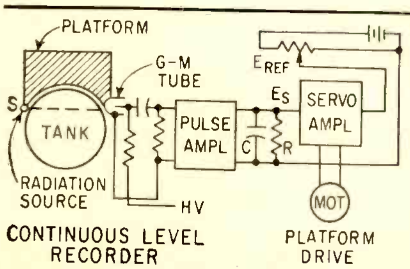
By **THOMAS L. GREENWOOD,**

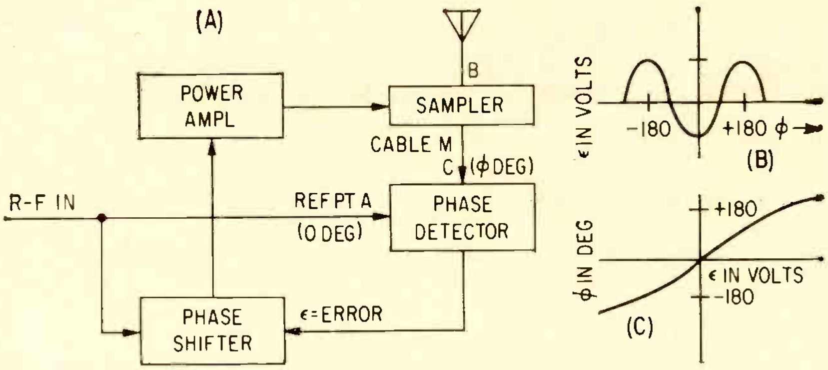
Instrument Development Section, Test Laboratory, Army Ballistic Missile Agency, Huntsville, Ala.

MEASUREMENT OF LIQUID level is often required in research and development problems. These frequently involve the calibration of turbine-type flowmeters. In this procedure, a known quantity of liquid flowing through the flowmeter produces a known number of output voltage cycles which yields the flowmeter constant in gallons/cycle. This system requires accurate methods of discrete level measurement.

For other applications, continuous indication of liquid level may be desired. Here a system which operates either on the principle of electrolytic conductivity or capacitance change is suitable. Another method uses nuclear radiation absorption as a means of detection. The latter has been developed for use with liquids that are nonconductive such as liquid oxygen.

All the methods described here were developed by ABMA personnel with the exception of the capacitance-change necked-tank method. Acknowledgement is made to A. E. Schuler, C. McElroy, E. H. Bohr, L. Thompson and C. Fulmer for their contributions.

Type of System	Principal of Operation	Circuit Features	Characteristics
	Uses the principle of electrolytic conductivity. In general, the conductivity is a function of electrode size and shape and proportional to the area of surface contact between electrodes and liquid. A small dia wire (20 gage) is mounted in a pipe. When immersed in water, resistance changes from several megohms to a few thousand ohms. If multilevel indication is desired, electrodes can be installed at a number of heights.	Total resistance change in electrode circuit should correspond to small change in liquid level. Capacitance of cable and electrode dictates use of 60-cps a-c voltage. Up to 200 ft of cable may be used.	With liquids of low conductivity, sensitivity sufficient for operation at resistivities up to 20 megohm—cm can be obtained with proper amplification.
	Parallel vertical metal rods are arranged to vary the impedance of one leg of an a-c bridge circuit. Depth of immersion of the rods causes a proportional unbalance of the bridge and the unbalance current is used to drive an oscillograph recorder or galvanometer. The bridge circuit is balanced when the tank is empty and calibration made with static water levels.	A-c bridge supply should be used to avoid long time constants associated with d-c supplies.	Used where high accuracy is not required. Capacitive component of electrode-liquid impedance causes nonlinear input-output relationship. Requires frequent calibration.
	Where the liquid being measured is nonconductive, such as liquid oxygen, a system based on capacitance change may be used. The detector is a capacitance electrode placed in a necked tank. When the electrode is immersed in the liquid, its capacitance to ground increases, and the vacuum-tube oscillator ceases oscillation. Output current goes to zero. When electrode is uncovered, oscillator current is normal.	Can be used as on-off control as well as limit-alarm.	Flowmeter calibrations accurate to 0.1 percent are obtainable with this method.
	Uses nuclear radiation absorption for non-conducting liquids. Platform shaped to fit contour of tank carries radium source *S* and Geiger tube. Path of gamma radiation is across chord of tank. Geiger tube output is train of pulses with frequency dependent on gamma energy. Pulses are integrated and compared to d-c reference. Servo motor drives platform up and down to reduce error to zero.	Reference voltage is adjusted to equal integrated pulse voltage in center of range. Servo keeps platform at liquid surface. Multiturn potentiometer on platform drive gives remote indication.	No stuffing box or seal required in tank wall, so method excels for high-pressure service or in corrosive fluid measurements. Accuracy of system is about $\pm\frac{1}{8}$ in.



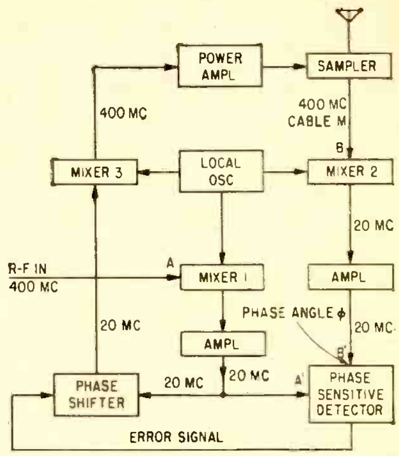


FIG. 1—Block diagram (A) of basic phase-control system. Input-output characteristics of phase detector (B) and phase shifter (C) determine system response

FIG. 2—Complete system for phase stabilization of uhf amplifier

Servo Phase Control

USE OF PHASE-STABILIZED r-f power amplifiers as elements in variable directivity antenna arrays has been restricted until recently by the unavailability of existing phase-controlled amplifiers and the lack of knowledge that practical methods are available for obtaining such control. In this article, a phase-controlled uhf amplifier developed as a unit of a steerable antenna system is described in detail.

This particular system operates over a wide band of frequencies in the uhf band, has a stabilization time of only a few microseconds, and controls the angular phase error between input and output to less than ±2 deg. Control is maintained for any condition of load mismatch, load change, change in frequency, power output variation or amplifier detuning.

A phase-stabilized amplifier is one in which the phase of the output signal measured at any selected point in the output transmission line is compared to the phase of an input reference signal and is held in some controlled relationship with respect to this reference signal regardless of frequency or load changes. In the usual case of an uncontrolled amplifier, the output signal phase is completely unrelated to the input. Furthermore, it is a variable between presumably identical amplifiers, no two having the same amount of phase shift.

Basic System

The basic system for obtaining phase control is shown in Fig. 1A. The output signal is sampled at any chosen point and the sampled signal is compared in phase with the input reference signal in a phase-sensitive detector. This device characteristically has an output which is a polarized d-c signal varying cosinusoidally as the relative phase

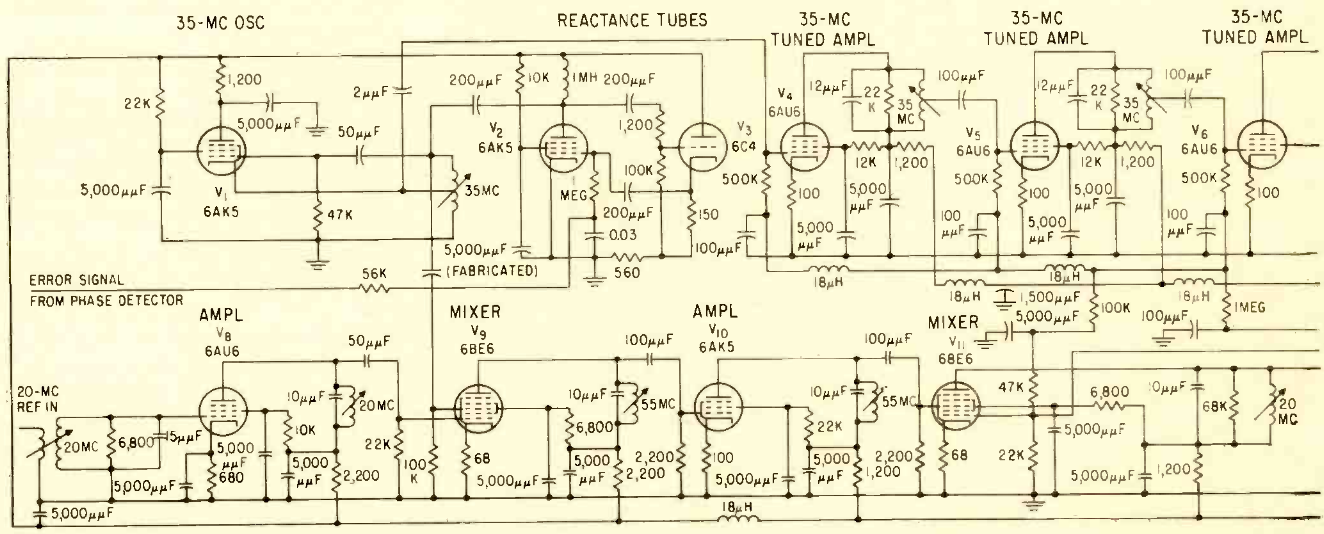


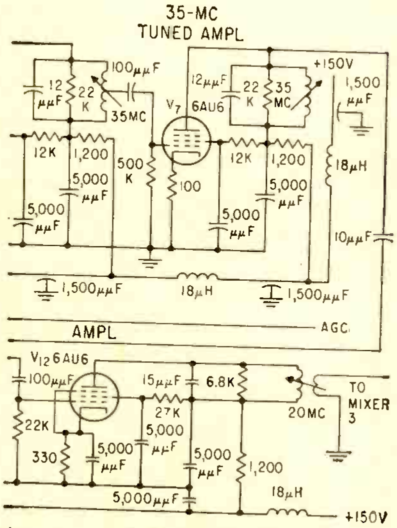
FIG. 3—Schematic diagram of the phase-shifting circuit used in the phase-stabilized system. Error signal from the phase detector (not through reactance tubes V_2 and V_3. Output of fixed-tuned stages V_4 through V_7 is shifted as a function of the d-c error signal

Phase-stabilized uhf amplifier is used to control directivity of a multielement stationary array. Phase of the amplifier output is compared with input reference signal in phase-sensitive detector. System keeps input-output error less than 2 degrees

By ELLIOTT W. MARKOW, Raytheon Manufacturing Co., Wayland Laboratory, Wayland, Mass.

Shapes Antenna Pattern

angle between the two inputs changes. This output is called the error signal and, since it is a measure of phase difference both in amplitude and sense, can be used in a closed feedback loop cascaded with an r-f phase shifter to maintain a nearly zero error signal. The phase shifter must perform in this system at radio frequency and must be capable of providing at least ±180 deg of phase shift as a function of input error signal ϵ. The design of a phase shifter meeting these requirements is described later. Typical input-output characteristics for the phase-sensitive detector and



shown) controls frequency of oscillator V_1

phase shifter are shown in Fig. 1B and 1C.

Since the phase-sensitive detector is the actual point of phase comparison, point *A* in Fig. 1 is the input reference signal (0° phase) regardless of the cable lengths preceding point *A*. Similarly, *C* is the reference point in the output and not *B*. The cable length shown as cable *M* in Fig. 1 contributes to phase shift between points *A* and *B* and must be taken into account if absolute phase angle control is required. Generally, only phase stabilization is required in which case in a multiamplifier system the only requirement is that cable *M* be identical for each amplifier.

Also, in a high-frequency r-f system with a variable or unmatched load it is necessary to restrict phase control to either voltage or current control since the two may not be in phase if standing waves occur on the transmission line. The nature of the sampler determines which is to be controlled; an inductive loop for current sampling, or a capacitive probe for voltage sampling.

Output Phase

The defining equation for output signal phase angle, assuming reference as 0 deg at point *A*, is $\phi_o = [\phi_r/(1 + K)] - [K\phi_M/(1 + K)]$ where ϕ_r is the open-loop accumulated phase shift in the system, *K* is the loop gain, and ϕ_M is the phase shift in cable *M*. If *K* is made large, $\phi_o = -\phi_M + (\phi_r/K)$; thus the phase shift in cable *M* is unaltered but system phase shift accumulation is reduced by the factor *K*. The angle ϕ_r can never be greater than ±180 deg; thus a system loop gain of only 18 would stabilize output phase to within ±10 deg. It is entirely practical to obtain stable loop gains of over 200, thus phase stabilization to within ±1 deg can be easily obtained. Since the system is completely electronic, it can be made to function extremely rapidly, limited only by tube and circuit capacitances and impedance levels. Stabilization time of a few microseconds is possible.

The simple system of Fig. 1A is entirely adequate for a system operating at a single frequency in the h-f region or lower, but for operation over a wide range of frequencies extending up to and above uhf region a more sophisticated and complete approach is required. By adding mixing stages and a local oscillator as shown in Fig. 2 the basic system can be extended to meet the more complete requirements of variable high-frequency operation thus providing a flexible system without modification of the fundamental principles. Figure 2 is the block diagram of a system developed for operation with a uhf power amplifier operating up to 400 mc. Circuit descriptions following will be in terms of this particular system. However, there is no reason why the same concepts cannot be extended to higher operating frequencies.

Mixers

Mixers 1 and 2 mix the r-f signal with a local oscillator signal to obtain a fixed relatively low-frequency output, chosen in this case to be 20 mc for convenience. The output of the phase shifter, also at 20 mc, is mixed in mixer 3 with the same local oscillator signal to recover the uhf frequency. The relative phases of the 20-mc signals at points A' and B' are the same as that of the uhf signals at points A and B because of a fundamental mixer property that phase angle relationships between the two input signals are preserved and transferred to the output sum or difference signal. For example, if the input signals to mixer 1 are so related as to produce a 20-mc output signal of a certain phase, a change of phase of either input signal by 30 deg will produce a 30-deg change in relative phase of the 20-mc output signal.

A change in phase angle of the 20-mc input to mixer 3 also results in an identical phase angle change in the uhf output signal. Except for the advantage of performing phase shift and detection operations at the fixed comfortable frequency of 20 mc, this system is identical in principle with that of Fig. 1A.

Phase Shifter

The phase shifter obtains its input from the 20-mc amplifier following mixer 1 which is always at reference phase of 0 deg. The output is the same 20-mc signal phase shifted by an amount and direction determined by the error signal from the phase-sensitive detector. Since the phase shifter can provide a full ± 180 deg of correction there is no limit to the available system error which can be removed. The phase shifter shown in the schematic of Fig. 3 amply meets the requirements for phase shift range over ± 180 deg and high sensitivity.

The d-c error signal from the phase detector varies the frequency of 35-mc oscillator V_1 by use of reactance tubes V_2 and V_3 to give 35 $\pm \Delta f$ mc. A 20-mc reference signal of phase 0 deg which is derived from the 20-mc amplifier is amplified and used to drive the mixer V_9. The $(35 \pm \Delta f)$-mc signal is also applied to the fixed-tuned stages V_4 through V_7, each of which consists of a high-Q single-tuned circuit sharply tuned to 35 mc.

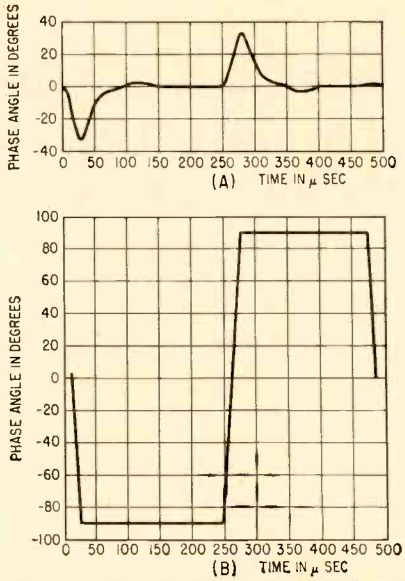


FIG. 4—System response to a step-function change in phase angle; (A) is closed-loop, (B) open-loop response

Any deviation from 35 mc results in phase shift of the output of each of the four tubes with respect to the input signal because of the fundamental phase shift properties of a tuned circuit. The total phase shift is four times that obtained in one stage and is a function of Δf which is controlled by the d-c error signal input. The output of the tuned stages with phase shift is mixed in mixer V_{11} with the 55-mc output of V_9. The output of V_{11} is then the original 20-mc signal plus the phase shift which occurs in the 35-mc channel.

In this system, the gain product is equal to approximately 100 with consequent phase error never exceeding 1.8 deg under any conditions of load or tuning, and is independent of operating frequency.

Response

By suitable choice of system time constants, the speed of control of the system is roughly 25 μsec and could be shortened more if necessary. To illustrate transient performance, Fig. 4 shows typical error signal in response to a step function change in system phase angle.

This amplifier was developed for use in a multielement steerable antenna in which each element of the antenna is driven by a separate phase-stabilized amplifier. The directivity of the antenna array is varied by the equivalent of varying the phase of the drive signals to each of the amplifiers, thus changing the relative phase relationships between the individual elements of the antenna array.

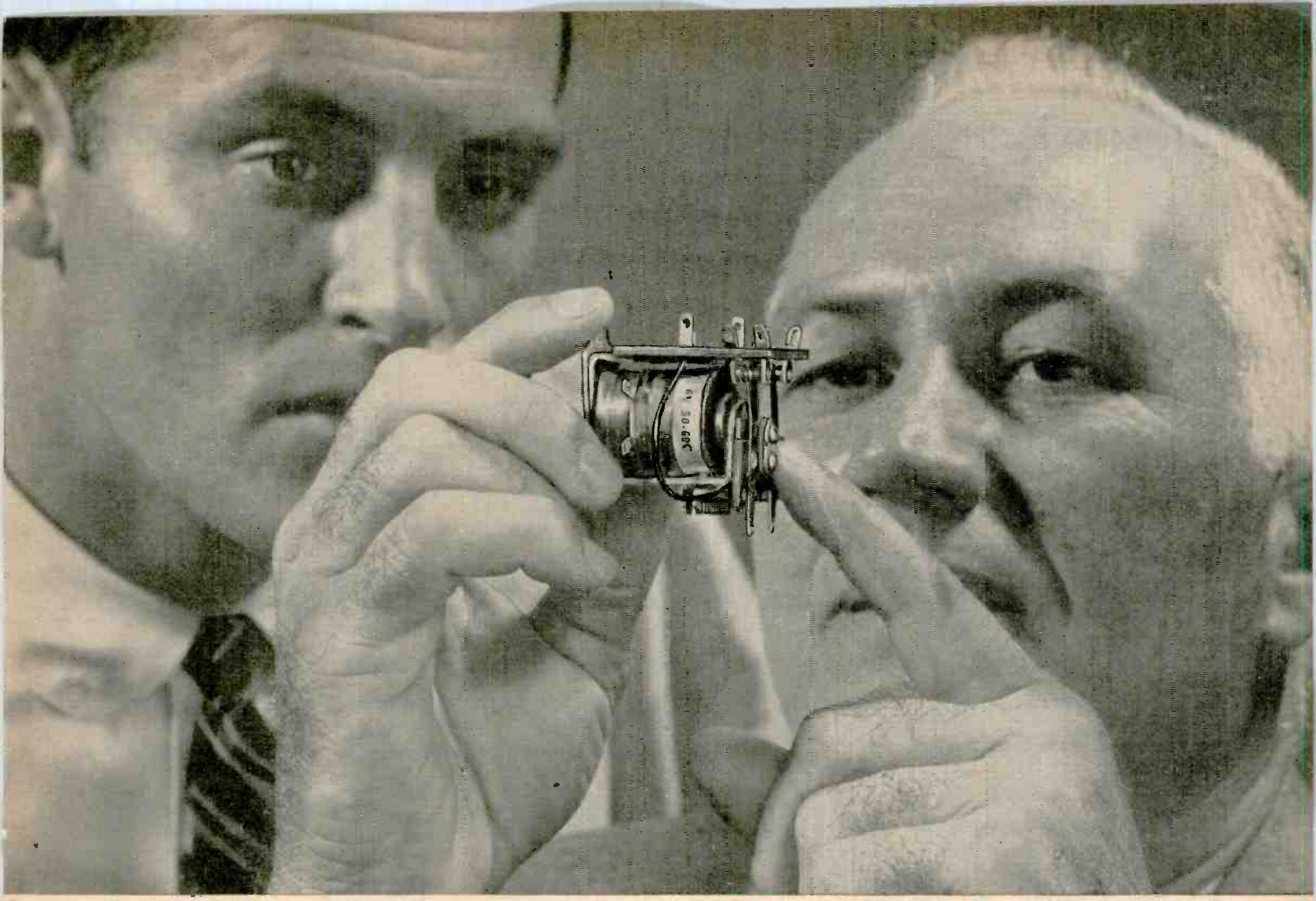
The same principle can be used for antenna scanning. If the error signal produced by the phase-sensitive detector is modulated, the phase of the output signal of the amplifier is similarly phase modulated. If two or more antenna elements are driven with phase-stabilized amplifiers which are also suitably phase modulated, a scanned array results. Scanning at almost any desired rate over any angle up to a full 360-deg azimuth can be achieved. The possible applications to radar and aircraft control systems are obvious.

Receiving

Although it does not require a stabilized amplifier, it is interesting to note that since antennas are bilateral devices the directivity of an antenna array used for receiving purposes can be changed in a similar way as for a transmitting antenna. In this case assuming that each antenna eventually feeds an associated mixer stage, the directivity is determined by the relative phasing of the local oscillator signals to the mixers. These signals all stem from a single local oscillator and are controlled in relative phase by phase shifters similar to that described above. Proper control of relative phase results in change in antenna array directivity if the outputs of the mixers from each element of the array are summed since only the in-phase signal components add.

This project was performed under Contract No. AF19(604)-2167 for the Electronics Research Directorate, Air Force Cambridge Research Center, Air Research and Development Command.

CIRCLE 28 READERS SERVICE CARD→



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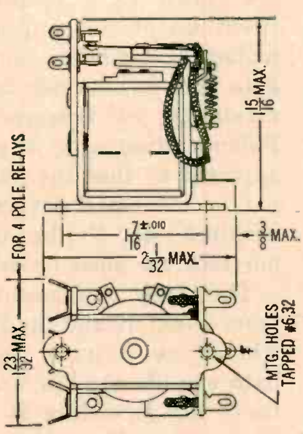

KL ENGINEERING DATA

GENERAL: Breakdown Voltage: 500 volt rms, 60 cycle between all elements standard 4 pole relay; 1500 volts rms, 60 cycle on special 3 pdt relay.
Temperature Range: −45°C. to +85°C.
Pull-In: Approx. 75% of nominal dc voltage.
Approx. 78% of nominal ac voltage.
Terminals: Pierced solder lugs for two #20 AWG wires.
Enclosures: Metal can $2\frac{5}{16}$" high x $2\frac{7}{8}$" long x $2\frac{11}{32}$" wide with octal plug or multiple solder header.

CONTACTS: Arrangements: up to 4 pdt.
Material: $\frac{1}{8}$" dia. gold-flashed silver. (Others available.)
Load: 5 amps @ 115 volts, 60 cycle resistive loads.

COILS: Resistance: 60,500 ohms max.
Power: 100 milliwatts per movable arm.
Duty: Continuous; coils will withstand 6 watts @ 25°C.
Voltages: up to 110 volts dc.
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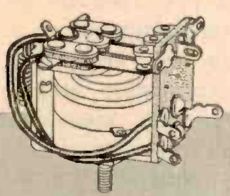

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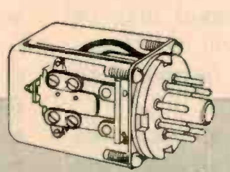
Ruggedly constructed for long life and dependability. Available up to 3 pdt.



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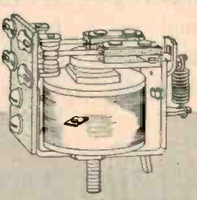
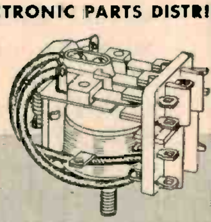
For plate circuit applications requiring low cost, sensitive relay. Polyethylene dust cover.



KT SERIES: ANTENNA RELAY
Insulated to minimize RF losses. Designed to switch 500 watts RF input to 300 ohm line.



KA SERIES: GENERAL PURPOSE
Compact, light-duty relay. U/L approved. Meets 1500 volts rms breakdown requirement.

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By G. I. TURNER

Semiconductor Measurements Project Leader, Standard Telecommunications Laboratories Ltd., Enfield, United Kingdom

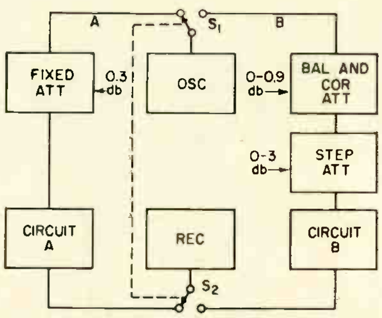


FIG. 1—Signal output of paths *A* and *B* must be equalized within 0.1 db in measuring technique described in text

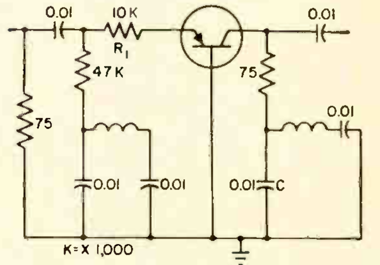


FIG. 2—Capacitor C of transistor circuit to be measured must be increased in valve for frequencies below 1 mc

Measuring Transistor f_{aco}

Alpha-cutoff frequency of high-frequency transistors is measured with accuracy exceeding ± 3 percent up to 30 mc and ± 5 percent up to 100 mc. Method can be adapted for production testing by ganging oscillator and receiver

QUANTITY PRODUCTION of junction transistors whose alpha-cutoff frequencies are in range 5 to 30 mc or higher is now a reality. But the upper frequency limit of currently available high-gain wide-band amplifiers requires a fresh approach to measuring alpha-cutoff frequency f_{aco}.

The method to be described compares the transistor with a short circuit. At the alpha-cutoff frequency, the gain through the transistor path *A* in Fig. 1 equals the gain through path *B*.

Circuit

Constant current passes through the 10,000-ohm emitter feed resistor R_1 of the circuit shown in Fig. 2. Variations in the input resistance of the transistor should not affect the input current by more than one percent. The output circuit is a virtual short circuit compared with the output resistance up to at least 50 mc. Capacitors of 0.01 μf show no resonance effects up to 100 mc.

A duplicate circuit with the emitter-collector connections short circuited is in the other path. The signal generator supplies a modulated 0.5-v rms for normal low-power h-f transistors. Ability to switch off agc improves overall accuracy when comparing paths.

Operation

The transistor whose f_{aco} is to be measured is connected in path *A* and its operating point is set. Signal generator and receiver are tuned to a frequency one twentieth of the minimum estimated f_{aco} where the current gain may be assumed to have its maximum low-frequency value. Balance attenuator in path *B* is adjusted so that the output signal is the same for each path within 0.1 db. Neither transistor nor receiver must be overloaded.

The step attenuator is set from 0-to-3 db and the frequency where the outputs from each path are identical is found. Initially the procedure is repeated with the oscillator level halved. If the same value for f_{aco} is found, the input signal may be considered small and the transistor considered to be operating linearly.

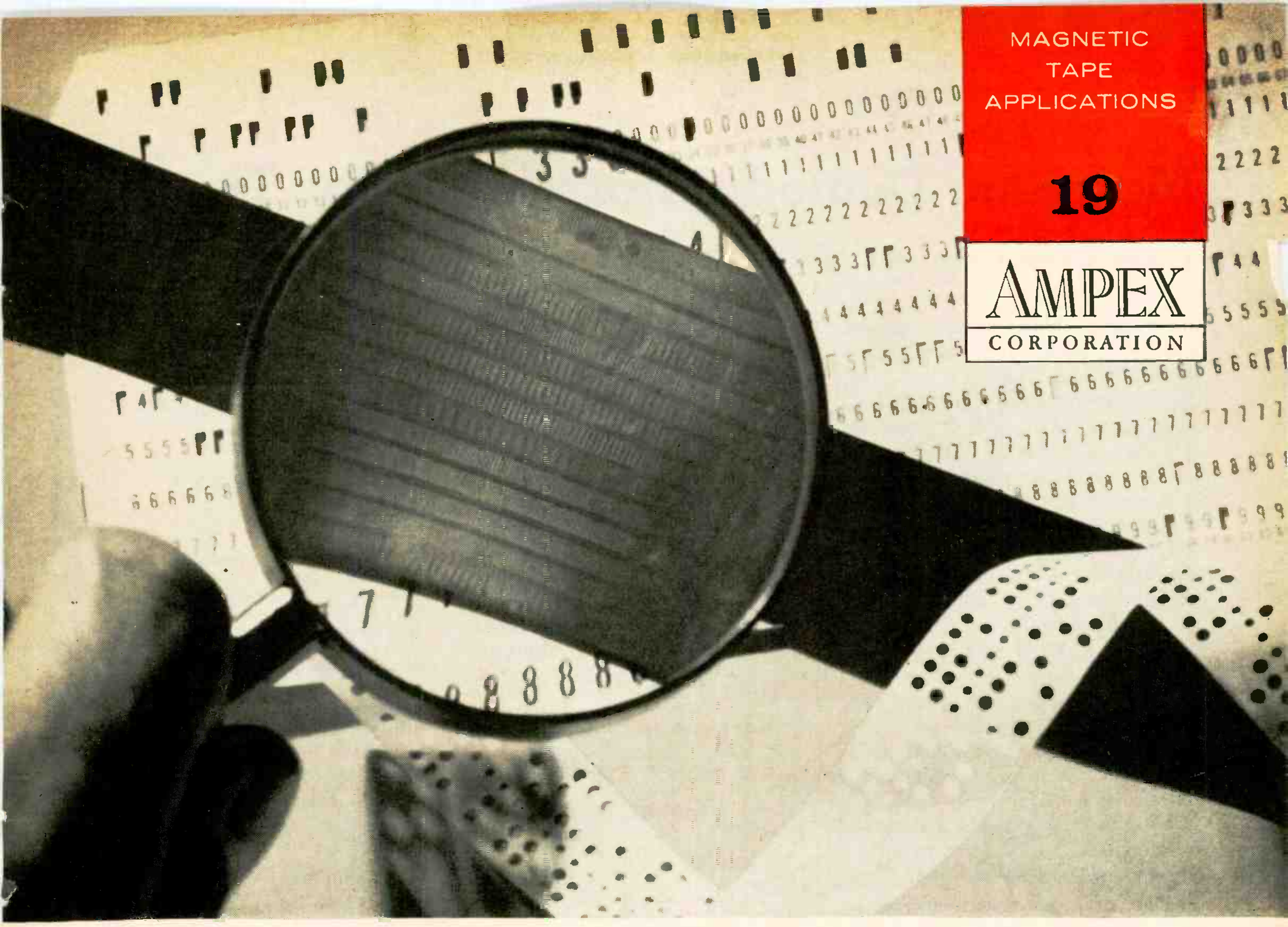
For maximum accuracy, the transistor, short circuit and attenuators should then be interchanged, the process repeated and resultant mean taken as f_{aco}.

In production testing the oscillator and receiver can be ganged, fitted with click stop mechanisms or a switched crystal-controlled oscillator can be used with the same number of receivers or a special receiver with switched crystal-controlled local oscillator.

Calibration and Accuracy

Differences in the two paths and ability to set the indicating meter to the same reading for each path affect accuracy. Path differences are compensated for by short circuiting the transistor connections for both paths. After an initial balance setting at a low frequency by the balance-attenuator, the frequency can be increased to the required maximum and the differences noted. A correction graph is drawn and a level response held when testing transistors by inserting corrections at proper frequencies with a 0.1-db step attenuator.

By replacing the transistor circuits with transistor amplifiers, insertion gain measurements over a wide frequency range can be arranged. Power gain measurements can be made with allowances for transistor impedance changes.



When to use magnetic tape in automatic control

Iron dust and a magnifying glass provide a revealing visual comparison

You are seeing iron dust clinging to signals recorded on magnetic tape. There can be 3200 extremely reliable binary bits on one square inch—or analog control information similarly compact. In the compacting of automatic control data, magnetic tape is supreme—second only to nature's remarkable chromosome. Nature makes people, dogs, cats and monkeys. Magnetic tape recorders make, for example, machined parts—their shapes the most complex and precise that have ever been produced in quantity. It is done by numerical control. The principles involved are very widely applicable to all kinds of control applications. Three main criteria determine where magnetic tape is your best choice.

QUANTITY OF CONTROL DATA

Any automatic control operation that can benefit from very large numbers of time-synchronized commands is a natural candidate for magnetic tape. For example, continuous-path control of a milling cutter may require X, Y and Z coordinates at several hundred points per inch of tool movement. The more points, the greater the accuracy. A reel of magnetic tape can define millions of points at extremely low unit cost.

Continuous real-time control of variables is applicable to process programming, simulation devices, automatic inspection and electronic-system checkout—provided there is need for great accuracy in a complex situation. The program tapes may incorporate the work of giant computers and intricate interpolating devices. A great advantage of magnetic tape is that the computer and interpolator are used only during tape preparation, hence may be shared with many other needs.

Criterion 2: HIGH TRANSFER RATE

The Ampex FR-300 digital tape handler can spew out alpha-numeric characters at rates as high as 30,000 to 90,000 per second. A short burst of digital information equivalent to a standard punched card can be extracted from magnetic tape under 4 milliseconds—including start and stop.

On analog position-control data, magnetic tape can provide many hundreds of complete commands per second—200 per second in one example and up to eight times this many if needed.

On control-system monitoring, a recording of as much as two hours duration can be played back in one minute for review by high-speed computers. Ampex tape recorders with overall speed ratios as high as 120-to-1 are available.

Criterion 3: ERASURE AND RE-RECORDING

Magnetic tape can be erased to accept new data an endless number of times. Hence tape-loop recorders can operate on a repetitive cycle of recording, reproduction, erasure and re-recording to serve as time-delay devices or endless monitors. Such a loop can be the analog equivalent of a production line, conveyor belt or process flow. The loop keeps in step, accepts sensing information at one place and then triggers commands at some fixed time downstream. Or as a calamity monitoring device, the tape loop stores information briefly and erases it to make way for new data if nothing has occurred.

Can we advise you on a specific application of magnetic-tape control or send further literature on magnetic-tape recorder principles and applications? Write Dept. E-19.

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CIRCLE 29 READERS SERVICE CARD

Magnetic Demodulators for Color Tv

By MICHAEL COOPERMAN, RCA Victor Television Div., Radio Corporation of America, Camden, N. J.

COMPOSITE color tv signals contain two components carrying color information, in addition to the brightness-variation signal of monochrome tv. These are the in-phase (I) and quadrature (Q) components, which amplitude-modulate 3.58-mc subcarriers.

In the receiver, these components are separated by a phase-sensitive demodulator. To do this, the color signal is mixed with a 3.58-mc reference subcarrier in a nonlinear device. The I, Q and brightness components are then matrixed (recombined) to recover red, green and blue signals.

Present color receivers use vacuum tubes in color demodulators. These demodulators and their associated matrix circuits are somewhat complex and subject to variations caused by tube and component aging.

A magnetic demodulator could improve performance of color tv. Their most serious present limitation is inefficiency. Output is too low to make their application to color receivers practical at this time. However, better magnetic materials and an improved method of performing a necessary integration to the output would improve efficiency.

The basic circuit is shown in Fig. 1. Mixing takes place in the ferromagnetic toroid, whose actual and idealized hysteresis loops are shown in Fig. 2. A graphical analysis of the basic operation is shown in Fig. 3. The idealized hysteresis loop of Fig. 2 is used in Fig. 3A.

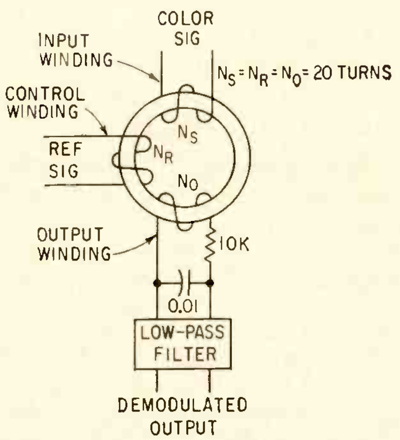


FIG. 1—Basic magnetic demodulator has input winding with color information, reference winding and output winding that supplies demodulated I or Q information

Figure 3B shows the ampere turns of the I and Q subcarriers and reference signal plotted as functions of time. Relative amplitudes are exaggerated. Actually, amplitude ratio of reference signal to I or Q component is made at least 10:1 to reduce distortion.

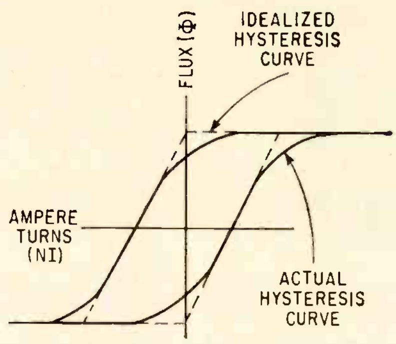


FIG. 2—Curves show actual and idealized hysteresis curves for magnetic material used in demodulator

Reference frequency is made one-half subcarrier frequency, although other ratios can be used. Also, sinusoidal current waveforms have been assumed for the reference and color signals. This is not a necessary condition of operation but is chosen to simplify analysis.

Total ampere turns acting on the core is the sum of the ampere turns of each signal. Since the ampere turns are produced by a-c currents, the hysteresis loop is traversed in a sequence indicated by the arrows.

Flux produced by each signal is shown in Fig. 3C. Average flux produced by the reference signal is zero, since areas during positive and negative cycles are equal.

Flux contributions from the I or Q signal can only come during the time interval ΔT. At any other time, maximum flux is already established by the reference signal,

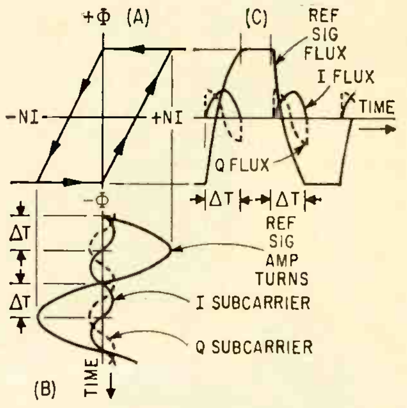


FIG. 3—Graphical analysis shows that only I component can be produced because reference signal saturates core except during time ΔT

which saturates the core.

Average flux produced by the Q component is also zero. Only the flux produced by the I component has an average value other than zero. Consequently, if the subcarriers are amplitude-modulated, the average flux would follow the envelope of the I component.

Efficiency

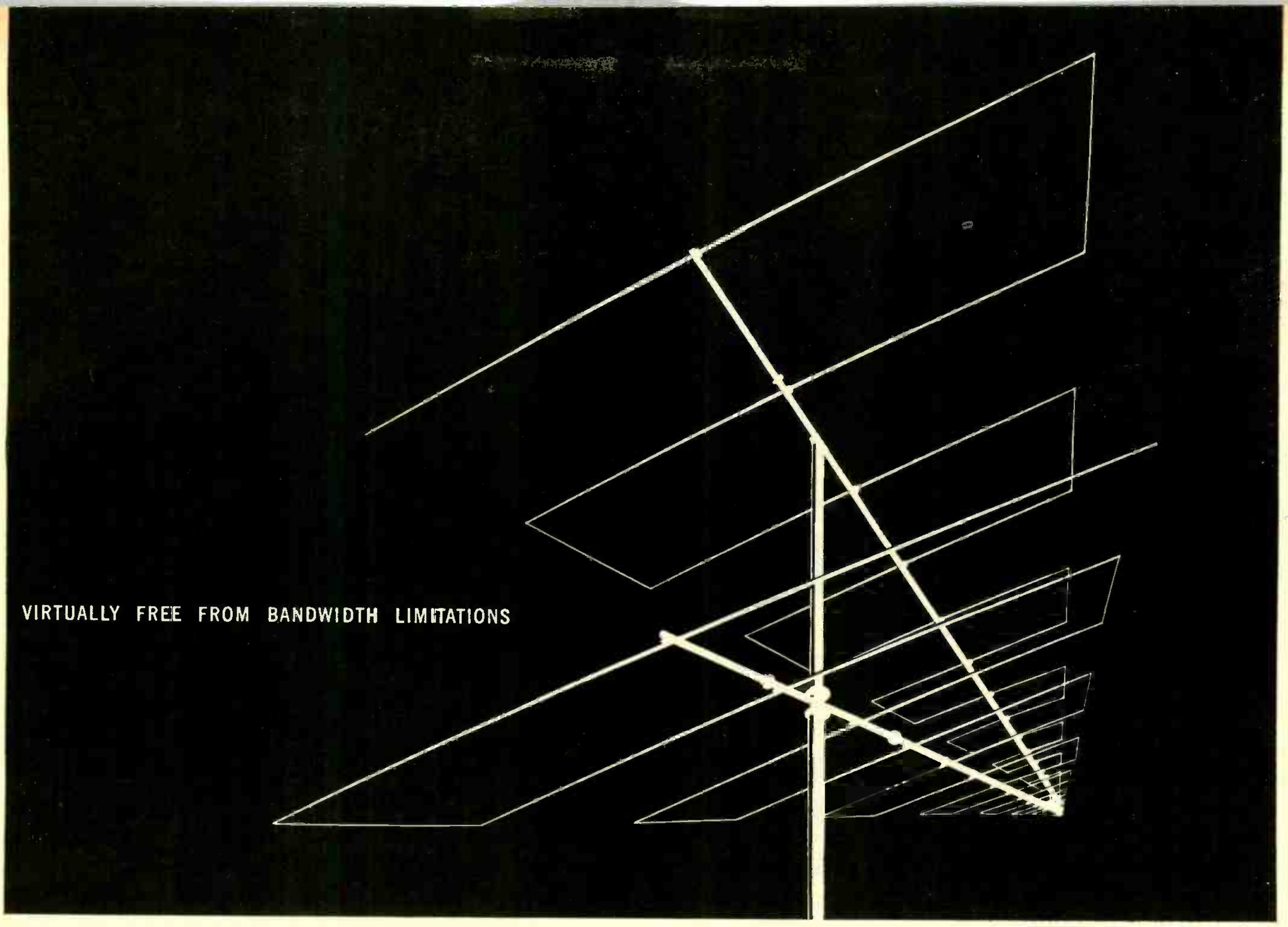
The demodulated information is available in the form of a flux containing either I or Q information. To be useful, it must be in the form of a voltage. The voltage induced in the output winding, N_o in Fig. 1, by the demodulated component of flux, ϕd, is

$$E_o = N_o \frac{d\phi d}{dt}$$

Voltage output is therefore the time derivative of the desired voltage and must be integrated. An integrator is formed by the r-c network of Fig. 1. As a result of the integration, output drops 40 db, reducing efficiency. Integrator output is passed through a low-pass filter that cuts off at 1.5 mc.

To obtain red, green and blue color signals, two demodulators are used—one for the I and the other for the Q information. The I and Q information is then matrixed to form the three color signals.

The demodulators in the matrix-



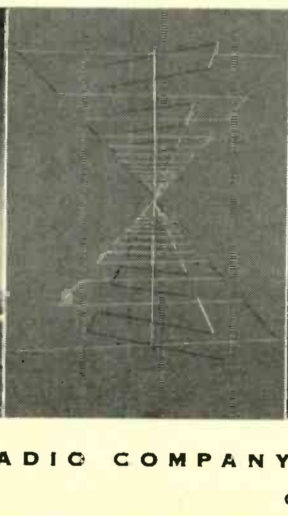
COLLINS LOG PERIODIC ANTENNAS

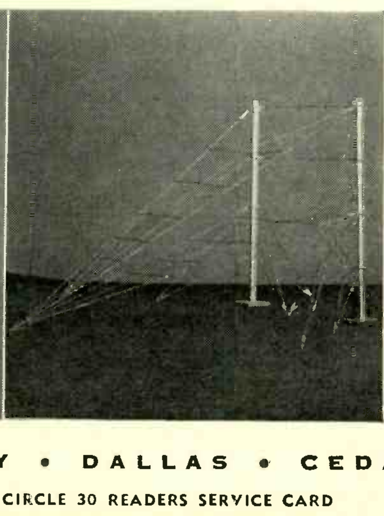
A radically new approach to broadband antenna design based on the principle of Logarithmic Periodicity has resulted in antennas with radiation patterns and impedance characteristics essentially independent of frequency. One Logarithmically Periodic Antenna can perform the functions previously requiring a large number of antennas, covering bandwidths as high as 10-to-1, with 100-to-1 within the realm of practicality.

The Logarithmic Periodic concept is based on a structural geometry in which the electrical characteristics repeat periodically as the log of the frequency. Since only minor changes occur over each period, and therefore all periods, the characteristics are essentially constant over the whole frequency range.

Typical is the rotatable Collins 237A (above), available for 6.5-60 mc, 11.1-60 mc or 19.0-60 mc. The elements form trapezoidal teeth in two planes of equilateral triangles. Radiation is unidirectional with horizontal polarization, providing a free space gain of 8 db over an isotropic antenna. The VSWR is less than 2:1, and the peak power capacity is 50 kw.

The principle may be used in omnidirectional antennas and in fixed antennas in which the vertical plane pattern is also frequency independent. Some other applications include electronic countermeasures and use as primary feeds for reflector and lens type antennas. Your Collins representative can provide details on these and other applications of this advanced antenna.





COLLINS

237A ANTENNA (left) with unidirectional beam may be rotated to any azimuth for general communication.

OMNIDIRECTIONAL TYPE (center), with horizontal polarization, uses a turnstile arrangement.

FIXED TYPE (right) holds vertical angle of beam independent of frequency for point-to-point circuits.

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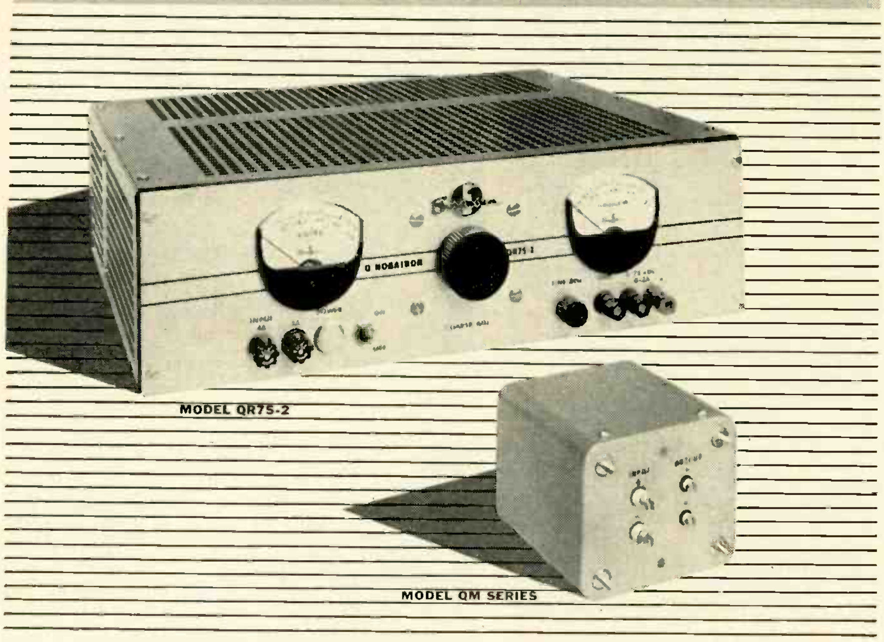
for lab, production test, test maintenance, or as a component or subsystem in your own products



3 new Sorensen transistorized d-c supplies can solve your lab, production and design problems

In the Sorensen "Q" Series, you can select from the most complete line of fully transistorized, highly regulated low-voltage d-c supplies on the market: **QR-Nobatrons**, (shown above, left) with output continuously adjustable down to zero volts, are ideal for labs or wherever maximum flexibility is required. Two models, QR36-4A and QR75-2, put out respectively 0-36V at up to 4 amps and 0-75V at 2 amps. Regulation of QR36-4A is ±0.025% or 4 MV for combined line and load variations. Input: 115vac 50-400 cps available for either bench or rack-panel (5½" x 19") use.

Q-Nobatrons®, with 2:1 adjustable output, can render outstanding service in semi-permanent lab set-ups, in production test, or integrated into your own product. Available in 15 models up to 200 watts capacity with 6, 12 or 28 volts out. Specs and packaging are similar to QR models above. Models for ±0.25% or ±0.05% regulation are available. Lower wattages are available two to a single rack panel (3½" or 5¼" x 19").

QM-Series, solder-into-the-circuit supplies (shown above, right) mount like a potted transformer or choke and come in 36 variations: nine voltages from 3.0 to 36vdc, regulated ±0.05%; and four wattages, 2, 4, 8 and 15. Input 50/60 and 400 cps at 115vac. (Incidentally, Sorensen also offers similarly packaged DC-to-DC and DC-to-AC converters.)

Ask us, or your nearest Sorensen representative, for the complete story on these precision transistorized regulated d-c supplies.

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ing circuit in Fig. 4 each have a control, an input and three output windings. Both input windings are driven from the same color source, while the two control windings are driven from reference sources of different phase. This difference in phase is adjusted so that one core demodulates I and the other Q information. By properly fixing the ratio and phasing of the output windings, the three color signals are obtained.

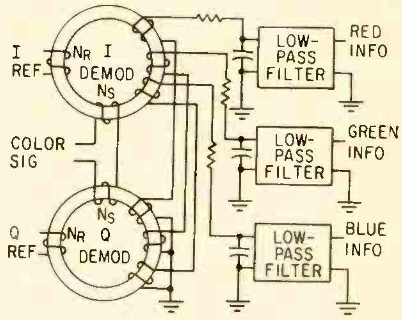

FIG. 4—Complete system shows core outputs integrated and filtered to produce red, green and blue information

Experiments and calculations have established that it is possible to use nonlinear magnetic materials as color demodulators. Since magnetic materials do not age, a magnetic demodulator can be expected to offer improved performance and reliability to color tv.

Wien Bridge Forms Rejection Filter

By J. K. GOODWIN
N. Loughborough, Leics, England

WIEN BRIDGES, often used as frequency-determining networks in high-stability oscillators, can be adapted for use as rejection filters. At low frequencies, the physical size of L-C filters makes their use troublesome. In addition, the Wien bridge filter provides very high rejection.

The circuit shown in Fig. 1 is in balance at some frequency, ω, when $V_3 = 0$ and $R_3/Z_2 = R_4/Z_1$. Assuming $R_1 = R_2$ and $C_1 = C_2$, admittance of branch 2 at resonance is $Y_2 = (1/R_2) + j\omega C_2$.

Since $R_2 = 1/(j\omega C_2)$, $Y_2 = 1/R_2 - 1/jR_2 = (1 - j)/R_2$. Impedance $Z_2 = R_2\ (1 - j) = (R_2 + jR_2)/2$.

It may also be shown that the im-

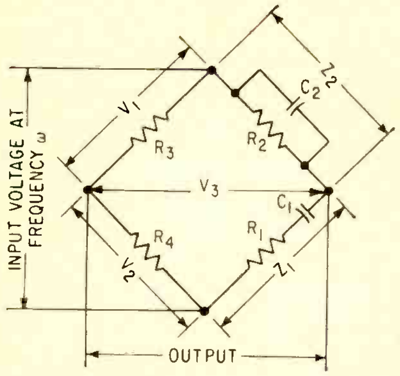

FIG. 1—Basic Wien bridge is balanced when $V_3 = 0$

pedance of branch 1 at resonance is $Z_1 = R_1 + jR_1$.

In order that $V_3 = 0$, $V_1 = V_2$. To achieve this condition, it is possible to make $R_4 = 2R_3$. If it is desired to keep $R_4 = R_3$, it is necessary to make $2Z_1 = Z_2$. In this case

$$2R_1 = R_2 \text{ and } \tfrac{1}{2}C_2 = C_1 \qquad (1)$$

The circuit in Fig. 2 uses a tube to achieve a three-terminal network, as distinct from the four-terminal network of Fig. 1. Resistor and capacitor values are related to equation 1. A potentiometer is included in the plate circuit to balance plate and cathode gain.

The type tube used is not critical, and most triodes in current use may be used with suitable rearrangement of component values in plate and cathode circuits.

Although this circuit does not have a very high Q, it offers high rejection. With one-percent tolerance components, it is possible to achieve approximately 40 db attenuation. With 0.1-percent tolerance components, attenuation approaches 60 db. Tests of the circuit using one-percent components showed an attenuation of 37.5 db.

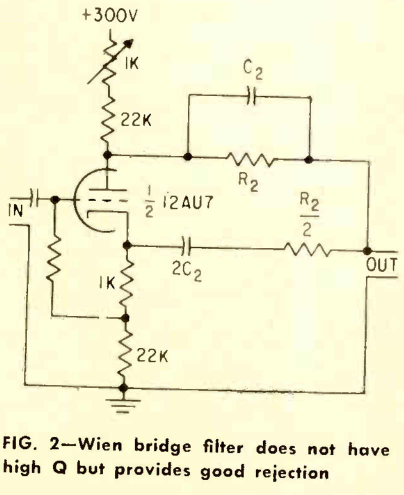

FIG. 2—Wien bridge filter does not have high Q but provides good rejection

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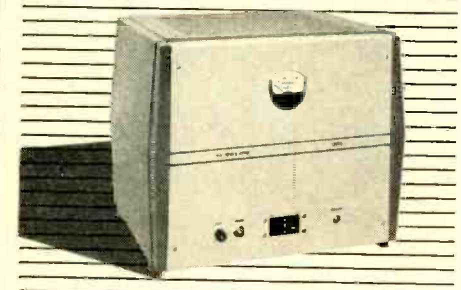
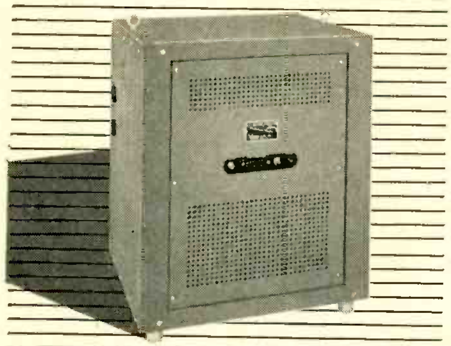
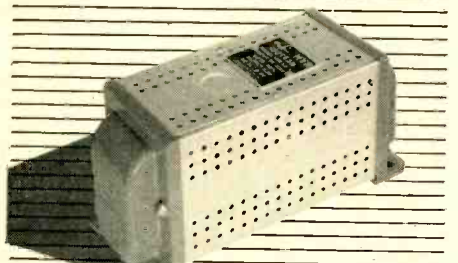


New tubeless 0.1% a-c line regulators give up to 5kva out. High output and fast response result from a unique combination of semi-conductor and magnetic amplifier principles in the new Sorensen Model R3010 and R5010 a-c line regulators. Model R5010 (left) puts out up to 5kva and Model R3010, 3kva. Provision for remote sensing allows you to hold regulation accuracy at the load despite length of output leads, and, with an external transformer, permits regulation of any a-c voltage.



Broadest line of a-c regulators. A complete line of electronic a-c regulating equipment, supplying powers as high as 15kva, is manufactured by Sorenson. Single phase and 3 phase, 50, 60, 400 cps, 115 and 230 vac models are available. Good example of these is the 10kva Model 10000S supply (left). Others: Precision a-c regulators (±0.01%) for labs or meter calibration; and fast-response low-distortion a-c regulators where line transients must be reduced to a minimum.



. . . and rugged, economical MVR's. Low cost, low distortion, long life and a broad selection of models are outstanding features of Sorensen MVR's (Magnetic Voltage Regulators). Capacities range from 30 to 2000 va. Regulation is on the order of ±0.5%. Both harmonic-filtered and unfiltered models are available with 115vac out. Models for 6.3 and 12.6 out, unfiltered, also available.

Sorensen makes a complete line of packaged power equipment—including regulated d-c supplies, inverters, converters and frequency changers. Despite the breadth of the standard Sorensen line, our engineers are always ready to discuss your specialized power requirements up to complete power systems for complex computers or other critical equipment. Write for complete data. 8.43

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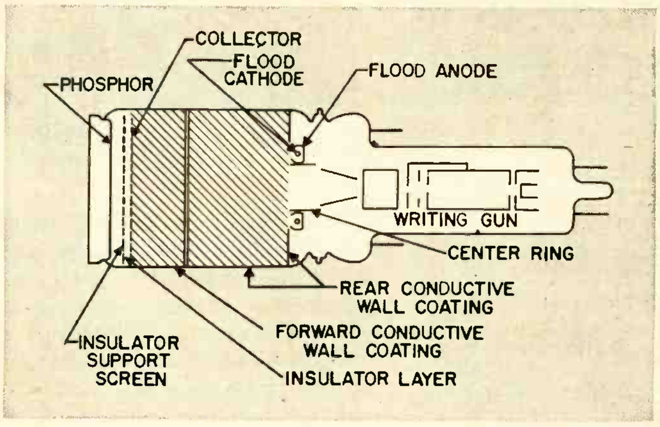
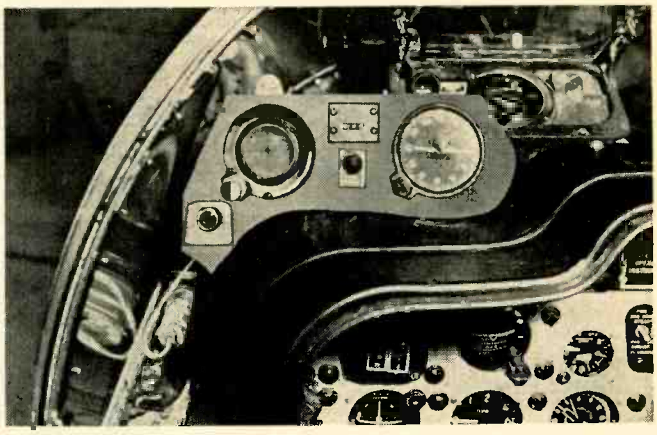


FIG. 1—Schematic diagram of 2.5-in. Iatron with symmetrical guns



Tube is used in radar indicator shown mounted in cockpit of F101

Storage CRT Has Symmetrical Guns

By MICHAEL F. TOOHIG, Components and Instrumentation Laboratory, ITT Laboratories, Fort Wayne, Ind.

BOTH THE WRITING and flooding guns of the Iatron cathode-ray display tube to be described are disposed symmetrically about the axis of the tube. The tube was developed for use in a fighter-plane cockpit. The tube, tube shields, video amplifier, two deflection amplifiers and an erase generator had to fit into a 3- by 11-in. cylinder. Among other required characteristics for the tube were an image brightness of 1,000 ft-lamberts at a final voltage of four kv and a viewing time of 30 sec.

Figure 1 is a schematic drawing of the tube. The writing gun is positioned so that the writing beam passes through the central opening in the flood gun after being deflected. Aluminized P20 phosphor is deposited on a flat faceplate. A storage screen of 500-mesh electroformed copper screen of 45-percent optical transmission has an evaporated dielectric coating on the gun side. The collector screen is 16 by 32 mesh knitted tungsten of 92-percent optical transmission. Two aquadag electrodes are painted on the inner surface of the bulb and a metal plate in the plane of the flood gun is connected internally to the rear-wall coating. Other components are a ring flood gun and a writing gun.

Flood Section

Figure 2 shows the ring gun flood section of the tube. Electrons from each elemental section of the cathode cover the entire presentation area. This is accomplished by cutting the anode aperture in the asymmetrical manner shown; by running the rear electrode of the flood section at flood-anode potential and by using a special electrode positioned in the central opening of the ring gun to control the injection angle of the inner surface of the ring-shaped beam. The electron lens is a double lens formed by the two wall electrodes, the front wall and collector screen.

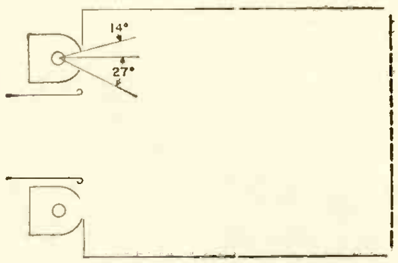


FIG. 2—Ring gun flood section of the tube

Negligible shading requires that the variation of both the normal velocity component of the flood electrons and the flood current density over the storage surface be small. In practice, after proper adjustment of the potentials of all electrodes, it is found that little shading is present. Cutoff potential is found to vary by a few tenths of a volt over the storage surface. When the tube is operated with recommended voltages, a phosphor current of 670 μa is obtained for a flood beam current of 2.8 ma.

Filamentary Gettering

Since viewing time is a function of positive ion current, the smaller the ion current the longer the viewing time. The positive ion current must be maintained at as low a value as possible during the life of the tube. In other words, the vacuum of the device must be as high as possible.

A solution to the problem involved heating a tungsten filament to about 2,700 C and evaporating a film of tungsten onto the glass wall of the tube. The filament is 5-mil tungsten wire developed for use in projection lamps and is positioned between the ring gun and rear shoulder of the envelope. The tungsten is evaporated after the entire tube is immersed in a beaker of water for cooling purposes. Improvements in vacuum of three to 10 times or better have been obtained on a number of tubes. Several tubes were regettered three times.

New, Fast-Switching Mesa Transistor

SWITCHING SPEEDS in the millimicrosec range and a typical alpha cutoff frequency of 250 mc are important features of the new 2N559

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Interior view of mobile teleprinter center

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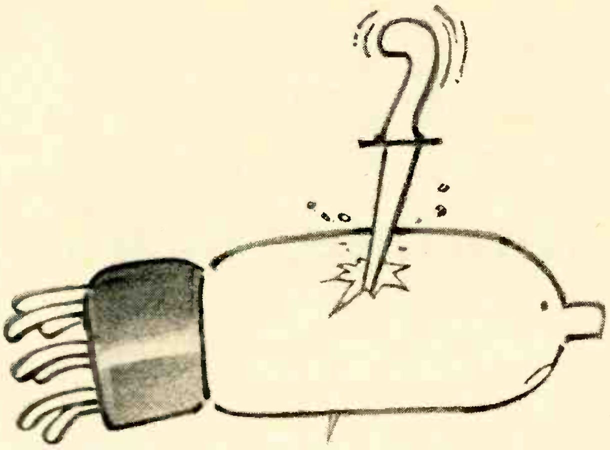


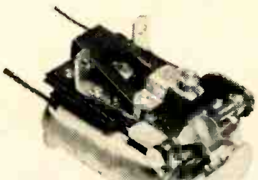
ET TUBE RUTAY?

The recent advent of Cadmium Sulfide cells stirred up the photo-electric street light control business for a fare-thee-well. All hands got busy dumping tubes and producing small controls activated by CdS. Lights were blinking all over the country.

Our parent company, Fisher-Pierce, is an old timer in this P.E. business. Before running off in all directions at once, they made sure that their CdS unit had the performance and reliability of their existing F-P tubed controls. The many problems inherent in designing around new components were classified — we got the one to do with the relay.

The relay had to switch 1000 watt lamps, handle inrush up to 100 amperes, yet operate on 100 milliwatts. And it had to do it 5000 times with no failures and exact, stable pull-on and drop-out. You don't get relays like this out of a barrel.

By using the basic mechanical design of one of our old standards and building a new contact mechanism, we done it. Fisher-Pierce's new CdS control has now proven itself. Which simply re-proves the immortal truth "STABBUS DE TUBUS, IF SERVUS DE PROGRESS."



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mesa transistor. The new diffused-base, germanium component is in production at Texas Instruments.

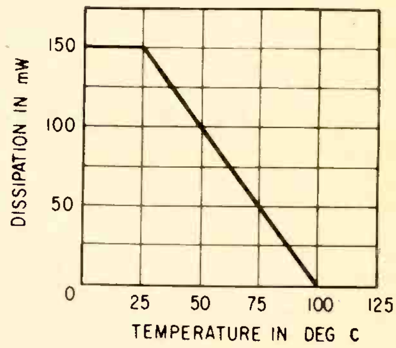


FIG. 1—Typical derating curve for TI 2N559 transistor

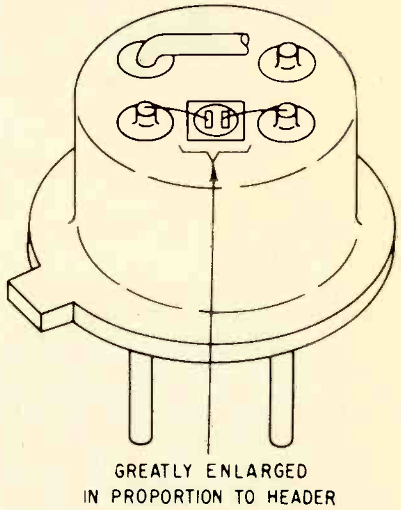


FIG. 2—Assembled device

The new transistor is rated conservatively to dissipate more than 150 mw in free air. It will operate at temperatures up to 100 C. A typical derating curve is shown in Fig. 1. The TI 2N559 is available in a miniature round-welded case less than half the size of standard JETEC-outline TO-5 unit.

Gaseous diffusion and high-vacuum techniques are combined to produce the new transistor. High dissipation is obtained through direct contact between header and

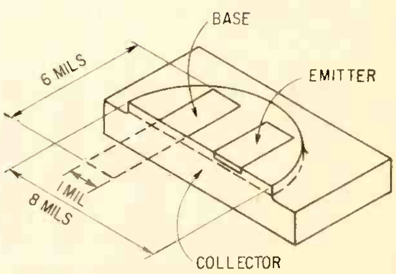


FIG. 3—Closeup of diffused-base germanium wafer

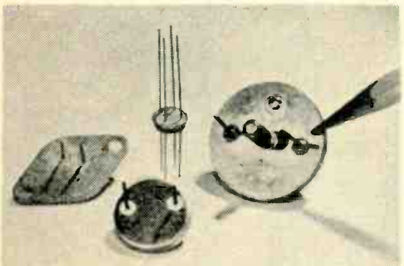
CIRCLE 34 READERS SERVICE CARD

element consisting of just three materials—germanium, aluminum and gold.

The assembled device is shown in Fig. 2. The diffused-base germanium wafer used is made up as indicated in Fig. 3.

New Glass Seals to Copper Directly

CAPABLE of being hermetically fused directly to copper, a new pressed and sintered Multiform glass is available from Corning Glass Works.



Power transistor bases show how leads are sealed directly to copper base without need for metal eyelets

The glass has an expansion of 154 × 10^{-7}/C which closely matches that of copper. Working point of the glass is 665 C; softening point is 465 C; annealing point, 366 C and strain point 344 C.

New Source Reported for Radioisotopes

GENERAL MOTORS Research Laboratories report a new radioisotope source, Samarium-153, which shows promise for radiography, liquid-level gaging, thickness gaging and specific-gravity measurements.

Inside-out panoramic radiography photon energies of 42, 70 and 103 kev are available from the source. It has a short exposure period—about five times less than any other known low-energy photon source. Half-life is about two days necessitating a new source each week to keep exposure times to a minimum. But this can be advantageous because exposure times during the first week of use are less than with any other source.

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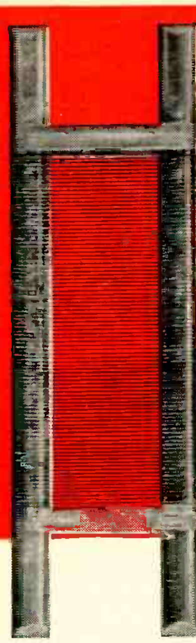

...the world's most modern high-gain twin triode

Amperex 6922

a RELIABLE premium-quality tube for military systems requirements and exacting industrial applications

- low noise
- long-life cathode
- new "dimple" anode
- frame grid construction
- reliable radar cascode stages
- high-speed computer operation
- for HF, IF, mixer and phase-inverter stages
- high transconductance

TYPICAL OPERATION

Plate Supply Voltage	100 volts
Grid Supply Voltage	+9 volts
Cathode Bias Resistor	680 ohms
Plate Current	15 ma
Transconductance	12,500 µmhos (min. 10,500; max. 15,000)
Amplification Factor	33
Equivalent Noise Resistance	300 ohms
Grid Voltage (rms)	0.75 volts

*It's the
FRAME GRID CONSTRUCTION
that makes the difference!

The frame grid is the closest approach to the ideal "physicist's grid"— the grid with only electrical characteristics but no physical dimensions.

It results in:

- higher transconductance
- tighter G_m and plate current tolerance
- low transit time
- low capacitances
- lower microphonics
- rugged construction

Amperex FRAME GRID

The grid-to-cathode spacing tolerance is determined by the carefully controlled diameter of grid support rods (center-less ground) and by frame cross-braces between these rods. Extremely fine grid wire eliminates the "island effect" usually encountered in conventional tubes with equally close grid-to-cathode spacing. Rigid support of fine wires reduces mechanical resonance and microphonics in the grid.

CONVENTIONAL GRID

Grid-to-cathode spacing tolerance depends on accuracy of grid dimension, obtained by stretching on a mandrel, and on tolerances of holes in top and bottom mica rod supports. Diameter of grid wire must be large enough to be self-supporting.

Other Amperex Premium Quality (PQ) frame grid tubes available in production quantities:
5847............broadband amplifier pentode
6688............ruggedized broadband amplifier pentode
plus other PQ and frame grid tubes for special reliability requirements and exacting industrial applications

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Wheels Make Spray-Coating Easy

By STEWART F. PATERSON, Electronic Tube Div., Westinghouse Electric Corp., Elmira, N. Y.

UNUSUALLY-SHAPED PARTS can be spray-coated evenly, economically and quickly on a rotating holding fixture. The equipment, devised to spray cathodes, can be adapted to other spray jobs by changing the chucks and possibly changing the relationship between the line of spray and the rotating support wheel.

Straight-line spraying, where work passes through a spray in a straight line, works well with flat or cylindrical cathodes sprayed only on the outside. Industrial tube cathodes, however, seldom look like conventional cathodes and do not receive the proper weight, density and uniformity of emission coating when the coating is applied by straight-line spraying.

Magnetic chucks speed loading of nickel cathodes on rotating fixture

Cathode Type

For example, the WL-632 cathode shown consists of 2 concentric cylinders about $\frac{7}{8}$ inch high. The outer cylinder has a $\frac{7}{8}$ inch inside diameter, is open at both ends and is connected by six radial fins to the inner cylinder, which is $\frac{1}{4}$ inch outside diameter and closed at both ends. It is made of nickel.

The problem was to coat the inner portion of the outer cylinder, the outer portion of the inner cylinder and both sides of the fins. To do this automatically, the fixture puts the cathodes in proper position and rotates cathode faces in front of a stationary spray gun. The gun is operated by timers.

The rotating support wheel carries 12 rotating magnetic chucks, assembled as in Fig. 1. The support wheel rotates clockwise at about 30 rpm while the magnetic chucks rotate counterclockwise at about 120 rpm. Rotation of the chucks is obtained by having each chuck connected, through bushings in the support wheel, to an individual drive wheel.

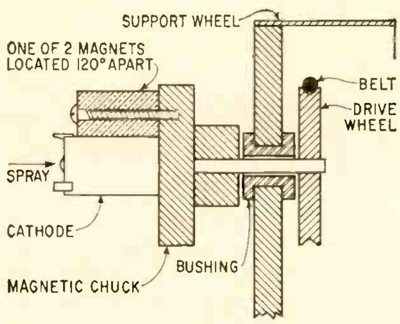


FIG. 1—Cutaway view of chuck and drive wheel assembly

These drive wheels are driven by a belt (Fig. 2) which is a loop tied to a stationary point. The belt runs in a groove in the circumference of each drive wheel. As the support wheel rotates clockwise, the chucks go in the opposite direction. This system is as trouble-free as a setup could be.

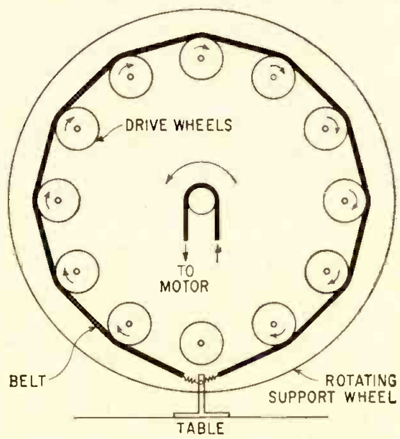
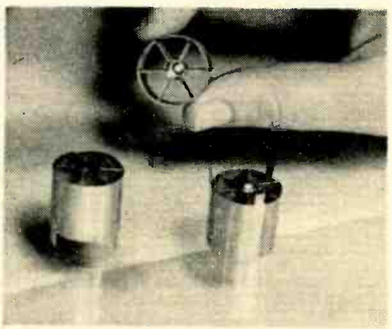


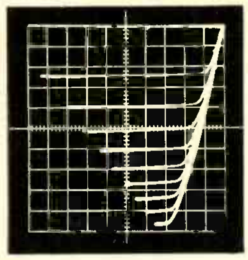
FIG. 2—Rear view of rotating support wheel

The entire mechanism is driven by a single motor located under the spray booth. The motor is directly connected by a belt to the shaft of the support wheel. The faces of the support wheel and chucks are perpendicular to the line of spray, so the spray enters the open ends of the cathodes.

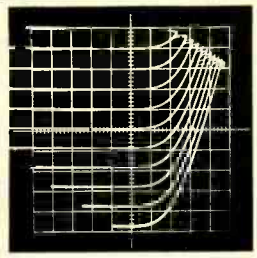


Type of cathode sprayed on inside surfaces

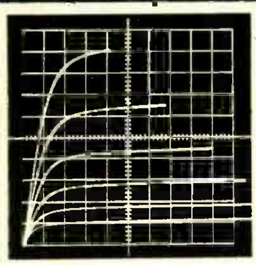
In operation, the operator loads the chucks, starts the wheel rotat-



HIGH COLLECTOR CURRENT
PNP transistor, collector current vs collector voltage with constant-current base steps. Collector sweep is 0 to 5 v with a 0.25-ohm load, base current is 50 ma/step. Vertical deflection is 1000 ma/div, horizontal 0.5 v/div.



HIGH INPUT CURRENT
PNP transistor, collector current vs collector voltage with base grounded and constant-current emitter steps. Collector sweep is 0 to 1.5 v, emitter current 200 ma/step. Vertical deflection is 200 ma/div, horizontal 0.1 v/div. Zero voltage is at center scale.



LOW INPUT CURRENT
NPN transistor, collector current vs collector voltage with constant-current base steps. Collector sweep is 0 to 1.5 v, base current 1 microamp/step. Vertical deflection is 10 microamp/div, horizontal 0.1 v/div.

Transistor-Curve Tracer

T Y P E 5 7 5 C H A R A C T E R I S T I C S

Positive or Negative Collector Sweep
Collector supply—0 to 20 v, 10 amperes.
—0 to 200 v, 1 ampere.
Dissipation limiting resistors—0 to 100-kilohms in 17 steps.

Positive or Negative Base Stepping
4 to 12 steps per family, repetitive or single family display.
17 current-per-step positions, 1 μa/step to 200 ma/step.
5 voltage-per-step positions, 0.01 v/step to 0.2 v/step, with 24 series resistance values from 1 ohm to 22 kilohms.

Calibrated Display
Vertical axis—
Collector current, 16 steps from 0.01 ma/div to 1000 ma/div.
Pushbuttons are provided for multiplying each current step by 2 and dividing by 10, increasing the current range to 0.001 to 2000 ma/div.
Horizontal axis—
Collector volts, 11 steps from 0.01 v/div to 20 v/div.
Both axes—
Base volts, 6 steps from 0.01 v/div to 0.5 v/div.
Base current, 17 steps from 0.001 ma/div to 200 ma/div.
Base source volts, 5 steps from 0.01 v/div to 0.2 v/div.

Test Condition Selector
Select either common-emitter or common-base configuration.

Price $925 **f.o.b. factory**

10-Ampere Collector Supply
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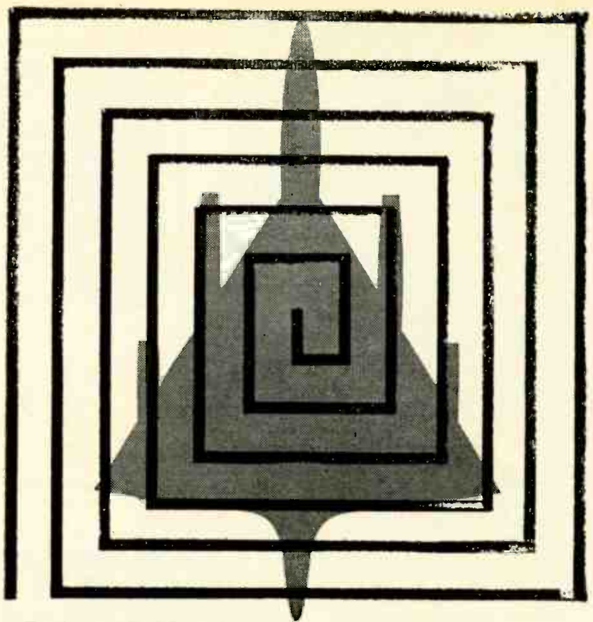

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Today we rely on devices hardly dreamed of a few short years ago. The limits of man's theoretical knowledge are being pushed farther almost daily. Between the theory and the device lies the exciting zone of applied research and development—the application of new concepts, and the development of new products. This is the fascinating challenge of creative engineering.

Radar Ambiguity is just one example, but typical, of the problems under intensive examination at Melpar. Important as the problems of radar are, they comprise but one part of the 110 different electronic research, development and production projects at Melpar.

Rewarding positions are presently available in the following areas of Melpar's activities:

Reconnaissance Systems Engineering Department
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Positions are also available in our Production Division and our Quality Control Department.

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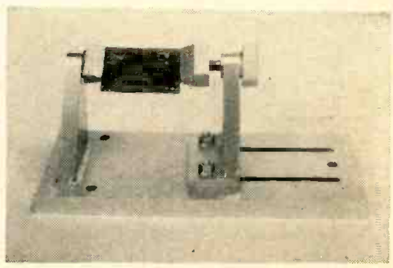
ing and starts the timer-operated spray gun. After the timer stops the gun and motor, the operator turns the cathodes around so the opposite end faces the gun and starts the wheel and gun again. When both ends are sprayed the cathodes are unloaded and the coating weight is checked. Since the spraying is regulated by the timer, the operator's time during spraying can be utilized elsewhere.

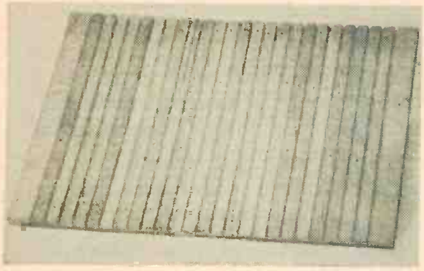
Miniature Vises Hold Small Circuit Boards

PROTOTYPE QUANTITIES of printed wiring boards are assembled at Avco's Advanced Research and Development Division, Lawrence, Mass., on small assembly lines like the one shown. In addition to purchased fixtures and feed trays, the assemblers are using 2 fixtures made in the division's shops.

Small vises provide a firm resting place for the boards while components are attached. Boards can be turned to any angle without obstruction. Boards are held in V



Board vises are bolted to workbench in use



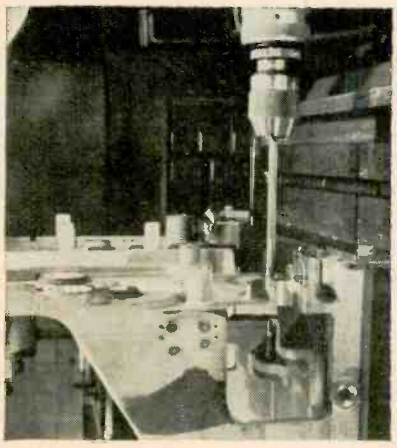
Board holder is pine strips nailed on plywood

grooves in the vise jaws. The left jaw is free to turn. The right jaw rides on an axle which extends through the upright to the turning knob.

The board is held by spring pressure. Washers are placed on the axle between the spring and the upright and between the upright and the knob. Friction between the washers and the upright hold the board at the desired angle.

The tabletop board holders are made of pine strips nailed at intervals on a plywood base, or from a slab of pine saw slotted.

Tap Extension Drills Blind Housing Hole



Tap extension in use on deep remote hole in radar gear train housing

TAPPING of a remote blind hole on a gear train housing for a radar assembly is accomplished with accuracy at Curran Machine Works in Long Island City through use of a tap extension made by Ritmar Corp., Huntington, N. Y. The extensions are available in standard lengths of 9 inches, in nine different sizes to accommodate 15 different sizes of standard taps.

Do you know a volt when you see one?

AC travels in strange ways. It may come rippling in on a sine, jog along a sawtooth, pulse up and down a square or stutter over a distorted wave.

Only if it arrives on sine can you be reasonably sure of root mean square readings on the conventional panel meter, an instrument which senses average voltage and is calibrated to show rms.

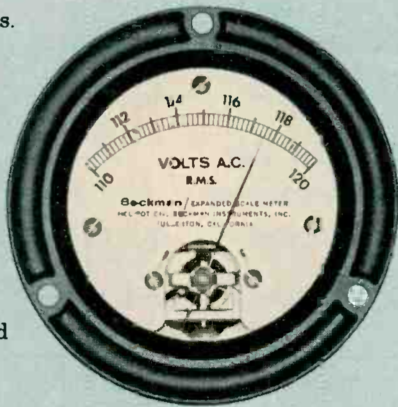
Beckman Expanded Scale AC Voltmeters, however, provide direct rms readings on all wave forms, and for a very simple reason. Thermal elements used in the expansion network operate as a function of heat, and that's just what rms is... the heat value of an AC voltage.

Add reliable rms to other exclusive advantages of the Beckman expanded scale panel voltmeter:

Accuracies to the fraction of a volt...reading resolutions to hundredths of a volt!

And you *will* know a volt when you see one.

Helipot offers you hundreds of models ...either AC or DC...commercial or ruggedized...in a variety of shapes, sizes and voltage ranges. Need color coding, special ranges, assemblies? Yours for the asking. *Send for data file A-14.*



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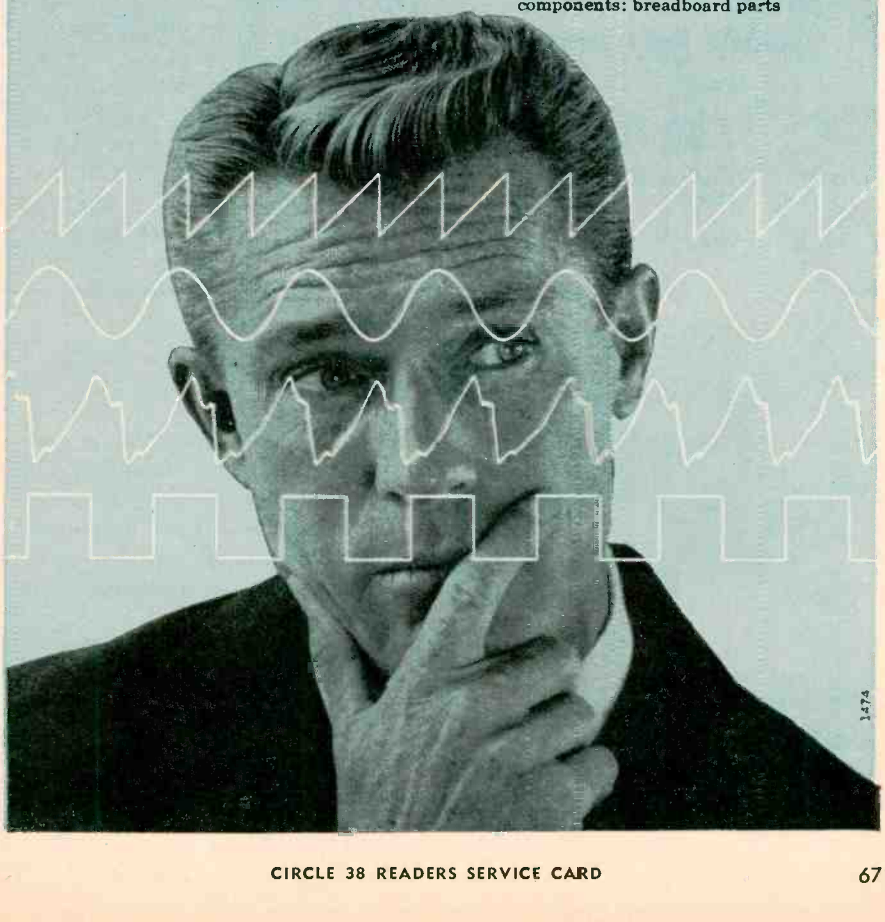
expanded scale meters: rotating components: breadboard parts

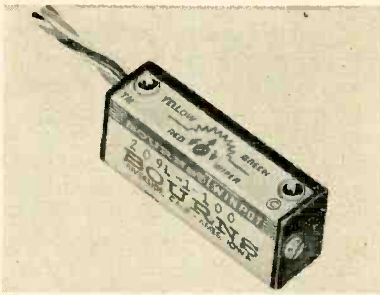


CIRCLE 38 READERS SERVICE CARD

ON THE MARKET

Potentiometer
dual element

BOURNS LABORATORIES, INC., P. O. Box 2112, Riverside, Calif., announces a new improved version of the model 209 Twinpot lead screw actuated potentiometer. Twinpot is a dual arrangement of two potentiometers in one compact unit that



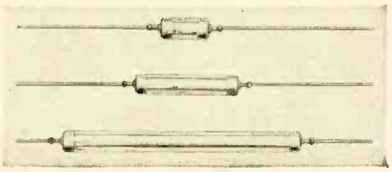
provides simultaneous control of two circuits by a single adjustment of the slotted shaft. Now featuring the Silverweld termination, a metal-to-metal bond, this model provides virtually a 100 percent usable pot range plus better stability and higher reliability. Model 209 measures $\frac{5}{16}$ by $\frac{1}{2}$ by $1\frac{1}{4}$ in. **Circle 200 on Reader Service Card.**

Ten-Turn Pot
high resolution

ELECTROMATH CORP., 42-14 Greenpoint Ave., Long Island City 4, N. Y. Model E-10 multiturn precision pot is designed to provide long life, high resolution, operational reliability and overall economy. The one-piece unit features distortion-free linearity as low as 0.015 percent due to a servo-control method of resistance winding. It is available in a wide variety of linear, nonlinear and loaded functions for integration into any impedance. **Circle 201 on Reader Service Card.**

Resistors
carbon film type

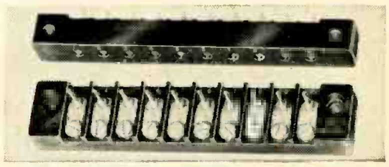
PYROFILM RESISTOR CO., INC., U.S. Hwy. 46, Parsippany, N. J., announces a complete series of glass sealed pyrolytic carbon film type resistors with new high stability,



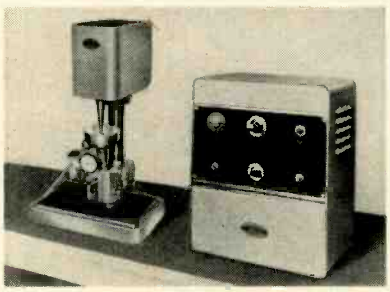
small size and reliability. They are completely free of gases, solder flux and other contaminants, and are virtually unchanging over long periods of storage. Average resistance change of resistors stored for three months at 500 C is less than 1 percent. Resistors are available in $\frac{1}{2}$ w, 1 w and 2 w. **Circle 202 on Reader Service Card.**

Terminal Block
for heavy duty use

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y., announces a new plug and socket terminal block, series 200-19. The rugged 10-contact connector is capable of handling up to 15 amperes and 10,000 v rms at sea level. Each pin contact is common with individual buss plates and separated by molded barriers. Solder cups accommodate No. 14 Awg wire. Precision machined pins and sockets of spring temper brass and bronze are silver and gold plated for low contact resistance



and ease of soldering. Floating socket contacts assure positive alignment of each contact. **Circle 203 on Reader Service Card.**

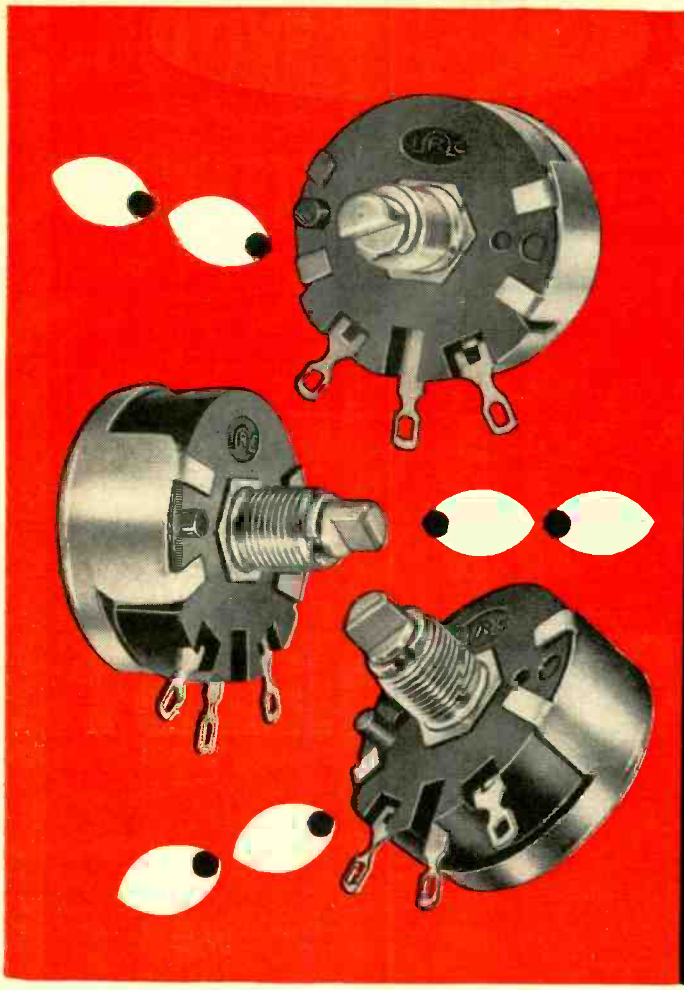


Impact Grinder
ultrasonic type

RAYTHEON MFG. CO., Waltham 54, Mass., announces model 2-335 ultrasonic impact grinder which uses a magnetostrictive transducer to permit a 100 percent duty cycle. Simple, rugged and versatile, the unit is used for cutting, slicing, drilling, grinding and trepanning regular or irregular shapes quickly, accurately and economically. Among the substances that can be worked are semiconductors, ceramics, ferrites, carbides, metals, jewels and other hard or brittle materials. **Circle 204 on Reader Service Card.**

Power Supply
voltage regulated

KEPCO LABORATORIES, INC., 131-38 Sanford Ave., Flushing 55, N. Y. Model SC-3672-1 transistorized, voltage regulated power supply delivers 36 to 72 v, 0 to 1 ampere. Regulation for line or load is less than 0.1 percent or 0.003 v, whichever is greater. Ripple is less than 1 mv rms. Recovery time is less than 50 μsec. Stability for 8 hr is less than 0.1 percent or 0.003 v, whichever is greater. Operating am-



Any way you look at them IRC Type 2W

2 WATT RHEOSTAT POTENTIOMETERS

are your best buy

LOOK AT THEIR DESIGN

IRC 2W's are designed with a one-piece nickel silver center terminal and collector ring. Resistance wire is wound by specially designed IRC machines and bonded to the core by a special coating to prevent wire shifting even under most unfavorable conditions.

LOOK AT THEIR ADAPTABILITY

You name it—the IRC 2W has it: Single control: single with SPST, DPST or SPDT switch; duals, concentric duals, with or without switch; 3-gang or 4-gang, waterproof shaft and bushing.

IRC 2W's are available with most any shaft and bushing style, including a "shaft locking" type bushing. For your further convenience there is a wide selection of standard and special locating lugs.

LOOK AT THEIR PERFORMANCE

IRC 2W Controls exceed MIL-R-19A specifications of 3% maximum and 1½% average change for 40°C load life at 1000 hours. Resistance change is less than 2% maximum after 25,000 cycles under rated load.

LOOK AT THEIR CHARACTERISTICS

2W Controls may be obtained in resistance values from 1 to 50,000 ohms, and in tolerances of 10% and 5%; lower tolerances are available on special request. Standard taper is linear; modified logarithmic or special tapers are available.

LOOK AT THEIR APPLICABILITY

IRC 2W Controls are widely used in circuits for servo-mechanisms, test instruments, measuring instruments, automatic controls, military equipment, and many other electronic devices where high stability and low cost are necessary factors.

LOOK AT BULLETIN A-3a

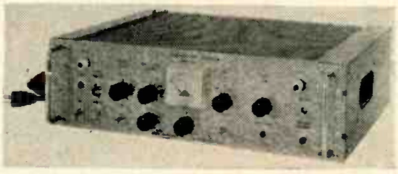
for complete details of construction and specifications; derating, taper and resolution charts. Write for it today.

IRC ®

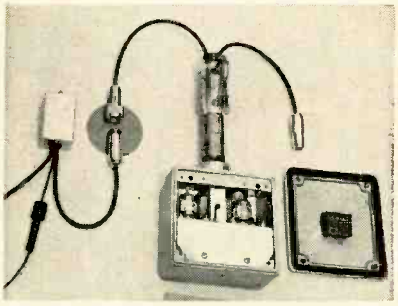
INTERNATIONAL RESISTANCE COMPANY • Dept. 371, 401 N. Broad St., Phila. 8, Pa. *In Canada:* International Resistance Co., Ltd., Toronto Licensee bient temperature is 50 C maximum. Temperature coefficient is less than 0.05 percent per deg C. Output impedance is less than 0.08 ohm. Circle 205 on Reader Service Card.

Microwave Leveler 2 to 4 kmc range

ALFRED ELECTRONICS, 897 Commercial St., Palo Alto, Calif. Model 703 microwave leveler flattens r-f power to ±1 db from 2 to 4 kmc from backward wave oscillators, klystrons, signal generators, and



twt amplifiers. It is specifically designed for increasing versatility of voltage tuned microwave oscillators to permit measurements which require constant output at fast or slow electronic sweeps. Microwave levelers include a directional coupler for r-f power sampling, a crystal detector, and a stable high gain amplifier. The signal level is compared with a reference voltage, amplified and brought out as a control voltage. **Circle 206 on Reader Service Card.**



R-F Amplifier for 150-165 mc

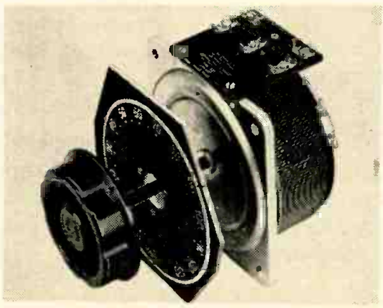
E. R. ROLLER CO., Fox Road, Putnam, Conn., announces model WA-1 sensitive r-f amplifier for 150 to 165-mc applications. Designed for outdoor use at the antenna, it provides a gain of 25 db, low noise figure, and narrow bandwidth. The 3 watts of power required is introduced on the transmission line to simplify installation. Up to 500 ft of RG8/U cable may be used, for the cable loss is compensated for by the amplifier gain. No ventilation is required, thereby allowing for complete waterproofing. **Circle 207 on Reader Service Card.**

Silicon Rectifiers 50 to 500 piv

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. Designed to bring miniaturization and high efficiency to such applications as miniaturized airborne power supplies, electrical instrument testing, oscilloscopes and other power supply requirements, a new series of diffused junction silicon rectifiers will provide currents up to six amperes over an inverse voltage range from 50 to 500 v. The units are operable at diode base temperatures up to 150 C. **Circle 208 on Reader Service Card.**

Autotransformer rugged, adaptable

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type W20 Variac autotransformer is claimed to be more rugged, more adaptable and more durable than its predecessors. Wrought metallic parts have been substituted for castings in the interest of improved mechanical properties. Heat trans-



fer between coil and base, brush and radiator has been improved. All models have Duratrak contact surface, which minimizes brush-track deterioration under adverse environmental or load conditions and assures long and trouble-free life. Basic uncased models are available for 115-v and 230-v service and are rated at a maximum of 3.0 and 2.4 kva respectively. Cased models have knockouts for conduit or armored cables. **Circle 209 on Reader Service Card.**

Ultrasmall Switch quick-connect type

MICRO SWITCH DIVISION, Minneapolis-Honeywell, Freeport, Ill. A new ultrasmall quick-connect switch has ratings of 10 amperes, 125 or 250 v a-c; ½ ampere, 125 v d-c; ¼ ampere, 250 v d-c. Lead receptacles for the switch (designated V3-1-D8) can be attached in seconds. Contact arrangement is spdt and the switch may be wired normally-open or normally-closed. A wide variety of roller and lever type auxiliary actuators may be

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CIRCLE 40 READERS SERVICE CARD

HOW TO USE INSTRUMENT CHOPPERS

BY JOHN A. KENNEDY
JAMES VIBRAPOWR CO.

DOUBLE POLE DOUBLE THROW CHOPPERS can be used to simplify circuit design and improve performance.

A DPDT Chopper can be used as both the modulator of the inout signal and as the demodulator or rectifier in the output. The unique JAMES design drives both sections of a DPDT chopper from a common reed. As a result both sections track together. The designer need only insure his circuit phase relationships are correct.

Signal isolation between the two pole sections of a JAMES chopper is good, interpole capacity being less than 7 MMFD. Since both poles have the same phase lag, system gains of 10^6 may be used safely.

The maximum continuous rating for JAMES instrument choppers is 10 volts at 1 MA. Input sections rarely approach this voltage and current level, however, in some cases output design requires higher values. Voltages on an intermittent basis (i.e. less than 10% of the time) up to 50 volts at 1 MA can be applied to the JAMES chopper with no component deterioration.

A common design practice where higher amplifier D.C. power outputs are desired is to use a straight D.C. amplifier after the demodulation of the chopper.

Another use of a JAMES DPDT chopper is dual input where one chopper feeds two separate channels. Either straight chopper amplifier design or chopper stabilized circuits can be used with assurance of negligible cross talk.

The problem of balanced input to the amplifier can be eliminated by using a DPDT chopper as a full wave modulator.

Where two D.C. levels are to be compared and yet must be at all times isolated, the DPDT circuit with a standard comparison voltage can be conveniently used.

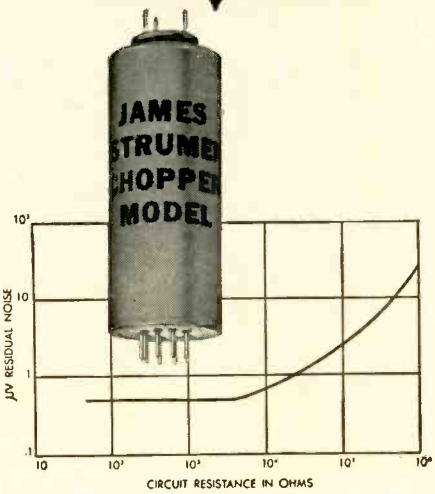
The reliability and common tracking characteristics of JAMES DPDT choppers give added flexibility to the circuit and equipment designer. Consult us here at JAMES with your chopper problems.

JAMES

10 µv

AT 400 CYCLES

LOW NOISE CHOPPERS



10 MICROVOLT D.C. INSTRUMENTATION NOW POSSIBLE WITH JAMES 400 CPS CHOPPERS

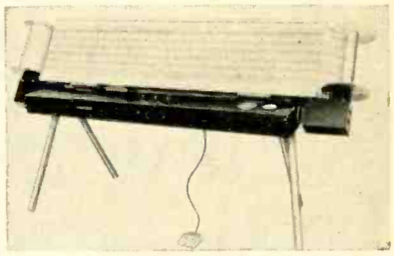
- Double pole double throw switching for dual input or input/output circuits.
- New miniature packages.
- Both make before break and break before make closures.
- Models for driving frequencies of 5 to 450 Cps.
- Low driving power—less than .2 watts at 400 Cps.
- Operations unaffected by shock, temperature and vibrations.

JAMES is the complete source of critical components for low level D.C. amplifications, supplying choppers, transformers and chopper drivers.

Write for engineering literature.

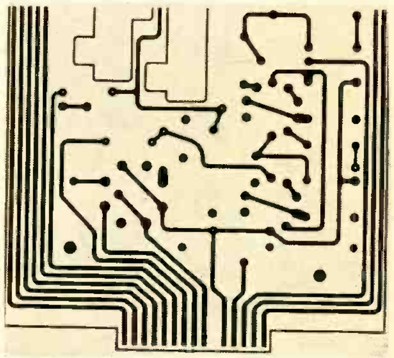
JAMES VIBRAPOWR COMPANY
4050 N. Rockwell St., Chicago, Ill., COrnelia 7-6333

easily attached for applications where the operating direction is not in-line with the plunger motion. **Circle 210 on Reader Service Card.**



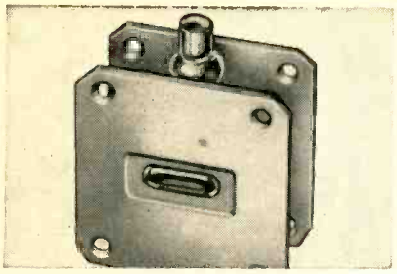
Oscillogram Scanner adjustable speed

The Gerber Scientific Instrument Co., 89 Spruce St., Hartford 1, Conn. The new model S-10 was designed to solve data reduction problems where an operator is required to scan a record over a large area. Oscillogram strips up to 1,000 ft in length may be tracked across the 66 in. illuminated scanning surface. Controls are provided in a panel set flush at desk level. **Circle 211 on Reader Service Card.**



Tapes and Symbols for p-c layouts

Chart-Pak, Inc., One River Road, Leeds, Mass., has available tapes and special symbols for preparation of master drawings for printed circuitry. Master drawings and layouts can be made faster and easier without drawing a single pen or pencil line. To make p-c master layouts the draftsman need only stick down the precision-slit tapes and precision die-cut symbols where desired on either Chart-Pak precision grids or Transograph Pen-cil-ized drafting film. **Circle 212 on Reader Service Card.**



Crystal Protectors miniaturized

BOMAC LABORATORIES, INC., 1 Salem Road, Beverly, Mass., announces a new line of miniaturized crystal protectors that are one-half the size of previous types. For example, the X-band tube is approximately ¾ in. between flange faces. The electrical characteristics are equal to or better than the usual broadband t-r tube, and they are available for all microwave bands. Circle 213 on Reader Service Card.

Capacitors high temperature

SCINTILLA DIVISION, Bendix Aviation Corp., Sidney, N. Y. The E-315 family of high temperature capacitors are available for use on high speed aircraft and missiles. Manufactured of nonstrategic materials they have completed qualification testing of 1,000 hr at maximum temperature and rated voltage. Temperature range is − 55 to 315 C. Capacitance is 0.05 to 4.0 μf at 600 v d-c with higher voltages available. The capacitor features: no voltage derating, low capacitance and power factor variation, minimum size and weight. Circle 214 on Reader Service Card.

Transistor Chopper miniaturized

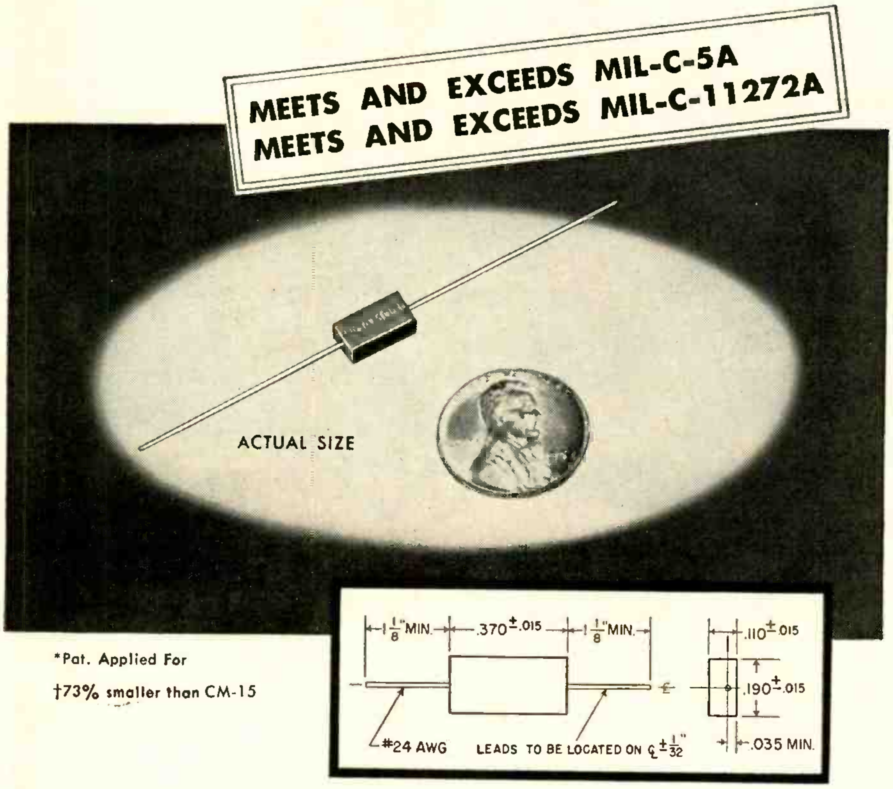
AIRPAX PRODUCTS Co., Jacktown Road, Cambridge, Md. A new transistor chopper switches signal source to load effectively at a frequency rate from zero to 100 kc. Having no moving parts it is

Smallest MOLDED* MICA CAPACITOR

73% Smaller†

Micamold Missilmite®

for 55°C to 125°C operation



*Pat. Applied For

†73% smaller than CM-15

Micamold's Missilmite subminiature molded mica capacitors are the Smallest Molded Mica Capacitors Ever Produced...73% SMALLER! Due to radically new engineering design, new materials and assembly methods, Perfectly Symmetrical Missilmites MEET and EXCEED MIL-C-5A and MIL-C-11272A, Characteristics "C," "D" and "E." These subminiature molded mica capacitors will withstand operating temperatures of −55°C to +125°C (standard range is from −55°C to +85°C), and weigh only ½ gram.

Reliable and stable Missilmites permit greater design flexibility to the engineer, and are especially desirable in critical miniaturized assemblies. Recommended for use in missiles, delay lines, pulse networks, computors, transistorized assemblies...or wherever minimum size and weight, with stability, are required.

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MICAMOLD ELECTRONICS MANUFACTURING CORP.

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CIRCLE 42 READERS SERVICE CARD

MARCONI

Carrier Deviation Meter

uses multi-crystal stability-lock

Direct indication of fm deviation
From 200 cps to 125 kc makes this latest model in the Marconi 791 series applicable to both communication and broadcast fm systems.

Crystal locking
at any point in its 4- to 1024- mc carrier range brings new, exceptional stability and freedom from microphony in low-deviation measurements. Use of an external indicator extends the deviation range down to 10 cps, allowing fm hum and noise on uhf close-channel transmitters to be measured with ease and certainty.

An in-built deviation standard,
crystal governed, insures full rated accuracy at all times.

Send for leaflet B143

ABRIDGED SPECIFICATIONS
CARRIER DEVIATION METER 791D
Carrier Frequency Range: 4 to 1024 mc.
Modulation Frequency Range: 50 cps to 35 kc.
Measures Deviation: 200 cps to 125 kc in four ranges. Measures down to 10 cps using external readout.
Measurement Accuracy: ±3% of full-scale for modulation frequencies up to 25 kc.
Internal FM: Due to hum, noise and microphony, less than −55 db relative to 5 kc deviation.
Tubes: 6AK5, 6AS7, 6C4, 6CD6G, 5651, 5647, 5Z4G, OB2.

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Marconi for f.m. test gear

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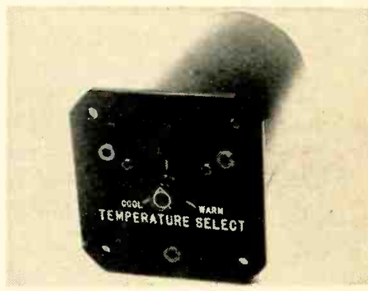
MARCONI INSTRUMENTS LTD · ST. ALBANS · HERTS · ENGLAND

capable of operating under extremes of shock and vibration. Its size permits use where space is at a premium. It weighs only 1 gram. Two types are available. Type 6000 operates throughout a temperature range of −40 C to +60 C; type 6010, in ambients from −40 C to +85 C. Type 6000 can accommodate an input signal from a fraction of a millivolt up to 5 v; type 6010 extends the upper signal level to 10 v. Circle 215 on Reader Service Card.

Mica Wafers add to reliability

PERFECTION MICA CO., 1322 No. Elston Ave., Chicago 22, Ill., has developed a new line of low-priced mica film wafers which increase reliability of transistors and other semiconductor products. The wafers are pre-punched to exactly fit a wide variety of bases and are used for electrically insulating the base from the heat sink. Interference with heat transfer is negligible. Circle 216 on Reader Service Card.



Control Amplifier versatile unit

PARAMETERS, INC., 195 Herricks Road, New Hyde Park, N. Y., has developed a control amplifier for contactor regulators and servos that has built-in control stabilization. The unit combines stable silicon transistor amplifier with rugged, long lived relays to make a high gain phase-sensitive contactor controller, and includes the unique Varigain circuit that automatically changes the system gain to meet the varying dynamic requirements of a high performance servo or regulator. Threshold input for actuation is 1 mv into a 1,500 ohm load impedance, and the output is 115 v at 2 amperes maximum for a power gain of 110 db. Circle 217 on Reader Service Card.

Control Panel Unit mounts in ⅜ in. hole

TRANSISTOR ELECTRONICS CORP., 3357 Republic Ave., Minneapolis 26, Minn. The Translec miniature Echo-Lite, combining a push button switch and a neon lamp, mounts in a hole only ⅜ in. in diameter. It features bifurcated contacts and an NE-2E bulb which maintains a fixed position relative to the lens. Available in six models, it offers independent or common lamp and switch connections with series resistors in either or both the lamp and switch circuits. Circle 218 on Reader Service Card.

Phototube improved version

RADIO CORP. OF AMERICA, Harrison, N. J. The new multiplier phototube 6342-A, which supersedes the 6342, features improved pulse-height resolution, reduced transit-time variation, higher cathode luminous sensitivity, higher current amplification, and low dark current over a wider range of operating voltages. Design features include a semitransparent photocathode on the curved inner surface of the face end of the bulb, a minimum photocathode diameter of 1.68 in., a faceplate with a flat external surface to facilitate the mounting of flat phosphor crystals in direct contact with the surface, and 10 electrostatically focused multiplying stages. Circle 219 on Reader Service Card.

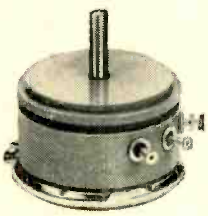
Pulse Delay Unit 125-ohm impedance

ELECTRICAL AND PHYSICAL INSTRUMENT CORP., 42-19 27th St., Long Island City 1, N. Y. New 125-ohm fast pulse delay units with step

. . . sign here!

If you want top-quality pots when you *need* them, you *could* make your own! Of course, you'll need Swiss screw machinery to produce the cases necessary to complete the job. So plunge right in — sign up for those highly precision screw machines . . . and *hang* the cost!

But before you deplete the family exchequer with a grand flourish of the pen, come to Ace! We've already *taken* the plunge, and it's paid off. These machines automatically deliver, at high speed, cases with mechanical tolerances closer than .0002. This also means the most flexible production operation in the industry. No sub-contracted parts to wait for — we design our own cams to any special size and shape, and we run the cases ourselves, on a 24-hour day basis! So for *dependable* delivery, see your ACErep!



Here's one of our automatic-production cases, on a servo mount A.I.A. size 1-1/16" ACEPOT®. In-plant production on cases up to 6".

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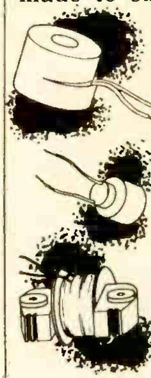
Make sure your products have the exact coil specified by your design engineers. Every Dano coil, regardless of type or quantity, is custom made to exact specifications — just what the doctor ordered to insure healthy, trouble-free performance.



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Men on the Move

Now available in a *new edition* ... with *new figures*.

This popular booklet points up the important sales problem of personnel turnover in industry. Out of every 1,000 key men (over a 12-month period) 343 new faces appear . . . 65 change titles . . . 157 shift . . . and 435 stay put. These figures are based on average mailing address changes on a list of over a million paid subscribers to McGraw-Hill magazines.

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variable pulse delays of 5, 10, 15, 25, 50 and 100 millimicroseconds are provided for matched use in pulse systems using RG 63/U cable. The characteristic impedance is 125 ohms and the attenuation characteristics as a function of frequency are equivalent to the characteristics of RG 63/U for the same delays. Circle 220 on Reader Service Card.

Metal-Case Meter 1.5 inch square

WacLine, Inc., 35 So. Clair St., Dayton 2, Ohio, announces a $1\frac{1}{2}$ in. square metal-case meter for electronic and aircraft equipment application. Prominent features include sealed external zero adjuster and twist-lock type glass-rubber-metal case seal. The bezel is die-cast aluminum alloy. Circle 221 on Reader Service Card.

Counter/Divider midget size

General Time Corp., 109 Lafayette St., New York 13, N. Y. A single Incremag unit can perform work that otherwise requires a battery of 10 or more binary type units. Counting and dividing Incremags are applicable in missile and industrial fields for scaling, computing, coding, and control. Device has a maximum count rate of 100,000 per sec, and accepts random or uniformly spaced pulses. One form contained in a 1 in. diameter by $1\frac{3}{4}$ in. cylinder can accept a 1,000-cps input and deliver four different outputs (1,000, 100, 10 and 1 pulse per sec.) Circle 222 on Reader Service Card.

HOW ABOUT YOU?

Do you know that many cancers can be cured if detected early? That an annual health checkup is your best protection against cancer?

Are you giving yourself this big advantage? Or are you taking chances with your life because of foolish attitudes about cancer like these?

DON'T EVEN MENTION THAT WORD!

Fear keeps some people from even *learning* cancer facts that can save their lives.

NEVER FELT BETTER!

Checkups help to detect cancer in its "silent" stage before you notice any symptom.

COSTS TOO MUCH!

Dollars you spend for the protection of your health can mean years of life.

Millions of Americans have made an annual checkup a habit ... *for life.* How about you?

AMERICAN CANCER SOCIETY

Variable Resistor subminiature

CENTRALAB, A Division of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc. Model 3 Radiohm, a subminiature variable resistor, has been internally redesigned to increase its rating from $\frac{1}{4}$ w to $\frac{1}{2}$ w. It utilizes Centralab's ICE (Interfused Composition Element) to provide exceptional heat dissipation and electrical stability under severe operating conditions. **Circle 223 on Reader Service Card.**

Laboratory Supply transistorized

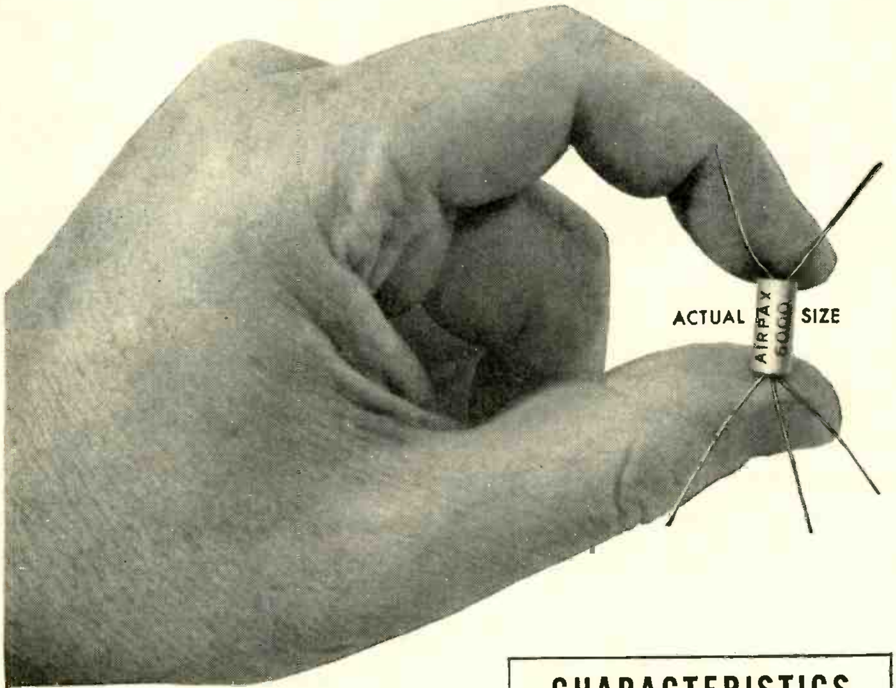
THE REFLECTONE CORP., Stamford, Conn., announces a new highly-regulated fully-transistorized power supply. Laboratory type PS-T-LV12 provides a continuously variable output of 6 to 18 v at 2 amperes. Load regulation is 0.3 percent no load to full load, and line regulation is 1.0 percent for a 105 to 130 v input. Unit is available in rack or bench mounting. **Circle 224 on Reader Service Card.**

Minified Control self-contained

ASSEMBLY PRODUCTS, INC., Chesterland, Ohio. A new control occupies the same panel space as a standard $4\frac{1}{2}$-in. indicating meter, and it mounts just as simply. All control components—including power supply, slave relays, interrupters, capacitors and resistors—are housed in a round barrel $2\frac{7}{8}$ in. in diameter and approximately $4\frac{3}{4}$ in. deep. Unit provides continual signal indication

AIRPAX

Transistor Chopper



The Airpax Type 6000 Transistor Chopper performs a switching operation over a frequency range of 0 (DC) to 100 KC with signal levels from a fraction of a millivolt to 5 volts.

Two percent linearity at signal levels as low as 1 millivolt and noise levels comparable to mechanical choppers, make this unit suitable for many null seeking applications.

Fully encapsulated, the transistor chopper is substantially immune to shock and vibration and its life is unlimited.

CHARACTERISTICS	
DRIVE	
Frequency	DC to 100 KC
Voltage	1 to 18 volts PP
Waveform	Sine or Square
ENVIRONMENTAL	
Temperature	− 40° to + 60° C
Humidity	to 100% RH
Shock and Vibration	100 G to 2000 CPS
PHYSICAL	
Diameter	0.22 inch
Length	0.50 inch
Leads	1.00 inch
Weight	1.00 gm.

AIRPAX PRODUCTS COMPANY

CM12

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JACKTOWN ROAD, CAMBRIDGE, MARYLAND

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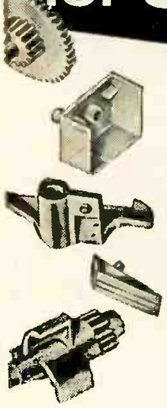
HELP from GRC
for SMALL PARTS users



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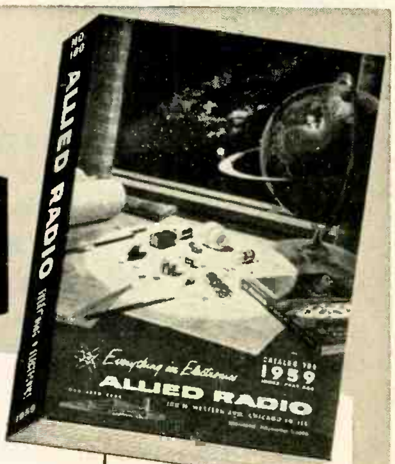

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and when preset limits are reached, it triggers control action by appropriate equipment. Either high or low signal limits may be set by adjusting fixed pointers. Signals from virtually any variable may be controlled, usually without amplification. Circle 225 on Reader Service Card.

Coaxial Switch
highly reliable

ALFORD MFG. Co., 299 Atlantic Ave., Boston 10, Mass. Type 1136 coaxial switch is a rugged and reliable switch for 3⅛ in. rigid coaxial transmission line. It has a frequency range of 0-500 mc with a vswr under 1.05. It is available in both motor-driven and manually-operated models. Crosstalk through the unused branch of the switch is over 60 db down at 80 mc, and over 40 db down at 500 mc. Circle 226 on Reader Service Card.

Conductive Cement
100 percent solids

HOUGHTON LABORATORIES, INC., Olean, N. Y. Hysol 6250 is a new conductive cement based on epoxy resins. Volume resistivity is measured at 0.01 ohm-cm at 25 C. Offering excellent bond strengths to most materials, it is particularly recommended for repair of printed circuits and for bonding of electrical components where soldering can not be tolerated. The compound will cure fully in 24 hr at room temperature, or in 2 hr at 140 F. It is supplied in convenient kit form. Circle 227 on Reader Service Card.

VTVM
20 cps-20 kc

SOLARTRON, INC., 530 Cooper St., Camden, N. J. Model VP 250-A

CIRCLE 49 READERS SERVICE CARD

resolved component indicator displays on two separate meters the rms values of both in-phase and quadrature components of input signal voltage with respect to a given sine wave reference voltage of the frequency. The instrument is well suited for applications where it is necessary to obtain indications free from errors induced by phase shift or spurious frequencies or harmonics. **Circle 228 on Reader Service Card.**

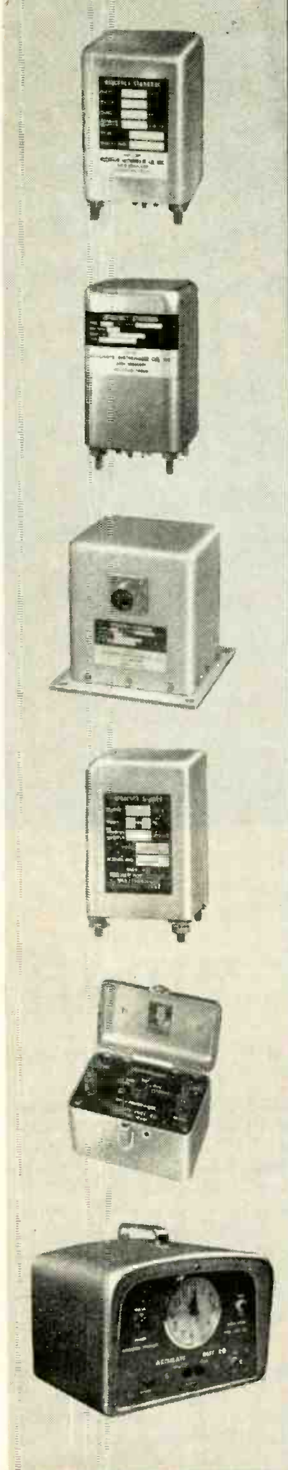
Converter
d-c to d-c

Polytron Engineering Inc., 32 W. Biddle St., Baltimore 1, Md. Model PP 12/300 d-c to d-c converter uses an all solid state circuit. It has a nominal output of 300 v d-c at 100 ma for a 12 v d-c input. The converter is ideal as a plate supply for all types of communications and telemetering equipment, due to its small physical size, and low weight. **Circle 229 on Reader Service Card.**

Electronic Counter
bidirectional

Benson-Lehner Corp., 11930 W. Olympic Blvd., Los Angeles 64, Calif. A new type decimal electronic counter employs a logical scheme which allows indication of true positive and negative numbers, with a single zero, and eliminates

Accurate



*These tolerances are from absolute frequency under any combination of the conditions within operating specifications. For specific operating conditions much closer frequency tolerances may be maintained.

TRANSISTORIZED TUNING FORK

FREQUENCY STANDARDS

TYPE MAFC — Frequency Standard
- Frequency Range Available: 360 cps to 4 kc
- Tolerances % ±: 0.2, 0.05, 0.02, 0.01, 0.005*
- Temperature Ranges: —20 to +71°C; —55 to +100°C; —55 to +125°C
- Power Supply Voltage: 12 or 28 vdc ± 15%
- Size: 1⅝"x1⅝"x2¼" • Weight: 8 oz.

TYPE AFC — Frequency Standard
- Frequency Range Available: 360 cps to 4 kc
- Tolerances % ±: 0.2, 0.05, 0.02, 0.01, 0.005*
- Temperature Ranges: —20 to +71°C; —55 to +100°C; —55 to +125°C
- Power Supply Voltage: 12 or 28 vdc ± 15%
- Size: 2⅛"x2⅛"x3¼" • Weight: 13 oz.

TYPE MAFCD — Frequency Standard
- Frequency: 60 cps
- Tolerances % ±: 0.2, 0.05, 0.02, 0.01, 0.005*
- Temperature Range: —55 to +71°C
- Wave Shape: Sine w/less than 1% harmonic distortion
- Power Supply Voltage: 10 to 14 vdc
- Size: 4¹⁄₁₆"x4¹⁄₁₆"x4¹⁄₁₆" • Weight: 4 lbs.

TYPE MFB — Frequency Divider
- Ratios Available: 2:1, 4:1, 5:1, 8:1, 10:1, 16:1
- Temperature Ranges: —20 to +71°C; —55 to +100°C
- Power Supply Voltage: 12 or 28 vdc ± 15%
- Size: 1⅝"x1⅝"x2¼" • Weight: 6 oz.

TYPE MFS — Frequency Standard for Laboratory or Field

Type MFS is a small, lightweight frequency standard that can replace units many times its size without sacrificing frequency stability. Internal batteries and provisions for external power supply make the unit ideal for either laboratory or field applications.
- Frequency Ranges Available: 50 cps to 4 kc
- Frequency Stability: 2 parts in 10^6/per month
- Temperature Range: —20 to +71°C
- Size: 3⅞"x5⁵⁄₁₆"x5⁵⁄₁₆" • Weight: 2 lbs.

TYPE MLS — Laboratory — Frequency Standard

Type MLS is an extremely high stability laboratory frequency standard. The clock on the panel facilitates easy checking of stability.
- Frequency Ranges Available: 50 cps to 4 kc (Multiple Taps Optional)
- Frequency Stability Available: 5 parts in 10^7
- Output: 10 watts at specified frequency
- Input: 115 v, 50 cycles to 400 cycles
- Size: 9"x10"x7" • Weight: 15 lbs.

A wide variety of units are designed to comply with the most severe military specifications.

Manufactured by

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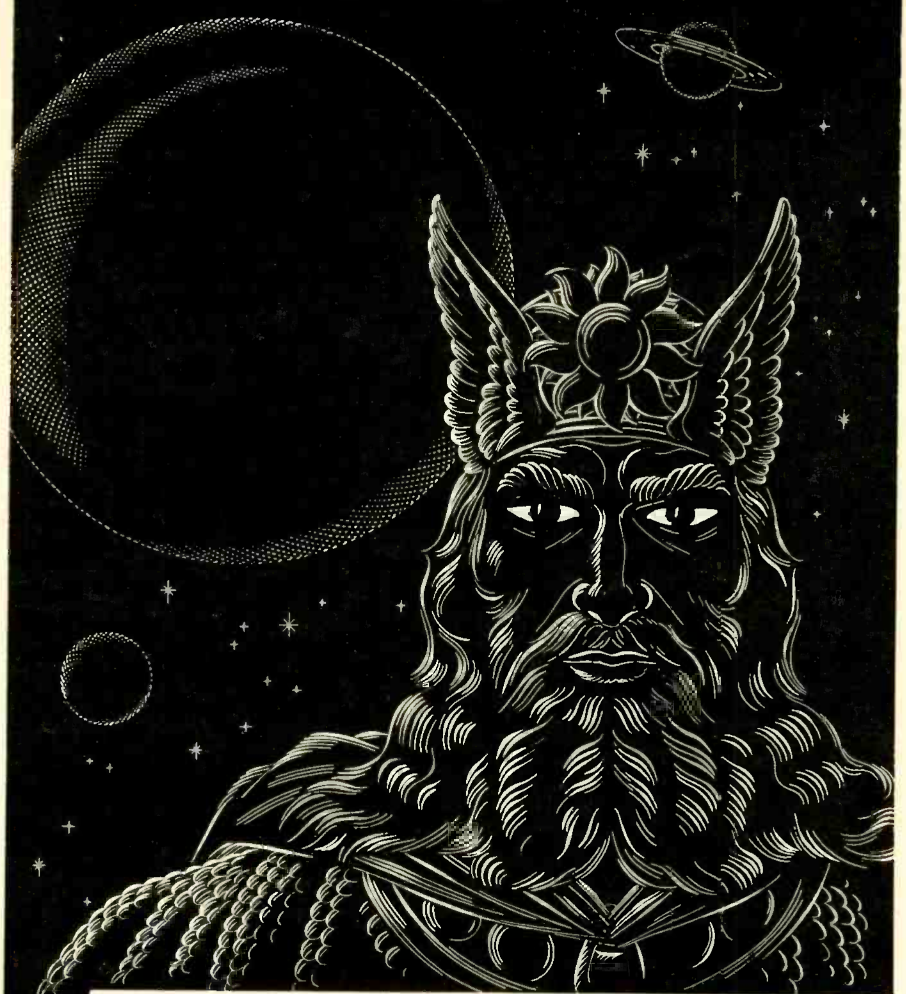

We're a long way from Valhalla, legendary home of the gods, but we're searching for such men as were

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**And who was Vidar? Ancient Scandinavians knew him as the god of Wisdom and Science. Son of the giantess Grid and of the great king of gods, Odin, he had a penetrating glance which read all secrets. To certain favored mortals he imparted the gifts of understanding and scientific knowledge.*

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You may be such a man. Then let us invite you to join in advanced work which may help to shape tomorrow's history. As a long term prime contractor for the Atomic Energy Commission we offer positions at all levels of responsibility in design, development or project engineering.

Especially urgent is our invitation to electronics engineers who are **specialists in automation or electronic tube application.** Experience in any of the following fields is valuable: general radar type circuitry involving pulse techniques, band pass amplifier techniques, standard and stripline microwave techniques, and subminiaturization using plastic embedment and encapsulation techniques.

Although we promise you here none of the nebulous delights of Valhalla, we do have unique, worldly rewards to offer both you and your family. It will cost you exactly 4¢ to inquire.

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Bendix
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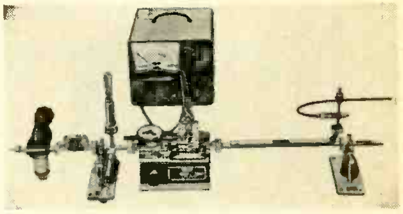
the problem of double zeros as would be experienced if complementary techniques were employed for negative number indication. Range of the counter is ±99999 counts. Counter operates at rates up to 50 kc. Each decade of the counter may be set to a predetermined value independently of the other decades and the entire counter may be reset to zero by operation of a single contact. **Circle 230 on Reader Service Card.**

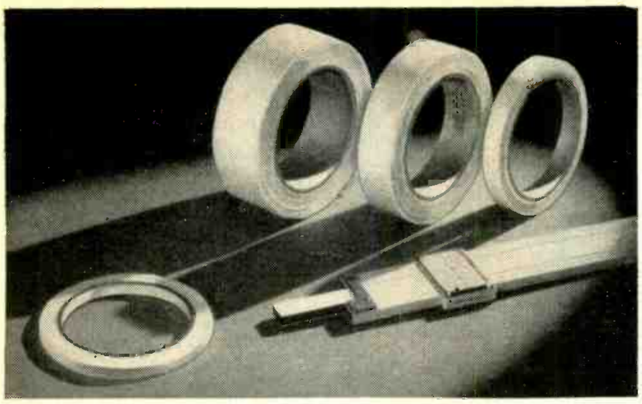


Millimeter Products versatile equipment

NARDA MICROWAVE CORP., 118-160 Herricks Road, Mineola, N. Y., has developed a complete line of electronic test equipment for the measurement of impedance, attenuation, and other microwave properties within the millimeter waveguide ranges. Specific equipment in K, V, Q, M, and E bands which is now available includes variable waveguide attenuators, tuneable waveguide detectors, high directivity directional couplers, impedance meters, vswr amplifiers, terminations, E-H tuners, frequency meters and waveguide clamps and stands. **Circle 231 on Reader Service Card.**

Frequency Standard transistorized

ACCURATE INSTRUMENT CO., 2422 Branard St., Houston 6, Texas. Type MAFCD-3 is a transistorized, 60 cycle, tuning fork controlled, frequency standard with a tolerance of ±0.005 percent under all of the following conditions: temperature, −55 to +71 C; power supply deviation from 10 to 14 v d-c; any variation in load impedance; operation in any position. Unit will deliver 12 v rms into a 100 K load with less than 1 percent harmonic distortion and will maintain at least



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pressure-sensitive TEFLON* tapes for Class H & C insulation, non-stick or chemical resistant facing

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* *du Pont T.M.*

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CIRCLE 52 READERS SERVICE CARD

USE dekatron®

COUNTING TUBES FOR RELIABLE, HIGH SPEED COUNTING APPLICATIONS

Baird-Atomic uses DEKATRON glow transfer tubes in all instruments where counting and read-out are required. A typical application is the Atomic Instrument Line's Model 134 Scaler for ultra-high speed counting of beta and gamma radioactivity . . . up to 1,000,000 counts/minute! The input circuit incorporates a fast, constant-sensitivity Schmitt discriminator driving a beam switching decade with glow tube read-out . . . 6 DEKATRONS.

You too, can count on DEKATRON for reliable performance. For detailed information request Data Sheet IC 4001.

Baird-Atomic, Inc.
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Baird Atomic

Instrumentation for Better Analysis

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Antennas — up to 10,000 mc

Large Waveguide Components

Prompt Delivery of any type antenna or reflector —precision built to your specifications. Write for technical data.

Ainslie CORPORATION

312 Quincy Ave., Quincy, Massachusetts

CIRCLE 55 READERS SERVICE CARD

You get more than 'hardware' when you buy from Bowmar

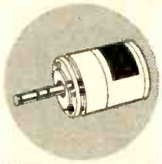
The big plus factor in all Bowmar designed components and assemblies is **RELIABILITY.** You can't hear it, touch it or see it . . . but it's there, your Bowmar insurance policy against performance mediocrity or failure.

When your project calls for precision counting or indicating devices . . . precision gearheads or speed reducers . . . precision electromechanical assemblies, Bowmar is the firm most experienced and best equipped to design and produce them for you.

Bowmar has the facilities and know how to manufacture these devices in quantities from single prototypes to thousands . . . all to your most demanding performance requirements.

PRECISION COUNTING DEVICES

PRECISION GEARHEADS AND SPEED REDUCERS



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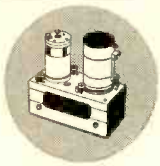

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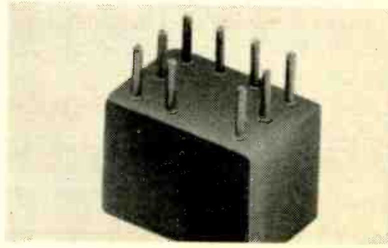
±2 percent voltage regulation into a fixed load under all conditions. Size is $4\frac{1}{16}$ in. by $4\frac{1}{16}$ in. by $4\frac{1}{16}$ in. **Circle 232 on Reader Service Card.**

Telephone Relay hermetically sealed

KURMAN ELECTRIC CO., 191 Newel St., Brooklyn 22, N. Y. Series SM-400 hermetically sealed miniature telephone relay operates on 400 cps. Various contact arrangements are available up to 4 pdt. Contacts are rated at 3 amperes, 115 v a-c, or 28 v d-c 0.5 ampere. Contact resistance is less than 0.030 ohm. The series SM will meet requirements of MIL-R-5757 B. **Circle 233 on Reader Service Card.**



Shift Register one core per bit

EPSCO, INC., 588 Commonwealth Ave., Boston 15, Mass. Model SR-60P is a one core per bit magnetic shift register capable of operating at frequencies up to 250 C and designed to be transistor driven. Unit measures $\frac{9}{16}$ in. by $\frac{3}{8}$ in. by $\frac{3}{8}$ in. **Circle 234 on Reader Service Card.**

Current Probe 14 kc to 100 mc

STODDART AIRCRAFT RADIO CO., INC., 6644 Santa Monica Blvd., Hollywood 38, Calif. Model 91550-1 current probe is a clamp-on type r-f current transformer. It is an accessory device used with calibrated radio interference measuring equipment to accurately determine the intensity of r-f current present in an electrical conductor or group of conductors. Frequency range of probe is from 14 kc to 100 mc; direct connection to conductor is not required. It measures con-

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ducted radio interference currents in accordance with military specification MIL-I-26600 (USAF). Circle 235 on Reader Service Card.

Solenoid high-speed unit

TELECOMPUTING CORP., 915 North Citrus Ave., Los Angeles 38, Calif. The compact R.S.5174 solenoid is designed to operate with a 24-lb load. The start of the 0.020 in. stroke occurs at a maximum of 14 millisec, and it completes its travel in less than 20 millisec from circuit closing. The unit is specified for operation in an ambient temperature range of from −65 to +160 F. Voltage rating is 24 v d-c at 78 F. Circle 236 on Reader Service Card.

Beam Power Tube forced-air-cooled

RADIO CORP. OF AMERICA, Harrison, N. J. Type 7213 forced-air-cooled beam power tube is designed for use as a linear r-f power amplifier and as a class C r-f power amplifier in airborne and fixed station equipment. The tube can be used with full ratings at frequencies up through the Aeronautical Radio-Navigation band of 960 to 1,215 mc. Circle 237 on Reader Service Card.

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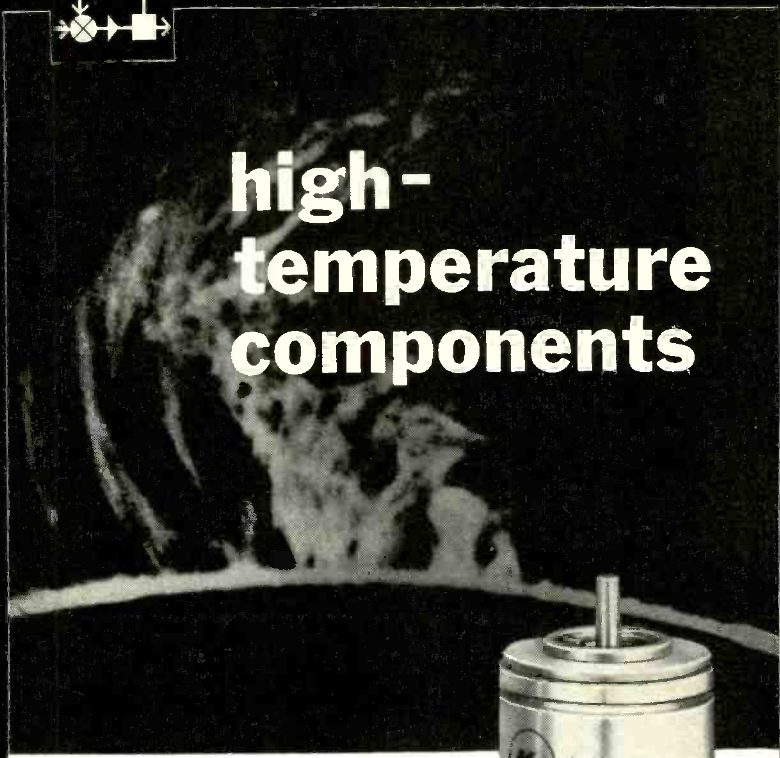

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Literature of

MATERIALS

Ceramic Parts. CFI Corp., Cottage Place, Mineola, N. Y. Bulletin 958 discusses the company's facilities for the design, prototype development, and production of such high-temperature ceramics: components, ceramic-to-metal vacuum-tight composites, glass-to-metal seals and specialized body compositions. **Circle 250 on Reader Service Card.**

COMPONENTS

Indicator Lights. The Sloan Co., 4101 Burbank Blvd., Burbank, Calif. Catalog A-58 describes in detail the complete line of Color-Lite subminiature incandescent indicating lights and accessories. **Circle 251 on Reader Service Card.**

Switch Engineering Data. Cherry Electrical Products Corp., 1650 Deerfield Rd., Highland Park, Ill. Detailed information for snap-action switch use in cam applications is described in a new bulletin. **Circle 252 on Reader Service Card.**

Synchro Testing. Theta Instrument Corp., 48 Pine St., East Paterson, N. J. A 14-page technical bulletin describes in detail many synchro test methods. It emphasizes the application of the synchro and resolver bridge for both component and system measurements. **Circle 253 on Reader Service Card.**

Power Packs. Electronic Measurements Co., Inc., Eatontown, N. J. Bulletin 350A, an up-to-date version of the original four-page bulletin, includes new models and complete specifications. Models are listed according to application: transistor and lab work, automatic control, computer, and general utility. **Circle 254 on Reader Service Card.**

Selenium Rectifiers. Syntron Co., 241 Lexington Ave., Homer City, Pa., has published an eight-page catalog giving complete de-

the Week

scriptions, data and specifications for a full line of h-v glass or phenolic tube cartridge-type selenium rectifiers. Circle 255 on Reader Service Card.

EQUIPMENT

Automatic Programming. Remington Rand Univac Div., Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y. A method of translating automatically, at electronic speed, the flow chart of a systems expert into the language of the Univac II data-automation system is described in booklet U1350. Circle 256 on Reader Service Card.

Test Instruments. Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. A wide variety of measuring equipment is illustrated and described in a 16-page catalog. Prices are included. Circle 257 on Reader Service Card.

Microwave Equipment. Sperry Microwave Electronics Co., Great Neck, N. Y., has published a catalog describing latest weapon system support equipment, ferrite devices, microwave subsystems, antennas, system components, radar test equipment, and precision microwave instruments. Circle 258 on Reader Service Card.

Transistorized Memory. General Ceramics Corp., Keasbey, N. J. An engineering data sheet contains complete application and performance data on the transistorized sequential load-unload 144 character memory system. Circle 259 on Reader Service Card.

FACILITIES

Environmental Chambers. Conrad, Inc., 141 Jefferson St., Conrad Square, Holland, Mich. A 6-page brochure shows the company's walk-in environmental chambers for temperature, altitude and humidity. It describes complete missile test facilities and components testing units. Circle 260 on Reader Service Card.

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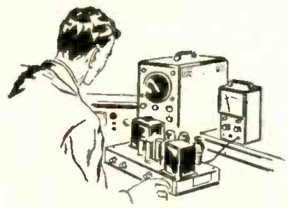

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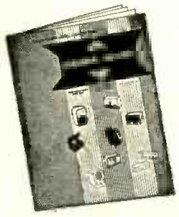

Also describes Heathkit ham gear and hi-fi equipment in kit form. 100 interesting and profitable "do-it-yourself" projects!

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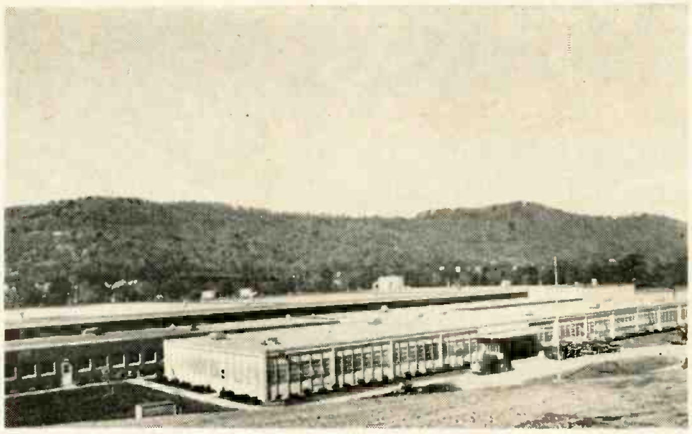

Corning Glass Adds Facility

A MODERN, multimillion-dollar electronic plant was recently placed in operation in Bradford, Pa., by Corning Glass Works.

Covering more than 142,000 sq ft of production and office space, the new facility produces glass resistors, capacitors and other electronic parts. Most of its products are thimble-size components for uses ranging from radio and tv sets to guided missiles.

Plant is the tenth new manufacturing facility constructed by Corning Glass Works in the past ten years. Factory employs nearly 500 persons, compared to a staff of 55 in Bradford only three years ago.

Corning has been making glass capacitors since World War II when company research scientists developed a method of forming glass ribbon only a thousandth of an inch thick. The ribbon made possible the glass capacitor in which the glass substituted for hard-to-obtain natural mica.

Born out of military need, the glass capacitor has maintained a growing role in peacetime electronics. This Corning credits to the capacitor's simple design, precise electrical characteristics and stability at temperatures up to 570 F.

Other Bradford products include power resistors up to five feet long and tiny glass level switches used in connection with gyroscopes for ships, planes and missiles.

Kelvin Electric Expands Plant

ACQUISITION of an additional 3,000 sq ft building adjacent to existing plant facilities of Kelvin Electric Co., Van Nuys, Calif., was recently announced. The added area is being utilized for engineering and production of electric wave filters and toroid inductors and transformers.

Kelvin's staff now numbers more than 50, and with accelerated production of firm's lines of precision wire-wound resistors, additional equipment has been installed for humidity and temperature cycling programmed to meet military requirements and individual customer's specific requirements. Company's resistors are used in the instrument, computer and missile fields.

Bradley Labs Changes Name

BRADLEY Laboratories, Inc., operating under that name since incorporation in New Haven, Conn., nearly twenty years ago, will henceforth be known as the Bradley Semiconductor Corp.

According to president Charles D. Bradley, company progress in recent years has called for a name more descriptive of the Bradley line of current rectifiers, diodes, modulators and arc suppressors.

The name-change is also in anticipation of the Bradley organization's impending move into new plant facilities now nearing completion in nearby Hamden, Conn., designed to accommodate the company's expanded production activities in silicon and other metallic rectifiers.

Hogan Labs Lists New Assignments

GEORGE M. STAMPS, assistant chief engineer for Hogan Laboratories, Inc. of New York City, which specializes in graphic instrumentation, communications, data handling and high speed facsimile, has been given the additional title of director of technical sales. He will divide his time between these assignments.

Also, John V. Hogan was recently elected secretary of the company. He is the son of John V. L. Hogan, president of the Laboratories, and with John W. Smith, chief engineer, is active in the administration of the engineering department.

Name Brooks To EIA Board

PRESIDENT of The Siegler Corp., John G. Brooks has been named to the board of directors of the Electronic Industries Association.

Brooks, as president of The Siegler Corp., heads an industrial complex with $73 million sales annually, predominantly in the electronic field. Divisions of the corporation active in both military and

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TO ARRANGE AN INTERVIEW, WRITE
JOHN SCHIMMEL III, EXECUTIVE ENGINEER

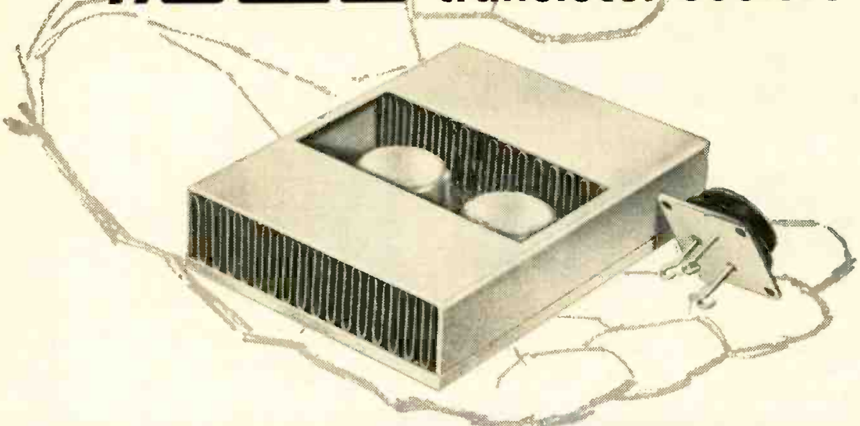
• • •

SPRAGUE ELECTRIC COMPANY

NORTH ADAMS, MASSACHUSETTS

Announcing . . .

Modine transistor coolers



Standardized for immediate shipment in module and strip form

These compact, lightweight aluminum units prevent thermal runaway in electronic circuits . . . hold transistor junction temperature safely within design limits. Heat is conducted through the base mounting plate and is dissipated by cooling air passing through the fins.

Modine Bulletin ID-158 contains performance data and application information on these efficient coolers. For full details on standard and custom-built models, write Electronic Cooling Dept., Modine Manufacturing Co., 1602 DeKoven Avenue, Racine, Wisconsin.

Modine MANUFACTURING COMPANY

T-1373

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commercial electronic work include: Hallamore Electronics, Anaheim, Calif.; Olympic Radio & Television, Long Island City, N. Y.; David Bogen Company and Presto Recording Company, Paramus, N. J.

Sprague Adds To Field Staff

WILLIAM L. DUDLEY has joined the semiconductor field engineering staff of the Sprague Electric Co. He will serve under James Balderston, who heads up the field engineering group at Sprague's Concord, N. H., semiconductor facility.

Dudley was formerly an engineer with the Long Lines Department of the American Telephone and Telegraph Co.

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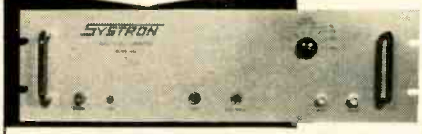

RMS to DC CONVERTER

Model 1240

- True RMS regardless of waveform
- ±0.1% (of Reading) Accuracy
- Linear DC output
- 50 CPS to 10,000 CPS frequency response
- 0.5 second time response
- Low output impedance
- High input impedance

Now, for the first time, laboratory standard accuracy readings of AC voltages (from 20 millivolts to 300 volts) are achieved without sluggishness, excessive loading, and nonlinear scales. Model 1240 provides a precision DC output directly proportional to the TRUE RMS of an applied AC voltage regardless of the waveform of the input. Linear DC output has low impedance for meter, analog recorder, data processing system. Combined with DC digital voltmeter operates as precision AC digital voltmeter.

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Ballard Takes New Position

SYSTEMS RESEARCH LABORATORIES, Inc. of Dayton, Ohio, has appointed James W. Ballard to the position of staff scientist. He joins the organization with twenty-five years' experience in research accumulated in industry and academic institutions. Most recently he was with the Wright Air Development Center as chief of advanced developments in the Electronic Components Laboratory.

News of Reps

Two new technical sales reps are named by the Vernistat Division, Perkin-Elmer Corp., Norwalk, Conn. **Avionics Liaison, Inc.**, of Seattle, Wash., will handle the Washington and Oregon territory. **Eder and Associates** of Milwaukee, Wisc., will cover Wisconsin, Minnesota, northern Illinois and eastern Iowa.

Burnell & Co., Inc., Pelham, N. Y., appoints **Dave Launt** as sales rep for the Syracuse, N. Y., area; **Raymond E. Vinson,** for the Colorado, New Mexico, Utah and Wyoming area.

Tally Register Corp., Seattle, Wash., developer of digital data systems and related input-output equipment, has appointed **H. W. Ruby & Associates** of La Canada, Calif., for sales representation in California, New Mexico, Arizona and Nevada.

Technitrol Engineering Co., Philadelphia manufacturer of pulse transformers, delay lines and computer equipment, names the **Jack Geartner Co.** of Miami Beach as its sales rep in Florida.

Lloyd F. Murphy & Associates of Minneapolis, Minn., is appointed to represent H. H. Buggie, Inc., Toledo, Ohio, manufacturer of electronic connectors, cable assemblies and component parts for the aircraft, missile, communications and electronic industries.

Electronic Associates Inc., Long Branch, N. J., recently signed up the following reps:

Electro-Sales Associates in Cleveland, Ohio, and **T. Louis Snitzer Co.** in Los Angeles, Calif.

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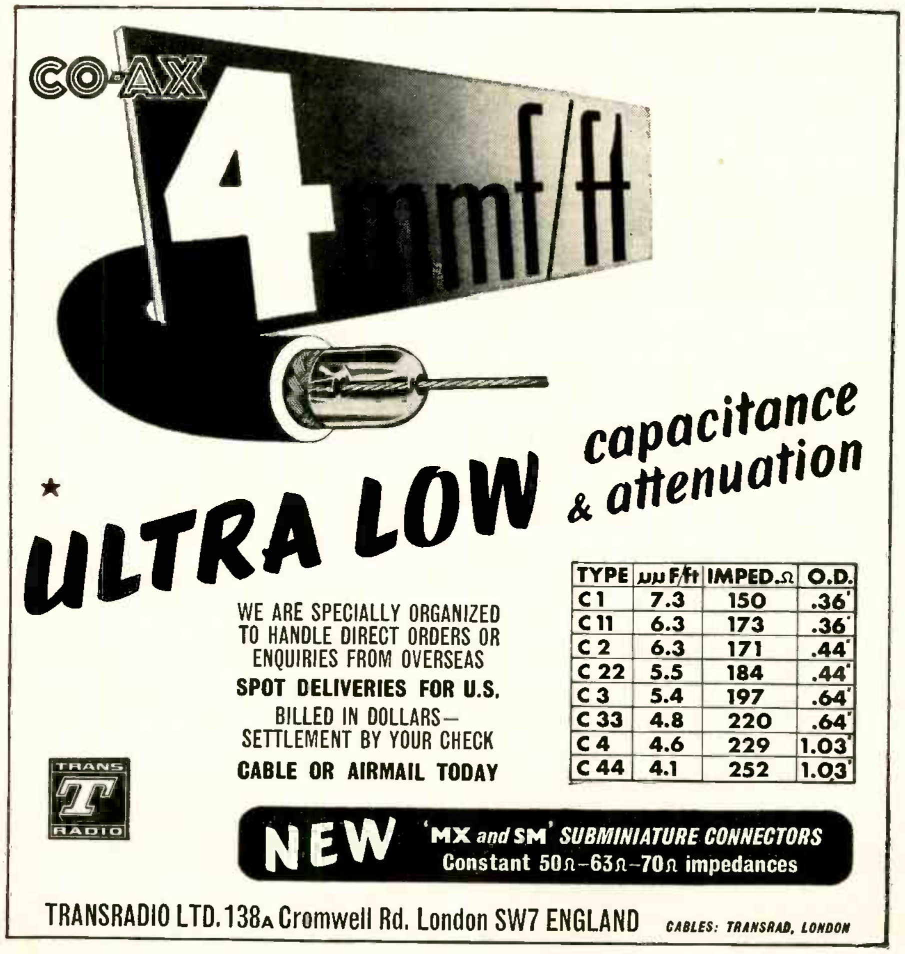

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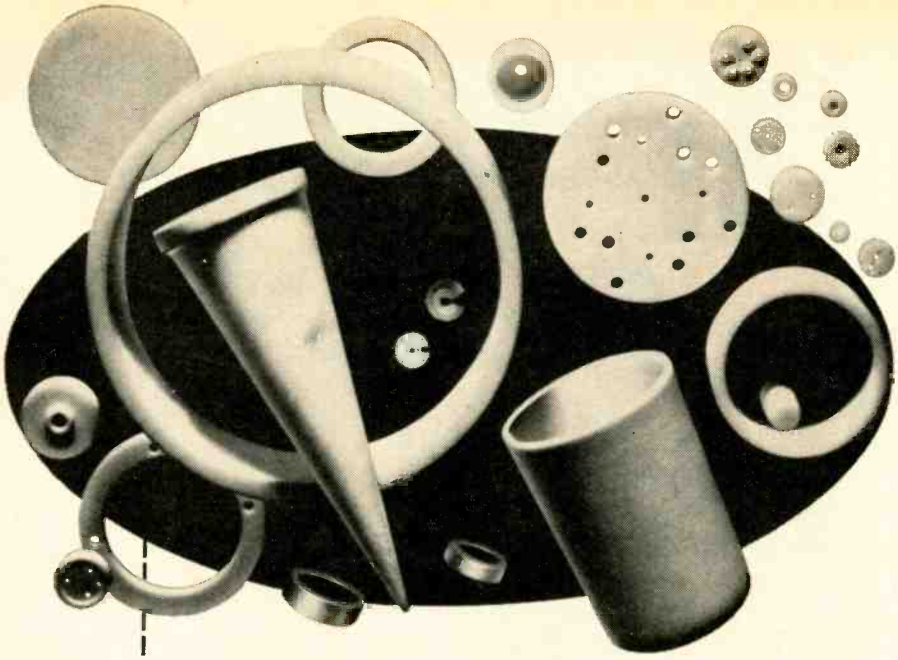

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COMMENT

Velocity Response

The article "Staggered Rep Rate Fills Radar Blind Spots" (Nov. 21'58, p 82) was extremely interesting.

Here at the Bendix Radio Corp. we are building, for Rome Air Development Center, the FPN-34, also a staggered rep-rate radar. However, we do not have to go through mathematical calculations to determine the composite velocity response of our staggered rep-rate moving-target-indicator system. Instead, using a piece of equipment of our own design, we can obtain oscilloscope pictures of the composite velocity response due to the use of any stagger ratio and any canceller shaping.

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J. F. BACHMANN

BENDIX RADIO
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Radio System Calculator

I was glad to see my "Radio System Calculator" in the Sept. 26 issue of ELECTRONICS (p 89). Mr. W. G. Granat of the power tube department of General Electric has written concerning some inaccuracies in the numerical examples given in the text. The examples have been completely recalculated with the results given here.

These errors do not affect the accuracy of the nomograph.

In the first example, receiver spatial sensitivity is given as 4×10^{-13} watts per sq meter, or 10 microvolts per meter; the more accurate calculation gives 2.51×10^{-13} watts per sq meter or 9.7 microvolts per meter. The receiving system sensitivity is given as 2×10^{-13} watts/m^2, should be 1.26×10^{-13} watts/m^2. Field strength is given as 3×10^{-9} watts/m^2, should be 1.86×10^{-9} watts/m^2. Signal-to-noise ratio is given as 42 db, should be 41.7 db. Noise figure for 150-kc

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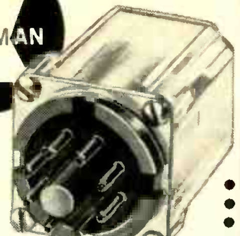

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bandwidth and −107 dbm sensitivity is given as 15 db, should be 15.2 db.

In the second example, the receiving system sensitivity is given as 300 microvolts per meter, should be 324 μv/m. The signal-to-noise ratio (dynamic range) is given as 77 db, should be 75.9 db.

J. J. LOGAN
TEMCO AIRCRAFT CORP.
DALLAS

Magnetron

With regard to our paper ("Spark Machining of a Magnetron," p 112, Oct. 24), it is the opinion of the authors that the contribution of Professor Masao Nishimaki of the Tokyo Institute of Technology has been so great that his name should also be included as one of the coauthors.

We would appreciate it very much if you could take our wishes into account.

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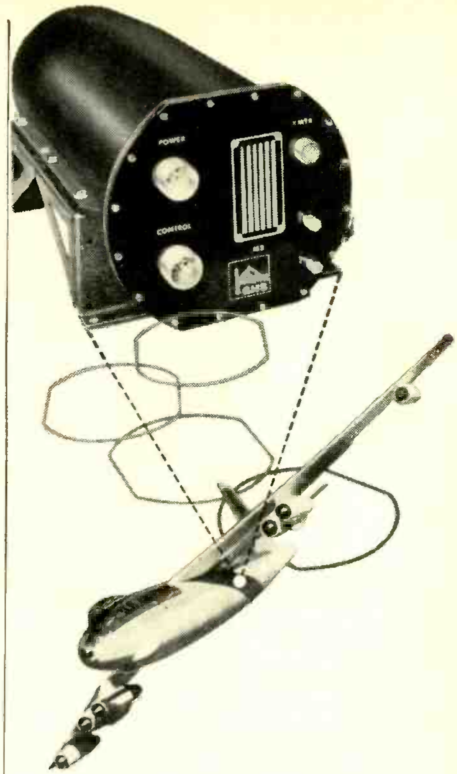
Space Research

It's a little irritating to read (Washington Outlook, p 12, Dec. 19) that the Advanced Research Projects Agency is rocking the boat of the U. S. space exploration program. It's also disheartening that you compound confusion by saying that the agency's future "is still up in the air."

The order that established ARPA gave it a definite cutoff. If my recollections serve me correctly, it was established last January with a mandate to coordinate space research for one year.

Naturally, as that year draws to a close, all the bureaucrats who have built their nests in the agency and hitched their little red wagons to its star are getting panicky. But their private panic ought not to color the straightforward progress of the nation's space research.

C. A. BURKE
ALEXANDRIA, VA.



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BMEWS development is currently in progress at RCA Moorestown, the weapon system manager, and also within the facilities of several other major corporations whose efforts are coordinated by RCA. Entering the BMEWS program at an early date will afford engineers the opportunity to contribute to the basic system development and, through continuing participation, to witness its evaluation into a final operating equipment.

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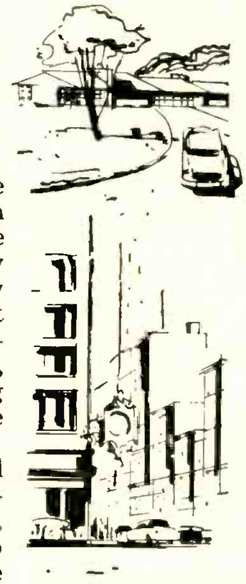

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—This is a precision receiver covering 38-4000 mc. The set utilizes 5 tuning units with direct reading dials in megacycles. The receiver has a wide and narrow band-width 30 mc I.F. strip which may be selected at will.

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AN/APR5A—Airborne superhet radar search rec. Freq. range 1000 to 6100 MC. Rec. has a 10 MC IF band width operating from 80/115V AC, single phase 60 to 2600 cps. and one amp. at 26V DC—complete with tubes..............$89.50

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MD4 - RT - 15
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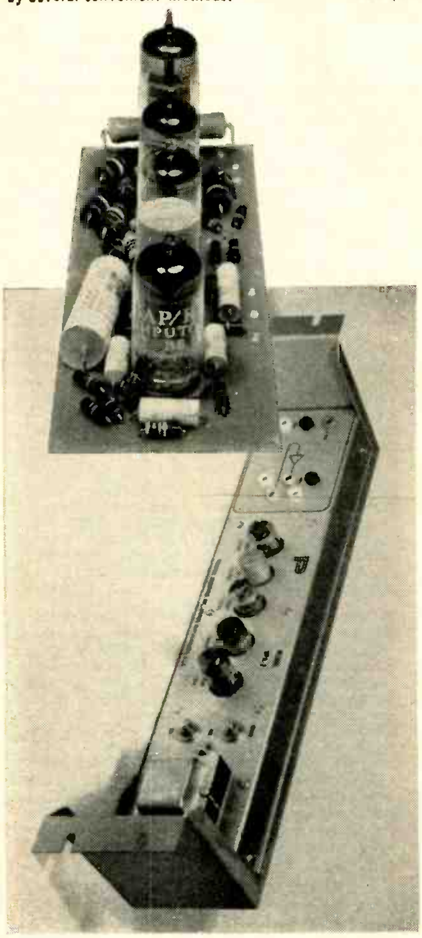

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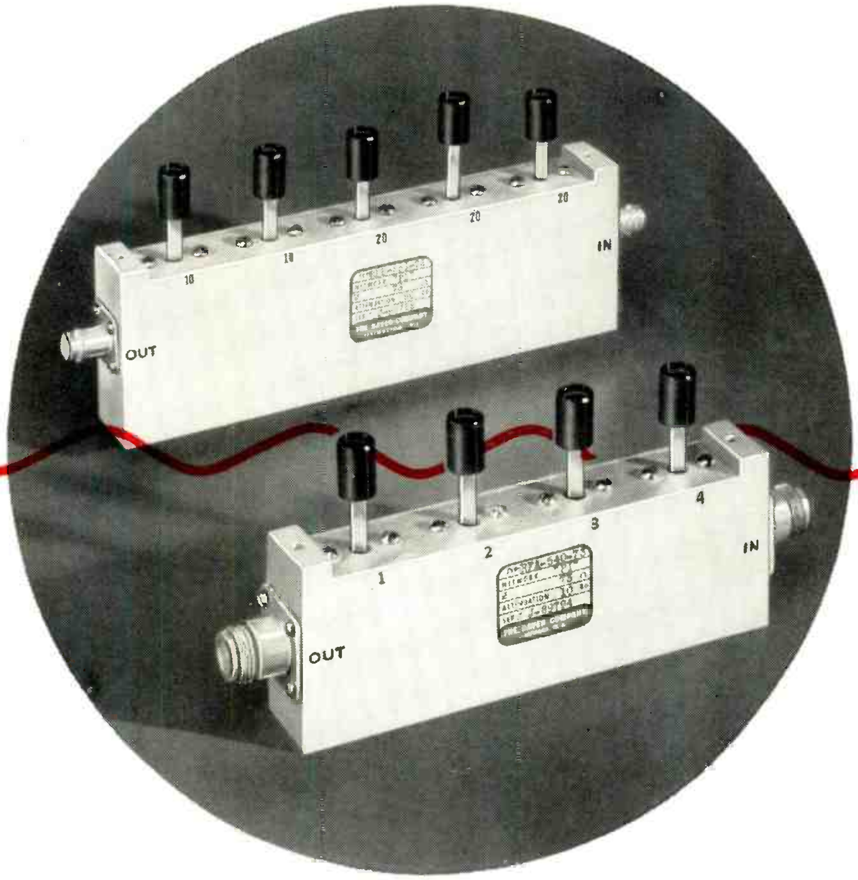

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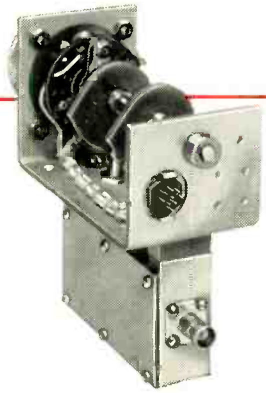

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TYPE	LOSS	TOTAL Db	STANDARD IMPEDANCES
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RFA & RFB 541	10, 20, 20, 20 Db	70	50/50Ω and 73/73Ω
RFA & RFB 542	2, 4, 6, 8 Db	20	50/50Ω and 73/73Ω
RFA & RFB 543	20, 20, 20, 20 Db	80	50/50Ω and 73/73Ω
RFA & RFB 550	1, 2, 3, 4, 10 Db	20	50/50Ω and 73/73Ω
RFA & RFB 551	10, 10, 20, 20, 20 Db	80	50/50Ω and 73/73Ω
RFA & RFB 552	2, 4, 6, 8, 20 Db	40	50/50Ω and 73/73Ω

Other Db loss combinations are available.

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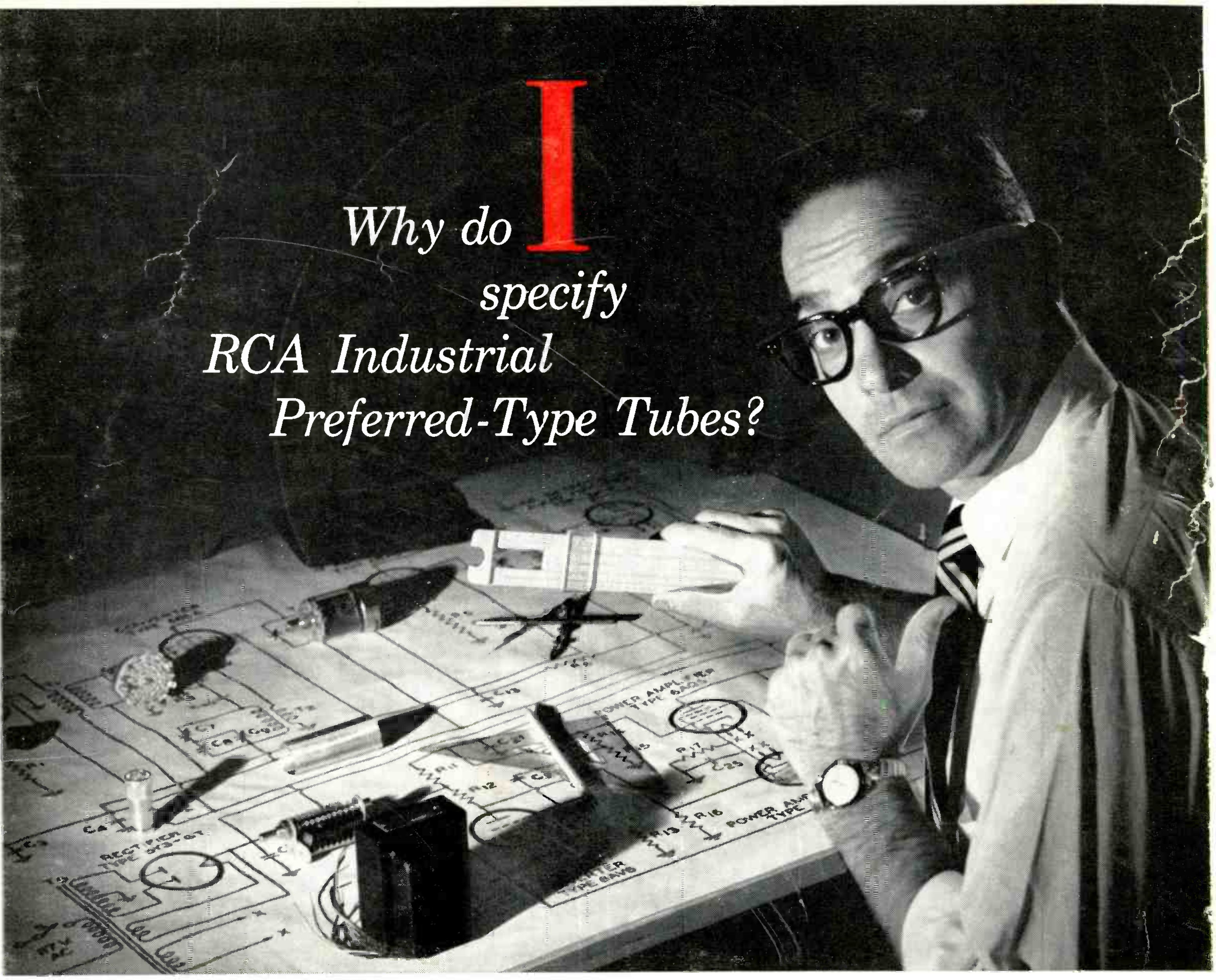

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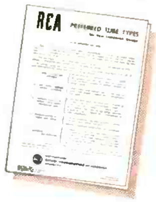

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