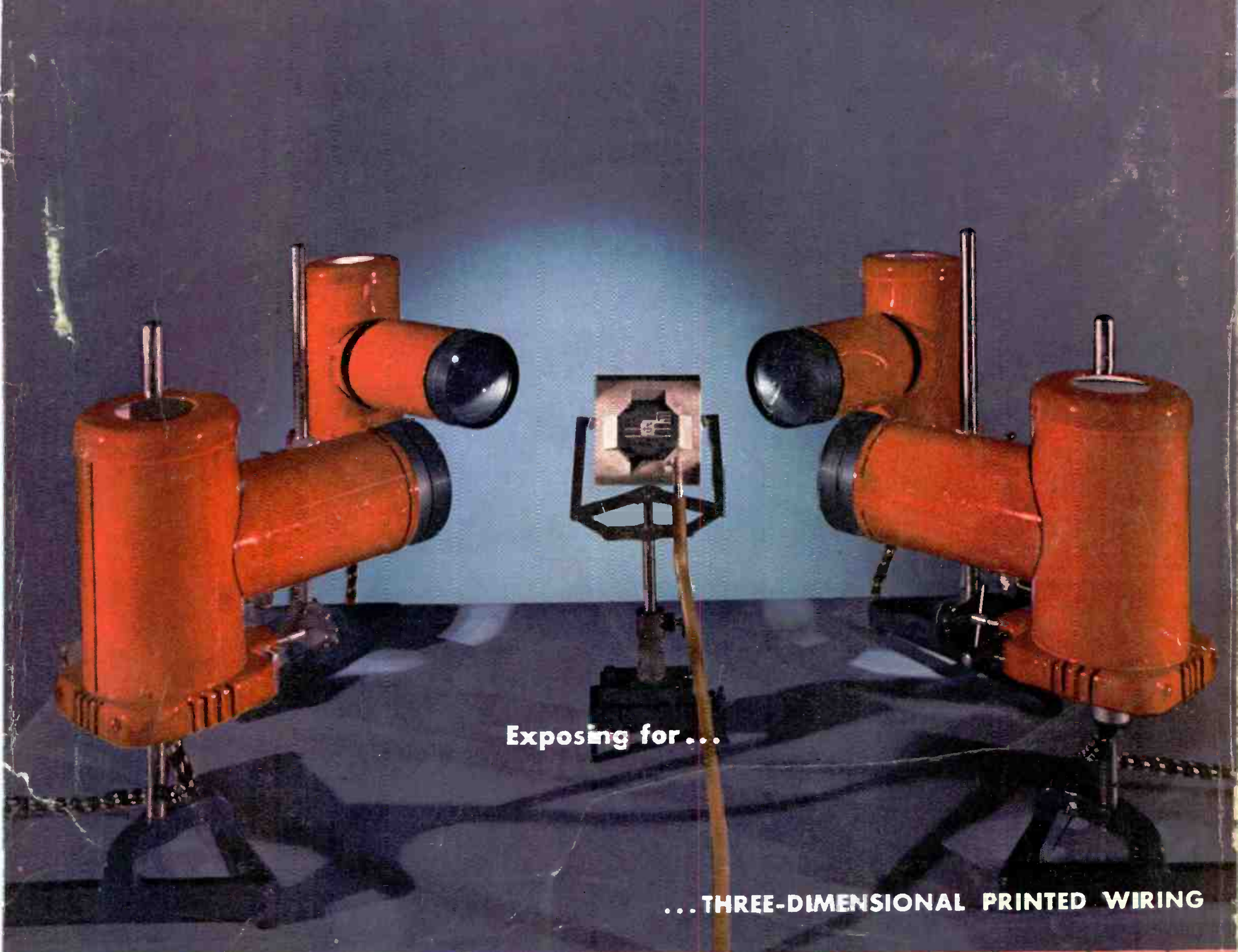
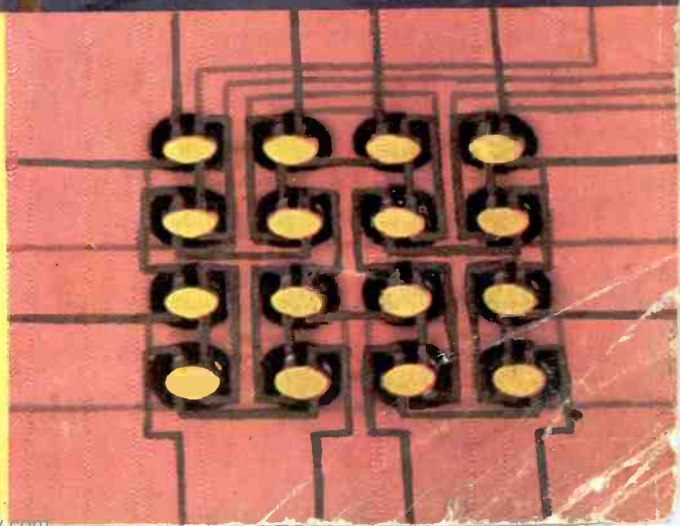
electronics

JUNE 1, 1957

A McGRAW-HILL PUBLICATION • PRICE 75 CENTS





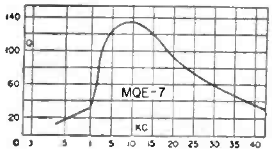
LARGEST PRODUCERS IN THIS FIELD FOR TWO DECADES...

HIGH Q INDUCTORS
FOR EVERY APPLICATION

FROM STOCK... ITEMS BELOW AND 650 OTHERS IN OUR CATALOGUE B.

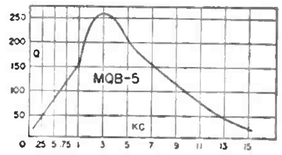
MQ Series Compact Hermetic Toroid Inductors

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.

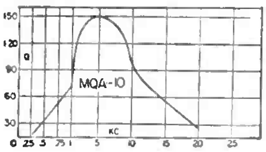


MQE
15 stock values from 7 Mhy. to 2.8 Hy.

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



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

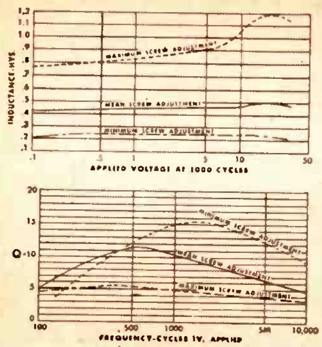


MQ drawn case structure.

	Length	Width	Height
MQE	1/2	1-1/16	1-7/32
MQA	11/16	1-9/32	1-23/32
MQB	1-5/16	2-9/16	2-13/16

VIC case structure

Length	Width	Height
1-1/4	1-11/32	1-7/16



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.

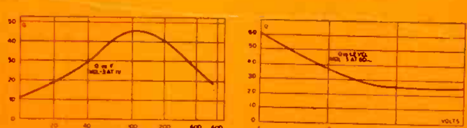
Curves shown indicate effective Q and L with varying frequency and applied AC voltage.

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.

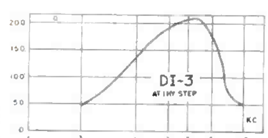
MQL-1	2.5/10 Hys.
MQL-2	5/20 Hys.
MQL-3	50/200 Hys.
MQL-4	100/400 Hys.

MQL case
1-13/16 dia. X 2-1/2" H.



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.



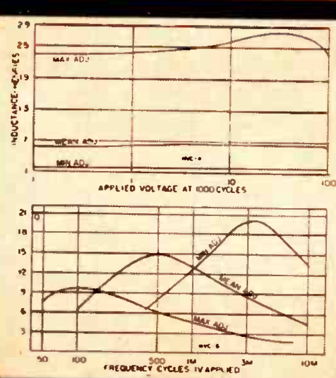
DI-1	Ten 10 Mhy. steps.
DI-2	Ten 100 Mhy. steps.
DI-3	Ten 1 Hy. steps.
DI-4	Ten 10 Hy. steps.

DI DECADE

Length	4½"
Width	4⅜"
Height	2⅜"

HVC Hermetic Variable Inductors

A step forward from our long established VIC series. Hermetically sealed to MIL-T-27 . . . extremely compact . . . wider inductance range . . . higher Q . . . lower and higher frequencies . . . superior voltage and temperature stability.



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 case structure.

Width	Length	Height
25/32	1-1/8	1-7/32

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electronics

JUNE 1 • 1957

A McGRAW-HILL PUBLICATION

THREE-DIMENSIONAL PRINTED WIRING—Use of four collimated light sources permits exposure of wiring pattern simultaneously on both sides of plastic sheet and through ferrite cores embedded in copper-plated board after which etching gives completely wired magnetic-core memory plane with no need to thread wires through core holes. Technique is Lincoln Laboratory development (see p 160). Photos by Ed Paradiso . . . . COVER

FEATURES

CONTINUED ON NEXT PAGE

contents

continued

SHOP

▶ OPENINGS . . . A number of readers have been impressed by the quantity and quality of ELECTRONICS staff, as shown in the photograph in *Shoptalk* for our May 1 issue. We collectively appreciate the bouquets.

The thought has occurred to us, however, that some readers may have gotten the impression that the staff is already so large that there could be no opening for which they might apply if they were interested in pursuing a career in technical magazine publishing.

There is almost always room for one more really promising engineer on ELECTRONICS. Industry experience is desirable and report writing or editing are plus values. All of us feel that there is nothing like an editing career for the right man.

If you think you are the right man, contact our editor.

▶ INDUSTRY MIRROR . . . One of the benchmarks of the electronics industry is our Buyers' Guide, the extra mid-year issue that every subscriber receives. Data on the products of about 3,000 companies in the field appear in the issue.

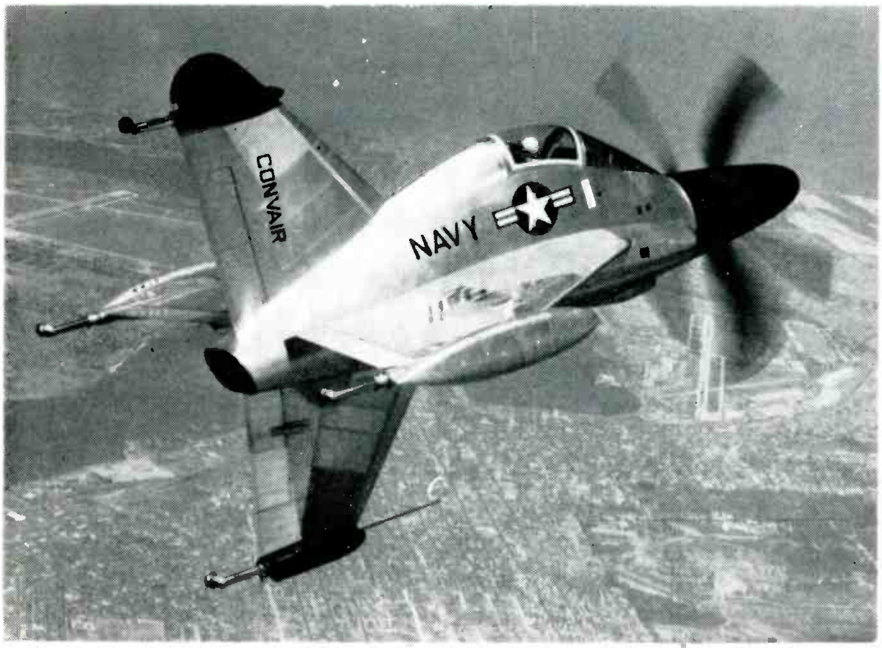
Like other growth industries, electronics is constant only in change. To keep the Buyers' Guide up to date with the changes it is necessary to send questionnaires to every company each year. Upon return, each questionnaire is reviewed for the additional information that was not available for the previous Guide.

electronics

JUNE 1, 1957 Vol. 30, No. 6

Member ABC and ABP

TALK



ELECTRONIC method of measuring speed of vertical take-off and landing of the Convair XFY-1 Pogo plane is described on page 150 this month. Most published photos of the plane show it in a vertical position and so does the article. The editors like the change of pace of the shot above. (It proves it can fly horizontally)

Companies in the field have always been very cooperative in supplying the data.

To insure complete coverage, one questionnaire is sent out every February, and a follow-up goes out a month later. Those few firms that have not replied by the April deadline are contacted directly by phone, telegram or in person.

For 16 years readers have relied on ELECTRONICS Buyers' Guide for specifications and data.

P. S. – A friend of ours reports that he recently saw a man in a used book store inquiring for and buying our 1953 Buyers' Guide.

▶ **SPACE P. O. NEXT** . . . During the normal course of editorial work we handle an appreciable amount of correspondence with subscribers in both the U. S. and foreign countries.

Mail, like skip distance and forward scatter signals, often jumps international boundaries unexpectedly. A recent letter sent to M. Klemmick here in the States seems to have been affected by a postal sporadic E layer disturbance.

"It might interest you to know that your letter to me must be a near record breaker for miles covered.

"You sent the letter to me at my old address in Sonoma, California. From there it was forwarded to Jacksonville, Florida by my parents.

"But I had left Florida for Europe. The letter returned to my parents in California, who again sent it to me.

"I finally received it while I was in Istanbul, Turkey."

▶ **NEXT MONTH** . . . Coincidentally appropriate for the season, our July cover will show how an ultrasonic generator solves a problem for brewers.

Getting the right color picture seemed impossible for a while because of problems of composition and lighting.

The electronic transducer is tiny, and mounted on a large beer bottle capping machine. It had to be moved up abnormally close to show in the picture.

The machine is located in a corner of a plant where suitable flash lighting for color was difficult to achieve.

Shots were taken on four different occasions, and by different photographers, before everyone was satisfied.

Complete technical details of the equipment will appear in the same issue.

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Single copies 75¢ for Technical Edition and 50¢ for Business Edition in United States and possessions, and Canada; $2.00 and $1.50 for all other foreign countries. Buyers' Guide $3.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years. Canada, $10.00 a year. All other countries $20.00 a year. Three-year rates accepted on renewals only, are double the one-year rate. Entered as second-class matter August 29, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U.S.A. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11; 68 Post Street, San Francisco 4; McGraw-Hill House, London E. C. 4; National Press Bldg., Washington, D. C. 4; Architects Bldg. 17th & Sansom Sts., Philadelphia 3; 1111 Henry W. Oliver Bldg., Pittsburgh 22; 1510 Hanna Bldg., Cleveland 15; 856 Penobscot Bldg., Detroit 26; 3615 Olive St., St. Louis 8; 350 Park Square Bldg., Boston 16; 1321 Rhodes Haverty Bldg., Atlanta 3; 1125 West Sixth St., Los Angeles 17. ELECTRONICS is indexed regularly in The Engineering Index.

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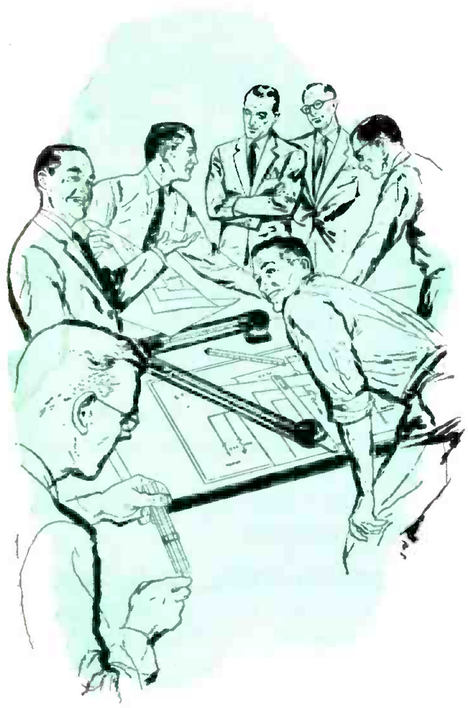
a completely new kind of regulator!



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- *FIVE* PRINCIPAL SENSING ARRANGEMENTS

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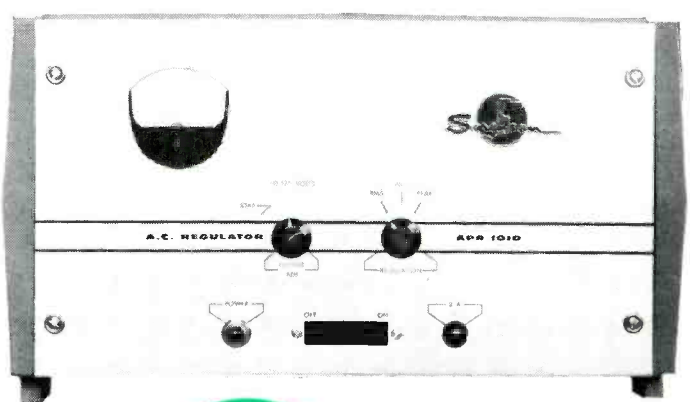
ELECTRICAL CHARACTERISTICS:

Input	95-130 VAC, 1ϕ (50 or 60 cps ±10%)
Output	115 VAC, adj. 110-120V
Regulation accuracy (RMS, average, or peak, switch selected)	±0.1% against line ±0.1% against load
Distortion	3% max.
Load	0-1000VA
P.F. range	Unity to 0.7 lagging
Recovery time	0.1 sec.

Write for complete technical data.



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The D-695 Muirhead-Wigan decade oscillator

Hourly Stability Better than ±0·02%

Low Harmonic Content
obtained by using controlled negative feedback in the oscillatory section.

Extreme Simplicity of Control
just set the frequency dials and adjust to the required level on the output meter.

SPECIFICATION

Frequency Range:
10 c/s—31 200 c/s (continuously variable) in two ranges (×1 and ×10)
Frequency Accuracy (within 5 minutes of switching on):
±0·2% (or better) above 100 c/s, decreasing to ±0·3 c/s at 10 c/s
Hourly Stability: better than ±0·02%
Resetting Accuracy: 0·1 c/s on ×1 range; 1·0 c/s on ×10 range
Harmonic Content at output level of 10mW:
30 c/s-30 kc/s 0·2% into 600 ohm balanced or unbalanced;
0·5% into 10k ohm unbalanced
Below 30 c/s: increasing gradually to about 0·6% in the two unbalanced conditions and about 4% in the 600 ohm unbalanced condition at 10 c/s
Hum Level with respect to 10mW:
−70dB (0·03% of the output voltage at 10mW)
Variation of Output Level with Frequency: (into 600 ohm unbalanced)
30 c/s-10 kc/s Flat within ±0·1dB; 30 c/s-20 kc/s Flat within ±0·[illegible]
10 c/s-30 kc/s Flat within ±1dB
Maximum Undistorted Output Power: 10mW
Output impedances:
600 ohm balanced; 600 ohm unbalanced and 10000 ohm unbalanced
Power Supply:
190-250V, 50 c/s (D-695-A); 95-125V, 60 c/s (D-695-A/100)
Power consumption 40 VA
Overall Dimensions:
17½ in. wide × 12¼ in. high × 8 in. deep (44·5 cm × [illegible] cm × 20·3 cm)
Weight: 37 lb. (17 kg)

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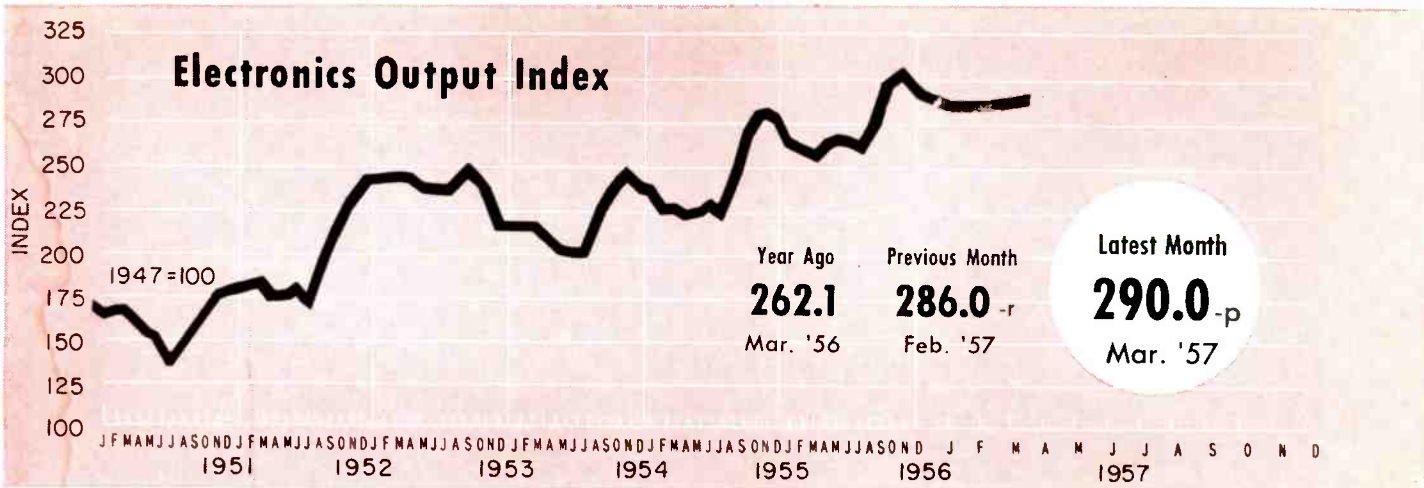


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month Mar. '57	Previous Month Feb. '57	Year Ago Mar. '56
Television sets, total	559,842	464,697	680,003
With UHF	62,815	68,219	82,805
Color sets	nr	nr	nr
Radio sets, total	1,609,073	1,264,765	1,360,113
Auto sets	597,532	522,859	478,272

RECEIVER SALES

(Source: RETMA)	Mar. '57	Feb. '57	Mar. '56
Television sets, units	534,115	525,437	544,411
Radio sets (except auto)	730,584	525,029	527,649

RECEIVING TUBE SALES

(Source: RETMA)	Mar. '57	Feb. '57	Mar. '56
Receiv. tubes, total units	43,010,000	44,460,000	42,525,000
Receiv. tubes, value	$37,007,000	$36,631,000	$34,849,000
Picture tubes, total units	833,088	728,363	848,055
Picture tubes, value	$14,847,798	$13,134,778	$15,714,365

INDUSTRIAL TUBE SALES

	Quarterly Figures		
(Source: NEMA)	Latest Quarter 4th '56	Previous Quarter 3rd '56	Year Ago 4th '55
Vacuum	$12,408,371	$8,895,012	$9,967,411
Gas or vapor	$3,223,612	$2,936,765	$3,251,621
Magnetrons and velocity modulation tubes	$15,890,681	$14,948,477	$13,726,323
Gaps and T/R boxes	$1,242,745	$1,196,369	$1,578,767

MILITARY PROCUREMENT

(Source: Defense Dept.)	4th '56	3rd '56	4th '55
Army	$56,185,000	$23,107,000	$48,477,000
Navy	$34,210,000	$22,273,000	$20,378,000
Air Force	$145,962,000	$84,952,000	$131,938,000
Total—Electronics	$236,357,000	$130,332,000	$200,793,000

BROADCAST STATIONS

(Source: FCC)	Latest Month Mar. '57	Previous Month Feb. '57	Year Ago Mar. '56
TV stations on air	515	515	488
TV stations CPs—not on air	126	123	109
TV stations—new requests	60	56	94
A-M stations on air	3,040	3,031	2,858
A-M stations CPs—not on air	145	133	115
A-M stations—new requests	308	303	262
F-M stations on air	526	529	536
F-M stations CPs—not on air	23	23	12
F-M stations—new requests	17	10	4

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Feb. '57	Jan. '57	Feb. '56
Aeronautical	50,859	54,243	44,570
Marine	61,246	60,774	54,637
Police, fire, etc.	22,500	22,450	19,971
Industrial	33,879	33,456	28,054
Land transportation	9,484	9,476	8,726
Amateur	158,232	157,275	145,427
Citizens radio	23,888	23,155	15,563
Disaster	343	331	327
Experimental	735	721	652
Common carrier	2,666	2,618	2,176

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Feb. '57	Jan. '57	Feb. '56
Prod. workers, comm. equip.	394,600-p	398,700-r	389,400
Av. wkly. earnings, comm.	$80.18 -p	$78.40-r	$74.93
Av. wkly. earnings, radio	$76.80 -p	$75.24-r	$70.84
Av. wkly. hours, comm.	40.7 -p	40.0 -r	40.5
Av. wkly. hours, radio	40.0 -p	39.6	39.8

SEMICONDUCTOR SALES ESTIMATES

	Mar. '57	Feb. '57	Mar. '56
Transistors, Units	1,904,000	1,785,300	708,000

STOCK PRICE AVERAGES (See p 28)

(Source: Standard and Poor's)	Mar. '57	Feb. '57	Mar. '56
Radio-tv & electronics	47.26-r	46.05-r	66.33-r
Radio broadcasters	63.46-r	62.02-r	78.23-r

p—provisional r—revised nr—not reported

FIGURES OF THE YEAR

	TOTALS FOR THE FIRST THREE MONTHS 1957	1956	Percent Change	1956 Total
Television set production	1,474,729	1,844,632	—20.0	7,357,029
Radio set production	3,959,367	3,532,243	+12.1	13,981,800
Television set sales	1,682,911	1,659,178	+ 1.4	6,804,756
Radio set sales (except auto)	1,818,976	1,513,722	+20.2	8,332,077
Receiving tube sales	125,041,000	120,420,000	+ 3.8	464,186,000
Cathode-ray tube sales	2,322,311	2,638,503	—12.0	10,987,021

INDUSTRY REPORT

electronics—June 1 • 1957

Trans-Atlantic Phone Cable Multiplies

Span, completed last September, will get partner to ease phone traffic. Cost: $22 million

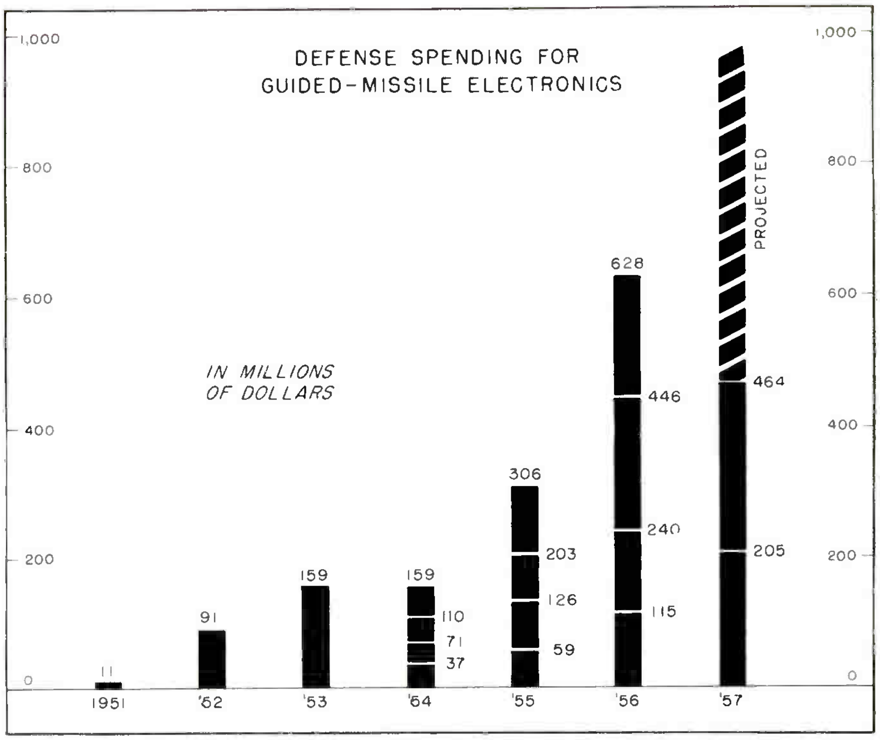
CANADA and Britain have announced plans to complete a second transatlantic telephone cable by 1961. Officials estimate it will cost $22 million, say it may be one link in a Commonwealth telecommunications network.

The new transatlantic link will consist of one cable and provide 60 telephone channels, with special British-made electronic repeaters about 20 miles apart to amplify voice currents. The present link, opened last year, has two cables, one carrying speech in each direction. It handles 36 circuits.

▶ **Financing**—Cost of a Newfoundland to Scotland link will be shared by the British Post Office and the Canadian Overseas Telecommunications Corp. The Canadian company will finance the cable between the mainland and Newfoundland.

Agreement on the new cable was reached by the British Post Office, Canadian Overseas Telecommunications Corp. and Cables and Wireless Ltd. American Telephone & Telegraph Co., which participated in the $42 million first cable with Britain and Canada, is negotiating for a third transatlantic cable.

Present weekly traffic between Canada and Britain is 1,500 calls, three times the number last year when the cable was opened. Traffic between the U. S. and Britain amounts to about 4,100 calls a week.



GRAPH shows the striking rise in military expenditures for guided missiles since 1951. Despite the infancy of the program, computations show . . .

Missile Spending Keeps Soaring

About 30 percent of military electronics currently goes into guided missiles

TOTAL missile spending since fiscal 1951 through the second-quarter of fiscal 1957 amounted to over $1.7 billions of dollars, according to estimates recently released by the Radio-Electronics-Television Manufacturers Association (RETMA). Breakdown for each year shows the tremendous growth of guided-missile spending for these years, the spending increasing almost sixfold since fiscal 1954.

These figures were arrived at by extracting military expenditures from such major defense-procurement categories as aircraft, ships, combat and support vehicles, electronics and communications, research and development and guided missiles.

The graph, derived from the report, shows the breakdown for guided-missile spending, applied on a quarterly basis for each fiscal year beginning in 1954 and for the fiscal years 1951, 1952 and 1953.

Further breakdown of electronics defense spending shows that 31 percent of the total goes into airplanes, 23 percent is for communications and nine percent goes into research and development.

Only two percent of the total electronics expenditures reaches ships and harbor craft and about the same amount goes into combat vehicles. However trends for six and a half years show that none of these have the accelerated spending rate of guided missiles.

Soviets Develop Underwater Camera

Remote control tv units will be handled by wireless operators on Russian ships

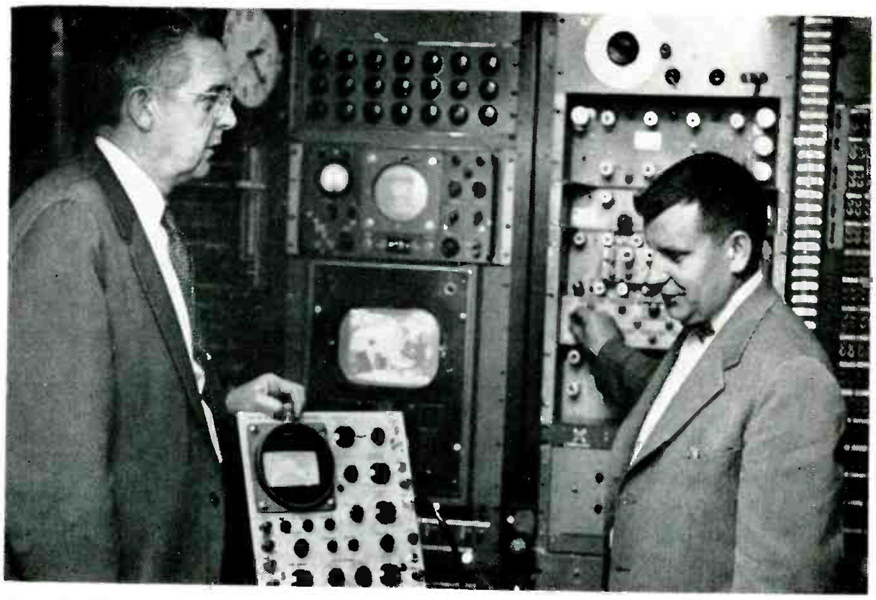
A RUSSIAN scientific journal reports a new remote control underwater television camera has been developed by the Soviet Academy of Science. The article says the Soviets plan to train ships' wireless operators to handle the equipment.

▶ **Present Use** — Sets are now being used for underwater work on ships, bridges, harbor installations, and for biological and zoological purposes, says the article in Westnik Academii Nauk SSSR.

A compass is attached to the submerged camera, with shooting direction showing up on a control board. There are other controls for variations of shutter speed and lens opening. A special device registers moisture within the camera housing to enable the gear to be pulled out of the sea before too much water penetrates the cover.

▶ **Limitations**—Range of the underwater camera is said to be limited, making it necessary to use a wide-angle lens. Additional lenses enable detailed study of small objects like plankton.

The Laboratory for Sea Electronic Techniques within the Academy's Institute for Oceanology has developed the underwater test gear for Russian ship operation.



ENGINEERS check amplitude-reference vertical-blanking interval test signal in WABC-TV master control room in New York as . . .

TV Networks Air Test Signals

Use of vertical blanking interval permits test signals to be sent with picture transmissions

TRANSMISSION lines and equipment along the paths of network television programs can now be checked during regular program transmissions by sending a test signal simultaneously with the picture. By placing the test information in the vertical blanking interval, the signal is made invisible to home viewers.

Since mid-April, both the American Broadcasting Co. and the National Broadcasting Co. have been making regular transmissions of experimental test signals.

▶ **Signal Types**—ABC uses an amplitude-reference signal that defines black-reference and white-reference levels for monochrome transmissions. The signal utilizes two horizontal lines per field.

Currently added only to programs originating from New York and scheduled for about 6 hours every weekday, ABC expects to have additional facilities at Hollywood and Chicago so the signal may be added on a continuous basis to programs from any of these points.

NBC is presently transmitting an RCA eight-interval test and reference signal with all color programs originating in New York. The signal, which utilizes three horizontal lines, includes reference-white and 50-percent levels and permits checking I and Q phase, differential gain and transient response.

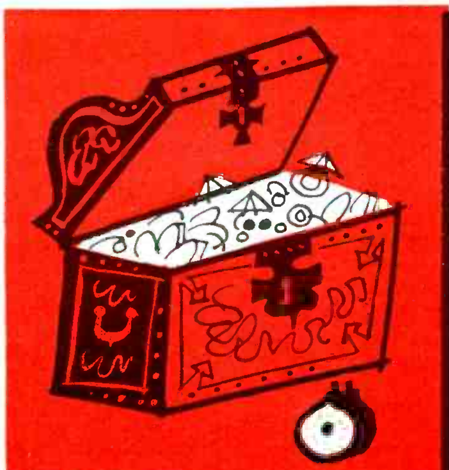
Because of its experimental nature, NBC inserts the test signal at master control. Both NBC and ABC intend to have the signal eventually inserted at the output of each camera or film chain.

Columbia Broadcasting System is not using the blanking interval for test signal transmissions, but expects to when an industry standard signal is adopted.

▶ **FCC Authorization**—All test signal transmissions at the present time are based on the blanket authorization for experimental transmissions issued by the FCC last fall.

Still to be decided are the specications for a standard signal for

(Continued on page 10)



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. . . the engineering skill in every component by Burnell. Burnell files contain thousands of special designs in regular and subminiature filters.

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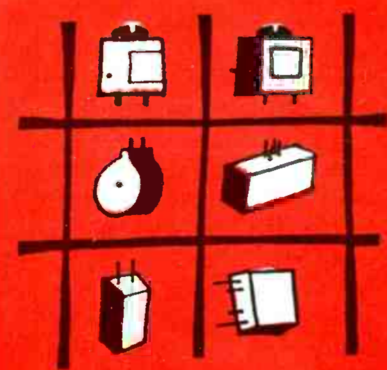
Burnell products incorporate the highest standards of engineering know-how and precision manufacturing in toroids, filters and related networks.



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Burnell has over 8,000 filter designs in stock, including subminiature filters for aircraft and guided-missiles, communications filters for receivers, and side-band filters for carriers . . . in addition to an array of other new, specialized components.

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they all tell the same basic story

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HOW ABOUT SOME ICING?

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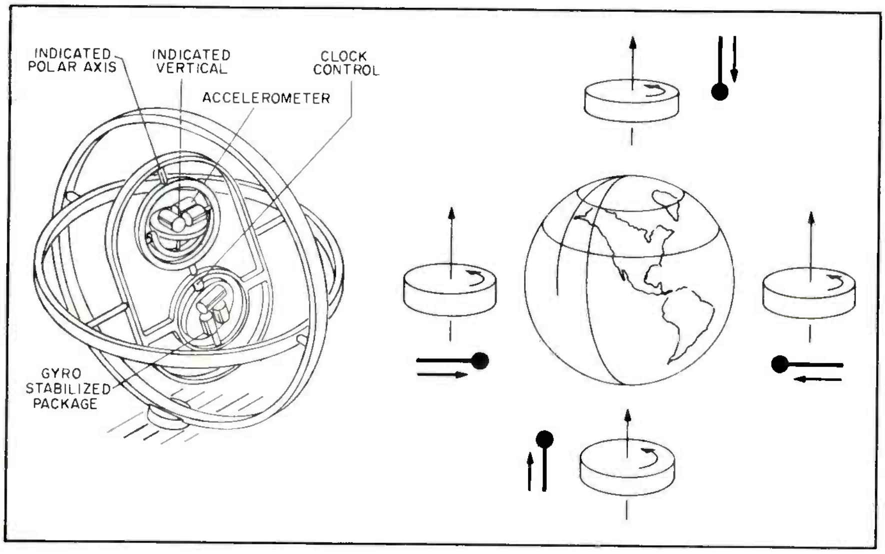
"first in toroids, filters and related networks" use by the entire television broadcasting industry. Work on establishing such a standard is being done by an IRE committee composed of representatives of the networks, independent stations and the AT&T. The committee will probably adopt a standard signal that will provide reference level signals. Test and remote-control signals may be incorporated in the future.

▶ **Equipment Cost**—The complexity of the industry-adopted signal will, to a great extent, decide the type and cost of equipment necessary. Telechrome is marketing a keying unit at $1,200 that permits insertion of the test signal; other manufacturers have indicated they will enter the market later.



PACKAGE and gimbal configuration (left) and simplified effects of moving it around the earth (right) graphically demonstrate system principles as . . .

Inertial Guidance Wraps Take Wing

Details of jam-proof system reveal complex technique involved in design

NEWTON'S laws of motion describe physical phenomena as they would be seen in inertial space. Forces that depend on changes of motion with respect to inertial space can be measured by self-contained equipment consisting of gyros, accelerometers and a verticle pendulum, a clock and a computer. These elements form the basic inertial guidance system.

▶ **How it Works**—Briefly, the system measures the change in angle between the vertical that existed at the point of vehicle departure, as maintained by the gyros, and the present vertical as indicated by a "Schuler-tuned" pendulum operating in conjunction with the accelerometer's. The clock provides the timing reference.

The accelerometers are initially oriented in the N-S and E-W directions. After take-off, their outputs are integrated twice in the computer to determine distance the vehicle travels in these directions. These distances are converted to changes in latitude and longitude and added to the starting point coordinates to show the vehicle's new position.

In a guidance system this information would be compared with guidance course information set into the computer before the vehicle takes off and any differences would result in changing the vehicle's course to bring the N-S, E-W coordinate information in correspondence.

▶ **Latest**—Work on ISIP (Inertial System, Indicating Position) has progressed at Minneapolis-Honeywell Regulator Company to the point where this pure inertial navigating system has been flight tested with favorable results in manned and unmanned aircraft ranging over several-hundred mile courses in Minnesota and Wisconsin.

The three-stage Vanguard rocket will be guided by a similar inertial guidance system also developed by this company.

Naval Report Surveys Electronics Industry

Estimates show that 495,000 workers will produce over $8.5 billions worth of electronic goods in 1957

AN ANNUAL REPORT of manufacturers of electronics equipment—facilities data, ratings and production capabilities—has been completed by the Office of Naval Materiel for the calendar year 1956 with industry's estimate of planned production for 1957.

The report shows planned production for 1957 at $8.533 billion of which $4.2 billion will be for the military. The proportions remain about the same as last year but the volume will be bigger.

▶ **Employees**—The report shows that the number of employees in the electronics industry has gone up from 441,000 to approximately 495,000. This year's survey is based on returns from 561 companies; last year's returns were from 549 companies.

▶ **Backlogs**—The military backlog as of Jan. 1, 1957 has increased to $4.9 from approximately $4 billion on Jan. 1, 1956, a $900-million increase.

There is a $4-billion backlog of prime contracts. About $900 million is military subcontracting. That means about 20 percent is subcontracting as compared with about 30 percent last year.

(Continued on page 12)

▶ Sales—Yearly average electronic sales per employee for 1956 was $14,376. The figure the previous year was $14,537, higher because of more subcontracting. This figure was obtained by taking the total production output delivered or billed and dividing by the number of employees.

The 1956 electronic sales figure of $7.1 billion exceeds electronic sales billings in the peak Korea year of 1953 by about $600 million. This is the first time since the Korean war that the figure has topped that of 1953.

▶ Increases—The maximum production capability per year in one shift has gone up to $11.3 billion, an increase of approximately 600 million from that reported last year.

The 1956 sales of electronic products increased $700 million over 1955 to the figure of $7.1 billion. This is within 4 percent of what last year's survey predicted would be manufactured in 1956. The record shows that the forecasts have come within 5 percent of actual production each year, sometimes as close as two percent.

The report was compiled by Theodore Bishoff, Office of Naval Materiel with the help of Naval field inspection offices and industry.

Business Briefs

▶ **Net profit** of Eitel-McCullough for 1956 of $1.3 million is nearly double the previous year. Sales increased 55 percent to $13.9 million

▶ **Annual report** of Fairchild Camera and Instrument includes novel glossary of business and engineering terms. "We are no longer taking it for granted that the average layman is a combination of Einstein and J. P. Morgan," comments company president, Sherman M. Fairchild

▶ **Restricted stock** option plan for officers and key employees recommended to stockholders by directors of Amphenol Electronics. The plan reserves 35,000 shares of capital stock for issuance to officers and employees

▶ **Electronics sales of** $60 million in 1957 predicted by Avco Manufacturing executives at meeting with New York Society of Security Analysts. Electronics estimate is 20 percent of total 1957 sales estimate of $300 million

▶ **Television set** sales for first quarter of 1957 set record at Sylvania. Factory unit sales through March nearly tripled sales in the same period of 1956. Previous first quarter record set in 1955 exceeded by 34 percent

▶ **Debenture issue** of $7.9 million proposed by Collins Radio. The debentures will be convertible into Class B common stock. They will be offered to class A and class B stockholders at rate of $100 principal amount of debentures for each 19 shares of common held by stockholders

Radar Mapping Device Reduces Distortion


Radar Restitutor camera rephotographs original photographs of PPI radar presentations without the inherent distance distortions

Radar's usefulness increased by new radar restitutor camera. Military and civil markets seen

PHOTOGRAPHS of airborne radar minus most PPI presentations, said to be free of all inherent distortions and inaccuracies inherent in the scope, are possible with Fairchild's Radar Restitutor camera.

▶ **How it works**—Normal photographs of radar presentations are rephotographed by a camera utilizing a rotating optical element that serves as an automatic computer. Slant range distances from aircraft to ground objects are automatically converted to actual ground ranges—the aircraft's nadir point to the objects.

Other distortions corrected are: sweep delay, plane motion during one scan, non-linear electronic sweep, lens distortion and curvature of the cathode ray tube.

Correction is said to be easy enough for unskilled personnel to operate equipment.

▶ **Uses**—Military application includes: mapping services, reconnaisance work and survey infor-

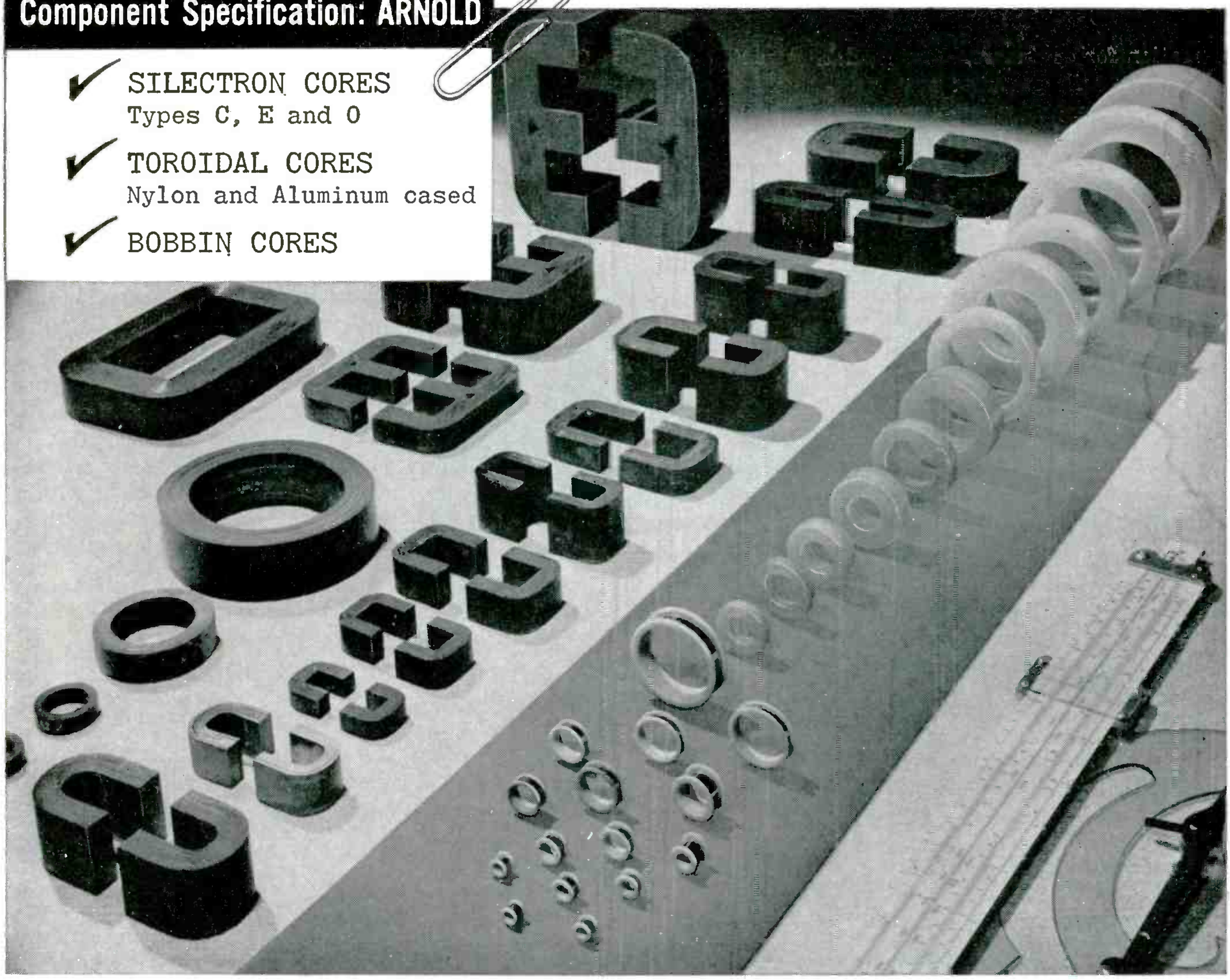
(Continued on page 14)

Component Specification: ARNOLD

✓ SILECTRON CORES
Types C, E and O

✓ TOROIDAL CORES
Nylon and Aluminum cased

✓ BOBBIN CORES



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TC-101A—*Toroidal Cores, nylon and aluminum cased*
TC-108—*Bobbin Cores*

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mation for engineers. Commercial markets will include: map compilation companies, survey groups for oil companies and road construction.

Researched, developed and constructed under a CPFF contract with the Corps of Engineers' Map Compilation Branch, first two cameras cost $35,000 each. Later production models should sell for about $9,000.

SNOW, ice and frigid temperatures almost cold enough to freeze gasoline fail to stop U. S. Air Force's new propojet transport, the Lockheed C-130 Hercules while continued developments in . . .

Electronics Will Conquer The Poles

Development of equipment that will function under adverse conditions is important task

PHASE FIVE, one of eight phases of testing conducted by the Air Force, is the all-weather test which exposes aircraft to natural and man-made adverse conditions, such as rain, thunderstorms, fog and especially icing conditions.

▶ **Problem**—Conquering arctic and sub-arctic wastes will depend upon the ability to develop electronic equipment that will nullify the hazards of polar flight. At the present time, this is one of the most important tasks confronting Air Research and Development Command.

Important developments now taking place, several in the classified stages, involve air-borne radio communications that will conquer precipitation static which disables communications when a plane flies through ice and snow.

▶ **Radar**—Reliable all-weather operation is assured the C-130 Hercules by advance navigational radar devices. Search equipment enables the crew to determine the nature of surrounding terrain, detect unfavorable weather conditions and the presence of other aircraft. Latest feature of the radar system used in the Hercules is a pilot's auxillary indicator, developed by Sperry Gyroscope and the U. S. Air Force.

Like that used by the navigator, the pilot's indicator uses a 5-inch cathode-ray tube with excellent definition for viewing targets located up to 240 miles away. The indicator may be held on a relative bearing type of presentation while the navigator's is oriented to magnetic north or some other preselected compass setting.

▶ **Mapping the arctic**—This month, aircraft with electronic gear and cameras are making the most northernly commercial mapping of some 40,000 square miles of Baffinland. Flying Fortress high-altitude aircraft will provide shoran-controlled photography. The aircraft will carry a profile recorder developed by Photographic Survey Co. Ltd. of Toronto.

This survey is a continuation of the Canadian Government's Shoran-controlled survey of Canada's northlands which was begun in 1947 by the Geodetic Survey. All of Canada south of the Arctic coastline has been filled in with a geodetic net of accurate ground positions established by shoran methods. It is necessary to establish several secondary shoran base stations within the net to assure accurate positioning of the photographic exposures.

How Expansions Are Financed

Electronics firms will face greater financing problems in the future

ONE big problem now facing a number of electronics manufacturers is where and how to get additional funds to carry out business expansion plans. Higher borrowing costs are now a reality and company funds are generally lower due to substantial expenditures for the record plant expansions that took place in the industry last year.

A recent survey by the Department of Commerce shows the sources and uses of corporate funds in 1955 by U. S. corporations as a whole. An analysis of the security transactions announced by over 50 firms in the electronics field indicates how electronics manufacturers have handled financing.

▶ **Pocketbook**—In 1955 U. S. corporations used $44.3 billion as follows: $24.2 billion for plant and equipment, $20.1 billion for increases in other assets such as inventories, receivable cash, deposits and other assets. These funds came from the following source. $8.8 billion from retained profits, $14.8 billion from depreciation reserves,

(Continued on page 16)

ACCELERATE PRODUCTION IN GLASS DIODE MANUFACTURING

WITH KAHLE'S FULLY AUTOMATIC DIODE BEADING MACHINES

Now, every diode manufacturer can speed up diode production. Kahle's Automatic Diode Beading Machines deliver 1500 beaded lead wires per hour — often, even higher rates are achieved. No operator is needed — loading and unloading are fully automatic . . . 16 rotating heads index continuously without attention.

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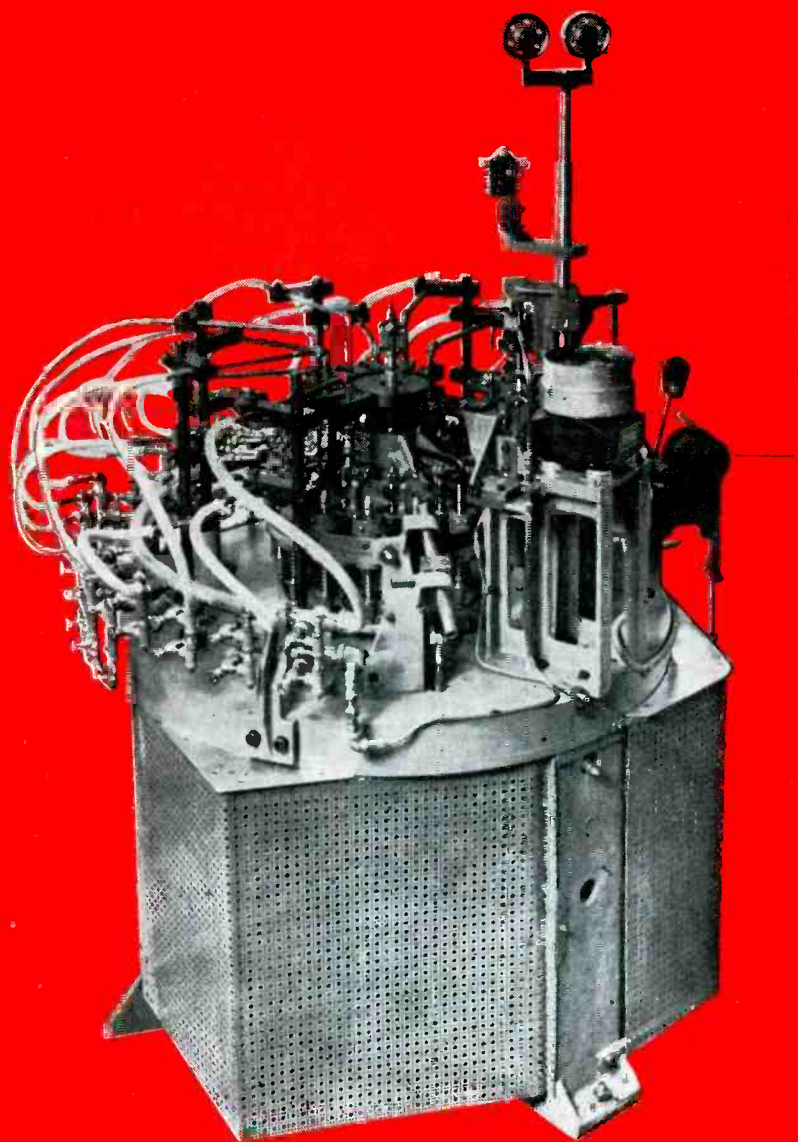
With its 25 years of experience, Kahle can improve your operation and profit-making picture too. Your guarantee of satisfactory service: the thousands of Kahle machines now serving the electronics industry . . . no machine delivered until thoroughly tested, accepted and approved by the purchaser.

The machine illustrated is one of a series for semiconductor production which include:

- Glass Cutting
- Encapsulating
- Crystal Growing (Germanium and Silicon)
- Crystal Slicing and Dicing
- Mounting and Etching
- Cat Whisker Production
- Final Sealing
- Testing



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$7 billion from new issues; $2.5 billion from stocks and $4.5 billion from bonds) and the remainder $13.8 billion from mortgage loans, bank loans and other loans.

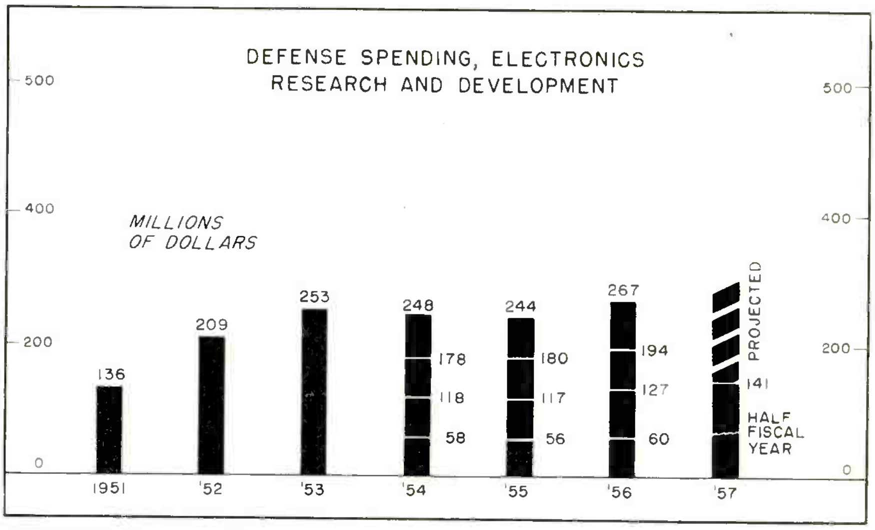
▶ **Comparison**—Analysis of security transactions announced by over 50 firms in the electronics field during the same year, 1955, indicates to some extent how the industry's financing compares to that of U. S. business as a whole.

In electronics, frequent use made of security offering proceeds for additional working capital. This was followed in frequency by use for plant and equipment expansions. This follows, in general, the pattern of U. S. industry as a whole. Among other frequent uses made of security proceeds were paying debts, for general corporate purposes, for acquisitions of other firms, for research and development and for producing new products.

▶ **Sources** — Debenture offerings accounted for the largest amount of capital obtained in offerings announced by electronics manufacturers as was the case for U. S. industry as a whole. This was followed by notes placed with private firms, such as insurance companies. Then came common and preferred stock offerings of which over 2 million shares were marketed.

Japan Enters Electron Microscope Market

Magnification of 500,000 is claimed for electron microscope displayed by Hitachi, Ltd. of Tokyo at the recent U. S. World Trade Show in New York. One of three models shown, it is priced at $26,000



AMOUNT of money the government has spent on electronics research since fiscal 1951. The technical advances coming from research spending prove . . .

Military Research Pays Off

About 90 percent of all military research is of the applied type

At the end of World War II, the huge government-research programs were dissolved, almost overnight. But it wasn't long before the Department of Defense began to spend more money to reactivate these programs and originate new ones.

▶ **Creativity**—The scientist and the engineer who will have the greatest effect on our national defense program will be the creative technologist. Dr. John T. Rettaliata, president of Illinois Institute of Technology, recently made the pertinent statement that "The effective use of the creative man requires an understanding and tolerant attitude which recognizes that ideas can be more important than facts; and imagination, even intuition, more important than logic." He further stressed the need for more fundamental research.

▶ **Grants**—Basic research in the sciences is supplied by college and university grants. During the quarter ending March 31, 1957, a total of over $4.3 million was spent by the National Science Foundation. These research grants were awarded to some 126 institutions of higher learning. Colleges and universities spent approximately $285 million for research and development in 1954, according to figures recently released by the National Science Foundation. Of approximately $206 million reported for separately budgeted research, about 70 percent originated from the Federal Government, and the balance from non-Federal institutions and organizations.

Federal funds were the source of most of the support in the physical sciences. Research Corporation distributed over $1-million dollars in 377 grants to aid basic research in science during 1956. These grants went to 114 colleges and universities both here and abroad. The foundation receives the bulk of its money from its wholly-owned subsidiary, Research-Cottrell, Inc., manufacturers of electrical precipitators and other gas-cleaning equipment in Bound Brook, N. J., and from patents it administers for universities and individual inventors.

▶ **Need**—At the present time, the greatest need for trained scientists is in the fields of rocket technology, telemetering techniques and upper-atmosphere research. Small-rocket upper atmosphere research will investigate important high-altitude

(Continued on page 20)

NEW PNP SILICON TRANSISTORS by RAYTHEON

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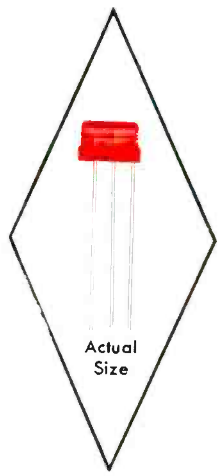
> 2N329 — *new high Beta type*

> 2N330 — *lowest noise factor of any make silicon transistor*



†based on 20,000,000 hours of Raytheon *fusion-alloy* transistor life tests

RAYTHEON NEW HIGH TEMPERATURE SILICON TRANSISTORS

Type	Replaces	Reverse Current at—20V*		Beta	Base Resistance ohms	Collector Resistance kilohms	Noise Factor db(max.)	Collector Capacity μμf	Alpha Freq. Cutoff KC
		Collector μA	Emitter μA						
2N327	CK790	0.005	0.005	14	1200	500	30	35	200
2N328	CK791	0.005	0.005	25	1400	500	30	35	350
2N329		0.005	0.005	50	1500	500	30	35	500
2N330	CK793	0.005	0.005	18	1300	500	15	35	250

*at 25°C

RAYTHEON SILICON TRANSISTOR TESTS INCLUDE:

- *Life* — conducted at 135°C and 50 mW dissipation
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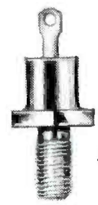
Diffused junction STUD RECTIFIERS

Temperature Range, minus 65°C to plus 165°C

AVERAGE CHARACTERISTICS			
Type	Peak Inverse Volts*	Average Rectified Current** Amps.	Reverse Current (max.) at PIV mAdc at 25°C
CK846	100	1.0†	0.002
CK847	200	1.0†	0.002
CK848	300	1.0†	0.002
CK849	400	1.0†	0.002
CK850	500	1.0†	0.002
CK851	600	1.0†	0.002
1N253	95	1.0‡	0.010
1N254	190	0.4‡	0.010
1N255	380	0.4‡	0.010
1N256	570	0.2‡	0.020

† Rated at 150°C ‡ Rated at 135°C



RAYTHEON

Diffused junction WIRE-IN RECTIFIERS

Temperature Range, minus 65°C to plus 165°C

AVERAGE CHARACTERISTICS				
Type	Peak Inverse Volts*	Average Rectified Current** Amps. 150°C Ambient	100°C Ambient	Reverse Current (max.) at PIV mAdc at 25°C
1N537 (CK840)	100	0.25	0.5	0.002
1N538 (CK841)	200	0.25	0.5	0.002
1N539 (CK842)	300	0.25	0.5	0.002
1N540 (CK843)	400	0.25	0.5	0.002
CK844	500	0.25	0.5	0.002
CK845	600	0.25	0.5	0.002

RAYTHEON

POWER RECTIFIERS

Temperature Range, minus 65°C to plus 165°C

MAXIMUM RATINGS					
		125°C Case Temperature		25°C Case Temperature	
Type	Peak Inverse Volts	Average Rectified Current** Amps.	Peak Current Amps.	Forward Voltage at 5 amps.	Reverse Current (max.) at PIV
CK774	25	5	15	1.5	5
CK775	60	5	15	1.5	5
CK775-1	125	5	15	1.5	5
CK776	200	5	15	1.5	5
CK777	325	5	15	1.5	5

*PIV ratings apply from —65°C to +150°C **Average rectified current into inductive or resistive load

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phenomena, cosmic rays, solar radiation, micrometeors, the aurora and magnetic storms.

▶ **Research Tool**—Rockets are becoming the work-horses for upper atmosphere experiments. One of these, the Terrapin high-altitude sounding rocket weighing 200 pounds, was developed by the University of Maryland in collaboration with Republic Aviation. Similar programs are being conducted at State Universities of Colorado, Iowa, Michigan and Utah.

▶ **Scatter**—Research at Philco Corp. for the U. S. Air Force has culminated in the development of a new microwave system which employs the principles of tropospheric scatter. Operating at super-high frequencies in the 7,125 to 8,500-mc band, it will permit single communication links up to 200 miles in distance.

Resistor Industry Reviews Its Growth

Volume and number of firms have grown substantially. Industry could meet war needs

MANUFACTURERS of resistors for the electronics industry in cooperation with the U. S. government recently reviewed and sized-up their ability to meet estimated defense mobilization requirements in case of war. They found that requirements for most types probably could be met, but cautioned that increased demand for highly reliable components could cut output severely.

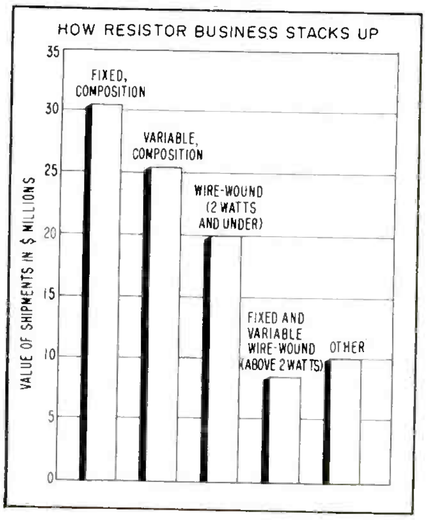
▶ **Growth**—A four-fold increase in dollar volume has been experienced by the resistor industry since 1947. Today, nearly 2 billion resistors are used annually in electronic equipment compared to 500 million ten years ago. Now annual dollar volume exceeds $100 million.

▶ **Makeup**—Today, the fixed composition resistor leads in both unit and doller volume. In 1954, 30.6 million were shipped valued at $1.4 billion. Variable composition types rank next with 25.3-million units valued at $111.7 million.

The remaining volume of the business is made up of wire-wound resistors and other types. Some 56.3 million of the fixed and variable wire-wound types above two watts were shipped in 1954.

▶ **Firms**—There are about 110 manufacturers of resistors in the U. S., a considerable increase over about 20 in the field in 1952, according to RETMA figures. They range in size from small loft operators to companies with multiplant operations. It is estimated that 23

(Continued on page 22)



Military Electronics

▶ **Military** interest in projection television may spawn big market. Army's Redstone Arsenal is already using GPL's PB-611A system. Navy recently made evaluation tests. Probably shipboard application, combat briefings. On land, close observation of rocket test firing and missile launching

▶ **USAF** has ordered 50 Northrop Snarks and an undisclosed number of new Martin PM 61C Matadors. Approximate cost of Matadors $60,000 each. Improvements in Matador C are said to be: greater range and accuracy, improved guidance system, higher resistance to electronic counter measures and greater traffic capabilities and ability to control more than one missile in the air at one time

▶ **Air Force** contract for $42 million supersedes GE's recent $20-million letter contract for radar jamming equipment. Purchase of spare equipment and parts may raise total to $58 million. More than half will be furnished by approximately 400 subcontractors

▶ **Top** four recipients of DOD prime contracts during 18-month period ending June, 1956 are: North American with 5.2 percent ($1.34 billion) of total military prime contracts, General Dynamics also with 5.2 percent ($1.339 billion), United Aircraft with 5 percent, GE with 4.1 percent

▶ **Armament-control** system for Douglas' Navy F4D Skyray fleet interceptor is being supplied by Westinghouse. Called the Aero 13, the system is cylindrically packaged, consists of radar, armanent-control director (computer), and optical system

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A NEW CONCEPT in shock and vibration protection

for missiles and jets

The total dynamic environment against which equipment must be protected in missiles and jets is so violent that protection by conventional unit isolators is impractical. Unit isolators built to meet the demands of this service would be relatively huge, yet there is no room for even admittedly inadequate present-day isolators.

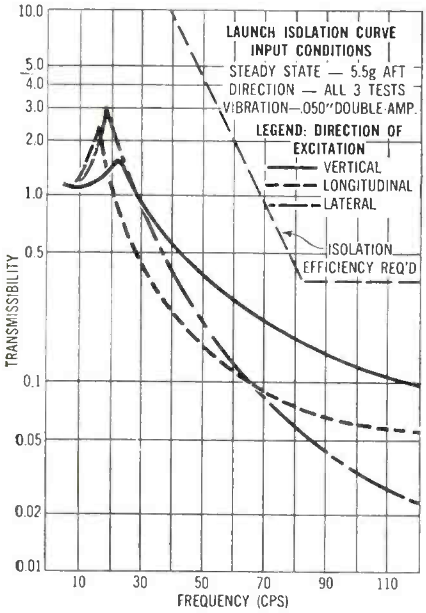


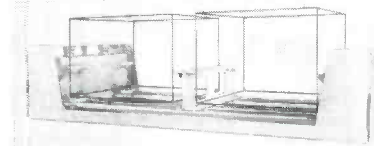
Figure 1. Graph showing specified limits of isolation efficiency during missile launching and the performance of distributed-element mounting system.

The total dynamic environment

Severe shock during launching, high *g* values of sustained acceleration with superimposed vibration, high-amplitude vibrations, and operation through all flight attitudes from horizontal to vertical — these are the elements of the dynamic environment met in currently operational missiles and detailed in the following specifications.

- Effective vibration isolation under steady-state acceleration of 6 g
- Shock transmissibility not over one for 15-g, 11-millisecond half-sine-wave shock, per Procedure I, MIL-E-5272A
- No snubber contact under high-amplitude low-frequency vibration input
- Low transmissibility at resonance
- Effective vibration isolation for all frequencies above 50 cycles per second
- Compliance with these requirements for every mounting position or attitude
- Provision of the required characteristics in an isolation system of minimum size and weight.

Obviously, MIL-spec isolators are inadequate to meet these stringent requirements.



A distributed system

A totally new design concept — a distributed-element isolation system — not only does the necessary job but provides substantial space savings as well. This is how it works. A number of small, single-degree-of-freedom, spring-and-friction-damper elements are so disposed about the mounted units that spring rates are equal for all directions of loading. This makes the isolation characteristics the same for every operating or installation position.

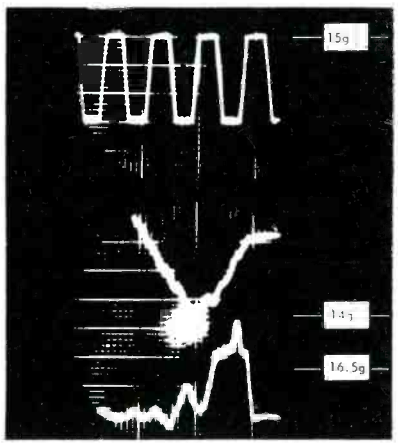


Figure 3. Typical oscillogram for shock test along vertical axis for an integral mounting system carrying two, six-pound electronic units. Upper trace: amplitude calibration at 60 cps. Middle trace: output from mockup of equipment. Lower trace: input to mounting assembly.

Matching the environment

With this new design concept, both the stiffness and the damping of the individual isolation elements can be selected so that the system is matched to the application. Thus it becomes feasible to provide greater shock protection in one plane, to design for different vibration inputs from different directions, or to provide whatever

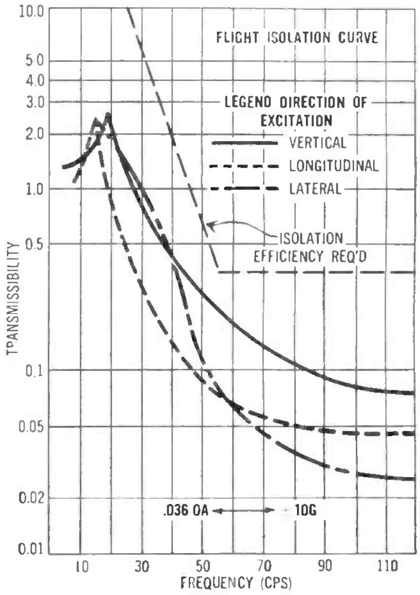


Figure 2. Graph showing in-flight performance characteristics of the distributed-element mounting system.

compensation is needed to suit the total dynamic environment. And because the separate elements can be located wherever space is available, this system minimizes space requirements.

A further advantage of this protection system is the ability to accommodate large vibration amplitudes without snubber contact. This is a result of the non-linear friction damping that can be set to limit the movement of the equipment under resonant conditions. This type of damping also allows efficient isolation of low-amplitude, high-frequency vibration because only slight damping occurs at the higher frequencies.

Additional design data

Detailed information on the specifications that are being met by Barry Integral Bases using the "distributed-element isolation" concept of characteristic selection are available on request. Ask for Report No. 602.

Barry's new Western Division, in Burbank, California, offers fast, on-the-spot design and prototype service, and production of special systems.

BARRY CONTROLS INCORPORATED

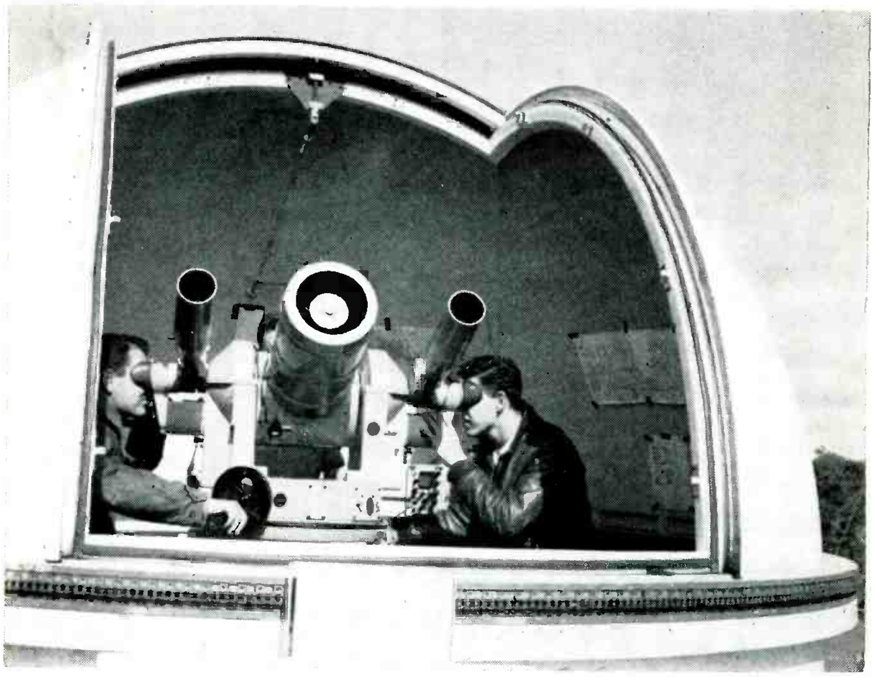
BARRY MOUNT

SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

707 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

resistor makers do the lion's share of the business.

One large maker expects its sales to be about 7.5 percent greater in 1956 than in 1955. The firm anticipates a sales increase of about 14 percent for 1957, assuming that the present business climate continues.



TEST plane under control of guidance system is tagged by complex electronic system installed in domes mounted on steel towers when synchronized . . . .

Tracker Evaluates Missile Worth

Systems can be tested at a fraction of the cost of launching a missile

BEFORE guidance systems are approved for installation in missiles they are tested in jet aircraft by Rome Air Development Center's tracking range, ACTOR (Askania Cine-Theodolite Optical-tracking Range).

Precise position of any airborne test vehicle is recorded at microsecond intervals for periods up to $1\frac{1}{2}$ hours. End result of the missile-test system is 35-mm film, but 90 percent of the $1,330,000 installation is electronic.

▶ **Operation**—Cine-theodolites are mounted on four 25-foot steel towers arranged to form a trapezoid. Distances between towers vary from 7.3 to 19.7 nautical miles. Two, three or all four synchronized cine-theodolites track and film a supersonic jet aircraft equipped with the guidance system under test.

Following a rigidly prescribed flight plan, the target flies back and forth over the test range. Visibility and camera range determine the radius of the range. Good conditions may permit 50 miles.

Elevation and azimuth of target are continuously recorded on film by two to four tower cameras. Exact time each frame is exposed is recorded on its lower edge by a 10-digit binary code. With precise azimuth and elevation from at least two known points a fix is computed.

▶ **Other uses** — Demands on the tracking system since it became operational six months ago have steadily increased. Besides testing guidance systems, information is valuable for testing automatic ground control approach systems, taxi radar, flare-out radar, RAPCON (radar approach control center) evaluation of both height-finding and ground control interception.

▶ **Electronics** — Reeves' precision tracking and computing radar system, located at master site is used as range control center and for initial acquisition of the target for the optical tracking instruments.

Raytheon's weather-tracking-radar system predicts weather and plots clouds that intercept radio path of electromagnetic system under evaluation.

A C-131 aircraft collects atmospheric data both before flight and after. Meterological parameters are detected and recorded by a Kollsman Aerograph. Electromagnetic propagation field is detected by a field intensity measuring set. Complete telemetering system detects and records all the aircraft's altitudes and flight characteristics. A University of Texas refractometer measures and records refraction index.

An f-m link transmits synchronization pulses from the master station to all three slave stations. Shutter return pulses are also transmitted back to the master station from all slave stations where they are recorded on a 4-channel hot stylus recorder.

An uhf voice link is used for technical administration of range. Data reduction is accomplished by an Underwood Elecom 120 digital computer and a Reeves Reac analog computer.

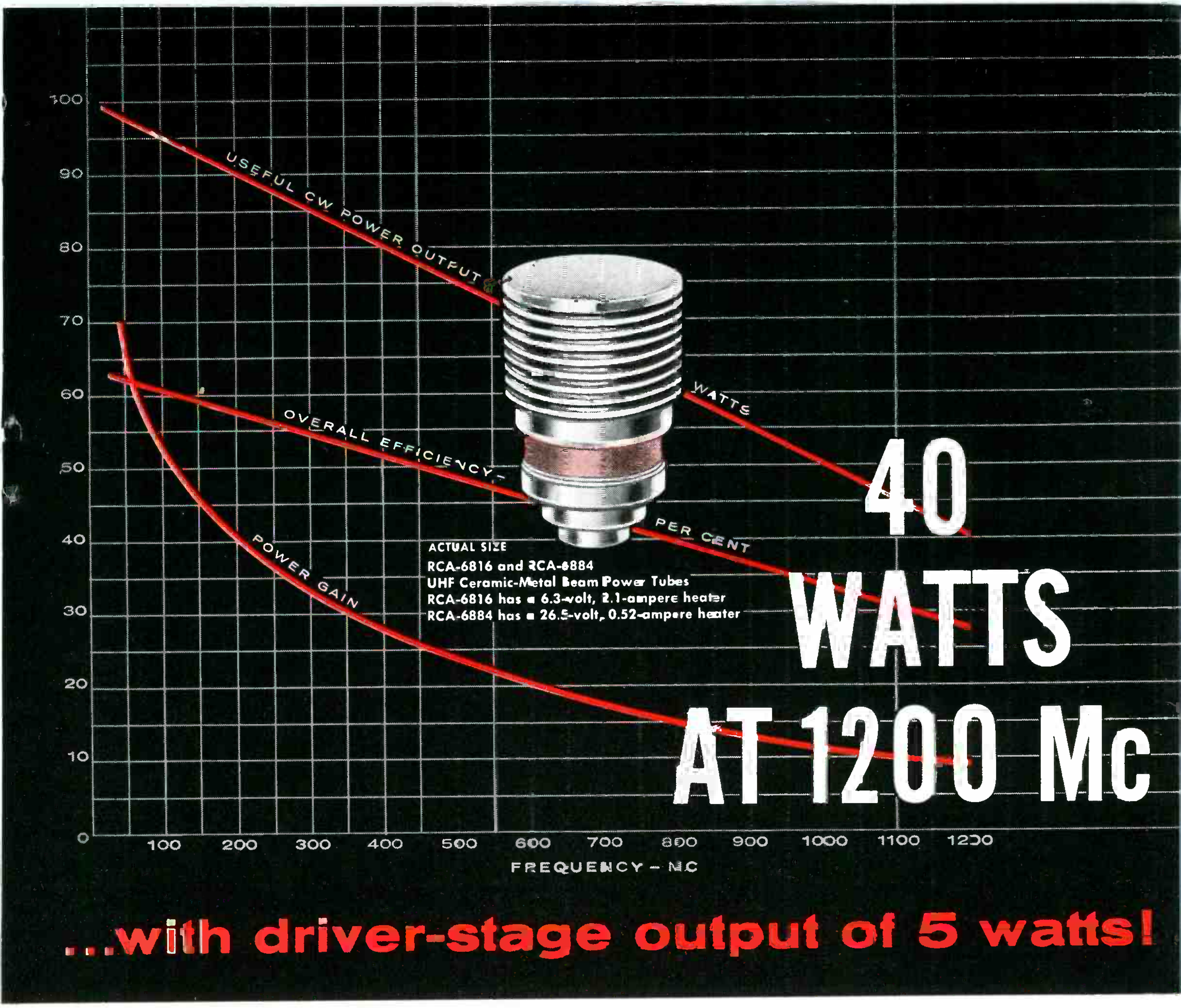
Ballistic Air Gun Launches Targets

Electronic device measures velocities of target disks shot at missile or rocket

LABORATORY testing at the crucial instant of target penetration by missiles can now be done using a reverse technique. A ballastic air gun developed by Magnavox, launches the target toward the test specimen instead of vice versa.

▶ **How it works.** Muzzle velocity (200 fps to 1,250 fps) of the target disk (diameter: 3 in.; weight: 8

(Continued on page 24)



For extremely compact and efficient UHF transmitter designs... RCA-6816 and RCA-6884, small-size, light-weight Ceramic-Metal beam power tubes have high power sensitivity and high efficiency at relatively low plate voltage.

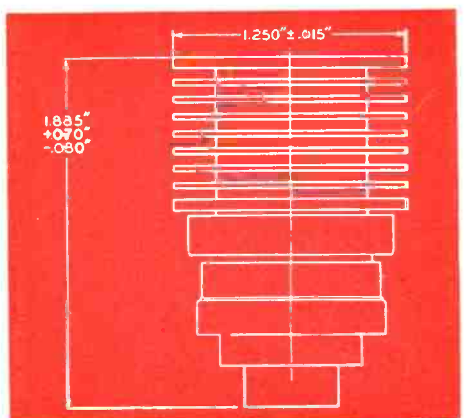
These tubes feature low-inductance rf electrode terminals—*insulated from each other by low-loss, high-strength ceramic bushings*—are particularly well-suited for UHF oscillator, frequency multiplier, and power amplifier applications.

Technical bulletin on the RCA-6816 and RCA-6884 is available from RCA Commercial Engineering, Section F19Q-1, Harrison, N. J. For sales information contact the RCA Field Representative nearest you.

East: HUmboldt 5-3900
744 Broad Street
Newark 2, N. J.

Midwest: WHitehall 4-2900
Suite 1181
Merchandise Mart Plaza
Chicago 54, Illinois

West: RAymond 3-8361
6355 East Washington Blvd.
Los Angeles 22, Calif.



TYPICAL CCS OPERATION OF RCA-6816 AND -6884
RF Power Amplifier, Oscillator—Class C Telegraphy
and
RF Power Amplifier—Class C FM Telephony

	at 400 Mc		at 1200 Mc
DC Plate Voltage	400	900	900 volts
DC Grid-No. 2 Voltage	200	300	300 volts
DC Grid-No. 1 Voltage	-35	-30	-22 volts
DC Plate Current	150	170	170 ma.
DC Grid-No. 2 Current	5	1	1 ma.
DC Grid-No. 1 Current	3	10	4 ma.
Driver Power Output (approx.)	3	3	5 watts
Useful Power Output (approx.)	23	80	40 watts

RADIO CORPORATION OF AMERICA
Tube Division Harrison, N. J.

oz.) is determined by timing the flight of the disk between timing wires. These wires are connected through associated circuits to an electronic counter. As a target disk is propelled from the muzzle of the gun, the timing wires are broken in quick succession.

As each wire is broken, the related circuits are interrupted and cause successive pulses to be relayed to a counter. The counter displays the elapsed time between the pulses and thereby indicates the time of the target's flight across the fixed distance between the wires. A simple calculation then gives the muzzle velocity of the target disk.

▶ **Savings**—Advantages of laboratory testing with the air gun over field testing: a test can be set up and completed in four minutes; test conditions are constant; rockets are not fired and expended, scattering valuable parts and data over a wide area; cost is negligible compared to field testing.

Data such as function time, output voltage, and switch closure time are transmitted to recording equipment instantaneously. Tests can be rerun at once if additional data are required.

By using target disks of various configurations, obliquities from 0 to 45 degrees can be simulated without changing the position of the device being tested.

Mine Detector Sweeps

Horizontal sweeping of path ahead is provided by Army's latest mine detector. It stops jeep automatically when it discovers a buried mine

FCC Actions

▶ **Proposes** to scrap tv allocation table except within areas 250 miles from Mexican and Canadian borders. Asks that written pro and con arguments be submitted by June 3

▶ **Will** use findings from its study of 25-890 mc part of radio spectrum to define its position at the International Radio Conference in 1959

▶ **Authorizes** tv stations to experiment with new test pattern techniques which allow test pattern to be telecast simultaneously with television shows without degrading quality of picture reception. Authorization ends April 3, 1958

▶ **Will** distribute Conelrad printed material such as manuals and amendments to stations at time of application for, renewal of, or modification of licenses

▶ **Requires** operators of industrial heating equipment to install their gear according to manufacturers' instructions. Regular inspection is also required

▶ **Suggests** that manufacturers or research firms first check with Commission on permissible frequencies before developing new gear. States that expensive mistakes have happened in past because this was not done

Scientists Review Solid State

New materials and devices revealed at MRI-IRE symposium point to bright future

RECENT discovery of the solid-state MASER principle may make the doubling of radar sensitivity possible in the near future. This and many other applications of solid-state devices such as gyrators, memories, switching devices and amplifiers were discussed by leading scientists and engineers at a symposium arranged by the Microwave Research Institute at Brooklyn in conjunction with the IRE, and co-sponsored by the scientific branches of the military.

▶ **Materials**—Each circuit application imposes new requirements for materials and many times it has been found that the chemical synthesis of an improved compound can do more to revolutionize performance than years of painstaking circuit work. One such material, discussed by T. S. Moss of the Royal Aircraft Establishment, England, is indium antimonide. This semiconductor may be used in magnetic, hall-effect and optical and photoelectric applications.

▶ **Magnetics** — Indium antimonide can be used as a variable resistor with no sliding contacts merely by varying its insertion in a magnetic field or by controlling the magnetic field. This occurs because its resistance changes with application of a magnetic field, about 25 to 1 for a strength of 10,000 gauss. The latter may be particularly useful in servo systems.

(Continued on page 26)

NOW...200, 300, 400 & 500 AMPERE

DC POWER SUPPLIES

with wide continuously adjustable 24 TO 32 VOLT RANGE

by PERKIN!

APPLICATIONS:

- Centralized Laboratory or Plant DC Power.
- Missile Check-Out and Launching
- Aircraft Engine "Soft" Starting and Testing.
- Battery Charging & Standby Service

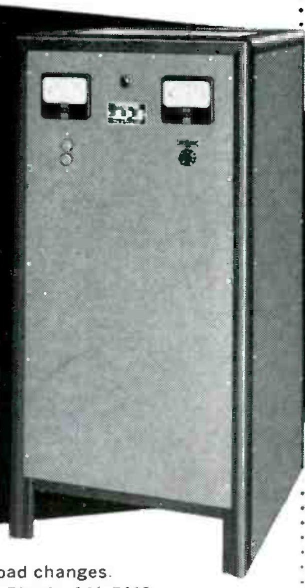
...and other heavy duty 28 volt DC Power applications.

immediate delivery!

OUTSTANDING FEATURES:

Automatic Magnetic Amplifier Regulation to ±½%...No Tubes, Moving Parts or Vibrating Contacts...Remote Voltage Sensing to Provide Regulation at Remote Loads...Wide 24 to 32 Volt Output Range to Compensate for Voltage Drop in Output Cable...Fast Response (0.1 to 0.2 seconds) With No Hunting or Drift...AC Line Voltage Stabilization...No Disturbing Radio Interference...Higher Efficiency, Maintenance-Free and No Warm-Up Time as Compared to M-G Sets...MIL-Type Workmanship & Conservative Design.

There are over 15,000 Perkin units in operation in industry today.



ADDITIONAL SPECIFICATIONS:

Regulation: ±½% for any combination of line and load changes.
AC Input: 208, 230 or 460V, ±10%, 3 phase, 60 cps. **Ripple:** 1% RMS.
All units available with dollies for mobility.

AVAILABLE MODELS:

MR2432-200A, 200 amps • MR2432-300A, 300 amps • MR2432-400A, 400 amps
MR2432-500A, 500 amps

When you require a power supply, SPECIFY PERKIN, for a wider range of standard models and immediate delivery from stock.

Wire factory collect for prices. For a prompt reply on your application, write factory on your letterhead.

PERKIN

PERKIN ENGINEERING CORPORATION
345 KANSAS STREET, EL SEGUNDO, CALIFORNIA • OREGON 8-7215
Leader in Tubeless Magnetic Amplifier Regulation

Immediate Delivery on standard models available from factory and:
New York area office: Sales and Warehousing: 1060 Broad St., Newark 2, N.J., MArket 3-1454
Chicago area: Loren F. Green & Associates, 5218 W. Diversey Ave., Chicago 39, Ill., PAlisade 5-6824

OTHER PERKIN STANDARD DC POWER SUPPLIES

28 Volt Models

Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
28-5VFM	0-32 V	5	15-20% (24-32V range)	115 V 1 phase	2%
28-10WX	24-32 V	10	±½%	100-125 V 1 phase	1%
MR532-15A	2-36V	15	±½%	105-125V 1 phase	1%
28-15VFM	0-32 V	15	15-20% (24-32V range)	115 V 1 phase	5%
M60V	0-32V	25	±1%	115V 1 phase	1%
MR1040-30A	5-40V	30	±1%	100-130V 1 phase	1%
28-30WXM	24-32V	30	±½%	100-125V 1 phase	1%
28-50WX	24-32 V ±10%	50	±½%	230 V* 3 phase	1%
MR2432-100XA	24-32V	100	±½%	208/230V* 3 phase	1%
MR2432-200	24-32 V	200	±½%	208/230V* 3 phase	1%
MR2432-300	24-32 V	300	±½%	208/230V* 3 phase	1%
MR2432-500	24-32 V	500	±½%	208/230V* 3 phase	1%

* ±10%. Also available in 460 V ±10% AC input. Will be supplied with 230 V input unless otherwise specified.

6, 12, 115 Volt Models

	Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
6 Volt	6-5WX	6 ±10%	5	±1%	95-130 V 1 phase	1%
6 Volt	6-15WX	6 ±10%	15	±1%	95-130 V 1 phase	1%
6 Volt	6-40WX	6 ±10%	40	±1%	95-130 V 1 phase	1%
12 Volt	12-15WX	12 ±10%	15	±1%	95-130 V 1 phase	1%
115 Volt	115-5WX	115 ±10%	5	±½%	95-130 V 1 phase	1%
115 Volt	MR15125-5	15-125	5	±1%†	95-130 V 1 phase	1%††
115 Volt	G125-25**	115-125	25	±1½-4%	230/460 V 3 phase	5%

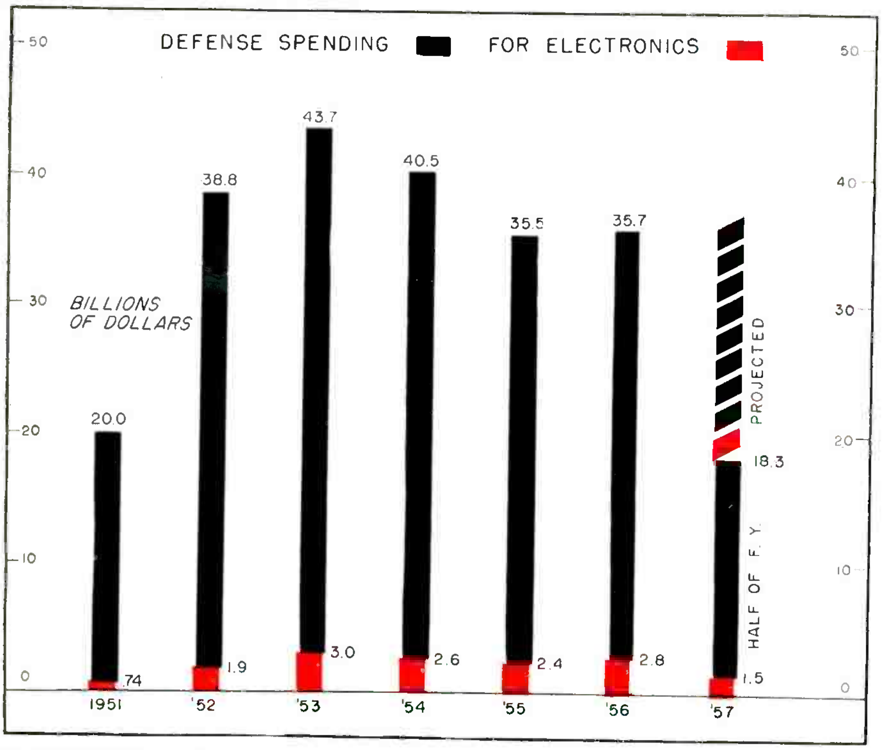
**Germanium Rectifier Unit ††Increases to 4% @ 15V.
†Increases to 2% @ 15V.

PERKIN POWER SUPPLIES

Want more information? Use post card on last page.

This material may also be used to make a magnetically-operated relay, a displacement gage, a microphone and a barrier-layer rectifier. Other applications of the hall-effect properties of InSb include flux meters, compasses, magnetometers, modulators and a-c power meters.

▶ **Photoconductors**—A bank of switches operating by photoconductive means was described by A. Bramley and J. E. Rosenthal of A. B. DuMont Laboratories. The bank consists of a glass plate on which a conducting material is deposited as one electrode leaving a matrix of nonconducting circular areas. Holes are drilled in the center of each area and a piece of wire is attached. Photoconductive material such as cadmium sulphide is then applied between each wire and the common conducting coat to complete the switch. Light emanating from a spot on the face of a crt causes the photoconductor to change to a low value of resistance thus tripping the switch. It is possible at present to obtain 100 such switches per square inch and eventually this figure may reach 10,000.



ELECTRONICS portion of total defense expenditures for each fiscal year since 1951 is shown in red. Breakdown shows . . .

Electronics-For-Defense Rises

MILITARY dollars spent for electronics in fiscal 1951 represented 3.7 percent of the total defense expenditures during that year. Breakdown for the first quarter of the current fiscal year shows that the total amount expended for electronics represented 7.6 percent of the total military spending for that quarter and 9 percent during the second quarter of fiscal 1957. In adding to already released figures for the first half of fiscal 1957, these RETMA computations indicate that current defense-electronics spending equals, and exceeds in many areas, the Korean level of defense-electronics expenditures.

▶ **Cumulative**—More than $15 billion has been spent by the Department of Defense for military electronics during the years 1950 through 1956. Using a newly-devised formula developed by its marketing data department, The Radio-Electronics-Television Manufacturers Association (RETMA) extracted military expenditures for electronics from such major defense procurement categories as aircraft, ships, combat vehicles, guided missiles, electronics and communications, and research and development.

Utility Market Takes On More Computers

Although only a handful of companies have large equipments, the field's potential is large

NEARLY all of the nation's utilities make use of some type of electronic accounting and billing device but as of today, relatively few are operating big units. Commonwealth Edison has an IBM 702 and Consolidated Edison and Detroit Edison each have a 705. About ten other utilities have 650's or Univacs installed. Between 5 and 10 more utilities are expected to have large-scale computers installed by the end of this year.

▶ **Rate**—Most of the 13 large electronic computers in use today were installed in 1956 and all have been installed within the past two years. Many utilities utilize electronic punch card equipment but the bulk have yet to install large computers.

▶ **Market**—The utility market for computers is still relatively untouched. There are nearly 300 utilities supplying electricity alone. Although only the larger companies will be ultimate users of electronic computers for accounting and billing, the increasing growth of individual utilities bids to make the majority prospective users of the devices.

According to Edison Electric Institute, investment in privately financed electric utilities alone is expected to gain an average of more than $4 billion a year over the next decade. It is estimated that 6.7-million kilowatts of generating capacity will be installed in the U.S. during 1957 and that

(Continued on page 28)

TAYLOR
Laminated Plastics
Vulcanized Fibre

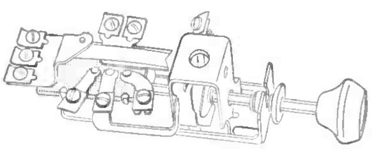
Shop Talk

TAYLOR FIBRE CO.

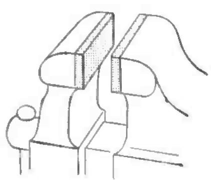
Plants in Norristown, Pa. and La Verne, Calif.

PHENOLIC—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • COPPER-CLAD LAMINATES • VULCANIZED FIBRE

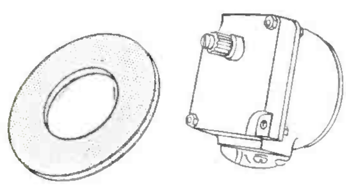
Tips for designers



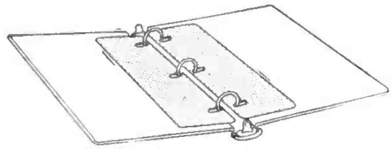
Back plate on an automobile headlight switch, punched and machined from Taylor Grade XP paper base laminate, has low moisture absorption and good dielectric strength.



Vise jaw caps, made of Taylor Grade C phenolic laminate, are easily cut and machined to shape. Marring of precision or delicate parts is eliminated.



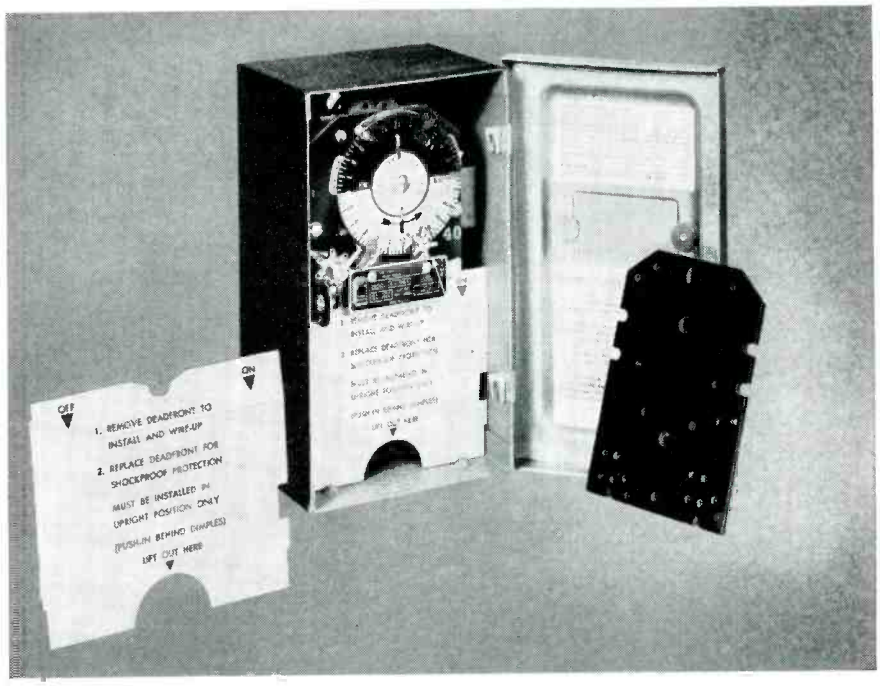
Self-balancing servo motor has stator case insulator which is cold-punched from 1/64" thick Taylor Paper Base Phenolic Laminate sheet.



Flippers for loose-leaf binders are made of economical Taylor Vulcanized Fibre . . . affording added rigidity and good protection for the paper pages.

TAYLOR SUPERIOR COPPER-CLAD LAMINATES

Taylor GEC (glass epoxy) Copper-Clad and Taylor XXXP-242 cold punching (paper-phenolic) Copper-Clad. Taylor uses high purity rolled copper on base materials with outstanding electrical properties.



Time switch, made by the Tork Clock Co., uses two Taylor products . . . the deadfront is made of vulcanized fibre for its insulating properties, shock protection and printability . . . the mounting panel of the clock is made of Taylor laminate XP-1-231, chosen for high strength and good punchability.

Have an Insulation Problem?

Taylor will provide the answer . . .

Select from Taylor's complete line of materials—laminates and vulcanized fibre—to get the right combination of electrical, physical and machining properties for your product. And, if you have a unique problem, Taylor will develop a special material to meet your requirements.

For example, rigid requirements for insulation materials in the Tork Clock Company's Time Switch were met by two Taylor materials—a laminate and vulcanized fibre. The mounting panel is made of Taylor laminate XP-1-231, especially formulated for the high strength and good punchability requirements of this application. In addition, Taylor vulcanized fibre serves as the deadfront—a shockproof cover removed only for installation and service. Fibre was chosen for its insulating properties, shock protection, and printability.

Taylor materials are developed to meet the need for dependable, moisture-resistant insulation. They have high dielectric and mechanical strength, and maintain original characteristics over long periods of time, under severe operating conditions. When you choose—and use—Taylor products, you'll have performance with stability.

Taylor application engineers can help you obtain the Taylor material that matches the exact requirements of your product. Contact your nearest Taylor sales office.

Want more information? Use post card on last page.

by 1961 there will be 29.5-million kilowatts of station capacity on order.

Figures Of The Month Changes

RECENT revision of the Standard and Poor Stock Price Index shifts the base period from 1935-39 to 1941-43 and affects this entry on ELECTRONICS Figures of the Month page, *Stock Price Averages*.

Stocks in the radio, tv and electronics and the broadcasters samples are substantially the same as before the change. The current aggregate market value of stocks in these groups is now compared with the average value during the new base years.

A further revision, giving a value of 10 rather than 100 to the base period, results in an index level that closely approaches the average price level of New York Stock Exchange listings. The new index is considered to be a more accurate and flexible gage of the market.

Financial Roundup

MOST of the fourteen electronics companies which reported first-quarter earnings in the last month showed increases for 1957 over 1956. Ten companies had larger first quarter earnings in 1957 than in 1956. In four cases earnings were less.

Three companies reported highest first quarter earnings in their history: Texas Instruments, Victoreen Instruments and Webcor:

Company	1st Quarter Net Profits 1957	1956
Aerovox	$201,000	$3,600
Century Electric	324,976	183,336
Crucible Steel	3,372,606	3,680,906
Eaton Manufacturing	3,055,232	3,760,770
General Dynamics	8,793,767	4,322,699
IBM	18,745,607	14,988,325
Kay Lab	90,499	15,481
Servomechanisms	141,255	137,569
Stewart-Warner	1,861,212	1,718,528
Texas Instruments	790,000**	540,000
Underwood	624,978*	146,406
Victoreen Instruments	106,000	297,537*
Webcor	354,914	65,596
Zenith	1,650,590**	1,831,165

* Loss, ** Estimated

Meetings Ahead

June 6-7: First National Symposium On Production Techniques, IRE, Willard Hotel, Washington, D. C.

June 10-11: Second RETMA Symposium On Applied Reliability, Mature Design/Reliable Design, Hotel Syracuse, Syracuse, N. Y.

June 17-19: First National Meeting Of PGMIL of IRE, Sheraton Park Hotel, Washington, D. C.

June 19-21: Twelfth Annual Meeting, Association For Computing Machinery, University Of Houston, Houston, Texas.

June 27-29: Thirteenth annual meeting, Institute Of Navigation, Sheraton-Park, Hotel, Washington, D. C.

June 27-July 1: British IRE Convention, "Electronics In Automation", University of Cambridge, England.

Aug. 20-24: 1957 WESCON, IRE, WCEMA, Cow Palace, San Francisco, Calif.

Aug. 22-Sept. 5: International Scientific Radio Union, Twelfth General Assembly, Boulder, Colo.

Sept. 4-6: Special Tech. Conference On Magnetic Amplifiers, Penn Sheraton Hotel, IRE, AIEE, Pittsburgh, Pa.

Sept. 9-13: Instrument-Automation Conference, Cleveland, Ohio.

Sept. 25-26: Conference On Industrial Electronics, IRE, AIEE, Chicago, Ill.

Oct. 7-9: National Electronics Conference, IRE, AIEE, RETMA, SMPTE, Hotel Sherman, Chicago.

Oct. 9-11: Fourth Annual Symposium on High Vacuum Technology, Committee On Vacuum Techniques, Hotel Somerset, Boston, Mass.

Oct. 16-18: IRE Canadian convention, Automotive Building, Exhibition Park, Toronto, Canada.

Oct. 31-Nov. 1: Professional Group on Nuclear Science, fourth annual meeting, Henry Hudson Hotel, New York, N. Y.

Oct. 31-Nov. 1: 1957 Electron Devices Meeting, PGED, Shoreham Hotel, Washington, D. C.

Nov. 2-10: 1957 International Congress of Measuring Instrumentation and Automation, Interkama, Dusseldorf, Germany.

Nov. 4-6: Third Annual Symposium on Aeronautical Communications, PGCS, Hotel Utica, Utica, N. Y.

Nov. 18-20: Conference on Magnetism and Magnetic Materials, AIEE, APS, IRE, ONR, Sheraton-Park Hotel, Washington, D. C.

Industry Shorts

▶ **Cyprus** will have regular television transmissions starting in July 1958. Preliminary plans for a television installation near Sofia, Bulgaria were recently approved.

▶ **Television** service is available now to more than 90 percent of Wales. Recent opening of a tv and vhf station by BBC brings the tv range to 72,000 people living along the Cardigan Bay coast.

▶ **Nearly** 60 cents of every 1956 sales dollar was paid last year to some 31,500 other businesses located in 3,200 U.S. cities and towns by Western Electric.

▶ **Three** Canadian companies have been appointed as subcontractors for engineering services on the electronic weapons system for the RCAF jet AVRO CF-105 being jointly developed by Minneapolis Honeywell and RCA. They are Computing Devices of Canada, RCA Victor Ltd and Honeywell Controls, Ltd.

HIGH Output (1.0 v. RMS into 70 ohms)
WIDE Range (2-220 Megacycles. All At Fundamental)
and
CONSTANT OUTPUT
(Fast Acting AGC)

NEW
KAY
Vari-Sweep

ALL-ELECTRONIC HIGH LEVEL SWEEPING OSCILLATOR OR, (with sweep off) CONTINUOUSLY TUNED CW SIGNAL SOURCE

- **Operates On Fundamental Frequency, Therefore Stable Narrow-Band Sweeps**
- **1.0 v. RMS (into 70 ohms) Output Flat to ±0.5 db Over Widest Sweep**
- **Output Automatically Held Constant (AGC) Over Complete Range**
- **Variable Sweep Width (to 30 mc. PLUS) — Variable Center Frequency**
- **Direct Reading Frequency Dial Accurate To ±2.0%**
- **Sweep Repetition Rates Down to 10 cps**

Price: **$695.** FOB Plant

SPECIFICATIONS

Range: Fundamental frequency 2 to 220 mc., continuously variable in 10 switched overlapping bands. Direct reading frequency dial calibrated to ±2.0%.

RF Output: 1.0 v. RMS into 70 ohms, metered. Flat within ±0.5 db over widest sweep and frequency band.

Sweep Width: Continuously variable to ± 30% of center frequency to maximum of at least 30mc.

Sweep Rate: Continuously variable 10 to 40 cps.; also locks at line frequency.

Attenuator: Switched 20, 20, 10, 6, and 3 db plus continuously variable 6 db.

Power Supply: Electronically regulated 105 to 125 v. A. C. 50 - 60 cycles

NEW KAY *Marka-Sweep* MODEL VIDEO 50

Combined Video and IF Sweeping Oscillator with Marks

SPECIFICATIONS

Frequency Range: Continuously variable, 50 kc to 50 mc.

Sweep Width: Linear, continuously variable, 4.0 mc to 50 mc.

Sweep Rate: Variable around 60 cps; locks to line frequency.

Amplitude: 1.0 v, peak-to-peak, into nom. 70 ohms. Flat within ±0.5 db over widest sweep.

Attenuators: Switched 20, 20, 10, 6 and 3 db, plus continuously variable 3 db.

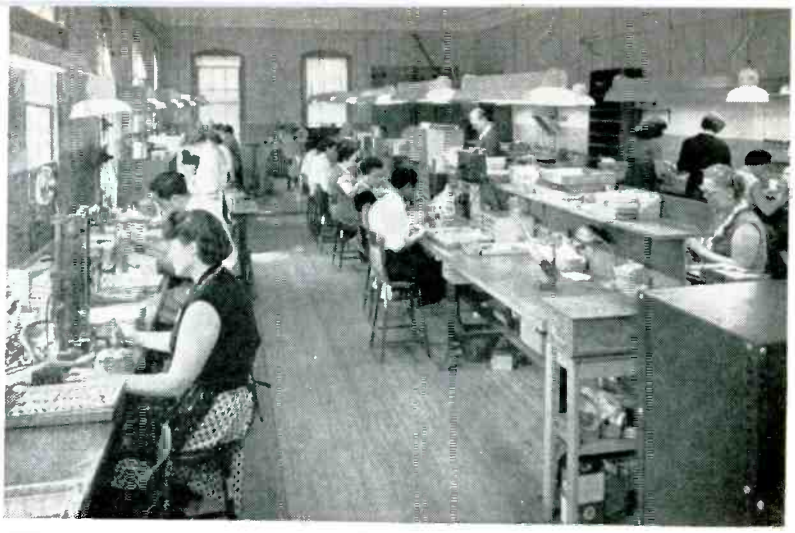
Markers: Eight sharp, pulse-type, crystal-positioned, internal and external markers.

Price: $695.00 F.O.B. Factory. Substitute markers, $10.00. Additional markers, $20.00 each.

KAY ELECTRIC COMPANY
14 MAPLE AVENUE PINE BROOK, N. J. CAldwell 6-4000 Dept. - E6

Want more information? Use post card on last page.

Ample Production Capacity— In this corner of the Assembly Department, spot-welding operations are performed on relay and thermostat sub-assemblies.



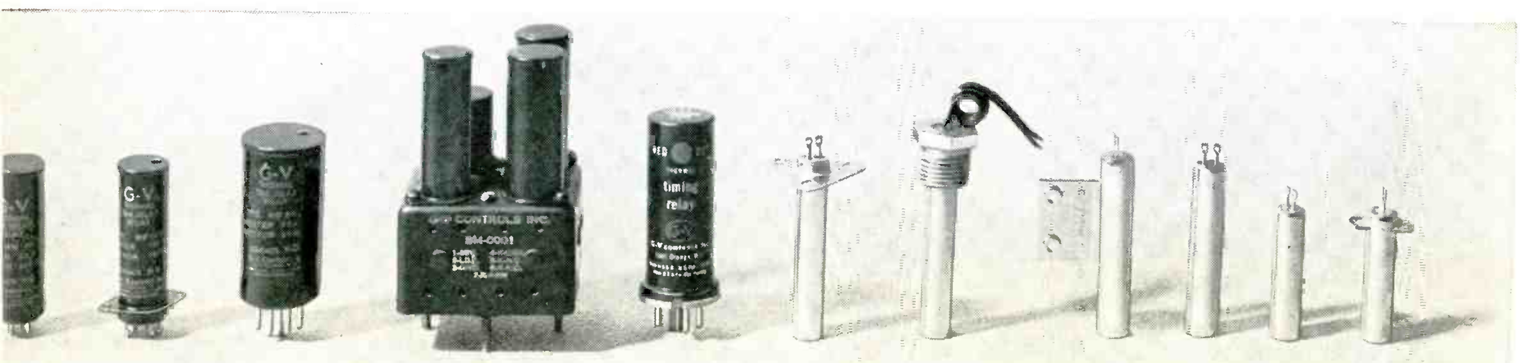
Thermal Relays are encased and hermetically sealed in this section of the Assembly Department.

How Does G-V's Leadership

Today G-V Controls is recognized as the leader in the design, development, and manufacture of thoroughly reliable thermal relays. What does this mean to you? First, you can be sure that G-V thermal relays will operate reliably time after time after time. The many hundreds of customers who are ordering and reordering G-V thermal relays provide the most valid testimony to the uniformly high quality and reliability of the G-V line. Second, you can count on getting G-V relays when you need them. Third, G-V's leadership has enabled the company to develop a line of thermal relays which embraces the widest scope of applications. Whatever your requirements, they will probably be covered by existing relays, and G-V has new ones coming along constantly.

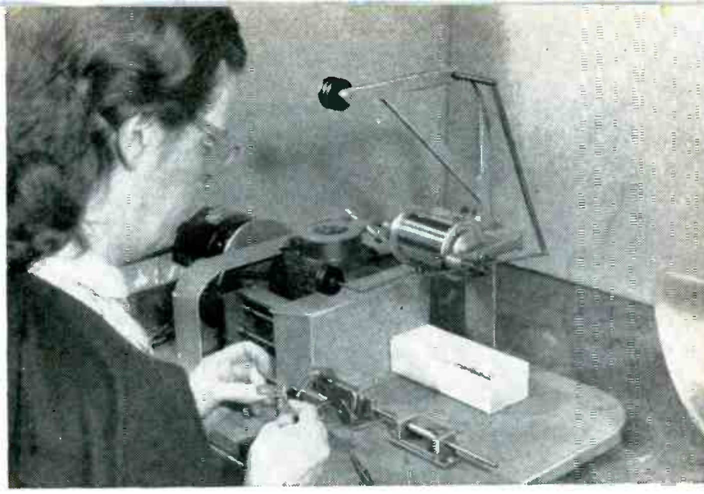
Dependable Deliveries— G-V Controls' production volume today is ten times what it was three years ago. Throughout this period, forward looking expansion plans have always kept facilities ahead of customers' needs. Efficient production control methods assure dependable deliveries. The production control board, pictured here, is used to monitor every order from the time it arrives through each step of manufacture to final shipment. G-V is known throughout the industry for its exceptional delivery record.

The G-V LINE— includes over 1000 variations of Thermal Time Delay Relays, Voltage and Current Sensing Relays, Hermetically Sealed Electrical Thermostats, and Relay Assemblies.



No. 2 of a series

Production and Quality Control



Skilled Personnel—There is no substitute for the skill and experience of the people who produce G-V Relays and Thermostats. The G-V Controls organization is a group who know their work is important, and who do it well. This is one of the prime factors responsible for the consistently high quality of G-V products.

In Thermal Relays Help You?

Quality Control ranks high in the G-V organization. Uniformly high reliability of product is maintained through the most complete and modern inspection methods. Effective statistical quality control is used. Roving Inspectors constantly check all processes on an hourly sampling basis. Each part and material has its detailed specification. All instruments and gauges are checked on regular schedule against primary standards. Every relay receives its final test on automatic equipment. Complete type tests at regular intervals are made in G-V's Environmental Laboratory on the newest types of testing equipment. These factors, together with the care and skill of the experienced people who build G-V products, have made G-V Controls a trusted supplier to the country's major electronic and aircraft manufacturers.

Key spots open for engineers interested in going places with a young progressive organization.

G-V®

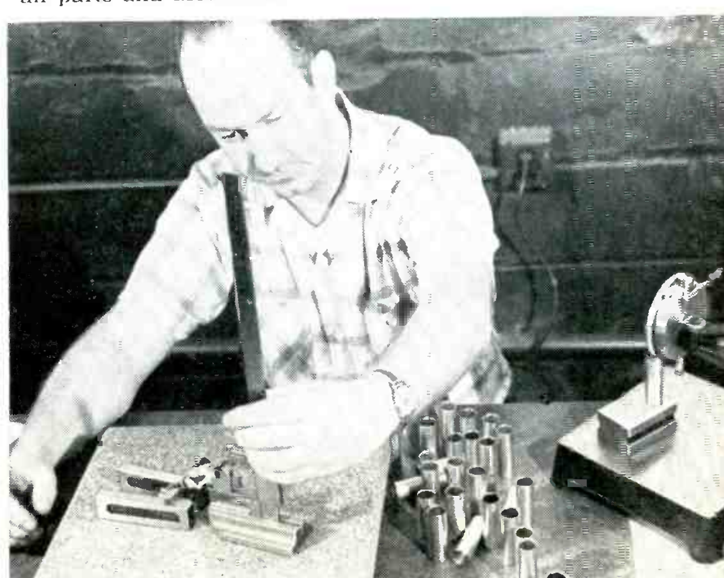
Complete catalog data is available.

G-V CONTROLS INC.

24 Hollywood Plaza, East Orange, N. J.

Quality Control—All G-V Relays are given 100% automatic time tests on this equipment developed and built by G-V Controls.

Incoming inspection and hourly in-process checks on precision gauging equipment assure dimensional accuracy of all parts and assemblies.



TEFLON GLASS FIBER LACING

Ben-Har Braided TAPES

New Ben-Har Braided lacing and winding tapes combine two superior insulation materials . . . duPont Teflon and glass fibers. Teflon, with its high heat resistance of 500°F. has been coated directly on the glass fibers before braiding so as to preserve a rough texture for knottability while eliminating the abrasive action of the glass.

Developed particularly for harnessing, lacing and winding applications where heat is a determining factor, Ben-Har offers these additional features:

- non-shrinking — will not cut through insulated wires.
- pliable through −100°F. to 500°F.
- wax-free — fungus proof.
- inert to most known chemicals and oils.
- non-absorbent.
- knots hold tight, won't slip.

Ben-Har Braided Tapes are available in .048, .062, .090 and .22 inch widths; in natural color (offwhite); in 250 and 500 yard spools and a Universal wound ¼ pound tube. Brown, white, yellow, orange, red, green, blue, violet and black can be had on special order. Write for prices and samples.

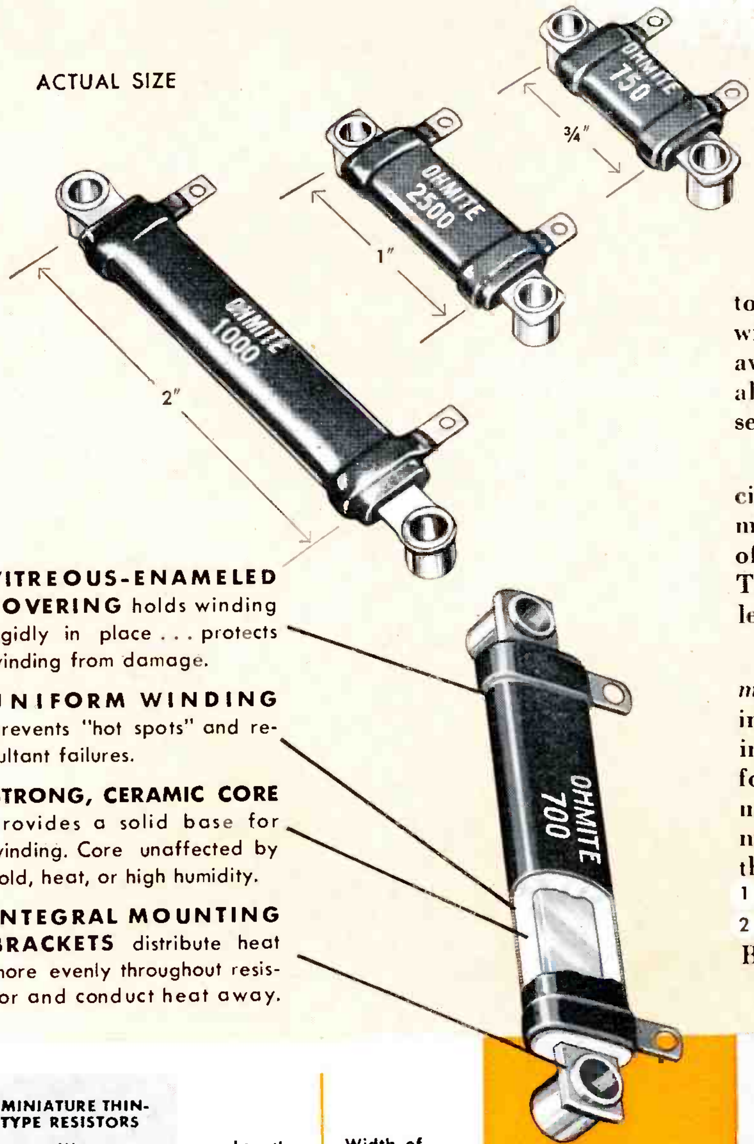
BENTLEY, HARRIS MANUFACTURING COMPANY
1306 Barclay St.
CONSHOHOCKEN, PA. • TELEPHONE: TAylor 8-0634

BENTLEY, HARRIS *Fiberglas** **INSULATIONS**

*"Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

...pack higher wattage into less space with NEW

MINIATURE OHMITE® THIN-TYPE power resistors



VITREOUS-ENAMELED COVERING holds winding rigidly in place . . . protects winding from damage.

UNIFORM WINDING prevents "hot spots" and resultant failures.

STRONG, CERAMIC CORE provides a solid base for winding. Core unaffected by cold, heat, or high humidity.

INTEGRAL MOUNTING BRACKETS distribute heat more evenly throughout resistor and conduct heat away.

The new Ohmite *miniature* thin-type power resistors are now available in three wattage sizes in a wide range of resistance values; two wattage sizes are available from stock; also three wattage sizes available from stock in the standard thin-type resistor . . . see (*) table below.

Designed especially for use in modern electronic circuitry where space is at a premium, these new miniature units have all the timeproven superiority of standard Ohmite vitreous-enameled resistors. They are only ⅛" thick and ⅜" wide, and range in length from ¾" to 2".

Because of their compact design, the new Ohmite *miniature* thin-type resistors pack higher wattage into less space. The stacking bracket allows mounting close to the surface and a hollow stud provides for convenient stacking of two or more units. The miniature thin-type rises only 11/32" above the mounting surface; stack mounted, four units are less than 1⅛" in height. Shown in photograph are: 1 Standard Thin-Type Resistors with Unit Brackets; 2 Standard Thin-Type Resistor with Stacking Brackets; 3 Miniature Thin-Type Resistors.

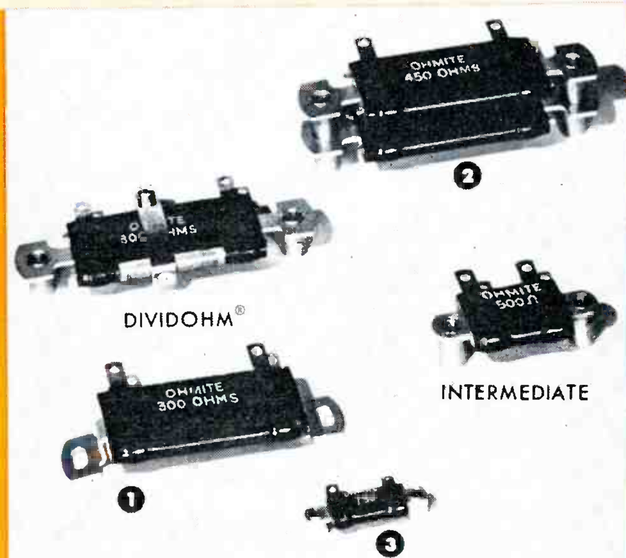
Write on company letterhead for Bulletin 138-B.

	Watt Rating	Length of Core	Width of Core
MINIATURE THIN-TYPE RESISTORS			
	* 10	¾"	⅜"
	15	1"	⅜"
	* 20	2"	⅜"
INTERMEDIATE THIN-TYPE RESISTORS			
	20	1"	13/16"
	30	1½"	13/16"
STANDARD THIN-TYPE RESISTORS			
	* 30	1¼"	1"
	* 40	2"	1"
	* 55	3½"	1"
	65	4¾"	1"
	75	6"	1"

***Now available from stock . . .**

2 miniature sizes: 10 and 20 watts

3 standard sizes: 30, 40, and 55 watts



WATTAGE RATINGS ARE BASED ON THE RESISTOR MOUNTED ON A HORIZONTAL STEEL PANEL .040" THICK BY 10" SQUARE. RATINGS SHOULD BE REDUCED APPROXIMATELY 15% FOR NONMETALLIC MOUNTING SURFACE.

BE RIGHT WITH OHMITE®

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES • TANTALUM CAPACITORS

OHMITE MANUFACTURING COMPANY • 3610 Howard Street, Skokie, Illinois

Ohmite maintains the world's largest stock of power-type resistance products—high-quality rheostats, wire-wound resistors, and tap switches in a factory stock of several million in a complete range of sizes, values, and types.

When you need these resistance components in a hurry, Ohmite can make fast delivery in reasonable quantities to meet your immediate requirements.

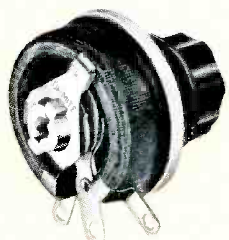
Furthermore, by tailoring your specifications to these stock items, you can always get speedy delivery that will help you keep experimental and pilot production operations on a smooth-running schedule.

To assist engineers and purchasing agents in making their selection from this huge stock, Ohmite *Stock Catalog No. 28* contains complete, up-to-date information on all Ohmite stock items. Resistance values, ratings, specifications, and other helpful information are included.

WORLD'S LARGEST STOCK

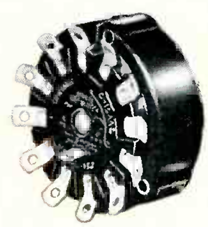
WIRE-WOUND RESISTORS

Fixed and "Dividohm" adjustable wire-wound types, 5 to 200 watts. Also composition type.



RHEOSTATS

Ten stock sizes—25 to 1000 watts. All-ceramic and metal.



TAP SWITCHES

Rotary type. Five sizes from 10 to 100 amps, with from 2—12 taps.

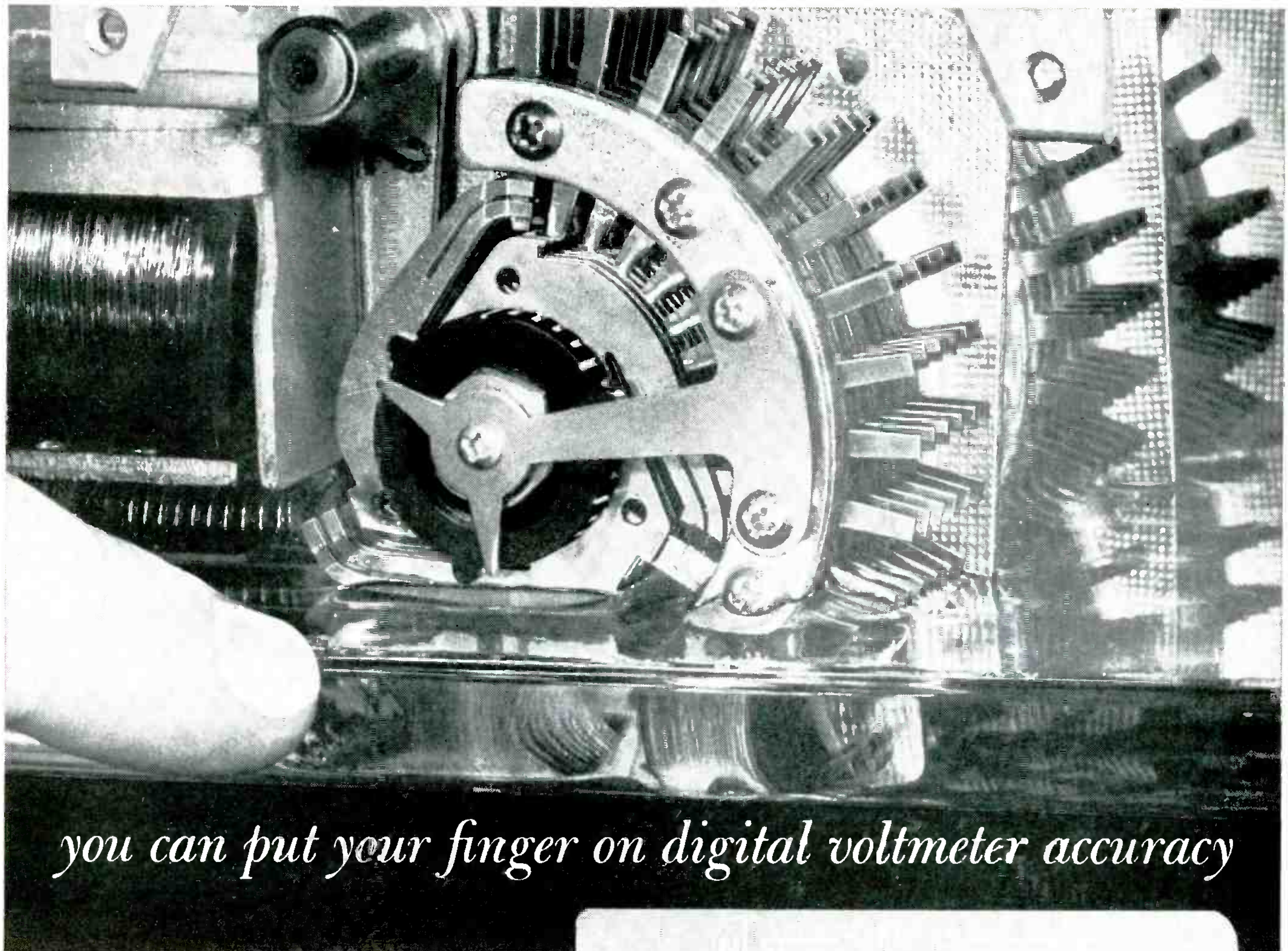
WRITE FOR STOCK CATALOG

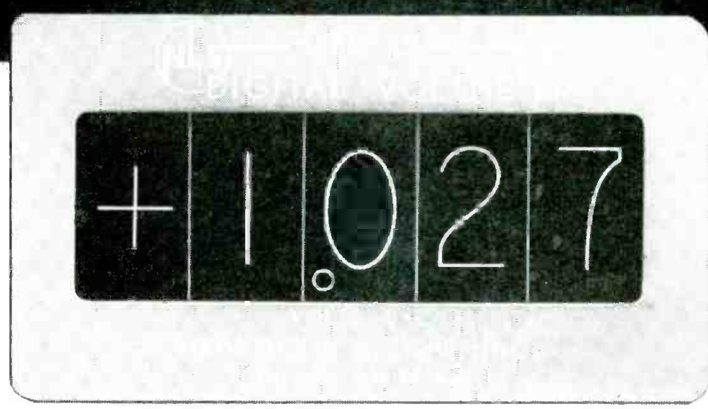
BE RIGHT WITH

OHMITE®

RHEOSTATS RESISTORS RELAYS
TAP SWITCHES TANTALUM CAPACITORS

OHMITE MANUFACTURING COMPANY
3610 Howard Street, Skokie, Illinois





ONLY NLS GIVES YOU THE RELIABILITY OF OIL BATH SWITCHING

The BIG difference that *can't* be explained away is the exclusive NLS oil immersing principle in digital instrument stepping switch lubrication! Sealed in a bath of specially refined oil, these electrical contacts as well as their driving mechanisms never need periodic disassembly for lubrication; constant accuracy, trouble-free operation and longer life are the results. NLS originated the automatic digital voltmeter and now manufactures a wide line of related electrical measurement instruments. Inch-high illuminated numerals provide high speed readings easily understood even by unskilled personnel. Automatic data recording equipment is available for all voltage or resistance measurement units. The NLS line of digital instruments covers the full range of engineering and scientific applications in this field. We will meet your most exacting requirements for electrical measurement instrumentation. Please write our home office at Del Mar, California, for name of representative nearest you; or mail coupon for information.

NLS AT CONVAIR, SAN DIEGO

Approximately 100 NLS digital instruments are currently conserving precious engineering time at Convair, San Diego. They are used in conjunction with analog computors and automatic test equipment for testing electronics and electrical parts in the receiving department and for inspection of completed electronic assemblies in production. They are also used as master meters for meter and other equipment calibration in the general laboratory.

MODEL 451
General Purpose Voltmeter—For display or recording of ±0.001 to ±999.9 volts DC.

Originators of the Digital Voltmeter

non-linear systems, inc.

Del Mar, San Diego County, Calif.
Phone: SKyline 5-1134

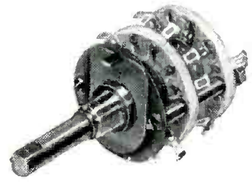
Digital Ohmmeters • AC-DC Converters • Data Reduction Systems • Digital Readouts • Peak Reader Systems • Binary Decimal Converters • Digital Recording Systems

101

NON-LINEAR SYSTEMS, INC.
Dept. D-657, Del Mar Airport, Del Mar, Calif.
Please send technical information on:
☐ AC or DC voltmeters ☐ ohmmeters
☐ analog-to-digital converters ☐ automatic testing systems

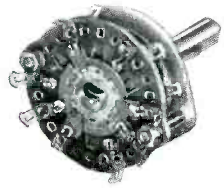
NAME ____________________
COMPANY ____________________
ADDRESS ____________________
CITY __________ ZONE ____ STATE ________

Want more information? Use post card on last page.



Type F: Miniature 12-position, 30-60° throw, can be mounted in 1-5/16" circle; phenolic, Mycalex or steatite.

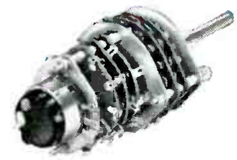
Type H: Standard 12-position; 1-7/8" diameter; 15-30-60° throw; phenolic, Mycalex or steatite.



Types J, K, N: 1-17/32" diameter; provides for flexibility of layout; interchangeable sections, phenolic or steatite.

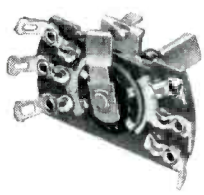
Type L or DL: Using dual eyelet fastening; 18-position; mounts in 2-9/32" circle, phenolic, Mycalex.

Special Switches

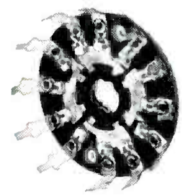


Multiple Shafts combined to operate snap switches and potentiometers; many different section types.

Type MF: 24-position switch may be mounted in 2-5/16" circle; in phenolic insulation.



Series 20: Simple switch for tone controls, band switching, and talk-listen circuits.



For Printed Circuits: Special lug design for insertion into printed circuit boards.

an INFINITE VARIETY from standard parts

SWITCHES
CHOPPERS
ROTARY SOLENOIDS*
SPECIAL ASSEMBLIES
VIBRATORS

● No matter what you need in low-current switches, you are most sure to find it in an OAK switch design. In the last 25 years, OAK has produced over a quarter billion switches—rotary, slider, pushbutton, plug, and door switches—in thousands of variations. Why not take advantage of OAK's unmatched, switch engineering background . . . production facilities . . . and huge inventory of tooling?

WRITE FOR **your copy of the OAK Switch Catalog which covers the most popular of OAK's standard switches.**

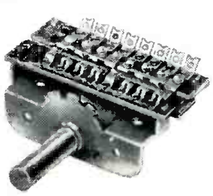
OAK

MFG. CO.

Dept. G 1260 Clybourn Ave., Chicago 10, Ill.
Telephone: MOhawk 4-2222

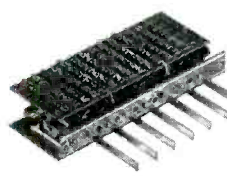
**Manufactured under License from G. H. Leland, Inc.*

Type 160 Rotary Slider: 7/8" height allows shallow chassis; leads are readily accessible.

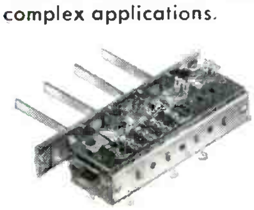


Type 185: New lever-operated version of the standard Oak rotary switches.

Type 130 Pushbutton: Available with from one to 24 buttons, 32 contacts each button.



Type 80 Pushbutton: Very adaptable. Used in communication equipment; economical for less complex applications.



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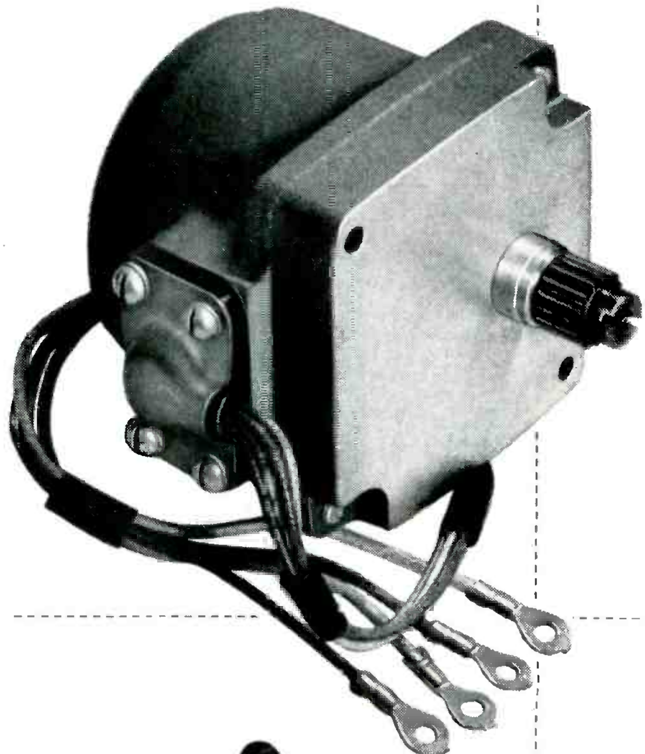
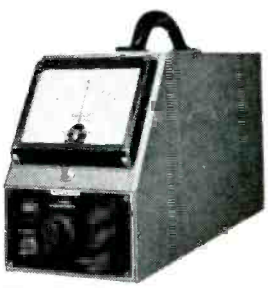


For positive positioning

use Brown 2-phase motors

in your servomechanisms



ElectroniK Null Indicator
Modern successor to the spotlight galvanometer. Immune to vibration . . . self-protected from overloads. Needs no leveling, no special mounting. Ideal for lab or factory. Sensitivity 0.001 microamp or 1 microvolt per mm. Price $175.00 f.o.b. Philadelphia.

Brown Servo Amplifiers
For instrument and computer servo loops. Convert low-level d-c input signal to ac, and amplify it to power level to drive a Brown servo motor. Extremely low stray pickup, high stability, excellent sensitivity, fast response. Four models with gains of 1, 4, 12 or 40 x 10^6. Choice of 4 input impedances from 400 to 50,000 ohms. Prices from $98.50.

NEED up to 85 inch-ounces of torque, at low speeds—for remote positioning in servos, computers, null circuits?

Brown 2-phase reversible motors are ideal for these applications. They're the same design that has given years of continuous service in thousands of Brown *ElectroniK* instruments throughout industry. And continuing refinements make them better than ever.

Long-life needle bearings reduce friction and maintenance. Improved gear trains deliver a smooth flow of power. Better seal, better lubrication, simpler and more attractive housing . . . all add to greater value in the latest models of Brown servo motors.

Shaft speeds of 27, 54, 162, 333 or 1620 rpm are available. Many variations in design of pinion, shaft, leads and materials can be supplied for special applications.

Power input is 115 volts, 60 cycles . . . 25-cycle model also available. Line field takes 11 watts; amplifier field 2.5 watts. Motor load impedance averages 12,000 ohms.

Check the table below for the models you need. Order single units for development work, or thousands for production runs. Prices from $42.00 (even more favorable depending on quantity).

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

No-load speed—rpm	27	54	162	333	1620
Rated torque—in. oz.	30	15	5	4	5
Max torque—in. oz.	85	43	19	11	9
rpm for max power	15	31	92	190	900

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

having your ups and downs?

. . . if they involve WIRE WOUND RESISTORS

DALOHM has the answer

You can depend on DALOHM ®

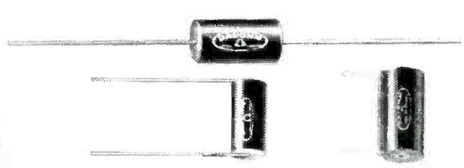
All Dalohm products are carefully designed and skillfully made to assure you of supreme quality and dependability, plus the widest versatility of application. Here are outstanding examples of the Dalohm line:

WIRE WOUND ENCAPSULATED PRECISION RESISTORS

Surpass MIL-R-93R

Completely impervious to penetrating effects of salt ions, humidity, moisture and corrosive gases and vapors, Dalohm's new encapsulating material has very high di-electric strength. Its coefficient of expansion matches that of the resistor wire itself, eliminating the possibility of distorted wiring and shorted turns. All are non-inductive, pi-wound.

NEW SUB-MINIATURE SIZES



- Resistance range 10 ohm to 1 megohm
- Tolerances 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%
- Powered at 0.1 watt to 0.8 watt
- Temperature coefficient 0.00002/Deg. C
- Maximum operating temperature 125° C.

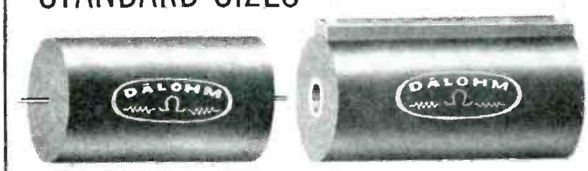
SIZES

	Length	Dia.
WWA 13	⅜"	⅛"
WWA and WWP 22	¼"	¼"
WWL and WWR 23	⅜"	¼"
WWA, WWL, WWR, WWP 24	½"	¼"
WWA 26	¾"	¼"
WWA, WWL, WWR, WWP 34	½"	⅜"
WWA, WWL, WWR, WWP 36	¾"	⅜"
WWA, WWL, WWR, WWP 38	1"	⅜"

TERMINALS

WWL—lugs;
WWA—axial leads;
WWR—radial leads;
WWP—parallel leads.

STANDARD SIZES



WWA WWL

- Resistance range 0.1 ohm to 5 megohms
- Tolerances 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%
- Powered at 0.5 watt to 2 watts
- Temperature coefficient 0.00002/Deg. C
- Maximum operating temperature 125° C.

SIZES

	Length	Dia.
WWA and WWL 44	½"	½"
WWA and WWL 45	⅝"	½"
WWA and WWL 48	1"	½"
WWA and WWL 4-12	1½"	½"
WWA and WWL 4-16	2"	½"

TERMINALS

WWA—axial leads; WWL—lugs.

Also available in MIL Types RB-09, RB-15, RB-16, RB-17, RB-18, RB-19

JUST ASK US:

You are invited to write for the complete catalog of Dalohm precision resistors, potentiometers and collet-fitting knobs. If none of our standard line fills your need, our staff of able engineers and skilled craftsmen equipped with the most modern equipment, is ready to help solve your problem in the realm of development, engineering, design and production. Just outline your specific situation.

DALE PRODUCTS, INC.
1300 28th Avenue
Columbus, Nebr., U.S.A.
EXPORT DEPT: Pan-Mar Corp.
1270 Broadway
New York 1, N.Y.

Want more information? Use post card on last page.

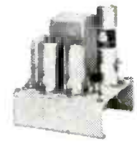
FREQUENCY STANDARDS

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*

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

*3⅛" high
400 - 1000 cy.



FREQUENCY STANDARD
TYPE 50L

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

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

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*

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

*3½" high
400 to 500 cy.
optional

FREQUENCY STANDARD
TYPE 2005

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

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

FREQUENCY STANDARD
TYPE 2007T
TRANSISTORIZED

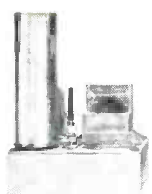
Size 1½" dia. x 4½" H. Wght. 7 ozs.*

Frequencies: 240 to 1000 cycles
Accuracies:—Same as 2003, above
Type 2007S—Silicon type
Input, 28V.
Output, Multitap, 75 to 100,000 ohms

*3½" in 2007S, 400 to 800 cycles.

FREQUENCY STANDARD
TYPE 2121A

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

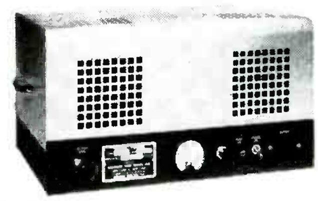


FREQUENCY STANDARD
TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.

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

FREQUENCY STANDARD
TYPE 2111C



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

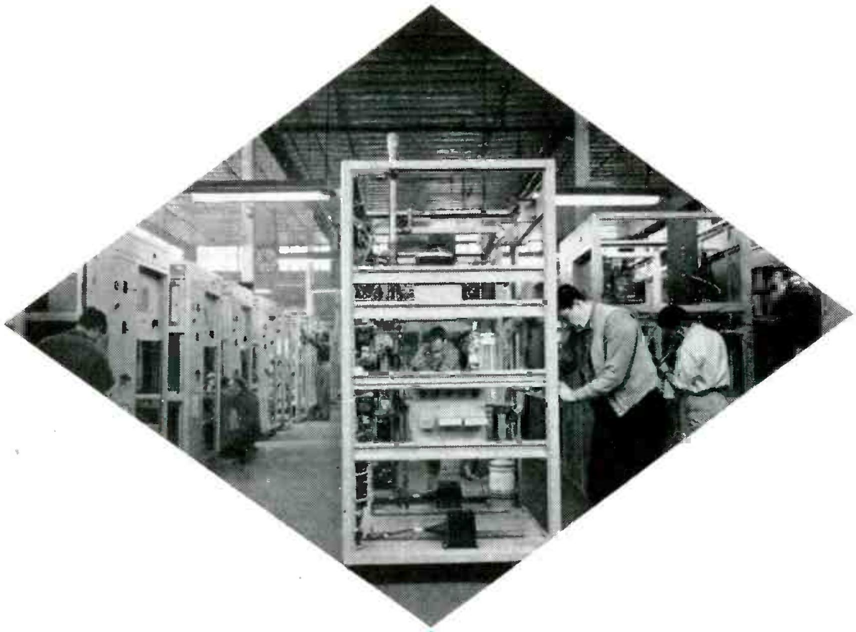
ACCESSORY UNITS
for TYPE 2001-2

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

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

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.
580 FIFTH AVENUE, NEW YORK 36, N. Y.



Across this floor

Within the short space of forty months, this portion of REL's production facilities has manufactured more kilowatt miles of tropo scatter radio equipment than that of all other companies combined.

During this same period, REL has also designed and produced more than 75,000 circuit miles of special radio gear for the telephone toll services, in addition to many other types of apparatus.

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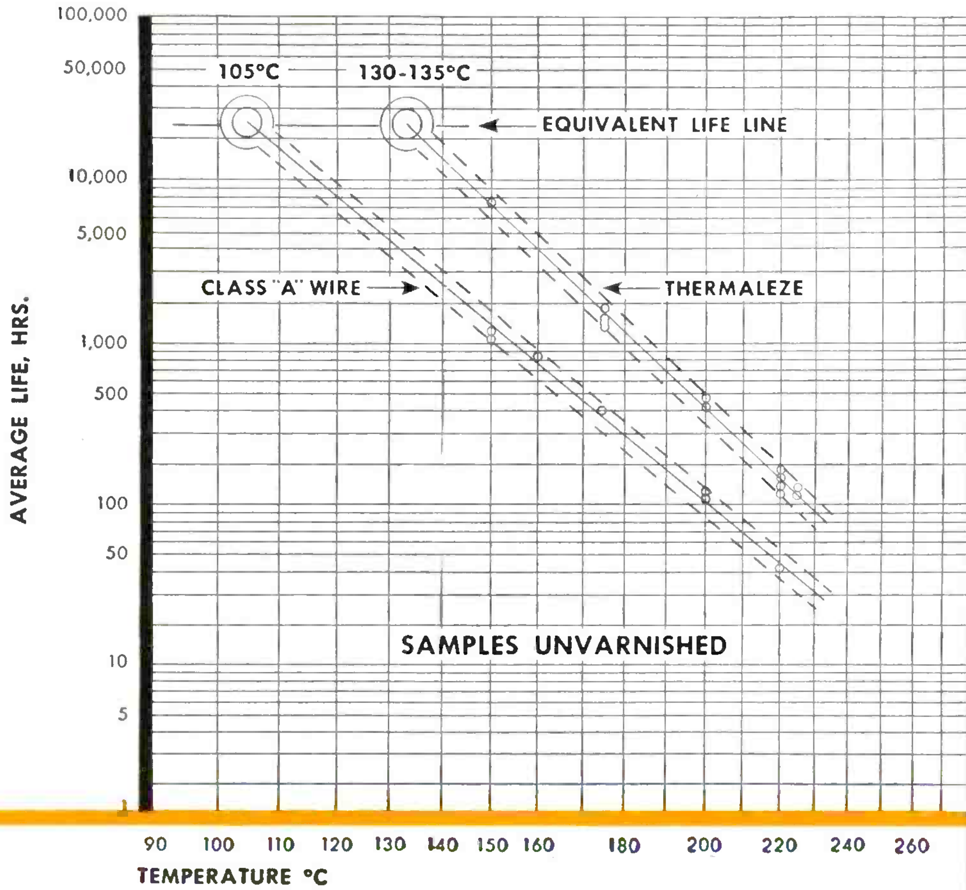
AGED DIELECTRIC TWISTS

Thermaleze vs. Conventional Class "A" Wire
AIEE Procedure



NEMA twist samples aged in oven at various temperatures following AIEE aging procedures

PHELPS DODGE COPPER PRODUCTS
CORPORATION

INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA

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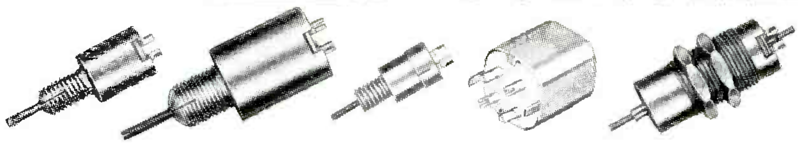
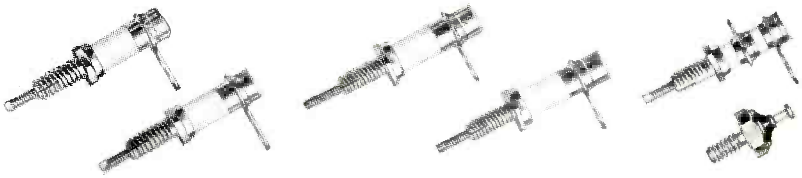


CTC QUALITY CAPACITORS

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

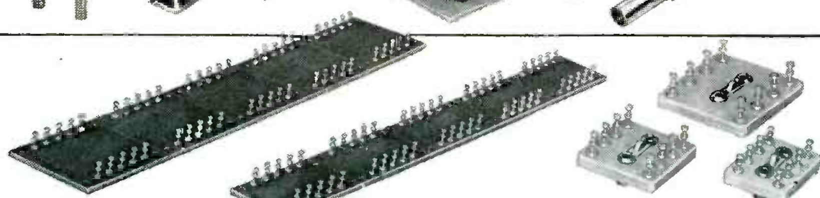


CTC QUALITY DIODE CLIPS

Seven different types, including spring-loaded units primarily for holding fragile diode pigtail leads from .005″ to .085″ in diameter. CTC also offers lines of quality battery clips and miniature plugs and jacks.

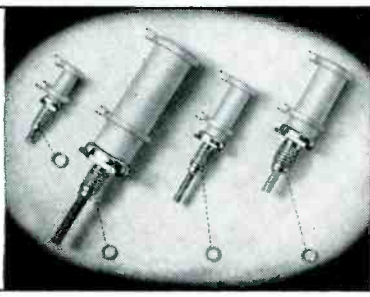
CTC QUALITY TERMINAL BOARDS

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



CTC QUALITY PERMA-TORQ COIL FORMS

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



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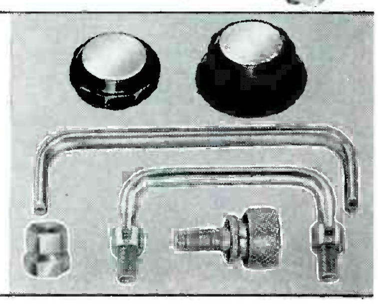
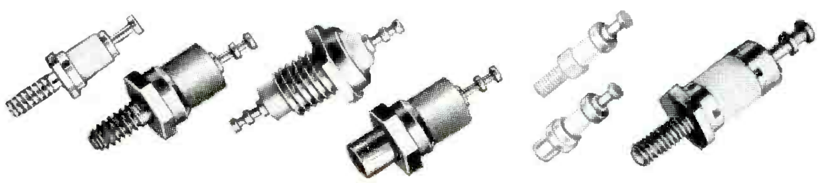
Selected materials, carefully processed and finished. Metal parts polished before plating. Hard-wearing surfaces, lasting lusters.



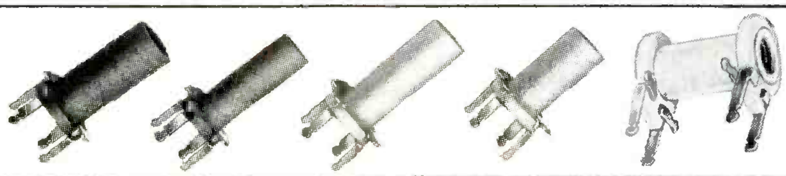
CTC QUALITY INSULATED TERMINALS

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



CTC QUALITY PRINTED CIRCUIT COIL FORMS

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



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-hp- 400H

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complete coverage 10 cps to 700 MC

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In each you find recognized *-hp-* accuracy, dependability, operating ease and rugged, quality construction. Each features high input impedance to prevent disturbance to circuits under test, plus high stability, good overload protection, clean, straightforward physical arrangement, new lightweight cabinetry.

In short, with every *-hp-* voltmeter you receive outstanding value and convenience, at moderate price.

For complete details, call your *-hp- representative* or *write direct*.

Instrument	Primary Uses	Frequency Range	Voltage Range	Input Impedance	Price
-hp- 400AB	General purpose ac measurements	10 cps to 600 KC	0.3 mv to 300 v 11 ranges	10 megohms 15 $\mu\mu f$ shunt	$200.00
-hp- 400D	Wide range ac measurements High sensitivity	10 cps to 4 MC	0.1 mv to 300 v 12 ranges	10 megohms 15 $\mu\mu f$ shunt	225.00
-hp- 400H	Extreme accuracy measurements	10 cps to 4 MC	0.1 mv to 300 v 12 ranges	10 megohms 15 $\mu\mu f$ shunt	325.00
-hp- 410B	Audio, rf, VHF measurements; dc voltages; resistances	20 cps to 700 MC	0.1 to 300 v 7 ranges	10 megohms 1.5 $\mu\mu f$ shunt	245.00

-hp- Voltmeter Accessories (not listed) include voltage dividers, connectors, shunts and multipliers to extend the useful range of your equipment.

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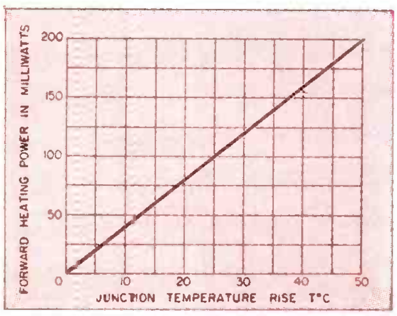
New Sylvania package offers

Maximum Dissipation in Miniature Diodes

Cooler operation resulting from higher dissipation of Sylvania glass-to-metal miniature diode permits closer printed board spacing for maximum savings in space.

Right angle bending of leads for printed board insertion does not affect the diode body since metal-to-glass design avoids chipping or cracking.



Typical dissipation curve of the Sylvania glass-to-metal diode.

Actual comparison of Sylvania miniature diodes with all-glass miniatures shows that the Sylvania metal-to-glass package design results in greater dissipation. As a result, cooler operation can extend diode life and improve product dependability and performance. Diodes can be banked closer on printed circuit boards for maximum space savings.

Metal-to-glass package offers other important advantages. The diode cartridge is assembled *before* installation of the whisker and die—avoiding excessive heating. In addition, right angle bending of the leads for printed board insertion does not result in chipping or cracking of the diode body.

Sylvania offers a complete line of miniature diodes in the glass-to-metal package. The package meets the standard RETMA outline of .105″ maximum diameter and .265″ maximum overall length. Write for complete details.

SYLVANIA

Sylvania Electric Products Inc.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
Shell Tower Bldg., Montreal

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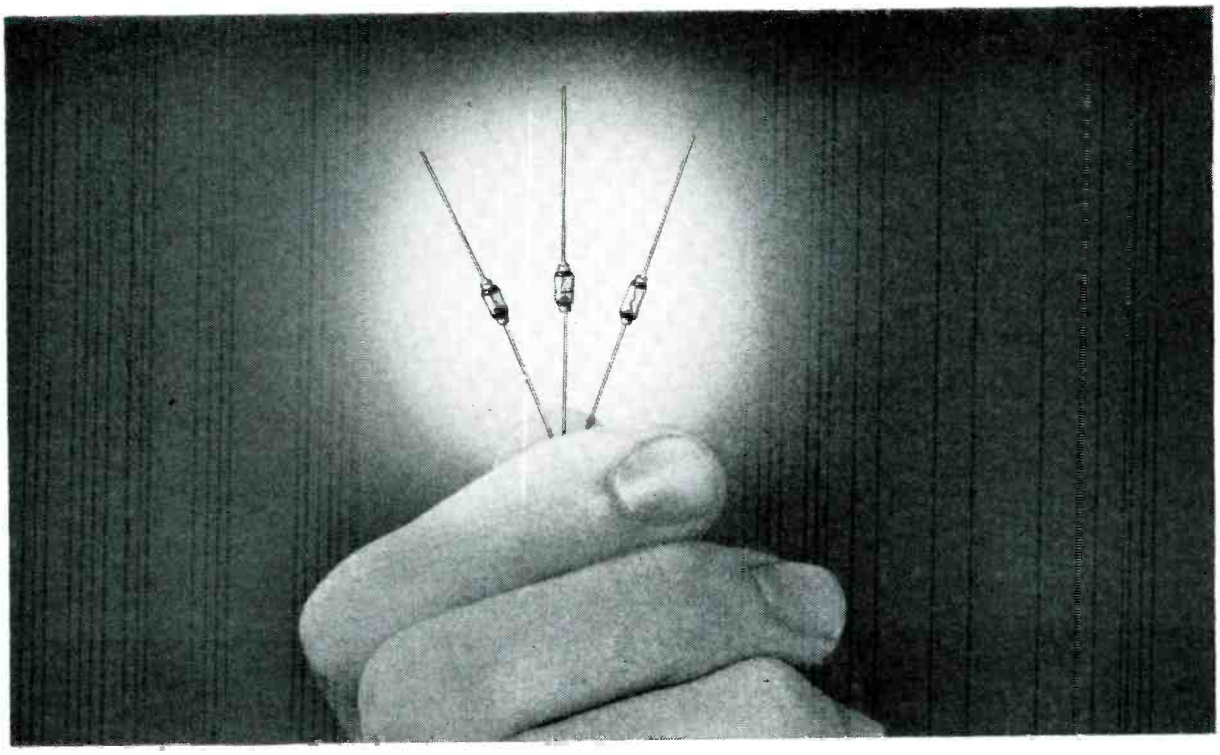

ELECTRICAL CHARACTERISTICS OF SYLVANIA MINIATURE DIODES AT 25° C

Type	Minimum Forward Current at 1 volt	Maximum Reverse Current	Minimum Peak Inverse Voltage (0 dynamic impedance)	Maximum Forward Voltage	Minimum Reverse Resistance	Maximum Reverse Recovery @ 0.3 u sec (Note 3)	Stability
IN67A	4 ma	50 ua @ −50 volts 5 ua @ −5 volts	100 volts				
IN90	5 ma	750 ua @ −50 volts	75 volts				
IN98	20 ma	100 ua @ −50 v 8 ua @ −5 v	100 v				
IN126	5 ma	850 ua @ −50 v 50 ua @ −10 v	75 volts				
IN127	3 ma	300 ua @ −50 v 25 ua @ −10 v	125 volts				
IN128	3 ma	10 ua @ −10 v	50 volts				
IN191	5 ma	Note 1	Note 1				
IN198	4 ma (5 ma @ 75° C)	50 ua @ −50 v (Note 2) 10 ua @ −10 v	100 volts				
IN631				3.5 v (Note 4)	500 kohms (Note 5)	500 ua	Note 7
IN632				1 V If = 7 ma	500 kohms (Note 5)	800 ua	Note 7
IN633				1 V If = 125 ma	500 kohms (Note 6)	1650 ua	Note 7
IN634	50 ma	45 ua @ −45 v 100 ua @ −100 v	115 volts				
IN635	50 ma	175 ua @ −150 v	165 volts				

Note 1: For type IN191 at 55° C the reverse resistance will be 400 ohms or greater between −10 and −50 volts when swept from 0 to −70 volts at a 60 cycle rate.

The reverse recovery time will not exceed 0.5 usec at 700 ua or 3.5 usec at 87.5 ua of current when rapidly switched (at a 60 cycle rate) from +30 ma forward current to −35 volts.

Note 2: For type IN198 at 75° C the maximum reverse current at −50 volts is 250 ua and at −10 volts is 75 ua.

Note 3: a) Forward current exposure = 5 ma. b) Reverse test voltage = 40 ±2 volts. c) DC circuit resistance = 2000 ohms.

Note 4: Peak measurement with half sine wave of 50 ma peak current, 0.1 usec pulse width, and 100 kc pulse repetition frequency.

Note 5: Minimum resistance in thousands of ohms when E/I characteristic is swept at 60 cycles from 0 to −70 volts and resistance slope observed between −10 and −60 volts.

Note 6: Minimum resistance in thousands of ohms when E/I characteristic is swept at 60 cycles from 0 to −100 volts and resistance slope observed between −20 and −90 volts.

Note 7: Additional control measurements are made for reverse current hysteresis, reverse current drift, and flutter.

"Sylvania—synonymous with Semiconductors"

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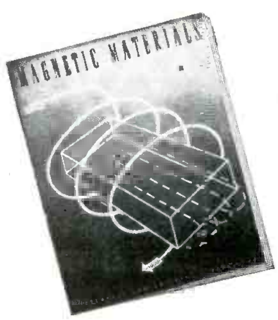
For your Magnetic Shielding Problems . . .

MUMETAL is the answer!



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Use it where high permeability is required at low flux densities, such as in input and microphone transformers, hearing aid diaphragms, instruments, wire and tape recorders, etc. For properly heat treating Mumetal, we can also offer commercial hydrogen annealing facilities.

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In addition to Mumetal and other high-permeability alloys, we offer a range of magnetic and electrical alloys and steels that is unmatched in its completeness. Our services also include the most modern facilities for lamination fabrication and heat treatment. • Let us supply your requirements. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

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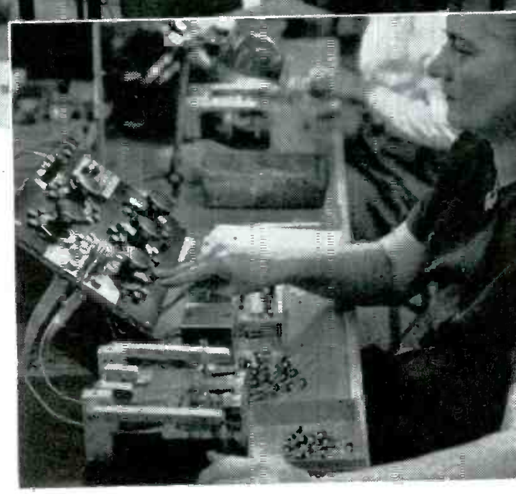
Operators in the foreground are trimming resistors down to close approximation of their final values, guided by L&N No. 4760 Bridges.



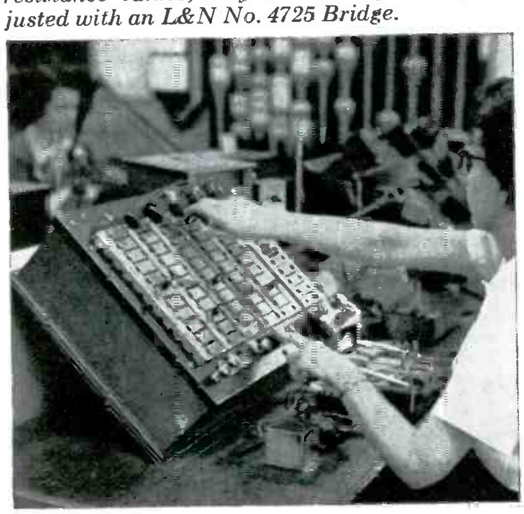
After the resistors are annealed to stabilize their resistance values, they are more precisely adjusted with an L&N No. 4725 Bridge.

88 L&N Bridges work ROUND THE CLOCK on resistor calibration

Continuous operation on production work is an exacting job for any precision instrument. But Resistance Products Company, Harrisburg, Pa., depends on L&N Bridges to measure precise resistors on a two and three shift basis. Some bridges have been in operation as long as nine years without any attention except routine maintenance.

Low maintenance and high precision are especially valuable, since many RPC resistors must be adjusted to a high accuracy, for use in guided missiles, computer networks, printed circuits, etc.

If we can help you select instruments for similar applications, from L&N's line of rugged, precise bridges, galvanometers and potentiometers, just let us know. A Field Engineer will either call or send printed information as you wish. Please write us at 4979 Stenton Avenue, Philadelphia 44, Pa., for Data Sheet Group E-53 describing L&N Bridges.



If an even higher degree of accuracy is required, the resistors are further adjusted with an L&N No. 4230 Anthony Pattern Bridge.

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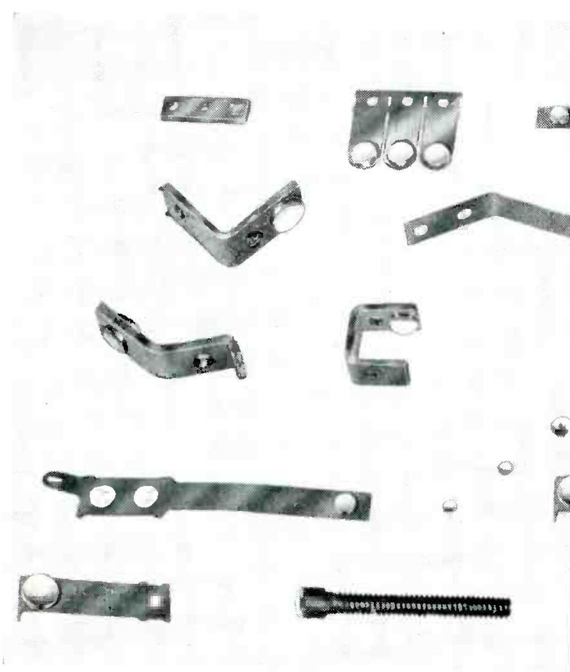
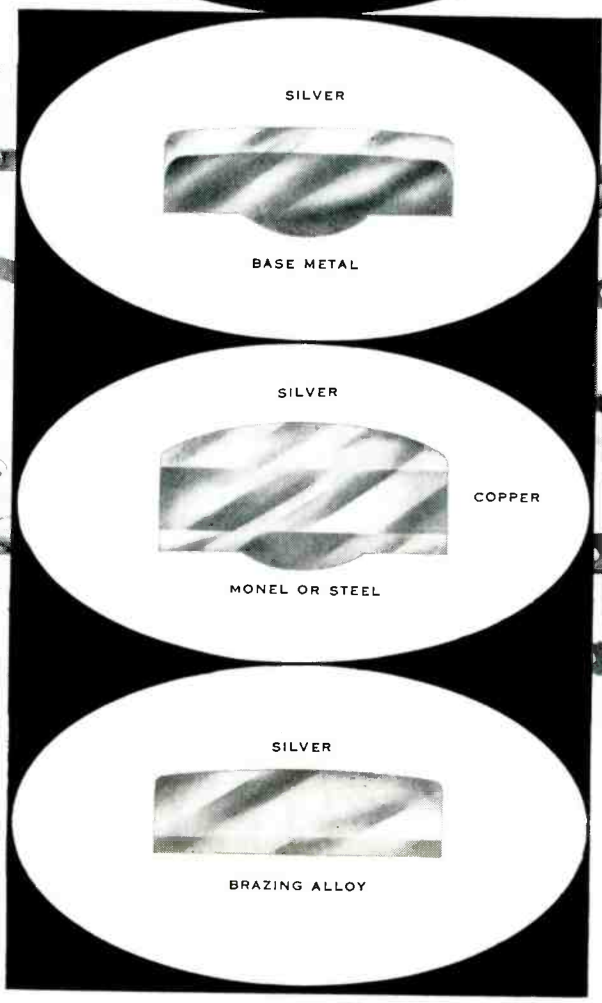


Typical General Plate clad projection welding button contacts.



Consider the outstanding features available to you in G. P. clad projection welding contacts:

- **TRIPLE CLAD CONSTRUCTION.** Three ply types have copper between contact face and backing for higher specific heat at lower cost — reduces surface temperature — prolongs operating life.
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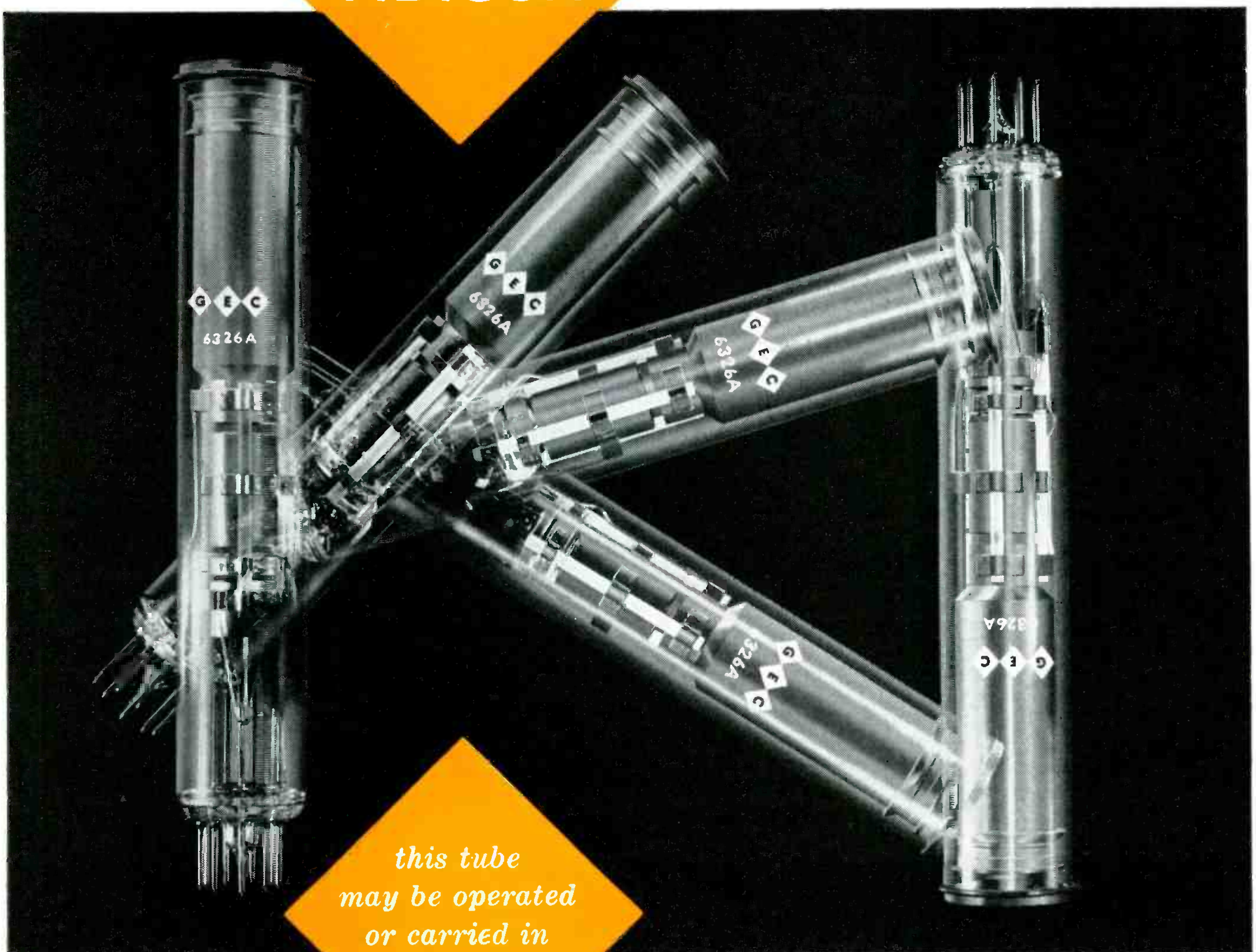
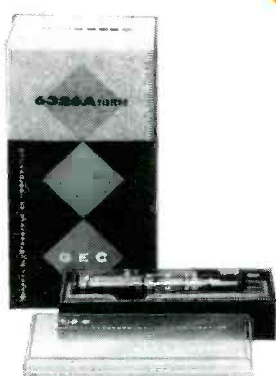


this tube may be operated or carried in any position



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Now you can get sturdy GEC Vidicons built for hard handling and usage. Also, you are assured exceptionally long service life by precision manufacture under controlled conditions in GEC's ultra-modern new plant. Both the Industrial 6198A and Broadcasting 6326A types (improved design with side tips eliminated) are available for immediate delivery. See your parts distributor or write directly to GEC.

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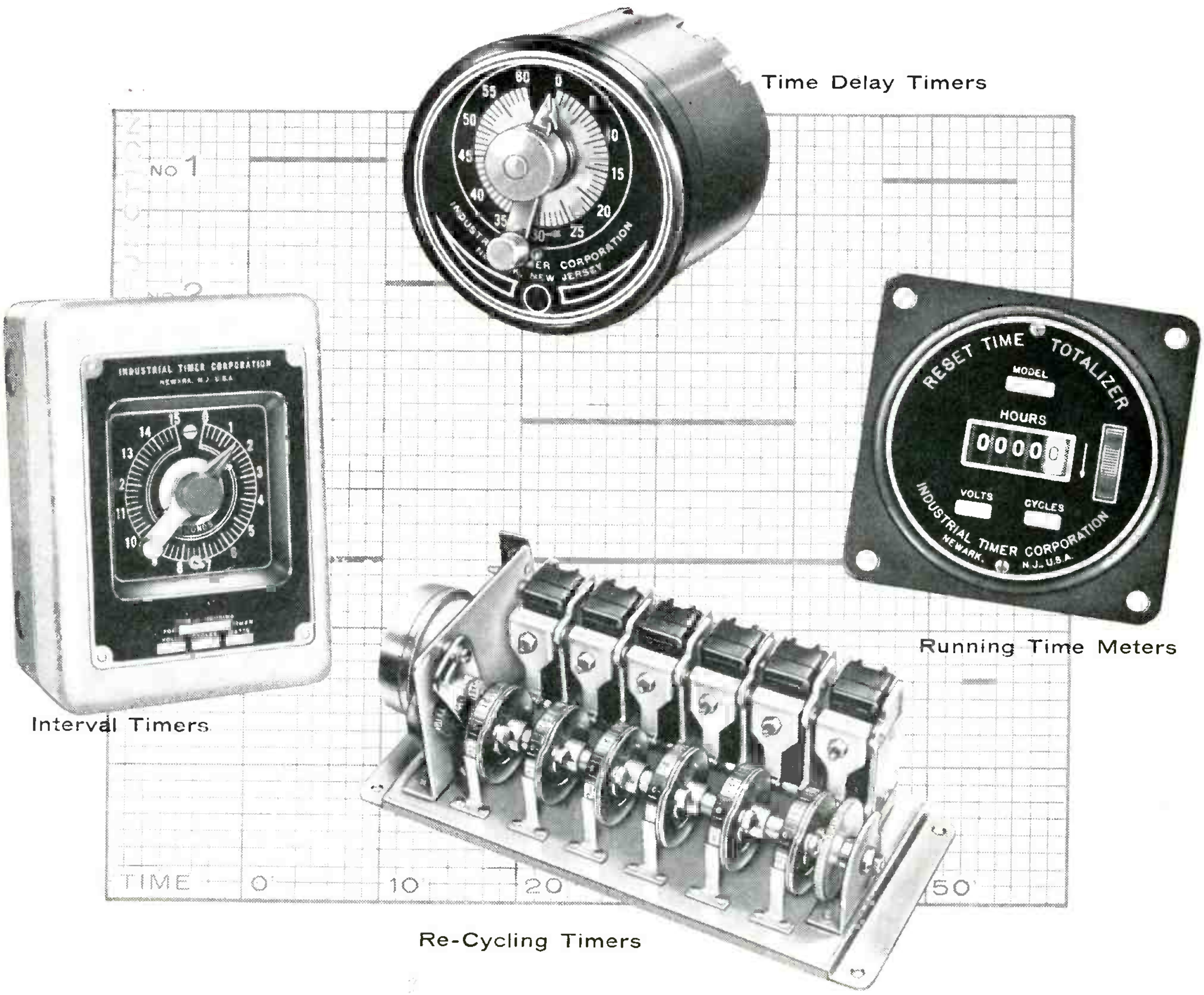

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If slow deliveries of timers have been delaying you in your automatic control projects, try us! True, your problem may be different and difficult indeed, for no two automatic control jobs are exactly alike. But our record in helping out in situations like these is excellent. For in this field we have a valuable background, twenty years of timer experience to be exact, that has provided us with the special knowledge required to supply our customers with the right answers.

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And our large stock assures you of rapid deliveries—even when we have to create a brand new timer for your special needs. So why not send us your specifications. You'll get a prompt reply and you may save yourself much lost motion.

Timers that Control the Pulse Beat of Industry

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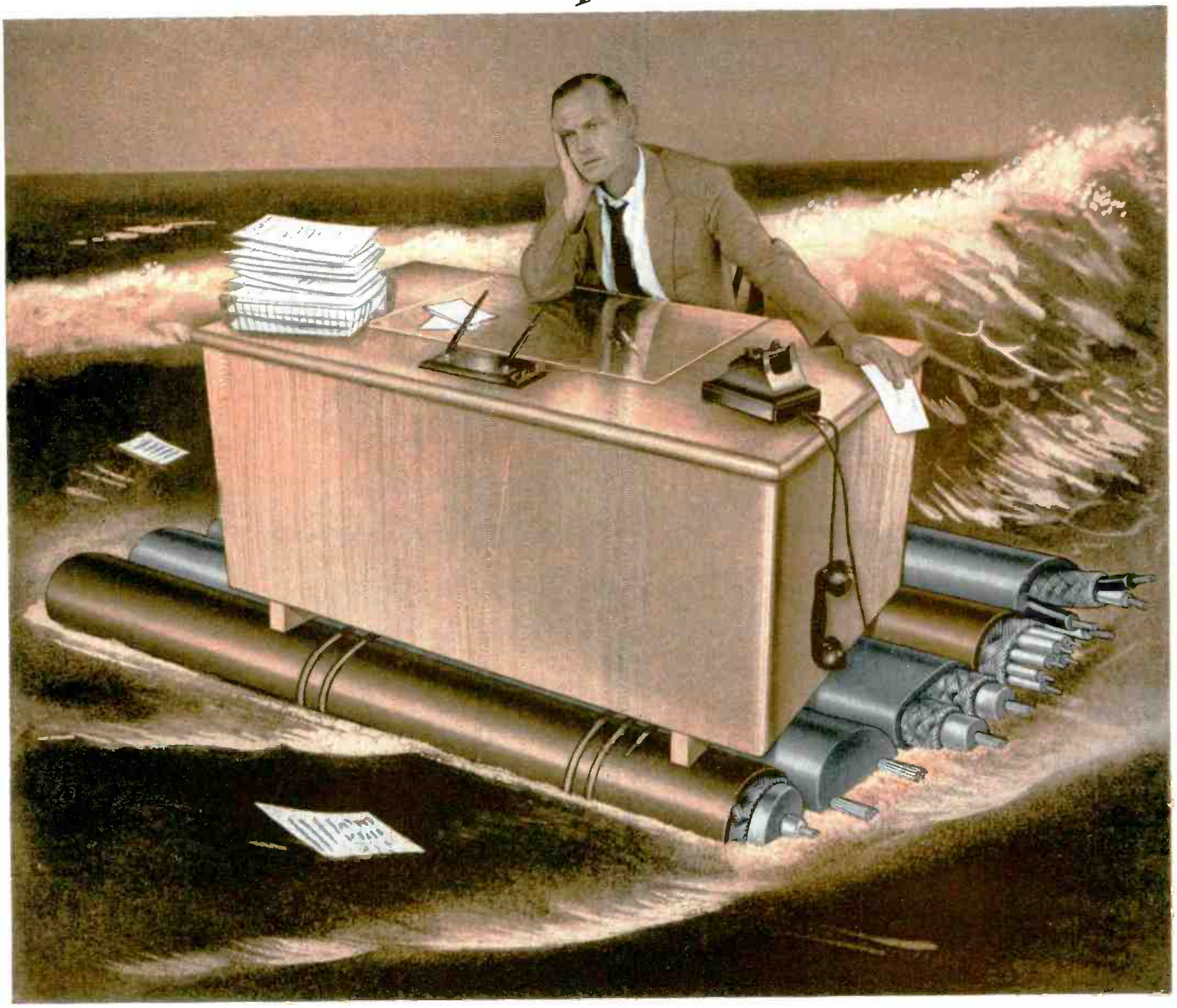
Custom Wire & Cable Specs Got You At Sea?



PHALO Will Know The Way Home!

It gets pretty rough at sea sometimes — especially when they're screaming for "that certain wire or cable". So how do you get home with the right answer? Well, if you're a thinking man (and we're sure you are), you think of PHALO . . . the custom wire and cable house who have helped more people in your position than almost any firm in the country.

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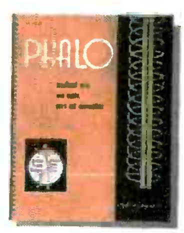
Here's one way to keep out of trouble — Get This Catalog!



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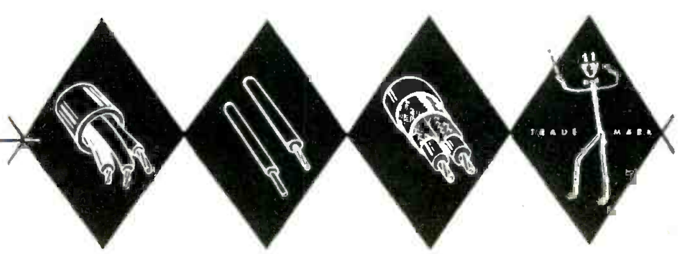

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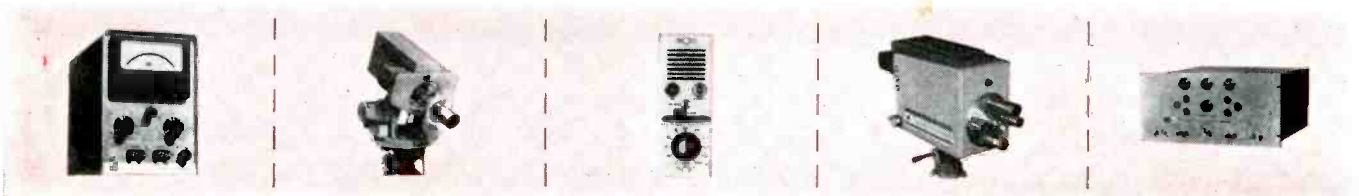

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Write, wire, phone today for demonstration

ELECTRONICS FOR COMMUNICATION · MEASUREMENT · CONTROL

5725 KEARNY VILLA ROAD · SAN DIEGO 11, CALIFORNIA · BROWNING 7-6700

MODEL M100-A20

- STANDARD CELL ACCURACY
- 0.01% STABILITY
- <0.5 MILLIVOLT RIPPLE
- 0.002% REGULATION
- <0.2 MILLISEC RESPONSE TIME
- 21 MODELS: 0-2000V, 0-2 AMP

KIN TEL's unique chopper stabilized circuit constantly compares the output with an **internal standard** cell, providing stability, accuracy, and dynamic characteristics **without equal.** Direct reading calibrated dials provide instant voltage selection. Both current and voltage regulated models available. Ideal wherever a general purpose precision voltage or current source independent of line or load is required . . . for laboratory and production meter calibration, computer reference, secondary standard, DC bridge supply, transistor testing, circuit design, nucleonics instrumentation, null voltmeter . . .

SPECIFICATIONS

POWER SUPPLY: Short Time Stability (several hours), ±0.005%—Long Time Stability, ±0.01%—Output Voltage Calibration, ±0.02%—Output Impedance, < 0.01Ω at DC, < 0.05Ω to 200 kc—Output Hum and Noise, < 0.5 millivolt—Load Regulation Factor, ±0.01%—Line Regulation Factor, ±0.002%:

METER CALIBRATOR: Same as Power Supplies with following exceptions for models which go to zero volts: Calibration Tolerance, ±0.05%—Hum and Noise, < 2 millivolts—Line Regulation Factor, ±0.01% of full scale.

KINTEL
[KAY LAB]

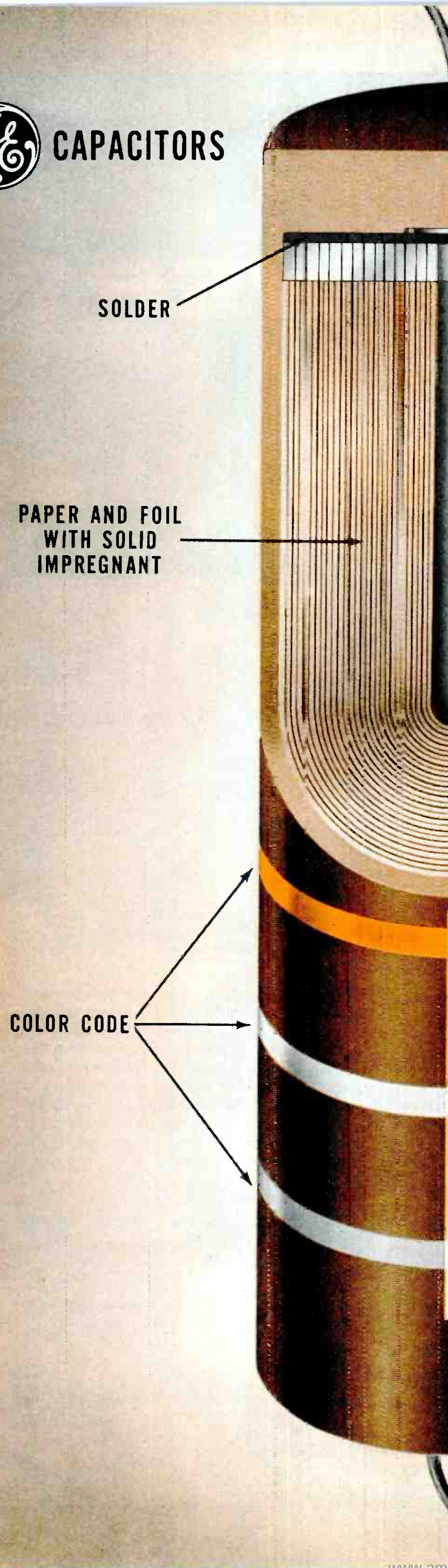
Representatives in all major cities

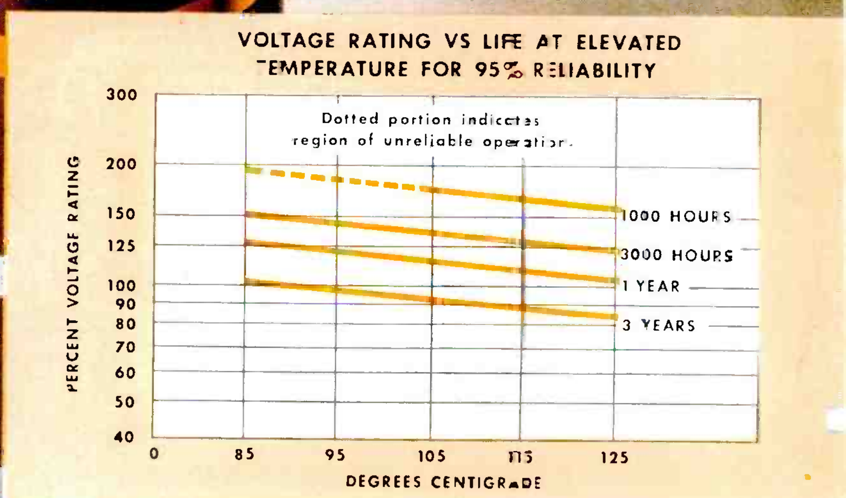
Write, wire, phone today for demonstration

5725 KEARNY VILLA ROAD • SAN DIEGO 11, CALIFORNIA • BROWNING 7-6700

Want more information? Use post card on last page.

CAPACITORS





GRAPH ABOVE shows outstanding temperature and voltage characteristics for 95% reliability.

Solve critical space and temperature problems with subminiature PVZ* capacitors

Low-cost molded units operate from —55 C to +125 C

Now immediately available for exacting applications in commercial and military electronic equipment, these molded paper capacitors meet performance requirements of Characteristic "E" for MIL-C-91A. General Electric's PVZ capacitors are priced substantially lower than comparable metal-clad tubulars. They are designed to operate for a minimum of one year at +125 C with no voltage derating.

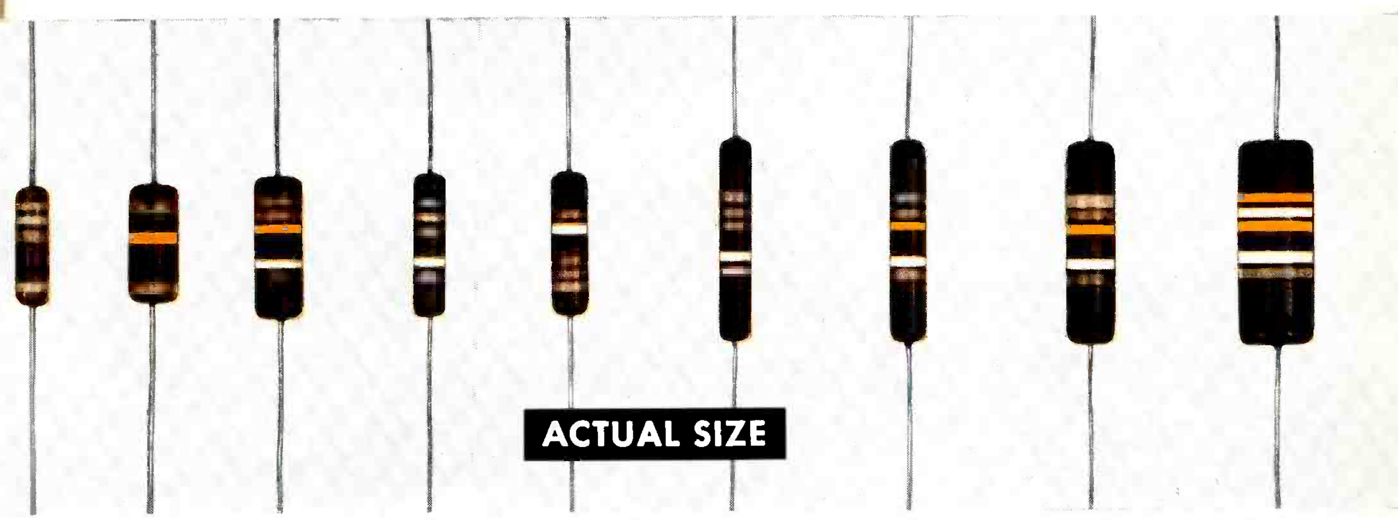
Completely solid after molding, PVZ capacitors feature the following advantages:

- small size
- excellent humidity resistance
- high lead-strength
- insulated body—solid impregnant
- high shock and vibration resistance
- color code for easy identification

General Electric PVZ capacitors are available at 100, 200, 300, and 400 volts. Microfarad ratings range from .00047 to .15.

If you need a capacitor with the characteristics described above, ask your General Electric Apparatus Sales Engineer about PVZ tubulars. He can give you expert application information. He can also arrange for immediate delivery of PVZ capacitors from factory stock in most ratings. For descriptive data write for bulletin GEC-1452 to General Electric, Section 447-2, Schenectady 5, N. Y.

*Trademark of the General Electric Co.



PVZ CAPACITORS range in size from .175″ diameter by .625″ length to .375″ diameter by 1.0625″ length. Capacitance ratings are available with ± 20%, ± 10%, and ± 5% tolerances. The color code indicates microfarads, volts, and capacitance tolerance.

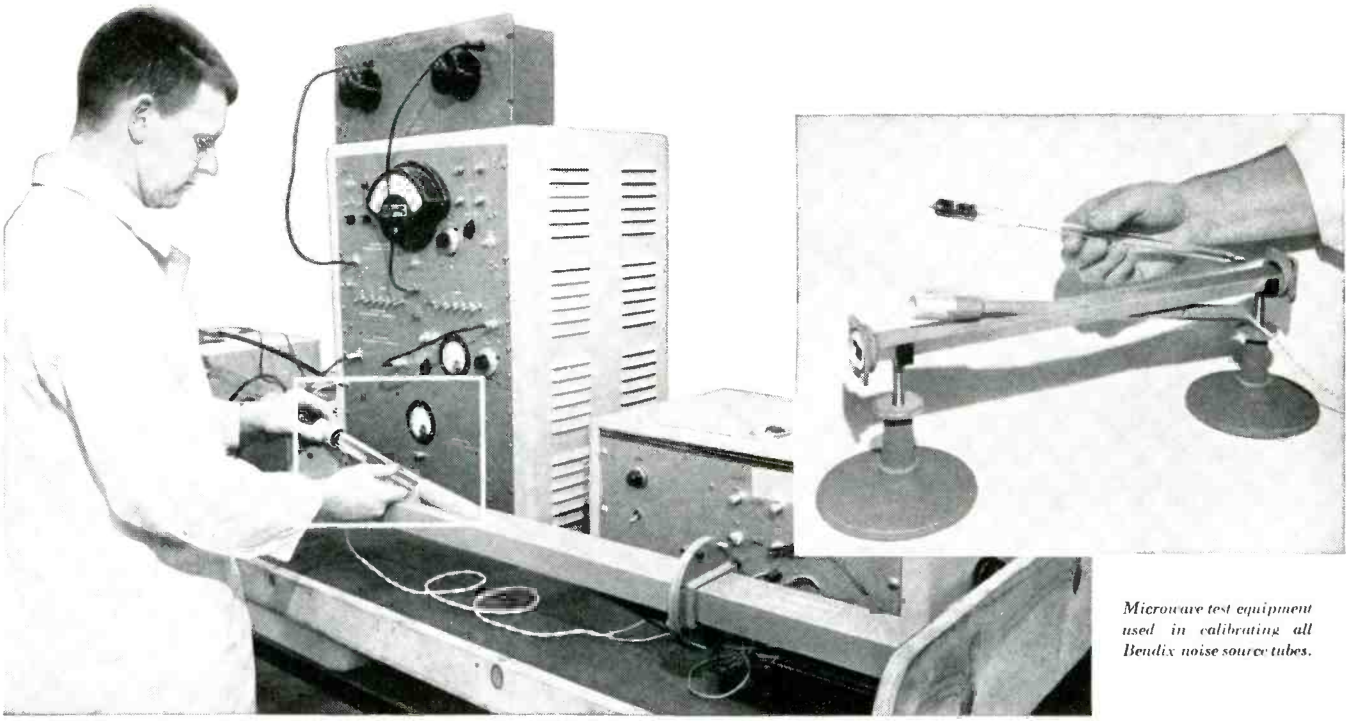
Progress Is Our Most Important Product

GENERAL ELECTRIC

Bendix Red Bank

NOISE SOURCE TUBES

Offer unusual stability plus freedom from ambient temperature corrections



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

As measured sources of noise power in microwave equipment, Bendix Red Bank noise source tubes offer several distinct advantages.

First, temperature changes and fluctuations in noise output present no problems with these tubes, because we make them so that no correction in noise figures is necessary over the range from −55°C. to +85°C. Next, our precise quality control works to close tolerances that produce unusual stability and long life—far beyond that usually found in noise source measuring equipment.

Finally, as can be seen in the table at right, Bendix Red Bank noise source tubes cover an extremely wide range of frequencies, so that there is no difficulty in finding a type to meet any specific need.

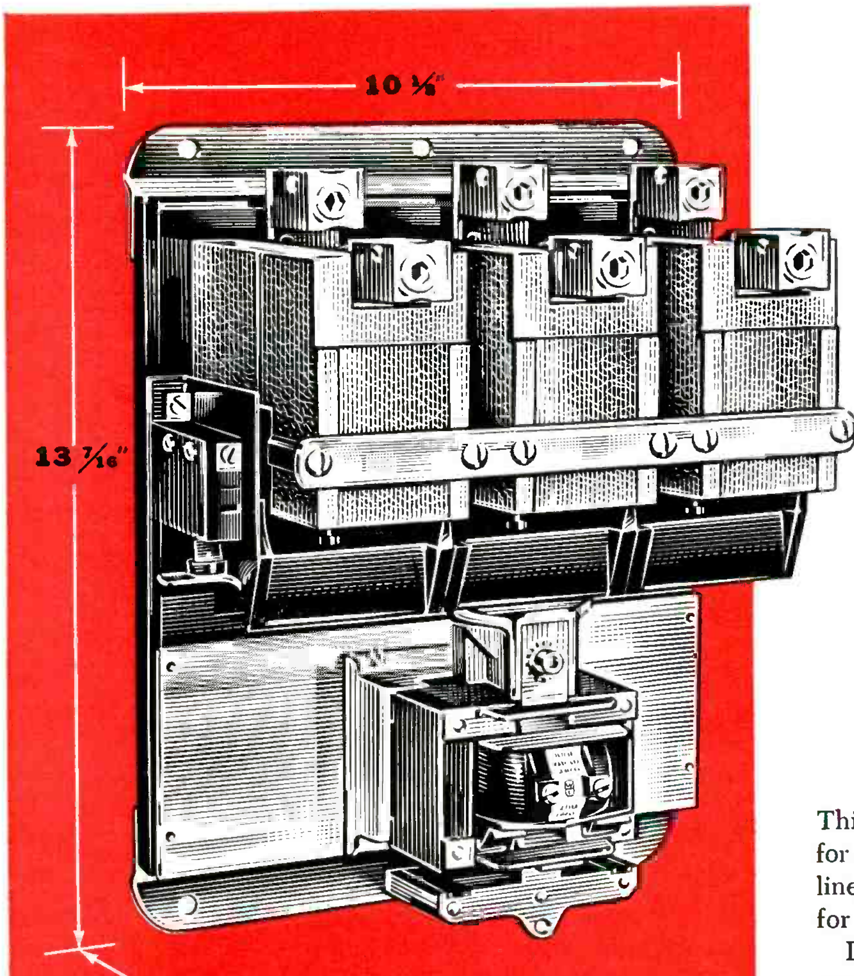
If you have any sort of application in measuring noise and sensitivity in microwave receiving equipment, check with us for the most efficient answer. Write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

West Coast Sales & Service: 117 E. Providencia Ave., Burbank, Calif.
Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.
Canadian Distributor: Aviation Electric Ltd., P.O. Box 6102, Montreal, Quebec

Bendix Type	RETMA No.	Wave-guide No.	Frequency KMC	Anode Current MA	Nom. Tube Drop Volts	Nom. Noise Rating db	Mount Type
TD-10	6356	RG49/U RG50/U	3.95-5.85 5.85-8.20	250	70	15.2	10°E
TD-11	6357	RG25/U	8.20-12.40	200	75	15.2	10°E
TD-12	6358	RG48/U	2.60-3.95	250	80	15.2	10°E
TD-13	6359	RG53/U	18.00-26.50	200	65	15.2	10°E
TD-18	6684	RG91/U	12.40-18.00	200	70	15.2	10°E
TD-21	—	RG69/U	1.12-1.70	250	65	15.2	90°H
TD-22	—	RG48/U	2.60-3.95	250	45	15.2	90°H
TD-23	—	RG52/U	8.20-12.40	200	115	18.0	10°E
TD-24	—	WR 229	3.30-4.90	250	65	15.2	10°E

Red Bank DIVISION

Bendix AVIATION CORPORATION



Solenoid Contactor, Size 4, three-pole, without auxiliaries.

NEW 150-amp solenoid contactor extends proven line

This new Size 4 A.C. solenoid contactor is ideal for use in motor starters and controllers for main line, accelerating and reversing purposes and for resistance heating and lamp loads as well.

It's the new Bulletin 4454—incorporating many advanced design features found on Ward Leonard's Sizes 0 to 3 contactors. Check these outstanding features:

New sintered-silver-cadmium-oxide contacts—can repeatedly handle high inrush currents without a sign of contact welding, excessive pitting or other damage.

Simple, compact solenoid design—excellent for modern metal control panels using accessible front-of-board wiring, particularly useful where panel space is limited.

Available with two or three main poles and up to 4 side-mounted auxiliaries. Also with provision for mechanical interlocking and addition of overload relays.

Completely described in Bulletin 4454. Write for your copy today. The Ward Leonard Electric Co., 30 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada Ltd., Toronto.) 7.6

ENGINEERING DATA

Size 4 A.C. Contactor Ratings*

Service	8-Hour Ampere Rating: Open	8-Hour Ampere Rating: Enclosed	Enclosed Power Rating, Three Phase: Volts	Enclosed Power Rating, Three Phase: H.P.
Across-the-Line Starting	150	135	110 220 440-550	25 50 100
Across-the-Line Plug-Stop or Jogging	150	135	110 220 440-550	15 30 60

Service	8-Hour Ampere Rating	Single Phase: Volts	Single Phase: K.W.	Three Phase: Volts	Three Phase: K.W.
Resistive Heating Load**	150	110 220 440 550	15 30 60 75	110 220 440 550	26 52 105 130
Tungsten Lamp Lighting or Infrared Heating Load**	120 Amperes for 250 Volt Circuits or Less				

*The ratings listed are those recommended by the National Electrical Manufacturers Association.
**These ratings apply to open or enclosed contactors.

LIVE BETTER...*Electrically*

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892

AER -O- COM

DEFINITELY DEPENDABLE!

Aerocom's Dual Automatic Radio Beacon

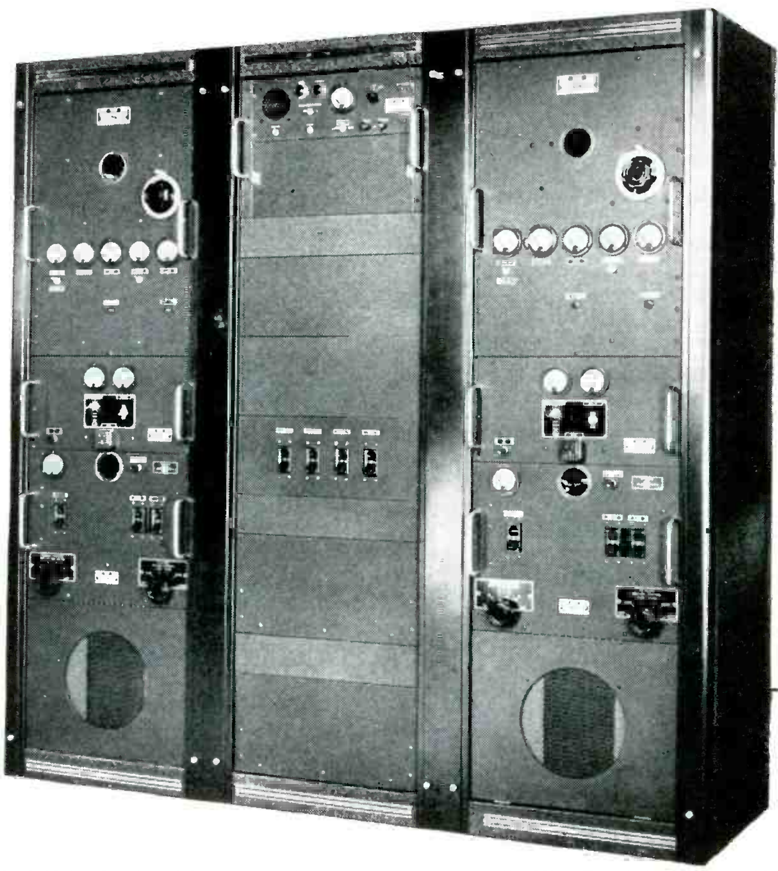
Reliability is built into every part of this dual 1000-watt aerophare unit. Ruggedly constructed and conservatively rated, it provides trouble-free unattended service, and at truly low operating and maintenance cost. It operates in the frequency range 200-415 kcs, using plug-in crystal for desired frequency.

Uses single phase power supply, nominal 220 volts, 50 or 60 cycles. Consists of two 1 kw transmitters with keyer (2 keyers if desired), automatic transfer unit and weatherproof antenna tuner. Each transmitter housed in separate standard rack cabinet, with controls in rack cabinet between the transmitters.

Nominal carrier power is 1000 watts. High level plate modulation of final amplifier is used, giving 30%-35% tone modulation. P-T switch interrupts tone, permitting voice operation. Operates in ambient temperatures from -35°C to 50°C, humidity up to 95%.

Standby transmitter is placed in operation when main transmitter suffers loss (or low level) of carrier power or modulation, or continuous (30 sec.) tone. Audible indication in monitoring receiver tells when standby transmitter is in operation.

Antenna may be either vertical tower or symmetrical T type.



Also available in
50 WATT
100 WATT
and
4 KILOWATT
models

A-101

AER -O- COM

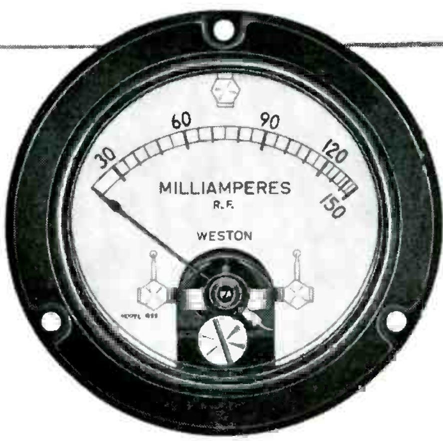
3090 S.W. 37th AVENUE • MIAMI, FLORIDA

Want more information? Use post card on last page.

time tested shock mount

The critical moving coil in Weston ruggedized instruments is insured against shock damage by these shock absorbing springs in back of each jewel bearing . . . another Weston ruggedized *first!*

The entire instrument movement is then cradled on a shock mount of specially formulated rubber . . . assuring continuous dependable operation in severest service.



A DAYSTROM UNIT

WESTON

Ruggedized

PANEL INSTRUMENTS

Equipment builders can't afford to compromise on instrumentation where service requirements call for instruments that will function dependably under severe impact, shock, moisture or temperature extremes. That's why *approved* Weston ruggedized instruments are so widely preferred. Their sound basic design . . . the *extra* values built-in . . . have proved their superiority under the most rigorous field conditions, providing unmatched performance that more than justifies their cost.

Expanded facilities now make Weston ruggedized instruments readily available for A-C or D-C needs in a variety of sizes and ranges. For the complete story, consult your local Weston representatives, or write . . . WESTON Electrical Instrument Corp., Newark 12, N. J.

Want more information? Use post card on last page

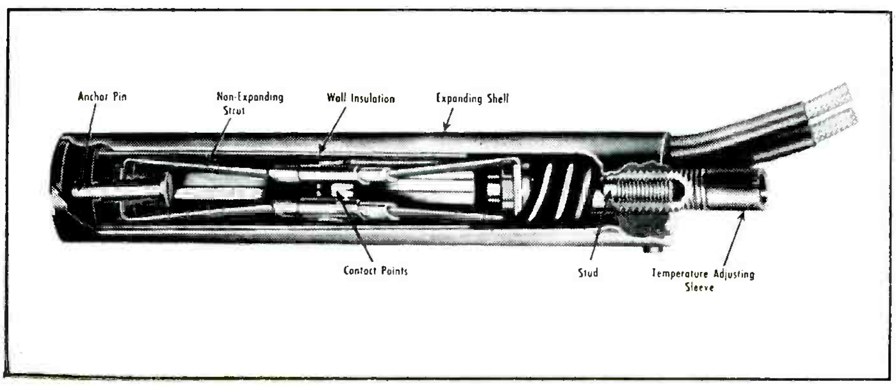
SEE WHY A FENWAL FITS ITS TASK AND

Standard Differential Expansion Units

are tough at the same time they are sensitive. They have these features in common: uniform sensitivity throughout the operating range . . . built-in temperature anticipation . . . enclosed, tamperproof assembly, direct radiant heat reception . . . operating range from −100° F to 600° F.

Midget and Miniature Differential Expansion Units

. . . some no larger than a sugar lump. Actual sizes 1/4″ to 2 25/32″ for the Midget, and 1″ x 1/2″, Miniature. Ideal for "tight spots" where dependability cannot be sacrificed. Hermetically-sealed models. Midget temperature range −50° F to 500° F. Miniature −20° F to 275° F.



Here's How Differential Expansion Units Work . . .

the control element is a single-metal shell that expands or contracts instantaneously with temperature changes, making or breaking the totally-enclosed electrical contacts. The standard size, midget and miniature units all use this principle.

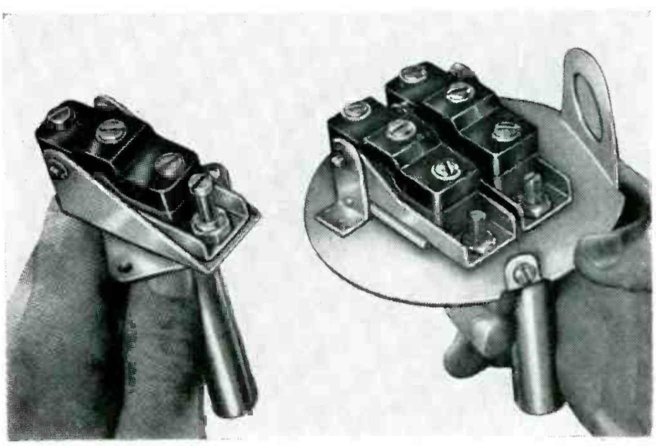
THERMOSWITCH® UNIT YOUR DESIGN SO WELL

Positive-Action Performance in Temperature Control Units in Many Sizes and Shapes

A better answer to many a temperature control situation is to be found on these pages.

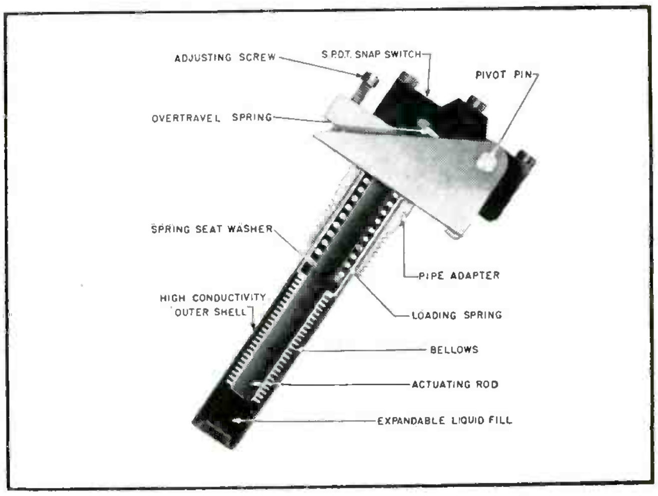
In fact Fenwal can furnish you with over 25,000 variations to satisfy your requirements of temperature range, precise control of set point, physical size and current carrying capacity.

Yes, Fenwal THERMOSWITCH units can provide the answer to your temperature control problems. The coupon will bring you the specific literature that will help you most. **Fenwal Incorporated, Ashland, Mass.**



Snap-Action Units

control loads up to 20 amps, 115-250 volts A.C., or 10 amps, 125 volts D.C. without relays. Picture shows only two of twelve basic models available from Fenwal's Series 20,000 (one switch) and Series 22,000 (two switch) snap-action units. Specialized units can be assembled for you from a selection of temperature ranges, headtypes and mounting styles.



Here's How Snap-Action Units Work . . .

the control action comes from an expandable liquid acting on a bellows assembly which actuates the switch contacts through a push rod. In Fenwal units, the liquid is outside the bellows, adjacent to the shell, for shorter heat transfer path and greater sensitivity.

Fenwal

CONTROLS TEMPERATURE
. . . PRECISELY

Fenwal Incorporated
206 Pleasant Street
Ashland, Mass.

Please send me literature and specifications on items checked.

- ☐ Fenwal Standard THERMOSWITCH units (MC-135A)
- ☐ Fenwal Midget and Miniature Controls (MC-124B)
- ☐ Fenwal Snap-Action Temperature Controls (MC-120B and MC-143)

Name . . . .

Company . . . .

Street . . . .

City . . . . *Zone* . . . . . *State* . . . .

WHY DEVELOPMENT ENGINEERS FAVOR ALLEN-BRADLEY ELECTRONIC COMPONENTS

NEW
hot-molded composition
Variable Resistors
for high temperature applications

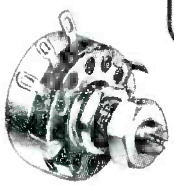
The new Type K Allen-Bradley variable resistor was developed primarily for use in high operating temperatures—so common in military applications. For the *first* time, a variable resistor is available with a conservative rating of 2 watts, operating in 100°C ambient temperatures, as the graph below shows. However, the new Type K control performs reliably at a temperature of 150°C—under "no load" conditions . . . while at temperatures of 70°C, it is *ultraconservatively* rated at 3 watts.

The new Type K control has *all* the features of the old reliable workhorse—the Type J Bradleyometer. With the *hot-molded* resistance type element, control is smooth and without abrupt resistance changes, and "noise" characteristics are extremely low, even after long use. Send for Bulletin 5200A.

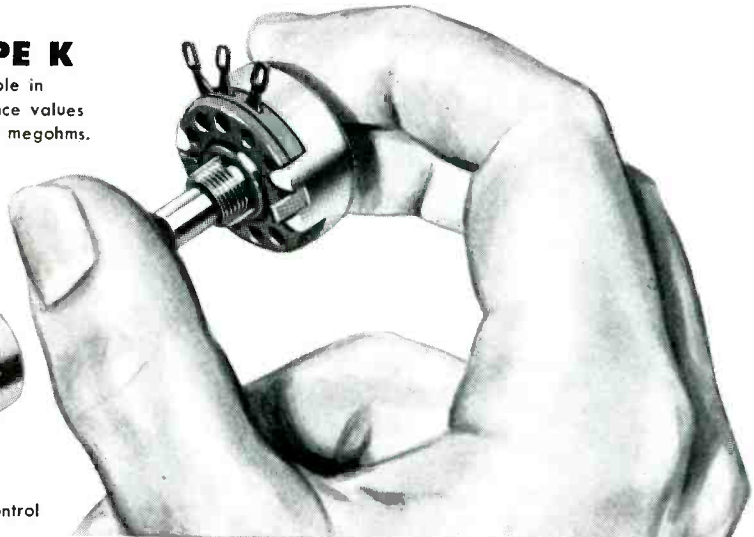
Allen-Bradley Co.
110 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd.
Galt, Ont.

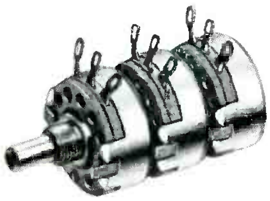
A-B Quality

TYPE K
available in resistance values up to 5 megohms.

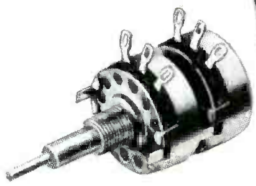


Type K single unit with short shaft and lock-type bushing.

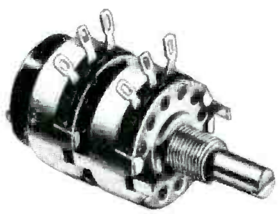




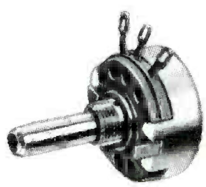
Type K triple unit control with plain short shaft.



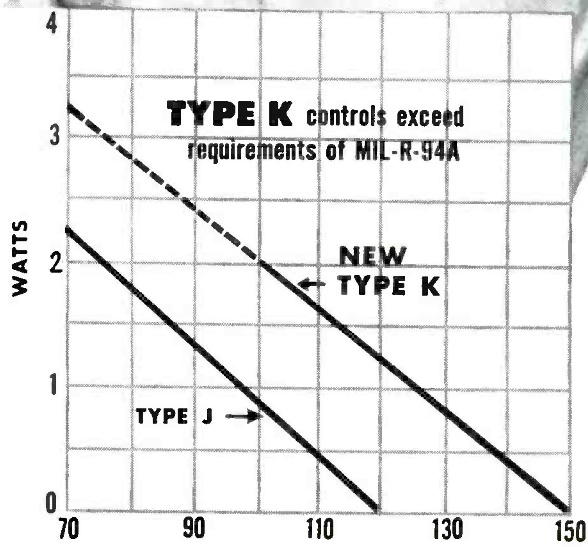
Type K dual element control with concentric shafts.



Type K dual element control with 125 v line switch.



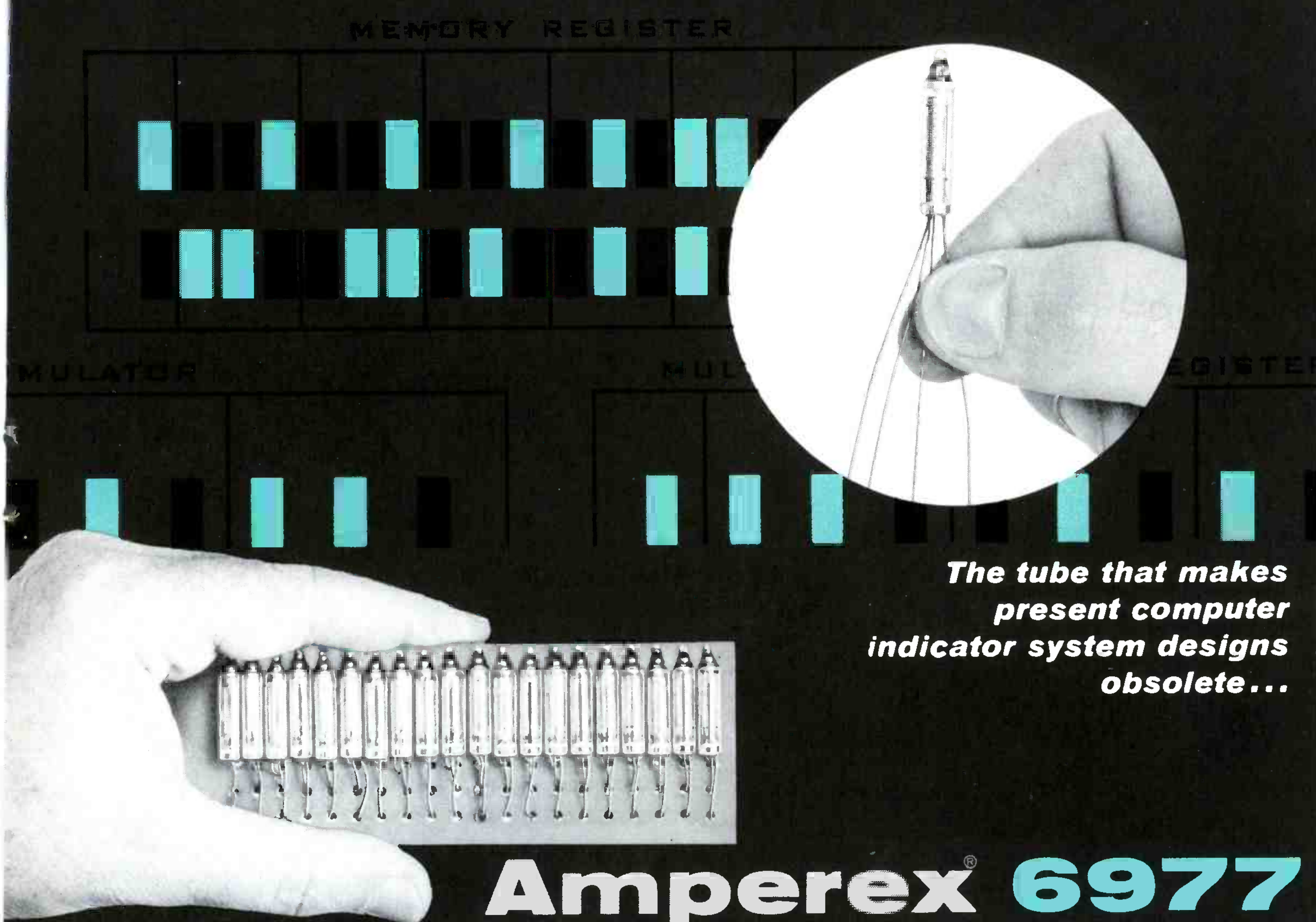
Type K single unit variable resistor with long shaft.



COMPARISON BETWEEN TYPE K AND TYPE J VARIABLE RESISTOR POWER RATINGS VS. AMBIENT TEMPERATURE

ALLEN-BRADLEY
ELECTRONIC COMPONENTS
QUALITY

Want more information? Use post card on last page.



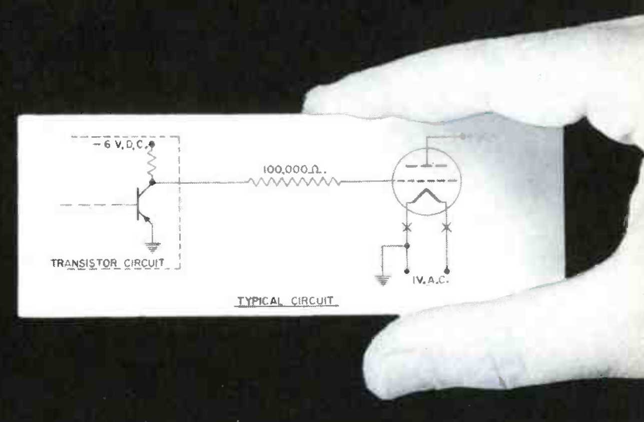
The tube that makes present computer indicator system designs obsolete...

Amperex® 6977

subminiature indicator tube

Monitors Transistorized Circuits

- with higher information density
- with simpler associated circuitry
- without ionization- and deionization-time problems
- with increased circuit protection
- with lower power requirements
- with lower cost per unit
- with ultra-compact assembly on printed circuit boards



The AMPEREX 6977 is a high-vacuum filamentary subminiature indicator triode which gives a bright blue-green indication when the control grid is at zero potential. It has been developed specifically for transistorized computers, where its high input impedance and small signal requirements enable it to monitor the transistor circuits without loading them and affecting their operation. It replaces the conventional and much more expensive high-voltage transistor and neon lamp combination so far used in transistor computers for the same purpose. Since its high input impedance permits the use of a series grid resistor, it will not short out the transistor circuit if it should ever fail. Manufactured with special computer tube techniques, the 6977 is designed for 20,000 hours life.

Heater voltage is only 1 volt, 30 ma, AC or DC. The anode will draw only 0.5 ma from a 50 volt DC supply during the zero-bias "on" condition. A 3.0 volt DC voltage is sufficient to cut-off plate current and light. Write for data sheet to Semiconductor and Special Purpose Tube Division, Amperex Electronic Corp., 230 Duffy Avenue, Hicksville, L.I., N.Y.

ask Amperex

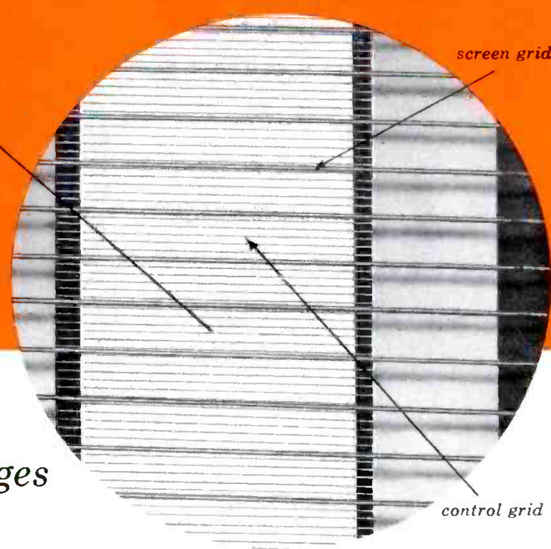
about products and services for the computer industry

no other transmitting tube
but the

Amperex® 6939

gives you

5.5 watts useful power in load (ICAS)
up to 500 Mc at maximum ratings
in a miniature envelope



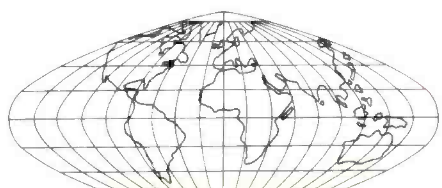
unsurpassed for low-power UHF transmitter applications... saves entire stages in original equipment design

AMPLIFIER, CLASS C, FM	*Operating Conditions*	
	C.C.S.	I.C.A.S.
Frequency	500 Mc/s	500 Mc/s
Plate Voltage	180 V	200 V
Screen Grid Voltage	180 V	200 V
Control Grid Bias	−20 V	−20 V
Plate Current	2x27.5 mA	2x30 mA
Screen Grid Current	11 mA	13 mA
Control Grid Current	2x1 mA	2x1 mA
Driving Power	1.0 W	1.0 W
Plate Input Power	2x5 W	2x6 W
Plate Dissipation	2x2.1 W	2x2,25 W
Screen Grid Dissipation	2 W	2.6 W
Output Power	5.8 W	7.5 W
Useful Power in Load	4.5 W	5.5 W

The Amperex 'FRAME-GRID' CONSTRUCTION insures extreme accuracy of interelectrode spacing, the secret of the 6939's brilliant performance. The relatively massive metal frame acts as a heat-sink, safely limiting control-grid temperature.

Write for detailed data sheets to Communications Tube Division, Amperex Electronic Corporation, 230 Duffy Avenue, Hicksville, L. I., New York.

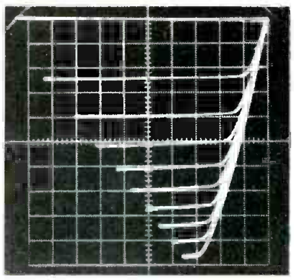
ask Amperex



...for applications engineering assistance on your communications tube problems

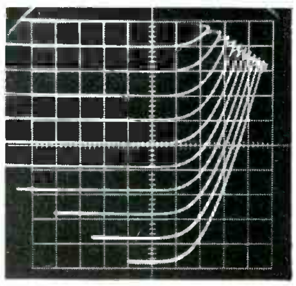
NEW TRANSISTOR-CURVE TRACER

has 10-AMPERE COLLECTOR SUPPLY
2.4-AMPERE BASE SUPPLY



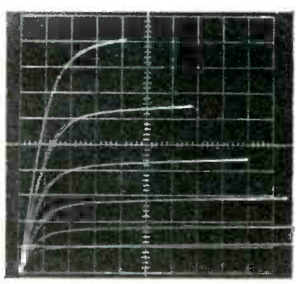
HIGH COLLECTOR CURRENT

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

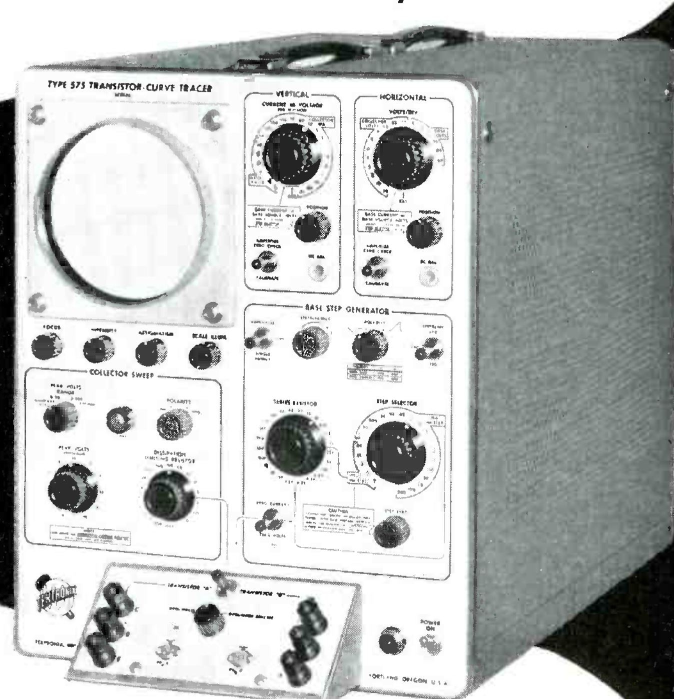
PNP transistor, collector current vs collector voltage with base grounded and constant-current emitter steps. Collector sweep is 0 to 1.5 v, emitter current 200 ma/step. Vertical deflection is 200 ma/div, horizontal 0.1 v/div. Zero voltage is at center scale.



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.

Displays 4 to 12 curves per family with input current from 1 MICROAMP/STEP to 200 MILLIAMPS/STEP



The Tektronix Type 575 traces characteristic curves for both PNP and NPN transistors on the face of a cathode-ray tube. Seven different types of curves can be plotted. Vertical deflection is calibrated in collector current, base voltage, base current and base source voltage. Horizontal deflection is calibrated in collector voltage, base voltage, base current and base source voltage. Collector current supply is capable of 10 amperes from 0 to 20 v, 1 ampere from 0 to 200 v. Constant current or constant voltage step supply to either base or emitter is calibrated in 17 values from 1 microamp/step to 200 milliamps/step, and in 5 values from 0.01 v/step to 0.2 v/step with 24 values of driving resistance from 1 ohm to 22 kilohms. Input steps are adjustable from 4 to 12 per family, with repetitive or single-family display.

First shipments of the Type 575 are expected to be made during October, 1957. Please keep in touch with your Tektronix Field Engineer or Representative for current details.

TYPE 575 TRANSISTOR-CURVE TRACER . . . **$925**

f.o.b. Portland, Oregon

ENGINEERS—interested in furthering the advancement of the oscilloscope? We have openings for men with creative design ability. Please write Richard Ropiequet, Vice President, Engineering.

Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon

Phone CYpress 2-2611 • TWX-PD 265 • Cable: TEKTRONIX

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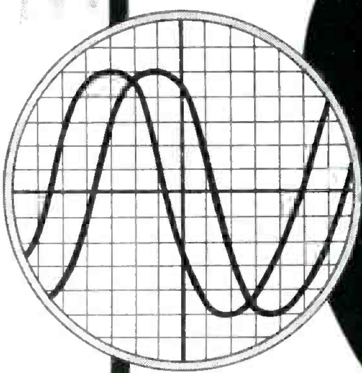
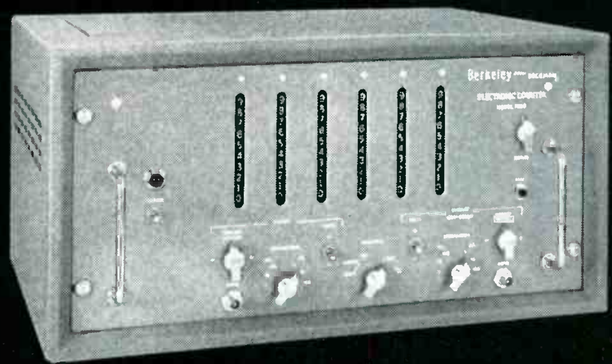
VERSATILE!

NEW Berkeley HIGH SPEED ELECTRONIC GATING COUNTERS





for use as:

- Frequency Ratio Meters
- Digital Phase Meters
- Nuclear Counters
- Digital Flow Computers
- "Slave" EPUT* or Time Interval Meters
- High Speed Digital Counters

ALL-NEW Berkeley Models 7050 (100 kc) and 7060 (1 mc) counters offer both manual and electronic gating for extreme versatility. Gate control signals may be of any frequency from d.c. to maximum counting rate of the instrument, with no restrictions as to input waveform.

Measurements are presented digitally on new larger, brighter DCU panels. Both models will operate directly into Berkeley remote in-line, in-plane readout units, digital printers, or data converters to operate strip chart recorders, electric typewriters, card or tape punches.

CONDENSED SPECIFICATIONS, PRICES

	Model 7050	Model 7060
Max. Counting Rate:	100 kc	1 mc
Readout Capacity:	5 digit	6 digit
Sensitivity:	0.1 volt rms	
Input Impedance:	10 megohm, d.c. or a.c. coupled	
Input Circuits:	Step attenuators with ±1, ±10 or ±100 volt adjustable trigger level ranges	
Power Requirements:	117 volt a.c. (±10%), 200 watts	
Dimensions:	(Cabinet) 10¼"H x 20¾"W x 16½"D (Rack) 8¾"H x 19"W x 16"D	
Price (f.o.b. factory)	$545.00	$645.00

If you have high speed counting and measurement applications or problems, it will pay you well to investigate Berkeley intruments now. As originators of high speed digital electronic counting instrumentation, we can offer you the most thoroughly-proved instruments in the field, plus practical engineering aid in the development of complete measurement, data reduction or control systems. Why not drop us a line? Please address Dept. G6

121

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Richmond 3, California

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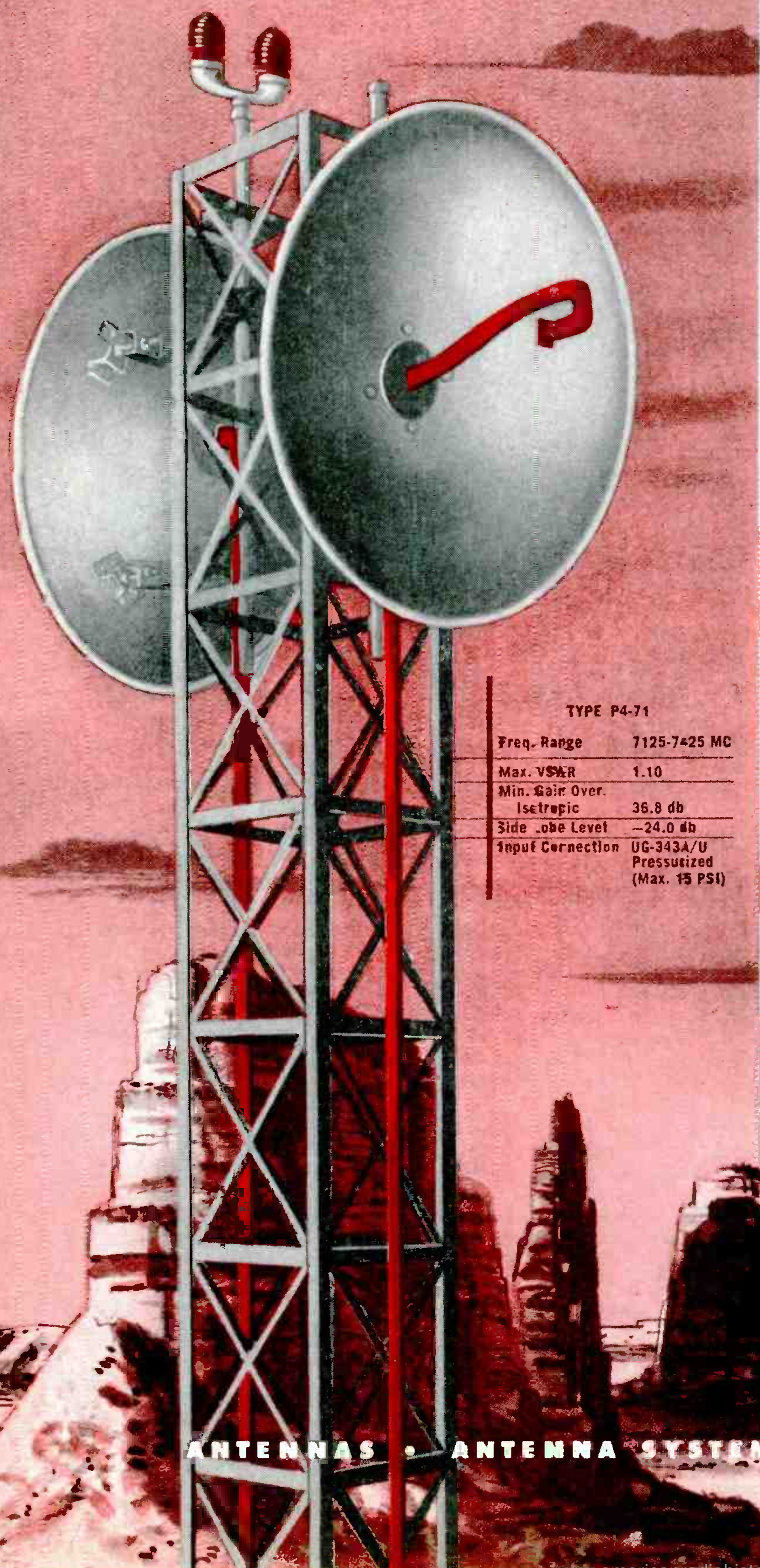
Reliability



ANDREW

Isolated microwave relay installations must be reliable and require the extra performance factors of mechanical and electrical design found only in ANDREW Parabolic Antennas. Thousands of installations serving over a million channel miles of microwave have proven their superiority.

ANDREW offers a complete range of sizes and frequencies. Specify ANDREW Antennas for your microwave system. Here is a representative selection of stock antennas.

TYPE NUMBERS OF STOCK PARABOLIC ANTENNAS

Frequency Range	ANDREW Type Number			
(MC)	4 ft. dia.	6 ft. dia.	8 ft. dia.	10 ft. dia.
890 - 920	1004A-1	1006A-1		1010A-1
920 - 960	1004A-2	1006A-2		1010A-2
1700 - 1850	2004A-1	2006A-1	2008A-1	2010A-1
1850 - 1990	2004A-2	2006A-2	2008A-3	2010A-3
1990 - 2110	2004A-3	2006A-3	2008A-3	2010A-3
2450 - 2700		P6-24		P10-24
3750 - 4200			PS8-37	
5925 - 6425	P4-59	P6-59	P8-59	P10-59
6575 - 7125	P4-65	P6-65	P8-65	P10-65
7125 - 7425	P4-71	P6-71	P8-71	P10-71

Specifications of these and other stock antennas and special design antennas are available by consulting the ANDREW Sales Engineer in your area or by writing to:

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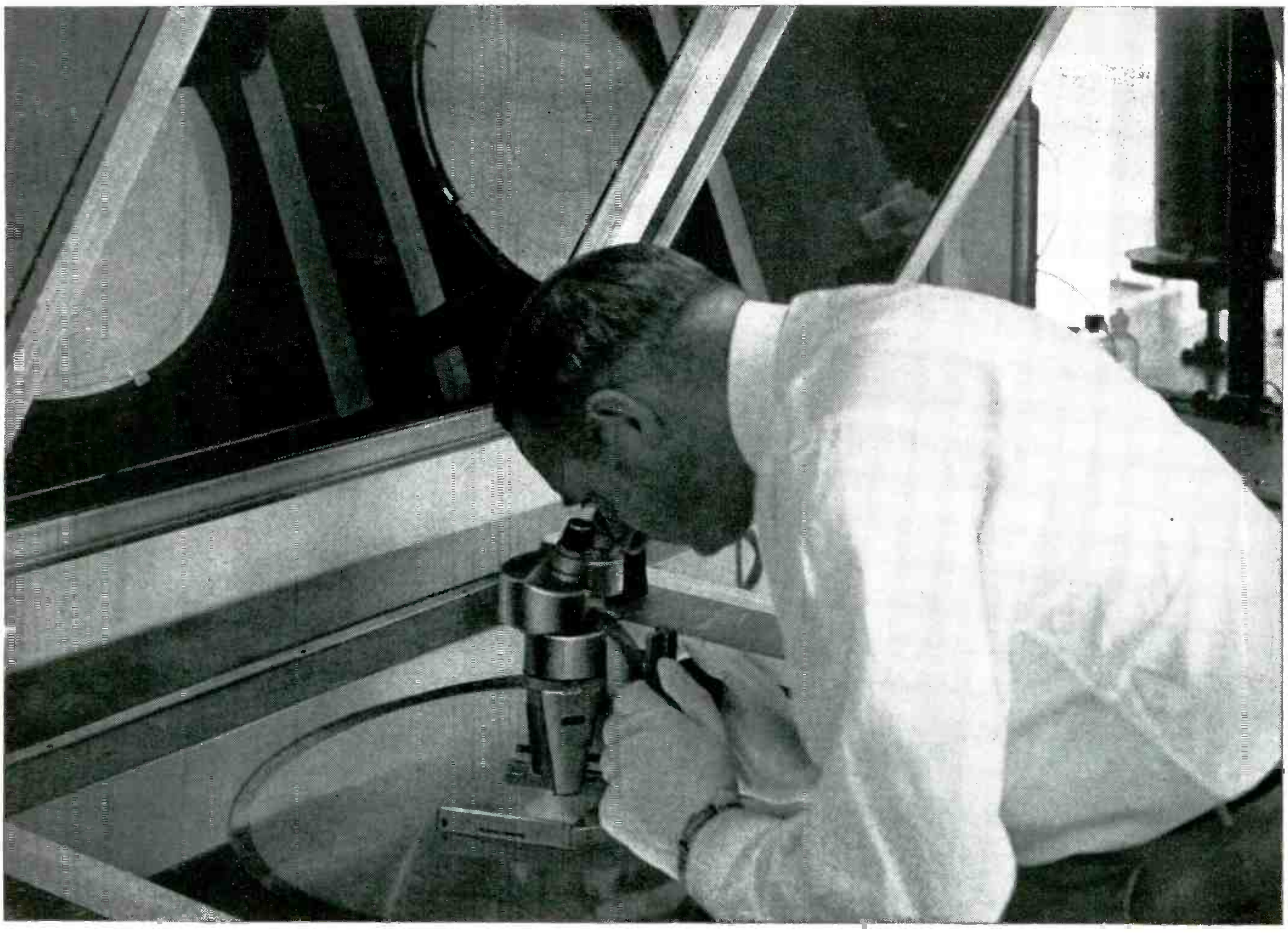
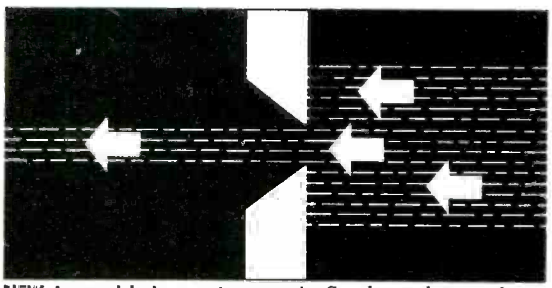
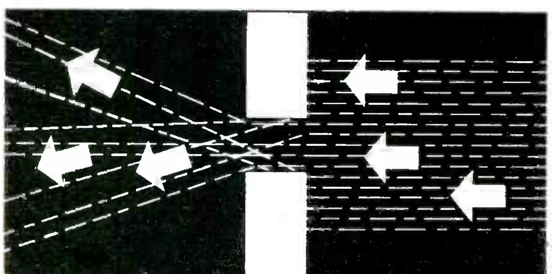


Get Sharper, Truer Color TV Pictures

New tapered-hole aperture mask reduces beam diffusion . . . minimizes false color . . . can be used in present design picture tubes



NEW tapered-hole aperture mask. See how electron beam passes through hole without diffusion. Hole dimensions: .010 in. small diameter; .015 in. large diameter. There are nearly 500,000 of these holes in each mask—all controlled to close tolerance.



OLD cylindrical hole aperture mask. Electrons striking aperture walls are scattered over several dots.

Here's another long step forward toward better color television—one that doesn't require radical changes in circuitry or picture tube construction. It's an improved aperture mask made by Superior Tube* that can be used in the picture tubes you are now using.

Ideally, an aperture mask should have zero thickness. Because electrons impinging on the walls of cylindrical holes are deflected out of the narrow beam and sometimes strike adjacent color dots instead of the single dot they are directed at. The result is a hazy picture or false color. But with these new Superior Tube tapered-hole aperture masks, beam diffusion is practically eliminated. The walls of the tapered holes lie outside the path of beam electrons—even at the extreme edges of the picture. The electrons see only the holes.

These new aperture masks demonstrate how accurate and to what close tolerances Superior Tube can fabricate metal components. For complete information, write for Data Memo No. 5. Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.

**Manufactured by Superior Tube Co. under license from Buckbee Mears, Co., St. Paul, Minn.*

Other parts Superior Tube makes for use in color TV receivers include three different types of disc cathodes (miniature, narrow neck and standard), seamless anodes, and a complete line of sleeve-type cathodes. Superior Tube is the world's largest independent supplier of cathodes for use in electron tubes.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N.Y.—an affiliated company making precision metal stampings and deep-drawn parts such as those used in the electron guns that go with this new cathode.

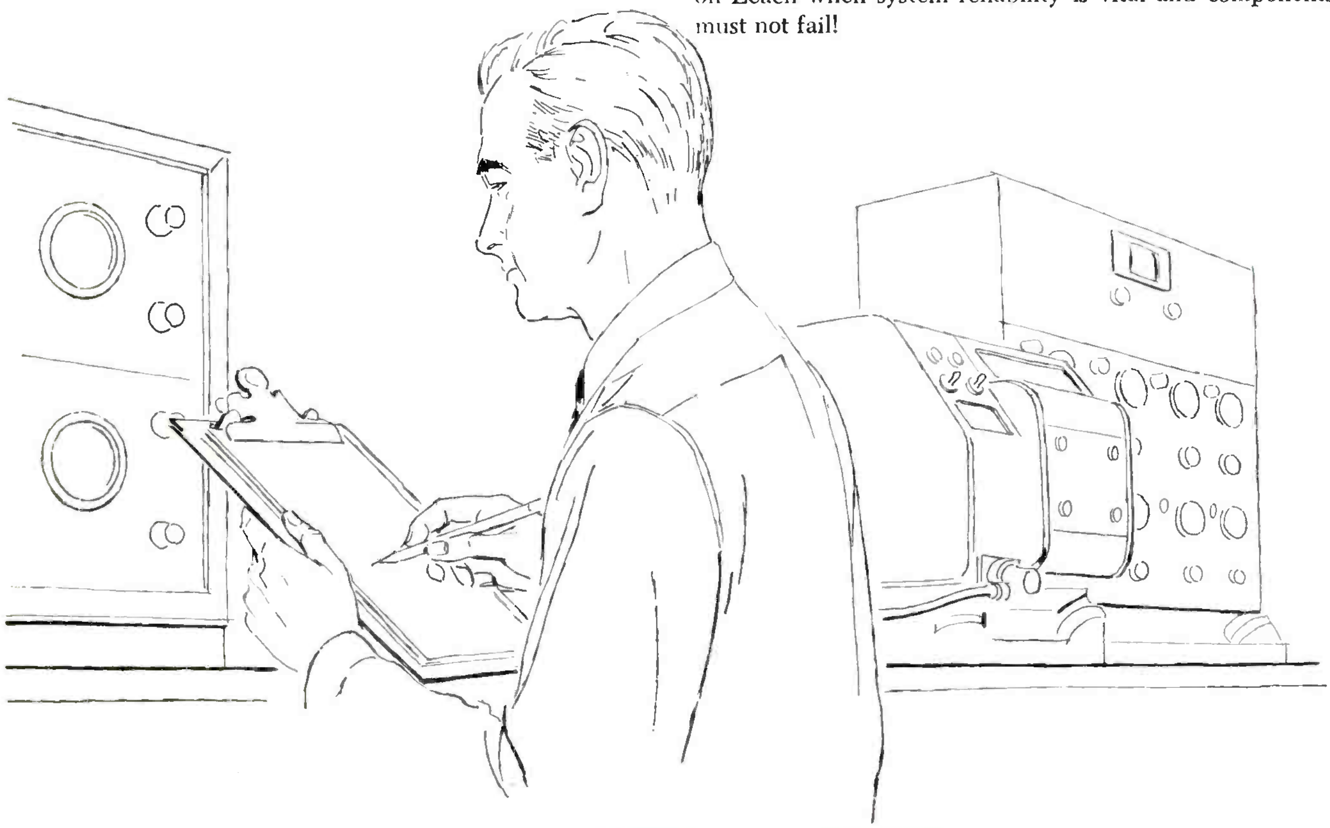
Compare LEACH before you buy

Your own tests will prove why so many critical buyers specify Leach relays

Test any Leach relay against any comparable relay on the market. You'll learn in your own laboratory why the aircraft, missile and avionic industries have learned to look for the Leach label when they're looking for:

- Resistance to greater shock and vibration
- Dependability at higher temperatures
- Space-saving design
- Outstanding reliability

That's why you find designers depending more and more on Leach when system reliability is vital and components must not fail!



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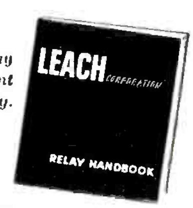
Leach's family of relays . . . offering the important advantages emphasized above

Send for the latest Leach Relay Handbook . . . your best starting point when selecting any relay.



LEACH CORPORATION | LEACH RELAY DIVISION

5915 AVALON BLVD., LOS ANGELES 3, CALIFORNIA

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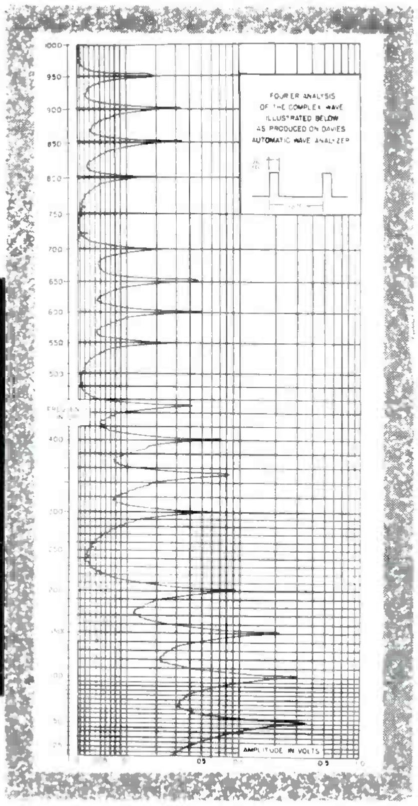

Once the data is on magnetic tape, there still remains the job of analyzing it. You can convert it to digital values, manually measure and sample it, and feed it to a digital computer on punched cards . . . but that takes considerable time and effort by skilled personnel. Rather than limit the number of analyses taken and the length of samples analyzed, labs are turning to direct analog analysis, which merits consideration by speeding reduction . . . permitting larger samples . . . increasing statistical reliability.

how automatic wave analyzers speed analog data reduction, improve statistical reliability

Automatic wave analysis is probably the least complicated technique for reducing analog data. Feed the taped data to an analyzer, flip the switch, and a complete Fouriér series is automatically plotted and printed in permanent record form. There are no intermediate steps, and what little the operator has to do can be trusted to relatively unskilled personnel.

Both of the two models available from Davies can accurately plot Fouriér series data as either *amplitude* versus *frequency* or *power* versus *frequency* at the flip of a selector switch. Both are also equipped with a "quick look" facility. Model 9020A provides a quick analysis across its frequency range of 3 cps. to 2 kc in 6 minutes; Model 9050A across its range of 3 cps. to 10 kc in just 15 minutes. Linear or square law output, as desired, is recorded by a Brown *ElectroniK* Potentiometer as a large, easily readable plot. You can visualize results immediately without any further curve tracing.

Multichannel inputs permit you to analyze as many as seven channels of data simultaneously. But the ultimate in automation is provided by the addition of a Davies Automatic Channel Selector, which you can program for serial analysis of up to 14 channels, changing tape speed, bandwidth, and output as you desire . . . all without any further attention.

It must be conceded that, while Davies Analyzers do provide high amplitude accuracy across wide frequency ranges, no analog analysis equipment could provide the *point* accuracy of manual and digital computer methods. But too often, that point accuracy is only achieved at the expense of reliable results. The speed with which Davies Automatic Wave Analyzers can run through data—in as little as 3% of the time required by digital methods—permits such large samples to be analyzed that the statistical reliability of the overall result remains unequalled.

That's why Davies Analyzers, first designed for aircraft studies, have since been successfully applied to vibration, noise, shock, and flutter analysis in vehicles, aircraft, missiles, and ships . . . seismic interpretation . . . powerline disturbance analysis . . . noise analysis . . . and any number of other phenomena characterized by randomly fluctuating data.

You'll find considerable additional information on Davies Automatic Wave Analyzers, how they operate, and what you can expect from them in the way of specific performance characteristics in Bulletin 9001. Write Minneapolis-Honeywell Regulator Co., Davies Laboratories Division, 10721 Hanna Street, Beltsville, Maryland, or call Webster 5-2700.

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DAVIES LABORATORIES DIVISION

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INDUSTRY APPROVED

AlSiMag® 196

PRECISION CERAMICS

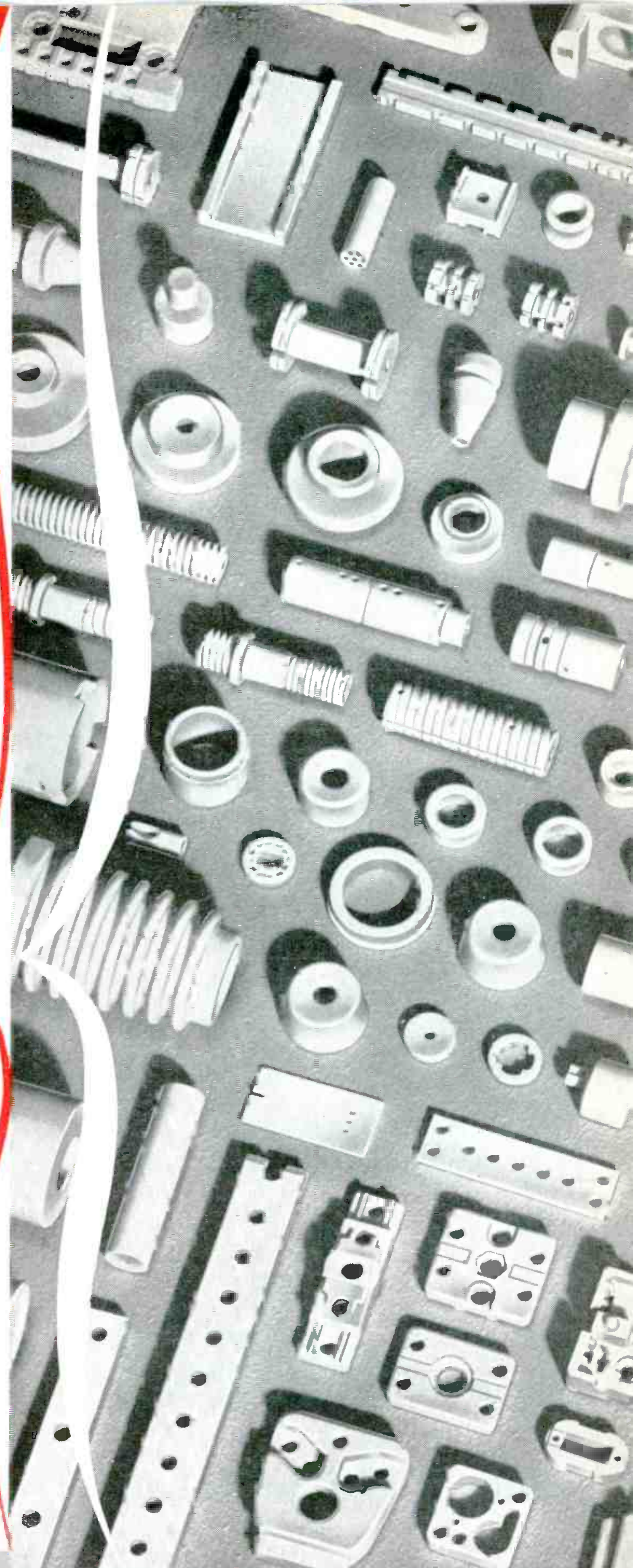
High Strength - Low Loss

Your best buy for uses requiring rugged strength, low dielectric loss, precision tolerances. Dependable performance. Produced by the source offering widest choice of specialized ceramic compositions in the field. Withstand high temperatures. Hard. Minimize chipping, breaking. Chemically inert. Permanently rigid. Cannot rust, corrode or deteriorate with time. Wide latitude of shapes and sizes. Pressed . . . extruded . . . machined. The right equipment for every operation, every size order . . . to improve quality, decrease cost. Rapid delivery of uniform parts. Prototypes available . . . small lots for test purposes without special tooling.

VERSATILE *AlSiMag 196* STARS IN SUCH APPLICATIONS AS THESE:

Atomic Applications	Mounting Plates
Appliance Parts	Spacers
Bobbins	Standoffs
Bushings	Supports
Coil Forms	Switchbacks
Dowels	Terminal Boards
Grommets	Transformer Bushings
High Frequency Insulators	Trimmers
	Tube Parts

Why not investigate the many advantages of AlSiMag 196 for your application? Sketch or blueprint, together with details of operation, will bring you complete information.



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CHATTANOOGA 5, TENN.
54TH YEAR OF CERAMIC LEADERSHIP

A SUBSIDIARY OF MINNESOTA MINING AND MANUFACTURING COMPANY

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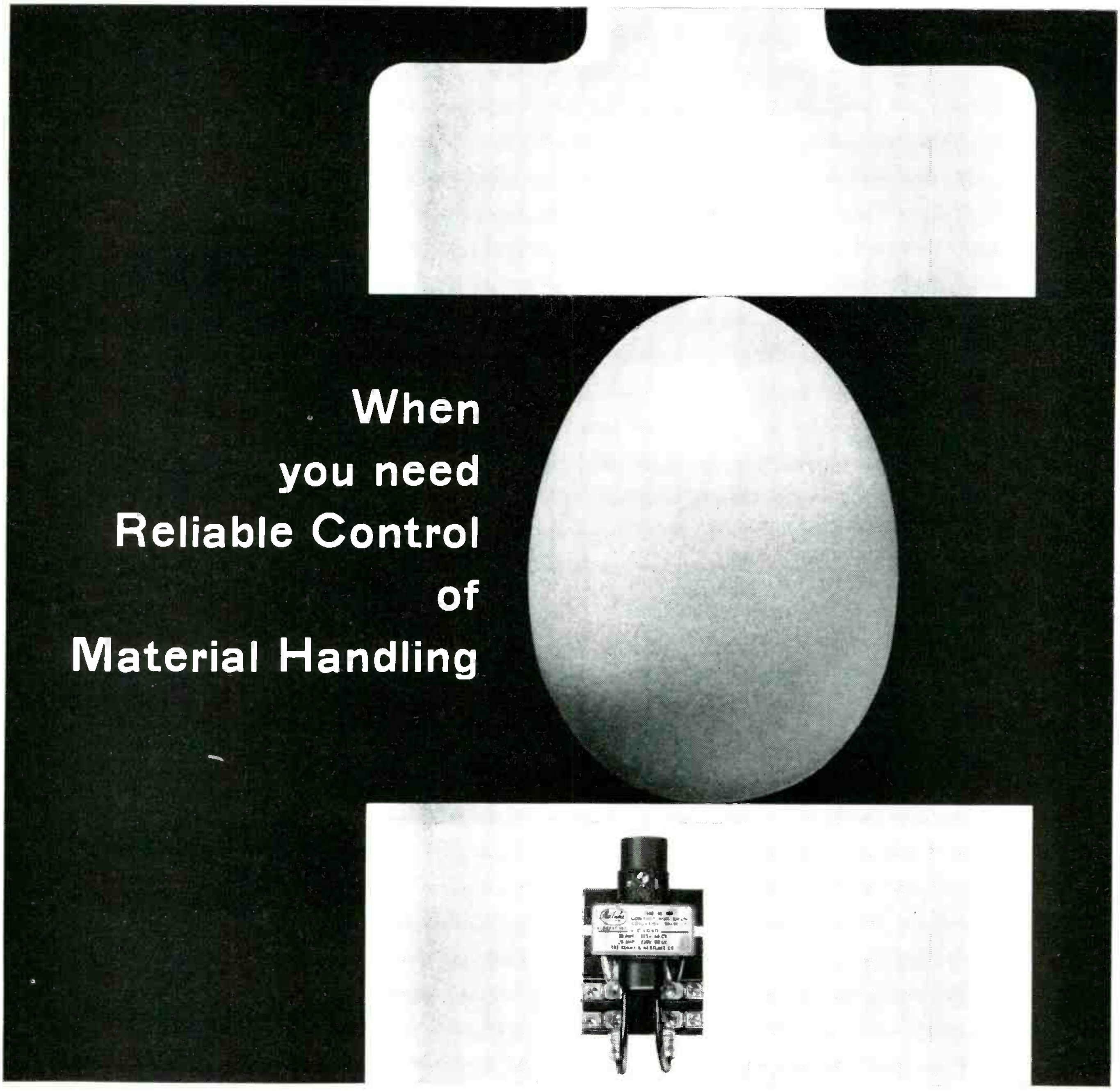

you need Adlake *mercury-to-mercury* relays

- **Mercury-to-Mercury contact of Adlake Relays gives ideal snap-action with no pitting, sticking or burning.**
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If you have a control problem, our engineers will be happy to help you solve it. There's no obligation. Write The Adams & Westlake Company, 1171 N. Michigan, Elkhart, Indiana.

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The Adams & Westlake Company
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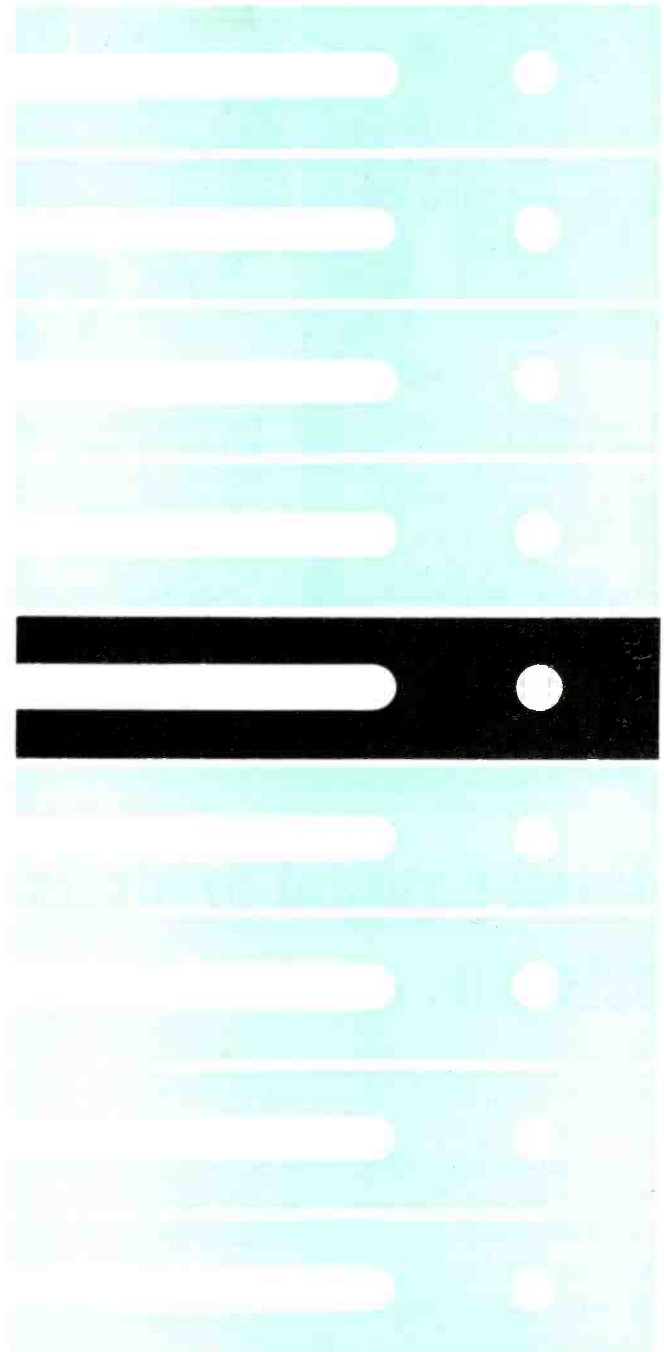

Tuning Fork Resonators, the ultimate in precision audio frequency control.

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PHILAMON LABORATORIES INC.

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MASS SPECTROMETER SEPARATES ELECTRON PARTICLES

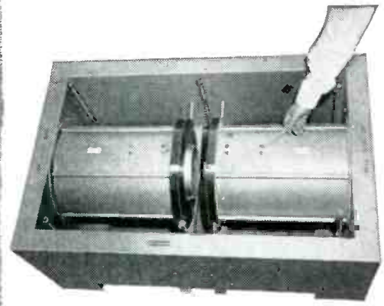
This mass spectrometer for basic research in the petroleum industry required an extremely stable, high-intensity field which could be varied.

This assembly, which incorporates a massive 1,300-pound Indiana Alnico permanent magnet, provided the answer. It has a maximum field strength of 6,000 gauss, and stability is maintained without the use of complex control equipment normally associated with electromagnets.

ELECTRONIC "BRAIN" SENSITIVITY DEPENDS ON ALNICO

This electronic computer manufacturer required a permanent magnet housing for the magnetic tape reader and recorder unit of the processing machine in order to improve sensitivity.

Using Alnico for this housing brought on immediate improvement in signal strength . . . and better sensitivity because of the magnet's high efficiency.



NUCLEAR RESONANCE RESEARCH UNIT USES 1,000-LB. MAGNET

The University of Chicago, renown in the field of basic research, required a high intensity magnetic field to extend their research in nuclear resonance.

This huge permanent magnet assembly, containing over 1,000 pounds of Indiana Alnico, produces a field of 6,750 gauss. The stability — an inherent quality of permanent magnets — is maintained without the use of costly controls.

How three unusual products use Alnico permanent magnets plus creative design ... by Indiana

These dramatic examples of the use of Alnico permanent magnets illustrate how the creative engineering and manufacturing skill of The Indiana Steel Products Company have combined to meet the critical requirements of three unusual products.

This same experience can be put to work for you, too . . . regardless of application. Indiana offers the largest staff of magnet engineers and the most complete research and production facilities in the world to assist in the development of permanent magnets for use in your products.

Be sure your new designs incorporate the most efficient and economical magnet! Contact Indiana, today, for engineering assistance and recommendations—without cost or obligation, of course!

You can expect from Indiana:

- Uniform, high energy magnets
- 24-hour service on "stocked" Alnico V magnets for your product development work
- Engineering assistance with new magnet designs—no cost or obligation
- World's most complete magnet production and research facilities

For your product development work, Indiana stocks a wide variety of standard Alnico V magnets—available immediately in experimental quantities. Write for Catalog 11-A6

THE INDIANA STEEL PRODUCTS COMPANY • VALPARAISO, INDIANA

World's largest manufacturer of permanent magnets

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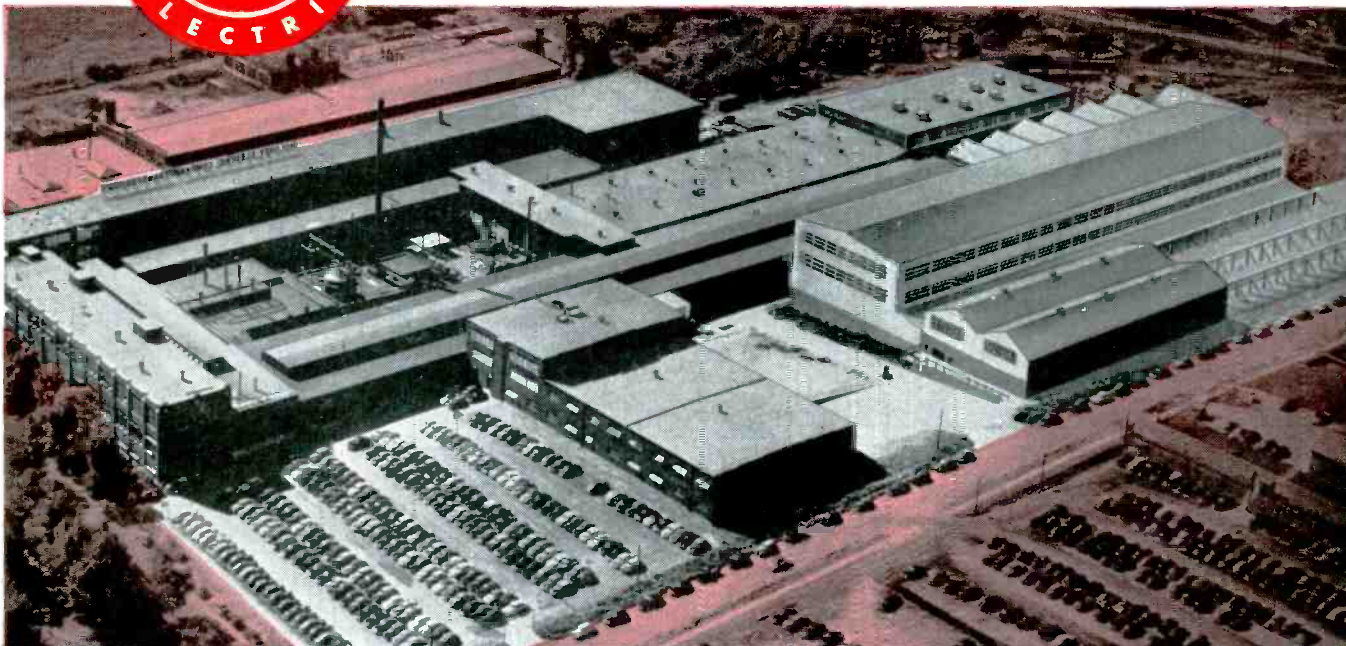
INDIANA PERMANENT MAGNETS

MAGNETIC COMPONENTS IN PROTOTYPE OR PRODUCTION RUNS



Slitting grain oriented core steel.

Winding Electronic Transformer Cores.

Annealing Electronic Cores.

40,000,000 watt Pulse Generator for testing Electronic components.

Moloney manufactures a line of quality components for electronic applications that comply in detail to ASA, RETMA, Mil-T standards . . . or to your particular requirements. Moloney manufactures for electronics the following products

Plate and Filament Transformers • Chokes • Unit Rectifiers • Modulation Transformers and Reactors Pulse Transformers and Charging Chokes • Developmental Magnetic Components • HyperCores for Magnetic Components

Moloney utilizes industry's finest test facilities for the testing of magnetic components in unlimited KVA and voltage ratings.

ME57-11

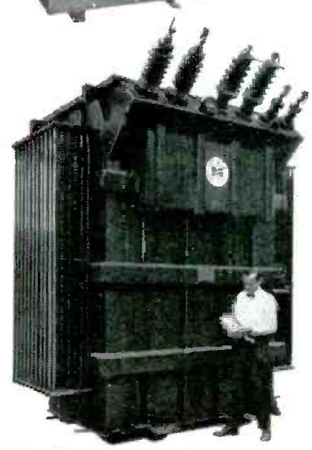
MOLONEY ELECTRIC COMPANY

Manufacturers of Transformers for Utilities, Industry, and Electronic Applications

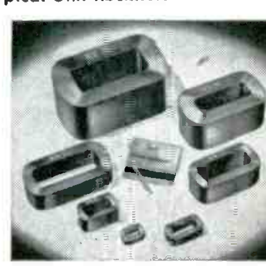
SALES OFFICES IN ALL PRINICPAL CITIES
FACTORIES AT ST. LOUIS 20, MO. AND TORONTO, ONT., CANADA

Typical Dry Type Plate Transformer.

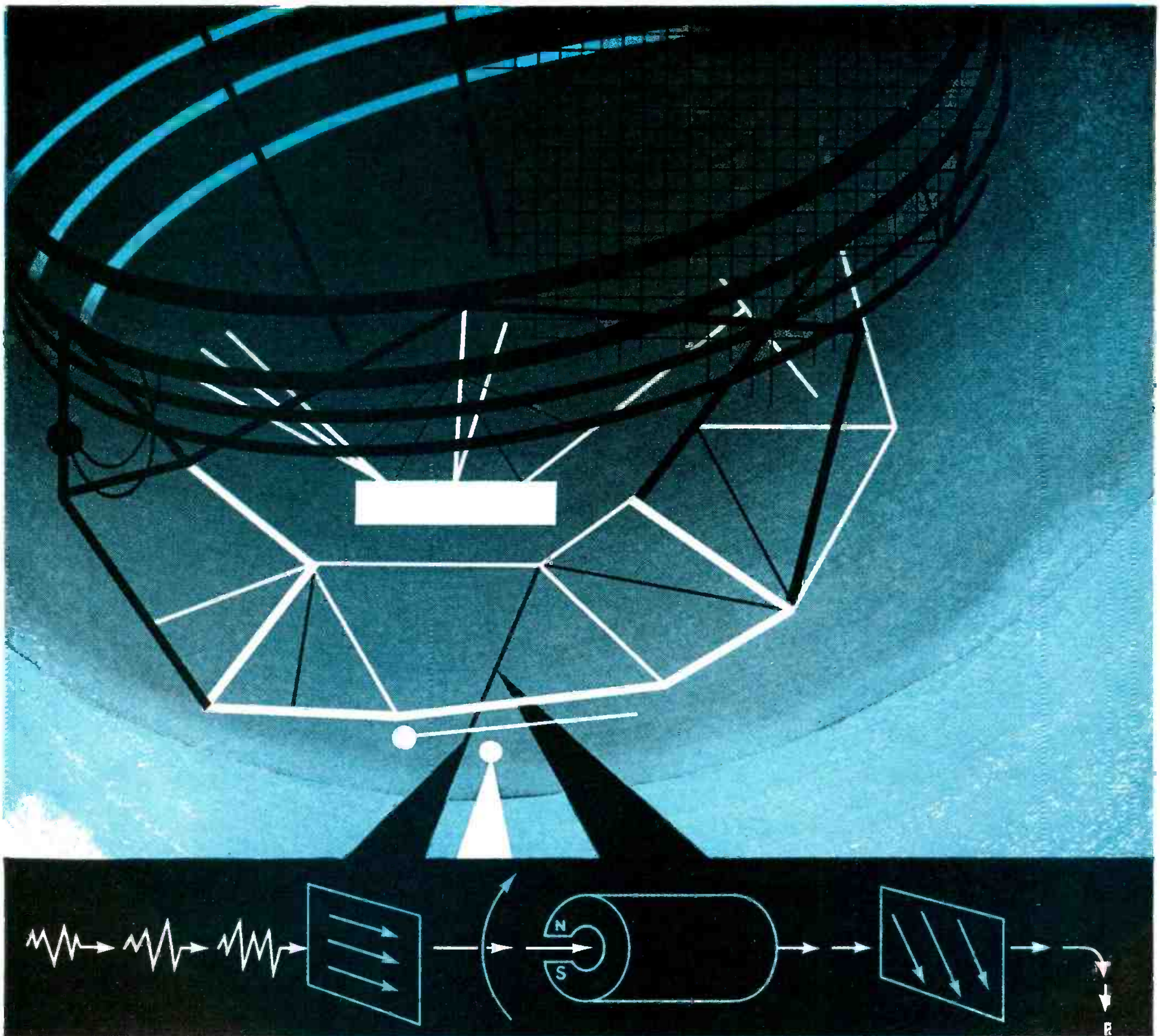
Typical Unit Rectifier.



Pulse Transformer—the world's most powerful and largest (over 49,000 lbs.)



HyperCores for electronic applications.



in radar load isolators, too

CRUCIBLE PERMANENT MAGNETS

give maximum energy. . . minimum size

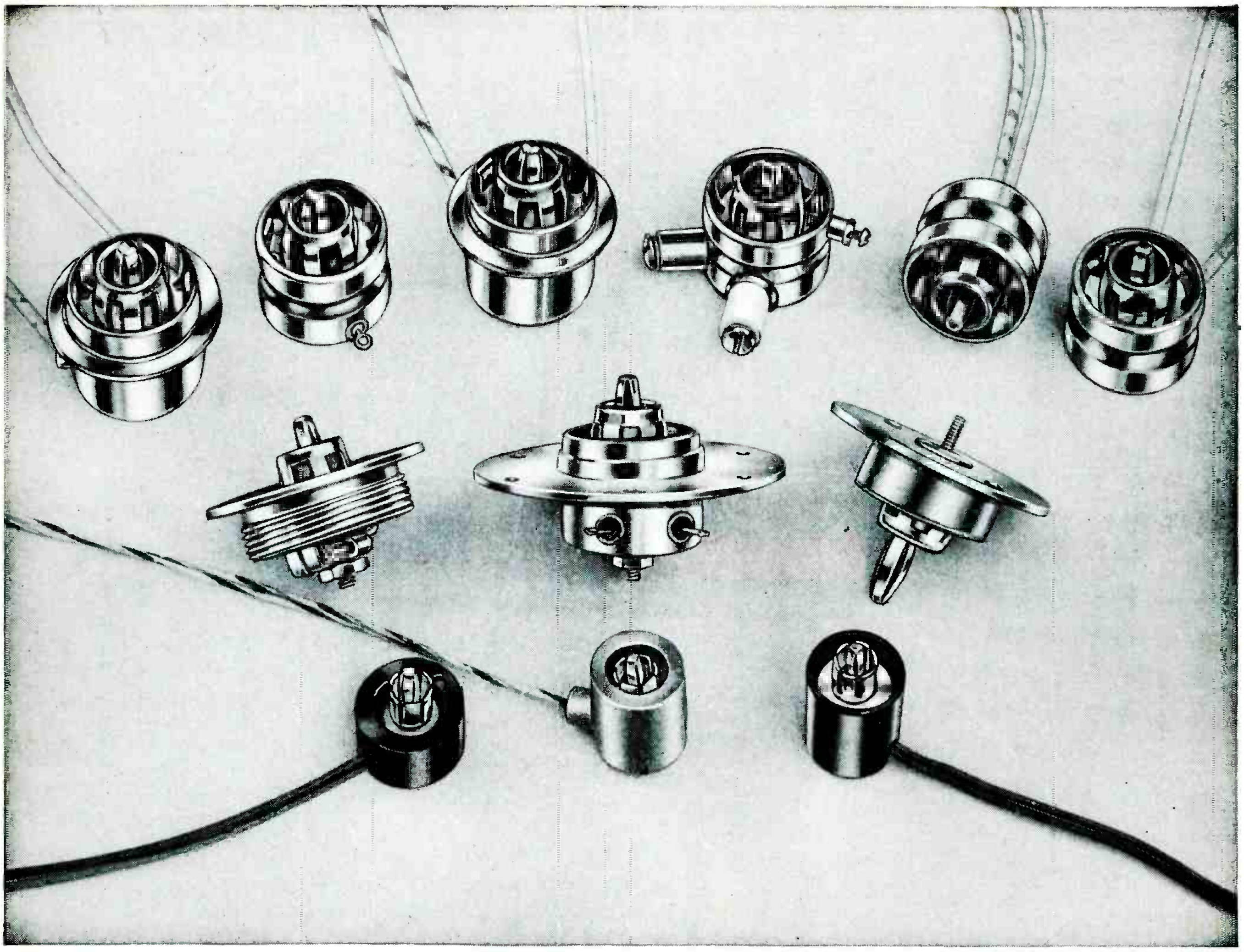
Special applications, such as radar load isolators, demand compact but powerful magnet assemblies. And this is but one of the many places where the *consistently* higher energy product provided in Crucible Alnico magnets pays off.

These Crucible Alnico permanent magnets can be sand cast, shell molded, or investment cast to exact size, shape or tolerance requirements . . . and in any size from a mere fraction of an ounce to hundreds of pounds.

The design and production of permanent magnets has been a Crucible specialty ever since Alnico alloys were discovered. It's one of the good reasons why so many people bring their magnet applications to Crucible. Why don't you? *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE **first name in special purpose steels**

Crucible Steel Company of America



HOW MANY WAYS CAN *Special Purpose Fasteners* CUT COSTS FOR YOU?

How many of your products employ laborious, old-fashioned fastening methods where simple fasteners could do the job and cut costs, too? How many parts and sub-assemblies can be adapted to include a self-fastening feature? How many future products could be improved by advance planning for fastener efficiency?

United-Carr's engineering staff offers you a wealth of experience in the design of special-purpose fasteners and self-fastening devices. Large-scale manufacturing facilities (including in-plant plastics molding equipment) ensure economical, *volume* production and prompt deliveries. United-Carr field representatives are ready to call on you at *your* request.

POLYETHYLENE MOUNTING FOOT

No mar, no scratch glide for use on TV receivers, record changers, small appliances, etc. Assembles into round hole in wood or metal cabinets.

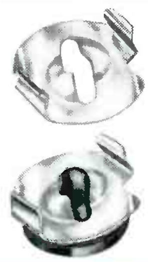
NYLON SNAP-IN NUT

Snaps into square hole stamped out of sheet metal . . . provides secure anchorage for any sheet metal or self-tapping screw . . . highly effective electrical insulator.

QUICKEY FASTENER

Eliminates need for welding or swaging studs to sheet metal stampings, facilitates nesting, eliminates damage in transit because Quickey snaps in before final assembly.

THREAD CUTTING FASTENER



Re-usable, self-locking, vibration-proof fastener cuts clean, deep threads on unthreaded chrome-plated studs. Available for ⅛″, 3/16″ and ¼″ studs.

PLUG BUTTONS

Snap into ⅛″ to 3″ dia. holes. Can be embossed with ornamental or functional designs . . . various finishes, shapes and sizes.

FISHTAIL RATCHET PLATE

Holds on smooth, die-cast metal or plastic studs to anchor name plates, trade marks etc. on appliances, automobiles, electronic apparatus, etc.

TRIMOUNT STUDS

Hold two or more thicknesses of material together. Easily installed by hand. Insure vibration proof attachment. Permanent or removable. Many shapes and sizes.

V-LOCK TEENUT

Re-usable, self-locking, one-piece, all-metal nut has high tensile strength, is unaffected by heat or oils. In various shapes, sizes and metals.

SOL-A-NUT

Self-locking, rustless, heat resistant. Sturdy, one-piece stainless steel construction prevents corrosion if nicked or scratched.

DURABLE DOT FASTENER

Snap fastener for cloth, leather, plastics and other materials. Positive closure, instant release. Black, nickel or brass finish.

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MAKERS OF DOT FASTENERS

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What happens to soldered joints at "fifty below"?

"Dutch Boy" solder specialists tell how to make sure they hold when cold

Push temperature down and lead's strength goes up – without major loss in ductility.

Not so with tin. Below – 18°F, tin may suffer allotropic transformation. Gets brittle. Changes color.

Recent "Dutch Boy" research shows, as you might expect, that lead-tin solders tend to split this difference in rough proportion.

A 50-50 solder, for example, yields joints with higher tensiles at —75°F than at room temperature. But it's more brittle. At —75°F the joined metals still fail before the joint. Further down the temperature scale, joints fail first.

Increasing the lead content lowers the temperature at which joints retain good ductility. But strength does not increase as rapidly as temperatures go down.

Up to 15%, tin content has little effect on ductility. Beyond that, the loss in ductility (and in impact and fatigue resistance) that occurs as temperatures go below —18°F should be considered.

Allotropic change in tin may be inhibited with antimony

For makers of aircraft, missile and arctic electronic equipment, and for others whose products meet with extreme low temperatures, a recent proposed change in Government specs is of interest.

This proposal, which calls for 0.2 to 0.5% antimony in solders in the 40 to 70% tin range, is based on investigations showing that antimony inhibits allotropic change in tin as the thermometer falls.

Your "Dutch Boy" Solder specialist is well informed on this and other frontier areas of solder technology now under investigation at National Lead Laboratories and elsewhere. Use his specialized knowledge freely. Or write National Lead Company, 111 Broadway, New York 6, N. Y.

Dutch Boy
SOLDER AND FLUXES

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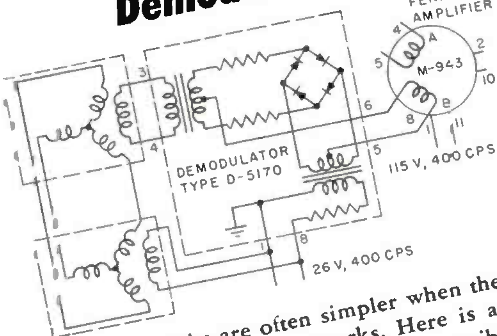
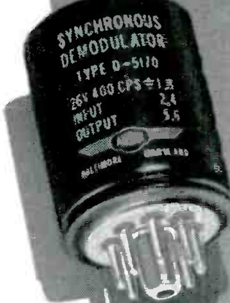
Accessories for Ferrac Amplifiers

400-CPS Phase-Sensitive Demodulator

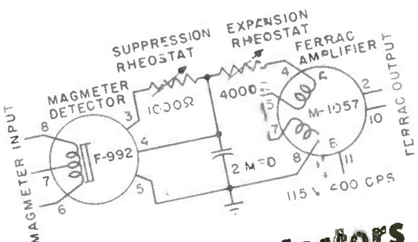




Your servo circuits are often simpler when they use DC lead and lag correction networks. Here is a magnetic demodulator that produces a polarity-reversible DC output from a 400-CPS phase-reversible control signal. The output can be mixed with other DC signals, and amplified in a Ferrac amplifier.

Type D-5170 demodulator has a stable null and is designed for use in zero-seeking systems such as synchro control transformers. Type D-5171 demodulator has a linear characteristic for use in proportional systems such as gyro pick-offs.

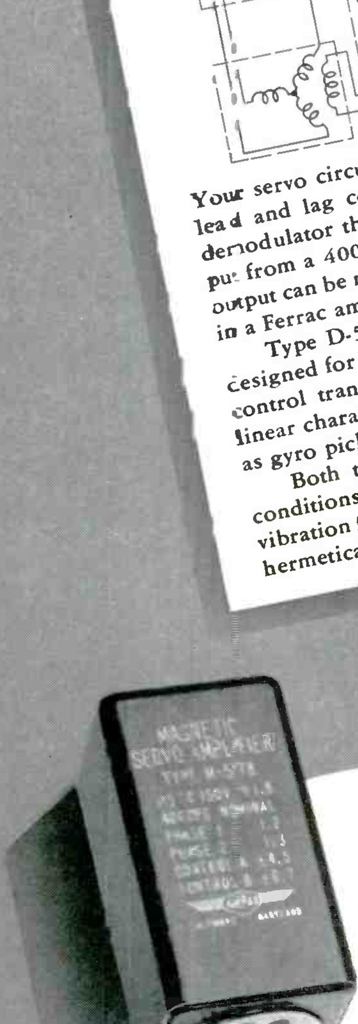
Both types operate under the same environmental conditions as do Ferrac amplifiers: −55 C to +85 C, 10 G vibration from 10 to 2000 CPS, and 30 G shock. Units are hermetically sealed for operation in any atmosphere.



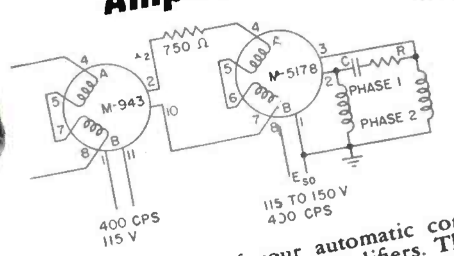
Magmeter Detectors

Where you require an output signal proportional to input frequency (or any parameter convertable to frequency such as RPM or pulse rate) you can use a Magmeter detector to advantage. This compact component delivers an output linearly proportional to input frequency within ±2%. The output can then be amplified or mixed with other control signals by a Ferrac amplifier.

Type F-992 Magmeter detector covers the band 375 CPS to 425 CPS. Other types are available covering any ±5% band (or wider) from 50 CPS to 5 KC or any band from 0 CPS to an upper limit that may be anywhere from 50 CPS to 5 KC.



Servo Power Amplifiers



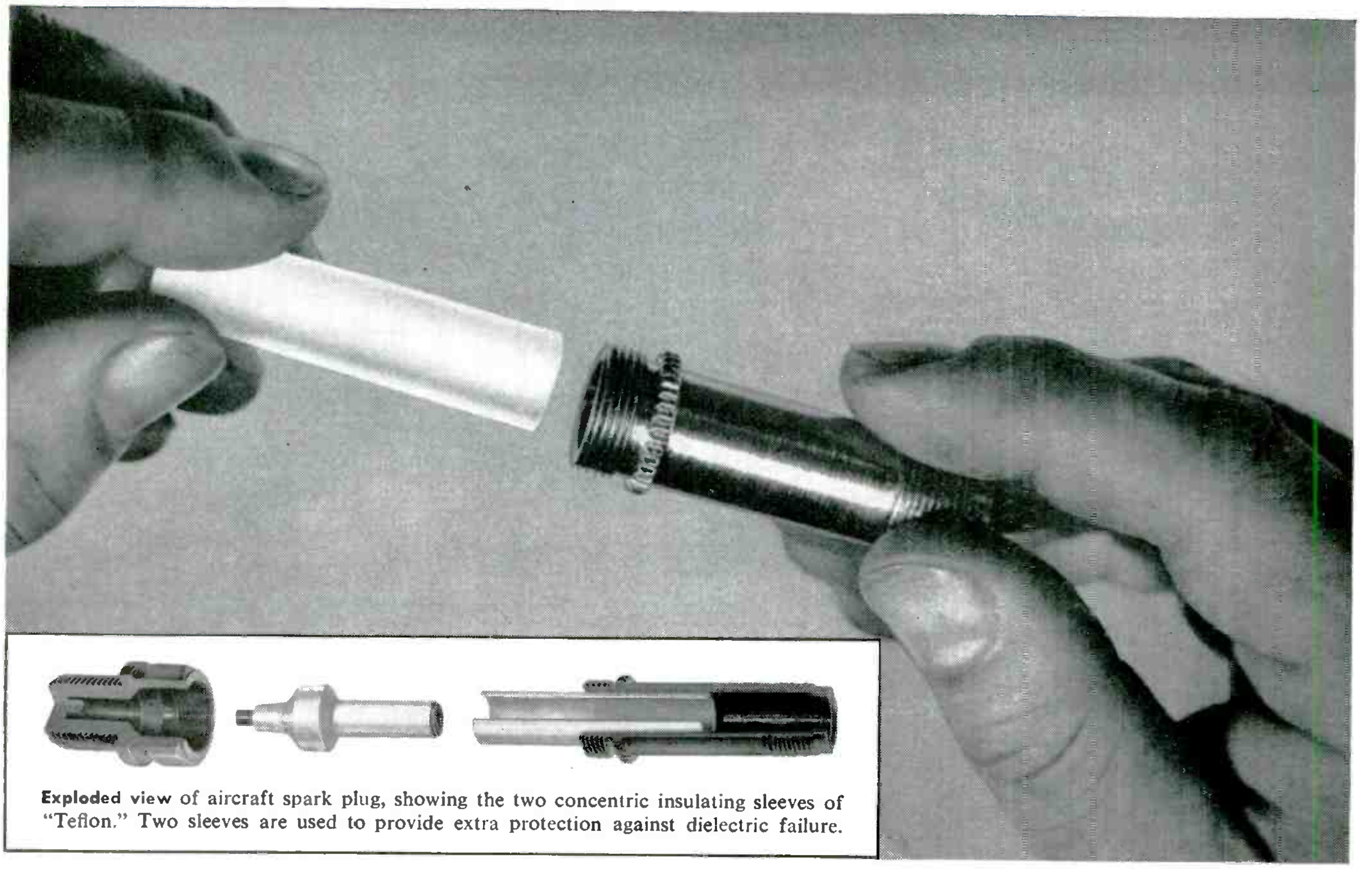
Analog computer operations of your automatic controller are readily performed by Ferrac amplifiers. The resulting control signal can drive an Airpax servo amplifier to power a servo motor. These power amplifiers control the currents to both windings of split-phase motors. As a consequence, the stand-by power to the motor is less than with other types.

Type M-5178 servo power amplifier develops 6 watts output per phase. It is 1⅜ inches square, 3 inches seated height, has an octal pin base, and weighs 14 ounces. Other types deliver from 3 to 10 watts per phase.

Ferrac amplifiers are instrument type magnetic amplifiers of exceptional stability and linearity for use in guidance and automatic control equipments.

DESIGNERS
AIRPAX PRODUCTS COMPANY
ENGINEERS

ENGINEERING DIVISION • MIDDLE RIVER • MARYLAND



Exploded view of aircraft spark plug, showing the two concentric insulating sleeves of "Teflon." Two sleeves are used to provide extra protection against dielectric failure.

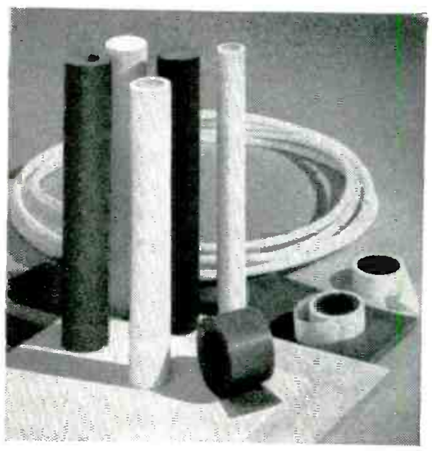
Insure trouble-free design with R/M Teflon* products

For thousands of electrical applications "Teflon" has proved to be the best material because of its combination of properties—electrical, thermal and mechanical. It permits compactness of design, and because of its resiliency and toughness, components made from it often simplify installation. R/M Tape handles easily, conforms well to corners and unusual shapes, can be readily adapted for automatic wrapping.

Here are some of the electrical properties of R/M "Teflon":

1. **Power factor** — less than 0.0003 over entire spectrum from 60 cycles to 30,000 megacycles.
2. **Volume resistivity** — greater than 10^{15} ohm-cm, even after prolonged soaking in water.
3. **Surface resistivity**— 3.6 x 10^{12} ohms even at 100% humidity.
4. **Good arc-resistance**— on exposure to an arc, the material vaporizes, leaving no carbonized path.
5. **High short-time dielectric strength** — values range from 1000 to 2000 volts per mil, depending on thickness.
6. **Resists high temperatures** — electrical properties are essentially unchanged up to at least 400°F.

Take advantage of R/M's long experience in developing the potentials of "Teflon" for the electrical industry. We fabricate "Teflon" to your specifications or supply it in rods, sheets, tubes, wire and tape in all standard color codings. Send for our bulletin "R/M Teflon Products."



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For Reliable Performance... Stability of Operation... Long Life!

ACTUAL SIZE

MINIATURE LOW LEVEL AUDIO TRANSISTORS (25 mw)

2N207	general purpose micro-miniature low level transistor, typical beta of 100, 15 db maximum noise figure
2N207A	10 db maximum noise figure version of 2N207
2N207B	5 db maximum noise figure version of 2N207
T0031	50 volt version of 2N207

Special versions of the 2N207 to selected beta ranges are available.

HIGH FREQUENCY, HIGH GAIN (MICRO ALLOY) TRANSISTOR

T1166	combines high frequency response with high gain for general purpose high frequency applications and switching circuits, typical f_{max} 60 mc

HIGH FREQUENCY SILICON TRANSISTORS (150 mw)

T1025	general purpose, 10 mc silicon transistor
T1159	high speed silicon switch for speeds up to 5 mc characterized by extremely low switch resistance

ACTUAL SIZE

HIGH FREQUENCY SURFACE BARRIER TRANSISTORS

SB100	general purpose, minimum f_{max} = 30 mc, beta over 10.5
2N344/SB101	general purpose, good beta control (11-33)
2N345/SB102	general purpose, higher beta (25-110)
2N346/SB103	general purpose, higher minimum f_{max} (60 mc)
2N128	general purpose, with military specifications, beta 19-66, minimum f_{max} 45 mc
2N129	general purpose, with military specifications, beta over 11.5
2N240	switching transistor, $f_{\alpha b} > 30$ mc
2N299	for tuned amplifiers, military specifications, 20 db minimum power gain at 10 mc, minimum f_{max} 90 mc
2N300	for video amplifiers, 50 mc minimum current gain bandwidth product, f_{max} over 85 mc
T1050	high frequency transistor for 50 mc oscillator mixers and 10-15 mc bandpass amplifiers, 22 db typical power gain at 10 mc

Other types with special parameter controls are available.

ACTUAL SIZE

MEDIUM POWER ALLOY JUNCTION AUDIO TRANSISTORS (100 mw)

2N223	39-120 beta driver transistor
T1000	45-85 beta version of 2N223
T1001	70-120 beta version of 2N223
2N224	high gain output transistor, 2N225 is a matched pair
2N226	medium gain version of 2N224, 2N227 is a matched pair

Versions of the 2N224 with various beta ranges and higher betas are available singly or in matched pairs.

AUDIO POWER TRANSISTORS

T1040	40 volt, 7 watt power transistor, thermal drop 3°C/w maximum
T1041	40 volt, 10 watt power transistor, thermal drop 2.5°C/w maximum
T1167	60 volt, 12.5 watt power transistor
T1168	80 volt, 12.5 watt power transistor

Proven performance of Philco Hermetically Sealed Transistors has made them the basis for design in commercial and military applications where reliability is the major consideration. Philco transistors range from the world's smallest germanium transistors now in production to silicon transistors with excellent performance at temperatures from —60°C to +150°C.

Philco produces a wide range of transistors designed for special applications in accordance with customer requirements. The Philco Micro-Alloy Transistor is in production. Specifications and design quantities are available. New and exciting transistor types, such as the Philco Micro-Alloy Graded Base Transistor, are now in development. In keeping with our policy, specifications will be made available as soon as these units reach pilot production and are available in design quantities.

Make Philco your prime source for complete transistor application information... write to Lansdale Tube Company, Dept. I-2, Lansdale, Penna.

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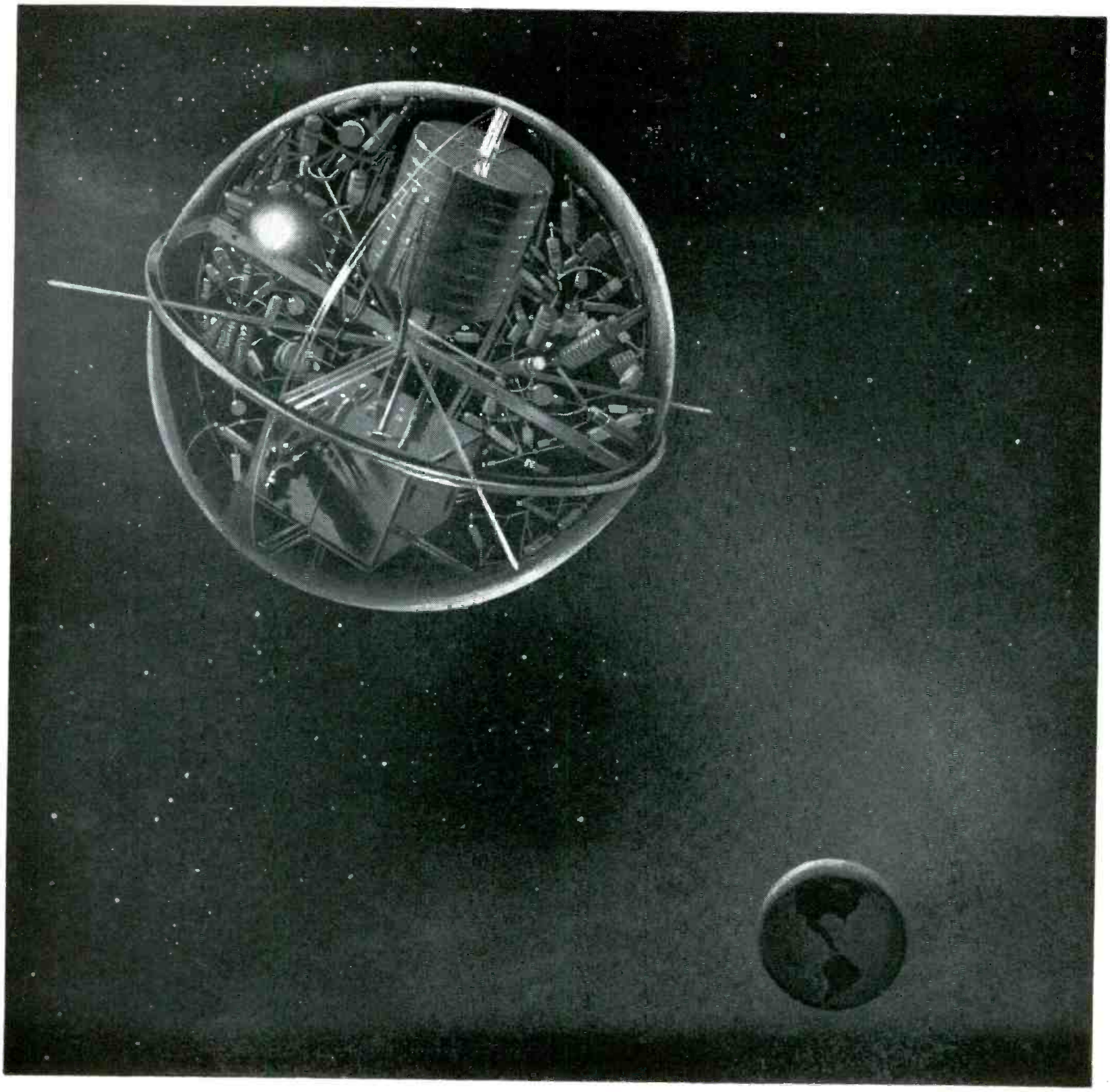

Putting a voice in the man-made moon

America's first man-made satellite will soon be launched into outer space where, traveling in its own orbit, it will circle the earth.

Deep inside will be sensitive electronic instruments which will "observe" cosmic activity and "report" findings back to us. Scientists believe that many a mystery of the universe may thus be solved.

Without electrical insulation of exceptional qualities, such as CDF supplies, the equipment inside these man-made moons could never operate.

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*duPont trademark for its tetrafluoroethylene resin

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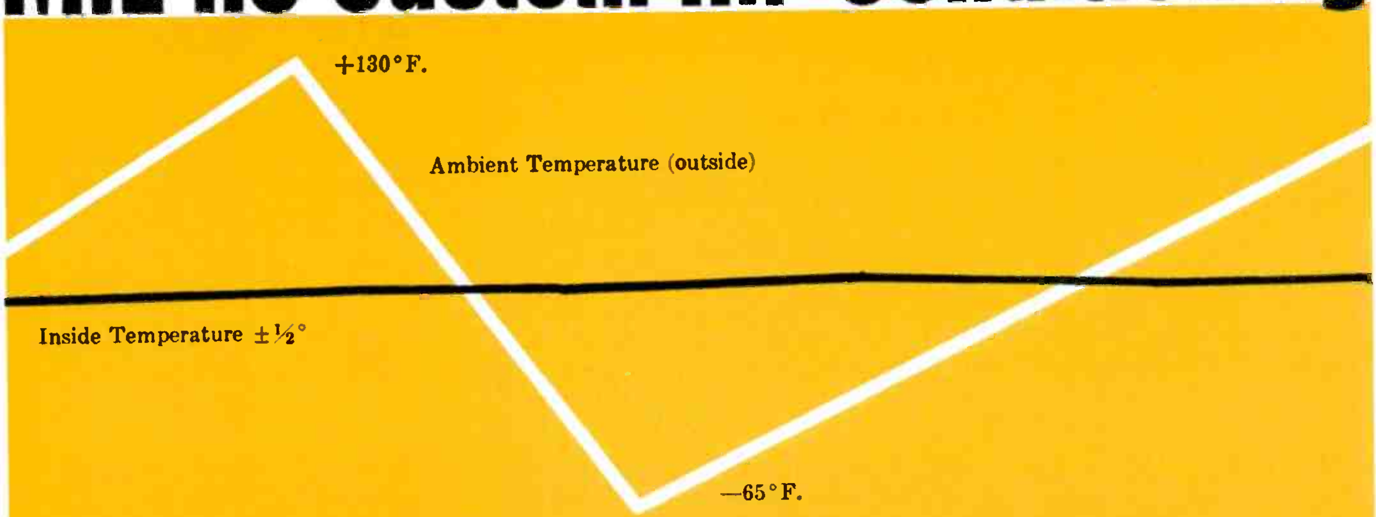

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MIL-AC Units are self-contained, compact, lightweight, readily air-transportable. They can be designed to cool, heat, humidify, dehumidify, filter, and can incorporate air-cooled or water-cooled condensers. Units are manually or automatically controlled. We are staffed with specialists who will analyze your requirements, submit a proposal, complete your installation promptly and to your complete satisfaction.

Write for helpful load calculating Nomograph and other technical data for use in making time-saving preliminary calculations.

*Military specification dealing with the following climatic and environmental conditions: Temperature, humidity, altitude, salt spray, vibration, fungus, sunshine, rain, sand and dust, explosive atmosphere, acceleration and shock.

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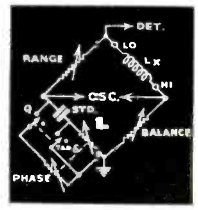
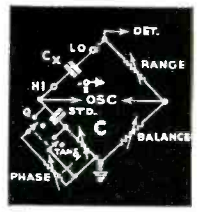
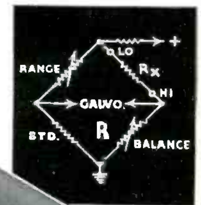


C at 1 or 10 kc



R at d.c.



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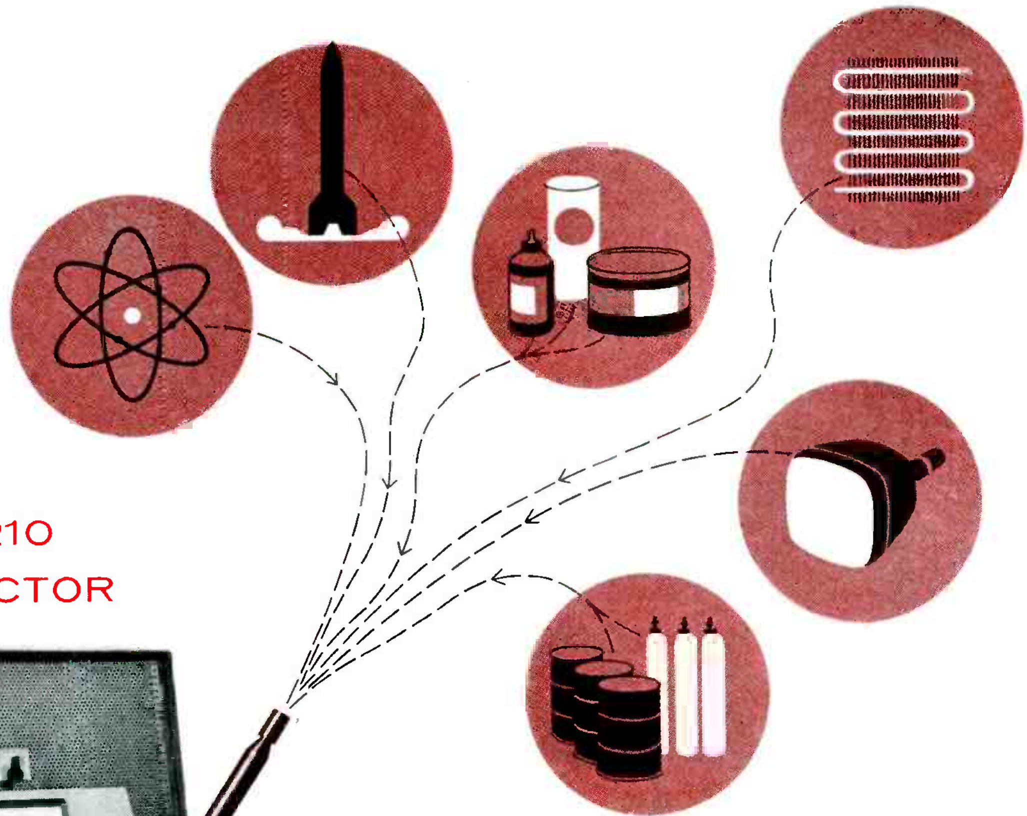
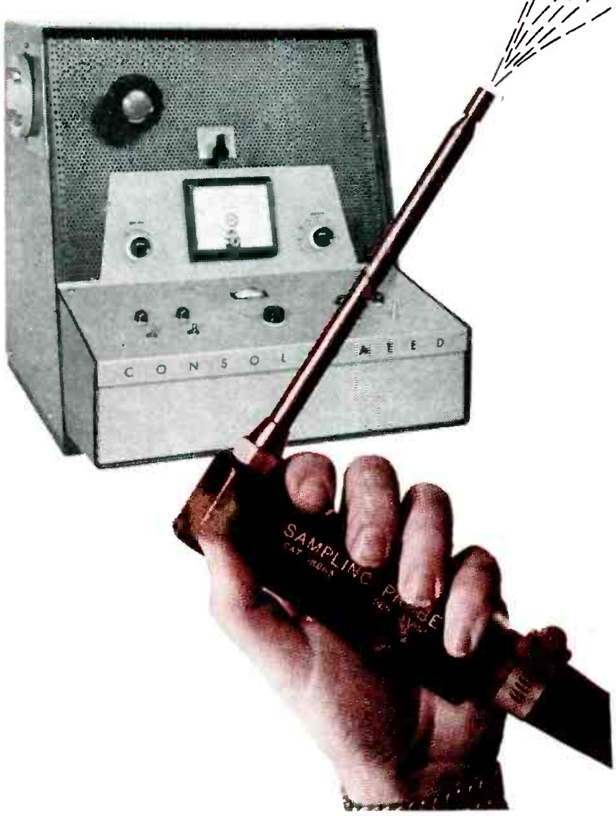


CEC'S 24-210
LEAK DETECTOR



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Now you can test your product for vacuum seal, or locate leaks in any pressurized system with pinpoint precision and practical economy. CEC's 24-210 gives you highly sensitive leak detection and long, trouble-free service. Compact and highly simplified, this low-cost, mass-spectrometer-type instrument detects leaks so minute that 50 years would be required for 1 cc to escape. Easy, convenient operation requires no special training or experience. Just plug into a 115-volt, 60-cycle line. Find out how fast the CEC 24-210 Leak Detector pays for itself. For detailed information contact your nearby CEC field office or write for Bulletin CEC 1830-X21.

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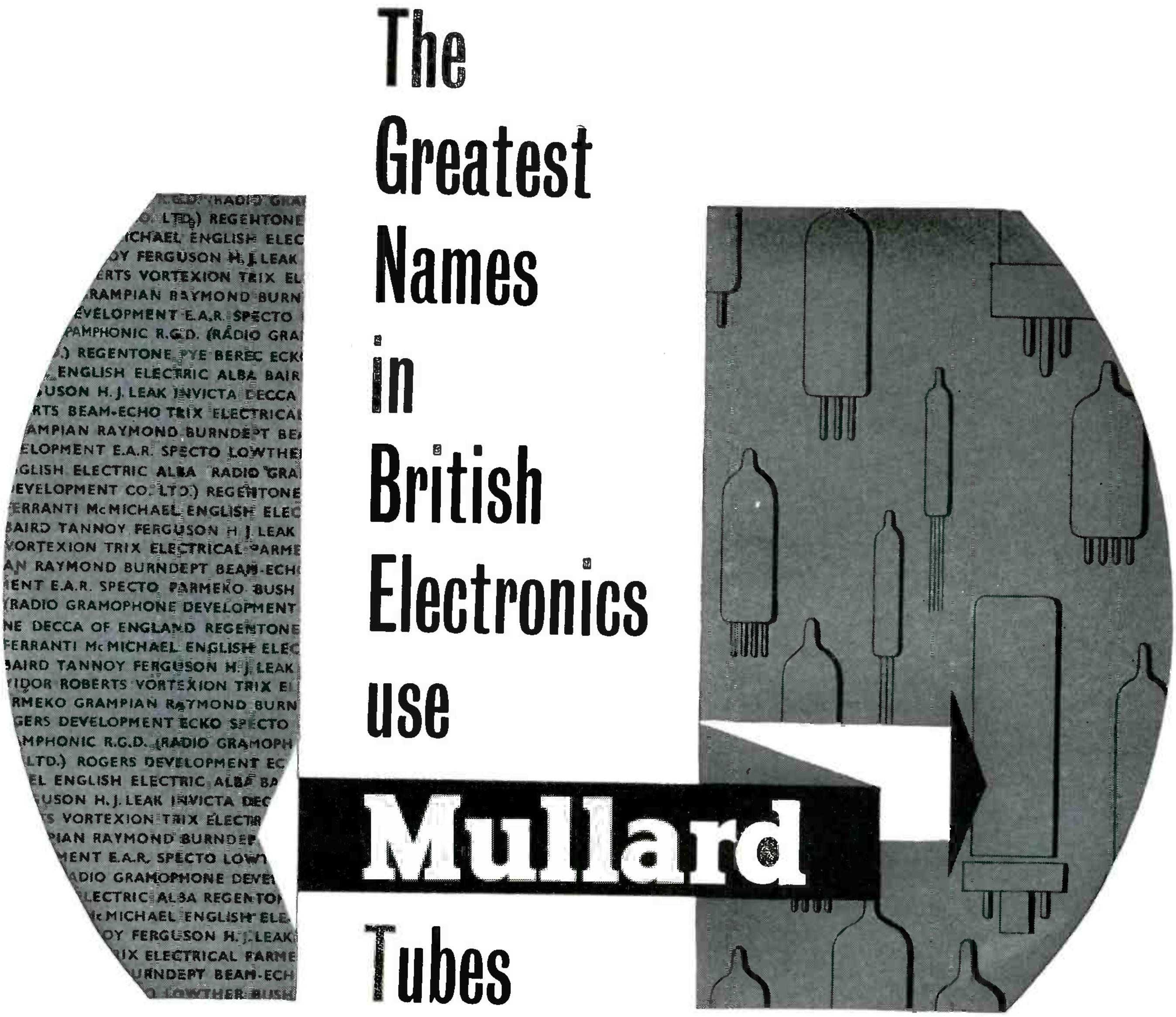

British equipment manufacturers are making a vital contribution to the development of electronics in all fields of application.

Their products are being exported to every corner of the world, earning a universal reputation for advanced techniques and excellent performance.

The majority of these electronic equipment manufacturers consistently use Mullard tubes. This choice is decided upon because they prefer the greater assurance of efficiency and dependability, and because the vast manufacturing resources of the Mullard organisation guarantee ready availability of Mullard tubes wherever they are needed.

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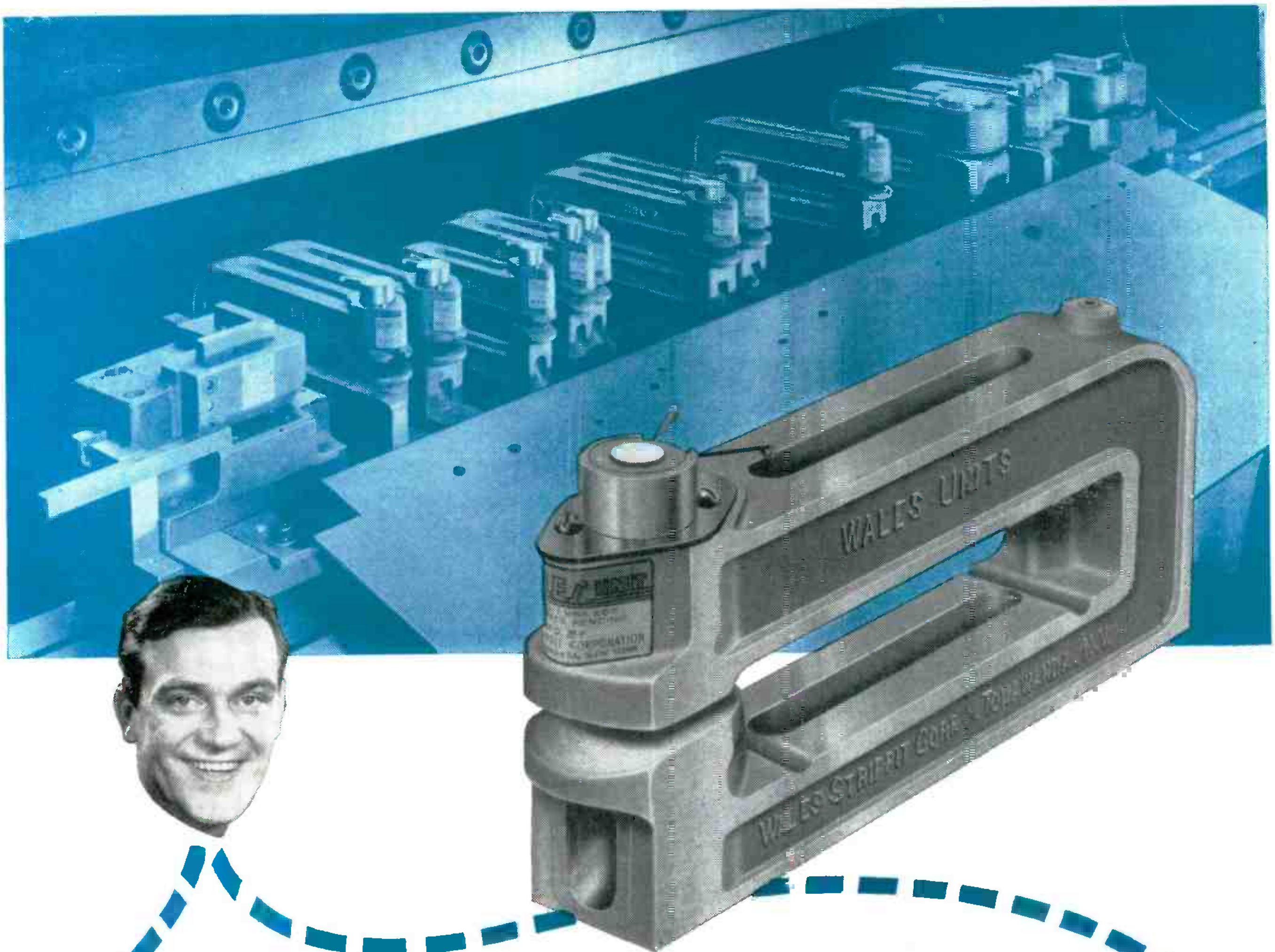

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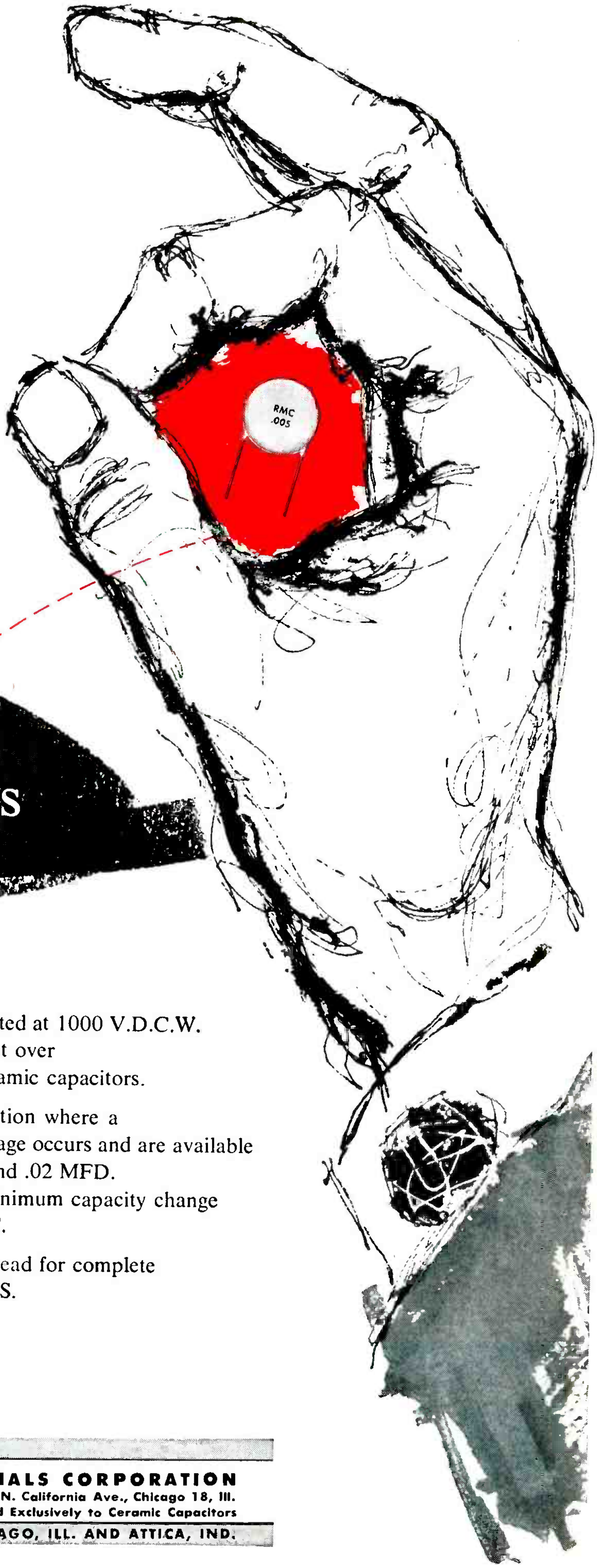

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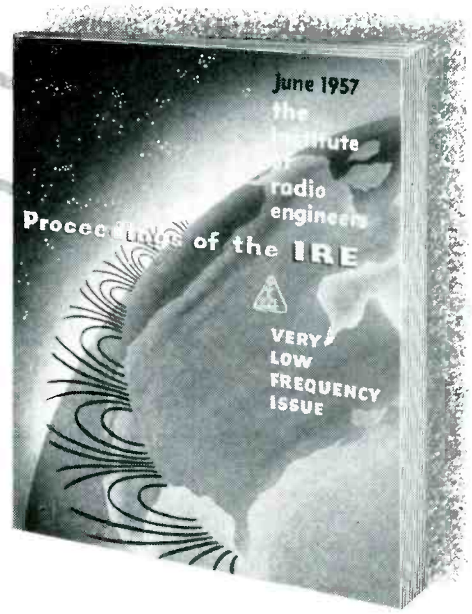

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June Proceedings of the IRE gives you the facts about VLF

This year, the Boulder Laboratories of the National Bureau of Standards and the IRE Professional Group on Antennas and Propagation co-sponsored a Symposium at Boulder, Colorado, on the propagation of very low frequency radio waves. From the papers given at this important meeting the editors of *Proceedings* have chosen those of broadest interest for publication in the June, 1957, issue.

Typical of the service offered members of IRE is this VLF report — to be used now and referred to for years to come. If you are not a member of *The Institute of Radio Engineers* be sure to reserve a copy of the June *Proceedings of the IRE*, today!

Partial Contents of this VLF issue:

"A Technique for the Rapid Analysis of Whistlers," by J. K. Grierson, Defense Reserve Board, Ottawa, Ontario, Canada.

"VLF Radiation from Lightning Strokes," by E. L. Hill, School of Physics, University of Minnesota.

"Some Recent Measurements of Atmospheric Noise in Canada," by C. A. McKerrow, Defense Reserve Board, Ottawa, Ontario, Canada.

"Intercontinental Frequency Comparison by Very Low Frequency Radio Transmission," by J. A. Pierce, Croft Laboratory, Harvard.

"The Mode Theory of VLF Ionospheric Propagation for Finite Ground Conductivity," by James R. Wait, National Bureau of Standards, Boulder, Colorado.

"The Geometrical Optics of VLF Sky Wave Propagation," by J. R. Wait & A. Murphy, National Bureau of Standards, Boulder, Colorado.

"Characteristics of Atmospheric Noise from 1 to 100 Kc/s," by A. D. Watt & E. L. Maxwell, National Bureau of Standards, Boulder, Colorado.

"The Present State of Knowledge Concerning the Lower Ionosphere," by A. H. Waynick, The Pennsylvania State University.

"Noise Investigation at VLF by the National Bureau of Standards," by W. Q. Crichlow, National Bureau of Standards, Boulder, Colorado.

"Reflection at a Shapely-Bounded Ionosphere," by I. W. Yebroff, Stanford University.

"The Attenuation Versus Frequency Characteristics of VLF Radio Waves," by J. R. Wait, National Bureau of Standards, Boulder, Colorado.

"The Waveguide Mode Theory of the Propagation of VLF Radio Waves," by K. G. Budden, University of Cambridge, England.

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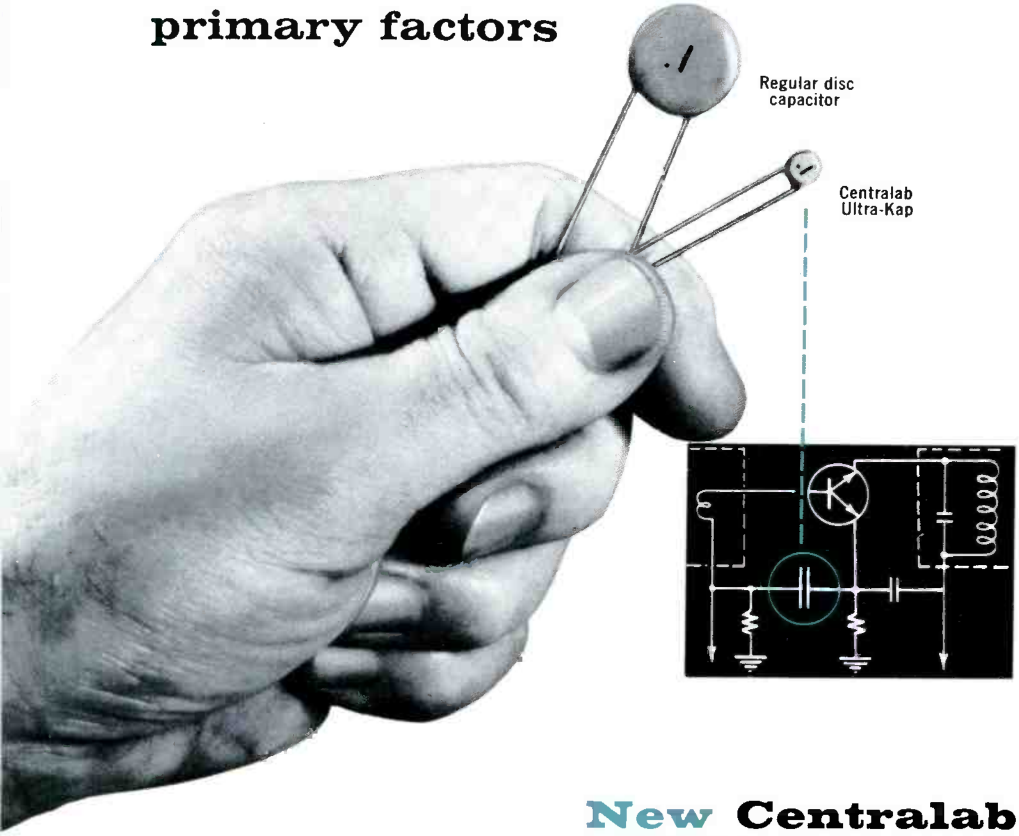

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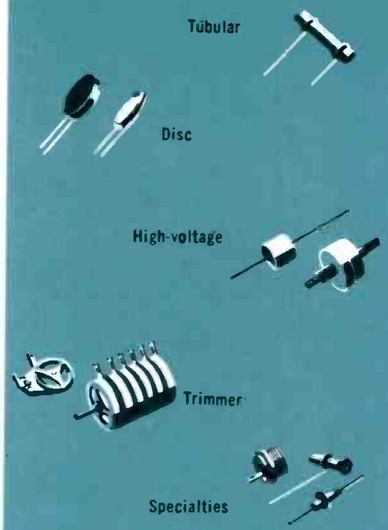

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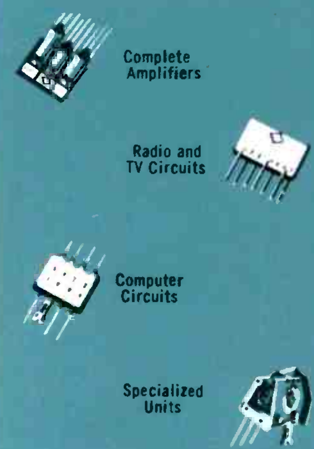

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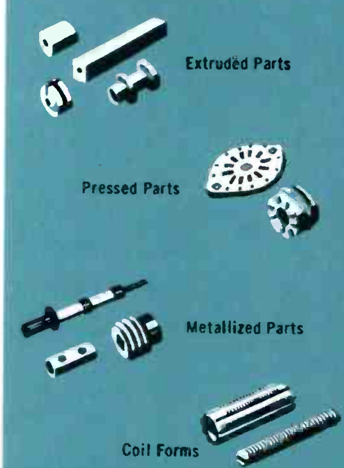

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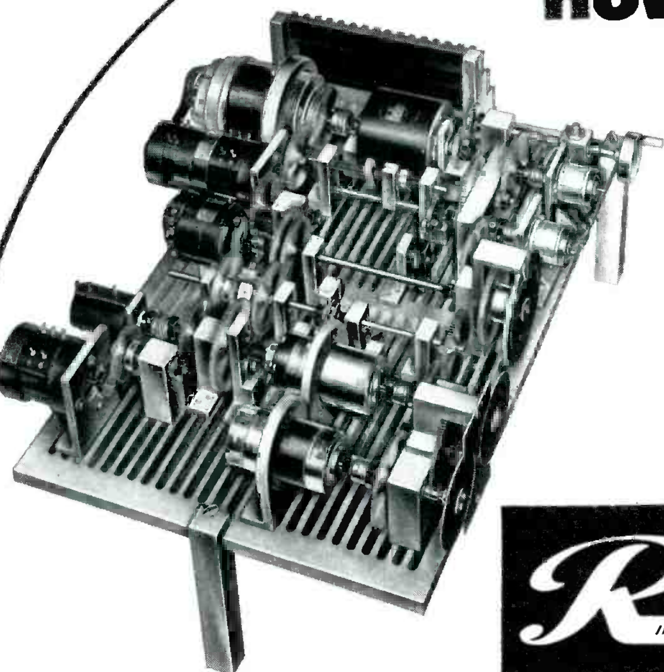

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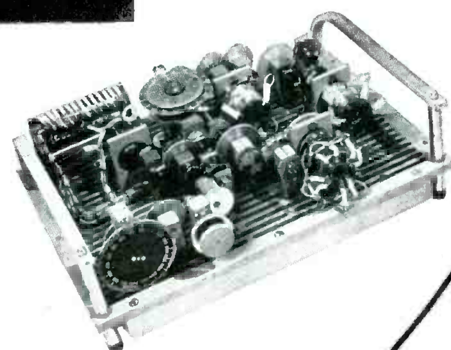

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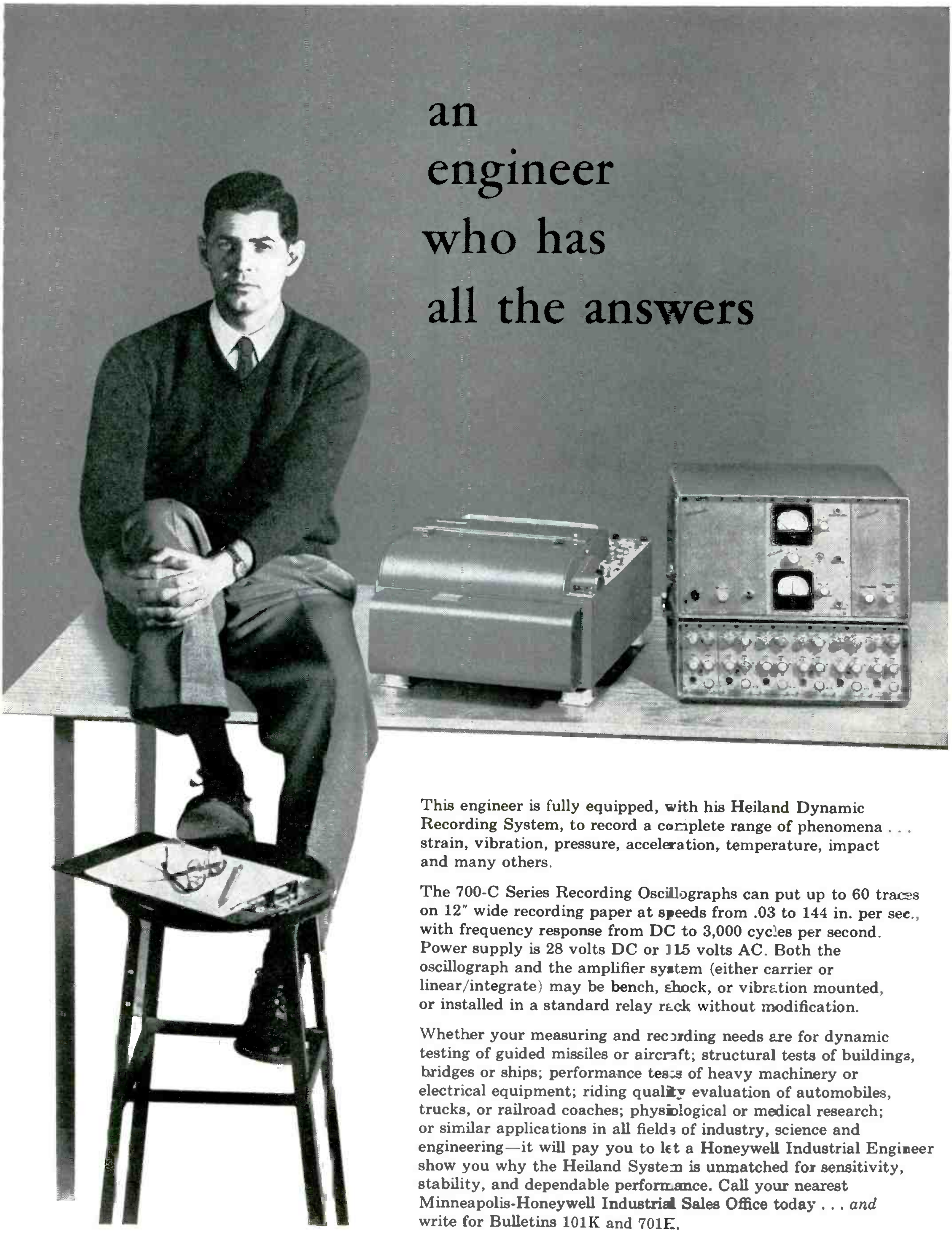

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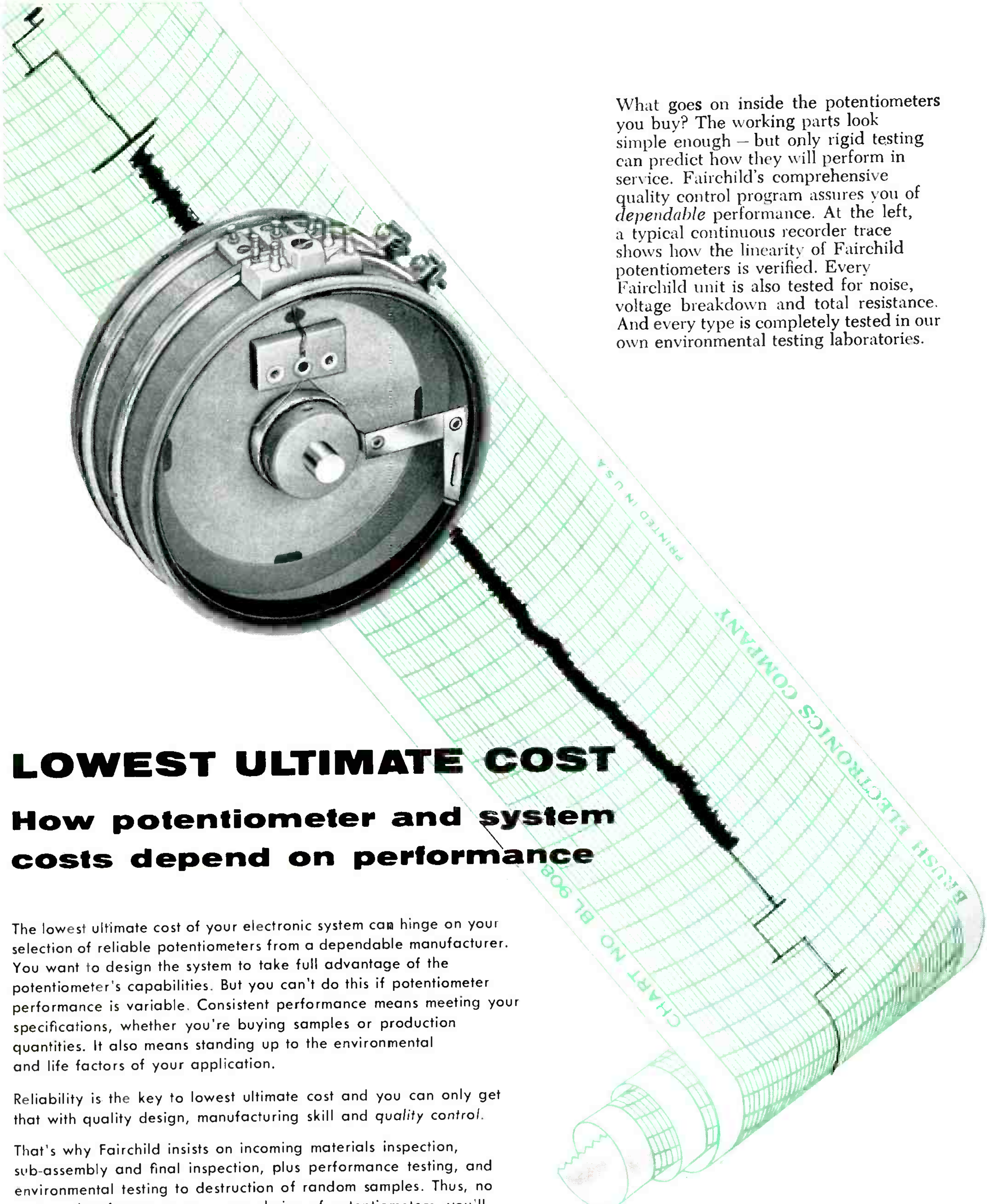


What goes on inside the potentiometers you buy? The working parts look simple enough — but only rigid testing can predict how they will perform in service. Fairchild's comprehensive quality control program assures you of *dependable* performance. At the left, a typical continuous recorder trace shows how the linearity of Fairchild potentiometers is verified. Every Fairchild unit is also tested for noise, voltage breakdown and total resistance. And every type is completely tested in our own environmental testing laboratories.

LOWEST ULTIMATE COST

How potentiometer and system costs depend on performance

The lowest ultimate cost of your electronic system can hinge on your selection of reliable potentiometers from a dependable manufacturer. You want to design the system to take full advantage of the potentiometer's capabilities. But you can't do this if potentiometer performance is variable. Consistent performance means meeting your specifications, whether you're buying samples or production quantities. It also means standing up to the environmental and life factors of your application.

Reliability is the key to lowest ultimate cost and you can only get that with quality design, manufacturing skill and *quality control*.

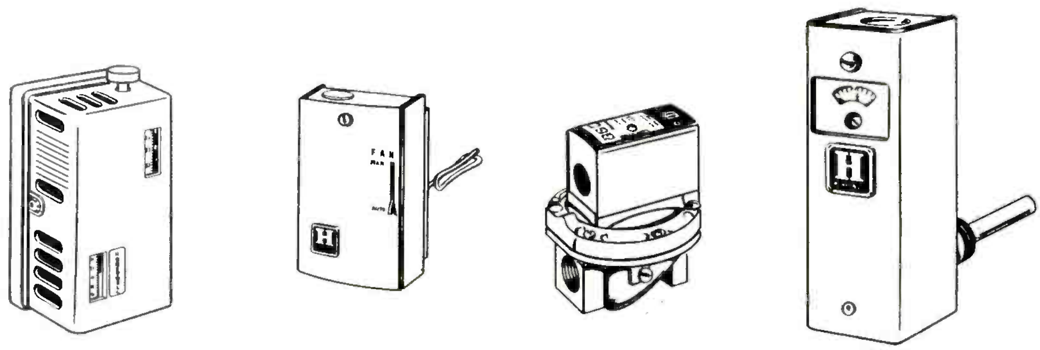
That's why Fairchild insists on incoming materials inspection, sub-assembly and final inspection, plus performance testing, and environmental testing to destruction of random samples. Thus, no matter what factors govern your choice of potentiometers, you'll find the lowest ultimate cost in Fairchild's complete line.

Write for catalog to Dept. 140-84A, Fairchild Controls Corporation, Components Division:

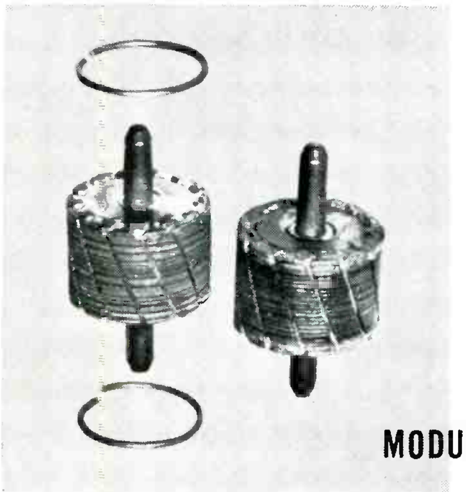
EAST COAST
225 Park Avenue
Hicksville, L. I., N. Y.

WEST COAST
6111 E. Washington Blvd.
Los Angeles, Calif.

FAIRCHILD
PRECISION POTENTIOMETERS and COMPONENTS



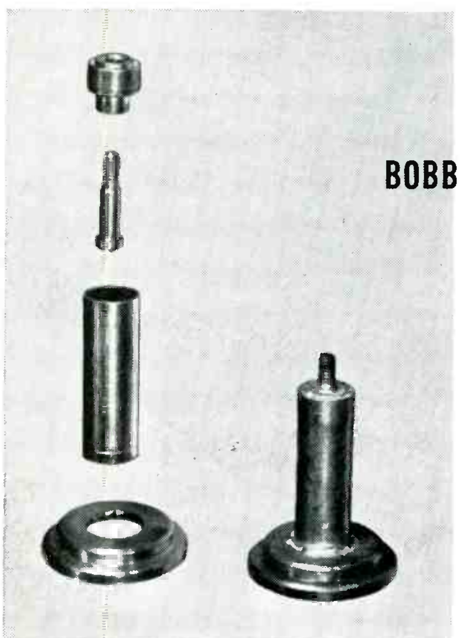
JOIN WITH HANDY & HARMAN SILVER BRAZING FOR PERMANENT PROFIT



Honeywell Control Solves Complex Joining Problems Simply and Speedily

Reliability is taken for granted wherever the name Honeywell appears on a temperature control. An important contributing factor is their method of joining control assemblies, for joints must withstand oxidation, corrosion, pressure, heat and moisture in operation. Typical of quality manufacturers, Honeywell is a seasoned user of Handy & Harman EASY-FLO and SIL-FOS low-temperature silver brazing alloys. Here are two typical examples:

MODUTROL MOTOR—used for two-position control of ventilating dampers in manufacturing plants and farm storage buildings. This simple copper-to-copper assembly requires two preplaced rings of Handy & Harman SIL-FOS, one at either end, and is self-fluxing. One operator runs two electric induction units and, jigging four at a time in each machine, brazes 433 rotors an hour.



BOBBIN ASSEMBLY FOR GAS VALVE—This complex four-part assembly is an excellent example of brazing versatility in joining *dissimilar* metals. The plug is made of leaded copper, the screw of Type 446 stainless steel, the tubing of Ambrac (4% zinc, 22% nickel, remainder of copper) and the base is made of Type 303 stainless steel. Two rings of EASY-FLO 3 join the entire assembly; one preplaced ring joins the screw and plug to the top of the tubing, the other ring joins the tubing and the base. HANDY FLUX is used in all operations. One operator brazes 141 assemblies an hour.

This same metal-joining speed and economy can be applied to your own production if you will call in Handy & Harman. We are prepared to help you design for silver brazed construction and aid you every step of the way in creating a highly mechanized brazing setup that will be tops in operating efficiency.

TAKE A LOOK

. . . at Bulletin 20. This concise introduction to silver alloy brazing talks about joining methods, as well as joint design and economies that can be enjoyed with EASY-FLO brazing. We'll send you a copy whenever you request it.

Your NO. 1 Source of Supply and Authority on Brazing Alloys

HANDY & HARMAN QUALITY SERVICE FOUNDED 1867

HANDY & HARMAN

General Offices: 82 Fulton St., New York 38, N. Y.

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FROM THE SMALLEST TO THE LARGEST UNITS...

the most desirable characteristics ever offered in selenium rectifiers!

RADIO RECEPTOR *hcd** PETTI-SEL

**high current density*

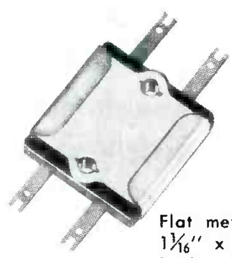
INDUSTRIAL TYPE SELENIUM RECTIFIERS

Made possible by the improved new vacuum process requiring no artificial barrier layer

Developed by Siemens Organization of West Germany, used extensively throughout Europe . . . and now manufactured exclusively in the U.S.A. by Radio Receptor Company.

the complete line ranges from . . .

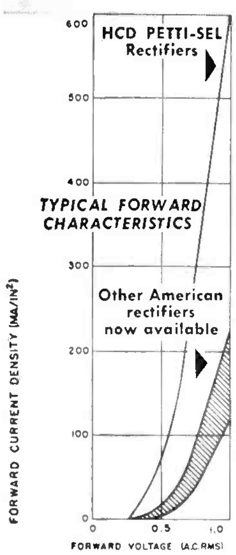
Plastic units, 7/16" x 7/16" x 3/32", single phase, center tap, 30V AC, 150 MA DC

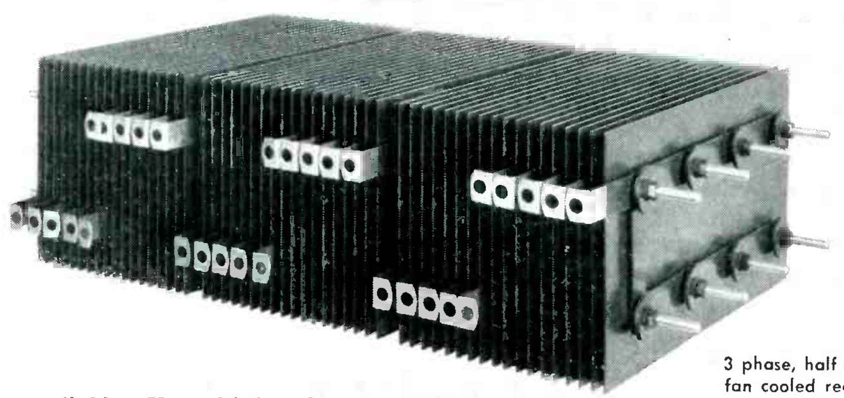


Flat metal rectifiers, 1 1/16" x 1 1/16" x 1/4", bridge, 30V AC, 200 MA DC

- **Better performance**
- **Estimated life 100,000 hours**
- **Lower forward voltage drop**
- **Suitable for high temperature applications**
- **Conveniently smaller cell sizes than conventional units of the same ratings**

. . . to the large space-saving





3 phase, half wave, fan cooled rectifiers, 8" x 16" x 24", 26V AC, 4500 amperes DC

Also available: Very high voltage rectifiers up to 296,000 peak inverse volts at 30 MA; Dwarfs — 5 MA up to 125V AC with resistive load; Cartridge types up to 17,000 peak inverse volts at 5 MA.

For complete information, submit your requirements today to Section E-6R

Semiconductor Division

RADIO RECEPTOR COMPANY, INC.

Subsidiary of General Instrument Corporation

240 Wythe Avenue, Brooklyn 11, N. Y. • EVergreen 8-6000

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

Allied's New MHJ Relay

Built for Shock and Vibration

10-55 cps at 0.125 inch double-amplitude • 55-2000 cps at 20g

Here are the facts:

Contact Ratings:
Low level up to 2 amperes non-inductive or 1 ampere inductive at 29 volts d-c or 115 volts a-c

Contact Arrangement:
MHJ-12D: 4 PDT
MHJ-18D: 6 PDT

Temperature:
Minus 65°C to plus 125°C

Vibration:
10–55 cps at 0.125 inch double-amplitude
55–2000 cps at 20g

Operating Shock: 100g

Altitude:
Sea level to 80,000 feet

Weight:
MHJ-12D: 3.0 ounces
MHJ-18D: 4.2 ounces

Insulation:
1000 megohms minimum

Dielectric Stress:
1000 volts rms at sea level;
450 volts rms at 70,000 feet

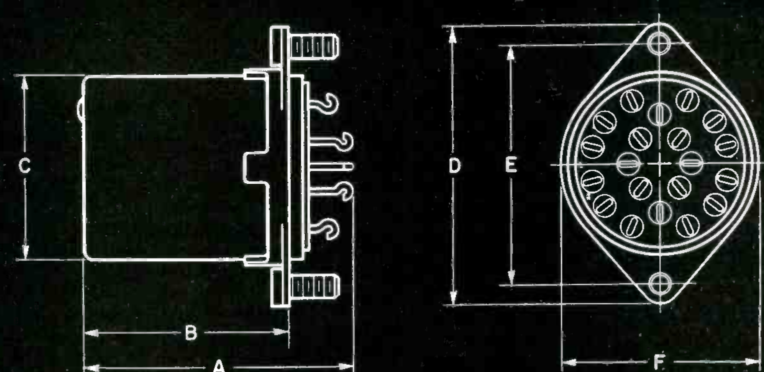
Initial Contact Resistance:
.03 ohms maximum at .01 to 2 amps

Operate Time:
15 milliseconds or less at rated voltage at 25°C

Release Time:
5 milliseconds or less at rated voltage at 25°C

ACTUAL SIZE

Type MHJ



MOUNTING #6-32 NC-2A THD. (2) STUDS

	A	B	C	D	E	F
MHJ-12D (4 Pole)	$1\frac{3}{4}$ max.	$1\frac{5}{16}$	$1\frac{3}{64}$	$1\frac{21}{32}$	1.406	$1\frac{1}{8}$
MHJ-18D (6 Pole)	$1\frac{3}{4}$ max.	$1\frac{5}{16}$	$1\frac{3}{16}$	$1\frac{13}{16}$	1.562	$1\frac{17}{64}$

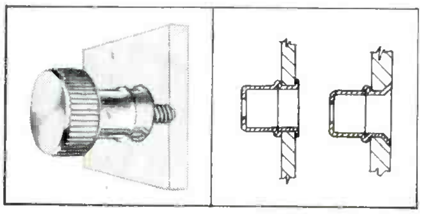
ALLIED CONTROL

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

AL 177

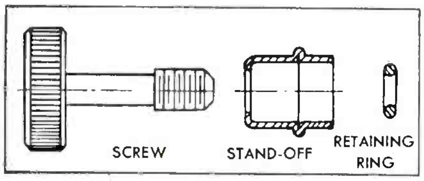
SELECT CLOSURE HARDWARE TO IMPROVE UTILITY, APPEARANCE, AND TO LOWER COST

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



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

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



SPECIFICATIONS

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

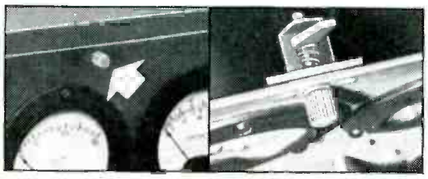
Sizes:

SCREW HEAD DIAMETER	THREAD SIZE
3/4"	1/4-20
5/16"	1/4-20, 12-24
7/16"	10-24, 10-32

Length of thread: 3/8"

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

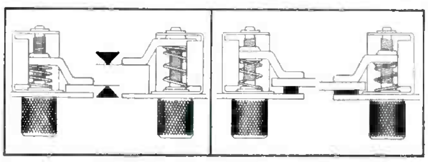
PRE-ASSEMBLED PAWL ADJUSTS TO DESIRED THICKNESS AND PRESSURE



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

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

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



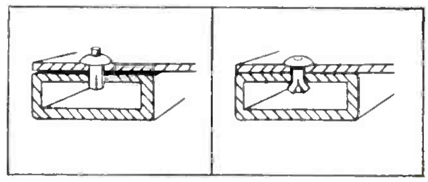
SPECIFICATIONS

Knob: Cadmium or chromium plated steel.

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

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

FAST, HAMMER-DRIVEN BLIND RIVETS CUT INSTALLATION TIME



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

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

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

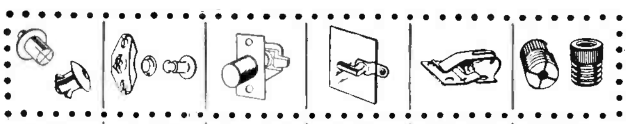
Increased widespread use is due to low installed cost and elimination of down time and maintenance associated with fasteners requiring special tools.

FREE!

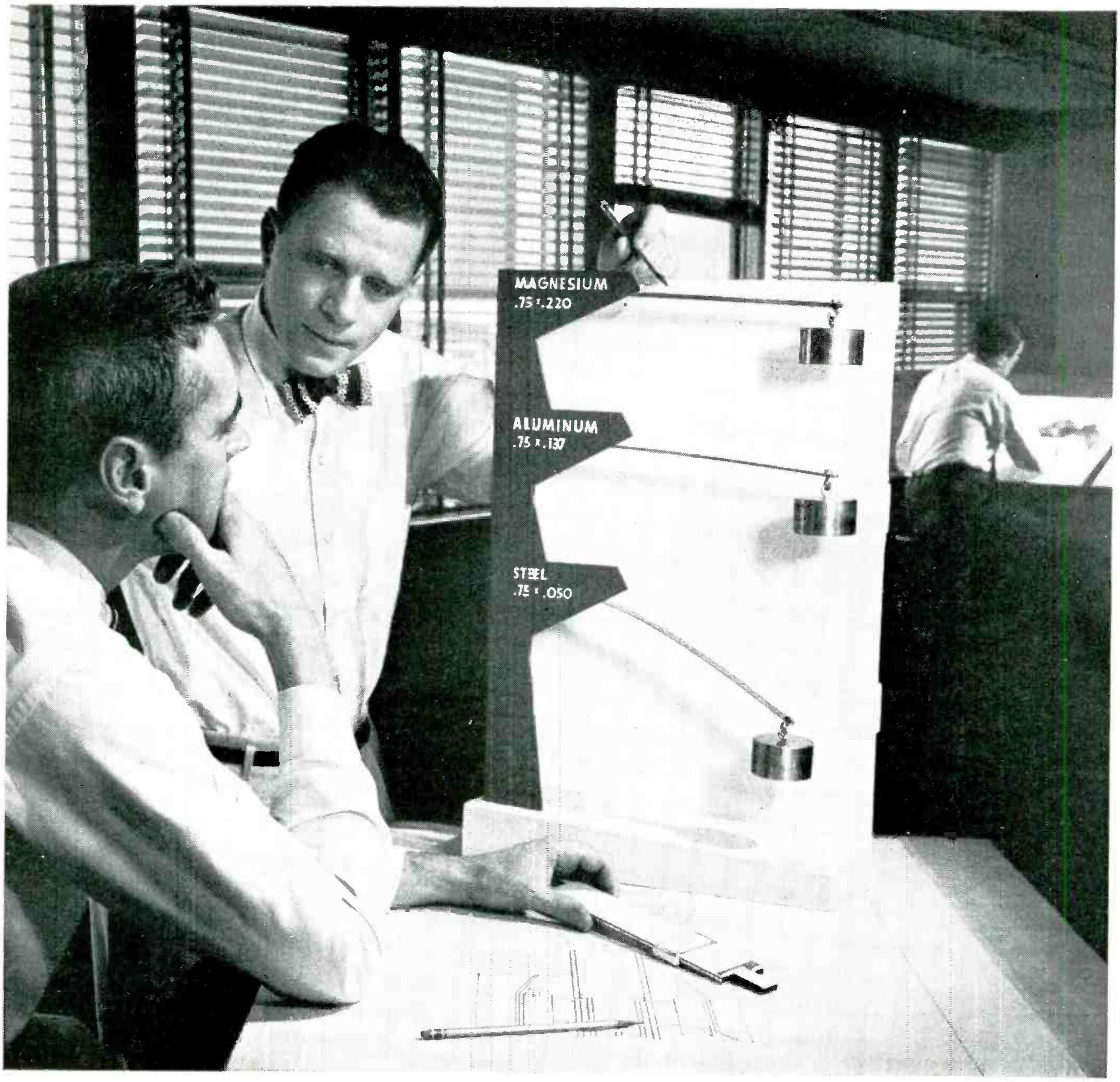
Fastener Handbook

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

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



SOUTHCO FASTENERS LION



Rigidity! At equal weight, magnesium is 18 times stiffer than steel

Magnesium's unique combination of strength and light weight gives it some outstanding abilities as a structural metal. Take rigidity, for example. A magnesium bar has 22% the stiffness of a steel bar of the same dimensions.

But stiffness increases as the cube of section thickness. So, if thickness of the magnesium is increased to twice that of the steel, the magnesium bar will be over 70% more rigid—yet weigh only half as much. And if thickness is further increased until the bars are of equal weight, the magnesium bar will be 1878%—or over 18 times—more rigid!

Similarly, a magnesium bar of equal rigidity to an aluminum bar will weigh only 75% as much as the aluminum bar. At equal weight, the magnesium bar will be over twice as stiff.

From these facts it's easy to see that magnesium can do a structural job equal to or better than steel and aluminum—and with appreciable savings in weight—whenever it's practical to increase section thickness. For more information contact the nearest Dow sales office or write to us. THE DOW CHEMICAL COMPANY, Midland, Michigan, Magnesium Department, MA 1402M.

YOU CAN DEPEND ON DOW

Want more information? Use post card on last page.

No SOLDERING TROUBLES *Here!*

1

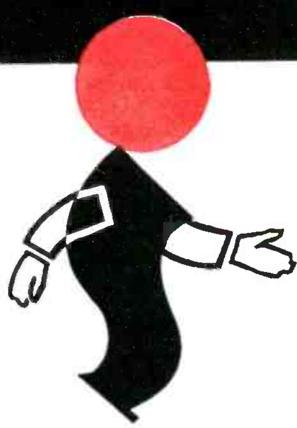
Wire leads of Stackpole resistors first receive the conventional tin-lead coating before being inserted in the molds.

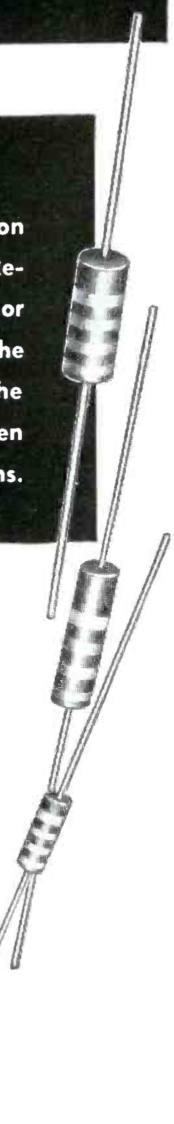
2

Then, as an EXTRA protective step, all leads are hot-solder dipped *after* the resistors have been formed and color-coded. Any tarnish that may have formed on the original tin-lead coating is nullified.

3

The effects of soldering heat on Stackpole resistors is negligible. Resistance change due to normal or recommended soldering is on the order of 1% . . . far less than the amount of change permitted, even by the most stringent specifications.





TOPS FOR PRINTED CIRCUITRY . . .

Ease of soldering is a "must" in printed circuitry applications. Stackpole fixed composition resistors provide it in full measure!

PACKAGED FOR AUTOMATION . . .

Stackpole fixed composition resistors in ½-, 1- and 2-watt types are supplied either in reel, stack or strip packs as required.

Electronic Components Division
STACKPOLE CARBON COMPANY • *St. Marys, Pa.*
In Canada: CANADIAN STACKPOLE LTD., 550 Evans Ave., Etobicoke, Toronto 14, Ont.

STACKPOLE
FIXED COMPOSITION **RESISTORS**

Want more information? Use post card on last page.

EE's, ME's can you qualify

FILL OUT AND MAIL TODAY

Collins Radio Company *Confidential Application for Technical Employment*

LAST NAME	FIRST NAME	MIDDLE NAME	BIRTH DATE
STREET ADDRESS	CITY	STATE	PLACE

EMPLOYMENT RECORD

FROM MO.	FROM YR.	TO MO.	TO YR.	EMPLOYER'S NAME, BUSINESS, LOCATION	SALARY	POSITION AND NATURE OF DUTIES
PRESENT OR LAST EMPLOYER						
FORMER EMPLOYER						

STATE NATURE OF YOUR MOST RESPONSIBLE POSITION

EDUCATIONAL RECORD

COLLEGE OR UNIVERSITY	MAJOR	DEGREE	GRADE PT. AV.

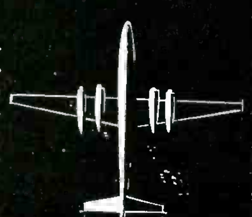
MILITARY SERVICE RECORD

BRANCH OF SERVICE	RANK OR RATING	ACTIVE SERVICE ENTRY DATE	DISCHARGE DATE

*Signature*________________________

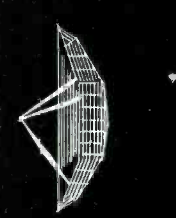
COLLINS in Aviation

Collins completely outfits airline, military and business aircraft with the most advanced communication, navigation, flight control and instrumentation systems in aviation. Many new lightweight, reduced-size versions are now being delivered. Collins designed the original Integrated Flight System, leads in combining comm/nav/ident units into a single compact "CNI" package for new military aircraft, and continues to pace the industry in developments in airborne radar, ADF, ILS, VOR, HF and VHF communication.



COLLINS in Ground Communication

Collins engineers, designs and supplies the equipment, installs, and puts into operation integrated point-to-point communication systems of any scope. The Collins system engineering staff is backed by the finest equipment in the world, whether standard MF, HF or VHF, Transhorizon "scatter," microwave relay and multiplex or single sideband HF. Typical of Collins communication progress is "Kineplex" — a high speed data transmission system doubling communication capacity.



Send your application to:

L. R. Nuss
Collins Radio Co.
Cedar Rapids,
Iowa

Fred Aiken
Collins Radio Co.
2700 W. Olive Ave.
Burbank, California

Harold McDaniel
Collins Radio Co.
1930 Hi-Line Drive
Dallas, Texas

as a Collins engineer?

You've got to be good to

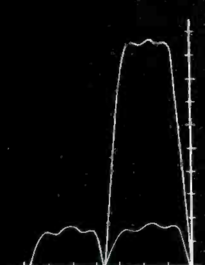
- ✔ *Command highest salary*
- ✔ *Advance rapidly in a strong, growing company*
- ✔ *Work with highest caliber development groups*
- ✔ *Use the world's finest engineering facilities*
- ✔ *Maintain Collins creative reputation*

Collins depends on its engineers. That's why you have to be good to earn a place on a Collins Research and Development team. Collins hard earned reputation was built on a solid foundation of engineering talent. The sales growth of the Company has justified Collins emphasis on engineering. Sales have increased 10 fold in the last 10 years. And employment of research and development personnel has more than kept pace. Collins growth will continue, and *you* can be a part of this growth.

Send the application form printed on the opposite page as an expression of your interest in knowing more about the opportunities at Collins. Your application will be held in the *strictest* confidence and will be answered immediately by a personal letter. Take only a few minutes now to fill out the application and mail to one of the addresses listed. This can be the turning point in your career.

COLLINS in Amateur Radio

In the early 1930's Collins set the standard in Amateur radio and, through continuous design and development, has raised this standard to its present single sideband station — the most honored and prized in the Amateur fraternity. This station is the top performing rig on the air with its kilowatt KWS-1 transmitter and highly selective 75A-4 receiver. Many of the leaders in the electronics industry became acquainted with Collins through the Company's superior Amateur equipment.



COLLINS in Broadcast

Collins supplies a complete new AM station from mike to antenna or modernizes existing facilities. Besides the superior line of transmitters, Collins supplies the broadcaster's needs with such advanced additions as TV-STL microwave relay system, the lightest 4-channel remote amplifier on the market, phasing equipment and audio consoles. Collins field service organization has built an enviable reputation in assisting the broadcaster in installation or in times of emergency.

Collins CREATIVE LEADER IN ELECTRONICS COLLINS

Collins Radio Company — Cedar Rapids • Dallas • Burbank

MARCONI'S HAND IN THE HISTORY OF ELECTRONICS

In 1896, at the age of 22, Marconi demonstrated the 'wireless telegraph' equipment he had invented in his family home near Bologna to British Post Office and Forces chiefs. The initial possibilities of his enterprise were grasped. 'Radio' had arrived.

In 1897 a company, headed by him, now known as Marconi's Wireless Telegraph Company, Ltd., was founded in England to develop his ideas. Over the past 60 years that company has remained in the forefront of both the practical application of electronic principles and further pure research into them. It has been a pioneer in Radio and Radio/Telephone Communications, in Maritime Radio, Airborne and Airport Radio, Broadcasting and Television, Radio Aids to Navigation and Radar.

The achievements of the engineers and physicists whom Marconi gathered about him, and of their successors, have laid a foundation of unsurpassed experience on which to base future activities. A tradition of resourcefulness, enterprise, foresight and persistence characterises the Marconi Company today.

Information about the Marconi Company's latest equipment is available to American radio and electronic engineers for the asking from:

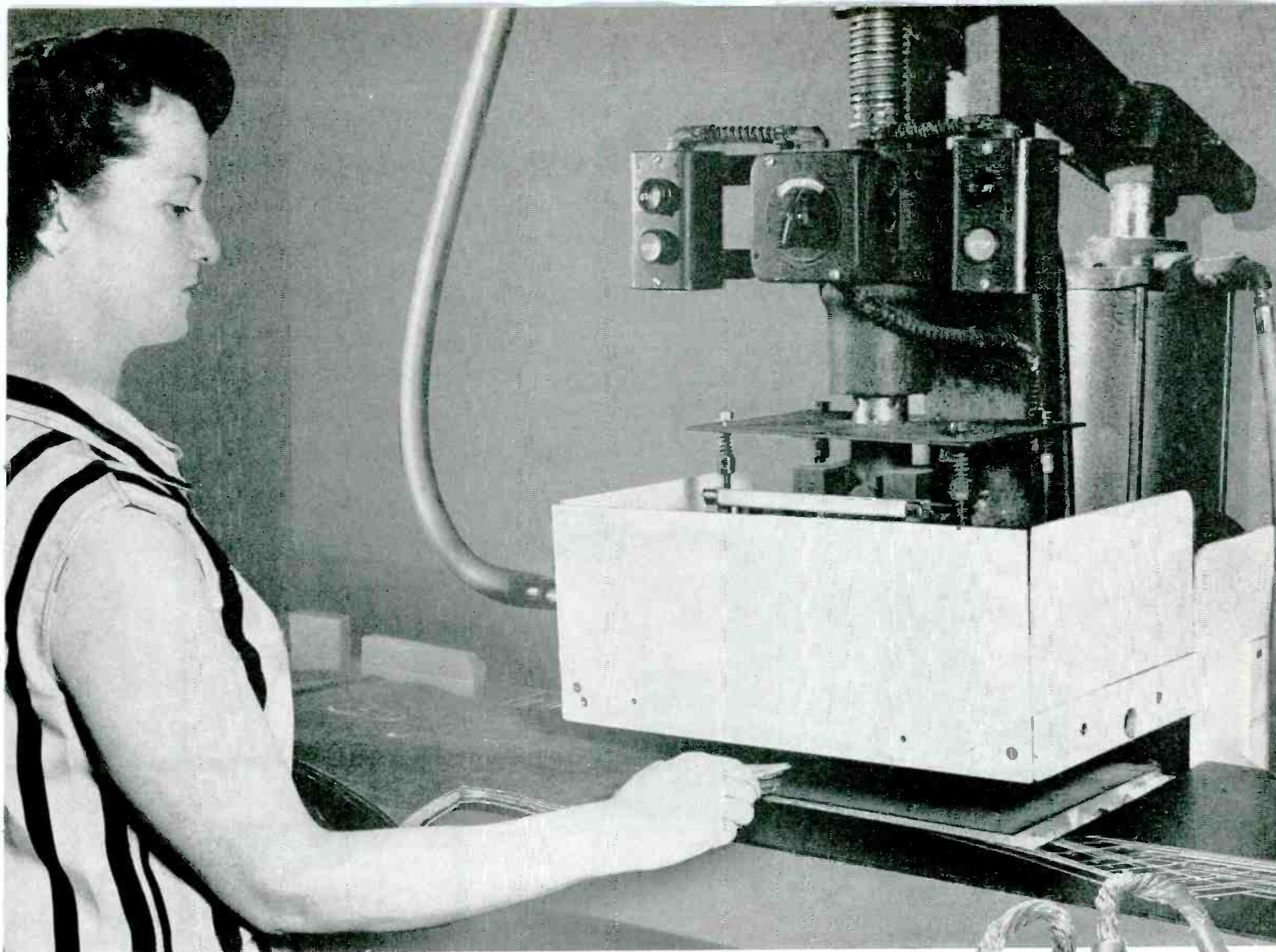
The bust of Guglielmo Marconi unveiled in the Hall of Fame of the Institute of Electrical Engineers, by his daughter in October, 1955.

J. S. V. Walton, Marconi's Wireless Telegraph Company Limited, 23-25 Beaver Street, New York City 4.

Marconi's Wireless Telegraph Company Limited, Chelmsford, Essex, England.

LG 13

Want more information? Use post card on last page.



EIMAC Powers Pants Reinforcer

10 kw dielectric heating system uses Eimac 3X2500F3

Industry has turned to the versatile electron to speed up mass production techniques. Shown above is the Radio Frequency Company 10KW patch press now in use at the Levi Strauss Company factory in Santa Cruz, California.

Used to literally "weld" strengthening rubberized patches into the knees of children's jeans, the speed and uniform heating of this modern dielectric heater does the job six times as fast as the old-fashioned all-steam press system. A single, sturdy, long-lived Eimac 3X2500F3 power triode is used in a conventional tuned-grid, tuned-plate 27 mc circuit, that welds patches permanently at the rate of 225 dozen pairs daily. The operator reinforces six pant legs at a time, at an average time interval of 30 seconds for each operation.

Eimac has a complete line of rugged "tubes that can take it" for electronic heating in food, plastics, plywood, rubber and other industries.

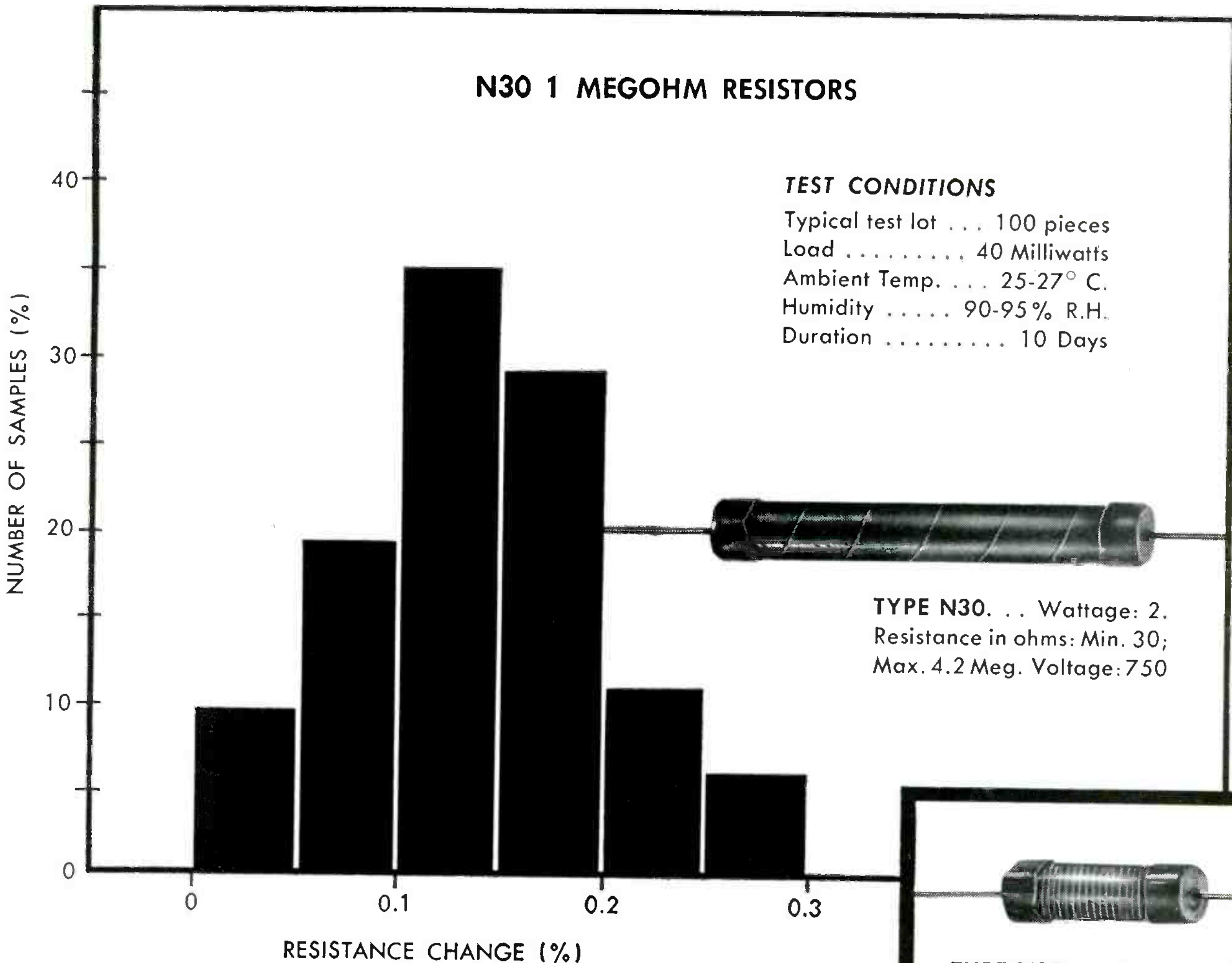
Consult our Application Engineering Department for further information.

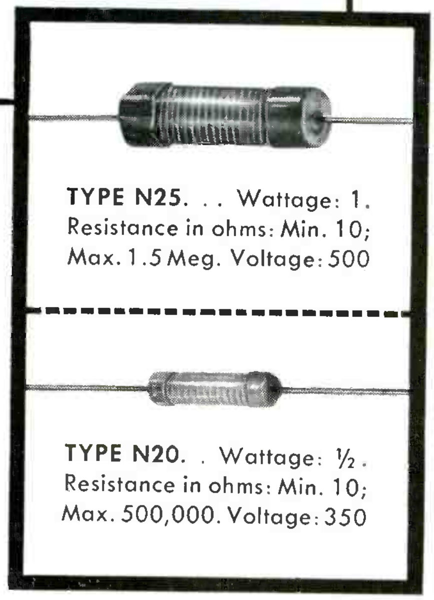
EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA
Eimac First for industrial electronic heating

Eimac

Typical operation 3X2500F3
Class C Power Amplifier or Oscillator

D-C Plate Voltage	6000 volts	D-C Grid Current	180 ma	Plate Power Input	12,500 watts
D-C Plate Current	2.08 amps	Peak R-F Grid Input Voltage	765 volts	Plate Dissipation	2,500 watts
D-C Grid Voltage	—500 volts	Driving Power (approx.)	136 volts	Plate Power Output	10,000 watts
		Grid Dissipation	46 watts		





Why Corning's Film-type Glass Resistors are unaffected by moisture

This graph gives some idea of the unusual properties that result when you fire a tin oxide film to a glass core.

Since film and core are fused into a single structure, you have a resistor that stands up under extreme humidity and moisture conditions.

Tin oxide reacts chemically with glass under heat; it actually becomes *part* of the glass.

So you have an integrated unit. One that's physically inseparable. Catastrophic failure is no problem with these rugged precision-film resistors.

You get *exceptional stability*. Less than 1.0% average change in resistance after 10,000 hours' operation at rated dissipation.

Long shelf life. Less than 0.2% resistance change after a whole year's aging under the most adverse conditions.

Low TC. Guaranteed ±300 ppm/°C. referred to 25°C. over a range of −55 to +105°C.

A last fact to shorten the long story we have to tell on our Type N Fixed-Film Resistors:

They are guaranteed to meet, and the majority of characteristics of these resistors exceed, the requirements of MIL-R-10509B and comparable specs.

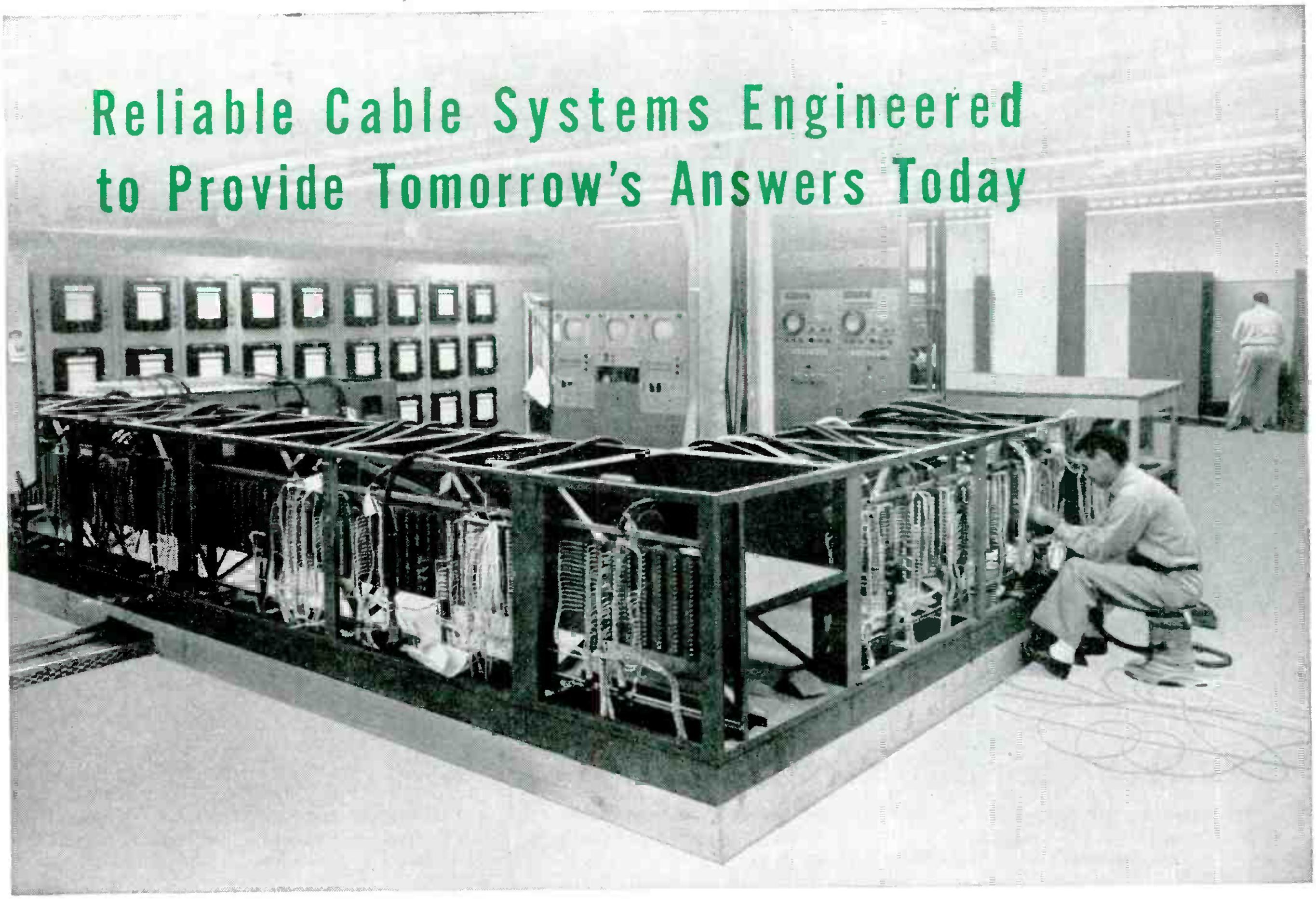
If you'd like the complete story on these amazing resistors, write for Data Sheet CD-2.00.

Keep your file up-to-date with data on these other electronic components made by Corning: Resistors: Low Power, Types S, R, H, HP, and WC-5; *Capacitors:* Fixed Glass*, Transmitting, Canned High-Capacitance, Subminiature Tab-Lead, Special Combination. Direct Traverse* and Midget-Rotary* Trimmers. Metallized Glass Inductances; Electrolytic Level Switches; Attenuator Plates; Fotoform Glass.

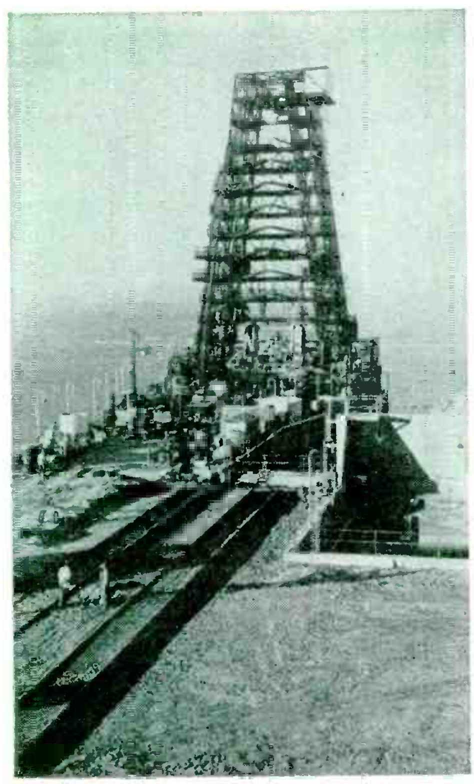
**Distributed by Erie Resistor Corporation*

Corning means research in Glass **CORNING GLASS WORKS, 94-6 Crystal Street, Corning, N.Y.**
Electronic Components Sales Department

Want more information? Use post card on last page.



Pacific Automation Products' *systems engineering service*, based on broad missile, aircraft, radiation, communication, computer and allied electronic experience, is available to assist you in your military and commercial projects.
This comprehensive service integrates and coordinates the cabling responsibility for a system in one facility.



PROGRESSIVE STEPS TO RELIABLE CABLING SYSTEMS

ANALYZE	overall system
PROPOSE	engineering concept of cable requirements conceived by the following criteria: combining circuits; minimizing total number of cables; establishing re-usable standard types
ENGINEERING	liaison team supplied to function with customer's engineering staff, designing cables concurrently with development of the overall system
MANUFACTURE	ready-to-install cables to be available as required
INSTALL	prefabricated cable and connect to terminal hardware in schedule with project activities
CHECK-OUT	the cable system to guarantee compatibility of cable installation with the overall function of the system
DOCUMENT	the complete cable system, including drawings, broken down into components covering consideration to segregation of elements that may be used as building blocks for future addition to the system

Reliability is the product of this comprehensive *systems engineering service* . . . achieved only through the thoroughness of the above procedure. For additional information regarding Pacific Automation Products' *systems engineering service*, write for Bulletin 158.

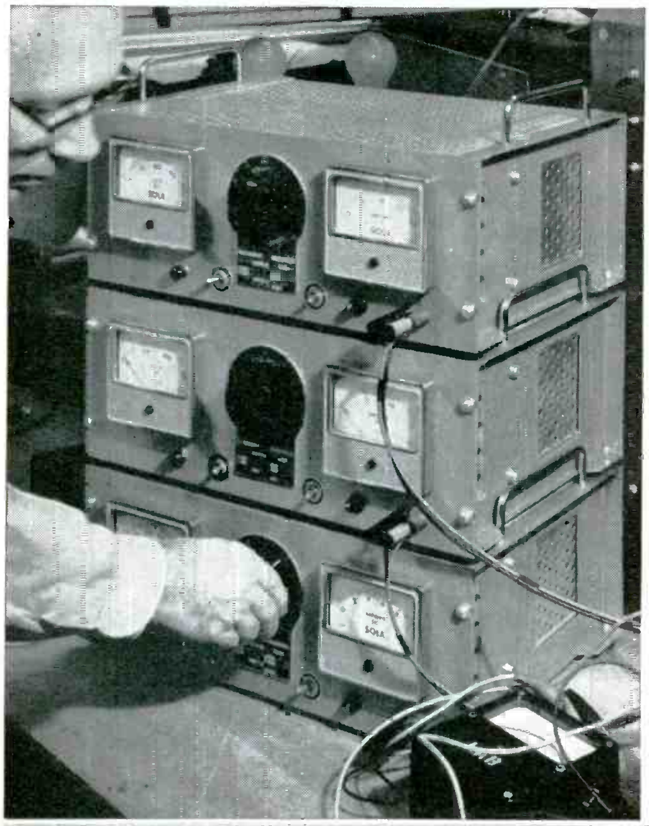
Pacific Automation Products, Inc.

1000 AIR WAY, GLENDALE 1, CALIFORNIA
CHapman 5-6871 • TWX: GLN 7371
137 Walnut Hill Village, Dallas, Texas FLeetwood 2-5806

Engineers and technicians are invited to investigate career opportunities with us. Submit resume for an interview.

Want more information? Use post card on last page.

COMPACT, CONVENIENT *three-high stacking of the new adjustable Sola Constant Voltage DC Power Supply is shown in the typical laboratory bench setup above. Below, engineer "dials" specific test voltage desired from each of the three standard models of "DC Solavolts" shown.*



A versatile DC supply for men who design or test electrical and electronic equipment prototypes

Do you design or test "prototypes?" If so, and you're seeking a laboratory source of high-current DC voltage, it will pay you to use the "DC Solavolt." It's a moderately-priced, adjustable, regulated dc power supply that provides unusual stability with intermittent, variable, or pulse loads. Output voltage is regulated to within ±1% though supply voltage may vary as much as ±10%. Ripple is held to 0.1% or less.

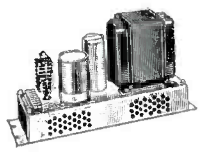
Electrical specifications of the six stock "DC Solavolts" available appear in the table below:

All Inputs 100-130 volts, 60 cps

Catalog Number of Stock Units	Regulated Adjustable Output Voltage Range	Rated Loadings in Amperes		Ripple* Voltage— % of Total Output
		At max. Voltage Setting	At min. Voltage Setting	
28510	5-35	7.0	7.0	0.10
28520	25-60	4.0	6.0	0.05
28530	30-90	2.8	4.0	0.04
28540	60-180	1.4	2.0	0.03
28550	150-250	1.0	1.5	0.02
28560	250-400	0.6	0.75	0.02

**Figures in this column cover ripple voltages measured at full rated load and input of 115 volts.*

Along with these laboratory standards of performance, the DC Solavolt offers compactness, low weight, high efficiency, and high short-time overload capacity. All stock models occupy only 7" of height and 12¼" of depth on a standard 19" relay rack frame. There are no tubes to replace, no compensating adjustments are needed, and no maintenance is required. Carrying handles, available as accessory equipment, provide "one-man" portability and self-stacking. Your local electronic distributor, who stocks the DC Solavolt, will be happy to give you further information.



Write for Bulletin **7F-DC-245**
SOLA ELECTRIC CO.
4633 W. 16th Street, Chicago 50

SOLA *Constant Voltage* **DC POWER SUPPLIES**

CONSTANT VOLTAGE TRANSFORMERS • LIGHTING TRANSFORMERS • CONSTANT VOLTAGE DC POWER SUPPLIES
SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414 • NEW YORK 35: 103 E. 125th St., TRafalgar 6-6464 PHILADELPHIA: Commercial Trust Bldg., RIttenhouse 6-4988 • BOSTON: 272 Centre Street, Newton 58, Mass., BIgelow 4-3354 • CLEVELAND 16: 19115 Detroit Rd., EDison 3-2223 • KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382 • LOS ANGELES 23: 3138 E. Olympic Blvd., ANgelus 9-9431 • SOLA ELECTRIC (CANADA) LTD., TORONTO 17, ONTARIO: 102 Laird Drive, Mayfair 4554 • Representatives in Other Principal Cities

Want more information? Use post card on last page.

Attention! All Users of Nickel Alloys...

New Driver-Harris Vacuum Melting Service Now in Operation

After many years of experience with vacuum melting programs, Driver-Harris now offers a complete vacuum melting service for almost all of the 132 special purpose alloys made by this company.

The specific benefits gained by vacuum melting in the production of nickel-chrome alloys are today clearly established. They are:

1. Much closer control of analysis—particularly in alloying with the highly reactive elements, Titanium, Aluminum, Columbium, Calcium, and Zirconium. The normally high affinity for nitrogen and oxygen these elements have is completely eliminated in vacuum melting, thereby opening new avenues in alloy production.

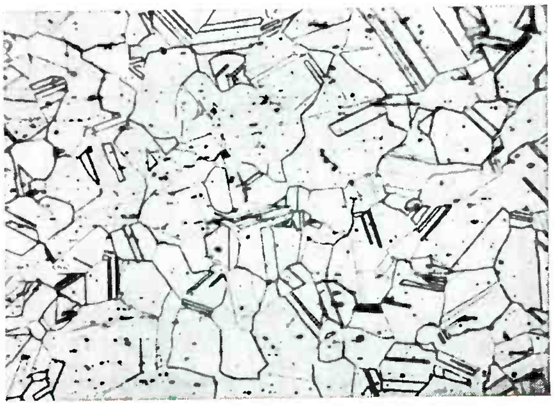
2. Great reduction in inclusions, especially oxides and nitrides, results in higher ductility and tensile properties. In fine wires, the improvement in properties is frequently so great that wire sizes may be reduced without sacrifice of strength. An example of the greatly improved microstructure is illustrated in the metallographs shown.

3. Complete elimination of gas, not from the surface only but from the entire mass. Alloys so produced are therefore more desirable in the manufacture of electron tubes.

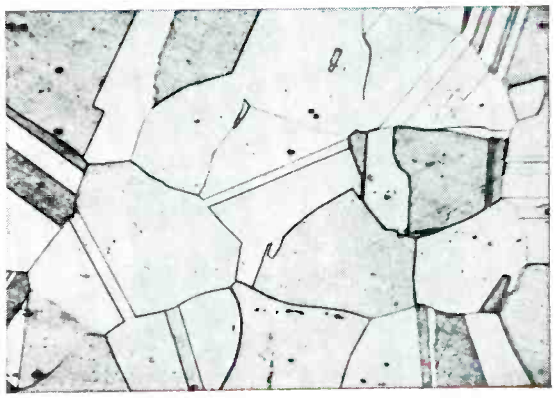
4. General improvement in electronic, electrical, and mechanical properties to meet specifications. Because closer control of analysis is a primary advantage of vacuum melting, we can now achieve these specific improvements with remarkable certainty.

Almost all of the Driver-Harris Alloys now vacuum melted and processed under close physical and analytical control show improvement in one or more of the above ways. If you are seeking further improvements in the D-H Alloys you use, inquire now for information on how Driver-Harris Vacuum Melting Service can help you. Address your inquiry to Dept. VMS.

*T. M. Reg. U. S. Pat. Off.



Polished and etched sample of Air Melted NICHROME V in annealed condition.*



Vacuum melted NICHROME V, annealed. Note that reduced inclusions result in much larger grain size for the same annealing treatment.

Driver-Harris COMPANY HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Louisville, Los Angeles, San Francisco In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES

Want more information? Use post card on last page.

STOP WISHING...START GROWING

...we think the right job for you is here at Western Electric

What do we mean by "the right job?" Well, mostly we mean there's a bonafide chance for you to *grow* at Western Electric.

It figures . . . in both the work we do and the status of the engineer in our company. Fully 55% of the college graduates in Western Electric's upper level of management have engineering degrees.

Keep in mind, too, that we follow a policy of promotion from within. And present indications are that at least *8,000* of our people will be promoted to management jobs in the next ten years.

Now, about our work. The wide range of functions at Western Electric includes production, merchandising, purchasing, installation and other aspects of the overall job. To make their technical work effective, many engineers participate in these broad managerial functions.

To keep pace with the ever increasing demand for more and better telephone service there's a constant need here for new products, new processes, new ideas. And for young engineers and scientists to help with the job.

Perhaps you'd work in the exciting world of transistors . . . automation . . . electronic switching . . . printed circuitry or one of our many other fields with a future. Or you might help with one of the defense contracts the government has asked us to take over – major projects like SAGE, the continental air defense system, the DEW Line arctic radar network, the Nike guided missile system—to which Western Electric engineering has made indispensable contributions.

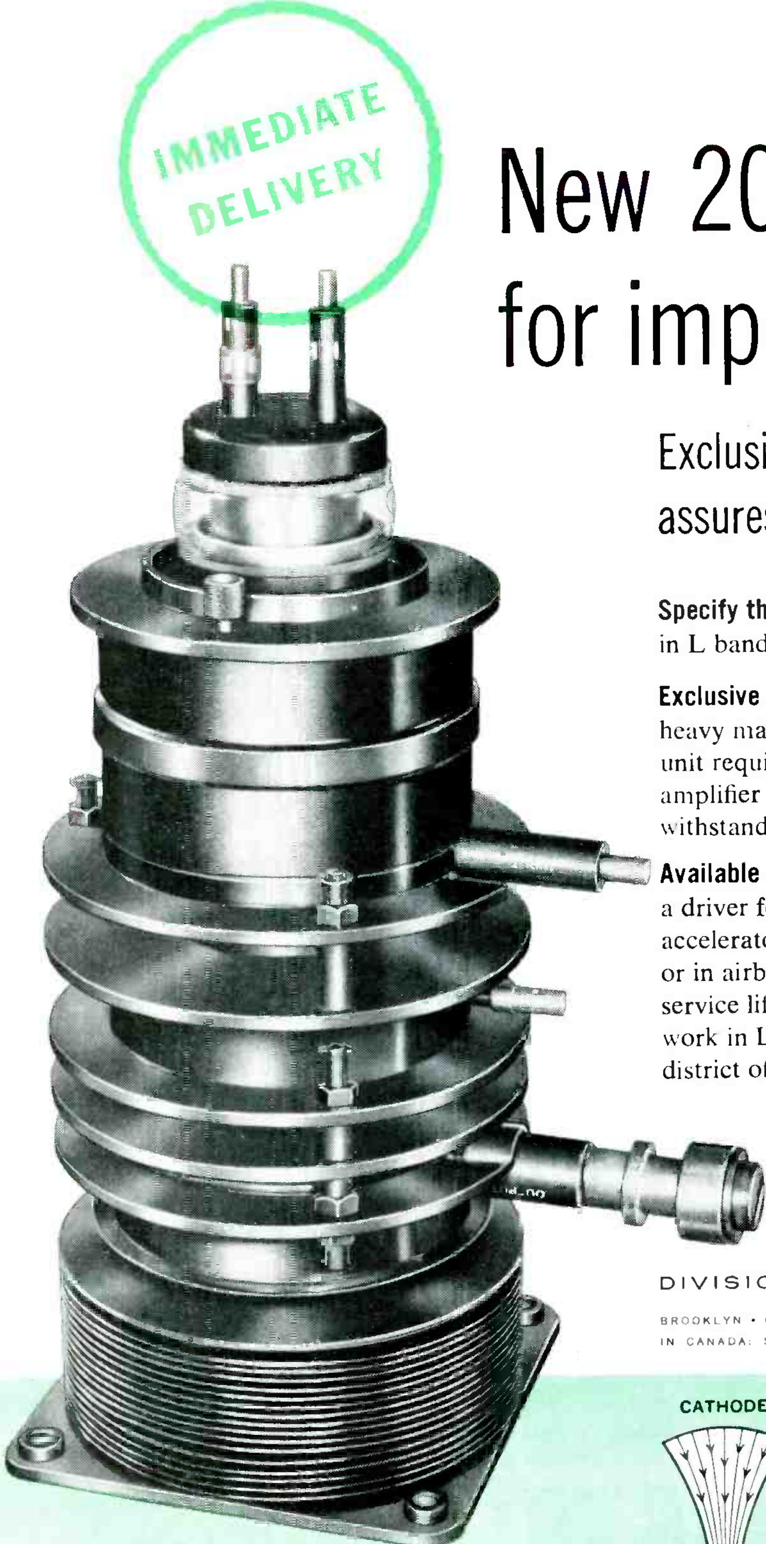
Whatever your assignment with us – whatever your field—you'd be encouraged to move to positions of increasing responsibilities and rewards . . . to *grow*. A full-time graduate engineering education program is given new engineers during working hours to aid them to more easily assume a full engineering role in the company. Also, a tuition refund plan is provided for out-of-hours study at nearby colleges at company expense.

Certainly you'll want to learn of the specific opportunities available to you. To apply, send resume of your education and experience to Engineering Personnel, Room 1066, Western Electric Co., 195 Broadway, New York 7, N. Y. In confidence, if you wish.

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

Manufacturing plants in Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; North Andover, Mass.; Lincoln and Omaha, Neb.; St. Paul and Duluth, Minn. Distributing Centers in 30 cities and Installation headquarters in 16 cities. Also, Teletype Corporation, Chicago 14, Illinois.



New 20kw Klystron for important L band

Exclusive Space-Charge Focus assures long life and reliability

Specify the SAL-81 when you are looking for a reliable tube in L band which will have extremely long service life.

Exclusive Sperry Space-Charge Focusing design eliminates heavy magnets—the SAL-81 is a complete microwave unit requiring no external equipment. This pulsed klystron amplifier features high gain and rugged construction to withstand shocks and vibrations.

Available for immediate delivery, the SAL-81 can be used as a driver for higher-powered klystrons in radar and linear accelerator systems, as a power source in laboratory work or in airborne navigation systems. Its unusually long service life and reliability make it the choice for systems' work in L band. Write or phone your nearest Sperry district office for details.

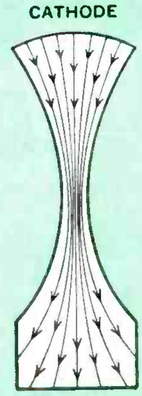
ELECTRONIC TUBE DIVISION
SPERRY GYROSCOPE COMPANY
Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION

BROOKLYN • CLEVELAND • NEW ORLEANS • LOS ANGELES • SEATTLE • SAN FRANCISCO
IN CANADA: SPERRY GYROSCOPE COMPANY OF CANADA, LTD., MONTREAL, QUEBEC

SAL-81 SPECIFICATIONS

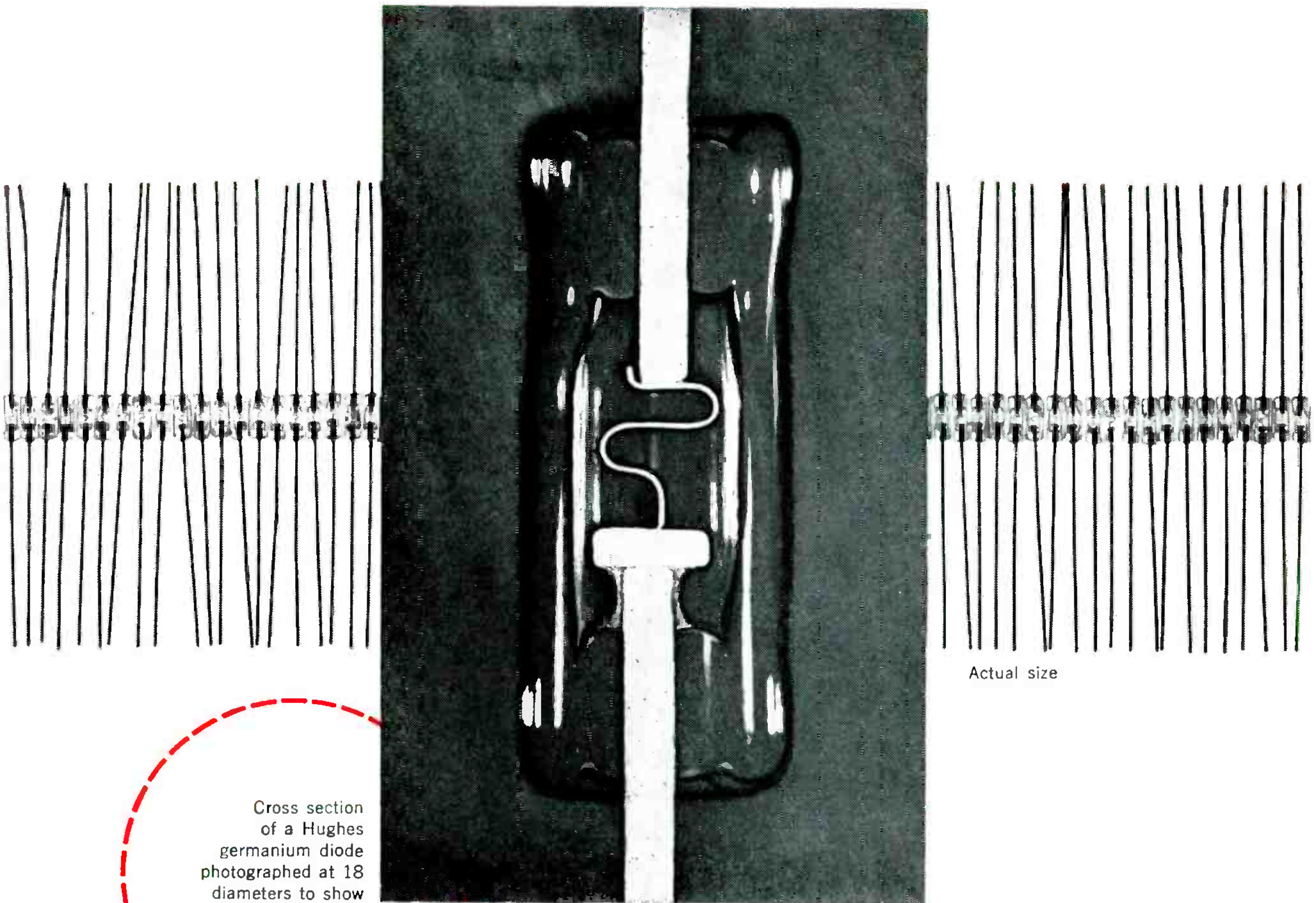
Frequency Range	1215-1365mc
Power Output	20kw
Gain	30db
Voltage Requirements	18kv



Sperry's Space-Charge Focus principle of beam control eliminates need for heavy, unwieldy magnetic structures. New Sperry tube design using this principle cuts weight, size, power consumption and cooling requirements.

Want more information? Use post card on last page.

Close-up of a diode



Actual size

Cross section of a Hughes germanium diode photographed at 18 diameters to show structural detail.

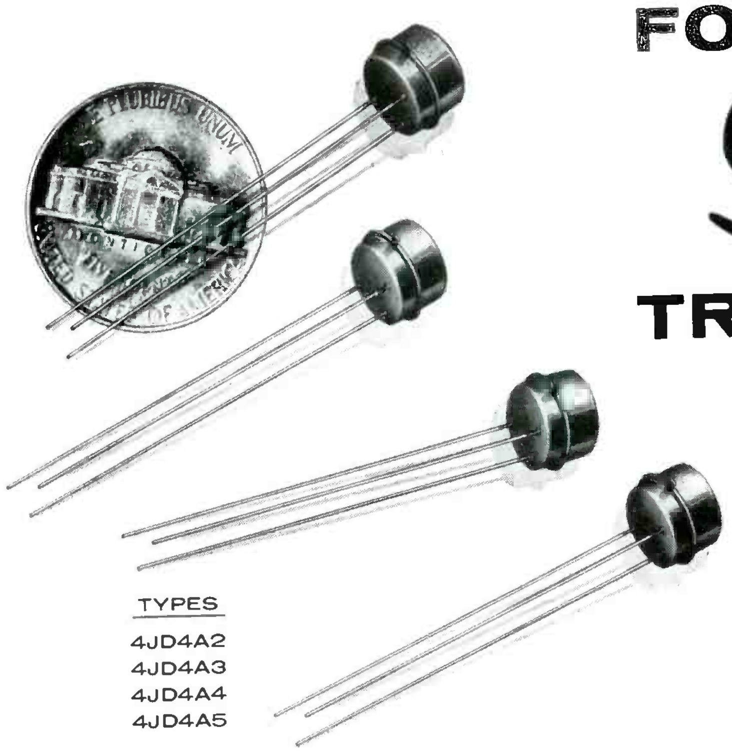
Inside, where it counts, a Hughes germanium diode is rigid, sturdy—well able to stand up under conditions of severe shock and vibration. With a microscope, you can see why clearly... the germanium crystal permanently bonded to one lead . . . the whisker firmly welded to the second lead . . . the point of the whisker welded to the crystal . . . the fusion-sealed glass envelope. Such positive mechanical stability (basic to every Hughes diode type) is vital to the achievement of electrical stability—and reliablity. Hughes diodes are manufactured, first of all, for reliability. So specify Hughes, and be *sure* of successful application to your electronics and communications equipment.

For descriptive literature please write:
HUGHES PRODUCTS
SEMICONDUCTORS
International Airport Station
Los Angeles 45, California

HUGHES PRODUCTS

Creating a new world with ELECTRONICS

HUGHES
SEMICONDUCTORS



TYPES
4JD4A2
4JD4A3
4JD4A4
4JD4A5

FOUR NEW G-E *Silicon* TRANSISTORS

- *Operation below zero and up to 150°C*
- *25 mc alpha cutoff*
- *Low leakage current*
- *Easy automatic insertion in printed circuit board*

DESIGN FEATURES

High Temperature Performance . . . maximum ambient operating temperature 150° C, storage temperature up to 200° C

New Package Design... for automatic insertion in printed circuit boards

Package Hermetically Sealed . . . no moisture seepage from outside air

Package Seams Are Welded . . . for great strength, long wear

Long Life and Stable Performance . . . when used within specified ratings

Small Size . . . extremely compact design provides added flexibility for most applications

Here are just a few typical applications for the NPN silicon triode transistors: wide band and d-c amplifiers, oscillator circuits, computer switching.

And now *all* General Electric transistors are a better buy than ever. Because of mechanized production lines, G-E transistors are made in less time and at a lower cost than before. Thus you benefit from lower prices.

Besides, machine methods used on the General Electric production lines promote the strictest adherence to top quality standards. As a result, characteristics are controlled and narrow limits are built into the production transistor for a more uniform product. Therefore, General Electric is able to give a one-year written warranty.

For specifications and application engineering assistance, call your G-E Semiconductor District Sales Manager, your G-E Semiconductor distributor, or write the General Electric Company, Semiconductor Products, Section S2567, Electronics Park, Syracuse, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

CUSTOMER CONFIDENCE 10th ANNIVERSARY SEMICONDUCTOR PROGRESS

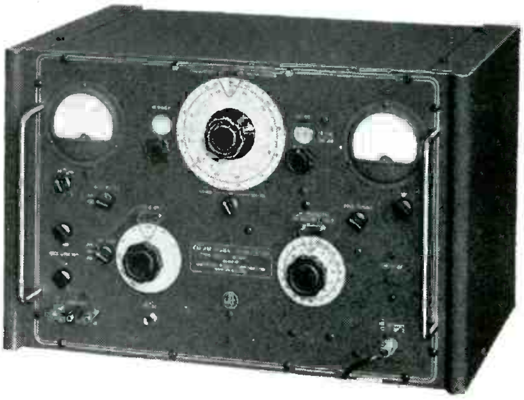
ECG-226

Want more information? Use post card on last page.

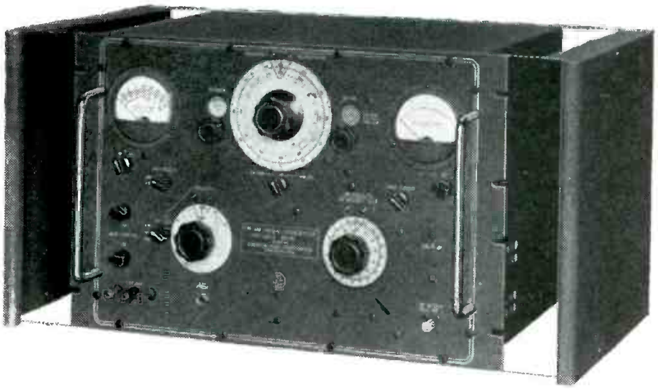
NEW! # FM-AM SIGNAL GENERATOR

Designed for bench use or rack mounting

Type 202-E 54 to 216 MC



Type 202-E with cabinet end bells attached for BENCH USE



Type 202-E with cabinet end bells removed for mounting in a standard 19" RELAY RACK

Power Supply used with Type 202-E for BENCH USE

Power Supply used with Type 202-E for 19" RACK MOUNTING

RF OUTPUT VOLTAGE:
Max. open circuit voltage at front panel jack is approx. 0.4 volts. With output cable attached 0.2 volts nominal. Output impedance 50 ohms resistive at front panel jack. Minimum output 0.1 microvolts.

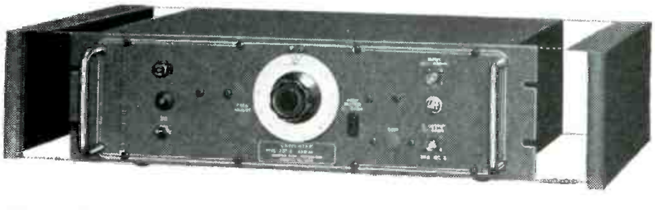
FREQUENCY MODULATION:
Three deviation ranges, 0-24 KC., 0-80 KC., and 0-240 KC., each continuously adjustable. FM distortion at 75 KC is less than 2% and at 240 KC less than 10%.

FIDELITY CHARACTERISTICS:
Deviation sensitivity of FM modulation system as a function of frequency is flat within ± 1 DB from 30 cps to 200 KC.

AMPLITUDE MODULATION:
Internal AM available from 0-50% with meter calibrations at 30% and 50% points. External modulation may be used over the range from 0-50%. A front panel jack connects to the screen of the final stage for pulse and square wave modulation.

SPECIAL FEATURES:
Incremental frequency range: The △ F switch permits tuning in increments of ± 5, ± 10, ± 15, ± 20, ± 25, ± 30, ± 50, ± 60 KC in the 108 to 216 MC range — half these values in the 54 to 108 MC range. A fine tuning control permits continuous tuning over a range of approximately ± 20 KC in the 108 to 216 MC range, and ± 10 KC in the 54 to 108 MC range.

FREQUENCY:
54 - 216 MC. may be extended down to 100 KC by using the Univerter Type 207-E below.



This Univerter can be used, as above, for bench or rack mounting.

BOONTON RADIO CORPORATION
Boonton, New Jersey

PRICES:

FM-AM Signal Generator Type 202-E with power supply $1090.00
Univerter Type 207-E $390.00
F.O.B. Boonton, New Jersey

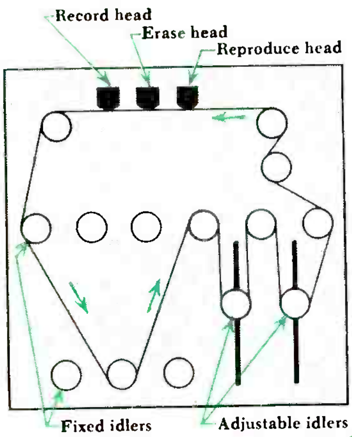
Want more information? Use post card on last page.

How to use the recorder that chases its tail

The continuous loop solves a variety of tricky problems

At first glance the tape-loop recorder is rather like a puppydog chasing its tail. But don't be fooled – electronically, it is as interesting as a re-invention of the wheel. And you can share the challenge of its practical uses.

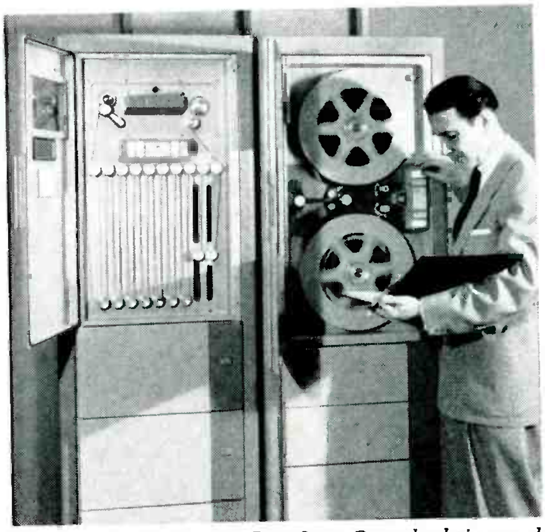
Are you waiting for lightning to strike? Let a tape-loop recorder stand the watch. It has infinite patience and a perfect sense of anticipation. The tape loop continuously records and erases until an important event takes place. At that moment everything is on the loop – even the important instants before. The tape loop either stops at the end of a cycle or it starts up a reel-to-reel recorder to copy the data. This scheme is used to study natural phenomena, to handle intermittent communications, and to collect data on abrupt mechanical or electrical failures.



The tape loop cycles in a period equal to loop length divided by tape speed. Movable idlers plus use of varying numbers of fixed idlers accommodate any loop length from minimum to maximum. Data can be repeated indefinitely or can be continuously erased.

For time-delay applications, the tape loop is like a conveyor belt for information. The tape continually receives data at the record head. Data rides the tape around the loop to the reproduce head and is withdrawn at a predetermined time delay. The interval is determined by length of tape loop and tape speed. Uses are machine and process control, communications memory, and handling of computer data.

The tape-loop recorder also has a talent for repetition. A short loop synchronized with the sweep rate of an oscilloscope provides a repeating signal that makes transient data stand still. For wave analysis, the tape loop reproduces a sample of data repeatedly until it has been scanned for all significant frequencies by a succession of filters. Even a short transient can be analyzed.



The new Ampex FL-100 Tape-Loop Recorder being used with an Ampex FR-100 Reel-to-Reel Recorder. Interchangeable plug-in units make the two compatible with any combination of track characteristics.

For processing or simulation devices, the tape loop provides a program-control cycle of great sensitivity. Tape-controlled repetitions are as identical in pattern as the successive cycles of a mechanical cam – but have advantages of electrical control and infinite variations possible with tape.

Newest of Ampex's tape-loop recorders is the FL-100. It shares the styling and features of Ampex's FR-100 and FR-1100 recorders. The FL-100 uses their same interchangeable plug-in amplifiers, hence each track can be used with any of three recording characteristics. Frequencies from DC to 100,000 cycles can be recorded.

Loop length on the Ampex FL-100 is continually variable from a minimum of 3½ feet up to one of three optional maximums – 25, 50 or 75 feet. Tape widths are quarter, half and one inch. Up to eight tape speeds are available on the same machine. Overall speed ratios can be as high as 128 to 1.

If you would like further information on Ampex's new FL-100 Tape-Loop Recorder – or if you have a special problem to which it is applicable, Ampex's application engineers will be pleased to provide added details. Also, would you like to have this informative ad series mailed to you direct? Write Dept. E-4

MAGNETIC TAPE APPLICATIONS BY AMPEX

4

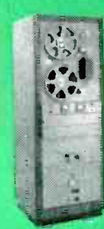
ONE OF A SERIES

Series FR-100

Series 800 Mobile and Airborne

Model FR-200 Digital

Series FL-100 Loop Recorders



Series FR-1100

INSTRUMENTATION DIVISION

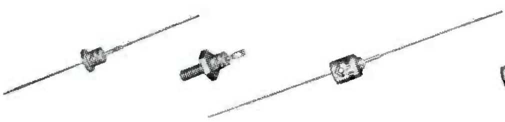
AMPEX CORPORATION

FIRST IN MAGNETIC TAPE INSTRUMENTATION

934 Charter Street • Redwood City, California

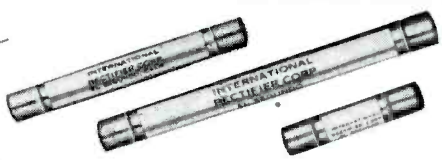
District offices serving all areas of the United States and Canada; Foreign Representatives in countries around the world.

International Rectifier Corporation also produces over 600 silicon rectifier types for all DC requirements.



Silicon Power Diodes

Hundreds of types in three basic styles in voltages from 50 to 1,000 PIV. Hermetically sealed, all-welded construction. Send your application for recommendations.



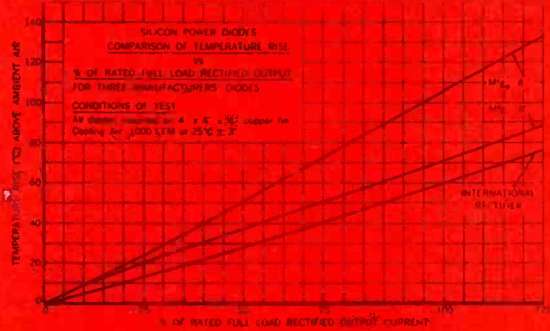
Silicon "Cartridge" Rectifiers

Ratings from 300 volts PIV at 100 ma half-wave DC output to 16,000 volts PIV at 45 ma. Hermetically sealed, metallized ceramic housings.

Silicon Rectifier Stacks

Hermetically sealed junction diodes mounted on copper cooling fins, stacked to include interconnections required for specific circuits. Inquire about wide range of ratings.

Engineered to excel in Industrial Power Applications!



CONSERVATIVE RATINGS MEAN COOLER OPERATION... LONGER LIFE!
Comparative temperature rise tests show the approximate ratio of conservatism in ratings of International Rectifier medium power silicon diodes and units of comparable ratings available from other manufacturers. Note that at the 100% point, the diode from Manufacturer A had a temperature rise approximately 75% higher than the International diode, while Manufacturer B's diode exhibited a temperature rise approximately 18% greater than the International unit. Cooler operation results from conservative ratings — means greater reliability to you!

1 HERMETICALLY SEALED... GLASS TO METAL
Hermetic sealing virtually eliminates possibility for contaminants to destroy the rectifying characteristics of the silicon crystal. This means greater reliability... less chance for field failure.

2 ALL WELDED CONSTRUCTION
No solders or fluxes are used in the sealing of International medium power silicon diodes. All welded construction reduces the possibility for contamination during the life of the product —adds to the mechanical stability of the unit.

3 LOWER CURRENT DENSITY IN THE CRYSTAL
The conservative rating of these units is the one factor that assures greater reliability and longer life, enables them to withstand greater surge overloads than other available units. In one laboratory test an International medium power silicon diode was pulse-tested at 300 amps. rectified output current at a rate of three pulses per minute for a total exceeding 3,000 pulses, without evidence of deterioration.

4 4 STUD TYPES TO MEET YOUR REQUIREMENTS
Engineered to be adapted to existing as well as new equipment, these rectifiers are available in various stud sizes and thread types.

If you are considering silicon rectifiers in your next application, consider International rectifiers *first!* The high forward conductance and the extremely low reverse leakage of these rectifiers provide rectification efficiency up to 99% at power frequencies. The rectifier junction is formed by an International Rectifier Corporation process which has resulted in silicon diodes of outstanding electrical performance and thermo stability. They may be operated at temperatures up to 150°C, and can withstand exposure to temperatures from −55°C to +170°C. These units are subjected to rigorous 100% production and quality control test procedures. To assure performance under the most adverse conditions, the reverse or blocking characteristics are tested at 150°C, and all units are pulse-tested at approximately 300% of the output current rating, to prove their ability to withstand high surge currents. Write, wire or telephone our Application Advisory Department. This group of experienced rectifier engineering specialists will be happy to supply specific information on how these rectifiers can fit into your project.

TYPES NOW IN FULL PRODUCTION

SINGLE-PHASE HALF-WAVE RATINGS AT 25° C

	Typical Forward Drop Volts RMS @ Fan-Cooled Rating	Typical Leakage ma. at rated V. RMS and 150°C Base Temp. MA	Maximum Surge Current for 3 sec. AMPS.	A.C. Input Volts		Rectified Output Amperes	
				PIV	RMS	Convection Cooled*	Fan Cooled @1000 LFM*
30LM1	1.10	75	300	50	35	30	70
30QM1		65		75	52		
30SM1		55		100	70		
30TM1		42		150	105		
30UM1		35		200	140		
30VM1		25		300	210		
68-0551	1.12	75	240	50	35	24	56
68-0751		65		75	52		
68-1051		55		100	70		
68-1551		42		150	105		
68-2051		35		200	140		
68-3051		25		300	210		
68-0591	1.05	75	140	50	35	14	33
68-0791		65		75	52		
68-1091		55		100	70		
68-1591		42		150	105		
68-2091		35		200	140		
68-3091		25		300	210		

***Mounted on a properly designed heat exchanger**
Maximum operating temperature 150°C
Maximum storage temperature 170° C

SILICON DIODES

For further information on International Silicon medium power diodes, request Bulletin SR 143 B.

A WORLD OF DIFFERENCE • THROUGH RESEARCH •

International Rectifier
CORPORATION

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281

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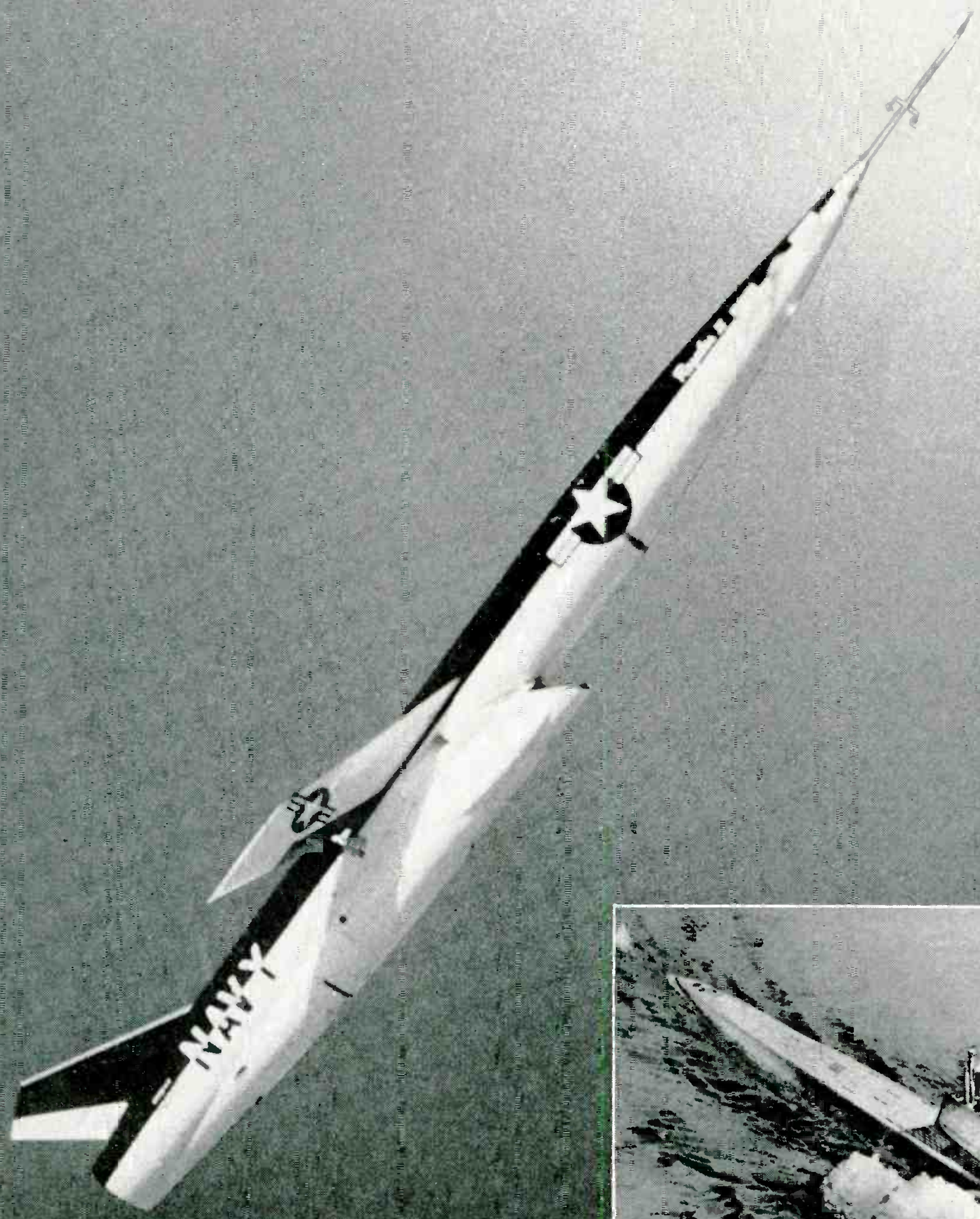
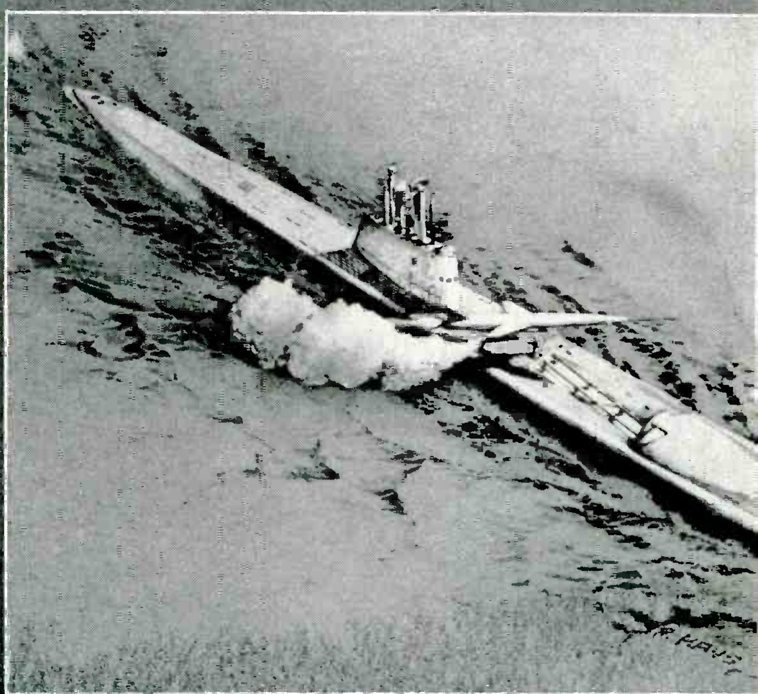
The World's Largest Supplier of Industrial Metallic Rectifiers

VOUGHT ENGINEERS' MISSILE





SYSTEM ARMS NEWEST NUCLEAR SUB

Regulus II—Massive Air Power For Navy's "Undersea Satellite"

Construction has begun on the *USS Halibut*, world's first missile-carrying nuclear submarine. Meantime, the *Halibut's* primary weapon — Vought's Regulus II missile — is being flown repeatedly as a supersonic flight test vehicle.

Before long the two will be joined — a *true* submarine with unlimited undersea range and a far-flying missile, ready to deliver a nuclear strike. You'll hear more about this "undersea satellite" when it begins its stealthy orbit through the deep waters of the world.

Right now — as a Vought engineer — you can help bring it into being.

Chance Vought has weapon systems responsibility for mating its missile with the atomic sub. Today, Vought engineers are designing the *Halibut's* missile support equipment. They'll help train submariners for Regulus II operation, and they'll be on board for check-outs of the entire missile system.

Vought engineers introduced missile power to the Undersea Fleet with Regulus I. In the process, they traveled a new and exciting development route . . . from test range to shipyard to shakedown cruise.

Join them this time and share their adventure. Help forge from sea and air power an *ultimate* weapon.

4 IMMEDIATE OPENINGS FOR ENGINEERS

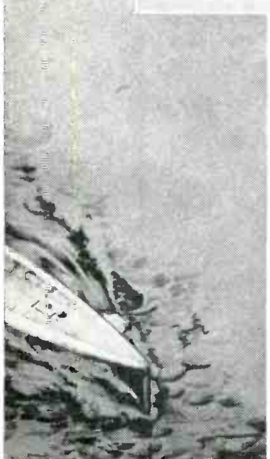
Senior Flight Test Analysis Engineer For Research Assignments. To integrate automatic computation methods into flight test data reduction and analysis methods, and to develop new methods of flight test and data analysis. Requires engineering degree and 3 to 4 years experience with flight test data reduction and analysis methods.

Propulsion Engineer. For assignment in installed turbojet and rocket performance; thermal control; inlet duct and nozzle design; aerothermodynamics.

Development Engineer. For weapon and tactical analysis. To plan optimum weapon systems prior to preliminary design, and to evaluate the military worth of new aircraft and missiles in preliminary design.

Electronic Development Instrumentation Engineer. To conceive, design, laboratory-evaluate and test intricate components and assemblies aimed at automation of data acquisition and analysis. Requires Electronics or Physics degree and 1 to 4 years experience in electronics design.

USS Halibut symbolizes advanced capabilities of the Navy's 57-year-old submarine force and signals a broad new frontier for weapon systems engineering at Chance Vought.



CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

To arrange for a personal interview, or for a prompt report on these or **other current openings,** return coupon to:

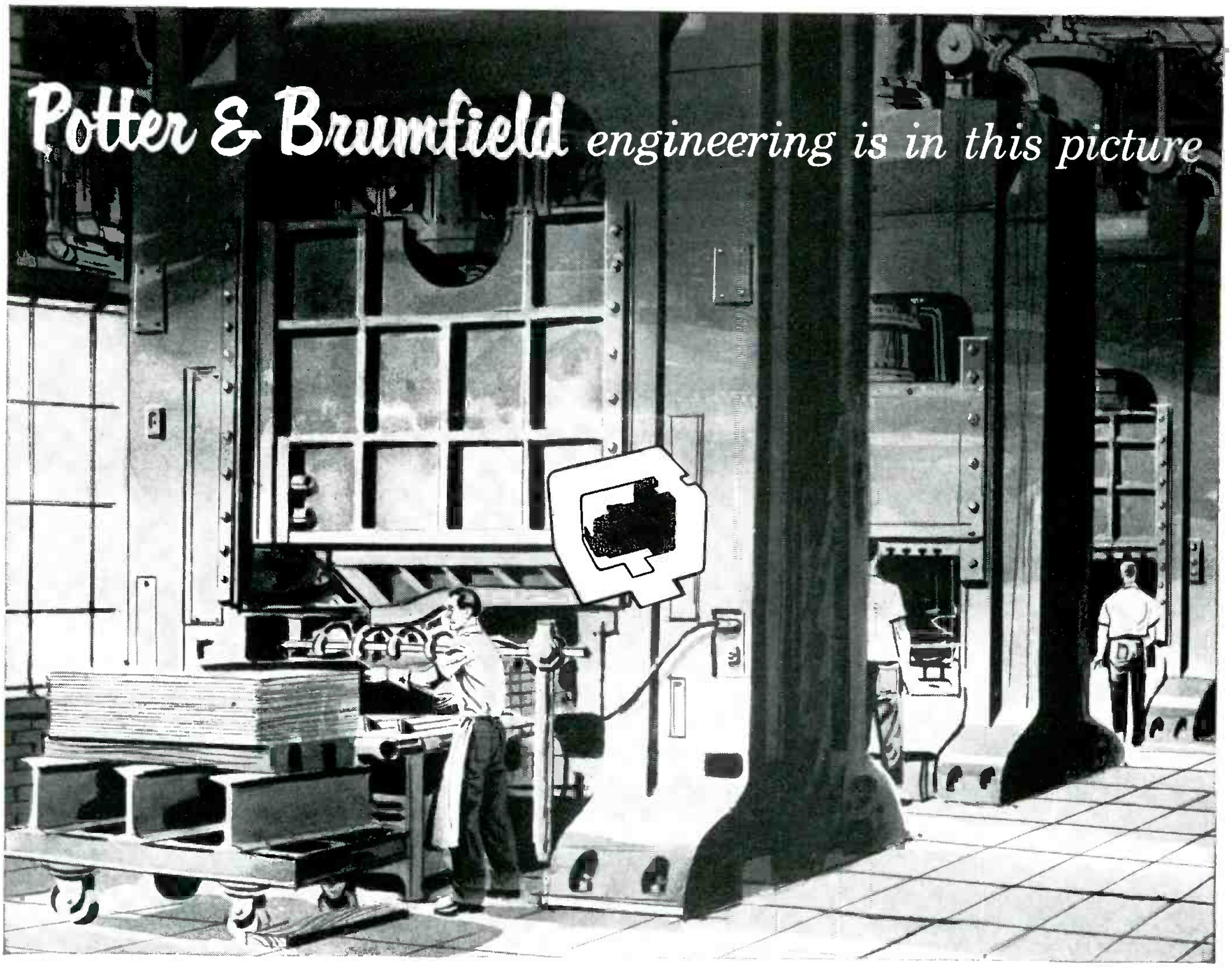
Mr. C. A. Besio
Supervisor Engineering Personnel
Chance Vought Aircraft, Dept. E-4
Dallas, Texas

I am interested in a detailed report ☐ personal interview ☐

on opening for ____________________

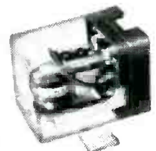
Name ____________ Address ____________

City ____________ State ____________



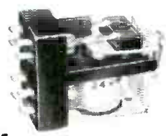
MECHANICAL MONSTER OR MODERN MARVEL?

Select the P&B Relay which helps make the difference



AG Series
Enclosed Power Relay
Shock-Proof and Dust Proof

MW Series
Appliance Type Relay
with above Average
Performance and Life.



AB Series
Appliance Type Relay,
Heavy Duty Construction.

Proper controls turn monsters into marvels . . . and controls are only as good as their components, such as relays. Without controls, this massive press, or any automated equipment, becomes a nightmare of disorganized force.

P&B AG Series relays are particularly suited to automation. They are ruggedly constructed for excellent shock resistance, withstanding 100 G shock without mechanical damage. The AG is a tough relay designed for rough jobs.

A metal enclosure keeps out shop dust and dirt. The phenolic base meets all U/L requirements for spacing and creepage distances . . . and the DPDT contact arrangement permits a wide variety of circuit variations.

For over 25 years, P&B has been building relays, and modifying existing types, to suit specific applications. Write for new catalog or engineering consultation.

ENGINEERING DATA

SERIES: AG. Enclosed power relay for use in dusty or dirty applications.

CONTACTS: 3/16" dia. fine silver. Rated 5 amps., single break, 115 V. AC resistive. Rated 8 amps., double break, 115 V. AC resistive.

CONTACT ARRANGEMENTS: SPST NO-DM, SPST NC-DB, DPST-NO, DPST-NC, DPDT.

VOLTAGE RANGE: DC: 6 to 220 V. AC: 6 to 230 V.

COIL RESISTANCE: 30,000 ohm maximum.

POWER REQUIRED: 1.5 W. minimum DC at 25° ambient. 6 W. maximum.

AMBIENT TEMP. RANGE: —55° C. to +85° C.

TERMINALS: Screw type molded in phenolic base.

ENCLOSURE: Special dust cover.

DIMENSIONS: 2¾" L. x 2 11/32" W. x 3 5/32" H.

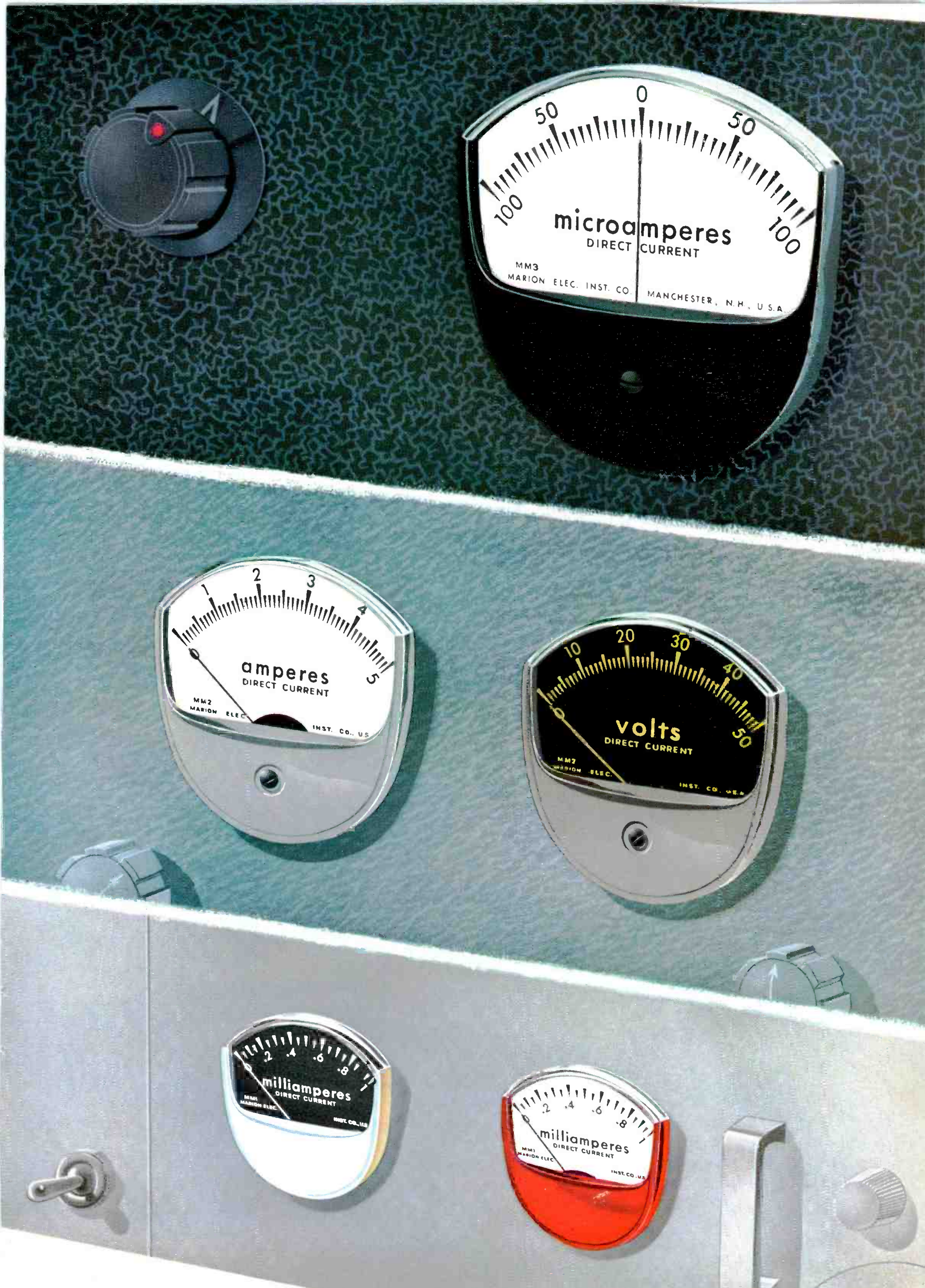
P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC, ELECTRICAL AND REFRIGERATION DISTRIBUTORS

Potter & Brumfield, inc. PRINCETON, INDIANA

See our catalog in Sweet's Product Design File.

Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY

Manufacturing Divisions also in Franklin, Ky. and Laconia, N.H.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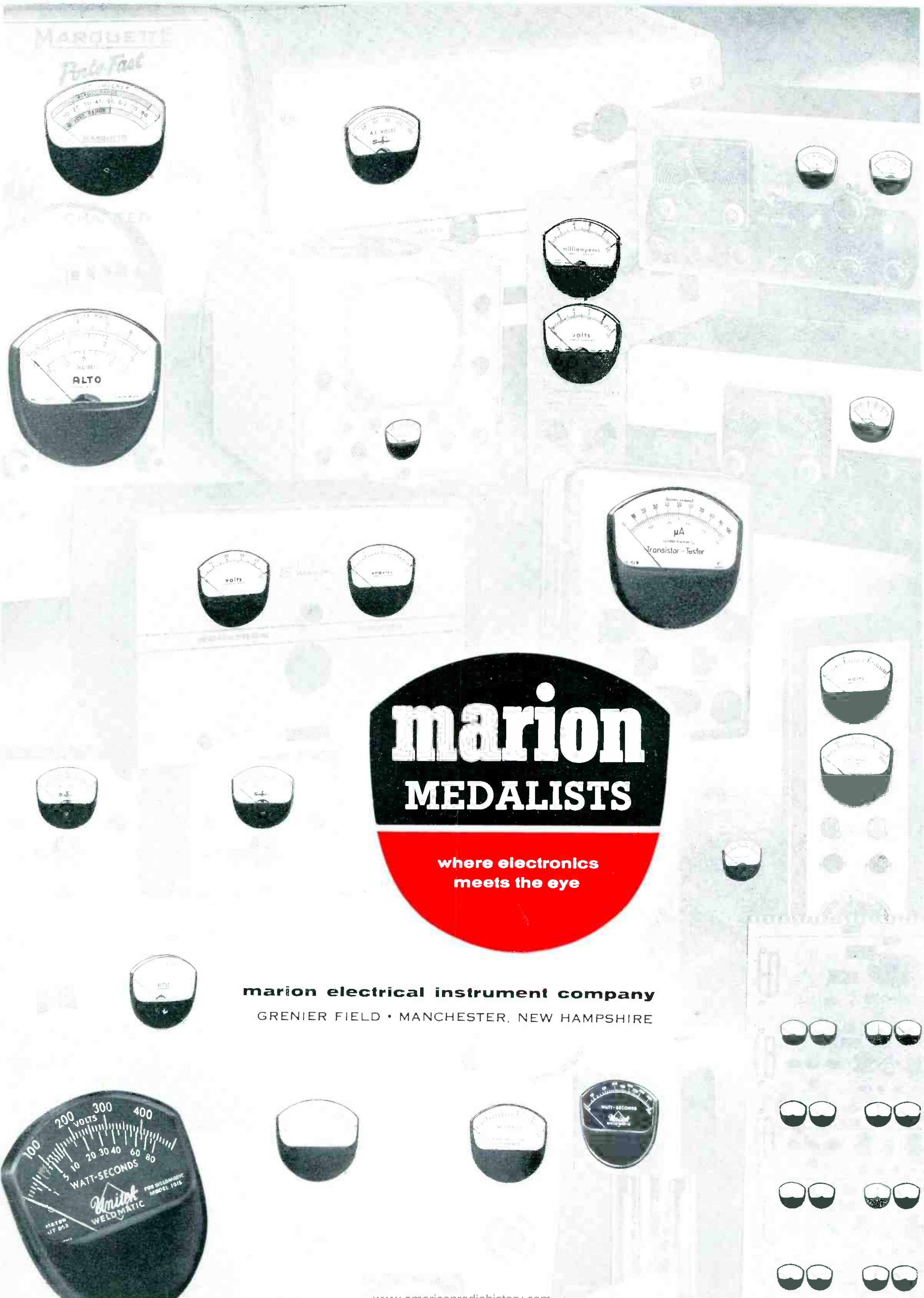
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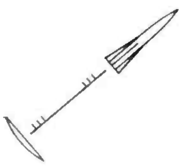
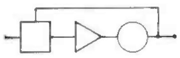
SYSTEMS DEVELOPMENT



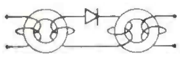


MODEL 2125B
GENERAL PURPOSE PULSE GENERATOR

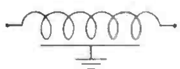
$J_1 = K_1 = Q_1 \bar{Q}_2 Q_3$

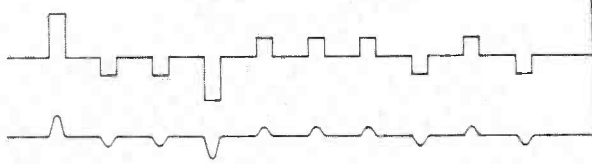
to...

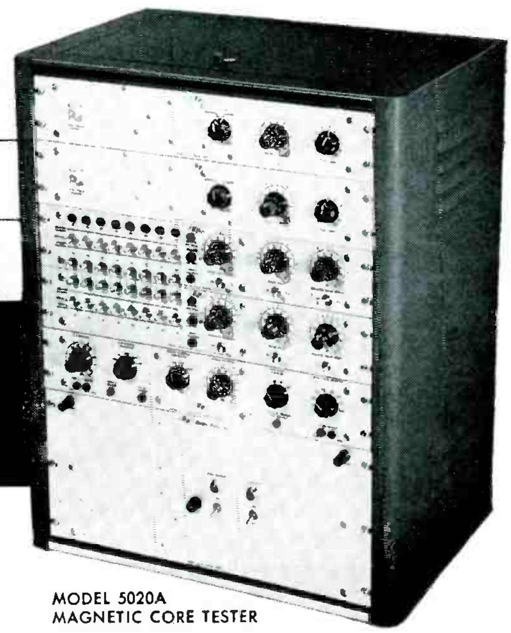
COMPONENT TEST



$V = \mathcal{L}^{-1} E_0 e^{-s\tau}$



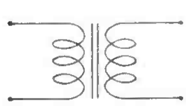


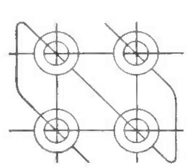


MODEL 5020A
MAGNETIC CORE TESTER

33 STANDARD ELECTRO-PULSE INSTRUMENTS to SIMPLIFY YOUR PULSE INSTRUMENTATION PROBLEM

$\Phi = -\frac{1}{N}\int e \cdot dt$





For digital or analog systems, from sub-sonic rep rates to megacycles, pulse widths from milli-microseconds to seconds, in general or special purpose equipment—Electro-Pulse offers a complete and integrated line, designed for your applications by pulse instrumentation specialists.

In addition to the wide range of complete instruments, combinations of standard "block-units" quickly and economically provide ready-made special instrumentation.

Advanced engineering, low-maintenance hard tube circuitry, and flexible wide-range operation typical in Electro-Pulse equipment offers unmatched instrument value for the protection of your project budget and time schedule.

Factory representatives will be pleased to discuss your requirements and recommend applicable equipment.

WRITE FOR COMPLETE CATALOG No. 1-57/E

Representatives in Major Cities

- ✓ Pulse Generators
  - Precision
  - General Purpose
  - Low Speed
  - Megacycle
- ✓ Multi-pulse Generators
- ✓ Pulse Code Generators
- ✓ Beacon Simulators
- ✓ Clock Generators
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- ✓ Core Testing Equipment
- ✓ Pulse Voltage Calibrators
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EP Electro-Pulse, Inc.

11861 TEALE STREET, CULVER CITY, CALIFORNIA • Telephones: EXmont 8-6764 and TExas 0-8006

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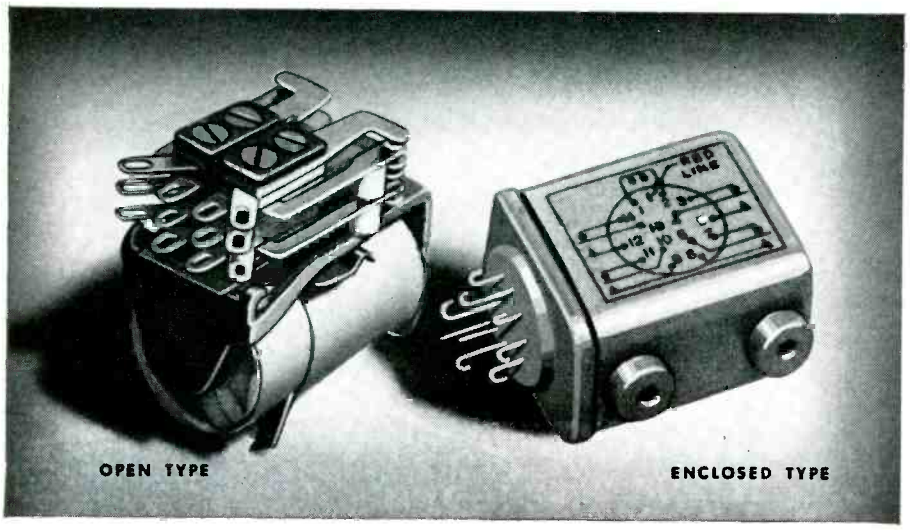
R-B-M Miniature Multipole Relays of Proven Reliability



Light weight, Small Size Open and Hermetically Sealed Types for Electronic and Communication Application

APPLICATION: R-B-M Miniature Multipole Relays are used where the prime factors in switching electronic circuits are small size, light weight and reliability. These proven designs are produced for switching low power circuits, low capacitance circuits and power circuits. 125° C insulation now available on some versions. Coils can also be designed for plate circuit.

CONSTRUCTION:

Magnet Frame—Four sizes available on open type relays and three sizes on hermetically sealed type.

Contacts—Cross-bar palladium welded to nickel silver springs or button contacts on Beryllium copper springs.

Terminals and Mountings—Glass headers provided with either solder or plug-in type terminals with many various types of mountings available. Octal type plug-in headers can be provided on the HL enclosure. Plug-in terminals to fit either 9 or 14 pin standard sockets. Maximum of 14 pins for solder connections.

TYPICAL SPECIFICATIONS*

Open	Maximum Coil Resistance (OHMS)	Minimum Power Requirements Per pole at 25° C (WATTS)	Maximum Contact Form With rated current at 32 V.D.C. or 115 V.A.C. (non-inductive load)	Maximum Coil Watts	Enclosed
SM	9,000	.2	4 PDT 5 Amps. or 3 Amps. 6 PST 3 Amps.	3.75	HSM
SMD-2	9,000	1.0	SPNO Parallel Contacts Make 80 Amps. Break 20 Amps. at 32 V.D.C.	3.75	HSMD-2
SC	18,500	.16	4 PDT 5 Amps. or 3 Amps. 6 PST 3 Amps.	4.5	HPSC
SA	18,500	.14	4 PDT 5 Amps. or 3 Amps. 6 PST 3 Amps.	4.5	HLSA
SM-RF	9,000	.2	SPNO, SPDT, DPNC, SPNC, DPNO	3.75	HSM-RF HLSM-RF
SAD-2	18,500	1.0	SPNO Parallel Contacts. Make 80 Amps. Break 20 Amps. at 32 V.D.C.	4.5	HLSAD-2

*Other ratings and specifications available.

For additional information write for Bulletin No. 1050

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Manufacturers of Magnetic Controls and Devices / LOGANSPORT, INDIANA

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other outstanding
***ESSEX ENGINEERED**
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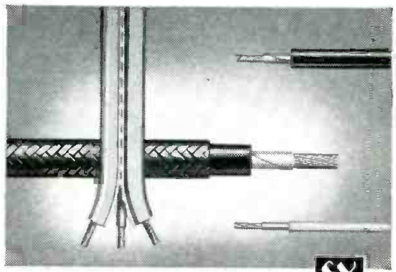
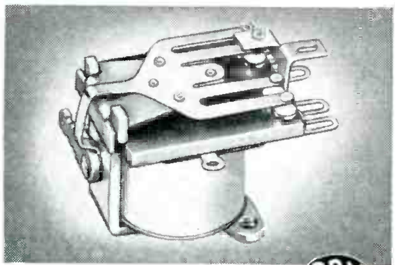


WIRE AND CABLE

A full "Extra Test" line of lead, appliance, automotive and refrigeration wires, plus submersible pump cable and 200° C. Sil-X insulations are examples of the versatility of "Essex Engineering".

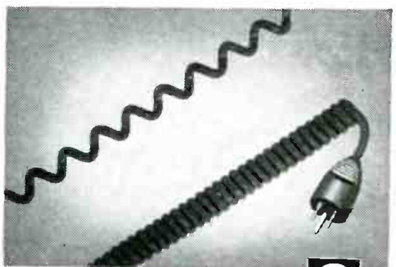
Wire and Cable Division
Fort Wayne, Ind



MINIATURE RELAYS

The Type MS Miniature Sensitive Relay is ideal for any application requiring a compact, highly reliable single pole D. C. device, where a low cost solution is required because of volume usage and competitive problems. Request Bulletin No. MS-1.

R-B-M "Control" Division
Logansport, Ind.



COILED CORDS

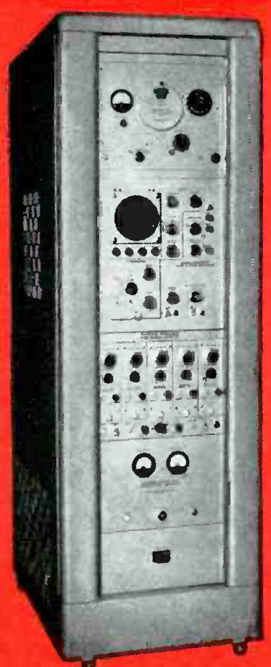
The "spring" in Coiled Cords automatically synchronizes with moving components that are electrically powered. There are no looping, tangling cords in the way . . . because Coiled Cords extend and retract as needed. Write for new literature.

Cords Limited Division
DeKalb, Ill.

ESSEX WIRE CORPORATION

Variable width — width of each of 5 pulses can be adjusted independently.

Variable delay—delay between each of 5 pulses can be adjusted independently.



CODE MODULATED MULTIPLE-PULSE MICROWAVE SIGNAL GENERATOR Model B

Pulse-time modulation—input provided in each of 5 pulse channels for external pulse-time modulation.

Variable repetition rate—repetition rate of each group of pulses can be varied.

CODE MODULATED MULTIPLE-PULSE MICROWAVE SIGNAL GENERATOR

Model B 950-10,750 mc

Generates multi-pulse modulated carrier for beacons, missiles, radar...provides 5 independently adjustable pulse channels, 4 interchangeable r-f oscillator heads, precision oscilloscope, self-contained power supplies ...all in one integrated mobile instrument.

The Polarad Model B is an essential instrument for testing beacons, missiles, radar, navigational systems such as DME, Tacan, H. F. Loran, etc., where multi-pulse modulated, microwave frequency energy with accurately controlled pulse width, delay, and repetition rate is required for coding.

A fully integrated self-contained equipment with these features:

Four Interchangeable Microwave Oscillator Units — all stored in the instrument . . . each with UNI-DIAL control . . . precision power monitor circuit to maintain 1 mw power output reference level . . . keying circuit to assure rapid rise time of modulated r-f output . . . non-contacting chokes.

Five Independently Adjustable Pulse Channels —each channel features variable pulse width and delay; has provisions for external pulse-time modulation.

Precision Oscilloscope with Built-In Wide Band RF Detector for viewing the modulation envelope and accurately calibrating the r-f pulse width, delay, and group repetition rate. Equipped with built-in calibration markers.

Self-Contained Power Supplies—Model B operates directly from an AC line through an internal voltage regulator. The coded multi-pulse generator is equipped with an electronically regulated low voltage DC supply. Klystron power unit adjusts to proper voltage automatically for each interchangeable band.

Contact your Polarad representative or write to the factory for detailed information.

SPECIFICATIONS:

Frequency Range:
- Band 1 . . . 950 to 2400 mc
- Band 2 . . . 2150 to 4600 mc
- Band 3 . . . 4450 to 8000 mc
- Band 4 . . . 7850 to 10,750 mc

Frequency Accuracy . . . ±1%

RF Power Output . . . 1 milliwatt maximum (0 DBM)

Attenuator:
- Output Range . . . 0 to −127 DBM
- Output Accuracy . . . ±2db
- Output Impedance . . . 50 ohms nominal

RF Pulse Characteristics:
- a. Rise Time . . . Better than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the initial rise.
- b. Decay Time . . . Less than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the final decay.
- c. Overshoot . . . Less than 10% of maximum amplitude of the initial rise.

Internal Pulse Modulation:
- No. of Channels . . . 1 to 5 independently on or off
- Repetition Rate . . . 40 to 4000 pps
- Pulse Width . . . 0.2 to 2.0 microseconds
- Pulse Delay . . . 0 to 30 microseconds
- Accuracy of Pulse Setting . . . 0.1 microsecond
- Minimum Pulse Separation . . . 0.3 microsecond
- Initial Channel Delay . . . 2 microseconds from sync. pulse
- Internal Square Wave . . . 40-4000 pps (separate output)

Pulse Time Modulation:
- Frequency . . . 40-400 cps any or all channels
- Required Ext. Mod. . . . 1 volt rms min.
- Maximum deviation . . . ±0.5 microsecond

Power Input (built-in power supply) 105/125 v. 60 cps 1200 watts.

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

POLARAD PROVEN RELIABILITY **ELECTRONICS CORPORATION** 43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

REPRESENTATIVES: Albany, Albuquerque, Atlanta, Baltimore, Boston, Chicago, Cleveland, Dayton, Denver, Englewood, Fort Worth, Kansas City, Los Angeles, New York, Philadelphia, Portland, Rochester, St. Louis, San Francisco, Schenectady, Stamford, Syracuse, Washington, D. C., Winston-Salem, Canada: Arnprior, Ontario.
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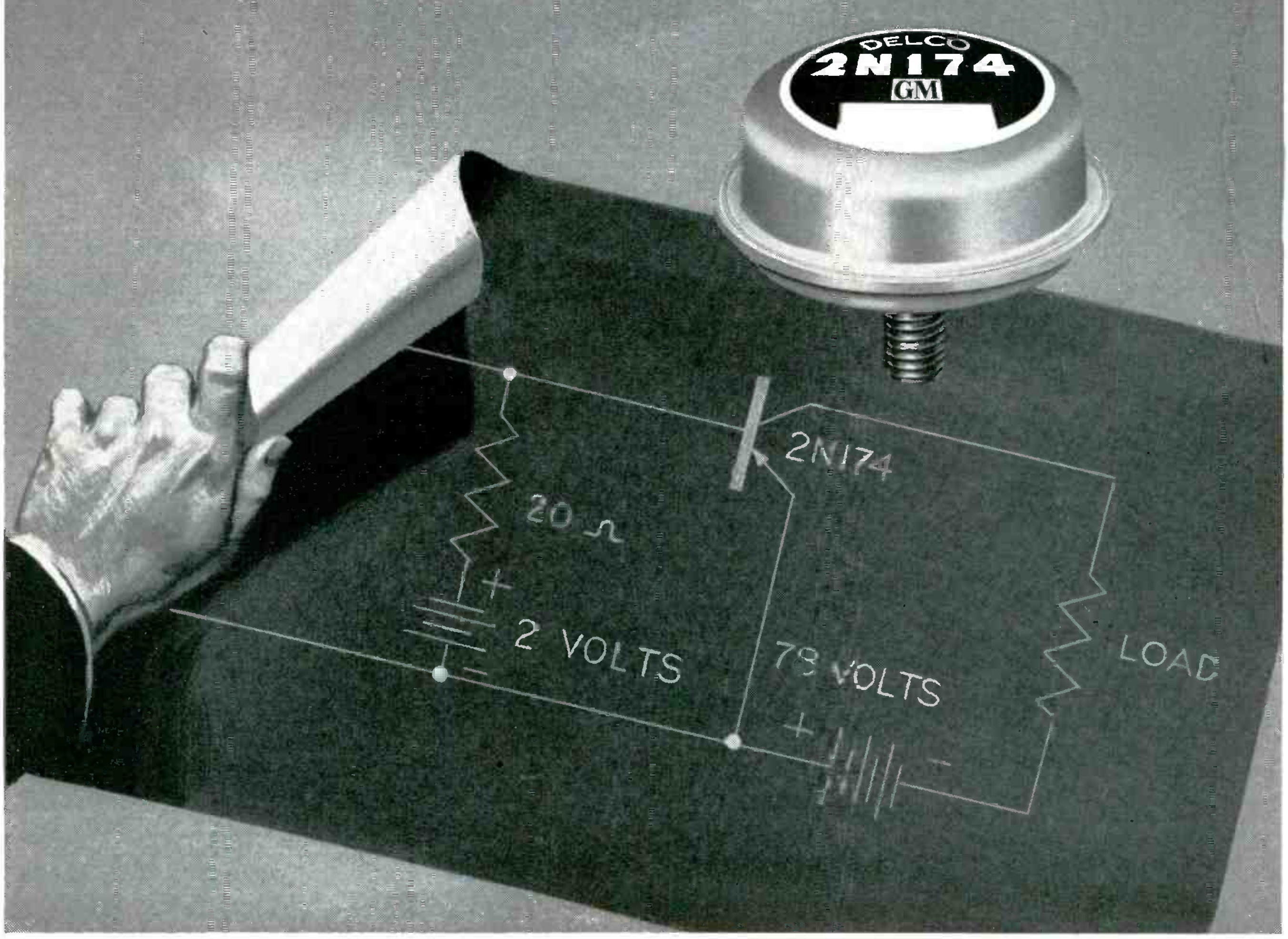
1 KW Transistor Switching



Industry's Highest Power Transistor

Eliminate arcing at switch points. Stop switch deterioration while increasing the efficiency and reliability of all electronic control equipment!

A single Delco 2N174 transistor can switch 1 kw with one watt of control power.

Because transistor switching eliminates arcing, switch life is longer and more reliable.

This switching performance is possible because of the excellent electrical characteristics of the 2N174; in particular, the high collector breakdown voltage, extremely high maximum collector current, and very low input impedance.

You may employ Delco 2N174 high-power transistors with confidence in their reliability and uniformity. These transistors, normalized to retain better performance characteristics regardless of age, are currently being produced by the thousands every day. Write for engineering data.

Power Switching Characteristics	
Switching Power	1000 watts
Current in "on" position	13 amperes
Input Control Power	1 watt
Power Gain	30 db
Dissipation in "on" position	8 watts
Switching time	60 microseconds

DELCO RADIO – DIVISION OF GENERAL MOTORS
KOKOMO, INDIANA

not just "new" but a new KIND of OSCILLOSCOPE

-hp- 130A Low Frequency Oscilloscope

High sensitivity, dc to 300 KC

21 direct reading sweep times

Sweeps 1 μsec/cm to 15 sec/cm

Easy to use

"Universal" automatic triggering

5% voltmeter, millivoltmeter

This totally new production and laboratory instrument obsoletes previous concepts of oscilloscope convenience, usefulness and reliability.

Horizontal and vertical amplifiers are similar. Sensitivity is 1 mv/cm or 10 mv full scale deflection. Amplifiers have wide pass bands, dc to 300 KC. Input circuits are balanced on 5 most sensitive ranges. Single-ended input may be dc or ac coupled. Amplifiers are stable; gain may be standardized by an internal 1,000 cycle square wave. Sweep times are highly linear, may be set and read directly. In most cases *-hp-* 130A needs no preamplification to present transducer signals as a brilliant, high resolution trace.

A special feature is the "universal" automatic triggering system where one preset condition provides optimum triggering on almost all input signals.

Brief Specifications

Input Amplifiers: (Similar Vert. and Horiz. Amps.). Sensitivity 1 mv/cm to 50 v/cm; 14 calibrated ranges, 1-2-5-10 sequence plus continuous vernier. Pass band dc to 300 KC; ac or dc coupling. Balanced input on 1, 2, 5, 10 and 20 mv/cm ranges.

Sweep Range: 1 μsec/cm to 15 sec/cm. 21 sweeps: 1-2-5-10 sequence, 5% accuracy.

Triggering: Internal, line voltage or external 0.5 v or more. Pos. or neg. slope, +30 to −30 v trigger range.

Preset Trigger: Optimum setting for automatic stable triggering.

Amplitude Calibration: 1 KC square wave. 5% accuracy.

Price: $650.00

For the complete story on a really new oscilloscope, call your -hp- representative, or write direct.

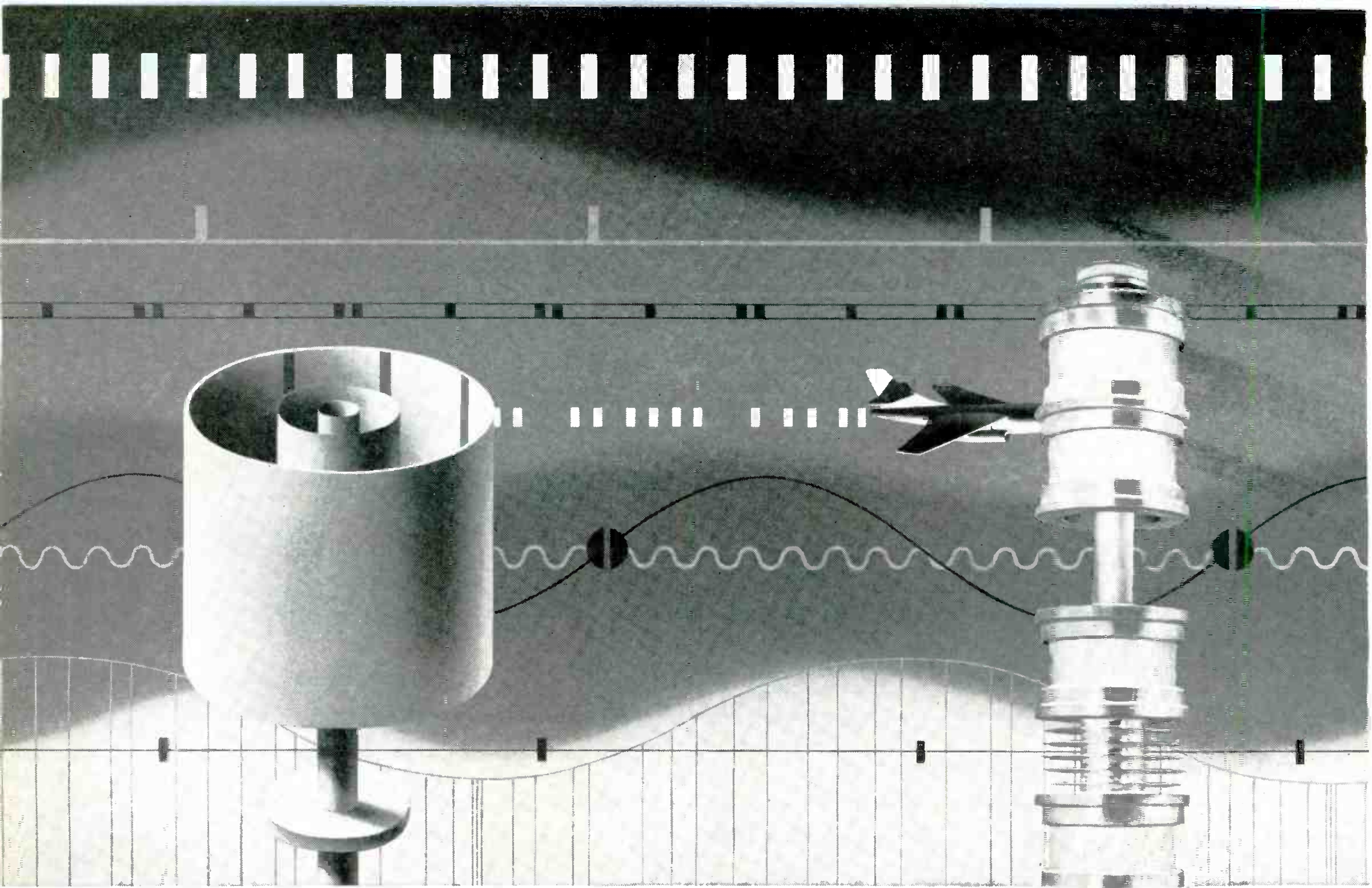
HEWLETT-PACKARD COMPANY

4054A Page Mill Road • Palo Alto, California, U.S.A.
Cable "HEWPACK" • DAvenport 5-4451

Field engineers in all principal areas

also offers *-hp-* 150A High Frequency Oscilloscope, dc to 10 MC, sweeps 0.02 μsec/cm to 15 sec/cm. Rise time 0.035 μsec.

Want more information? Use post card on last page.



Eimac X676 Modulating Anode Klystron

Eimac X676 Meets CAA Air Navigational Requirements

Designed for air navigation systems, the Eimac X676 three cavity, air cooled klystron will deliver 30 KW peak power output in the 955 to 1220 mc range. With a power gain of 35 db, this tube has an efficiency of 40 per cent.

A typical air navigation systems requirement is a shaped RF pulse output to eliminate spectrum interference in adjacent channels. The Eimac X676 conservatively meets the 60db requirement of the CAA's air navigational system without using critically tuned, expensive filters in the RF output transmission line. The modulating anode permits pulsing the beam current while keeping the accelerating voltage constant. Also, the modulator circuit for this application is quite simple.

The RF cavities are external to the vacuum system and detachable from the klystron. The user may purchase spare tubes without buying additional tuning and focusing assemblies.

For the design engineer, the features of the X676 simplify circuitry — for the equipment operators the X676 provides reliable, long-lived performance at moderate cost.

For further information about the Eimac X676 Modulating Anode Klystron, consult our Application Engineering Department. Also available are two highly informative booklets; "The Care and Feeding of Klystrons" and "Klystron Facts . . . Case Four".

EITEL-McCULLOUGH, INC.
SAN BRUNO CALIFORNIA
Eimac First **in high power amplifier klystrons**

Eimac

Typical Pulse Operation X676

DC Beam Voltage	24 KV	Power Output	32 KW	Power Gain	35 db
DC Beam Current	3.3 Amps	Driving Power	10 watts	Average Power	1 KW
Power Input	80 KW	Efficiency	40%		

NEW! FM Telemetering Discriminator*

ultra-stable

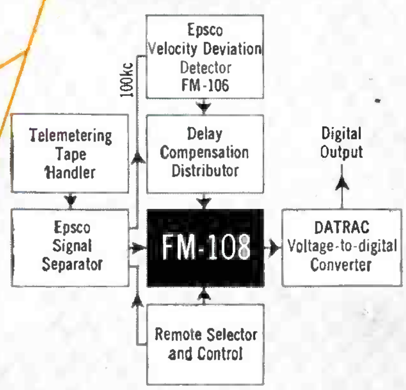
**Epsco Model FM-108 FM-to-Voltage Converter.*

EPSCO'S MODEL FM-108 crystal-controlled ultra-stable, all-channel discriminator presents a new *standard of accuracy* . . . better than an order of magnitude more accurate and stable than any other commercially available equipment . . . and with absolutely *no* adjustments! This new standard of FM data processing features:

- **HIGH DYNAMIC ACCURACY:** Absolute accuracy is better than 0.05%, and the dynamic accuracy of the equipment from input to associated band-pass filter through the low-pass output filter is better than 0.2%.
- **LONG-TERM STABILITY:** 0.2% for life of equipment with no adjustments for zero drift, gain and line voltage variations, etc.
- **VERSATILITY:** Converter operates on any of 23 standard IRTWG telemetering sub-carrier frequencies from 400 cps to 70kc. Band switching may be accomplished remotely or by selector switch on front panel.
- **AUTOMATIC WOW and FLUTTER COMPENSATION:** With Epsco FM-106 Velocity Deviation Detector and Epsco CD-601 Velocity Deviation Compensation Distributor, errors from tape speed variations are reduced by a minimum of 35 db.
- **ZERO and 100% DATA CORRECTION:** Produces automatic compensation for variation of transmitting sub-carrier oscillator frequency and gain by a transistorized electro-mechanical servo feature.
- **DYNAMICALLY ACCURATE SELECTABLE LOW-PASS FILTERS:** A 5-pole filter utilizing precision wire-wound resistors and ultra-stable polystyrene capacitors in combination with chopper-stabilized d-c amplifiers provides:
  - Phase linearity deviation not exceeding 0.25 degrees over 90% of bandwidth.
  - Pass band flat within ±0.1% (0.01db) to F_c.
  - Minimum attenuation of 54 db of nearest beat frequency between sub-carrier channels.
  - A total of 62 different low-pass filter bandwidths selectable from 11 cps to 3490 cps.
- **PHYSICAL CHARACTERISTICS**

SIZE: 10½" of space of standard 19" cabinet.
WEIGHT: 29½ pounds.
CONSTRUCTION: Constructed of 8 separate plug-in chassis assemblies containing electronic and magnetic components. All components are accessible on the standard layout forms.

Engineering data sheet available on request.



Epsco Model BF-601 Signal Separator units, each of which contains 23 band-pass filters, are available for separating the composite sub-carrier signal prior to input to FM Converter.

Complete FM telemetering receiving stations are available with or without wow and flutter compensation and zero and 100 percent correction features. Also available is the Epsco Model VCO-718 All-Channel Voltage-Controlled Oscillator for FM Discriminator calibration . . . which occupies only 3½ inches of panel space including power supply.

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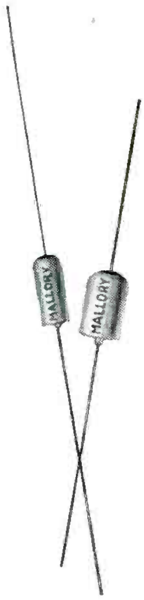

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electronics

W. W. MacDONALD, Editor

JUNE 1 • 1957

CROSS TALK

►**YOUNG IDEAS** . . . Judged high-school junior and senior physics exhibits at a local Science Fair the other night. Four of the five awards went for work in electronics; a digital computer, a servo-controlled "dog" that followed right at our heels, a high-speed counter and a light-beam communicator. Co-judge, who was a prominent M. E. holding no brief for tubes or transistors, independently made the same selections so the awards were a pretty good indication of the extent to which scientifically inclined youngsters are interested in our art.

These boys nearing college age are smart. So smart, in fact, that our advice to full-fledged engineers who might judge similar contests next year is not to under-rate them when asking questions. Like the youngsters on the quiz programs, these boys have a great deal of highly specialized knowledge and fire back answers in depth and detail that are positively astounding and can be downright embarrassing.

►**ON THE FENCE** . . . From time to time over the past several years we have commented upon the position of color television in the market. In all these instances we have tried to reflect the feeling of the industry itself, an area which is more or less comfortable because of our many day-to-day business contacts.

In dealing with the attitude of the ultimate consumer there is less competence. We are getting the impression, however, that it now would take very little to push the public over the line.

Color television could easily be an important factor in the industry by fall.

►**SKYHOOK** . . . Most men who have worked with high-frequency communications apparatus since the early days still dream about the ideal "skyhook" . . . some means of radiating line-of-sight signals from a higher point above the shack, or bouncing them off a controllable heaviside layer, or both. Our own work progressed through towers that raised neighborhood eyebrows to kites and captive balloons and ceased for economic reasons at the point where we were dreaming of some kind of vertical light beam that would accept a standing wave and serve as an antenna.

Now, out in New Mexico, Stanford University and the Air Force are about to fire off some rockets that will ionize the upper air when they explode. Amateurs within a radius of 700 miles will try to utilize the artificial reflective layers to communicate on frequencies all the way from 14 to 148 mc.

All this dreaming, it seems, may soon bear fruit.

►**DEFINITION** . . . "Systems Engineering is when you have the prime contract."

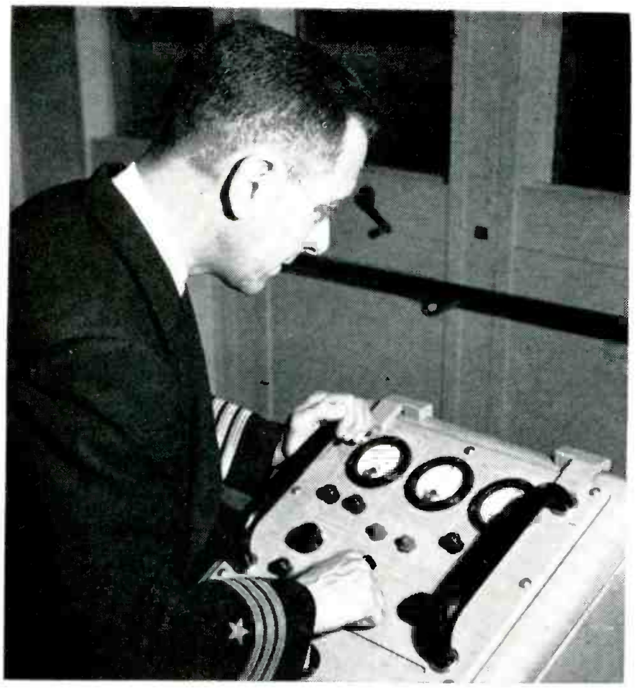
LOOKING AHEAD . . .

Glass stronger than steel may be just around the corner, if adaptable to aircraft and missile construction could further step up importance of infrared detection systems.

Continuing intense investigation of such phenomena as semiconduction and superconductivity is bringing electrical, metallurgical and chemical engineers into closer and closer contact

As demand for component miniaturization increases, more and more design engineers are remembering that one way to achieve it is by increasing the output frequency of power supplies

Extension of submarine operating ranges, among other things, is bringing about more widespread study of radio propagation at extremely low frequencies



Captain of Navy's USS Compass Island, engaged in Polaris guided missile program, checks operation of Gyrofin stabilizers by monitor meters that indicate ordered-lift and both fin angles. Other controls adapt stabilizers to varying weather conditions

Out-rigged fin is inspected while Navy's experimental ship USS Compass Island is in drydock. Stabilizers will allow forerunner of fleet of nuclear-powered, ballistic missile-launching ships to roll a degree and a half while sister ships roll 15 degrees

By RICHARD SCHEIB, Jr.

Marine Division
Sperry Gyroscope Company
Division of Sperry Rand Corporation
Garden City, New York

TRANSISTORS STABILIZE

AMERICAN SHIPS are again being equipped with stabilizers to attenuate their rolling motion. They have been installed on the SS Mariposa and SS Monterey in Pacific cruise service and on the Navy's USS Compass Island, a missile ship now in service in connection with the US Navy's Polaris missile program.

To the commercial ship owner, stabilization offers improved passenger comfort and safety as well as economies afforded by maintaining speed and schedule in rough weather. To the Navy, ship stabilization also offers improved missile launching conditions and navigation accuracy under adverse sea conditions.

Computer studies facilitated the development of the new stabilizer, called the Gyrofin Ship Stabilizer. The dominant role played by the application of electronic and servo techniques to the stabilizer control system will be discussed in this article.

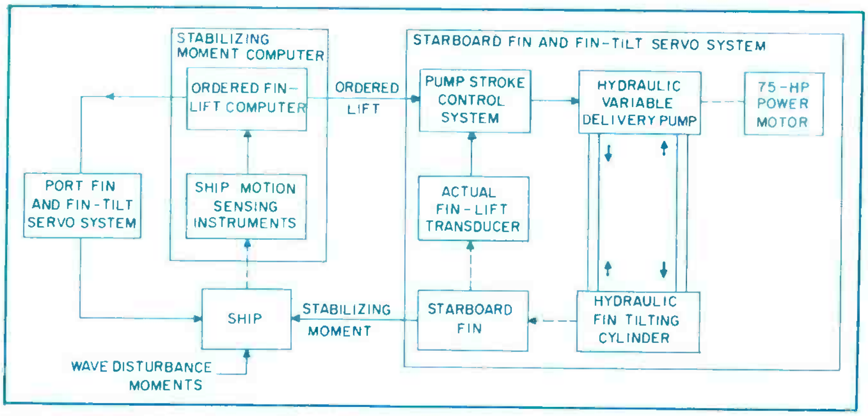
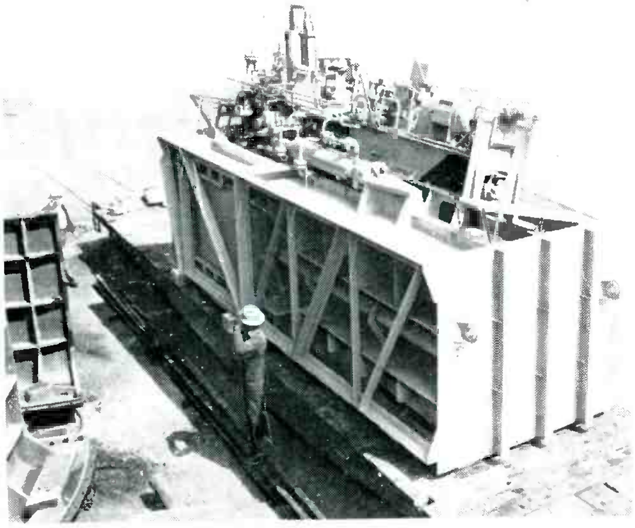


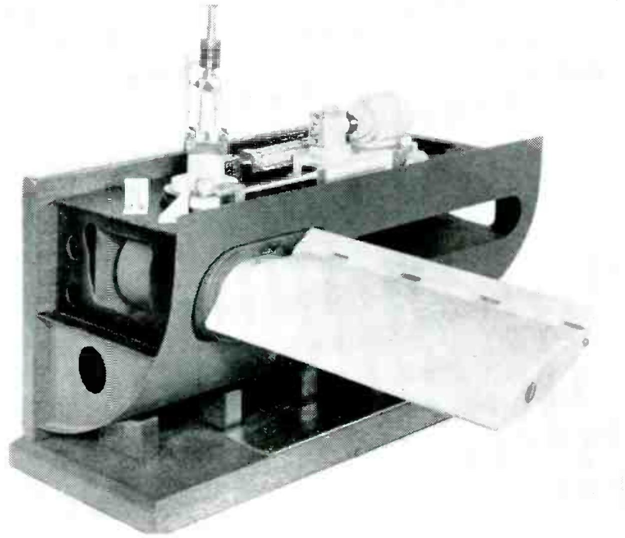
FIG. 1—Complete ship stabilizer system consists of port and starboard fin-tilt servos and stabilizing-moment compute. Hydraulic system provides huge torque

Stabilization Problem

Frequency and amplitude of a ship's rolling motion depend on the frequency spectrum of the waves as well as the ship's natural roll frequency and damping character-



Relative size of fin machinery and hydraulic servo ready for shipboard installation can be gleaned by comparison with man



Fin model shows how below-decks machinery is installed on ship. Vertical hydraulic cylinder tilts fin to stabilize ship

SUMMARY —— Measuring, computing and servo techniques are combined to control underwater fins. Up to 90 percent of ship's roll is eliminated thus providing stable platform for missile launching. Servos combine transistor and magnetic amplifiers obtaining 15-watts output for fin orders. Automatic overload protection of fins in heavy seas also is provided

MISSILE SHIPS

istics. The largest amplitude and greatest regularity of roll motion occurs at frequencies near resonance, typically 4 cpm for a 20,000 ton ocean liner.

Reduced but more random amplitudes occur at frequencies below and above the resonant frequency. An ocean liner stabilizer must, therefore, cope with this wide range of roll frequencies, typically from 1 to 10 cpm. A stabilizer theoretically capable of maintaining a 5-degree list reduces rolling to negligible amplitudes in all but most violent seas.

Of the many methods available, ships are stabilized most effectively by actively controlled underwater fins. Typically, two fins only 7 by 14 feet in size will stabilize a 550-foot, 20,000 ton ship. Fins such as these are capable of applying stabilizing moments indefinitely to cope with low-frequency wave disturbances. By making the fin operate rapidly enough, the stabilizer is able to counteract the highest frequencies of wave disturbance to which the ship will respond.

When operated within the capacity of its fins, the Gyrofin stabilizer is capable of attenuating the roll amplitude by as much as 90 percent, reducing a roll of ±20 deg to less than ±2 deg.

Two 100-sq ft fins, located about

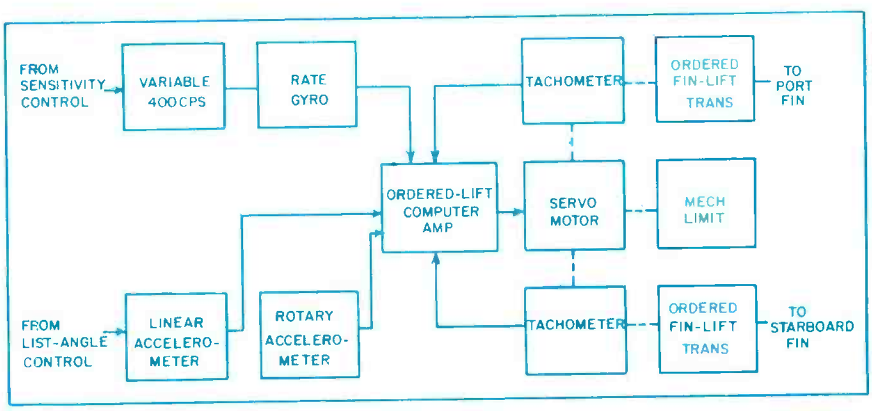


FIG. 2—Stabilizing-moment computer is located in control console on ship's bridge

the middle of the ship, 20 feet below the water line, provide the stabilization. When not in use they are folded back into recesses in the hull. The fins cooperate, one by tilting downward, the other upward, to apply a stabilizing moment to the ship. They are capable of lift forces up to 70 tons each, resulting in a maximum stabilizing moment of 6,000 ton-ft. The fins operate rapidly at speeds up to 30 degrees per second and are capable of accelerating to that speed in 0.3 second. Thus a fin may travel between the 25 degree extremes of its travel in less than 2 seconds.

Hydraulics

To impart these accelerations and speeds to a 20-ton fin moving in water at 20 knots, hydraulic servo controls are used to apply torques up to 100,000 lb-ft to the fin shaft. The hydraulic piston and cylinder that operates the fin shaft through a simple crank arrangement, is controlled by a variable-delivery, reversible-flow pump that can transfer oil from one side of the cylinder to the other at rates up to 100 gpm. This pump, with a peak output of 100 hp, incorporates a hydraulic pump stroke amplifier which requires a mechanical input control power level of only 2 watts.

Since this heavy fin actuating machinery can be controlled by only a few watts of power, small electro-magnetic transducers are used to obtain signals indicating the ship's motion as well as fin action, low-level transistor and magnetic amplifiers are used in computation and special electronic circuits were developed to assure the efficiency and safety of stabilizer operation.

A 400-cps power frequency is used exclusively in the control system to take advantage of the high signal gradient characteristic of 400-cps transducers and the availability of standard 400-cps magnetic amplifier and servo components.

Operating Principles

Basic principles of stabilizer operation are illustrated in Fig. 1. The stabilization system has two major divisions, the stabilizing moment computer which detects the roll motion and orders the proper stabilizing moment and two identical fin tilt servo systems which cause the fins to apply the ordered stabilizing moment to the ship.

The stabilizing moment computer deduces the disturbing moment being applied to the ship by wave action from measurements of the ship's response to these disturbances. Sensing instruments detect and measure several functions of the ship's roll motion from which the stabilizing moment is computed. The fin-lift computer orders both fin servos to apply equal fin-lift forces to the ship which cooperate to produce a stabilizing moment equal and opposite to the wave-disturbing moment.

The desirable equality of fin-lift forces is assured first by the equality of fin-lift orders to each fin servo and second by the unique lift-control feature of the fin servo system. As shown in Fig. 1 the hydraulic servo system responds to the difference between the ordered and actual fin-lift signals; the latter derived from a strain gage which measures the actual lift force exerted by the fin.

The stabilizing-moment computer system, located in the control console on the ship's bridge, is illustrated in Fig. 2. The ship's roll motion is measured by a linear aceletometer that senses the ship's roll angle, a conventional rate gyro that senses the roll velocity and a rotary accelerometer that senses the roll acceleration. Each instrument incorporates a small electromagnetic pickoff that supplies a 400-cps signal proportional to the function being measured.

The linear accelerometer can be tilted physically to compensate for any steady list of the ship so that stabilizer capacity will not be wasted in combating small list angles. Excitation of the roll-velocity transducer can be varied to adjust the stabilizer for optimum performance as sea conditions vary.

Computer Servo

The sensing instrument signals are combined by a servo system that continuously computes fin lift orders proportional to the combination of the three roll motion functions. As shown in Fig. 2, the computer servo system consists of a resolver measuring the servo position and two transmitters that send ordered lift signals to the fin servo units. Mechanical limits on the computer servo prevent the ordering of a fin lift exceeding 70 tons.

The servo amplifier combines the 400-cps signals linearly to control the servo motor. In response to signals from the sensing instruments

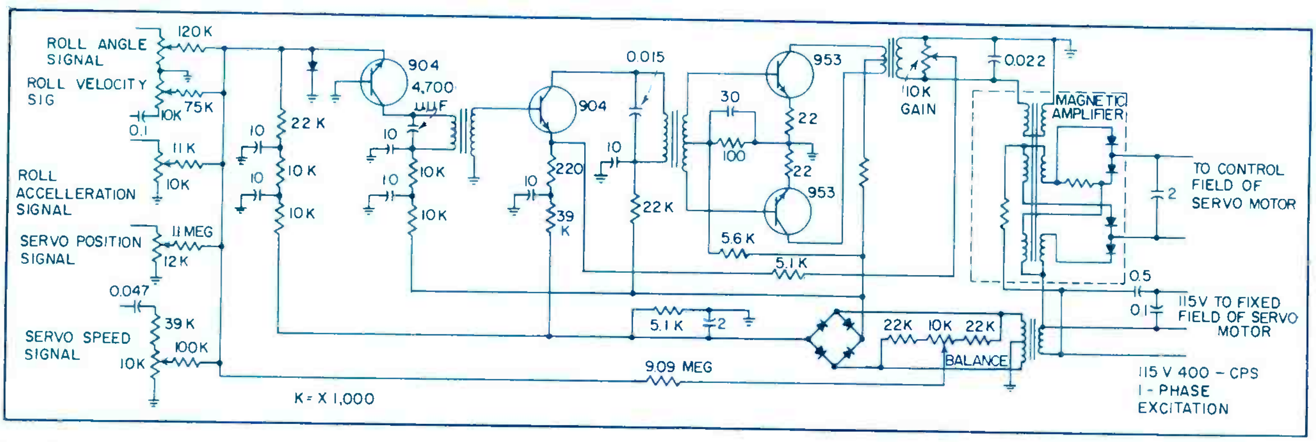
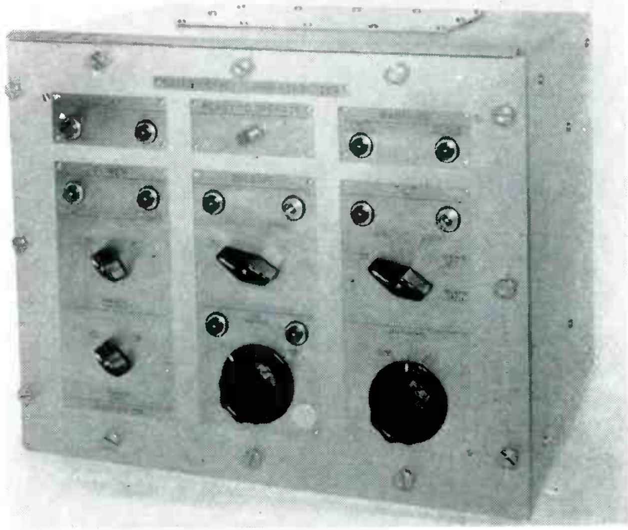
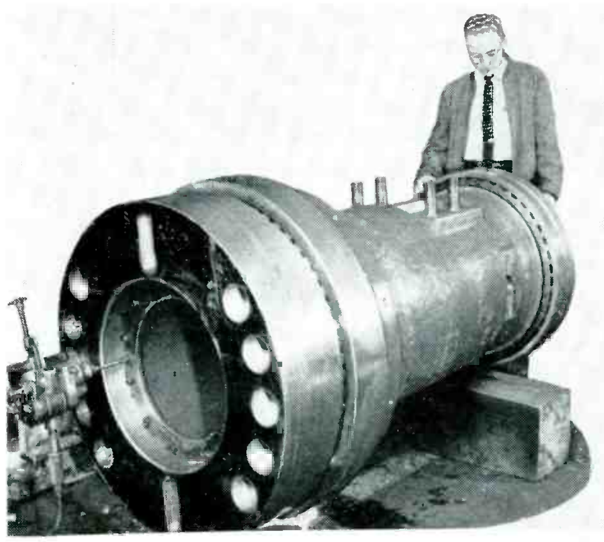


FIG. 3—Low input impedance of first transistor stage assures accurate signal mixing at input to ordered-lift computer servo amplifier



Local control panel houses overload limiter circuits fed by strain gage and also hydraulic servo amplifier to monitor fin stow



Stabilizing fin bolts to shaft. Fin-tilting servo is controlled by fin lift as measured by strain gage located inside shaft

the servo nulls when the feedback signal cancels the sensing instrument signals. The tachometer signal attenuates the servo response to high frequencies from the ship's vibrations.

Computer Amplifier

The computer servo amplifier shown in Fig. 3 combines transistor and magnetic amplifiers. The five input signals are attenuated, phase shifted and mixed by a network of resistors and capacitors. The low input impedance of the grounded-base input transistor is used to assure accurate signal mixing. The three-stage transistor amplifier section features local degeneration in each stage, transformer coupling between stages, tuning of interstage transformers to the 400-cps signal frequency and adjustable gain control in the negative feedback loop around two stages.

The rectifier in the input circuit limits input signals to avoid exceeding the peak rating of the first transistor. The balance control cancels any in-phase residual null signals from the sensing instruments.

The transistor amplifier section supplies about 0.3 watt to drive a half-wave magnetic amplifier that can supply 15 watts to the control field of the two-phase servo motor. The servo motor fixed-field excitation is obtained from the supply line through a phase-shift network.

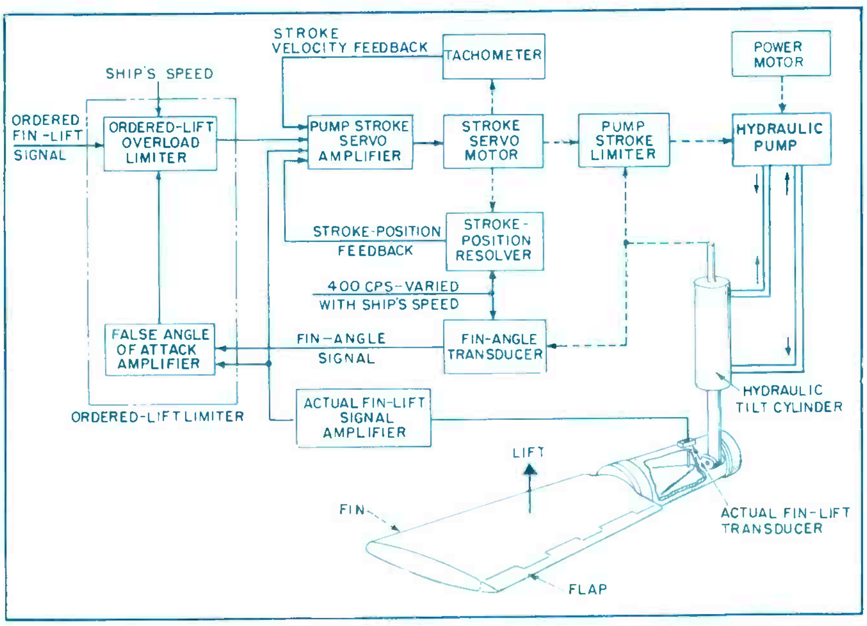


FIG. 4—Strain gage in shaft supporting fin provides actual fin-lift signal that is compared with ordered fin lift to determine lift error to drive pump-stroke servo

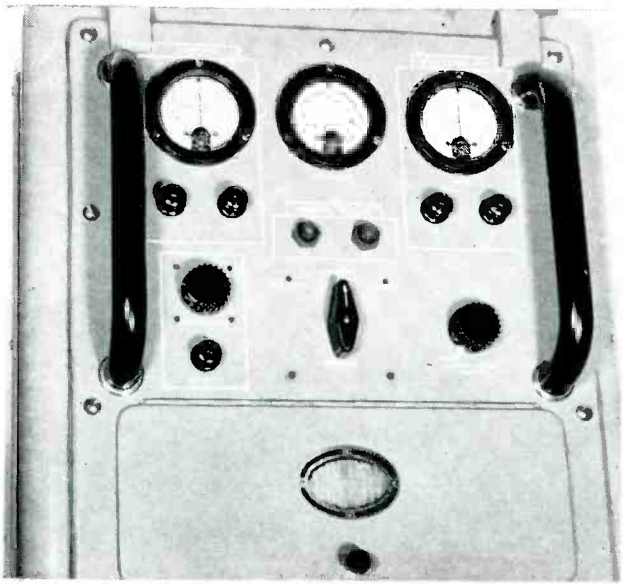
Two identical fin-tilt servo systems receive equal ordered fin-lift signals from the computer system. A schematic of one complete fin-tilt servo system is shown in Fig. 4. Each fin is protected from overloading itself by the ordered lift limiter.

The ordered lift signal is supplied to the pump-stroke servo amplifier which is identical to the lift computer servo amplifier except for the input mixing circuitry. This amplifier is controlled by the lift error or difference between the ordered-lift signal and the actual fin lift signal.

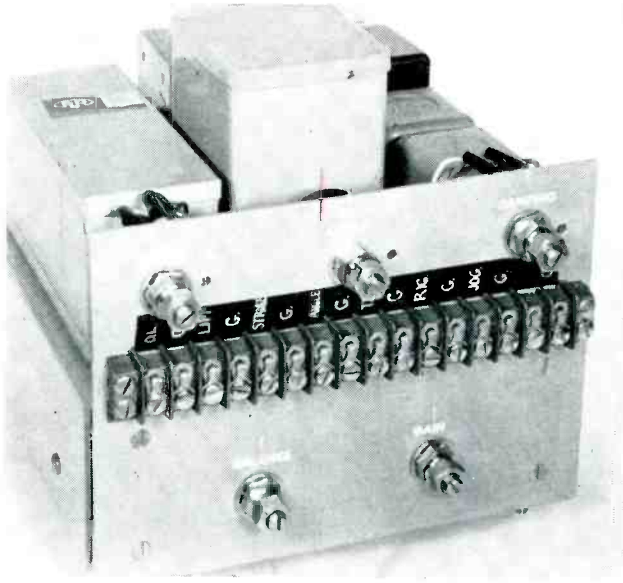
The pump-stroke servo system is operated by the same type servo motor used in the ordered-lift computer. A resolver, geared to the servo motor, feeds a signal proportional to pump stroke (fin speed) back to the stroke servo amplifier. Thus, for small values of lift error, pump stroke is proportional to lift error up to 15 tons.

Hydraulic Stability

To maintain hydraulic system stability the excitation of the stroke-position resolver must be varied with ship's speed to compensate for the variation of the



Control console panal located on bridge of ship allows complete control and monitoring of stabilizers. Hinged panel conceals ship speed, list angle and sensitivity adjustments



Compact stroke control amplifier, typical of transistor-magnetic amplifier chassis used throughout system, provides 2 watts to control hydraulic pump with peak output of 100 hp

actual fin lift. The tachometer geared to the servo motor stabilizes the stroke servo and the overall hydraulic servo system.

An auxiliary mechanical coupling to the fin-tilt cylinder automatically returns the pump stroke to zero as the mechanical angular limits of fin motion are approached. This prevents the pump from driving the fin beyond the limits of its angular motion.

As the fin-tilt cylinder applies a fin angle and a lift force is obtained, the stub shaft supporting the fin bends slightly. The bending of this 4-ton shaft amounts to only 0.012 inch for the maximum lift of 70 tons. This small motion is measured by the fin-lift transducer that supplies a 400-cps signal of 0.4 millivolt per ton of lift.

To bring this signal to a level comparable to the ordered-lift signal it is amplified by the fin-lift transducer amplifier shown in Fig. 5. Grounded-emitter transistor stages are used to obtain high gain. Gain stability is assured by local degenerative feedback and feedback around the entire amplifier.

The push-pull power stage supplies an amplified lift signal to the stroke servo amplifier and the ordered-lift limiter circuit. Amplifier gain is adjusted by varying the amount of feedback around the three stages.

To achieve the most efficient operation from a stabilizer of given size and to assure safety of the ship and its stabilization equipment under the most adverse sea conditions the ordered-lift limiter system is employed.

Fin Lift Limitation

The characteristics of the fin must be considered to understand the need for fin-lift limitation. At a given speed in calm water, the typical fin-lift against fin-angle relationship is linear out to about 20 deg of fin angle, after that the lift peaks and then decreases for larger fin angles.

For efficient stabilizer operation, it is necessary to stay in the linear region to avoid the cavitation, objectionable noise and the excessive drag that is encountered beyond this region. In keeping with this criterion, the stabilizing fin has a maximum allowable lift of 70 tons for a fin angle of 18 deg when moving at 20 knots in calm water. Figure 6 shows the maximum allowable lift as a function of speed. One function of the lift limiter is to keep lift orders within the appropriate boundaries of Fig. 6.

The fins rarely operate in undisturbed water. The angle of water flow with respect to the fin differs from the angle of the fin with respect to the ship by the so-called false angle of attack. False angles arise from the penetration of wave action to the fin depth and from various ship motions including pitching, heaving (vertical translatory motion) and residual ship rolling. In the extreme, false angles of 15 to 20 deg are possible. The fins are permitted an angular travel of ±25 deg so that maximum permissible lift forces may be obtained in spite of false angles.

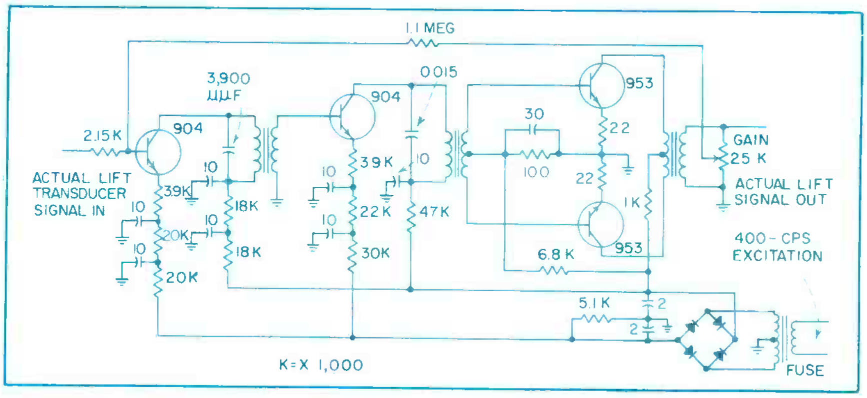


FIG. 5—Fin-lift transducer amplifier supplies actual-lift signal to stroke servo amplifier and also to ordered-lift limiter circuit which assures safety of the ship

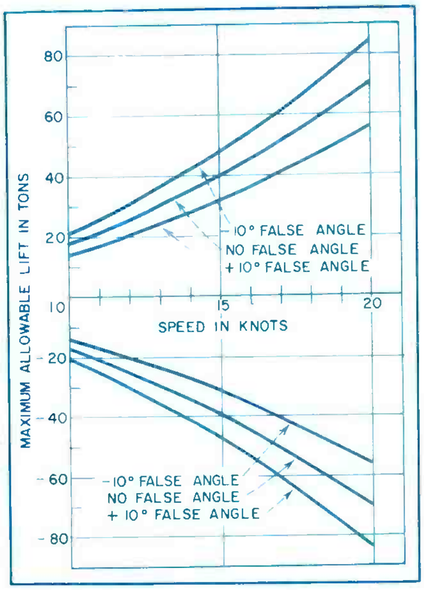


FIG. 6—Curves show maximum allowable lift as a function of speed. Lift orders must remain within boundaries shown

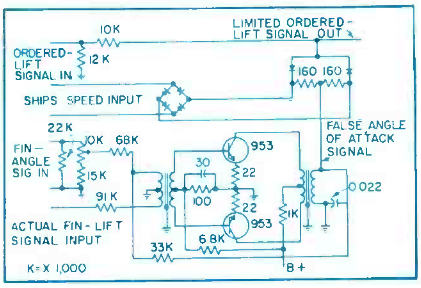


FIG. 7—Ordered-lift limiter circuit determines false angle of attack of fins and uses this to modify ordered-lift signals

At 20 knots and with a false angle of +10 deg, the linear region limits are +56 tons and −84 tons.

The second function of the lift-limiter system is to recognize the magnitude and direction of false angles and to limit the lift orders asymmetrically in accordance with the curves of Fig. 6.

False-Angle Determination

The false angle of attack of a fin at any given instant may be found with reasonable accuracy from the algebraic difference between the actual fin lift and the lift expected from the fin based on its angle with respect to the ship. The ordered-lift limiter system shown in Fig. 4 consists of a false-angle amplifier and the overload limiter proper. The false-angle amplifier receives the fin-lift signal and a fin-angle signal. The latter is corrected for ship's speed so the two signals cancel each other when no false angle is present. Output of the false-angle amplifier is proportional to the false angle while its phase indicates the direction of the false angle.

The false angle of attack amplifier shown in Fig. 7 is a single-stage transistor amplifier. The actual fin-lift and fin-angle signals are mixed in the primary of the input transformer. The push-pull transistor stage with transformer output supplies the signal proportional to the false angle of attack.

The ordered-lift signal input to the limiter section of this circuit is a 400-cps sine wave. But for the attenuation of the 10,000-ohm series resistor and the shunting effect of the biased back-to-back diodes, the output or limited-lift signal would follow the input signal. The variation of the lift limit with ship's speed is accomplished by the back-to-back diodes which shunt the ordered-lift signal. Their biasing voltage is full-wave rectified to avoid lift signal waveform distortion.

The common connection of the 160-ohm resistors in the limiter circuit is connected to ground through the output transformer of the false-angle amplifier. The false-angle signal now biases the entire limiter circuit by an amount proportional to the magnitude of the false-angle signal. This bias is asymmetrical as required by fin characteristics and is in a direction which depends on the relative phases of the false-angle signal and ordered-lift signal. Thus this circuit achieves the ordered-lift limitation as a function of ship speed, modified asymmetrically by the magnitude and direction of the false angle of attack experienced by the fin.

Fin lift is prevented from exceeding limits of efficient operation and the fin is protected against damage by sea action for all operating speeds of the ship. A separate limiter system is required for each fin since each fin generally experiences different false angles of attack.

Performance

Typical stabilizer performance is illustrated in Fig. 8. These records were obtained from an analog computer investigation conducted under accurately simulated sea conditions. In the unstabilized portion of the record, wave disturbances are causing near resonant rolling with amplitudes up to 13 deg. Ordered stabilizing moments, expressed as equivalent steady list of the ship, are limited to 4 deg. The stabilizing moment is constantly zero although there is appreciable fin motion as required by the lift control feature to maintain zero actual lift in the presence of false angles of attack caused by the ship's roll.

The average characteristics of the disturbing wave slopes are continued through the stabilized portion of the record. The ship's roll motion averages less than 1 deg. The ordered and actual disturbing wave slopes are within stabilizer capacity. The record shows the effect of an occasional disturbing wave slope which exceeds the stabilizing capacity.

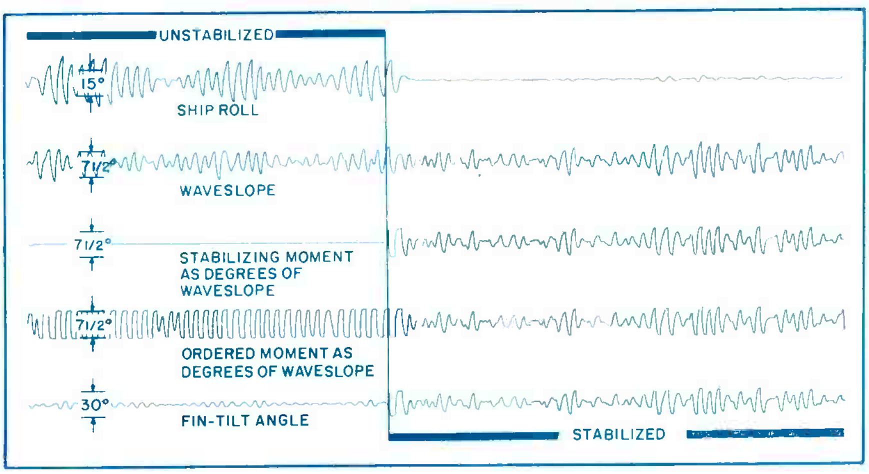


FIG. 8—Curves obtained from analog computer investigation under accurately simulated sea conditions show system response to ship's roll when unstabilized and stabilized

Radio Transmitter For

SUMMARY — Unit utilizes existing high-frequency transmitter with radio-frequency portion redesigned especially for ionospheric communications. Neutralized triode drives grounded grids of two triodes to deliver 8 to 12 kw to an 8-tube grid-separation power amplifier. Output power is 60 kw from 30 to 65 mc

UTILIZATION of frequencies between 30 and 60 mc for long-distance communications requires transmitting equipment of exceptional reliability with power in excess of 20 kw. The inherent reliability now accepted for high-frequency communication, has progressed in most cases up into the high 90. This transmitter has been designed specifically to cover a range of 30 to 65 mc and to develop 60-kw output. Reliability, or the ability to stay on the air and perform its normal function, has been a guiding principle throughout the design.

Modified Transmitter

The equipment utilizes certain portions of a high-frequency transmitter, the 40-kw AN/FRT-6, originally designed to cover 4 to 26-mc. Actually, much of the field experience with this transmitter has been on 30 to 50-mc operation for scatter communications circuits. For this use it has been modified to operate at a fixed frequency within that range.

The transmitter has proved to be of a practical size with reliable control circuit and power components. Field tests revealed several sources of difficulty and provided reliable solutions within this portion of the equipment. The entire radio-frequency portion of the AN/FRT-6 has been redesigned specifically for ionospheric communications.

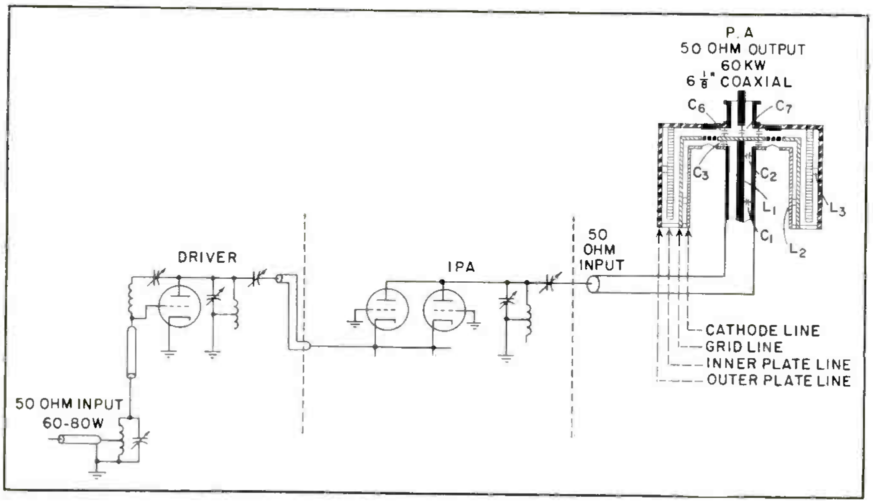


FIG. 1—Basic r-f circuit of 60-kw transmitter showing driver, ipa triodes and the 8-tube power amplifier

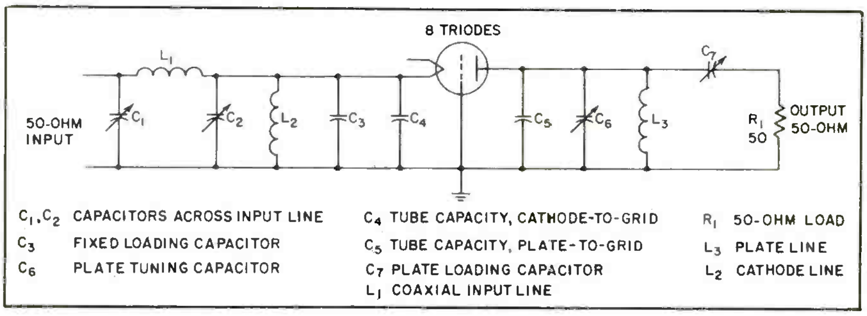


FIG. 2—Lumped-constant equivalent circuit of the 8-tube final amplifier. One tube is shown to represent the entire assembly

Basic R-F Circuit

Input of 60 to 80 watt is amplified to 60-kw output by eleven identical air-cooled triode tubes. The first two stages use one and two tubes respectively and utilize lumped-constant tank circuits. The final power amplifier utilizes eight tubes in a grid separation circuit, with coaxial input and output circuits.

Figure 1 is a simplified schematic illustrating the three r-f stages. A neutralized triode driver operates as a linear amplifier to provide 2 kw, driving a pair of triodes in the grounded grid ipa circuit. These in turn deliver 8 to 12 kw to the 50-ohm input of the 8-tube power amplifier circuit. The power amplifier is a grid separation, coaxial tank design in which driving voltage is impressed between the grid and cathodes, while output

IONOSPHERIC SCATTER

By J. L. HOLLIS,
W. H. COLLINS
Page Communications Engineers, Inc., Washington, D. C.

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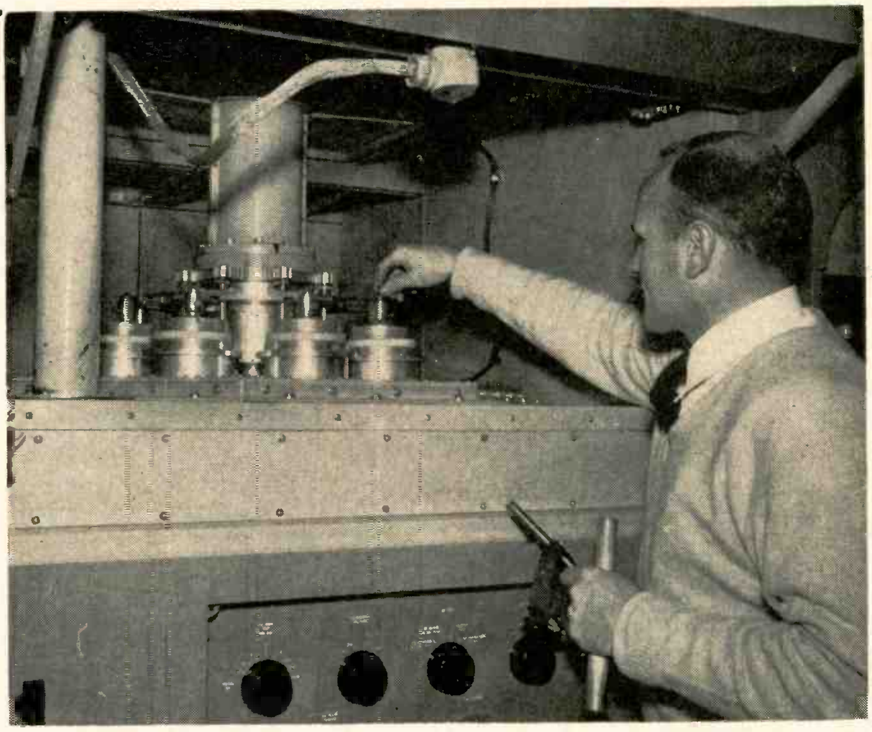
Rixon Electronics, Inc., Silver Spring, Maryland



Operator is shown replacing a power amplifier tube of the 60-kw transmitter. Radio-frequency current-carrying contacts are replaceable with the tube

power is extracted from the voltage existing between the grid and anodes.

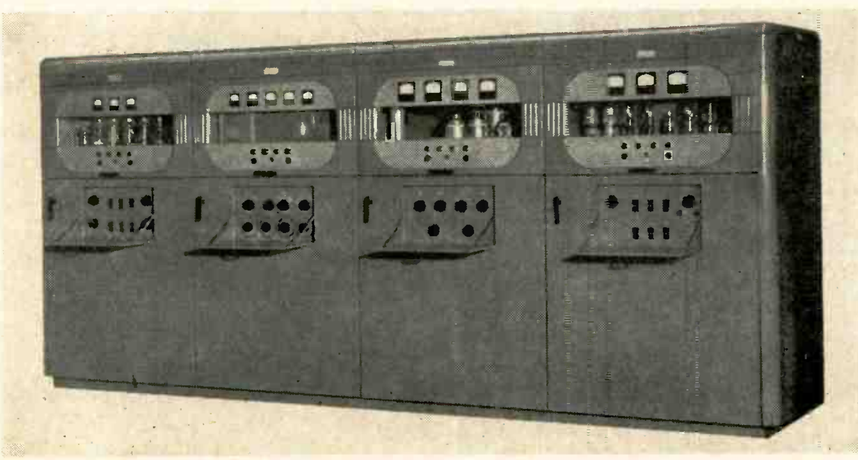
Power Amplifier

The power amplifier is patterned after a commercially available 50-kw f-m final amplifier. It differs however in that the lower frequency operation is accomplished by folding back the output coaxial circuit and loading both input and output circuits with fixed capacitance. Variable vacuum capacitors are used throughout for tuning purposes so that sliding shorting bars are completely eliminated. The output coaxial circuit consists of two concentric cylinders, the outer of which is the folded-back portion.

Major frequency adjustments are accomplished by moving the indicated shorts while minor or tuning adjustments are accomplished by the variable capacitors. The coaxial tank employs 6½-inch input for mechanical convenience only.

Maximum effective coaxial cylinder length occurs when the shorting bars are at the top of the outer cylinder. When the shorting bars are moved to the bottom of the outer cylinder, the effective length of the coaxial cylinder is reduced materially. Parameters are so chosen that the highest design frequency is obtained with the shorts at the bottom of the outer cylinder. Since practical mechanical considerations established the physical length of these coaxial circuits, the characteristic impedance of each was chosen to produce the required susceptance for resonance. Thus the inner coaxial section is spaced close and has a very low Z_o. The outer coaxial section has much greater spacing and a higher Z_o.

Figure 2 shows a lumped-constant equivalent circuit of this power amplifier with one tube envelope used to represent the entire assembly. This is a grid-separation or more commonly termed grounded-grid circuit. The input impedance of such an amplifier is low, being in the order of 15 to 25 ohms in this case. The combination of L_2, C_3 and C_4 are resonant at the operating frequency so a resistive load is presented to the pi network consisting of L_1 and C_1, plus C_2, which transforms the low impedance to 50 ohms at the input



The 60-kw transmitter consists of four bays. From left to right are: power supply and control for intermediate and driver amplifiers, the intermediate and driver amplifiers, power amplifier and power supply and control for the power amplifier of the amplifier. In actual practice, L_1 is a section of coaxial line. Capacitors C_1 and C_2 are adjustable vacuum types.

The eight tubes that comprise this amplifier are symmetrically placed around the axis of the coaxial circuits so they are equally affected by it. Eight small vacuum variable capacitors shunted across the plate grid circuit of each tube and driven by a common drive, provide the means for vernier tuning of the tank circuit. These capacitors vary from 3 to 30 $\mu\mu$f each and tune the output circuit.

Coil L_3 in connection with C_5 and C_6, shunted by the reactance of the load circuit, constitute the plate tuned circuit. Inductance L_3 is physically accomplished by the coaxial circuit previously described. The 50-ohm output load resistor is coupled to the amplifier by a simple series capacitor, C_7. Such coupling arrangements are generally avoided because they tend to couple harmonic voltages to the output circuit, which is undesirable. Several factors influence this choice however.

First, it is extremely simple and easy to understand and operate. Second, because of the nature of the final tank circuit, the operating Q can be high with the result that the harmonic voltage developed at the plate of the tube is many db below the fundamental. Furthermore, since design objectives are reliability and simplicity, it is more practical to provide additional rejection to undesired harmonics by means of filters in the 50-ohm transmission line. Such circuits are readily available, highly practical and completely fixed in adjustment.

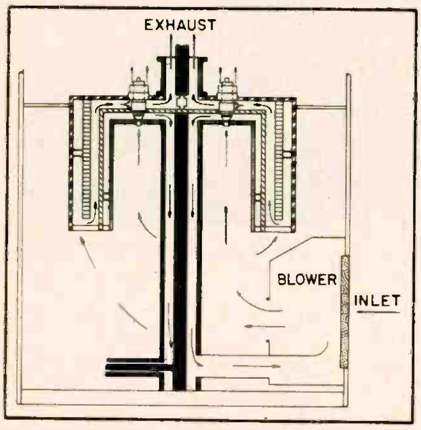


FIG. 3—Power-amplifier cooling system. Cross section shows two of the eight tubes. Blower draws air into lower compartment and forces air upward through the tube radiators

Cooling the Tubes

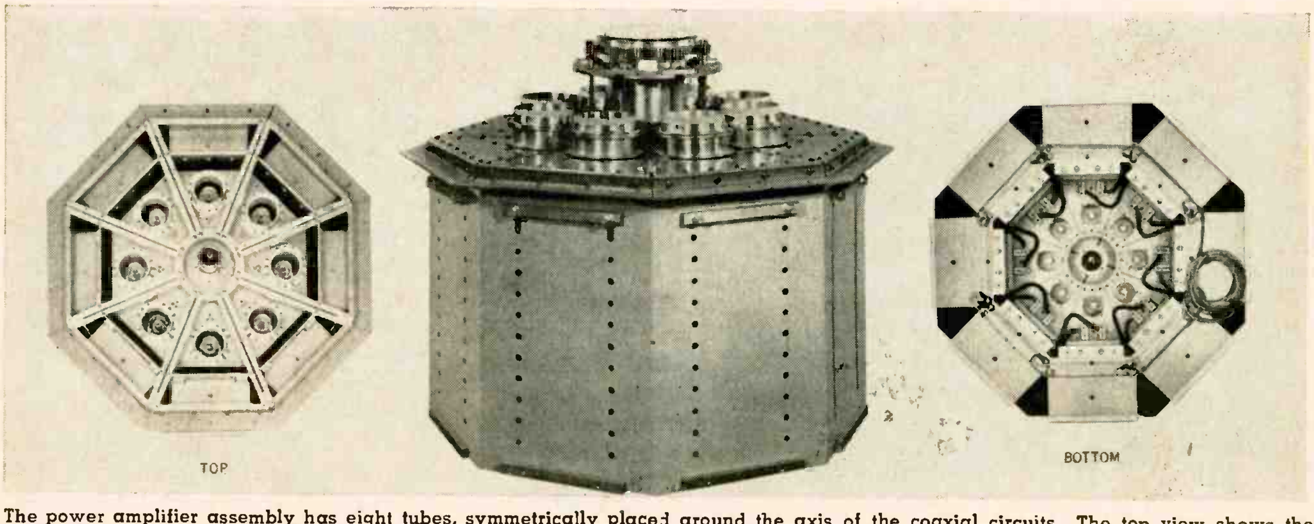
Reliable operation of air-cooled tubes depends on efficient cooling. This is possibly the one single factor that affects tube life most. Figure 3 shows the cooling employed in this design. The amplifier is mounted in a cabinet, divided into an upper and lower compartment. The lower compartment is pressurized by a blower that draws air from the outside, while the upper compartment is exhausted to atmospheric pressure either in the room or into an air system.

Air escapes from the lower compartment by entering openings in the lower rim of the coaxial circuit and flowing upwards between the walls to exhaust through the radiators of the tubes. These passages are relatively large and unimpeded so essentially the full blower pressure is available to force the air through the cooling radiators. Furthermore, there is adequate room above the tubes for free and unrestricted pasasge of the air.

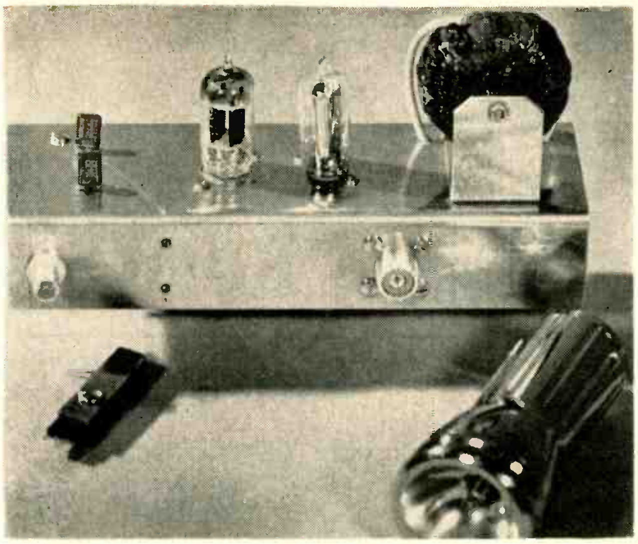
Two more cooling circuits will be noted. Some of the air that would tend to go through the anode cooler passes downward past the grid contact surface and into the area between the grid and filament connections. This area has been intentionally evacuated by connecting it to the suction side of the blower. Additionally, air is directed over the filament seals in a similar manner. In this case the full blower pressure forces air past the filament contacts.

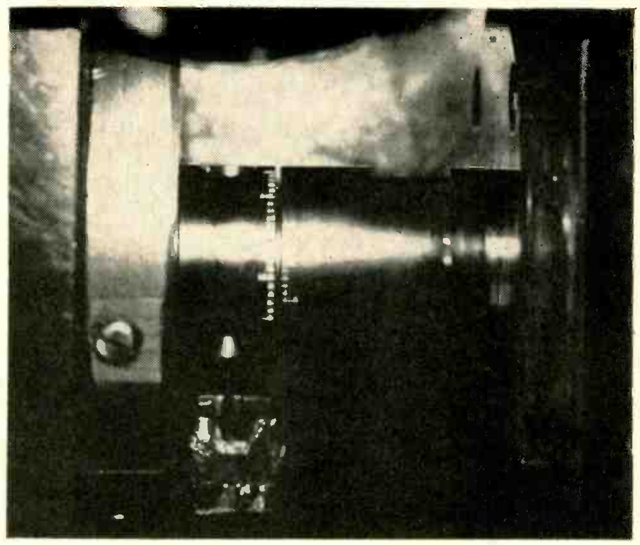
Although the intermediate and driver amplifiers employ lumped constants in their tank circuits, similar consideration has been given to their cooling circuits.

This development resulted from the confidence of responsible personnel of MIT Lincoln Laboratory who recognized both the need for such equipment and the inherent practicability of such a design. The support of A. J. Poté and William Radford is particularly appreciated.



The power amplifier assembly has eight tubes, symmetrically placed around the axis of the coaxial circuits. The top view shows the assembly with plates removed and the grid by-pass capacitors appear as cylinders. The filament contact sleeve and chuck are seen through each of the grid contact cylinders. The holes up the sides are for the fixed positioning of the shorting conductor which changes the length of a plate coaxial circuit. In top position shown, operation is at the lowest frequency





Miniature strobe lamp, magnetic pickup and amplifier, shaper and pulser chassis (left) measure dynamic shaft twist (right)

Transistorized Strobe Measures Shaft Torque

By JOHN PATRAIKO

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SUMMARY —— Magnetic pickup for reference pulses feeds transistorized amplifier and shaper that triggers pulser circuit for strobe lamp. Miniature unit has peak light intensity of 2,000 c-p which is equal to average intensity of 10 c-p at 60,000 flashes a minute. One-microsecond pulses at rates between 3,000 and 60,000 fpm are produced by unit designed to determine torque by measuring dynamic shaft twist

STUDY of modern high-speed turbines requires a stroboscope having higher flashing rates, smaller flash durations and reduced jitter than are usually available. Using the unit to be described, an engraved scale can be read indicating shaft twist on a shaft rotating at 60,000 rpm. The shaft twist is used to measure the transmitter torque.

System

Figure 1A shows the physical setup. A block diagram of the strobe system is shown in Fig. 1B. The reference-pulse pickup, shown in Fig. 1C, is a 1,000-turn magnetic pickup with a permanent-magnet field. A signal of about one volt is generated when the radially-protruding steel pin on the rotating shaft passes through the pickup field. The slope of the signal just as the pin passes through the center of the magnetic field is about 0.2 volt per μsec.

The circuit shown in Fig. 2 amplifies and shapes the pickup signal into a 250 volt, one-μsec positive pulse with an initial slope of 600 volts per μsec.

The output pulse is applied to the pulser and triggers a VC-1258 thyratron within 0.2 μsec from the start of the pulse. The thyratron is employed as a switch to apply a pulse of energy to the strobe lamp. The strobe lamp begins to conduct within 1 μsec of the thyratron firing time.

Pulser Unit

The circuit employed in the pulser is also shown in Fig. 2. A single pulse controlled by the thyratron is used both to trigger and activate the strobe lamp. One ad-

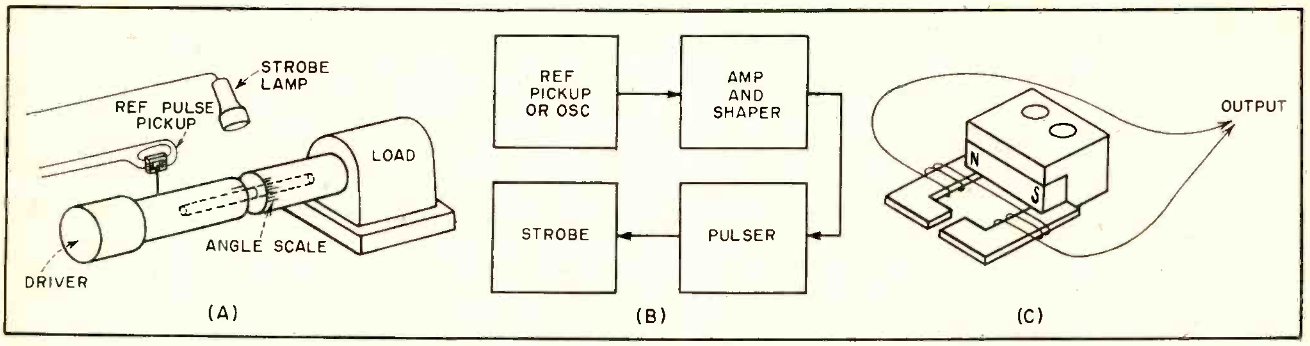


FIG. 1—Test setup to measure shaft twist (A) uses magnetic pickup (B) to provide pulses for strobe circuits (C)

vantage of this circuit is the common ground for the thyratron and strobe lamp. This permits convenient remote operation of the strobe lamp through a single conductor coaxial cable without danger to the operating personnel.

Thyraton Characteristics

Figure 3A shows the idealized waveform of thyratron plate voltage with emphasis on the four phases of pulser operation. Voltages E_T and E_i and times t_1, t_2 and t_3 have been exaggerated. Normally E_T and E_i are a few percent of $2B$ volts and t_3 is a few μsec compared to a millisec for T_R.

With the thyratron open circuited, capacitor C and line N will become charged through resistors R_N, the diode and inductor L. Application of an input pulse at time t_0 drops the thyratron anode to near ground potential E_T and the charged capacitor C is essentially connected across the strobe lamp. Because of inherent lamp delay, conduction will not occur until time t_1. When the lamp conducts, capacitor C discharges according to the time constant of C and the resistance of the conducting strobe lamp. For circuit values given, the discharge time is about one μsec.

Delay line N in conjunction with R_N produces an inverse voltage E_i at time t_2 by line reflection. The length of line determines the occurance of time, t_2 after the discharge of capacitor C. For this delay line, t_2 is about three μsec.

The inverse voltage present from t_2 to t_3 permits partial thyratron deionization and aids in the prevention of subsequent thyratron reignition. The longer the time t_2 to t_3 the more rapid the subsequent thyratron voltage rise may be without reignition. Thus higher flashing rates can be had with larger values of $t_3 - t_2$.

However for this charging circuit the line time constant ($\tau = t_2 - t_0 = t_3 - t_2$) must be kept much less than the charging circuit time T_R to achieve the required charging circuit isolation during the time the thyratron conducts and the start of cutoff. Also, the line time constant should be slightly larger than the time to discharge C and charging time T_R must necessarily be less than the period of the maximum flashing rate.

Because of charging-circuit resonance the discharge-capacitor voltage attains a value approximately twice the supply voltage at time T_R and retains this value up to the triggering time t_{02} by the unidirectional action of diode D.

Parameter Selection

The flash lamp was selected primarily on the basis of size but certain minimum requirements of firing delay, light output, and dis-

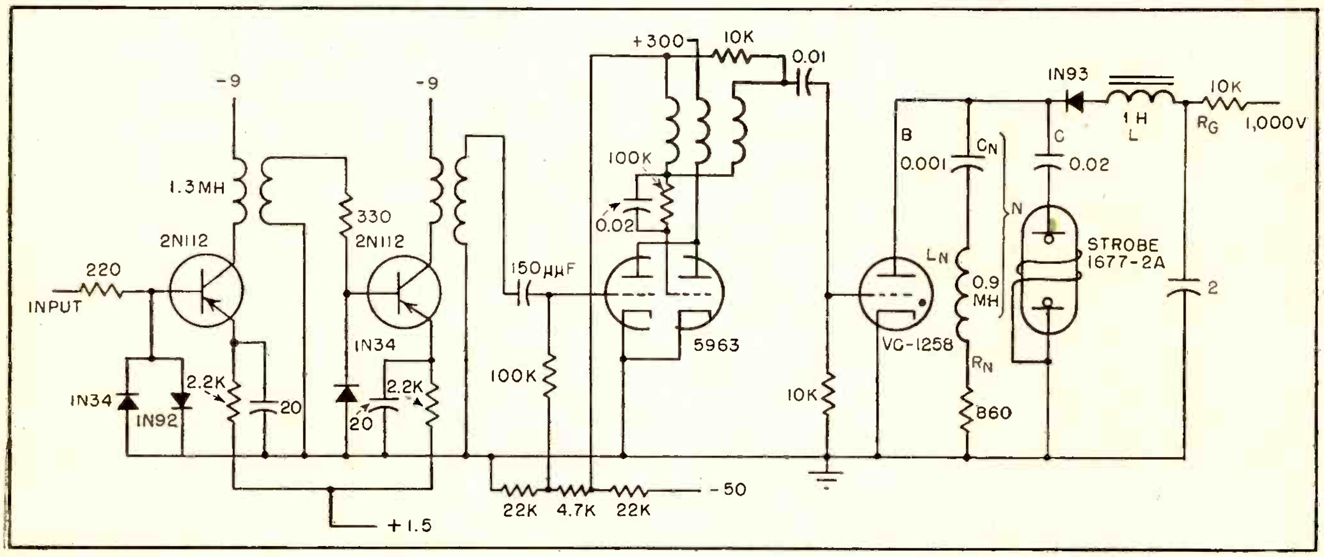


FIG. 2—Amplifier and shaper provide 250-v one-μsec pulse to pulser that acts like radar modulator by discharging stored energy in C through strobe lamp. Common ground for thyratron and strobe lamp permits convenient remote operation

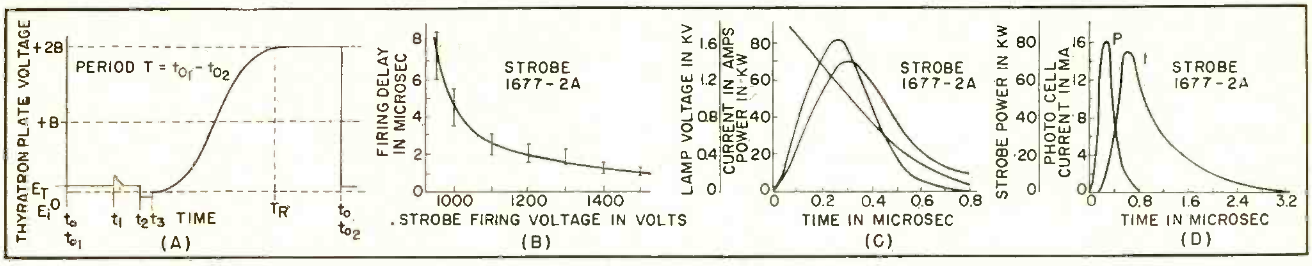


FIG. 3—Idealized thyratron plate waveform (A) shows four phases of pulser operation. Other curves show firing delay of strobe as a function of applied voltage (B), instantaneous strobe voltage, current and power (C) and light output (D)

charge time were necessary. Krypton lamp 1677-2A satisfied these requirements. The curves of Fig. 3 show the results of tests on this lamp. These tests were conducted to aid in selecting some of the operating parameters.

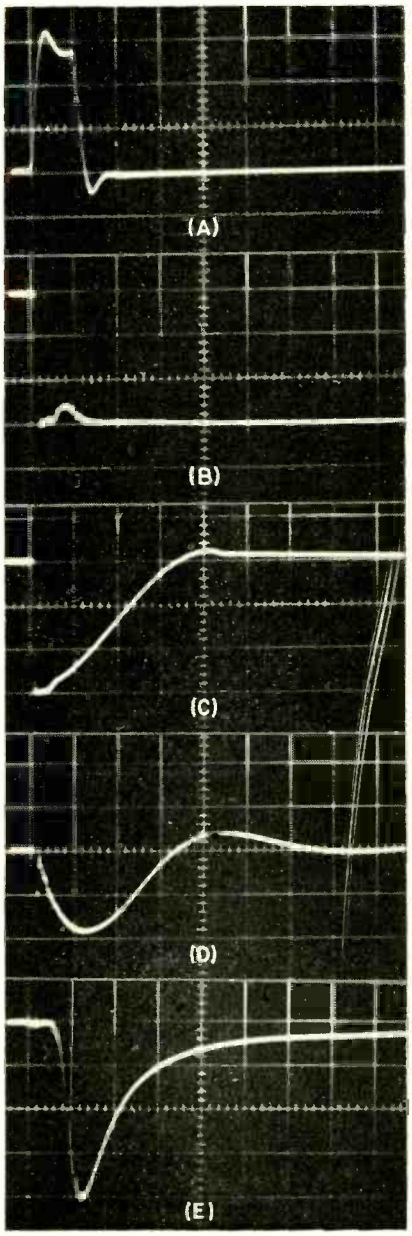


FIG. 4—Waveforms taken at 500 fps show input test pulse (A), thyratron plate voltage on scale of one μsec/div (B) and 100 μsec div (C) delay network current (D) and light pulse output (E)

In Fig. 3B the delay is less than one microsecond for voltages greater than 1,500 volts The jitter in firing as indicated by the vertical lines in the figure is also less than a microsec above 1,500 volts.

Strobe Voltage

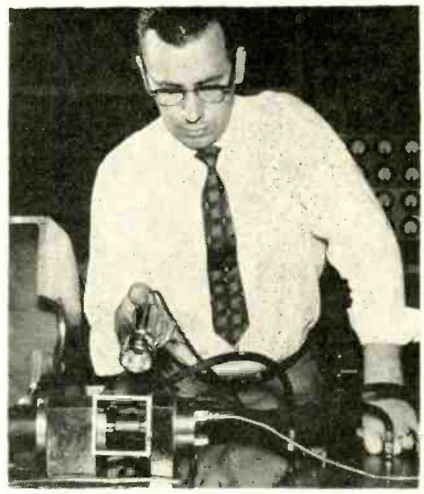
The curves of Fig. 3C show the instantaneous strobe lamp voltage, current and power using a 0.02 μf capacitor charged to 2,000 volts in series with a hydrogen thyratron acting as a switch. The energy per flash is 26 milliwatt-sec. This value together with the 18-watts rated power input of the lamp permits determination of the maximum flashing rate as 41,000 fpm.

A higher flashing rate may be permitted by lowering the charge voltage or capacitance. The voltage decrease is proportional to the square root of the flashing-rate ratio while capacitance decrease is directly proportional. Lamp dissipation is kept within the rating up to 60,000 fpm by lowering the voltage and maintaining the capacitance.

This is done by inserting a 10,000-ohm resistor R_G in series with the power supply. As power supply current increases because of increased flashing rate the charging-capacitor voltage is reduced by the drop to 1,660 volts at 60,000 fpm.

Light Intensity

Figure 3D shows the shape and width of the light intensity with respect to the instantaneous power curve of Fig. 3C for the same voltage and capacitance. The one-third intensity points are separated by



Use of pulser circuit enables operator to use strobe without danger of shock from accidental contact with work surface

one microsecond. The delay in light with respect to instantaneous power is of little consequence since the delay is free of jitter.

Results

Photographs of waveforms at the test points shown in Fig. 4 were taken for a typical flashing rate of 500 fps. These waveforms show that the delay in the firing of the thyratron is negligible and the current for forceful thyratron conduction exists for three microseconds as required. The remaining cycle of current exists as a result of circuit losses, such as an equivalent shunt resistance across inductor L and deionization effects.

The last waveform shows that the light has reached its peak one microsecond after triggering.

Although this article pertains to a particular strobe light system is can be applied to other types of thyratron control devices with increased repetition rates.

REFERENCE

(1) J. Patraiko, A Miniature Strobe Light For a 60,000 RPM Bearing Tester, *IRE Trans* on Industrial Electronics, PGIE-3, March 1956.

RATE-OF-CLIMB METER

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SUMMARY —— Direct-reading indicator for vertical-takeoff aircraft uses continuous-wave Doppler radar operating at 10,000 mc to determine plane velocity during vertical-landing and hovering maneuvers. Ground below aircraft is reflecting surface. Dual-channel receiving and gating resolve frequencies ambiguities and noise interference. Tests reveal performance from zero altitude up to 2,300 feet for vertical velocities up to 10 fps going up and 30 fps coming down

VERTICAL-TAKEOFF aircraft, such as the Navy XFY-1 Pogo Stick built by Convair, require accurate determination of vertical velocity, both magnitude and direction.

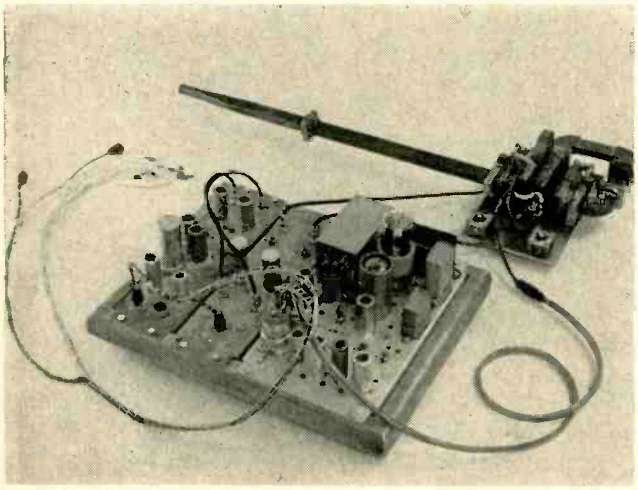
At altitudes above 100 feet the pilot's ability to estimate his velocity by observing the ground is insufficient to allow safe operation of the aircraft during landing and hovering maneuvers. Conventional barometric rate-of-climb indicators are sluggish in response and suffer from misleading fluctuations in turbulent air. To solve this problem, a compact all-electronic system was developed to provide the desired instrumentation.

Doppler Radar

The electronic rate-of-climb meter, is a cw Doppler radar operating at 10,000 mc, using the ground below the aircraft as a reflecting surface. The frequency of reflected energy is compared with transmitted energy and any difference, the Doppler resulting from vertical velocity, is measured. Since there are 10 wavelengths per foot at 10,000 mc, each foot change in altitude changes the radar path length by two feet, or 20 wavelengths. Thus each foot-per-second of velocity produces a 20-cycle-per-second Doppler frequency.

Since the same Doppler frequency results for a given velocity regardless of whether ascending or desending, two channels are used to sense the direction of the velocity. The dual channel microwave receiving system used can be understood with the aid of the block diagram in Figure 1.

The klystron generates one watt that enters the *H* arm of a waveguide magic tee where it divides between the two side arms. One half of the power is transmitted



Rate-of-climb chassis at left consists of three lay-in units. Left unit containing limiters, gates, inverting amplifier and pulse counters, and the regulated high-voltage power supply. Microwave assembly is separate

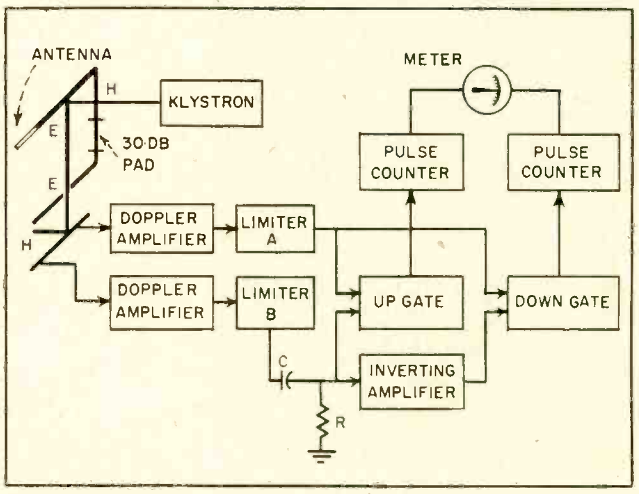


FIG. 1—Block diagram of rate-of-climb meter. One watt from klystron is distributed to magic tee. Half the power is transmitted through the dielectric-rod antenna, the other half enters the two crystal mixers

USES DOPPLER RADAR

out through a dielectric-rod antenna, while the other half goes into a 30-db attenuator pad and then to the H arm of a second magic tee where it divides again and enters two crystal mixers.

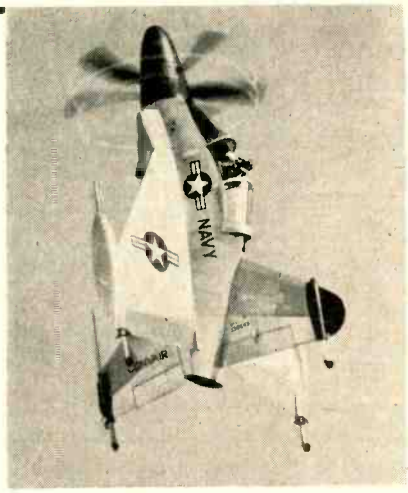
The unavoidable cross-coupling between the H and E arm of the first magic tee is adjusted to -33 db and used to provide a signal to the E arm of the second magic tee. This signal also divides between the two crystal mixers. Thus 0.5 milliwatt of local oscillator power is supplied to each crystal.

The phase relationship between these signals is shown in Fig. 2. The E and H-arm local oscillator voltages are of equal amplitude and differ in phase by 90 deg. This phase difference is obtained by proper choice of wave-guide path lengths. The H-arm voltages between the two crystals are in phase while the E-arm voltages differ in phase by 180 deg, a basic property of the magic tee.

Reception

The weak ground-reflected signal is received by the antenna. It divides between the E and H arms of the first magic tee and the E arm output then enters the E arm of the second magic tee where it divides between the two mixers. This signal voltage is shown in Fig. 2 at S. Since S differs from the two local oscillator signals by the Doppler frequency, its vector representation will rotate relative to the E and H vectors at the Doppler rate. Vector R is the sum of these three signals, S, E and H. The tip R traverses a circle and equal time intervals on the circle are numbered in sequence, one through four.

A plot is also shown on the amplitudes of R at each mixer crystal as a function of time. These amplitudes correspond to the mixer output voltages. The output from mixer B leads mixer A by 90 degrees. As shown the ground return signal, S, is higher in frequency than E or H, which is the case for a descending aircraft. On ascent the frequency of S is lower than E and H, and would then rotate clockwise. For this case, mixer A would lead mixer B by 90 degrees. Thus the phase between the two signal channels indicates the direction of the aircraft velocity.



The Pogo-Stick, Navy XFY-1, ready to make a vertical landing. The c-w Doppler radar system that determines vertical-landing velocity is housed in lower portion of wing-tip pod. Indicators are at cockpit

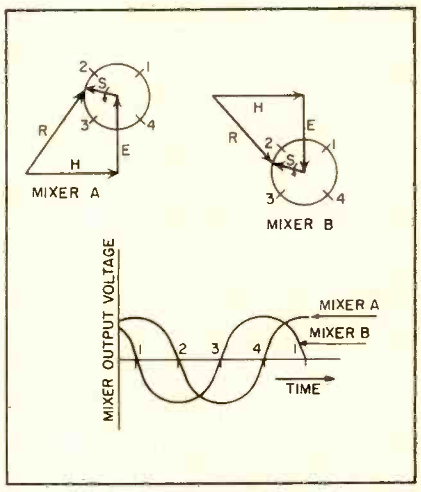


FIG. 2—Phase difference between input signals of crystal mixers A and B is obtained by proper choice of waveguide path lengths. The H-arm voltages are in phase, the E-arm voltages differ by 180 degrees

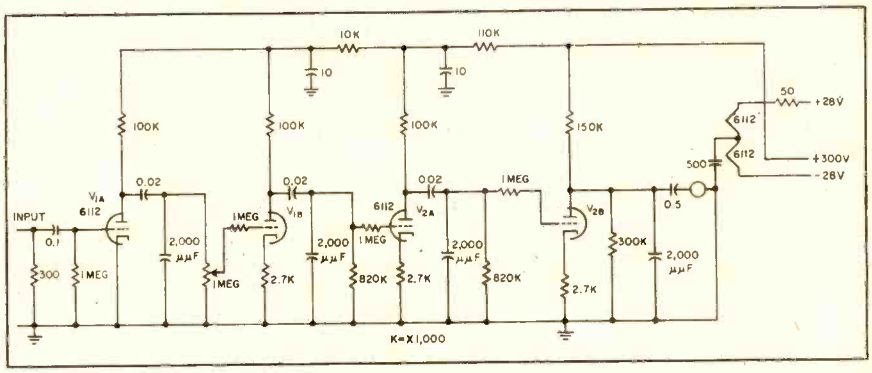


FIG. 3—Identical Doppler amplifiers increase the mixer voltage outputs to operate bistable multivibrators. The 2,000 μμf capacitors reduce the noise output above 1,000 cps. Series grid resistors prevent shifts in zero-axis crossings when large signals overload the amplifiers

Two identical Doppler amplifiers, shown in the circuit of Fig. 3, increase the mixer voltage outputs by 100 db to suitable levels to operate the amplitude limiters. The amplifier interstage coupling time constants are arranged to give rapid signal fall-off below 20 cps, thus preventing the indicating meter from vibrating visibly at very low velocities. Since high Doppler frequencies are not expected, 2,000 μμf capacitors are shunted across the outputs of each stage to rapidly reduce the noise output above 1,000 cps. Series grid resistors prevent shifts in zero-axis crossings when large signals overload the amplifiers.

The amplifiers outputs operate the frequency counting circuit, shown in Figure 4. Bistable multivibrators are used to provide limit-

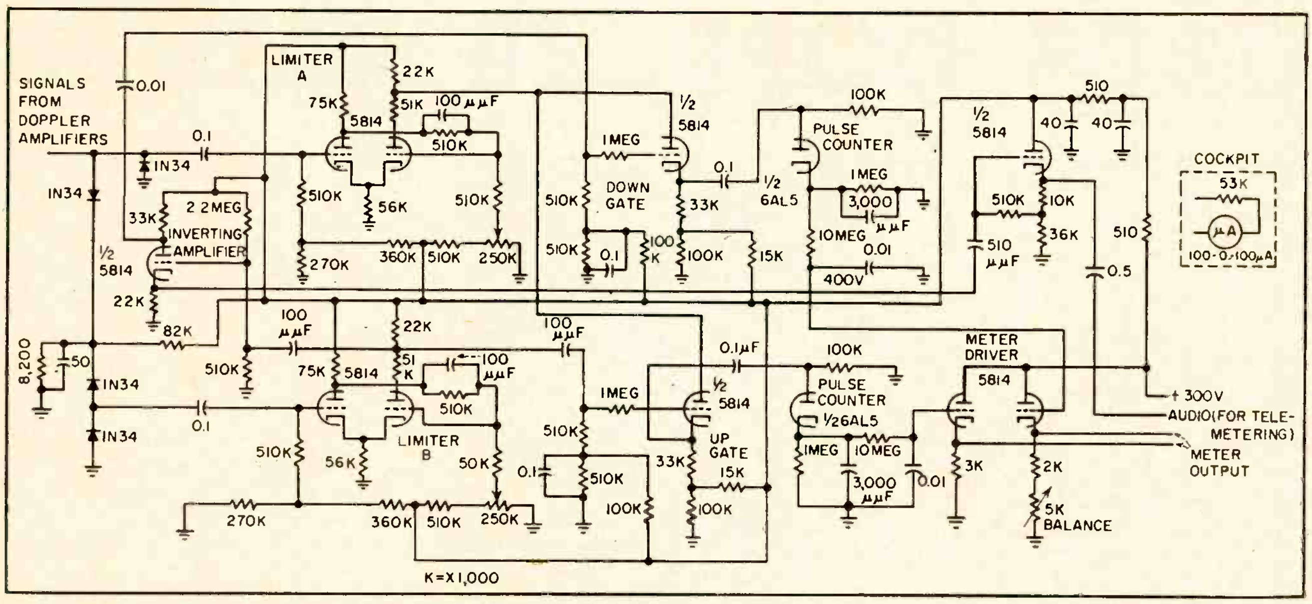


FIG. 4—Signals from the two Doppler amplifiers operate the rate-of-climb frequency circuit. Limiters *A* and *B* are bistable multivibrators, with output switch between two fixed output voltages, independent of input. Triggering is set to eliminate thermal noise in absence of ground-receiving signal

ing. A basic property of multivibrators is that their outputs switch between two fixed voltage levels, independent of the input, which provides a high degree of immunity from changes in signal level. Their triggering levels are set to prevent spurious meter indications due to thermal noise when no ground return signal is present, a disadvantage of more conventional limiters.

Sorting The Cycles

Crystal diodes help limit the signals that trigger the multivibrators and prevent zero-axis crossing shifts. The limiters operate a set of gates that sort the *up* cycles of Doppler frequency from the *down* cycles. Each gate consists of a cathode follower in which the cathode current is kept at zero in two ways; the grid is biased negatively below cutoff and the plate is negative with respect to the cathode. Both grid and plate voltages must increase in the positive directions to produce an output from the gate.

Figure 5 shows typical voltage wave forms associated with the gates. The square-wave output from limiter *A* is connected to the plates of both gates. The output of limiter *B* is differetiated by an R-C network to produce narrow pulses which go to the grid of the *up* gate. These pulses are also inverted in polarity and applied to the grid of the *down* gate. Only when the outputs from limiter *A* and the differentiator are in the positive direction do pulses come through the *up* gate. Also, the outputs from limiter *A* and the inverter be in the positive direction for pulses to pass through the *down* gate.

Pulse counting is achieved by rectifying the gate outputs to produce direct current proportional to the number of pulses per second. The cathode time constants of the diode rectifiers are adjusted so that peak clipping at higher Doppler frequencies produces a compression of the indicating meter scale at the high velocity ranges. This results in a desirable expansion of the meter scale in the low velocity region. A zero-center-scale microammeter mounted in the cockpit indicates the rate of climb. The cockpit meter is driven by a balanced cathode follower connected between the counters and measures the difference between their outputs.

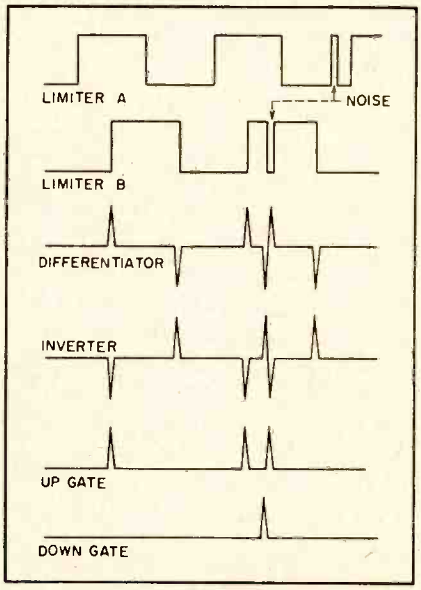


FIG. 5—Typical voltage waveforms of rate-of-climb indicator

Gate Pulses

Up gate pulses then deflect the meter upward, while *down* gate pulses deflect it downward. The waveforms shown in Fig. 5 then correspond to the case where the aircraft is ascending, since pulses are coming from the *up* gate (ignoring for a moment the effects of noise pulses). The case for descent, where the output limiter *B* leads limiter *A* by 90 deg, can be pictured by inverting the limiter *B* waveform. This then inverts the differentiator and inverter waveforms and thus interchanges the up-gate and down-gate waveforms. Pulses then come from the *down* gate, deflecting the meter downward.

The effects of noise on the gating action is also shown in Fig. 5. Should a noise pulse trigger the limiter *A* multivibrator, it does not result in pulses from the gates.

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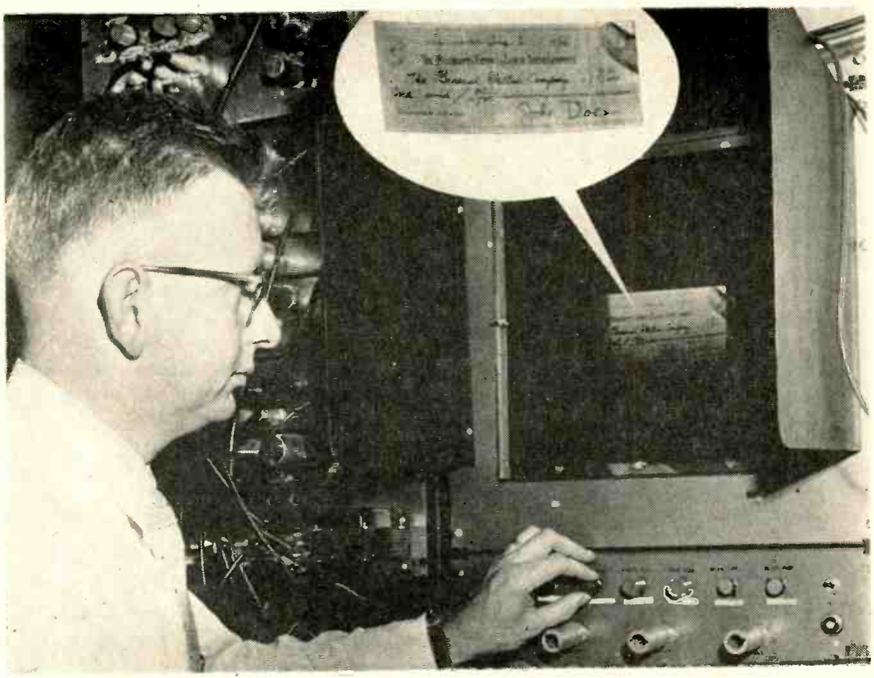


Author views check displayed on slow-scan monitor from converted video signal

Slow-Scan Adapter for Conventional TV Signals

SUMMARY —— Video signal from standard television pickup source, such as camera or flying-spot scanner, is sampled to obtain slow-scan signal with bandwidth compression of 800 to one. Narrow-bandwidth signal can be used to transmit picture information to distant points over voice-communication facilities while standard signal can be sent simultaneously to nearby points

MANY CASES occur where most of the monitors used with an industrial camera are located in the same building and a few other viewing places are required in other parts of the city. In such cases, a combined system is highly desirable in which the standard television signal is used locally and converted to a slow television signal to be sent over telephone wires. This article describes a simple converter that is necessary to make such a system practical.

The ideal combined system is shown in Fig. 1. For local use, there is a standard television camera and monitor. The converter is attached to this system with a short cable. The slow-video output signal is transmitted over a long wire to the remote slow-scan monitor.

Sampling Converter

An ordinary television signal can be converted into a slow-scan signal, without the use of storage devices, if the two standards are interrelated.

The line frequency in the slow system must be equal to the field frequency of the conventional system. The two rasters must also be orthogonal. This means that the direction of the scanning lines in the slow system is vertical for horizontal lines in the original raster, as illustrated in Fig. 2.

The block diagram of the video sampling converter is shown in Fig. 3. The gating pulses are sufficiently narrow to gate out only one picture element during each line. Gated elements lie on a vertical line, since the repetition rate of the pulses is close to the 15,750-cps line rate.

The sampling rate differs by a small amount from 15,750 cps causing the sampled vertical line

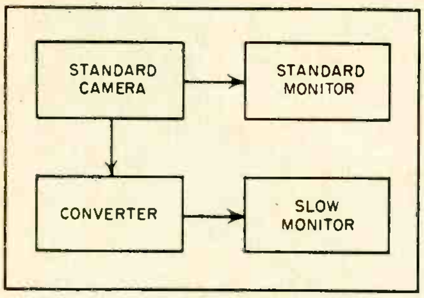


FIG. 1—Simplified representation of basic conversion system

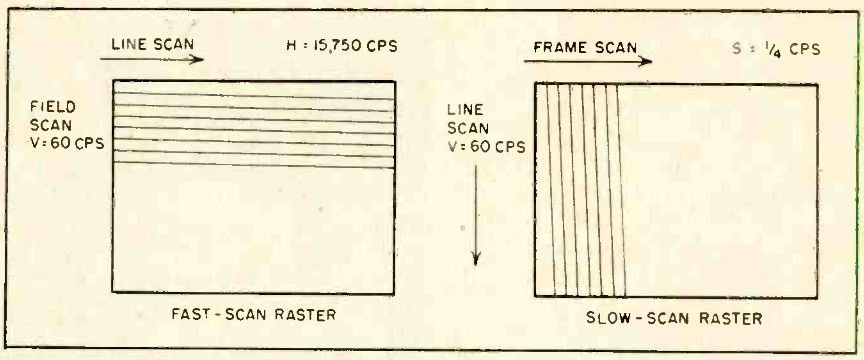


FIG. 2—Sampling conventional-video signal at rate close to line frequency results in vertical line scan for slow-scan raster

to scan slowly over the raster, left to right if the sampling frequency is slightly lower than 15,750 cps. Each scan takes a few seconds.

The sampled pulses represent the picture elements scanned at the new slow rates. A low-pass filter changes the pulses into a continuously varying signal which is not distinguishable from a signal obtained from a slow-scan camera.

Frame Rate

Horizontal resolution will be poor if the new slow-scan system frame rate is too fast because of the limited number of scanning lines per frame. It does not serve a useful purpose to make the frame repetition rate slower than needed to resolve the detail in the incoming video signal.

If the standard system has a field rate of 60 cps, there are 60 lines per frame for each second of slow-frame time. A slow-frame repetition rate of once every four seconds is a good compromise.

Vertical resolution of the system is determined by the low-pass filter; useful frequencies do not go much beyond five kc, which is $(\frac{1}{3})$ (15.75) kc.

According to the sampling theorem, frequencies up to half the repetition frequency can be used. This is, however, true only if the sample is taken from an ideally filtered signal. This ideal sharp cutoff low-pass filter would have to be placed in the optical path before the image is scanned by the fast television raster. Sharp optical low-pass filters are fundamentally impossible since they require an equivalent impulse response with negative lobes.

These cannot exist since they would require negative light energy.

In an unfiltered sampled signal, frequencies up to approximately one-third the sampling frequency can be obtained. In this way, at least three samples are available for each period of the signal frequency. Three samples are sufficient to determine a wave both in amplitude and in phase. The Kell factor is used for the same reason

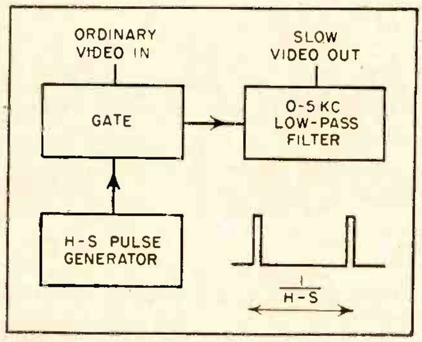


FIG. 3—Video gate in converter is pulsed at 15,749.75-cps H—S repetition rate

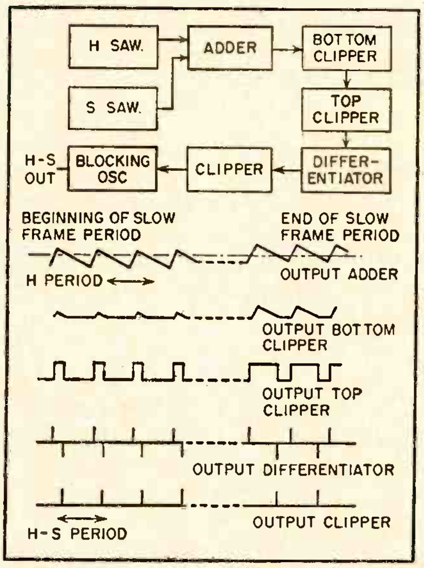


FIG. 4—Line-rate sawtooth modulates ¼-cps S-rate sawtooth to produce 15,749.75-cps H—S sampling pulse

in determining the vertical resolution in a conventional television system.

Normal television uses a horizontal line system; this produces a vertical line system with the slow-speed monitor. The present use of vertical lines on the slow-speed monitor appears quite satisfactory. If, however, a horizontal line system is desired on the slow-speed presentation, a vertical line system on the camera will be required.

The direction of scan has an effect on the nature of the image distortion with motion in the scene. Objects appear contracted or expanded if they move in the direction of the frame scan. They are subject to skew distortions if they move perpendicular to this scan. The latter type of distortions are more confusing than the former. For this reason, it is generally more desirable to have a vertical line slow-scan system since there are more horizontal than vertical movements in nature. A system built to watch an elevator would be an obvious exception.

Sampling-Frequency Generation

The frequency difference between the sampling frequency and the line frequency must be kept constant, since it determines the uniformity of the slow horizontal scan. Random variations in the incoming horizontal line frequency are often large in comparison to this difference frequency.

The required uniformity can be obtained by deriving the sampling frequency from the horizontal line frequency by a uniformly increasing phase advance. A sawtooth at the slow-scan frame frequency is used to modulate the pulse width in

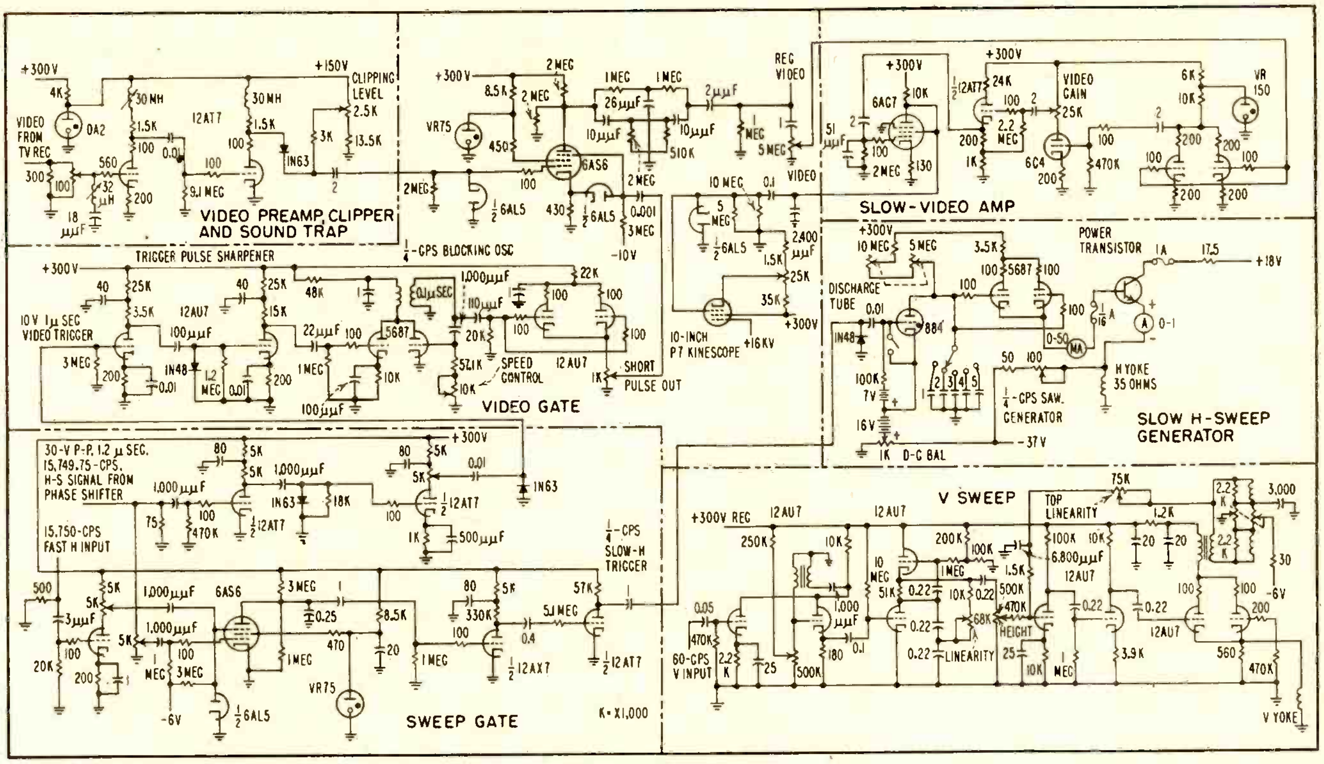


FIG. 5—Narrow recurring pulse gates incoming video at H—S rate. Output video is applied to long-decay-phosphor crt through 5-kc bandwidth filter. Slow H-sweep trigger is generated in coincidence circuit driven by 15,750-cps H pulses and 15,749.75 H—S pulses

a 15,750-cps delay multivibrator.

The slow sawtooth can also be used to change the clipping level on a 15,750 sawtooth as in Fig. 4. The trailing edge of the clipped sawtooth recurs at the sampling rate; this trailing edge is converted into a pulse by using a bottom clipper, a differentiator and another clipper.

Experimental Version

A laboratory setup was built to prove the feasibility of the conversion scheme. Use was made of available equipment, which was in some cases designed for previous experiments. The circuit (Fig. 5) should, therefore, in no way be considered to be an optimum economical design.

A conventional television receiver was used as a signal source. Though the off-the-air broadcast signal is not representative of an itv camera signal this was not considered a disadvantage since it is more difficult to reproduce on a slow-scan monitor.

No attempt was made to design an all-electronic difference-frequency generator, as illustrated in Fig. 3, since a motor-driven phase shifter was available[1]. This unit converts the incoming pulsed horizontal-sync signal to a sinusoidal wave of ten times this frequency. This sinusoidal wave is split into three phases and applied to a phase-shift capacitor. The output signal is divided by ten and the output pulse position is shifted by turning the rotor of the capacitor.

Width of the sampling frequency pulse must be shorter than the time required for one picture element to preserve the horizontal resolution.

The short pulse is derived, in the video gate section, from a blocking oscillator with a 0.1-μsec transformer, synchronized by the phase shifter.

The composite synchronizing signal is stripped from the incoming video signal in the video preamplifier clipper and sound trap section. The H-sweep gate generates the synchronizing pulse for the slow horizontal sweep by gating the fast horizontal pulse with the sampling pulse.

Slow-H Sweep

The slow-horizontal-sawtooth generator uses a thyratron as a discharge tube, since a large current is needed to discharge the large capacitors. The positive synchronizing pulse is fed to the grid of the thyratron. The circuit will behave as a free-running sawtooth generator if the pulse is absent since breakdown of the thyratron is also initiated if the plate voltage rises above a certain value. This effect protects the sweep circuit and the phosphor from overload.

Transistor Output

The low frequency makes it impossible to use a step-down transformer to match an output tube to a conventional yoke. A high-impedance yoke could have solved this problem. However, it was simpler to derive the required high currents from a power transistor.

The low horizontal frequency makes it impossible to use capacitors to bypass screen grids. Glow-tube voltage regulators are therefore extensively used.

The picture was displayed on a 10-inch tube with a P7 long-decay phosphor.

REFERENCE

(1) I. C. Abrahams and R. C. Thor, A Precision Line Selector for Television Use, *IRE Conv Rec*, 1953.

Vortac Beacons for

SUMMARY —— Short-distance navigation system gives azimuth continuously and distance when challenged by beacon equipment in aircraft within range. Transition from earlier VOR-DME system, never completely implemented, retains VOR azimuth but adds Tacan distance information

VORTAC is a short-distance radio aid to navigation of the rho-theta type. It is ground based, requiring airborne co-operation and is unique in the large class of aids of this type in that the ground facilities disseminate azimuthal information in two distinctly different ways to accommodate two different classes of users. Distance information, is not so generously dispensed and requires the same co-operation from all users.

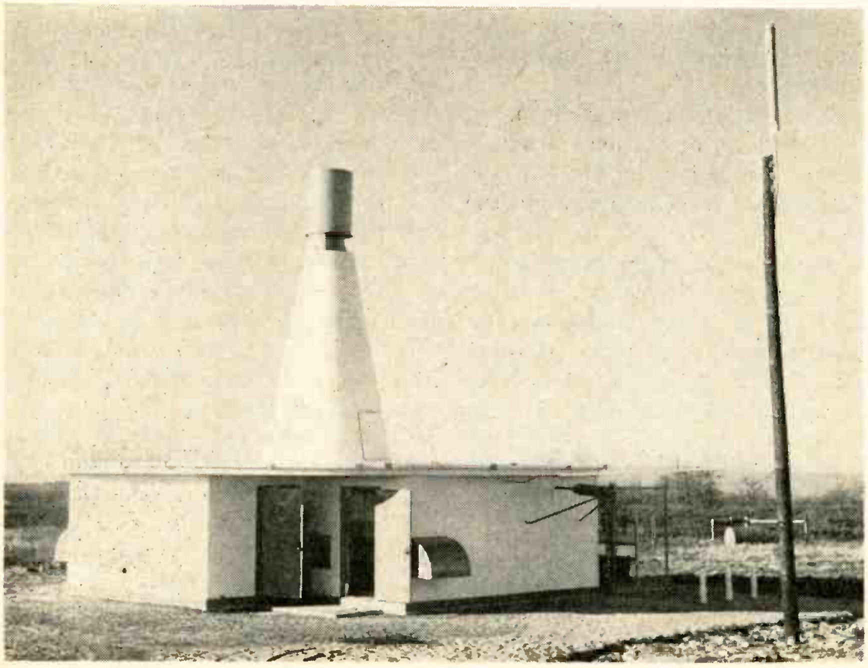
The name Vortac is condensed from the addition of the names VOR (vhf omnirange) and Tacan (tactical air navigation) and rather literally describes the ground facility. The latter is a combination of VOR and uhf Tacan, each retaining intact its own identity. With this combination, azimuth information is available on vhf from VOR and on uhf from Tacan; distance is available on uhf from Tacan.

Vortac Components

The VOR broadcasts a signal comprising a carrier (between 108 and 118 mc) modulated by two low-frequency (30 cps) tones. These modulations are so arranged that the phase difference between them, as measured at any point in the service area of the station, is essentially equal to the azimuthal displacement of the observer from a fixed arbitary azimuth.

This fixed direction is north and along this radial the two modulation tones are in phase. As the observer moves clockwise around the compass, one of the modulation tones changes in phase while the other, serving as a reference, does not. This effect is achieved by radiating the carrier with the sidebands of the reference tone in a nondirectional, horizontal pattern, whereas the sidebands of the variable-phase tone are radiated in a rotating multilobar pattern like a figure 8.

Heretofore two separate antennas have been used for these two patterns, four elements at the corners of a horizontal square for the rotating pattern and a single element



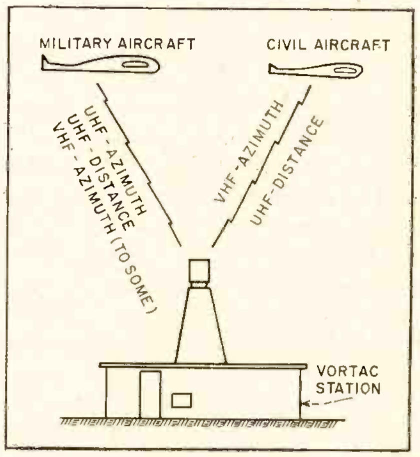


FIG. 1—Information available from Vortac facility shown in simplified form

Complete Vortac installation shown at left has the VOR antenna beneath Tacan antenna

Rho-Theta Navigation

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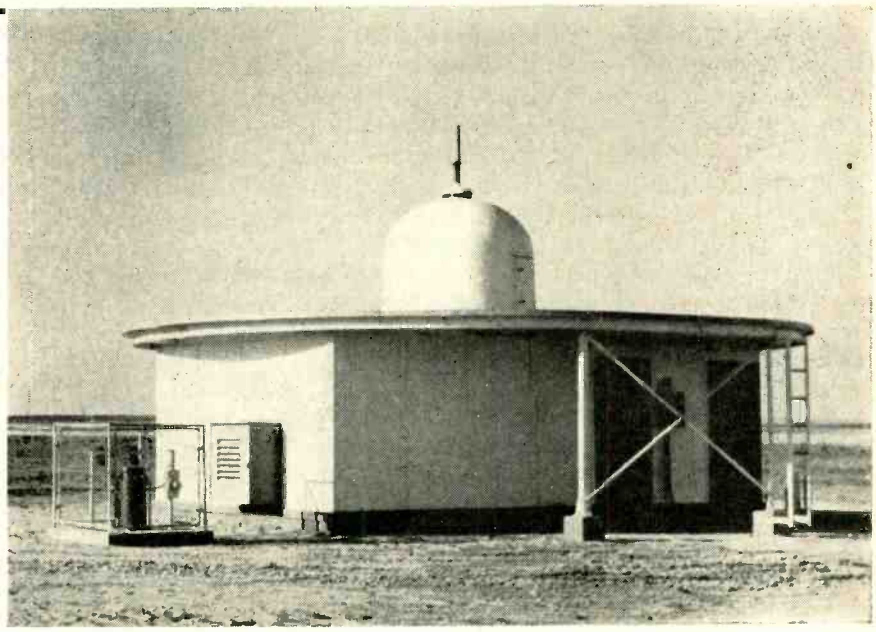
at the center for the nondirectional pattern. The latter antenna is now being removed, and the nondirectional pattern is obtained from the four sideband antennas by feeding the carrier to all of them in phase.

The antenna elements themselves are magnetic dipoles in the form of horizontal loops designed to have fairly constant current throughout the periphery. The signals radiated by these elements are horizontally polarized.



One of 220 existing VOR stations equipped for DME distance determination

Tacan Technique

The Tacan system uses pulse techniques and therefore quite different circuitry from the VOR, but it is essentially the same. It also provides azimuth information by radiating a nondirectional and a rotating directional signal with the phase difference between the two proportional or equal to azimuthal displacement from north.

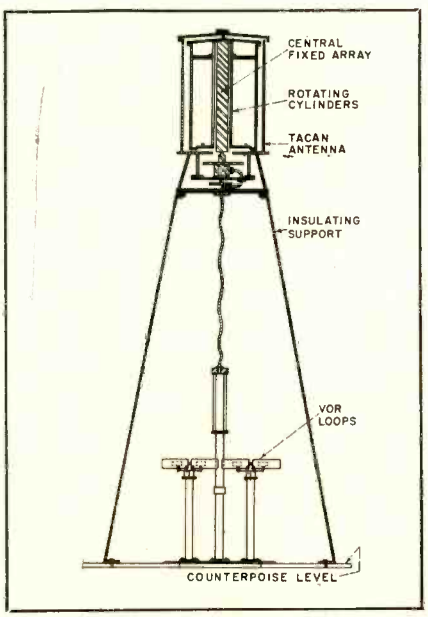


FIG. 2—Vortac antenna system combines VOR loops with rotating Tacan antenna

The Tacan carrier is in the 1,000-mc band. It is a pulse system wherein the phase measurements involve modulated envelopes of series of pulses. Rotation of the variable phase signal is achieved by mechanical rotation of some antenna elements. The antenna has been designed with vertical directivity to reduce illumination of the surrounding terrain and thus reduce untoward effects of nearby obstructions and site irregularities.

In addition to these differences, the variable phase cardioid rotating at 15 cps is further modulated at 135 cps and the phase of this latter is itself compared to a reference signal. The effect of this synchronism is to provide a nine-fold magnification of the observed azimuth.

Rotating Antenna

The antenna used to obtain these results consists of a stationary central vertical stack of 7 dipoles surrounded by two concentric, rotating cylinders. These cylinders are dielectric material with vertical parasitic elements imbedded in their surfaces.

The inner cylinder carries one element and produces the 15-cps cardioid; the outer has nine elements producing the 135-cps modulation. The reference pulses are controlled by small electromagnetic units rotating with the concentric cylinder.

Distance information is obtained from the same equipment. The same pulses that are amplitude modulated by the antenna to provide bearing data, are time-modulated to provide distance. This function, unlike that of providing azimuth data, is operative only on request. An aircraft desires distance information from a certain station and interrogates it. Upon receipt of this interrogation the station replies and the aircraft automatically calculates its distance from the time taken to receive the reply.

When there is no interrogation, the station continually emits pulses that provide bearing data. If interrogating pulses are received, the station synchronizes some of its pulses with the received pulses and it is this synchronized group that is selectively received by the aircraft and used to calculate distance. The bearing function is thus practically unaffected.

Present Use

About 220 existing VOR's are already equipped with distance measuring equipment (DME) in full operation. This DME functions exactly as described except for channeling. Each Tacan occupies a 1-mc segment of the radio-frequency spectrum. Existing DME uses ten radio-frequency channels 2.5 mc wide (actually 20 channels since ten are required for interrogation and ten for reply) and ten pulse spacings or modes resulting in 100 effective channels. This is essentially the only difference, although it is enough that airborne equipment designed for one system cannot be used with the other.

One way of summarizing Vortac is to describe it as a combination of two rho-theta systems with a common rho as shown in Fig. 1.

Implementation Problems

The fact that a Vortac ground station combines two different techniques and operates on two entirely different frequency bands, presents problems from a technical as well as a programming standpoint. The problems derive chiefly from the mutual proximity effects of the two antenna systems and the difference in propagation characteristics of the two frequency bands.

Early tests showed that the two antennas could not be placed near each other without serious mutual ill effects unless the separation was greater than 1,000 feet (for antennas at heights of 10 to 20 feet). This separation raises difficulties of siting and land acquisitions.

Since the vertical axis of each antenna is the axis of substantial conical nulls, it is possible to mount the two antenna systems one above the other with little or no mutual effects. This, in fact, is done in the Vortac station, the uhf system being placed above the vhf system. Figure 2 shows a cross section of this arrangement.

The difference between the frequency bands (the higher being roughly 10 time the lower) is helpful insofar as direct mutual interference is concerned. The siting requirements are not quite the same and this immediately presents a conflict the extent of which cannot be intelligently evaluated until a considerable number of Vortac stations has been installed and tested.

The fundamental aspects of siting are fairly simple: service area and quality of information. Site characteristics affecting the service area can be evaluated by observing the terrain profile along all directions and determining the extent to which this profile screens the antenna. All functions of Vortac are thereby affected though the VOR is slightly less sensitive than Tacan owing to the lower frequency of the former.

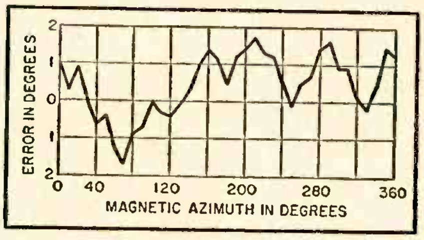


FIG. 3—Phillipsburg error curves for VOR at 4,500 feet at 30 miles

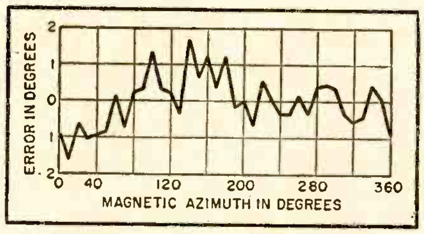


FIG. 4—Error curves from Phillipsburg Tacan comparable to Fig. 3

The effects of siting on the data transmitted result chiefly from distortion of the radiation patterns by reflections from obstructions or irregularities of terrain. The distance information is in a nondirectional pattern and is not particularly subject to siting. The azimuth information, however, is sensitive to siting. Effects result from horizontal reflections and effects of vertical reflections.

The first are those that cause information in one portion of the horizontal pattern to be superimposed on that of another portion. This effect generally results from reflections in a horizontal plane and tends to produce erroneous azimuth information along certain radials. The second type reflections are those that cause the null structure of the vertical pattern to change and result from reflections in a vertical plane. This effect may result in nulls at wrong angles, deep enough to reduce the signal-to-noise ratio in the airborne equipment below a critical level.

When this occurs, the noise in the receiver may make the azimuth indications uncertain or may produce erroneous indications.

High Counterpoise

For VOR's using a counterpoise 10 feet above ground level, the vertical pattern from about 10 deg up to the zenith is dependent primarily on the counterpoise itself and irregularities of terrain are not important. For angles below 10 deg, which are an important part of the pattern, the counterpoise is no longer important but the surrounding terrain is.

Rises of terrain will reduce the null structure and are therefore not objectionable, while dips will increase the number of nulls and may cause difficulties. In general, terrain irregularities beyond the immediate vicinity of the facility have only a local effect.

For the Tacan portion of Vortac, the main half of the vertical pattern is roughly 15 degrees wide at the half-amplitude points and the maximum occurs at about 5 or 6 degrees above the horizon. The antenna is mounted at a height of thirty feet above the ground and the counterpoise has practically no effect on its performance, owing partly to its small size and partly to the intrinsic vertical directivity of the antenna.

Vertical Pattern

Almost the entire vertical pattern of the facility is dependent on the surrounding terrain to a radius twice that for VOR, because of the Tacan antenna height. This greater height helps reduce the intensity of illumination thus compensating somewhat for the greater area illuminated.

The problem of siting is almost wholly a problem of geometrical optics and the effects are therefore an inverse linear function of wavelength. Thus all physical dimensions, such as height, terrain, elevation and obstructions are electrically ten times larger for Tacan than for VOR.

In any actual case, the site configuration including obstructions and terrain is mathematically complex. The larger aspects of this configuration can be evaluated and so-called site criteria are issued to field personnel on this basis. But the lesser deviations are less tractable and in practice are evaluated by an actual flight check using portable ground equipment.

Facility Evaluation

Theta information is available continuously around 360 deg of azimuth and at all vertical angles to within 35 deg of the zenith for VOR and 55 deg for Tacan. For any given azimuth and altitude the quality of the information may vary with distance. There are thus three orders of infinity of information required for a full description of the station.

It is therefore a matter of sampling judiciously and extrapolating with care. The technique developed for VOR consists of two parts. First check is upon performance of the equipment itself including the antenna by accurate field measurements on the rim of the counterpoise. In this manner the effects of siting and terrain are eliminated. The second part involves flying a horizontal orbit of fixed radius within 6 to 10 miles of the station, another at approximately 20 miles and constant altitude flights along selected radials.

On all these flights the accuracy of the indicated azimuths is recorded continuously and the orbital recordings provide error curves shown in Fig. 3 and 4. Figure 5 shows variation of accuracy with vertical angle. Indices of a satisfactory station are: azimuth error less than a prescribed maximum at any azimuth; smooth transitions when flying across a preset azimuth; proper width of the course (this refers to the required angular displacement from the true course to obtain full-scale deflection of the omnibearing indicator); adequate usable distance coverage at minimum altitudes.

These flight-checking techniques are equally applicable to Tacan

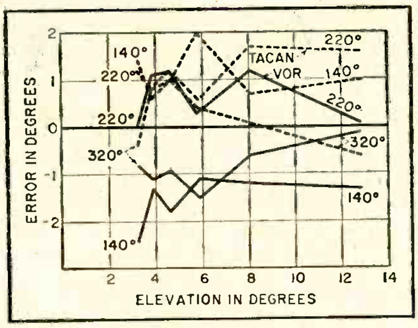


FIG. 5—Variation of error with elevation angle at Phillipsburg Vortac

azimuth. The counterpoise measurements are probably not equally applicable to Tacan owing to the position of its antenna relative to the counterpoise.

Performance of any facility can be described usefully only in statistical terms. However, the volume of data involved would render a more determinate presentation not only useless but impractical.

Error Probability

Probability of occurrence of a given error is information providing a basis to the users for making operational decisions. What is more, the user need not be concerned about any single facility, providing the agency having responsibility insures that the facility operates within tolerances that lead to the published probability figures.

This discussion generally applies to the azimuth portion of Vortac whether it be derived from the VOR or the Tacan equipments. In the VOR's the equipment is adjusted so the most probable error is zero and the distribution curve is symmetrical. Probability of a positive error is essentially equal to that of a negative error that might occur.

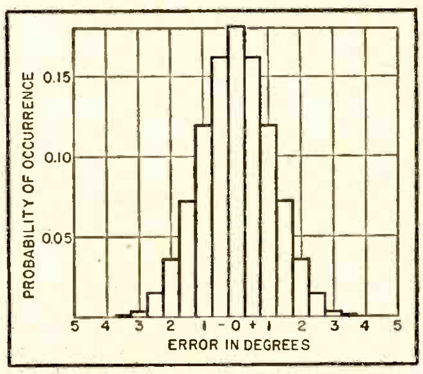


FIG. 6—Probability distribution of errors in VOR radials

Fig. 6 shows the probability distribution of the network (not just one station) based on data from 276 stations taken at random from a total of some 400. The data were taken at 1-deg intervals on each station. As shown in the histogram, the error was measured to ½ deg. This analysis is about a year old and there were no Vortac facilities then but the VOR portion of Vortac will have a similar distribution, reflecting any improvements that may have occurred since the last analysis.

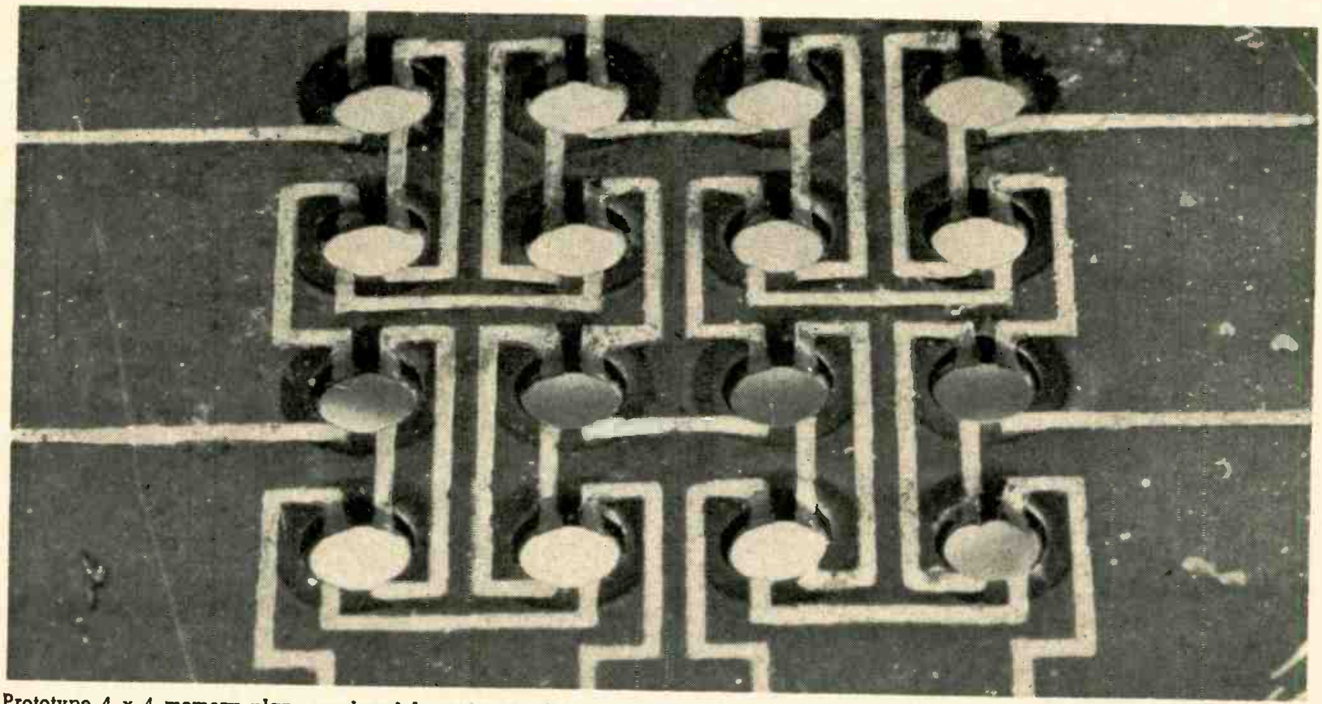
There is no corresponding data yet on Tacan azimuth. The only such is that obtained on limited experimental installations, but the Vortac program will provide the source of such data as facilities are commissioned.

The distance portion of Vortac presents somewhat different and simpler problems. The radiated pattern is nondirectional in the horizontal plane and a whole infinity of observations is thus avoided. The major source of error lies not in the ground facility but in the airborne equipment, particularly in the indicator. The total system error for the best airborne equipment is ± 2 percent or ± ¼ mile, whichever is the greater. Less than 500 feet of this is contributed by the ground station.

Program Status

At the present time there is only one Vortac facility in existence: at Phillipsburg, Pennsylvania. There are 280 additional programmed for completion by July 1, 1959 and 87 more by July 1, 1960. Of these, about 60 percent represent conversions of existing VOR's. Eventually more complete coverage will be provided in an orderly program over three to five years.

In the meanwhile, until adequate distance information can be obtained from Vortac, existing DME installations will be retained chiefly for use by aircraft already equipped with multiplex type DME (mostly executive type of aircraft) and by CAA flight inspection aircraft. These installations will be phased out as adequate service from Vortac becomes available or as they cause interference to Vortac facilities.



Prototype 4 x 4 memory plane produced by print-wired technique, showing how etched conductors on one side of board go right through holes in embedded ferrite memory cores to join wiring pattern on other side of board. Four conductors thread through each core. Technique permits mass production of memory planes with absolute uniformity of wiring and no core breakage

THREE-DIMENSIONAL

SUMMARY — Use of four collimated light sources for exposing acid resist permits production of etched wiring which goes through holes in ferrite cores of memory planes. Technique eliminates need for threading delicate wires through the millions of such cores used in large computers, holds promise that all wiring for a 64 x 64 plane can be produced in one etching operation. Extension of method may permit print-wiring of windings directly on toroid cores

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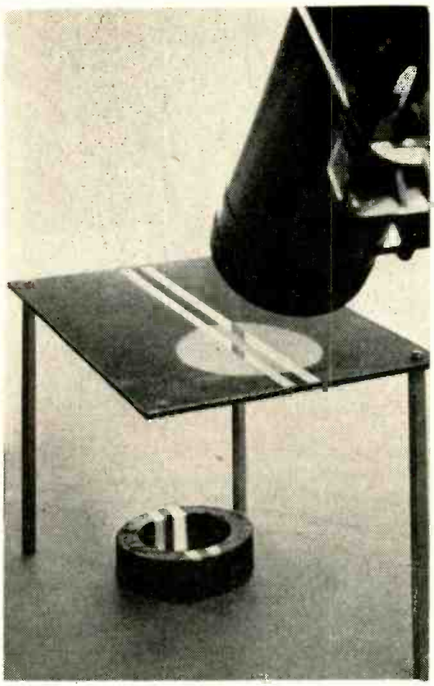
MODULAR MEMORY PLANES using ferrite cores can be connected to form huge memory arrays. The MIT Lincoln Laboratory computer TX-2, for example, stores 2.5-million binary digits in a 256 × 256 × 38 stack of ferrite cores.

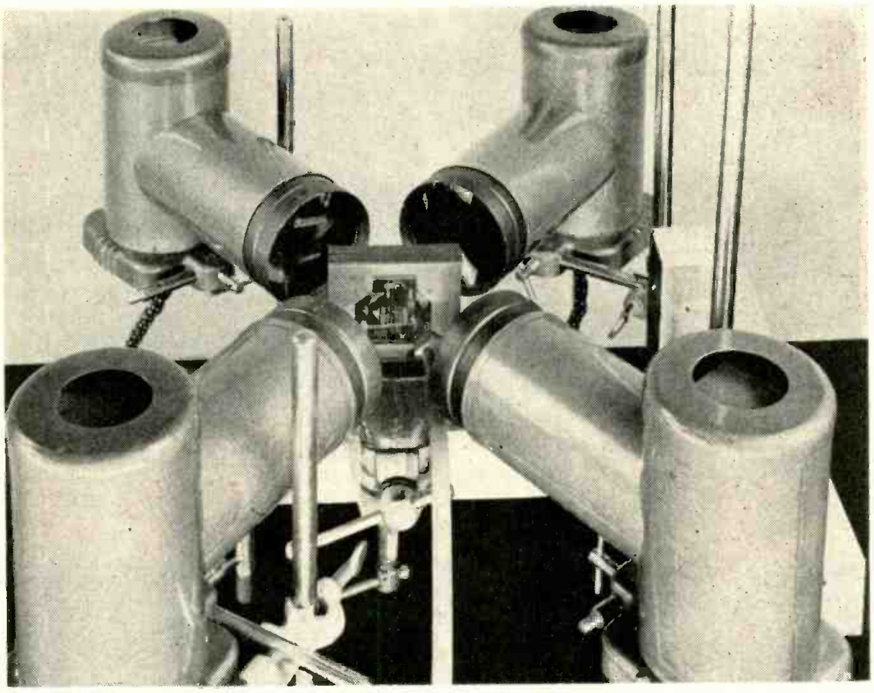
Each standard 64 × 64 modular plane requires one man-day to assemble, because four insulated wires must be individually threaded through each of 4,096 cores. Core damage and consequent replacement during the wiring operation represent a significant time and cost factor in the assembly operation.

Three-dimensional printed wiring now appears to be a solution to the problems of assembly time and core damage. Collimated light is the basis of a new technique which produces, in a single exposure, a latent image of the complete wiring pattern for a memory plane. With ordinary light, the negative mask must be in intimate contact with the photosensitized surface, as in Fig. 1A. With collimated (parallel) light, the mask and the photosensitive surface can be separated as in Fig. 1B.

If the beam of parallel light is directed through an aperture mask at an angle to a photosensitive panel as in Fig. 1C and 1D, the pro-



Single-lamp setup illustrates how collimated light projects wiring pattern through ferrite core



THE FRONT COVER—Final four-lamp setup used for exposing memory-plane board positioned between two precision masks in vacuum holder designed to give precise register. Light sources each produce parallel light rays

PRINTED WIRING

jected image follows the contour of the panel. The image of any aperture can thus be projected with fidelity onto any surface, regardless of its irregularity, for exposure of the resist pattern.

Rearranging Wiring

Before this technique could be applied to the production of print-wired memory planes, the intricate wiring pattern of conventionally wired planes had to be rearranged. Four wires must pass through each core—X and Y coordinate selection windings, a sense winding for reading out stored information and a digit-plane winding to determine the information to be stored. The coordinate-selection windings were planned as shown in Fig. 2A. A given core is selected by the coincidence of two current pulses, each one-half the minimum value required for switching.

The coordinate-selection wiring is conventional in that it threads successively through the cores to form rows and columns. The sense winding, as a whole, is cancelling with respect to half-select signal outputs and air-flux voltages. It

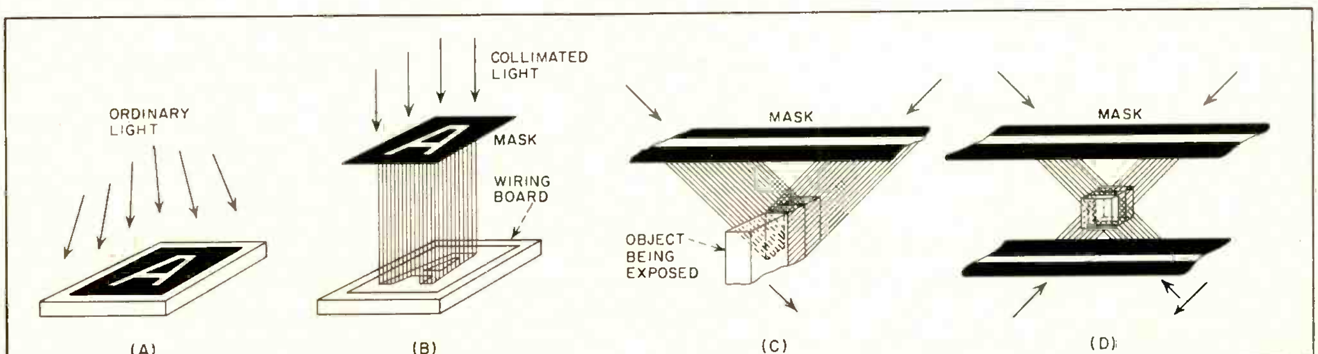
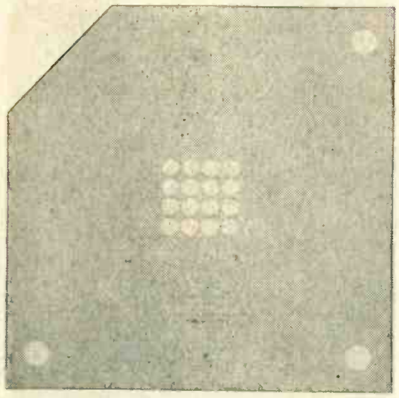
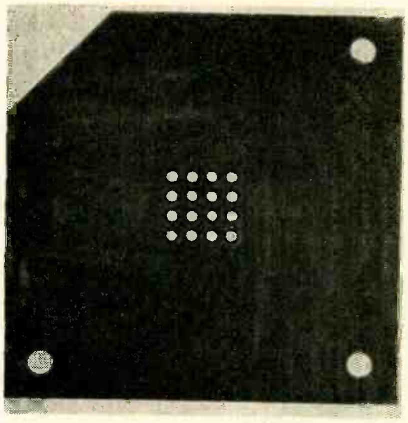


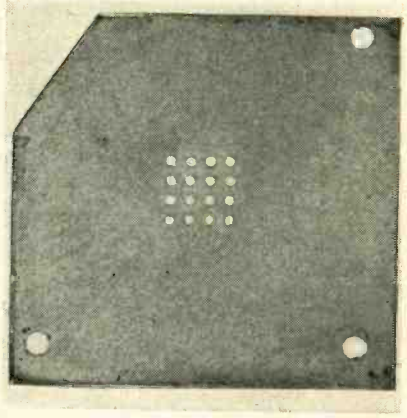
FIG. 1—Divergent nature of ordinary light makes it necessary to use contact printing, whereas use of parallel or collimated light permits projecting image without change in size, for exposing shaped objects



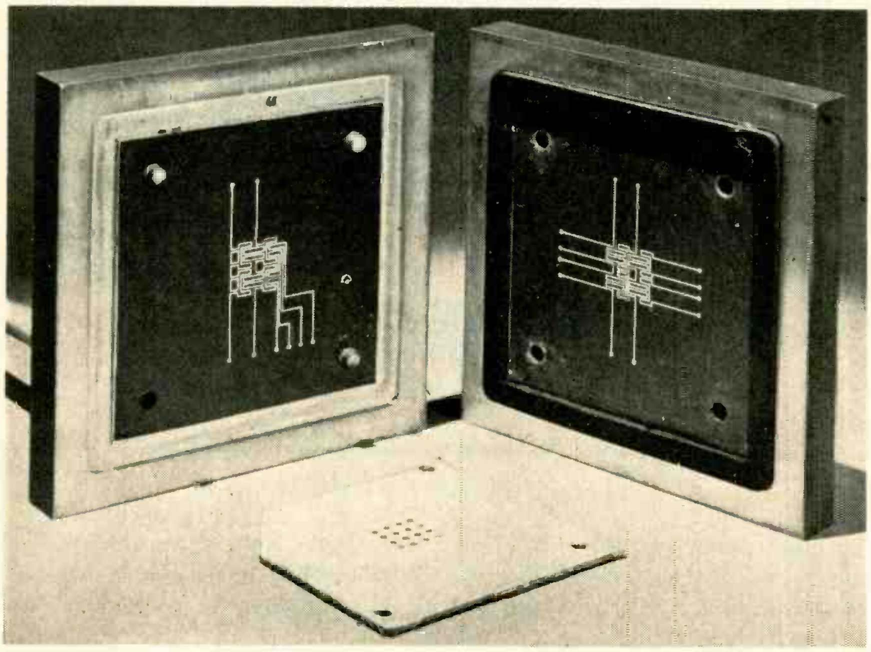
Step 1—Holes are jig-punched in paper-base phenolic laminate for ferrite cores and registration pins



Step 2—Tiny doughnut-shaped cores are dropped into holes and entire board is coated with plastic to anchor them



Step 3—Entire board is copper-coated, first by chemical deposition, then by electroplating to give 0.002 inch of copper



Opened masks used for exposing resist to produce wiring for prototype 16-core memory plane. Three positioning pegs on left-hand mask holder go through register holes in memory plane board and in other mask, to provide required high precision of alignment for printing wiring pattern simultaneously through cores and on both sides of board. When masks are together in printing position, vacuum line pulls masks tightly up against photo-sensitized copper-plated board

consists of quadrants of noncancelling windings appropriately print-wired in series. This configuration avoids the difficult problem of designing a sense winding which cancels half-select signals on a core-to-core basis without crossing wires.

The digit (inhibit) winding is similar to the sense winding and links all the cores in series. A quadrant sense winding is shown in Fig. 2B and a companion digit winding in Fig. 2C. Windings of this type, hand-wired into a 4,096-core memory plane, were found to be electrically equivalent to conventional sense and digit windings.

Making Accurate Masks

A second major problem was that of producing a pair of accurate masks which could be held in close registration to connect the front and back surface wiring patterns with four connecting paths through the 0.050-inch hole in each of the

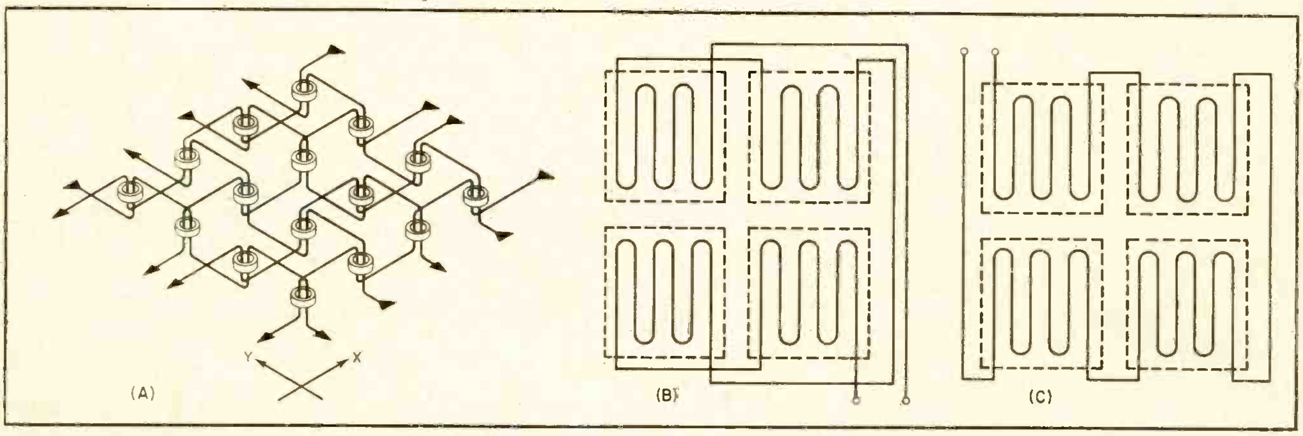
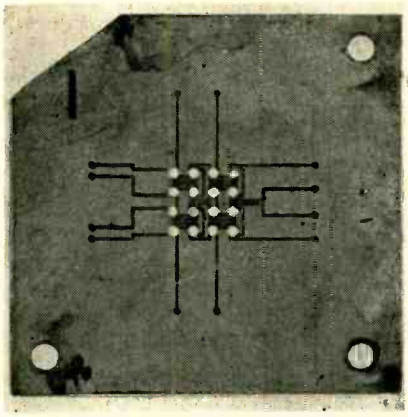
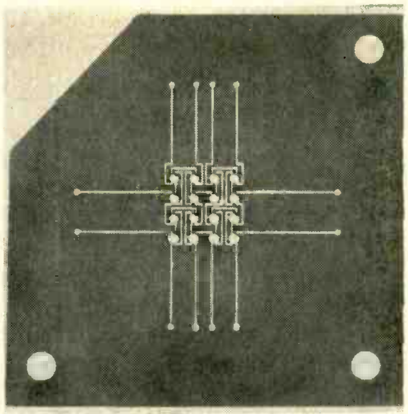


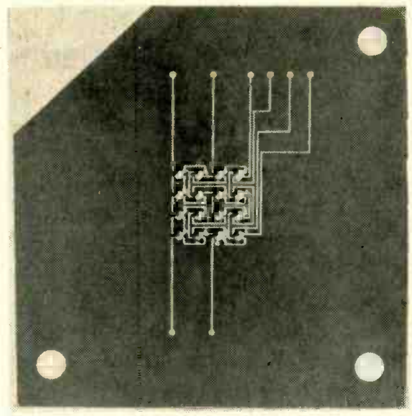
FIG. 2—Rearrangement of coordinate-selection windings of memory plane as at *A*, quadrant-cancelling sense winding as at *B* and quadrant-cancelling inhibit winding as at C eliminates crossovers, to permit printing four wires through each core



Step 4—Board is sensitized with Kodak acid resist, exposed, developed and dyed to give resist pattern on both sides



Step 5—Front wiring pattern of prototype 4 x 4 memory plane after etching is ready for external connections



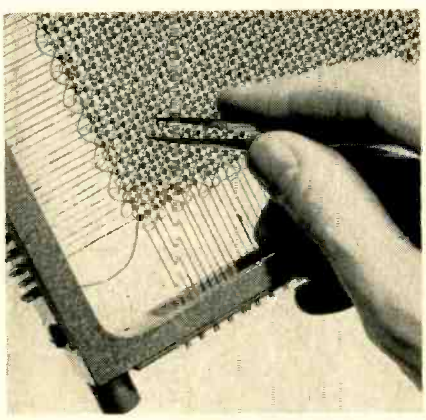
Step 6—Rear of finished board; all wiring is continuous from one side of board to the other through the cores

cores. A set of satisfactory masks was prepared by photoengraving methods, though cost was high. Further study resulted in the development of a selective masking technique capable of economically producing masks with a line-center position accuracy of ± 0.001 inch from an outside reference line.

Selective masking is based on the fact that it is possible to rule a single pair of parallel lines to great accuracy. These two lines can be used to form appropriate segments of a wiring pattern by repeated exposures on a step and repeat table.

The finished masks are mounted in a vacuum holding fixture. The memory plane to be exposed is placed between them, with its photosensitized surfaces held in intimate contact with the masks. Registration is maintained by three pilot pins.

Before exposure, the entire memory plane assembly must be coated with copper. The board is first covered with a clear plastic solution which, when set, anchors the cores firmly in the holes and covers any gaps. The plastic provides a smooth unbroken surface on which to deposit copper chemically. This initial layer of copper adheres firmly to the plastic as a highly conductive base on which to electroplate another layer approximately 0.002 inch thick. Conventional photo-etching techniques begin with the application of Kodak acid resist to the entire assembly.



Example of 64 $\times$ 64 ferrite-core memory plane wired by conventional methods (ELECTRONICS, p 214, Feb. 1956)

Photographic exposure of the sensitized plane through the masks is made with four projection lamps having collimating lenses. These form the contact images of the surface wiring on both sides of the panel and the projection images of the lines connecting the surfaces through each core. Placement of the lamps is not critical, nor is the exposure time.

The two parallel apertures needed to print the conductors within each core are extensions of the same lines which produce the surface wiring. The cores are only 0.050 inch in inside diameter and are located on 0.100-inch centers.

After exposure and etching the wiring pattern on one surface of the plane extends through each of the cores and connects to a similar wiring pattern on the opposite face. The finished wiring is 0.002 inch thick, 0.010 inch wide and spaced 0.010 inch at the points of least separation. This spacing is adequate for the signal voltages impressed between the windings, which are operated at d-c ground voltage level.

Except for the use of collimated light sources, the production of completely print-wired memory planes is based on present commercial methods. Yields of two planes per hour are achieved in the laboratory by this method, which is adapted to completely automatic production. Because the cores are almost completely protected by the phenolic panel, there is negligible danger of core damage during the processing operation.

Conclusions

At the present stage of development, 16-core (4 $\times$ 4) planes have been successfully produced to verify and refine the method. These planes have been the electrical equivalent of conventionally wired planes of the same size.

Masks are now being prepared for 16 $\times$ 16 arrays. The practicality of the method has been demonstrated. Its appeal rests on the fact that it is, even on a laboratory basis, about 20 times faster than current production methods for memory arrays.

Ultimate speed is much greater than this because the method is completely amenable to current automatic production techniques. It is reasonable to expect that automatic production will result in further improvement in the quality of memory planes because of accuracy and uniformity inherent in the basic method.

Sincere appreciation is expressed to Frank Hazel, staff member of Lincoln Laboratory, for his efforts in the organization and preparation of this material.

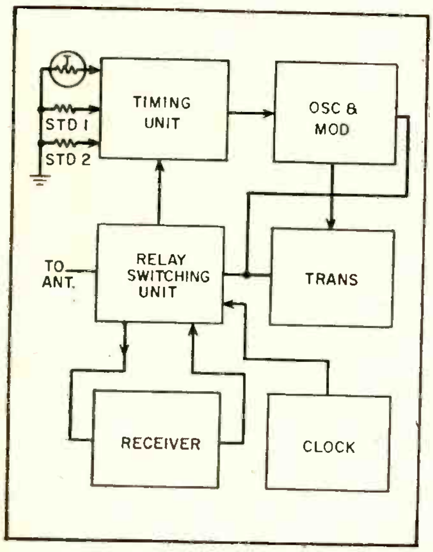
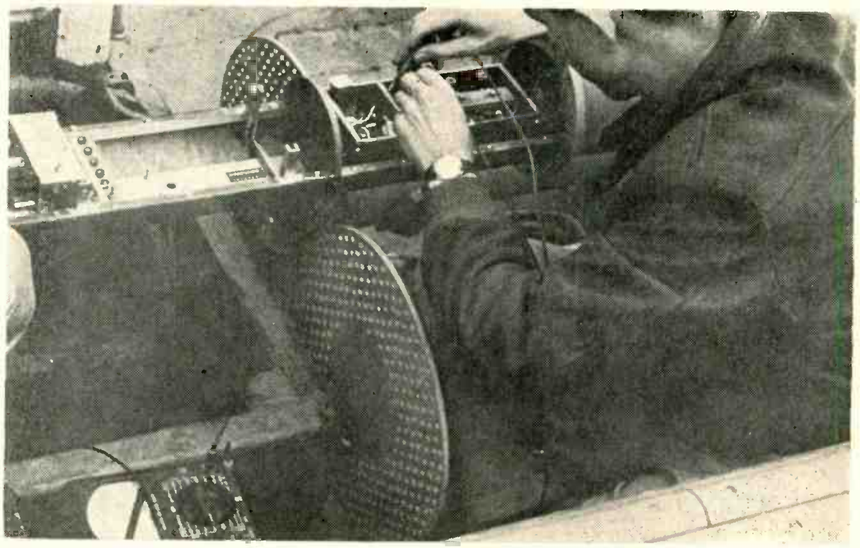


FIG. 1—All sections of telemetering buoy are controlled by relay switching unit



Transistor receiver is given final check before buoy is sealed for launching. Receiver is used to turn on transmitter when propagation conditions are favorable

Buoy Telemeters Ocean

SUMMARY —— Temperature measuring telemetering system in buoy is triggered by audio modulated r-f signal received by transistor receiver. Cycle of transmission includes two standard tones and thermistor temperature data together with identifying code signal. Data can be obtained at distances up to 600 miles by triggering at favorable propagation times

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INCREASING cost of operating oceanographic vessels emphasizes the need for a method of making semicontinuous measurements at many different locations independently of the ship. Telemetering anchored buoys can provide measurement of surface or deep temperatures, or when allowed to drift can provide ocean current and circulation data.

The buoy shown in the photographs can be triggered remotely by a radio signal modulated with a distinctive tone or may be triggered by an internal clock at regular intervals. A signal from the buoy, modulated by a thermistor-controlled R-C oscillator, transmits water temperature data in terms of the modulation frequency.

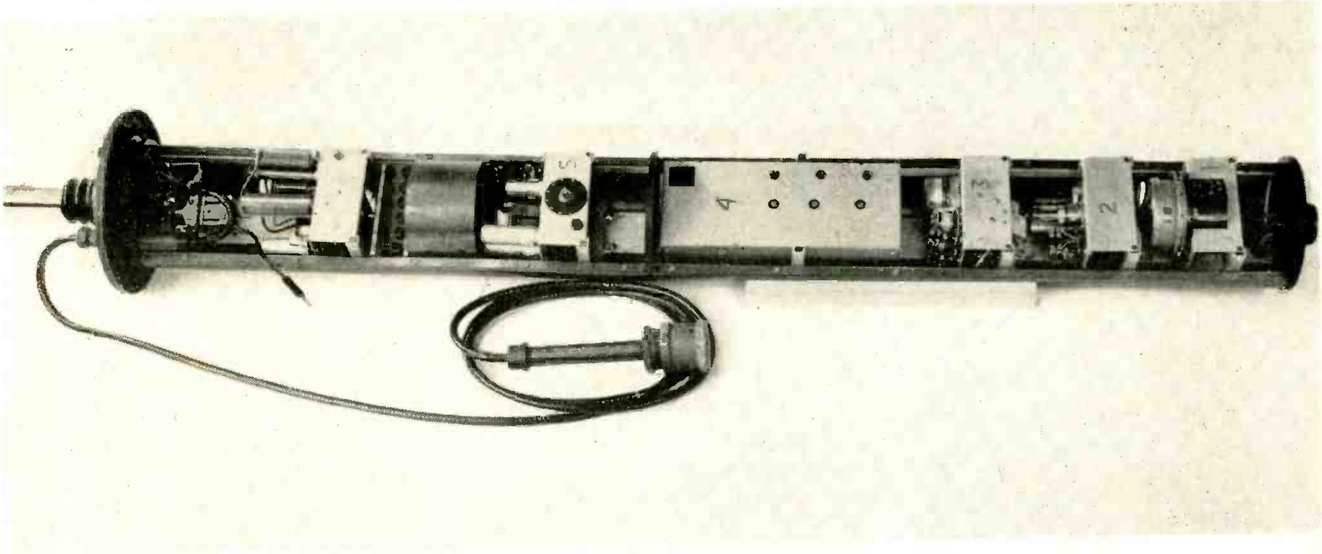
The buoy has been reliably triggered and read at ranges up to 300 miles at frequencies between 2 and 3 mc. This range has been increased to as much as 600 miles by triggering at times of optimum propagation.

Operation

In operation, a number of buoys are anchored at locations determined by the physical problem to be investigated. The buoys transmit and receive on the same frequency, but each buoy responds to an interrogating signal only if the signal is modulated with a tone of particular frequency.

Vibrating-reed relays are used in the output of the buoy receivers to obtain a narrow audio-frequency response that almost entirely eliminates accidental transmissions caused by noise and interference. The interrogating transmitter is modulated by tones derived from a resonant reed-controlled oscillator with a separate resonant reed for each tone.

The reception of the proper tone by the buoy receiver actuates a time-delay relay which allows quick-heating transmitter filaments five seconds warmup time. The transmitter is then keyed with the call sign followed by three consecu-



Electronic components for buoy removed from housing. Six chassis from left to right are transmitter, modulator, receiver, timing unit, relay switching unit and clock. All units are powered by battery pack

Temperature Data

tive tones. The frequencies of the three tones are controlled by: a standard resistor representing a point at the low end of the temperature — audio-frequency curve, a standard resistor representing a point at the high end of this curve and the thermistor, which measures the water temperature.

The total transmission lasts 15 seconds. At two transmissions per day the estimated battery life is about two months. This f-m/a-m signal is received on a standard communications receiver and recorded on magnetic tape. The tone frequencies are then measured with an eput meter. In the event of garbled reception the buoy may be triggered again at a more favorable time.

The electronic equipment is contained in six aluminum chassis which plug into a cylindrical aluminum and bakelite rack. A two-inch aluminum channel, which forms the backbone of the rack, carries the receptacles and interconnecting wiring. The entire rack fits snugly into the tubing that forms the buoy. A glass fiber center-loaded marine antenna, supported by the end cap, effectively withstands the salt atmosphere and the force of moderate seas that occasionally break over the buoy. The cylindrical battery stack consists of 18 45-volt B batteries and 17 No. 6 1.5-volt cells.

Timing

Figure 1 shows a block diagram of the electronic circuits. The electrically wound clock and a transistor receiver operate continuously with relatively low battery drain. The clock may be set to operate a switch once or twice daily at any desired time. The clock switch actuates a sequential circuit in the relay switching unit that applies filament power to the modulator and transmitter, allows about five seconds warm-up time and then operates the antenna relay and timing unit. The timing unit then keys the modulator to transmit call signal and temperature data.

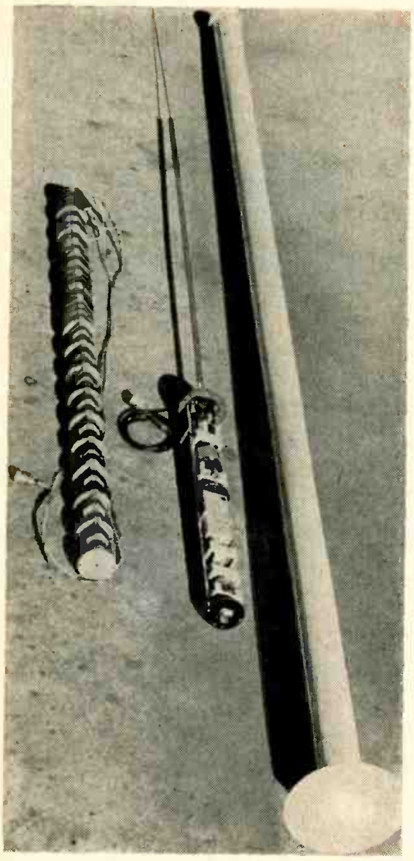
At the end of the thermistor tone, power is removed from the transmitter and modulator, the antenna is switched back to the receiver, and the device is ready for another cycle. The same sequence of events may also be initiated through the receiver by reception of the proper signal from a remote ship or shore station.

Since the receiver must run continuously during the life of the buoy, the most important design consideration is low battery drain. The receiver, shown in Fig. 2, employs nine transistors in a conventional superheterodyne circuit. To achieve the high sensitivity required for long-range operation, a stage of r-f preselection and two i-f amplifiers are included.

All stages through the second detector are surface-barrier transistors, chosen for their high-frequency response and low power consumption. The local oscillator is crystal controlled. Stable operation of the r-f and i-f stages is effected by not bypassing a portion of the emitter resistor in each stage.

The push-pull, class-B output stage drives a resonant-reed relay. No forward emitter bias is used in this amplifier, since distortion of the output signal does not materially affect operation of the relay. Power consumption of the output stage is thus negligible in the absence of an input signal. The resonant-reed relay contacts are in series with a sensitive d-c relay shunted by a capacitor.

The discharge time constant of



Complete assembly consists of (l to r) battery pack, electronic unit and buoy case

the combination is long enough to hold the contacts closed during the intervals when the vibrating contacts of the relay are open. An input signal with a duration of about one second is sufficient to set the relay switching unit in operation.

Receiver sensitivity is defined as the minimum value of r-f voltage appearing across the antenna terminals required to hold the d-c relay contacts closed. An r-f generator, 100-percent modulated with the appropriate audio-frequency signal, provides the test voltage. The measured generator impedance and the calculated receiver input impedance are used to arrive at the sensitivity figure. A typical value is 2 to 5 microvolts.

Overall bandwidth of the r-f and i-f sections was found to be about five kilocycles between half-power points. The actual bandwidth of the receiver, however, is determined by the resonant-reed relay, whose bandwidth increases somewhat with the amplitude of the driving current.

Relay Response

The usable response of the relay is at most only a few cycles wide. The result is an excellent overall s/n ratio and almost complete elimination of response to unwanted signals.

Total receiver power consumption with no signal present is 40 milliwatts. With full audio output the batteries must supply about 150 milliwatts.

Because an efficient avc system is not easy to achieve in a transistor receiver, this feature, for simplicity, was omitted. This defect, particularly in the high-gain circuit described, results in overloading with a moderately strong input signal. If the signal is not 100-percent modulated, the entire modulation envelope may be clipped off in the i-f stages, causing loss of audio output. This disadvantage is easily overcome by reducing the power of the interrogating transmitter when the buoy is nearby.

The operation of the relay switching unit shown in Fig. 3 is as follows: When the switch S_1 is operated capacitor C_1 discharges through the coil of the high-resistance relay RE_1, closing the contacts and holding them long enough to actuate RE_3. Relay RE_3 turns on the transmitter and modulator filaments and locks up RE_1 through RE_4. At this time capacitors C_1 and C_2 charge to the voltage across the coil of RE_1.

After five seconds, the time-delay relay RE_2 operates starting the timing motor, which closes S_2 and operates RE_4 and RE_5. As the contacts of RE_4 break, RE_1 holds due to the charge on C_1 and C_2, holding in RE_2 and RE_3. Then RE_4 and RE_5 close, holding in RE_2 and RE_3, switching the antenna, and energizing the voltage-regulator tube for the multivibrator power supply. After one revolution of the timing motor S_2 opens, and the circuit returns to its original state. Closure of the receiver relay contacts initiates the same train of events, except that RE_3 operates first, causing RE_1 to close and lock.

Timing Unit

The 4-rpm timing motor is directly coupled to a commutator. A code wheel is also coupled to the motor through a 1-to-3 gear train. The teeth on the code wheel correspond to the buoy's call sign in International Morse code and oper-

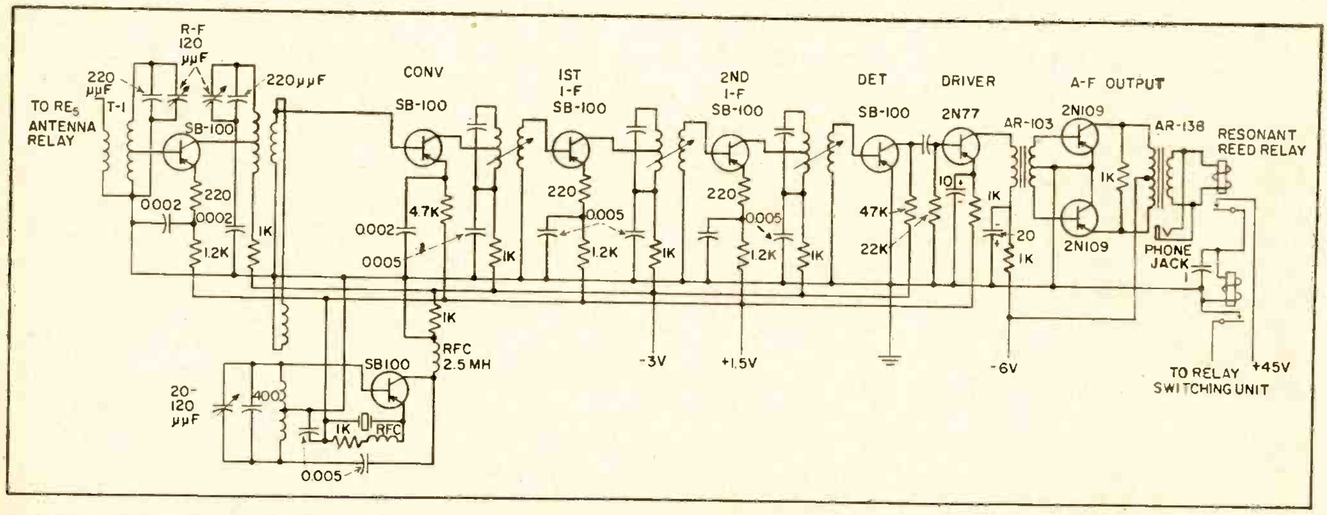


FIG. 2—Transistor superheterodyne receiver turns on transmitter when interrogated with signal modulated with proper audio tone

ate a keying switch.

The commutator is shown as it would appear at the start of a cycle. For the first 120 degrees of rotation RE_6 is energized through the keying switch contacts, thus keying the multivibrator by completing its grid return circuits through the precision 50,000-ohm resistors. During 120 degrees of commutator rotation the code wheel makes one revolution.

At the end of the first 120 degrees the commutator operates RE_7, which inserts the 150,000-ohm precision resistors in the multivibrator grid circuits to generate the first standard tone. After 60 degrees of travel RE_6 is again operated. The 50,000-ohm resistors are now in the multivibrator grid circuits, resulting in the generation of the second standard tone.

This tone continues for another 60 degrees of rotation, followed by the operation of RE_8, which substitutes the thermistor for the multivibrator grid resistors. The frequency of this final tone is a function of water temperature. At the end of one revolution a cam on the commutator opens S_2, the relays in the relay switching unit drop out and the timing motor stops.

Modulator Unit

The modulator unit consists of a multivibrator, driver and push-pull modulator, all of conventional design. The frequency of oscillation of the multivibrator is controlled by the grid resistors.

Precision, low temperature coefficient resistors are used to establish the two standard tones, whose frequencies correspond to the upper and lower extremes of the thermistor range. Thus a means is provided to detect frequency drift caused by decay of the battery supply voltages. Both plate voltage and filament current of the multivibrator are regulated to insure maximum frequency stability with supply voltage variation.

A plot of frequency against thermistor temperature is made while the batteries are fresh, and the frequencies of the two standard tones are noted at the same time. When the buoy is in operation, a rough correction may be applied to this curve by noting the deviation of the standard tones from their original values. A typical plot is shown in Fig. 4.

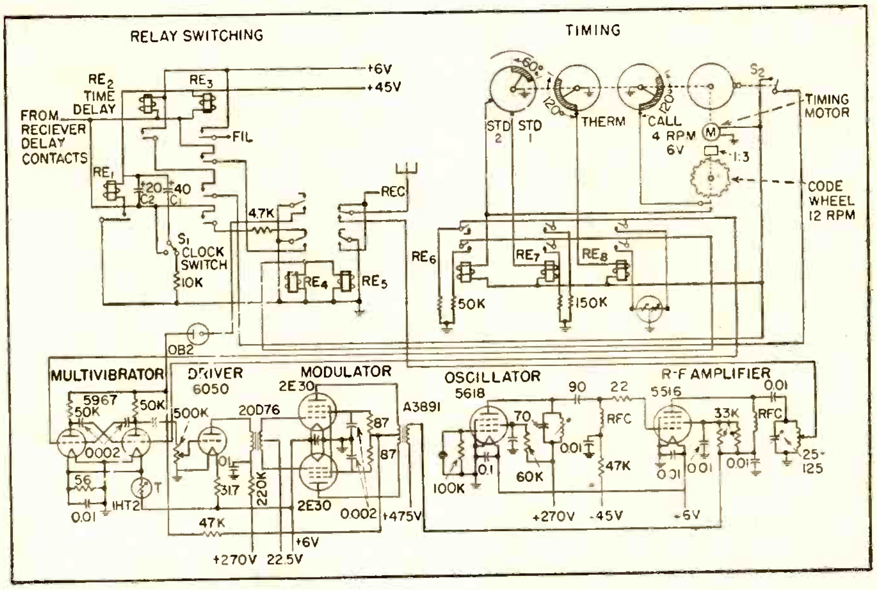


FIG. 3—Relay switching unit and timing motor control operation of telemetering transmitter to broadcast standard tones, temperature tone and identifying code signal

Transmitter Unit

A crystal oscillator designed to operate in the 2-to-3 megacycle range drives a single-ended plate-modulated power amplifier in the transmitter unit. Fast-heating filament-type tubes are used to minimize warm-up time and consequent battery drain. Input power to the final is approximately 30 watts.

The accuracy of temperature measurement is almost wholly dependent upon the frequency stability of the multivibrator. Although a resolution of 0.1 C is obtainable, the maximum error is ± 0.2 C. This error was determined by comparisons with measurements taken with a precision thermometer.

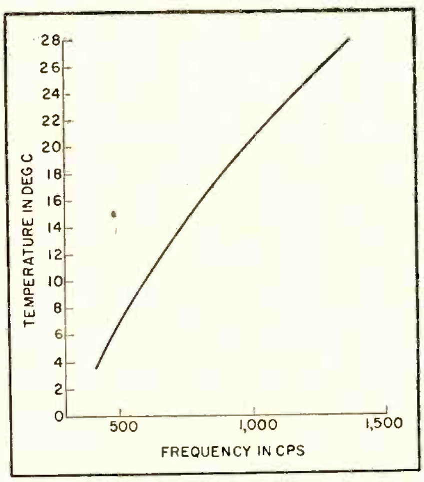


FIG. 4—Typical plot of temperature against frequency of multivibrator

The frequency of the multivibrator is sensitive to changes in both plate voltage and filament current. Regulation of these quantities and the use of precision resistors to generate standard tones reduces the error to the amount stated. Unfortunately, the simple regulators do not completely eliminate the effects of battery decay. More development is needed to produce a frequency-stable oscillator requiring minimum power.

Although a system has been described which was designed specifically for the remote measurement of ocean temperature, it is obvious that the device is easily adaptable to the measurement of other quantities by the substitution of different transducers for the thermistor. Modulation schemes other than the resistance-controlled oscillator could also be profitably investigated. Within the limitations of battery life it appears feasible that a number of quantities could be measured with the data transmitted in sequence.

The authors acknowledge the assistance of Elmer Barstow, Edward Chute and Paul Dingwell, who constructed and tested much of the original equipment. The development work was supported by the Office of Naval Research. Contribution No. 895 from the Woods Hole Oceanographic Institution.

SUMMARY —— Portable instrument uses pulsed klystron operating in X band to provide artificial echo to radar. Range rates from 200 to 1,000 mph in either direction can be simulated between 800 to 24,000 yards of radar range. Unit provides a variable delay simulating aircraft's straight-in approach but by supplying various sweep waveforms from external sources, other aircraft approaches may be created

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Flight Simulator Tests

TESTING FIRE-CONTROL radar systems or training personnel in the operation of such systems has long called for the use of moving aircraft or corner reflectors. The flight simulator to be described is a compact, portable transponder that can be used in place of aircraft and operates remote from the radar.

The simulator can also be connected to the radar directional coupler through a coaxial cable and can be triggered by connecting a transmitter trigger signal into its video jack.

Basic System

Figure 1 shows a block diagram of the flight simulator and the direction of information flow.

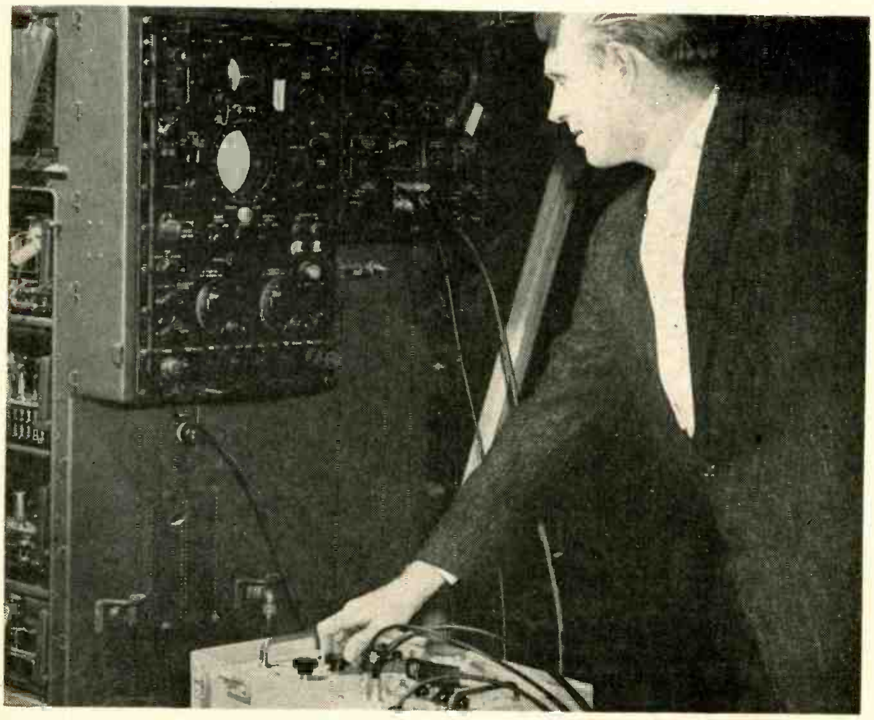
The radar r-f pulse is received through the horn, detected and fed through the video amplifier and pulse forming section to produce a trigger pulse for the voltage-controlled delay circuit. The delay circuit has a range from 5 to 150 μsec, which corresponds to 800 to 24,000 yards of radar range.

The control voltage for the delay circuit is produced by a sweep section that has limit and direction controls and rate-of-change controls. Thus, the variation in delay as a function of rate of change and direction of change can be controlled through the use of panel-mounted potentiometers and switches. The rate of change of delay can be controlled over the range of 0.6 μsec per sec to 3 μsec per sec to simulate target speeds of 200 to 1,000 mph.

The delayed pulse triggers a blocking oscillator that produces a signal of proper amplitude and duration to pulse modulate a 2K25 klystron that is tuned to the radar frequency by mechanically tuning the cavity for coarse tuning and adjusting the repeller voltage for fine tuning. An r-f attenuator controls the power fed to the horn.

A waveguide magic-tee isolates the r-f detector section from the klystron section. This insures that the delayed pulse will not retrigger the system.

The incoming signal detected at



During tuning, a sawtooth frequency-modulates the klystron to cover approximately 100 mc making the location of the radar frequency simpler

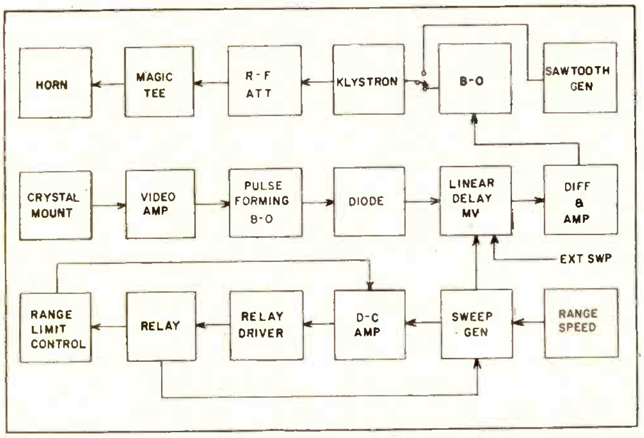
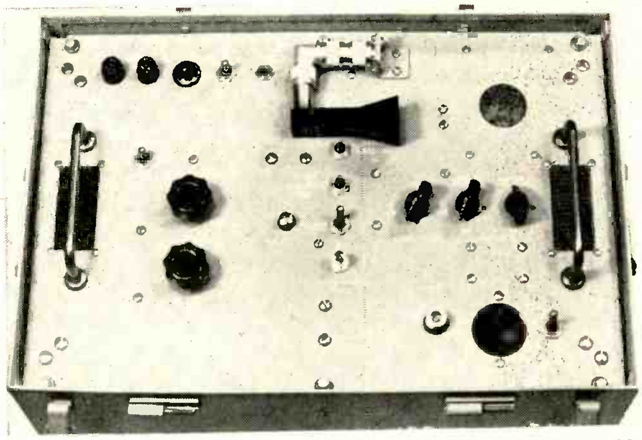


FIG. 1—Block diagram of system shows signal flow. Magic-tee allows horn to be used for both receiving and transmitting



Front panel of simulator has minimum controls that occupies 12 by 18:5 by 14.5 inches and weighs just over 50 lb

FIRE-CONTROL RADARS

the crystal mount is converted into a viedo pulse coincident with the zero time base of the radar plus the delay resulting from the simulated target distance from the radar. Figure 2 shows the complete schematic.

Pulse Forming

A two-stage amplifier increases the incoming video pulse to provide a stable trigger for the pulse-forming blocking oscillator. The combination of the gain of the amplifier and the bias on the blocking oscillator are such that the r-f signal will trigger the system when operating up to 600 ft from the radar but will not trigger on the radar antenna side lobes when the radar is searching.

The blocking oscillator is used because of its inherent characteristics as a threshold device for the video signal and constant pulse amplitude and pulse width output.

Variable Delay

The linear delay multivibrator has a delay proportional to the d-c voltage applied to the grid of the normally-cutoff stage.

A negative pulse from the pulse-forming blocking oscillator triggers the circuit causing a reduction of cathode bias. The normally-cutoff stage is now in command since the circuit is bistable. However, the grid of the normally-conducting stage is tied back to $B+$; hence it will start raising the cathode voltage as determined by the circuit constants in the feedback path around the multivibrator. This charging is based on the Miller integrator action and is essentially linear from 5 to 150 μsec.

When the cathode voltage reaches the d-c level on the grid of the normally cutoff stage, the circuit regenerates. The multivibrator output is differentiated and amplified so that a positive pulse corresponding to the delay point is generated.

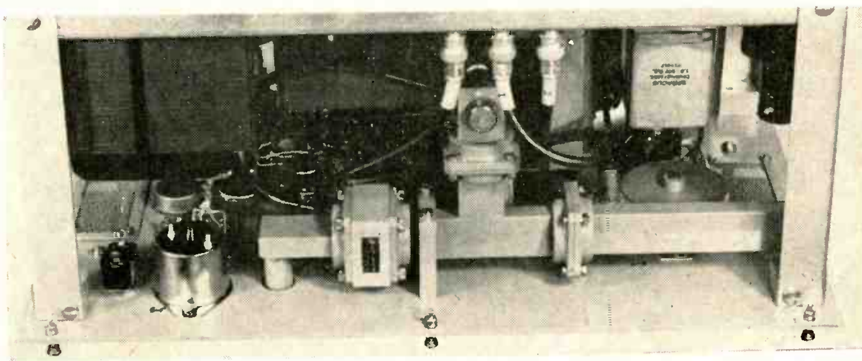
The cathode voltage at the start of the linear rise is determined by the magnitude of the trigger and any variation in this trigger will cause jittering of the delayed pulse. Thus the pulse-forming blocking oscillator removes any modulation from the video pulse. to avoid this jitter.

An isolation diode between the blocking oscillator and the linear delay multivibrator eliminates the loading effect of the coupling circuit from the blocking oscillator during the integrator action.

Sweep Section

The delay of the system is proportional to the voltage applied to the grid of the multivibrator. This voltage is obtained from a sweep circuit to accomplish automatic range variation.

Sweep generator operation is based on the fact that the cathode potential of a cathode follower is greater than the grid potential. Therefore, with a capacitor con-



Internal view shows mounting of hybrid-tee waveguide components. Gearing for Klystron tracking potentiometer is located at lower left nected between grid and ground of the stage and the potentiometer connected between cathode and grid, the cathode voltage will rise as a function of the difference in potential and the time constant of the r-c network. This bootstrap action will continue until the tube reaches saturation.

If the grid potentiometer is connected to the wiper of a potentiometer in the cathode circuit, this cathode potentiometer can be adjusted until the wiper is at the same potential below the grid as the cathode is above the grid. This causes the cathode voltage to decrease at the same rate as it increased when the r-c network was tied back to the cathode. Thus the potentiometer used in the feedback network is the range speed control and the cathode potentiometer is the sweep balance control.

Sweep Reversal

The direction change of the sweep generator is accomplished through the use of a d-c amplifier and a biased relay driver. This circuit has predetermined, adjustable limits for reversing the sweep.

The output of the sweep stage is fed into the d-c amplifier that has a manually controlled bias. When the sweep voltage is increasing, the d-c amplifier is biased below cutoff causing a positive voltage to be applied to the relay driver, energizing the relay. As the sweep voltage increases, the d-c amplifier grid bias decreases until the stage conducts. This causes the relay driver to cut off and switch the direction of the sweep voltage. The switching point is varied by the maximum range adjustment that controls the bias on the d-c amplifier during the range-out action.

When the sweep direction switching is accomplished, the sweep voltage will start decreasing and will continue to do so until the bias on the d-c amplifier goes negative at which time the opposite action takes place. This switching point is varied by the minimum range adjustment that controls the bias during the range-in action.

The sweep direction may be changed at any point by using the range direction in switch that opens the cathode circuit of the relay driver causing the relay to de-energize, or the range direction out switch that opens the cathode circuit of the d-c amplifier causing the relay driver to energize the relay.

In addition, the sweep may be held at any point by using the range sweep start and stop switch that breaks the sweep generator feedback path when the switch is in the off position.

R-F Section

The r-f section of the flight simulator consists of a blocking oscillator, a sawtooth generator and the klystron.

The blocking oscillator produces a ½-μsec, 50-v negative pulse to modulate the klystron.

Tuning the klystron to the radar frequency is accomplished by adjusting the coarse tuning control while watching the radar ppi indicator.

Once the radar frequency is located, the mode switch is turned to the b.o. position where the blocking oscillator pulse is introduced to the klystron. The fine tuning control is then adjusted for the best target.

A tracking potentiometer is geared to the coarse tuning control to vary the repeller voltage as a function of the cavity tuning.

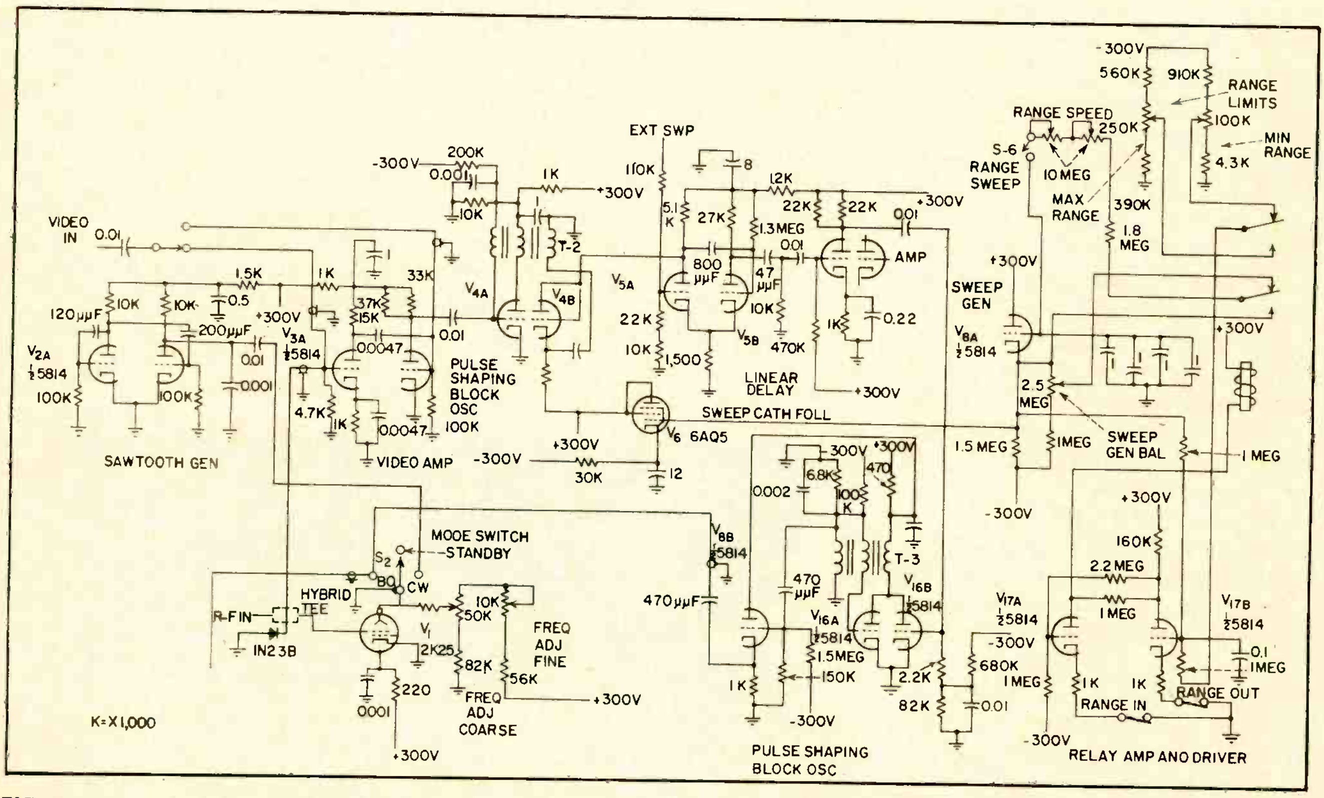
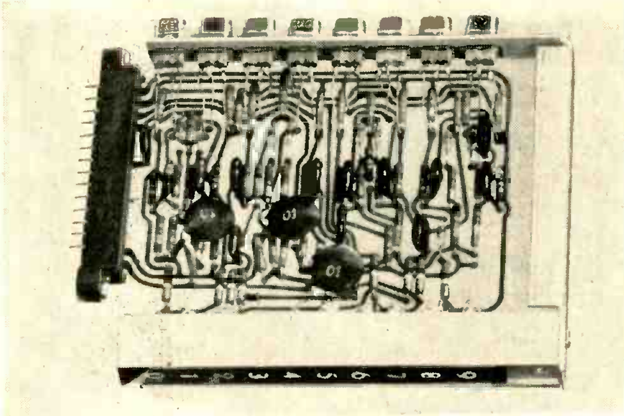


FIG. 2—Complete schematic of simulator showing details of linear delay multivibrator and sweep reversal circuitry



Printed-circuit techniques permit compact packaging of counter

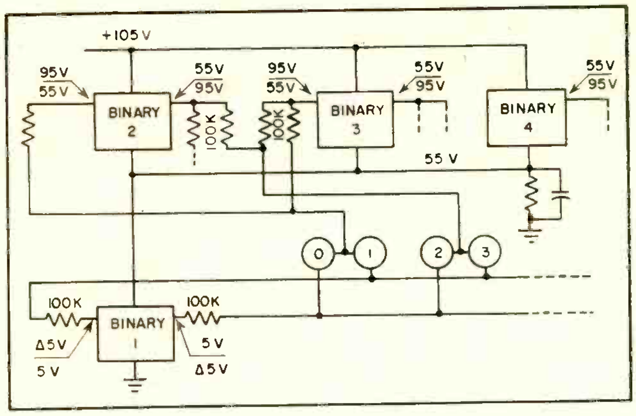


FIG. 1—Indicator system for counter uses NE-2A neon lamps

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HIGH-RELIABILITY Transistorized Counter

SUMMARY —— Cascaded silicon-junction transistor binary stages energize neon-lamp indicators for digital frequency meter at counting rates up to 100,000 per second. Step-by-step calculations are shown for design of binary stages. Counter has logged 14,600 hours of continuous operation with no component failures or waveform deterioration

TRANSISTOR COUNTING CIRCUITS are readily designed, but systems for count indication have led to considerable complexity. However, owing to the unique transistor characteristic of minute saturation resistance evident in switching applications, it is practical to cascade binary circuits to obtain a decade counter. Such a system, as described in this article, provides potentials sufficient to reliably operate neon lamps by direct near-conventional methods.

Readout Indicators

Experience has shown that long-term repeated operation of the NE-2A neon lamp requires ionization potentials of at least 85 v and extinguishing potentials must be less than 55 v. For a decade counter, it is possible to operate the lamps with an effective 50-v bias and a superposed 40-v swing.

The basic counter is shown in Fig. 1. Input is at binary 1, which triggers binary 2 once for every two input pulses. In turn, binary 2 triggers binary 3 once for every two of its own input pulses and similarly, binary 3 triggers binary 4.

The resistor matrix for only four lamps is shown to simplify the illustration. The matrix terminations at the blocks are, by implication, directed to the left and right-hand collectors of the two transistors composing each binary. The upper voltage indicates d-c collector potential at zero count, while the lower voltage indicates the potential of the second stable state of the binary. The output voltage of each binary swings 40 v. The neon lamps are operated at 0.2 ma by potentials which vary at both of their terminations.

Binary 1 operates to select the odd or even numbered lamp, while the other binaries select pairs of lamps through the resistor matrix. The system can best be understood by considering the situation at zero count.

Binary 1 applies a five-volt potential to the even-numbered lamps and a 45-v potential to the odd-numbered lamps. The potential at the junction between pairs of lamps is an average of the potential existing at the binary ends of the resistors. The resistors connecting the zero-one lamp pair are each terminated at potentials of 95 v. Therefore, before ionization occurs the zero lamp has 90 v applied and the one lamp has 50 v applied; the zero lamp will ionize while the one lamp cannot.

Current flow through the zero lamp is limited by the series resistors. The resistor matrix is arranged such that for the indicated voltages, a 90-v potential cannot exist across any of the other lamps.

A single pulse input to the counter triggers binary 1 to its second stable state and reverses the potentials applied to the even and odd-numbered lamps. The zero lamp is extinguished while the one lamp is ionized. Succeeding pulses cause the binaries to assume combinations of steady state voltages which ionize the lamp corresponding to the count stored in the decade counter.

Transistor Requirements

As the counting rate expressed as a frequency is 100 kc, it is desirable to have pulse rise times on the order of 1 μsec. In order that the transistor not be a limiting factor, its alpha cut-off frequency must then be 2 or 3 mc.

High current gain is not necessary and, in fact, would require larger binary crossover resistances to limit base current. This would increase waveform decay time and limit maximum counting frequencies.

Operating temperatures include the range from −20 C to +50 C. The former requires that the selected transistor retain a practical value of large signal gain at the coldest temperature. The high temperature requires that transistor leakage current I_{co} not increase to a large value and cause loss in output amplitude. Such a loss would seriously affect the neon lamp operating potentials.

The requirements of high operating voltage and high alpha cut-off frequency are met by the type 903 silicon-junction transistor. Maximum rated voltage for this unit is 30 v, but the collector junction has a breakdown voltage in excess of 50 v.

Binary Design

Since the binaries are of the saturating type, it is particularly important to know the base current requirements for the conditions of lowest gain and poorest operating conditions. The 903 transistor has a beta range of 9 to 19. Of more significance in binary circuit design is the large signal gain, B, which varies for this type from 7.5 to approximately 17. For complete interchangeability of transistors the binary is required to function with all values of B; therefore, it was necessary to design with the lowest value.

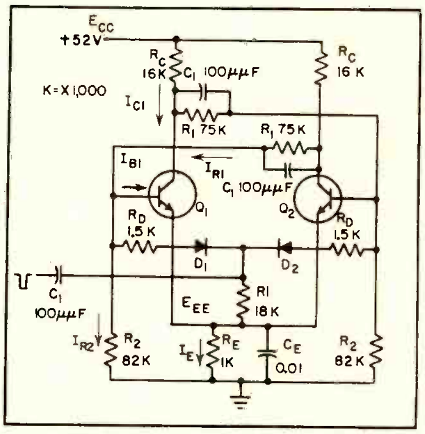


FIG. 2—Basic binary counter circuit

From the actual characteristic curves for many 903 transistors operated at −20 C, it was determined that the base current must be increased by 50 percent over the current value at 25 C to insure stability. Under this condition, a transistor with a B of 7.5 would saturate to a minor degree and transistors of higher gain would saturate in proportion to their large signal B.

Emperical data indicated that the transistors would exhibit a change in current gain of two to one over the specified temperature range. This data, when related to the normal two-to-one spread of beta, demanded that the binary circuit accommodate a total gain change of at least four to one.

The binary circuit is illustrated in Fig. 2. The design calculations are based on the following values: $V_o = 40$v; $E_{EE} = 3$v; $I_c = 2.5$ ma (assumed); $B = 7.5$ min.

The design procedure begins with a required output voltage, V_o, and establishes a supply voltage as the last step. Collector load $R_c = V_o/I_c = 16{,}000$ ohms.

Assuming transistor Q_1 on and Q_2 off: $I_{B1} = I_{C1}/B_{min} = 333$ μa at 25 C ambient. At −20 C, $I_{B1} = (333)\ (150\%) = 500$ μa.

Assuming $I_{R2} = 50$ μa, $I_{R1} = I_{B1} + I_{R2} = 550$ μa; $R_1 = V_o/I_{R1} \cong 75{,}000$ (assumes $V_{B1} = V_{C1}$ on); $R_2 = V_{B1}/I_{R2} = 4/50 \cong 82{,}000$ where $V_{B1} = E_{EE} + V_{CE}$ (sat) and V_{CE} at current saturation is 1 v. Neglecting minor leakage currents of the cut-off transistor: $I_E = I_{C1} + I_{B1} = 3.0$ ma; $R_E = E_{EE}/I_E = 1{,}000$ ohms and R_E is adequately bypassed when $C_E = 0.01$ μf.

Resistor R_2 establishes a reverse bias at the base of the transistor in a cut-off condition. Neglecting leakage currents, the reverse bias potential can be computed as follows: $V_{B2} = R_2\ (E_{EE} + V_{CE})/(R_1 + R_2) = 2.1$ v; reverse bias $= V_{B2} - E_{EE} = 2.1 - 3 = -0.9$v.

The supply voltage is computed as a summation of the common emitter level, the output voltage swing, and the product of the collector load and the base driving current. The crossover capacitances improve the rise time characteristics of the binary waveforms. Larger values sharpen the rise time, but also increase the time constant for the decay characteristic.

With $C_1 = 100$ $\mu\mu$f rise times on the order of 1 μsec were obtained with fall times of approximately 3 μsec.

Complete Circuit

The complete schematic of the decade counter is given in Fig. 3. The grouping of the four binaries is the same as that indicated in Fig. 1; the binaries are identical with only minor differences existing in their drive circuits. The resistors of the indicator lamp matrix shunt the 18-kilohm collector load resistors to an effective value of 16 kilohms.

The upper value of potential for each collector is for the zero count

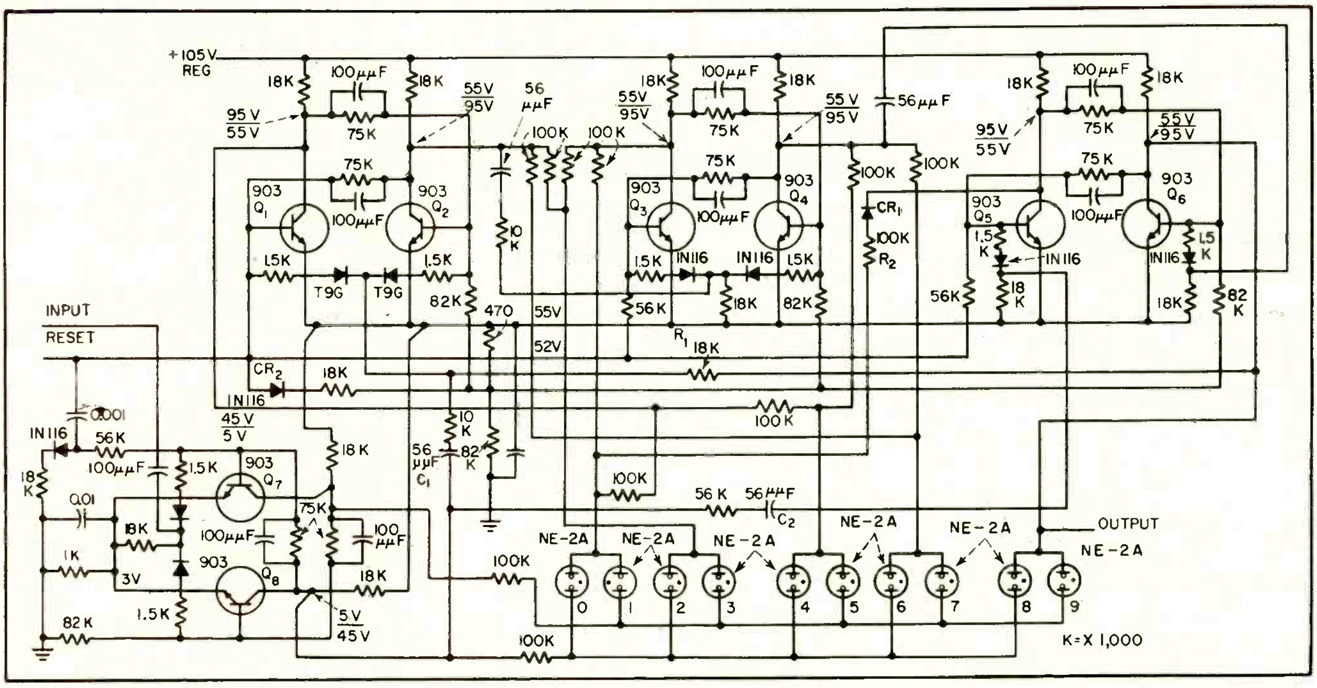


FIG. 3—Decade counter for digital frequency meter has four cascaded stages of two-transistor binary counters

state and the lower potential is the value to which the binary switches in proper sequence.

A basic four-binary counter scales to a count of 16. To scale to a count of 10, the counter is gated after the eighth input pulse and then, after the tenth pulse, returned to the zero count conditions. The first three binaries scale in a normal manner up to the eighth input pulse.

After the eighth input pulse binary 4 is triggered to its second stable state. The collector potential of transistor Q_6 rises to 95 v and is applied through R_1 to the juncture of the steering diodes in binary No. 2. The diodes are hereafter reverse biased by approximately 40 v and input pulses from binary 1 through coupling capacitor C_1 are effectively blocked. With these conditions, lamp 8 is ionized.

The ninth counter input triggers binary 1 and switches the ionizing potential from lamp 8 to lamp 9. The tenth input pulse resets binary 1 to its normal steady state. During this regenerative switching, a pulse is applied through capacitor C_2 to the base drive circuit of transistor Q_5 in the fourth binary, which returns to its normal steady state and completes the cycle of 10 counts. An output pulse may be taken from the fourth binary to drive a second decade counter which will then indicate the tens count.

D-C Gating

The d-c gating method of the counter is simple and reliable. The two steering diodes in binary 2 are special only in that their reverse impedance and breakdown voltage are sufficiently high to withstand the 40-v reverse bias.

Relatively large leakage current here is sufficient, under certain counting conditions, to trigger binary 2 and nullify the gating function. Silicon junction diodes at this circuit point are unsatisfactory because the diode-junction capacitance is large enough to transfer triggering pulses under certain operating conditions.

At zero count the even numbered transistors, or right-hand units, are in the on condition and lamp 0 is ionized. On count 8, the right-hand transistors of the first three binaries return to the on condition. Two high potentials now exist attempting to ionize lamps 0 and 8. Lamp 0 is prevented from ionizing by the application of a 55-v potential at transistor Q_5 through diode CR_1 and R_2 to the 0-1 lamp junction.

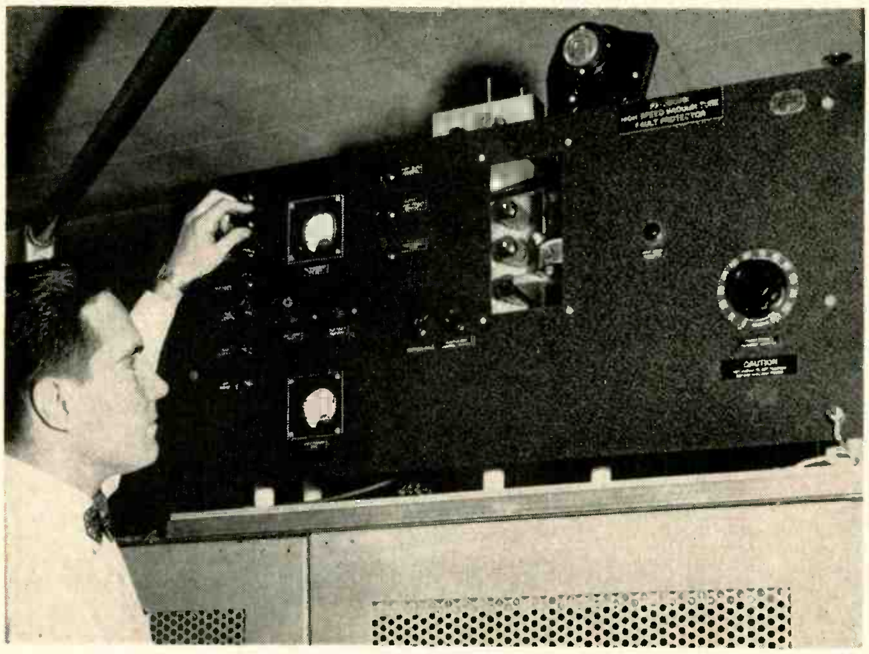
In addition, a current-limiting resistor is omitted in the path from the collector of Q_6 to the 8-9 lamp junction. These two lamps then operate at a 300-μa current level, as limited by the matrix resistors connected to binary 1. The result is a rise in the potentials applied to the lower side of the odd and even numbered lamps and an assist in preventing lamp 0 from ionizing.

Reset

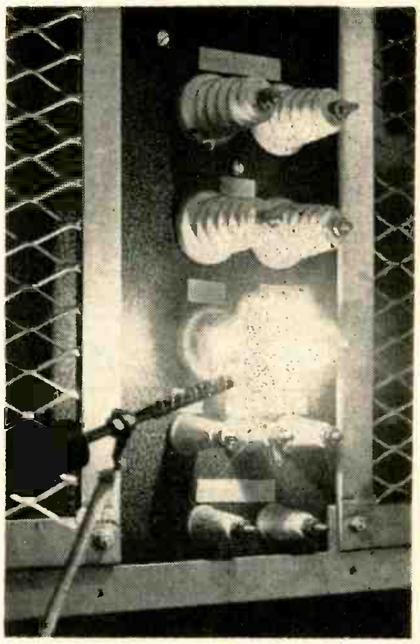
The reset circuit is composed of two networks performing identical functions. The desired condition at reset is 0 count in which the right-hand transistors are conducting. This is accomplished by application of a pulse which will switch-off the left-hand transistors should they happen to be conducting. In the base return circuit corresponding to R_2 of the computations, a diode is inserted.

A negative pulse applied to the anode of the diode drives the transistor to a nonconducting state. The base return resistors of binaries 2, 3 and 4 are returned together through common diode CR_2 to the common bias potential. The reset pulse must be of 50-v amplitude and 40-μsec duration.

The developments were supported by contract with the Frequency Control Branch of the Army Signal Supply Agency.



Operator sets fault-protector controls to fix cutoff bias and establish maximum permissible load current. Excess current caused by tube fault is removed from high-voltage circuit rapidly enough to protect tube electrode supports from spontaneous breakdown. The 20-kv chassis-support insulators are visible behind the grounded control panel



Photograph shows the results of a short-circuit at 5,000-volt operation. Here the fault protector was not incorporated as a part of the circuit

ELECTRONIC CROWBAR

SUMMARY —— Electronic switch guards high-power c-w transmitting tubes against flash-arc destruction. Self-protective circuit uses grid-cutoff of power triode to remove excessive voltage within four microseconds after fault occurs. Wide-range time control permits tube recovery and continuity of operation for extended period. Tube-processing use features high-power beam-voltage pulser for gas cleanup as well as high-level beam-voltage modulator for high-power backward-wave oscillator applications

FLASH ARC, commonly called Rocky Point effect, appears to be the result of a spontaneous breakdown of the insulation normally afforded by the high vacuum within an electron tube.

Currents resulting from flash arc may approach several thousand amperes during initial transient conditions and with the available energy inherent in conventional power-supply systems, severe damage may result. In some cases the arc contains sufficient energy to vaporize segments of electrode support members, rendering the tube useless.

Milder effects of flash arc, may manifest themselves in the form of cathode poisoning which will determine the useful life of the tube. Until a better understanding of flash arc and its causes is available, the power tube must be protected.

A circuit known as the electronic crowbar was introduced to provide this protection. Its function, in the event of a fault, was to remove instantly the available energy from the protected tube by short circuiting the power supply with a device, such as a thyratron or ignitron, which would dissipate the power. Installation of this device in high-power transmitter installations has markedly increased the operating life of the power tube and reportedly has reduced out-of-service time.

Protection Circuit

In the event of a fault, the available energy is removed from the protected tube within microseconds. In addition, a wide range of time

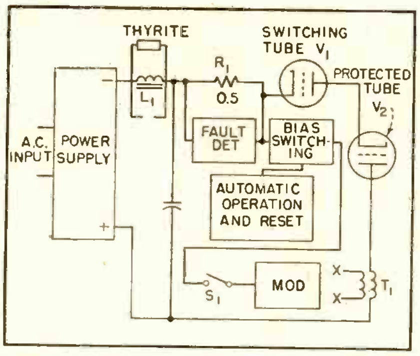


FIG. 1—Incipient breakdown of high-voltage transmitting tube V_2 produces unwanted voltage rise which activates the fault detector. Bias switch drives grid of V_1 beyond cutoff and removes supply voltage from V_2 before irreparable damage occurs. The entire chain of events occurs rapidly enough to prevent damage to the tube

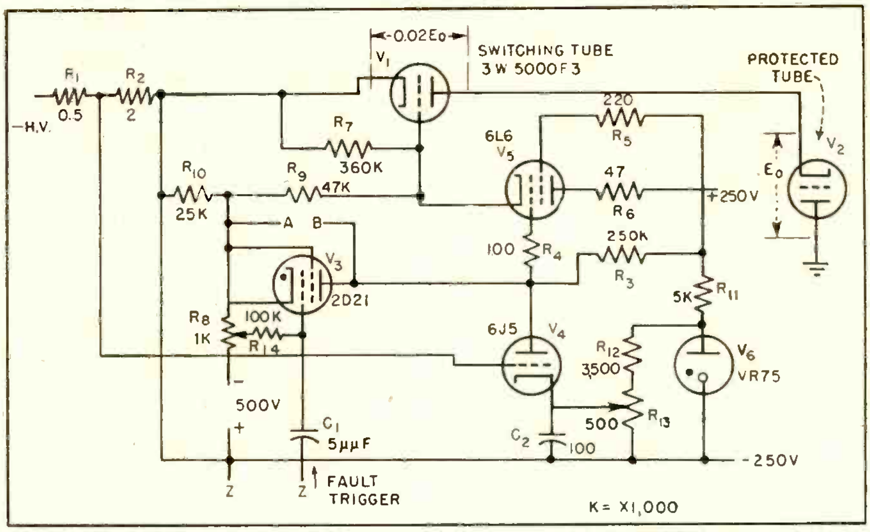


FIG. 2—Bias switching circuit, shown with power triode V_1 protecting high-voltage transmitting tube V_2. Resistor R_{13} establishes grid voltage for V_1 and R_8 determines bias

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PROTECTS TRANSMITTER

control permits tube recovery or provides automatic operation for extended periods during unattended operation.

A high-power beam-voltage pulse, with duty cycles to unify, is used for gas clean-up while the tube is on exhaust. A high level beam-voltage modulator is incorporated for high-power backward-wave oscillator applications.

The modified electronic crowbar is shown in Fig. 1. When a fault occurs, current increase through R_1 produces an undesirable voltage rise which actuates the fault detector. The bias-switching circuit then applies a negative bias to the normally positive grid of switching tube V_1.

The automatic reset and operation circuit shuts the system off in the event of a recurrent fault.

For operation as a beam-voltage pulser switch S_1 is closed.

This allows pulses of predetermined width and repetition rate, produced by the modulator, to control the grid of V_1 through the bias switching circuit.

Although not incorporated in the present working model, a shaped pulse of low magnitude could be applied to the switching circuit to provide large voltage variations across V_2, a valuable feature for backward-wave oscillator applications. The thyrite arc suppressor shown connected across L_1 was not used in the original circuit. No adverse effects were noticed in handling load powers up to 20 kw with average load currents of 2½ amperes.

The entire system operates above ground and is completely isolated from attending personnel. Insulated phenolic shafts are used to make operating adjustments. The system can be operated at ground potential by inserting it between ground and the positive return of the high-voltage supply.

Fault-sensing resistor R_1, can be eliminated by using transformer T_1. The fault may be sensed at the ground return of the protected tube. Tube-current variation appears across the T_1 winding.

Bias Switching

The bias switching circuit, together with switching tube V_1 and protected tube V_2, are shown in Fig. 2.

Switching tube V_1 normally conducts with about 2 percent of the load voltage appearing as a plate-to-cathode voltage drop. This relationship is maintained throughout normal operation by varying the positive grid bias on V_1. As the load supply voltage is raised and more current is required, the positive grid bias increases proportionally.

As the load current through R_2 increases, a larger negative bias voltage is applied to the grid of V_4 which decreases the plate current and causes a reduced voltage drop across the plate load resistor R_3. The control grid voltage of V_5 decreases the voltage drop across V_5

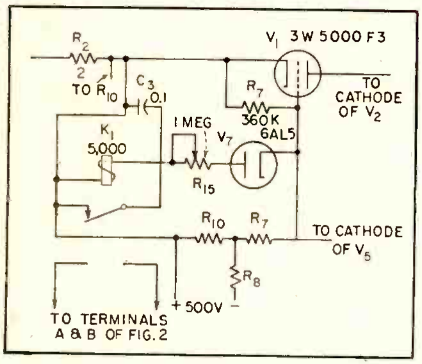

FIG. 3—Reset circuit returns the tube-protection system to normal operation. Relay K_1 shorts terminals *A* and *B*, while potentiometer R_{15} establishes the time

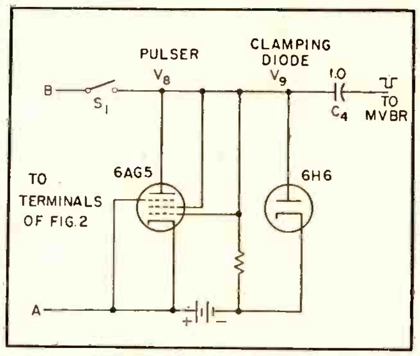

FIG. 4—Modulator allows predetermined pulses to control the grid of switching tube V_1 (shown in Fig. 3) through the bids switching circuit

and places a larger percentage of the available + 250 volts across R_7. Resistors R_4, R_5 and R_6 are parasitic suppressors. Potentiometer R_{13} establishes the potential grid voltage for V_1, the value being determined by the grid characteristics of V_1.

Power-handling capabilities of V_1 are determined by the voltage and current of load V_2. For a load of 10 kv at 2 amperes, V_1 dissipates a minimum of 2 percent of the load power, or 400 watts. A safety factor of two or three is used. Switching tube V_1 withstands maximum no-load plate-to-cathode voltage which occurs under cutoff conditions.

When a fault begins, a positive triggering pulse of short duration is applied to the control grid of switching thyratron V_3. This trigger pulse is obtained from the fault detector. Positive triggering overcomes the normally high-negative bias which holds V_3 at cutoff and V_3 conducts. This fixed bias voltage is determined by R_8 When V_3 fires, V_5 is driven to cutoff. A portion of the negative voltages from the − 500-volt supply appears across R_7. Its value is proportional to R_7 divided by $(R_7 + R_8)$. This valve is chosen to drive the grid of V_1 well beyond cutoff, starving the arc.

Reset Relay

The system is returned to normal operation after the fault is removed by momentarily extinguishing V_3, using relay K_1 in Fig. 3 which shorts terminals A and B. The reset time can be adjusted manually to any value greater than the actuation time of the relay. This relay operates in the m-sec range.

Variable potentiometer R_{15} establishes the time required for the voltage to rise exponentially across C_3 to a value sufficient to actuate relay K_1. Tube V_7 conducts only when the grid of V_1 is negative at the incipience of a fault. If the fault is recurrent, V_3 (Fig. 2) conducts immediately and the cycle is repeated.

The fault-counting circuit may shut off the entire system if the fault recurs beyond a predetermined number of cycles.

Modulator

The fault protector operates as a beam-voltage pulser by shorting terminals A and B in Fig. 3. As shown in Fig. 4 the pulse control tube V_8 is normally conducting and E_o is zero. A negative pulse of predetermined width determines the on time of E_o and is applied to the control grid of V_8 through C_4 by a multivibrator. The duty cycle is varied by changing the multivibrator frequency, pulse width or both. Clamping diode V_9 establishes a reference level.

The basic fault detector responds to the load current exceeding a predetermined value. The degree of protection this circuit affords is determined by the maximum allowable current and by the time-delay response of the circuit. A typical circuit is shown in Fig. 5.

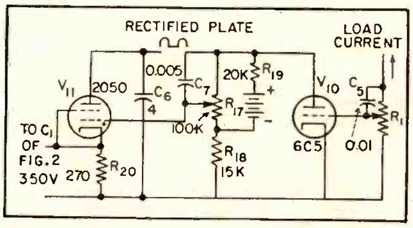

FIG. 5—Thyratron V_{11} in fault detector circuit will fire only above the peak current limit set by R_1. Cutoff bias for thyratron is fixed at R_{17}

Peak Current Limit

As the load current increases, the negative voltage across R_1 increases, causing the current through V_{10} to decrease. Voltage distribution across network R_{17} R_{18}, R_{19} and V_{10} reduce the initial negative bias on the control grid of V_{11} and fires thyratron V^{11}. A large positive pulse is developed across R_{20} which is applied through blocking capacitor C_1 to the switching circuit shown in Figure 2. Potentiometer R_{17} fixes the required cutoff bias for V_{11}. The peak current limit control R_1 establishes maximum permissible load current beyond which V_{11} will fire.

The value of C_6 is sufficiently low so that its discharge time through V_{11} and R_{20} is appreciably less than one-half cycle of the half-wave voltage applied to the plate of V_{11}. This extinguishes V_{11}.

Sensitivity may be increased by employing a slope detector which consists of a high gain a-c amplifier in conjunction with a differentiation network. Network time constants are adjusted so that a gradual variation of load current receives little amplification. However, a low-level excursion having a short rise-time is amplified to a value sufficient to fire V_{11}.

Where the protected tube is to be used at radio-frequencies, a differential fault detector may be used. Here the fault produces a rapid decline in r-f output. A differential amplifier compares a portion of the rectified r-f output voltage with a portion of the load voltage. Voltage unbalance resulting from a decrease in r-f output allows this differential amplifier to fire V_{11}.

This project was developed in connection with work sponsored by the Signal Corps.

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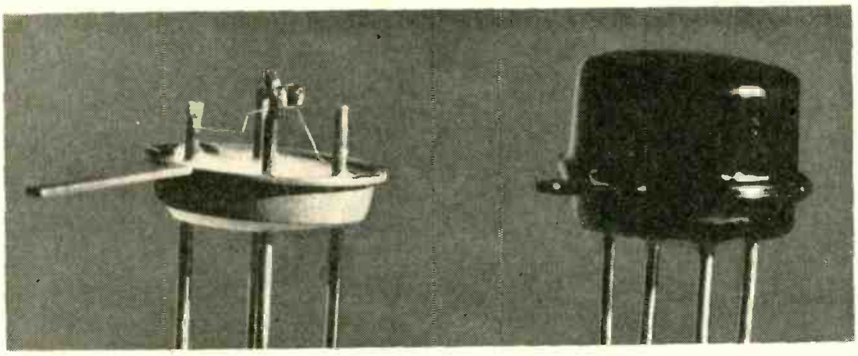
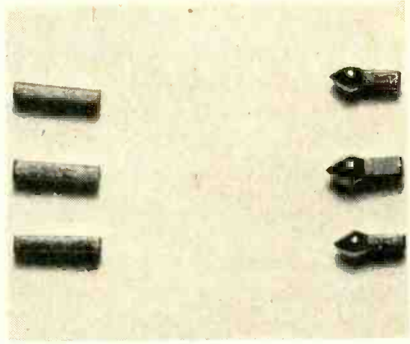


Mounted tetrode before capping (left) and complete in housing (right) after capping while enveloped in a dry inert atmosphere



Germanium pellet before (left) and after (right) meltback

High-Frequency Circuits Use Meltback Tetrodes

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SUMMARY —— Application of transverse vias to *pnp* germanium transistor through second base lead enhances intermediate and high-frequency power gain. Design, construction and evaluation of tetrode unit are covered along with applications to tv receiver, pulse-amplifier and oscillator circuits

FREQUENCY LIMITATIONS of junction transistors have been a deterrent to the wide application of transistors in the vhf range. Several types of devices have shown possibilities for the improvement in high-frequency performance of transistors. The tetrode type[1] has been developed in production quantities specifically for applications up to 100 megacycles. Developmental units have produced maximum oscillating frequencies up to 1,000 mc.

Several companies have been working independently on tetrode design and development in various sections of the country. This article covers design, techniques of fabrication, evaluation and application of one of these tetrodes.

Construction

This particular tetrode is made from germanium which contains donor and acceptor impurities added in specific predetermined amounts to the single crystal melt. The single crystal is processed into pellets approximately 0.020 by 0.020 by 0.120 in. cross section and length, respectively.

After cutting, the pellets are cleaned and prepared for melting-back. The individual units are fed automatically into a meltback furnace that has conditions of controlled atmosphere, time, and heat.

The doping ratio existing within the initial pellet allows the impurities to segregate out under controlled conditions. When the melted portion of the pellet solidifies, a greater number of acceptor impurities separate out first, thus producing a *p*-type doped base. The width of this base may be varied to a considerable degree by using different doping ratios, impurities and heating and cooling combinations to obtain desired results.

The entire melting-back operation is carefully programmed to insure a high yield of pellets possessing a base width under 0.0005 of an inch, which are suitable for high-frequency use. Individual pellets are cleaned and evaluated prior to fabrication to determine their high-frequency potentialities.

Pellet Mounting

Headers are prepared for pellet mounting by welding, cutting and joining the end leads for pellet support. The melt-back pellets are attached to the end leads of the header mount, while the device is elevated to a high temperature in an inert atmosphere. The pellet after mounting on the header is step-etched. All units are thoroughly washed and dried after the etch.

Base and end leads must make

good ohmic contact to their respective areas. A poor emitter contact, for example, would seriously reduce the ratio of output to input impedance, limiting gain.

In the attachment of leads to the base region, it is important to have not only a good ohmic contact but negligible emitter and collector overlap. Base one, the active base of the tetrode, must be secured to the pellet along its entire base depth by a low-resistance ohmic contact with minimum overlap. Lack of a good ohmic contact or a small area contact would increase the base resistance.

Emitter overlap capacity C_{eb} at high frequencies might shunt the input terminals of the transistor causing a reduction in alpha. Additional collector capacity produced by overlap will also reduce gain; however, overlap on the collector is not as serious as overlap on the emitter. Another disadvantage of overlap is the reduction of barrier breakdown voltage.

At certain frequencies h_{11} may be inductive reactive; which in some cases could produce an alpha greater than unity, due to the formation of an antiresonant circuit of low Q with the input circuit of the inherent transistor.[2]

The second base-lead contact, the tetrode-bias lead, must have qualities similar to the active base; however, it is not as critical. Increased contact resistance may be overcome by a corresponding increase in tetrode bias in some cases, but the collector breakdown voltage must exceed the sum of the transverse bias voltage and collector bias voltage. Overlap capacity can seriously limit, if not prohibit, the measurement of certain high-frequency parameters.

After both base leads are attached to the pellet, the other ends are welded to the header leads.

Surface conditioning consists of two operations, final etch and surface stabilization. The tetrode is then capped while enveloped in a dry inert atmosphere. The cap is welded to the header and provides a tight hermetic seal. Header leads spaced 0.100 in. off center permit easy adaption to printed circuit applications. An extra lead is provided for grounding the case when the device is used at high frequencies.

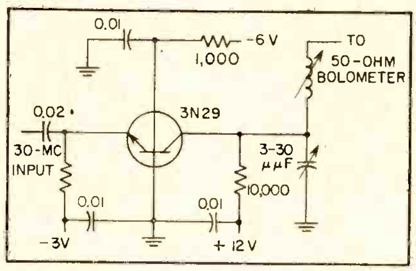

FIG. 1—Thirty-megacycle amplifier has 10-db power gain with 2-mc bandwidth

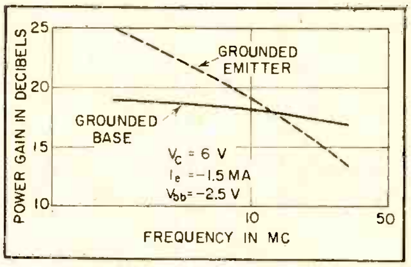

FIG. 2—Tetrode power-gain characteristics for grounded-base and grounded-emitter configurations

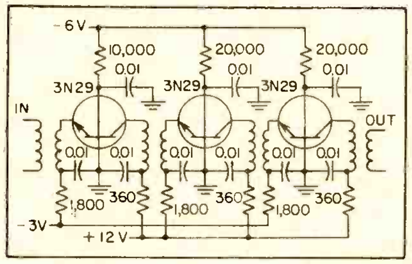

FIG. 3—Three-stage 25-mc tv i-f amplifier has 57-db gain with 4-mc bandwidth

Evaluation

A number of device characteristics have been measured. The resulting information should not be construed as final specifications for the device. However, all units will operate under the same bias condition and may be easily substituted for one another.

While objective specifications call for a 10-db power gain at 30 mc with a 2-mc bandwidth, in a circuit similar to that of Fig. 1, the actual device exceeds this requirement quite readily. As shown in Fig. 2, grounded-base power gains average around 15 to 20 db at 30 mc and a 2-mc bandwidth, with a number of units having gains in excess of 30 db. Though grounded-emitter power gain is greater at low frequencies, grounded-base power gain begins to equal and eventually exceed grounded-emitter power gain between 10 to 20 mc.

Useful power gain can be obtained up to and beyond frequencies of 60 mc. If the bandwidth is not restricted to 2 mc, these same 15 to 20-db power gain units will readily produce nonoscillating gains of 30 to 50 db at bandwidths around 0.5 mc at 30 mc. Power gain does not decrease 3 db over the temperature range -55 C to $+85$ C.

Substantial variation in bias conditions is permissible with only a slight reduction in power gain. Variations of 6 v, 2 v and 5 ma on the collector, base 2 and emitter, respectively, will not cause a drop of 3 db in grounded-base matched power gain.

Application of a transverse bias to a transistor not only enhances high-frequency power gain but intermediate-frequency gain as well. Better than 10 db of power gain can be added to transistors over the range of 445 kc to 30 mc.

Parameters

The h or hybrid parameters of the tetrode have been measured up to 50 mc. Since parameters are complex at high frequencies all quantities are presented in the conjugate form, $R + jx$ or $|Z|\angle\theta$.

At 30 mc, the short-circuit input impedance h_{11} has a resistive component which varies from 20 to 40 ohms and a reactive component which is 10 to 20 ohms. The reactive portion becomes inductive reactive in this frequency range.

Open-circuit output admittance h_{22} $(g_{22} + j\omega c_{22})$ contains a conductive component which varies from 10 to 60 ohms and a capacitive component which varies from 5 to 12 $\mu\mu$f over the frequency range of 1 to 30 mc.

Both the magnitude and phase, $(|a|\angle\theta)$, of $-h_{21}$ the short-circuit current-transfer function, drop gradually with frequency. At 30 mc, alpha averages around 0.75 to 0.85 with a phase angle of approximately 40 degrees. The frequency of alpha cutoff, f_{aco}, varies from 40 to 60 mc. The units may be subjected to fairly substantial emitter currents with no change in alpha.

The application of tetrode bias produces a reduction in the r_b' C_{22}

product. Usually $r_b' C_{22}$ drops from several-thousand ohm-micromicrofarads to a few-hundred ohm-microfarads or less.

The noise figure of these tetrodes at 30 mc is in the 10 to 15-db range. It varies from approximately 8 db to 21 db over the frequency range from 10 to 50 mc. Only slight variations in noise figure are produced by changes in bias, the greatest change being caused by transverse bias.

Thus far the tetrode has successfully completed JAN 193, 20,000 g's centrifuge and 1,000 g's shock tests.

Video Amplifiers

In television circuitry, several of the earlier tetrodes were designed into the tv-if amplifier shown in Fig. 3[3]. This amplifier consists of six stages and operates at a center frequency of 25 mc. Gain is 57 db with a 4-mc bandwidth.

To utilize the maximum bandwidth from each stage, the tank circuit of each transistor consists of a variable inductance only. This inductance resonates with the output capacitance of the transistor plus the stray circuit capacitance.

The coupling transformer matches the input and output impedances approximately at 25 mc for all stages. The stages are tuned away from 25 mc to give three staggered pairs. Two series-resonant traps, one a sound trap at 21.9 mc and the other an adjacent-channel sound trap at 27.9 mc, were inserted in the input circuit.

No neutralization is used in the amplifier and transverse bias is adjusted to give optimum gain. The bias points used are $I_e = -1.5$ ma, $V_c = +10$ v and $V_{bb} = -2$ to 3 v.

The two-stage video amplifier in Fig. 4 was designed for low-level input preamplifier applications. The frequency response compensates for the effect of a constant-current signal source. This circuit produces a power gain of 32 db ± 0.4 db from 30 cps to 10 mc, which is equivalent to vacuum-tube performance.

Several types of oscillator circuits have used tetrodes in their operation, one an oscillator operating at 108 mc produced 10-mw output power.

The driven blocking oscillator in Fig. 5 can be used as a regenerative pulse amplifier.[4] The transformer simultaneously supplies regenerative current feedback from the collector to emitter and matches the output of the transistor to the load impedance. The damping diode across the transformer primary provides a path for the rapid discharge of the energy stored in the magnetizing inductance of the transformer.

This oscillator has a peak-pulse power gain of 32 db; peak power of the trigger pulse is 50 μw with a pulse width of 1 μsec. The repetition rate is 30 kc, with a rise and fall time of 0.3 μsec.

A variation of this circuit contained an additional feedback path from the output of the transformer to the auxiliary base. This feedback path introduced a degenerative signal at the auxiliary base so current amplification of the transistor was increased as the pulse built up across the output. The experimental performance of this second driven blocking oscillator circuit was similar to that of Fig. 5.

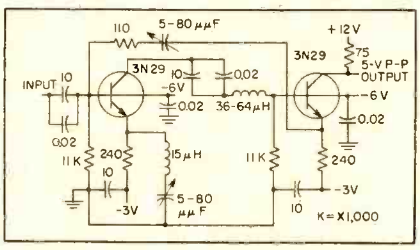

FIG. 4—Video preamplifier has 32-db power gain over range of 30 cps to 10 mc

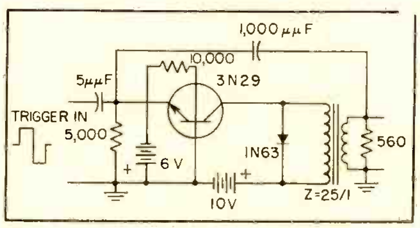

FIG. 5—Driven blocking oscillator has 0.3-μsec rise and fall times at 30-mc repetition rate

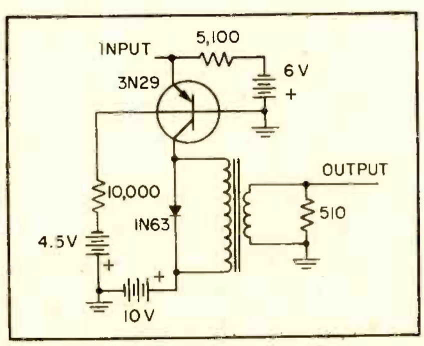

FIG. 6—Linear pulse amplifier has 10-db power gain at 1-mc pulse repetition rate

A minor variation in the processing of the tetrode controls to some degree the magnitude of internal feedback parameter h_{12}. Units possessing high values of h_{12} are ideally suited as high-frequency oscillators. Other types, designed with values of low h_{12}, operate well as high-stability amplifiers.

Pulse Amplifier

Excellent results are obtained when tetrodes are used as linear pulse amplifiers. In the circuit of Fig. 6, a pulse transformer couples the output to a resistive load. However, some distortion is produced by the transformer's magnetic properties. The diode in parallel with the transformer primary dampens the transient response of the output circuit.

Pulse-repetition rate is 1 mc with a peak pulse power gain of 10 db. Output pulse rise and fall times are 0.025 μsec and pulse width is 0.07 μsec.

Tetrodes can be used in free-running Eccles-Jordan multivibrator circuits with the same coupling as conventional transistor triode circuits.

Appreciation is expressed to associates within the General Electric Company for their helpful suggestions, with particular thanks to R. L. Pritchard, R. N. Hall, I. A. Lesk, S. O. Johnson and W. P. Barnett for their guidance and encouragement.

All work done on this project has been supported by the USAF Air Research and Development Command under contract AF 33(600) 38956.

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SELECTIVE A-F

By L. E. PHILIPPS

Director of Research
Auth Electric Co., Inc.
Long Island City, N. Y.

SUMMARY — One-way signals are transmitted on any one of seven audio frequencies from 6 to 20 kc. Pulses at various preselected rates energize an inductive loop tuned for each of the frequencies. Pocket receivers in the field of the loop convert audio bursts to d-c pulses and amplify the pulses as low-frequency audio that drives a tuned-reed striking a diaphragm

PRACTICAL selective one-way signaling has been achieved by the use of audio induction rather than r-f as a means of signal propagation. The system described here employs audio frequencies in the range from 6,000 to 20,000 cps. Within this range, 175 channels can be accommodated. One hospital installation is currently using 60 receivers and provides signal over an area of approximately 400,000 sq ft.

Signal Region

The area to be covered with signal is encompassed by a loop of No. 14 wire. A multifrequency oscillator produces any one of seven audio frequencies. The selected frequency is amplified and released into the loop in bursts at various preselected rates. The loop is inductive and tuning it by means of fixed capacitors for each of the various frequencies permits considerable current to flow in the loop greatly increasing its radiation.

Individuals moving about the area carry small pocket-sized receivers that pick up the signal, amplify it, convert the audio bursts to d-c pulses and amplify the pulses as low-frequency audio, which is then used to drive a piezoelectric tuned-reed driver.

At the resonant frequency of the tuned reed, the amplitude of the reed excursions causes it to strike a diaphragm thereby alerting the bearer who can go to the nearest telephone and get his message.

In addition to simple key-operated transmitting equipment, an automatic transmitter is available for use in large installations where it is often necessary to place several calls at the same time. This transmitter is remotely operated by a plug board, located adjacent to the telephone switchboard.

The board is equipped with a miniature jack for each receiver in the system. The jacks are arranged in rows designated by letters horizontally and numbers vertically.

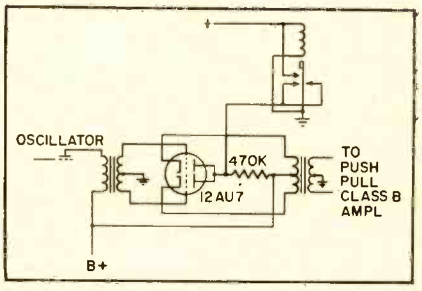


FIG. 2—Method of modulating audio-frequency carrier

The receivers are designated by individual combinations of a letter and a number. Insertion of a plug in any jack acts as a switch connecting the vertical and horizontal rows. A small diode in the sleeve of the plug provides a low resistance circuit in one direction and a high resistance in the other to prevent back-circuits when three or more plugs are in the board.

A pushbutton, a panel lamp and a neon glow-lamp complete the panel. To place a call, the operator first determines the letter and number of the receiver she wants to call, inserts one of the plugs in the proper jack and presses the pushbutton.

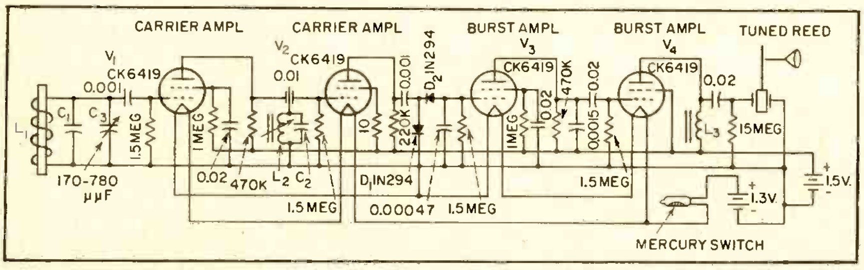


FIG. 1—Circuit of the induction-type receiver showing on-off switch

Automatic Calling

A call finder, consisting of three switches each driven by a small clutch-type motor, is located in the rack that contains the multifrequency oscillator, a number of vibrators and a power amplifier.

Induction Signaling

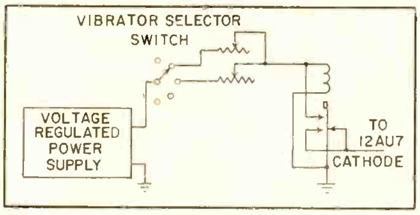
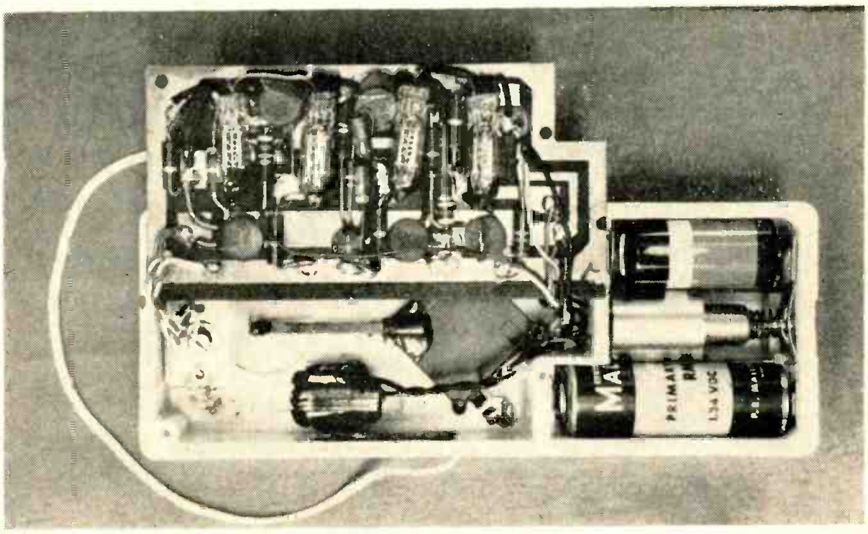


FIG. 3—Vibrator frequency is partially determined by voltage



Interior view of induction receiver at right. Subchassis has been turned over to show tubes

The first motor-driven switch scans the numbered rows and, when positioned, selects the correct audio frequency for the receiver being called, as well as the correct capacitor to tune the loop to that particular frequency.

The second motor-driven switch then scans the lettered rows and, when positioned, selects a vibrator whose rate of closure is the same as the resonant frequency of the tuned reed in the receiver being called. When the first two switches have been positioned, the third motor-driven switch energizes the vibrator, passes the pulsed audio to the power amplifier for a two-second interval, disconnects the vibrator and then permits the other two switches to resume scanning the circuits in quest of other calls.

A simple timing device activates the call finder when the pushbutton on the plug-board has been operated and permits the mechanism to operate continuously, placing calls in sequence as long as a plug remains in the board. When the last plug has been removed from the board the timing device switches the mechanism to a stand-by state.

Receivers are 5¾ in. high, 2⅛ in. wide, 1⅛ in. thick and weigh 9½ ounces, complete with batteries. The A battery has a filament drain of 120 milliamperes, while the B battery supplies a drain of 120 microamperes. The carrier frequency is amplified by V_1 and V_2 in Fig. 1.

Carrier Pickup

Pick-up coil L_1 and L_2 are tuned to the carrier frequency. Type 1N295 germanium diodes D_1 and D_2 are arranged as a voltage-doubling detector. Tubes V_3 and V_4 amplify the resulting d-c pulses as low-frequency audio, which is used to drive a bimorph twister plate to which a tuned reed has been affixed.

At resonance, the reed excursions become great enough to cause it to strike a small adjustable screw mounted in the apex of a plastic diaphragm cone, thus sounding an alert signal.

Adjustment of this screw has a marked effect on the reed's selectivity, which is normally set for 5-percent spacings. A mercury switch is used to open and close the filament circuit. Placing the receiver in an inverted position in a storage rack assures battery shutoff.

Table I shows the values of capacitors C_1 and C_2 for various carrier frequencies Figure 2 shows the modulating portion of the circuit that switches the carrier on and off in bursts at rates to match the various tuned reeds in the receivers. The 12AU7 is transformer-coupled to the oscillator and the reed of a vibrator connects the cathodes to ground at twice the vibrator frequency. The 470,000-ohm resistor reduces contact arcing by biasing the tube to cutoff when the circuit is not grounded through the vibrator.

The vibrators are tuned by the addition of weights to the reed and by the application of different drive voltages. One vibrator is used to generate two burst rates as shown in Fig. 3. The voltage-regulated power supply employs a control of plus or minus 1 percent and as a result the vibrator frequencies are held to the same tolerance.

Table I—Values of Capacitance for Receiver

	Carrier frequency in kc					
	6.4	8	10	12	14	16.5
C_1	0.005	0.0045	0.003	0.002	0.001	None
C_2	0.005	0.004	0.0022	0.002	0.002	0.001

Digital Printer Boosts

By H. W. GETTINGS
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Melbourne, Florida

SUMMARY — High-speed numeric printer for digital computer uses standard electronic circuits to help break readout bottleneck. Breadboard model prints 180 lines of twelve characters per line in one second. With modifications, recorder design is expected to attain almost unlimited speeds. Speed and capacity of system are made possible by fixed-styli recorder that contains no moving parts other than the chart-drive mechanism

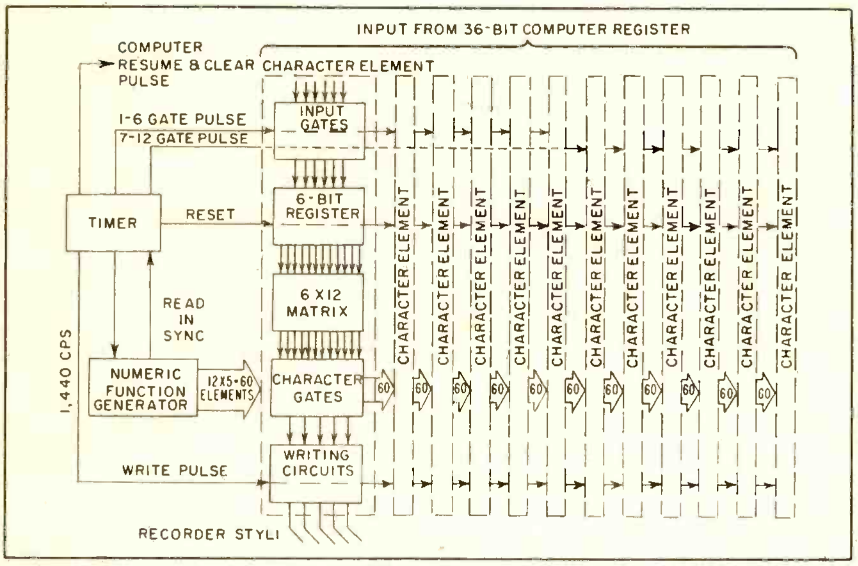


FIG. 1—Supplied by signals from the timer and function generator, twelve character-element circuits trigger the writing circuits and signal the recorder styli to print out the characters. Overall-system design is entirely new

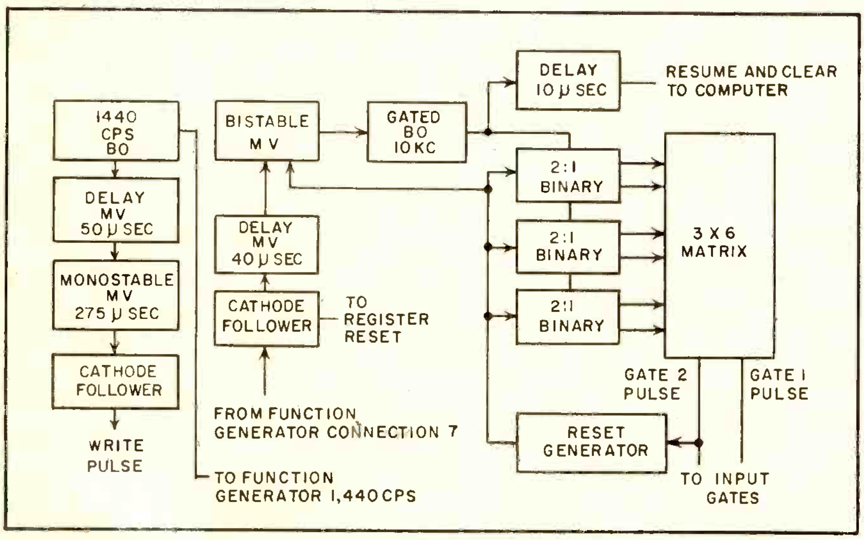


FIG. 2—The timer provides output pulses to the function generator, computer input gates and register. The timer is the programmer and source of frequencies

CONVENTIONAL mechanical or electromechanical printers, used to provide a tabulated readout of the computer output, can handle only about 500 lines a minute, a snail's pace compared to the speed of a digital computer. Even if present speeds could be doubled or tripled, this would still leave much to be desired. The only answer for more efficient output lay in converting the entire system to electronic operation.

Acceleration

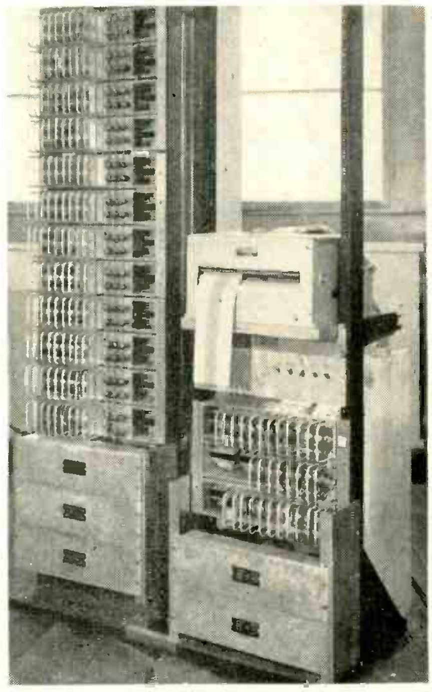
Using conventional electronic circuits in unique applications, a system has been designed that can print 10,800 lines per minute, or 180 lines per second, on an electrosensitive direct-reading paper chart. This is at least 20 times faster than the usual printers. Since this is only the developmental model, however, much higher speeds are expected to be attained.

The basic system prints lines of 12 characters each. This same configuration will handle up to 102 characters per line and further modifications in recorded design will allow almost unlimited speeds. The 102-character line provides 1,101,600 characters per minute, the equivalent of an average book every minute. Further, if a place can be found to store the enormous quantity of tape, this speed can easily be doubled to provide twice the capacity.

A block diagram of the basic system is shown in Fig. 1. The overall design and application are entirely

READOUT TIME

Twenty times faster than conventional printers, the recorder is shown here printing lines of twelve characters. Direct readout is accomplished by current, passing through fixed styli, which breaks down the electrosensitive paper coating. The same basic configuration will handle 102 characters per line and attain a readout speed of over a million characters a minute



Complete assembly of the high-speed digital printer showing arrangement of the character-element circuits, which energize the styli of the recorder in proper time relation

new, however no new or unique circuits are used in the system. This printer is used with the ERA 1103 computer, employing a conventional electric typewriter code, but the unit is not limited to any particular computer.

The timer, serving as a programmer and source of basic frequencies, provides gating, writing, and reset pulses. The numeric function generator generates the basic numerical format of the various characters and provides the input to the character gates and a sync pulse to the timer. Each of the 12 character elements contains input gates, a 6-bit register or memory, a 6 × 12 matrix which serves as a decoder, character gates and the writing circuits.

Basic-Pulse Timer

The timer shown in Fig. 2 provides the basic 1,440-cps pulse to the numeric generator and the writing circuits. It also provides a resume-and-clear pulse to the computer, gate pulses to the input gates and a reset pulse to the 6-bit register. These outputs are shown in Fig. 3.

The number 7 pulse provides a single reset signal to clear all the 6-bit registers of the character elements. The 2-to-1 binary counters supply first gate 1, then gate 2 through the 3 × 6 matrix. Gate 1 allows 36 bits of information from the computer to enter character elements 1 through 6. After a 10-μsec delay, the computer is cleared and signaled to resume. After 90 μsec, the gate 2 pulse is triggered and the second group of 36 bits enters the character elements. Again the computer clears and resumes. Since, in this particular application, only 12 characters are used per line, the gate-2 pulse goes to the reset generator, which stops the 2-to-1 binary counters and bistable multivibrator. This section of the timer then remains dormant until the next number-7 pulse.

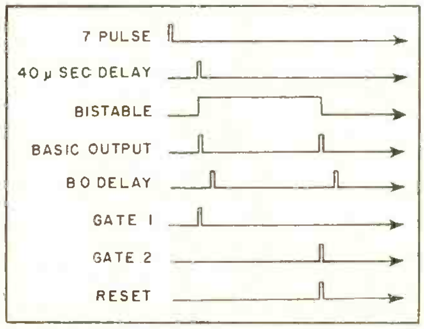


FIG. 3—Timer output pulses

All-Electronic Generator

During the early work on this device a mechanical type of function generator, using light beams and a cylinder with punched characters, was at first considered. It was found, however, that an all-electronic unit could be built. This was desirable since speed and the elimination of mechanical components were important to the design of the system.

The all-electronic function generator is the heart of the system. As seen in Fig. 4, the character networks actually delineate the twelve characters. Figure 5 shows

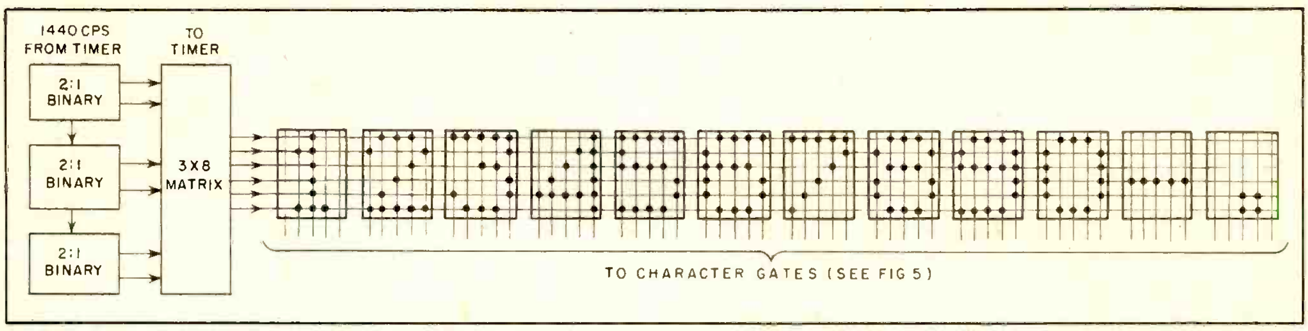


FIG. 4—The function generator supplies the line element pulses to the twelve networks that delineate the numeric characters

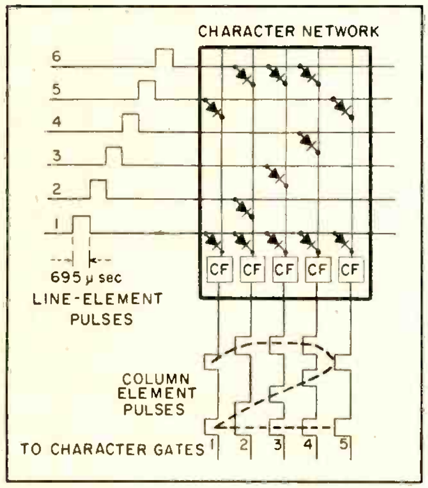


FIG. 5—This diagram of the second network shows the arrangement of the crystal diodes to form the number 2. Each line-element pulse is fed across the horizontal lines of the network and to the diodes, feeding the signal vertically downward in proper time sequences to each of the five cathode followers. Column-element pulses describe the number

an enlarged view of one of the networks with the crystal diodes and their positions. The line element pulses are shown with their proper time relation tracing out the figure 2. Following the line element pulses through the network, we see that the first pulse passes through the character network and through the diodes and is fed onto all five vertical lines of the network. Similarly, the second line element pulse signals the second line and so on through the others, feeding the signal with the proper time relation to each of the five cathode followers. The outputs of the cathode followers then form the column element pulses as shown.

Character Elements

The input gates, the 6-bit register, the 6 × 12 matrix, character gates and the writing circuits are grouped together in one unit called the character elements. As shown in Fig. 1, this basic system uses 12 such units, one for each character column. Using the signals from the timer and the function generator, the character elements trace out the various characters in the proper form, trigger the writing circuits and actually write the number on the chart.

Gating the Information

The input gates are conventional two-diode gates that function to gate the computer information into the balance of the character elements and to keep new information in the computer until the rest of the system is ready for it. This is accomplished by keeping a point in the gate circuitry sufficiently negative so no information will pass this point until driven positive by a change in the gate pulse from the timer. As the computer delivers a positive signal for 1 and a negative signal for 0, only a 1 can be transmitted beyond this point. However, the −20 volts bias in the output circuit will supply a minus signal equivalent to zero. As there are six gates per character, six output pulses per character are passed on to the next stage.

Storing the Information

The 6-bit register, so called, is a memory that stores the information from the input gates and supplies continuous readout to the 6 × 12 matrix. The unit is composed of six bistable multivibrators fed by the 6-bit code from the input gates. The bistable multivibrators are set at 0 where one side of the tube is not conducting. If the input signal is negative, as in the case of a 0

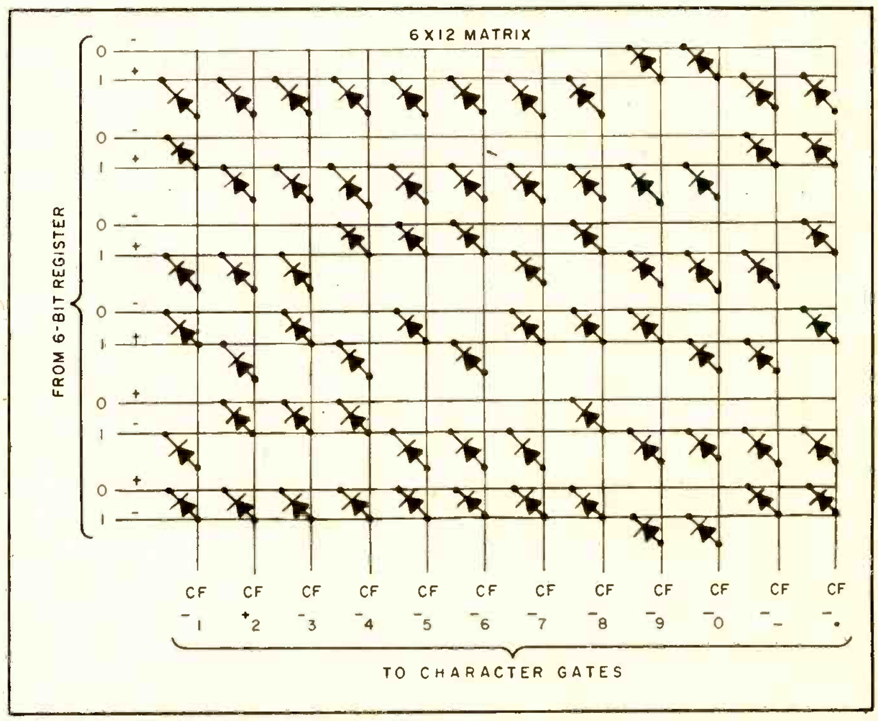


FIG. 6—For each character to be printed, the 6 X 12 matrix receives one of the twelve binary signals from the 6-bit register. In this case, positive polarity is supplied by the second cathode follower and the signal for number 2 passes on to the character gates

from the input gates, this side of the tube will still remain cut off and the condition will remain the same. If, however, the input is positive, as in the case of a 1, the multivibrator flips and the 1 reads into the 6 × 12 matrix. On receipt of the positive reset signal from the timer, the multivibrator returns to or stays in its original state.

Information Output

The 6 × 12 matrix, shown in Fig. 6, receives the twelve output signals from the 6-bit register and sends out eleven negative signals and one positive signal, the positive signal defining the character to be written. The input is binary in form, as a 1 produces a negative-positive sequence and a 0 produces a positive-negative sequence. If, as in this case, the digit 2 (binary 111100) is written, the sequence of pulses to the 6 × 12 matrix is as shown in Fig. 6. Thus, since the diode conducts in only one direction, there will be eleven negative outputs and one positive output. The positive polarity will be supplied by the particular cathode follower to occur, in this case, on the second, or digit 2, line.

Gating the Signals

The block diagram of the character gates, with an enlarged drawing of a typical gate block, is shown in Fig. 7. These gates pass on to the writing circuits a single set of five signals necessary to write a character. If the input, as in the example, is for writing the digit 2, all signals will be negative except the one for the actual digit desired. Point *A* of the gate will then be negative and no signal will pass. If however, the signal is positive, the five outputs from the numeric function generator for that digit will pass on to the writing circuits. Fig. 7 shows that if the digit 2 is to be written, the five outputs from the numeric function generator will pass on to the writing circuits owing to a positive signal from the 6 × 12 matrix along the line marked 2.

Writing Pulse

The writing circuits supply a high-voltage pulse to the recorder styli to write the desired character.

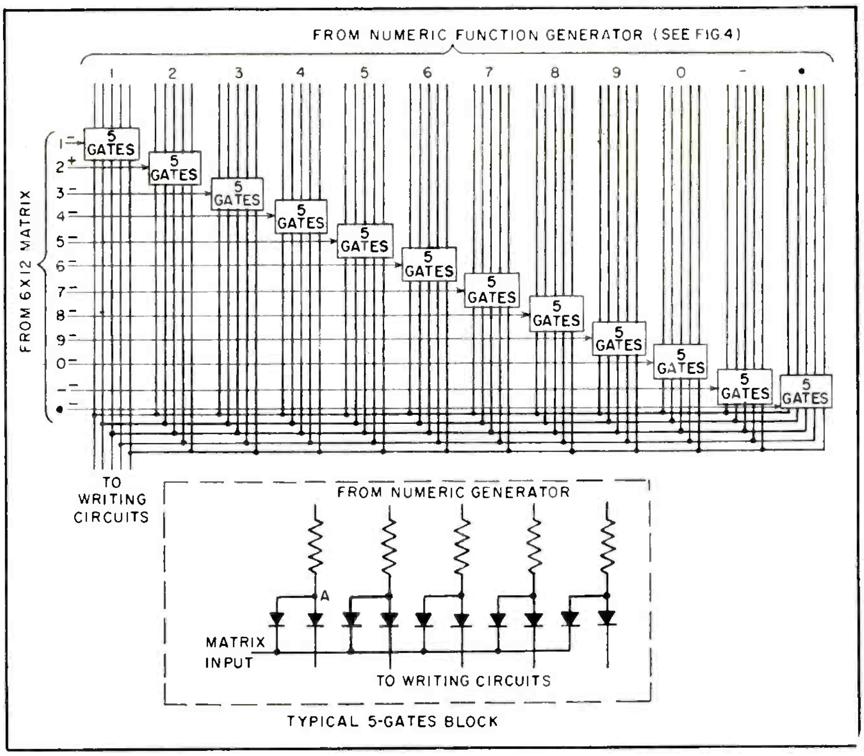


FIG. 7—Here the second character gate receives the positive signal from the 6 X 12 matrix and the output from the function generator passes the number-2 signal to the writing circuits

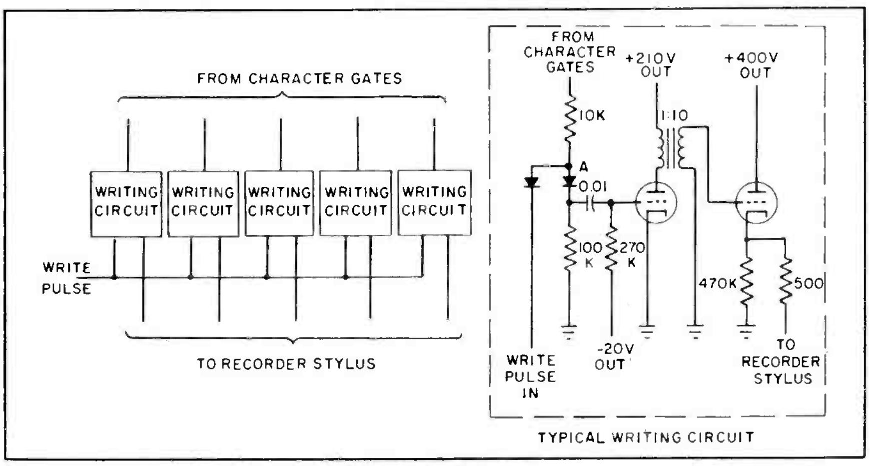


FIG 8—Activated by the character gate, the positive write pulses pass into the writing circuit at point A and then out to the recorder styles

The five outputs per character from the character gates are received at the writing circuits and held at point *A* of Fig. 8 by a negative voltage applied to the write-pulse bus. When activated by the positive write pulse, the inputs are passed into the actual writing circuit. These circuits consist of a gate, an amplifier, and a cathode follower. The five output pulses from the writing circuits are similar to the outputs from the cathode followers as shown in Fig. 4. The write pulse determines the width of the actual writing dot at 275 μ sec. Every 695 μ sec a new line element is written so the first line element will be a blank-dot-dot-dot-blank signal from the accompanying five writing circuits. The other line elements are as shown.

The speed and capacity of the system are made possible by the fixed-styli recorder.

Certain portions of the work described were done under Air Force Contract No. AF 33(616)-3660 for Wright Air Development Center. Basic circuit research was carried out by C. A. Campbell and R. P. Bishop.

Transmission Line Impedance Measurement

By H. F. MATHIS

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Akron, Ohio

SUMMARY — Graphic procedure provides convenient and simple method for determining the impedance and propagation constant values of three different lengths of a lossless transmission line terminating in a reactive load

If a movable short and a slotted line are used to determine the characteristic impedance Z_o and the propagation constant β of a transmission line, their ranges may be too small to obtain the required data and it is inconvenient to use the formula $Z_o^2 = Z_{sc}Z_{oc}$. The following procedure eliminates this disadvantage.

Measuring Impedance

Input impedance Z_1 is measured for any convenient length of the transmission line terminated in a reactive load. A length d is removed from the line and input impedance Z_2 is measured using the same or an equivalent reactive termination. The word *remove* may mean moving a movable short nearer to the input end of the line. Length d is removed again and the input impedance Z_3 is measured in the same way. In the example given here, $d = 2$ inches.

Impedance Z_1, Z_2 and Z_3 are normalized with respect to any Z_o' and plotted on a circular transmission chart as shown in Fig. 1.

For this example: $Z_1 = j200$, $Z_2 = j60$, $Z_3 = j22.7$ and $Z_o' = 100$.

Construct the impedance plot as follows:

Draw $Z_1 Z_3$ and Z_2 to center C of chart.

From C, draw AC perpendicular to the $X = O$ line and continue through chart.

From B, draw BD perpendicular to Z_2C.

From Z_2, draw Z_2E parallel to line $X = O$.

From C, draw CE perpendicular to Z_1Z_3. Draw DE.

From Z_2, draw Z_2F parallel to DE.

Draw FG perpendicular to FC.

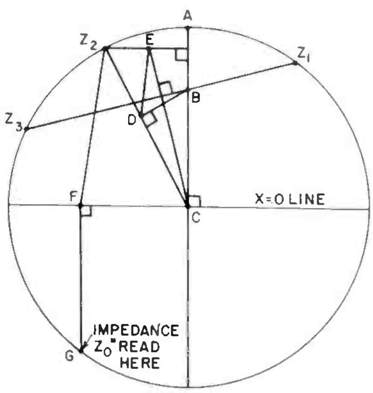

Fig. 1—Construction to determine characteristic impedance

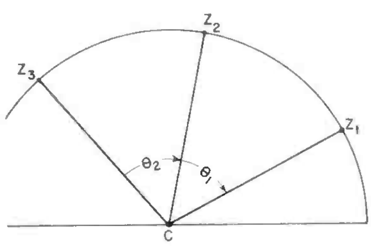

Fig. 2—Construction to determine propagation constant

Read impedance Z_o'' *at G*.

The value of Z_o is given by $Z_o = Z_o'|Z_o''|$. For the construction shown in Fig. 1, $Z_o'' = -j0.5$ and $Z_o = 50$.

Propagation Constant

Normalize Z_1, Z_2, and Z_3 with respect to Z_o and plot on a circular transmission chart as shown in Fig. 2. Angle θ_1 should equal θ_2. The value of β is obtained from the equation $\theta_1 = \theta_2 = 2\ \beta\ d - n \times 360$ deg, where $n = 0, 1, 2, \ldots$ If d is measured in inches and θ_1 is measured in degrees, then β is the phase change in degrees per inch.

The value of n must be determined by considering other information which may be available. Ofter only one of the values of n gives a value of β which could possibly be used. If this is not the case, the procedure should be repeated using a smaller value of d. For the example, $\beta = 12.88$ deg per in.

This procedure was derived by writing equations for Z_1, Z_2, and Z_3 as functions of Z_o, β, d, and the original length of the transmission line. These three equations were solved for Z_o as a function of Z_1, Z_2, and Z_3. A graphical procedure for solving this equation was found. The procedure for determining β follows from the rotational properties of circular transmission line charts.

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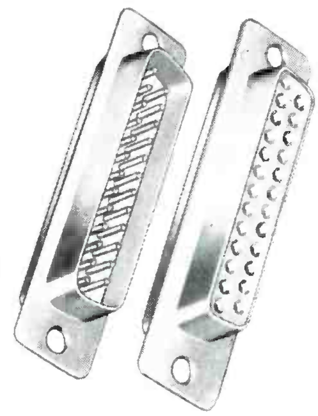

DB-25P

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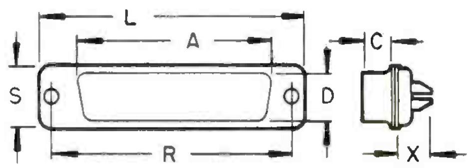
STANDARD PIN AND SOCKET INSERTS:



size	A	C	D	L	R	S	X	weight
DA-15P	1 1/64	15/64	23/64	1 17/32	1.312	31/64	5/16	.013
DA-15S	1 3/32	15/64	5/16	1 17/32	1.312	31/64	5/16	.014
DB-25P	1 9/16	15/64	23/64	2 5/64	1.852	31/64	5/16	.023
DB-25S	1 33/64	15/64	5/16	2 5/64	1.852	31/64	5/16	.031
DC-37P	2 13/64	15/64	23/64	2 23/32	2.500	31/64	5/16	.035
DC-37S	2 11/64	15/64	5/16	2 23/32	2.500	31/64	5/16	.035
DD-50P	2 7/64	15/64	15/32	2 5/8	2.406	39/64	5/16	.035
DD-50S	2 5/64	15/64	27/64	2 5/8	2.406	39/64	5/16	.040
DE-9P	45/64	15/64	23/64	1 13/64	.984	31/64	5/16	.011
DE-9S	41/64	15/64	5/16	1 13/64	.984	31/64	5/16	.012

FRACTIONS ±1/64 Tolerance   DECIMALS ±0.005 Tolerance

D SUB-MINIATURE SPECIFICATIONS:

Shell, including flange — steel or brass; Finish — Cadmium plate or Irridite. Contacts — No. 20, 5 ampere rating — Copper base alloy, gold plate finish.

Insert arrangements — 5 plus coaxials in 9, 15, 25, 37 and 50 contacts.

Insulation material — Zytel 101 or DIALL.

Polarization — Keystone cornered shell.

Operating temperature —67° to +310°F.

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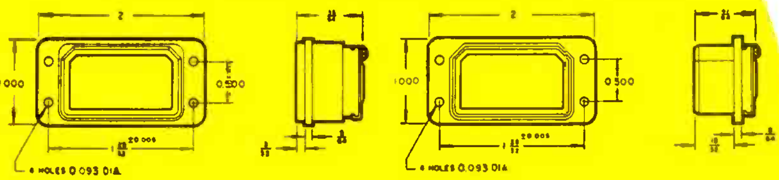
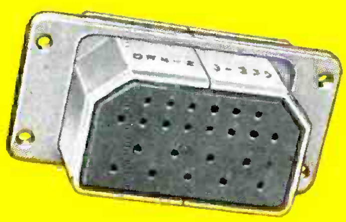


DPX 23-34P



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DPX CONNECTORS:

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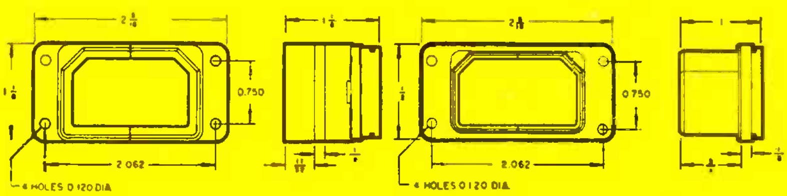

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Heater Surge Chart

By M. P. FEYERHERM
Defense Electronic Products
Radio Corp. of America
Camden, N. J.

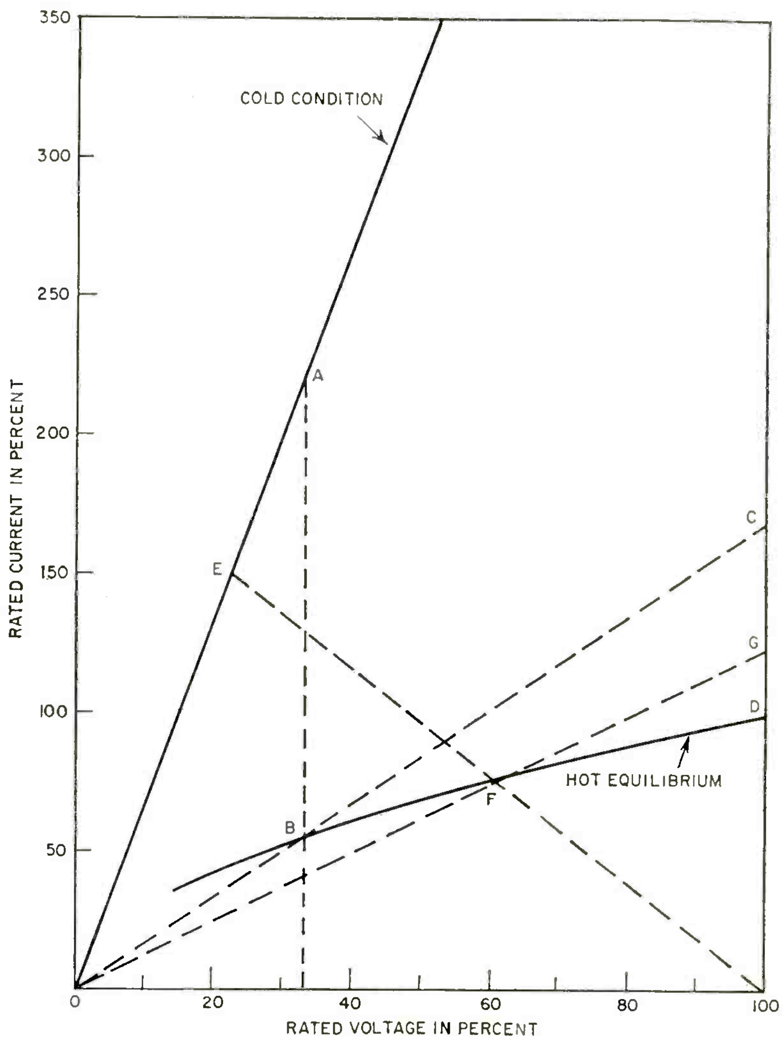
SUMMARY — Effect of heater current surges when voltage is applied to cold tube and efficiency of surge-restricting arrangements can be evaluated with chart. Hot and cold characteristic curves are typical for most tubes

TO MINIMIZE damaging effects of high initial current when heater voltage is applied to a cold tube starting current surges should be restricted.

The magnitude of heater current surges under various conditions may be calculated by use of the accompanying graph, which consists basically of two curves plotted on coordinates of heater current and voltage relative to normal full-voltage conditions. The first curve, a straight line, represents the resistance of a cold heater. It represents a resistance which is 0.15 of the normal operating resistance. This is typical of most receiving tubes. The second curve shows the locus of points at which thermal equilibrium is obtained for steadily-applied voltages. Deviations from this curve are relatively small for common receiving-type tubes.

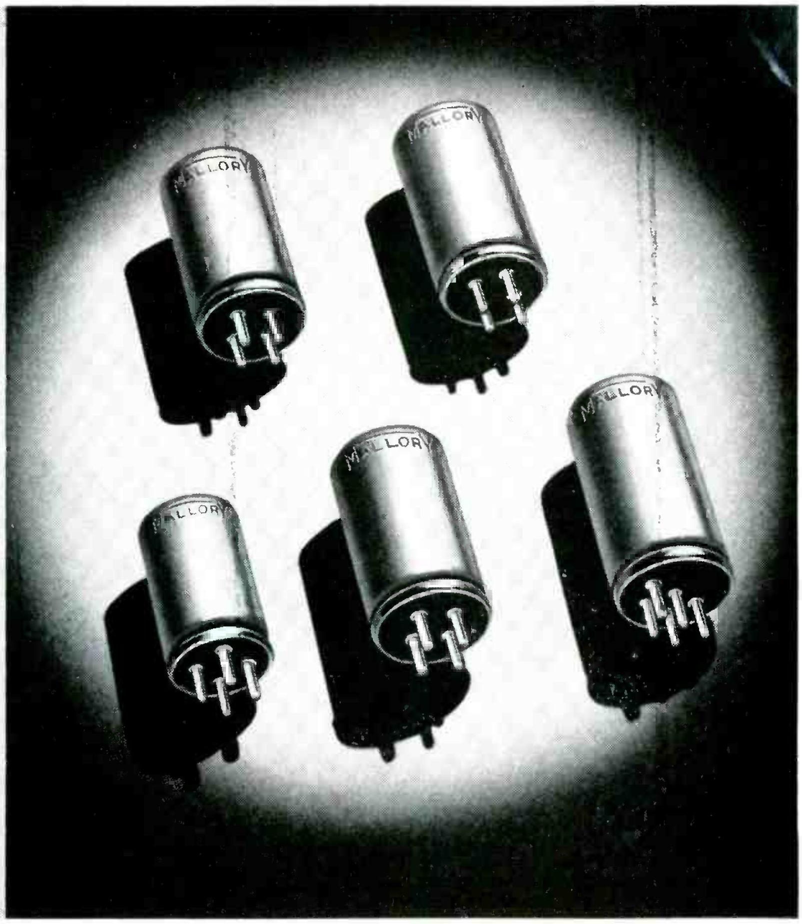
The results of applying heater voltage in steps may be shown by simple constructions. By constructing a line at a chosen value of initial voltage, the magnitude of the initial cold-resistance surge is shown by point *A*, and thermal equilibrium occurs at point *B*. A line through the origin and point *B* represents the heater resistance attained in the partially-heated equilibrium condition. If 100-percent voltage is then applied, a current surge of magnitude indicated by point *C* occurs, and final equilibrium is attained at the normal operating point *D*.

The effect of applying 100-percent rated voltage through a series resistor may be shown by the construction of a line having a slope based on the ratio of the series resistance to the normal hot resistance of the tube. The cold-tube surge is indicated by point *E*, and equilibrium occurs at *F*. Construction of a line from the origin through point *F* then represents this equilibrium heater resistance. If the resistor is then shorted out, 100-percent voltage will be applied and will result in a momentary current indicated by point *G*. Final equilibrium will occur at the normal operating point *D*.



Current-voltage plot for hot and cold tube conditions used to evaluate surge

New MALLORY Vibrator Designs



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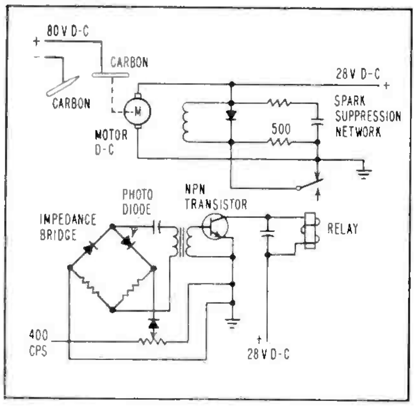
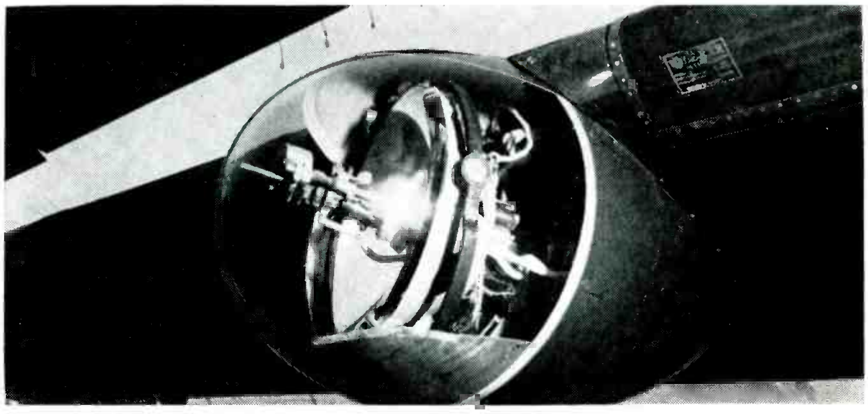
Electrons At Work

Edited by DAVID A. FINDLAY

Airborne Searchlight Uses Electronic Controls



Schematic of the positive carbon drive



Searchlight in wing nacelle of a fleet plane standing guard against enemy submarines

OPTICAL methods are ultimately needed in nighttime operations of Navy patrol aircraft that initially make contact with targets by radar. A new carbon-arc searchlight has recently been developed by American Bosch Arma Corp. that employs transistors.

Typical of the newer approach is the positive carbon drive mechanism for which a simplified schematic diagram is shown. This is essentially a focus control system in which a photodiode feeds a single transistor stage to operate a sensitive relay. The relay contacts normally shunt a field-control resistor in the drive motor.

Mechanically, the system comprises a small rhodium-plated mirror set at 45 degrees to the carbon axis so the image of the crater is reflected through the center hole of the main reflector to the photodiode.

▶ **Speed Change**—Gearing between motor and positive carbon normally moves the carbon forward at a fixed rate. When the crater is at the focal point, the small reflector is set such that the reflected beam strikes the photodiode at a point just off its sensitive area. As the carbon burns back from the focal point, the reflected beam moves onto the sensitive area of the photodiode, changing its impedance and unbalancing the bridge circuit.

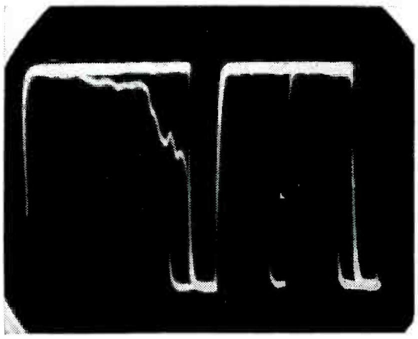
A small signal applied to the collector of the transistor is amplified to a level sufficient to operate the relay. Contacts of the relay remove the shunt across the field resistor, decreasing field current and increasing motor speed. The carbon then moves forward at greater than the burning rate and the projected beam is thus removed from the photodiode.

Phototube Checks Razor Blades in Production

AUTOMATIC inspection of mass-produced units, such as strips of razor blades, can be accomplished photoelectrically.

In this particular application, it was desired to inspect razor blades at a rate of six a second. The blades are formed from a continuous strip of spring steel. After being punched in the required outline and hardened, the blades are ground and honed on each edge. Individual blades are then broken out of the strip.

In the equipment illustrated a representative band of blades is moved past a strong light. The illuminated edge of the blade is magnified by the microscope and an enlarged image is formed in the plane of a slit that is at right angles to the edge.



Composite oscillogram showing two good blades with space between. Superimposed are traces formed by defective blades with broken edges, uneven edges or other deformities. Scale of 0.007 in. represents 2 in. on crt

A type 931-A phototube receives all the light passing through the slit and applies a signal to the vertical d-c amplifier of a cathode-ray oscilloscope. The sweep is synchronized to obtain a repetitive outline of the blade edge. Any deviations from the set pattern indicate defective blades. Vertical deflection of the crt beam can be made directly first in Performance Reliability and Quality

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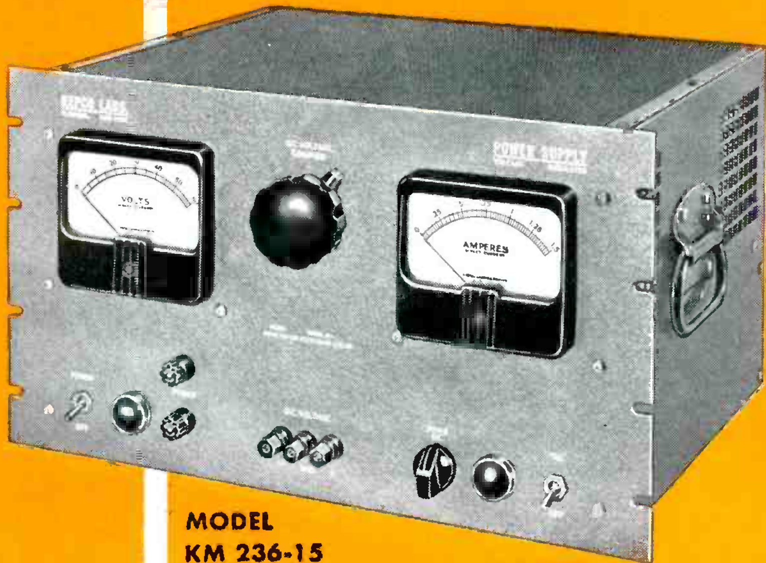

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2-36 VOLTS
15 AMPS.

featuring

- **Output voltage within 0.5% during recovery time for line transients 105-125 volts.**
- **Short circuit will not damage supply.**
- **Full current may be drawn at any voltage from 2-36 volts.**

OUTPUT VOLTAGE DC: 2-36 volts continuously variable.

OUTPUT CURRENT DC: 0-15 amperes continuous duty.

REGULATION: In the range 2-36 volts the output voltage variation is less than 0.5% for line fluctuation from 105-125 volts, and less than 0.5% or 25 millivolts, whichever is greater, for load variations from minimum to maximum current.

RIPPLE VOLTAGE: Less than 0.5% or 25 millivolts RMS, whichever is greater.

FUSE PROTECTION: Input fuses on front panel.

OVERLOAD PROTECTION: An automatic current limiting device allows direct shorting of the output terminals without damage to the supply.

POWER REQUIREMENTS: 105-125 volts, 57-63 cycles.

OUTPUT TERMINATIONS: DC terminals are clearly marked on the front panel. Either positive or negative terminal of the supply may be grounded. DC terminals are isolated from the chassis. A binding post is available for connecting to the chassis. All terminals are also brought out at the rear of the chassis. Two terminals are mounted at the rear of the chassis to provide for picking up the error signal directly at the load. This connection compensates for the voltage drop in the wires connecting the power supply to the load.

METERS: Ammeter: 0-15 amperes, 4" rectangular
Voltmeter: 0-15 volts, 4" rectangular

CONTROLS: Power on-off switch, DC on-off switch, remote error signal on-off switch, coarse and fine voltage controls.

PHYSICAL SPECIFICATIONS: Rack panel construction. Panel height 12¼", width 19", depth 17" Color Kepco standard gray hammertone. This unit is designed for relay rack mounting or bench use. Carry handles are provided.

OPERATIONAL CHARACTERISTICS: This regulated unit consists of a ferro-resonant line regulator followed by a magnetic amplifier regulator The ferro-resonant line regulator furnishes well regulated transient free AC power. The high gain magnetic amplifier is used to regulate the DC output voltage to compensate for voltage changes in the power unit for varying load currents. The response time for pulse loads is less than 0.2 seconds.

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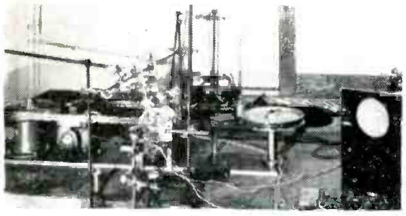
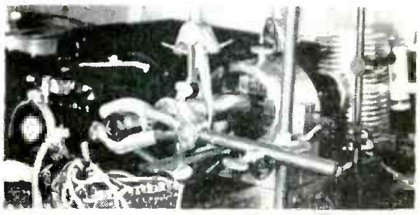


Experimental inspection setup used in development of technique

proportional to distances at the blade edge and tolerances can then be marked on the tube.

The same general technique, together with suitable automatic rejection equipment, could be used with gears and pinions, circular and band saws, zippers, wire mesh and other similar materials.



Closeup of light source (right rear) blade guide, optical system and phototube

Driving Simulator Shows Crash Hazards

By Harry H. Schwartz
Electrodesign
Montreal, P. Q., Canada

Demonstration setup of simulator in use by Mayor of Montreal

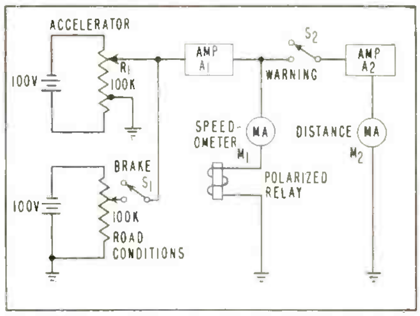


FIG. 1—Simplied diagram of the automobile driving simulator

Operating a car, the driver must at all times be aware of his stopping characteristics. In fact, he must solve a complex mathematical equation involving a number of variables to determine the safe stopping distance.

There exists no simple instrument that will actually solve these equations properly. However a simulator that is effectively an electronic computer will solve these equations.

The variables that the driver must consider are velocity of the car, distance to the hazard and the condition of the road. The instrument described takes these factors into account and indicates clearly whether there would have been a crash under the given conditions and if so, what the amount of damage or whether the driver had calculated correctly and by what margin he was safe.

▶ **Example**—Assume the car is being drive at u mph and the distance to the hazard is S. Let the road condition permit a deceleration of a ft per sec per sec. Let the distance covered during the human reaction time T be s_1; therefore the distance available for braking is $s_2 = S - s_1$.

In the circuit shown the potentiometer R_1 is connected to the gas pedal. The voltage from the potentiometer is fed into an integrating operational amplifier. The output from amplifier A_1 is then the velocity, which is shown on meter M_1.

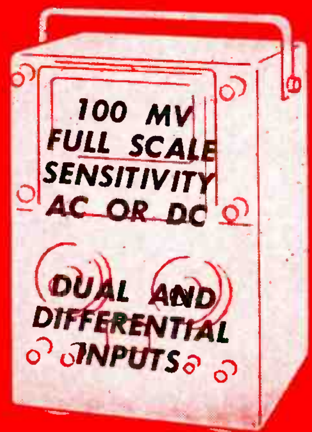
Speed of the car can be varied up or down by moving R_1 as the potentiometer is tapped and a negative voltage will slow the car down.

When a predetermined warning signal is given, either by a light or a bell, switch S_2 is closed. The output of A_1, the velocity, is applied to operational amplifier A_2, which integrates this and therefore the output of A_2 is the distance covered by the car. This output is shown on meter M_2. As soon as the brake is depressed, switch S_1 is closed. A negative voltage is applied to A_1 thus reducing the speed (M_1) but allowing the continued

Metal Detector Checks Fabrics

Textile inspector developed by RCA will spot metallic pieces as small as 0.39 in. in diameter in fabric strip traveling at speeds from 10 to 1,000 ft per min. Machine will take fabrics up to 60 inches in width

New Du MONT TYPE 405 VTVM



Now there's no need to weigh feature against feature when it comes to vacuum tube voltmeters — the new Du Mont 405 has everything!

The 405 is the first VTVM to combine **100 millivolt** full scale sensitivity, either **AC or DC**, with **dual and differential inputs**. Besides, it features DC performance from **2 millivolts to 1000 volts** with **120 megohm input**. It doesn't stop there, for it also offers highly accurate AC performance from **below 50 cps** up into the **UHF range.** As an **ohmmeter,** the Type 405 is calibrated from **0 to 500 megohms,** in eight ranges.

Another in the outstanding Du Mont 400 Series, the 405 is "human engineered" for ease and convenience of operation, reliability, and precision. Its rugged construction is backed by the exclusive Du Mont 5-year guarantee offered with all instruments of the 400 Series.

Price **$265.00**

Slightly higher in 50-cycle areas.

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FEATURING

- **ACCURACY:** 2%.
- **SCALE:** Illuminated 4" mirror-backed scale for accurate readings.
- **STABILITY:** Very low drift. Less than ± 3 millivolts on any range.
- **VERSATILITY:** Designed for safe off-ground operation up to 1000 volts DC.
- **REGULATED:** Regulated DC and filament supply.
- **AMPLIFIER OUTPUT:** Amplifier output available with power gain over 60 db.
- **SIZE:** Compact, weighs only 12 pounds.
- **PROBE STORAGE:** Built-in probe storage compartment.

DU MONT® *One of the 400 Series*

Technical Sales Department, ALLEN B. DU MONT LABORATORIES, INC., Clifton, N. J.

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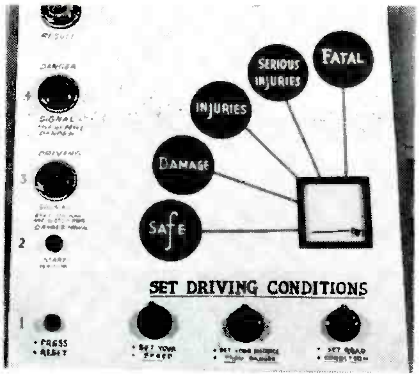
integration of A_2.

At this point, one of two events will occur. Either the output of A_2 will increase to such an extent that the needle indicator will reach the set point of the instrument or the velocity M_1 will reduce to zero.

In either case, the computer will be stopped and the results will be held. In the first case, the value shown on M_1 will be the velocity of impact; in the second case, the value on M_2 will be the distance covered by the car.



Visual signals and operating controls show test driver his effective reaction time

Portable Transistor Frequency Standard

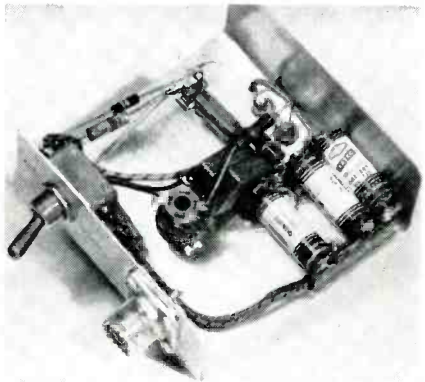
By DONALD S. BEYER
General Electric Co.
Syracuse, N. Y.

IN EVERY PHASE of electronics, the need often arises for a convenient signal source of known frequency, voltage and waveform. When using an oscilloscope, for instance, it would be most useful to have a reference-frequency signal source to connect to the vertical input terminals with the object of establishing an accurate time base on the X axis.

Sometimes an electrical signal having high rise time components must be observed on an oscilloscope. If the true waveform of such a signal is to be interpreted, the operator of the oscilloscope must first be certain exactly how his oscilloscope will respond to this complex signal. Were some substitute signal available with waveform and rise time known to be constant, it could supply the missing information to the operator.

The oscilloscope cannot always be relied upon to give the correct reading of complex-signal voltage even within an accuracy of several hundred percent because of a fall-off in response for high frequency phenomena. This might not seem a problem except that oscilloscope voltage calibrators utilize 60-cps clipped sine waves having frequency components no higher than 1,000 cps. Lack of an adequate built-in device requires a high-frequency source for the calibration when measuring waveforms involving high frequencies.

The device to be described is small enough to be always handy and easy to use for performing all the above services. In addition, it has many uses, such as its use as a calibration signal source for alignment of radio receivers.



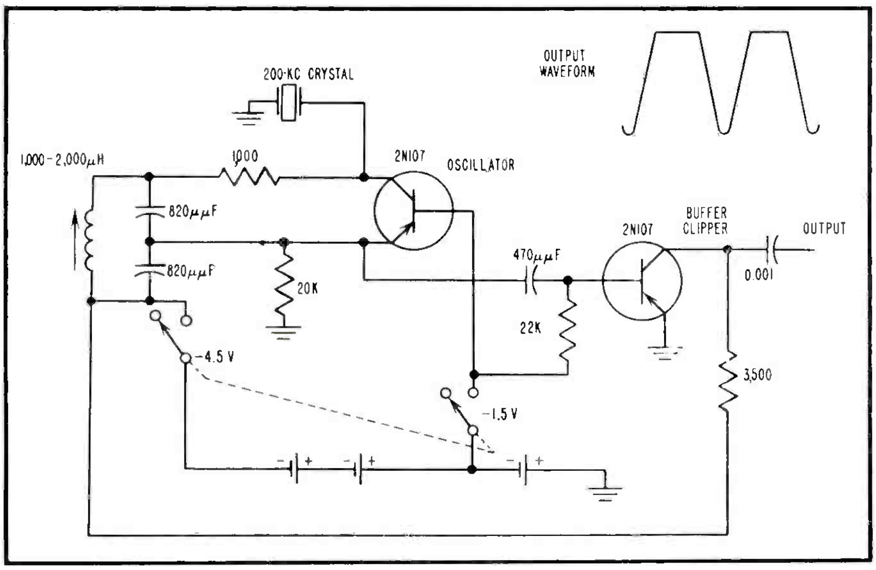
Bottom view of the transistor standard

▶ **Circuit**—A low-priced *pnp* transistor in common base configuration is used in a modified Colpitts oscillator. It is frequency stabilized by a 200-kc crystal in a parallel resonant circuit. For battery economy, only 4½ v of collector bias is used. For the same reason, emitter bias is obtained without a resistor voltage-dividing network by deriving this bias directly from one cell of the battery.

Common emitter configuration is used for the other *pnp* transistor. This stage is overdriven by output from the oscillator so the output will be rich in harmonics owing to the clipping that results. This stage also serves as a buffer, to prevent loading by external circuits.

Output signal obtained is 3.5 v peak-to-peak of clipped sine wave at 220 kc, having a rise time of approx. 0.1 μsec. The output impedance is 1,000 ohms. Harmonics are present to over 10 mc. Stability is such that when the output is shorted, the oscillator does not shift more than 5 cps.

The oscillator is adjusted as follows. Move the slug so it is nearly out of the coil (low-inductance end) and loosely couple the output to a broadcast receiver tuned to 600 kc. Correct adjustment is obtained



Schematic circuit diagram of the portable frequency standard

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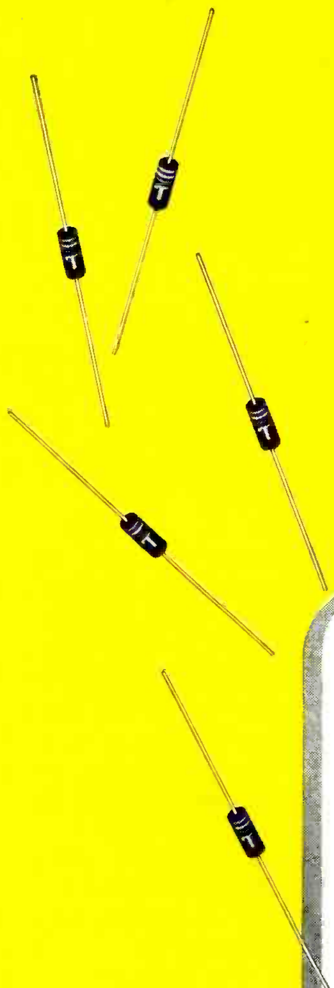


Featuring

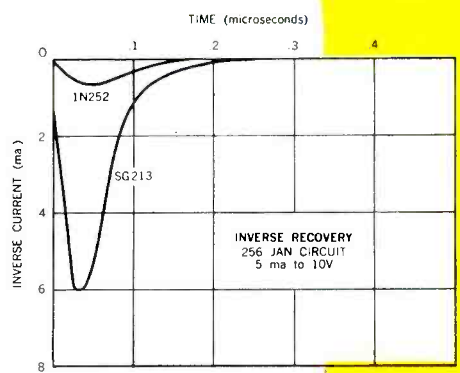
- Recovery times under .3 μs
- High conductance
- High voltage ratings
- Operation to 150° C

Transitron's fast switching silicon diodes are intended for medium and high speed circuits in which diode recovery characteristics are important. These new types are considerably faster in recovery time than other silicon and germanium diodes. They are particularly useful in computer and similar applications.

In addition to excellent static and dynamic properties, reliable performance is assured through close process control and all glass encapsulation.

Type	Minimum Forward Current at 1.5V (ma)	Maximum Inverse Current (μa)	Maximum Inverse Voltage (Volts)	Maximum Recovery Time* (μsec)
SG228	100	.25 @ 175V	200	1
SG226	100	.25 @ 60V	80	1
SG223	30	.25 @ 175V	200	.5
SG221	30	.25 @ 60V	80	.5
SG213	5	.25 @ 175V	200	.3
SG211	5	.25 @ 60V	80	.3
Low Capacitance Types				
1N251	5 @ 1V	.1 @ 10V	30	.15
1N252	10 @ 1V	.1 @ 5V	20	.15

*Measured in the 256 – JAN Recovery Circuit



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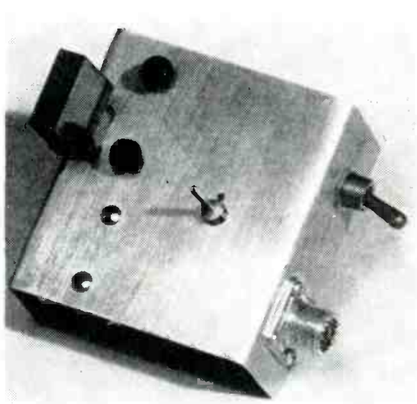
when the S meter or tuning eye indicates the strongest harmonic signal of 200 kc.

For more precise adjustment, couple the output to a short-wave receiver tuned to standard-frequency station WWV on 5 mc. Adjust the slug until zero beat is heard.

► Use—In aligning radio receivers, every 200-kc point on the dial can be marked. When connected to the horizontal or vertical inputs of an oscilloscope, a convenient frequency reference is available for measuring signals of unknown frequency.

By counting the number of 200-kc square waves that appear with a given horizontal sweep-frequency setting and then by counting the number of cycles of unknown input signal when using the same sweep frequency, the frequency of the unknown input signal can be determined. It can be used as a complex waveform reference signal to indicate oscilloscope amplifier response, and rise time errors.



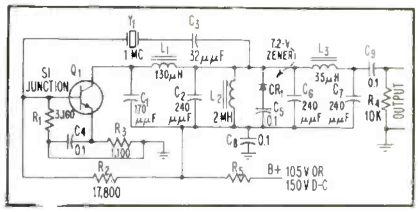
Top view shows chassis layout. Crystal is left rear beyond transistors

Crystal Clock for Airborne Computer

By C. W. Pederson

Bell Telephone Laboratories, Inc. Whippany, N. J.

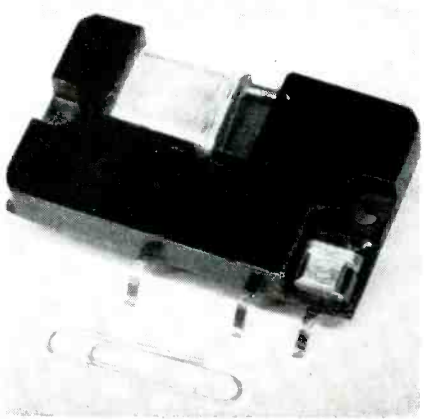
TRADIC, the transistorized airborne digtal computer developed at Bell Telephone Laboratories, is a system designed to take full advantage of the desirable features offered by transistors. One device required in this system is a timing clock operating at a frequency of 1 mc ±0.05 percent. This clock must provide sine-wave output of 25 mw ±10 percent into a 500-ohm load over a temperature range of 0 to 50 C and must fit into a space no larger than 1 7/16 × 2 7/16 × 5/16 in. The oscillator described below was designed to meet these rigid requirements.



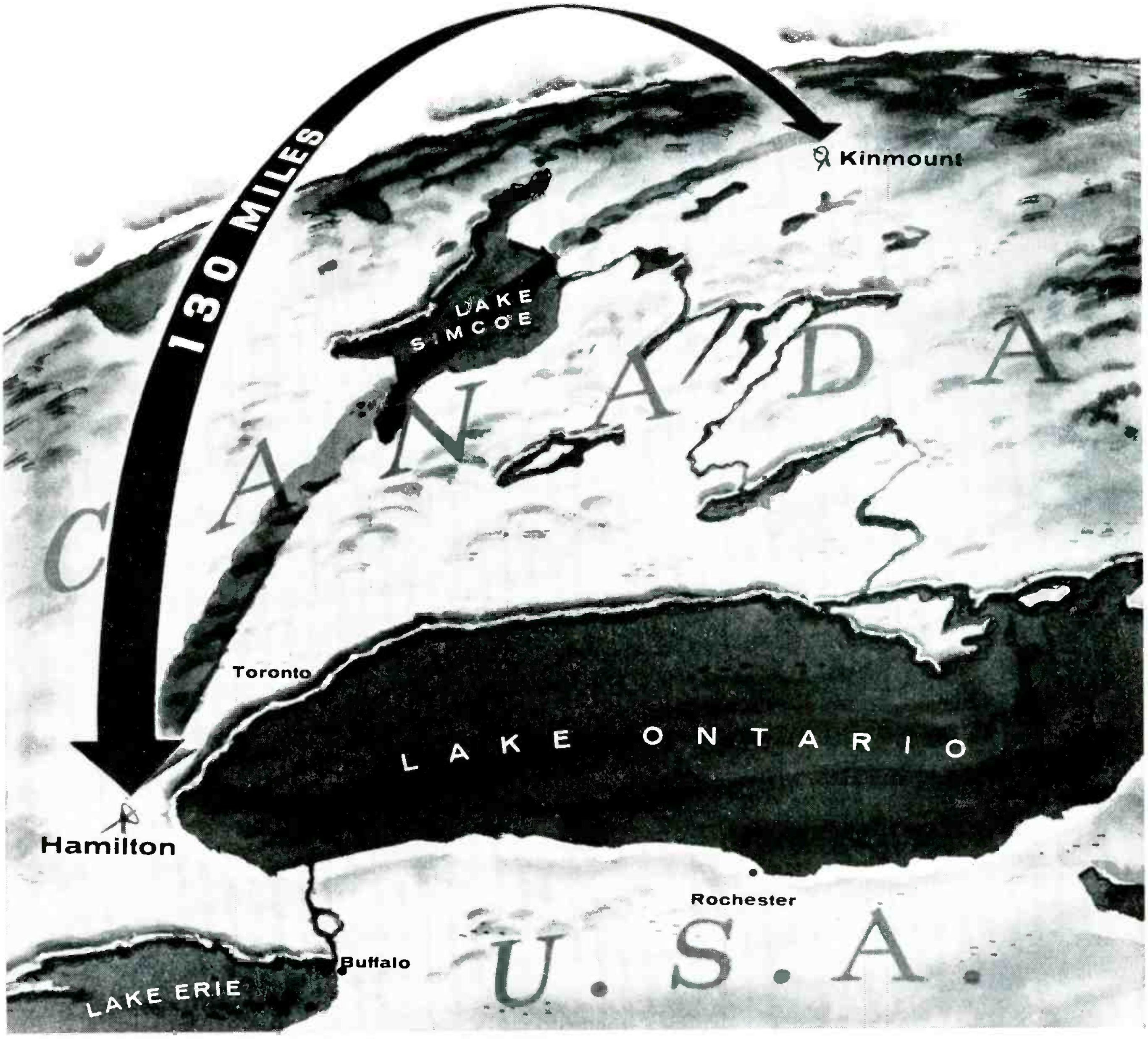
Schematic circuit diagram of the oscillator

A single-transistor, grounded-emitter circuit was selected. The frequency of oscillation is determined primarily by the quartz crystal Y_1. Capacitors C_1, C_2 and inductor L_1 form a low-pass pi network that provides the required phase shift to sustain oscillations at the operating frequency.

To provide a nearly constant output over the temperature range stated above, output limiting obtained by diode CR_1 and capacitor C_5 was employed. The limiting introduced some distortion, so an output filter was added to provide a sine-wave output. This filter is

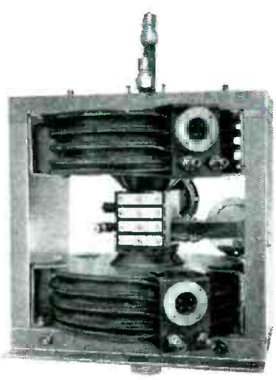


Transistor and crystal unit lead are soldered into the package after the rest of the oscillator is encapsulated



ANOTHER VARIAN FIRST!

2 kW SHF Varian Klystron



The VA-804D (4.85—5.0 kMc) mounted in its focusing magnet, the VA-1504.

The heart of the new Canadian Westinghouse SHF scatter transmitter, now being operated in a "proving ground" circuit between Hamilton and Kinmount, Ontario, is the Varian VA-804 klystron amplifier, designed specifically for forward scatter communication service. The now familiar qualities of all Varian klystrons — remarkable efficiency (see below), economy, reliability, and proved performance — made this tube the logical choice for Westinghouse.

Electrical Characteristics:

Frequency —	4.4 to 5 kMc
Power —	2 kW minimum
Gain —	50 db
Efficiency —	40% nominal

For a complete description of this and other Varian klystrons contact your local Varian Representative or write Varian Associates, Application Engineering Department, Palo Alto, California.

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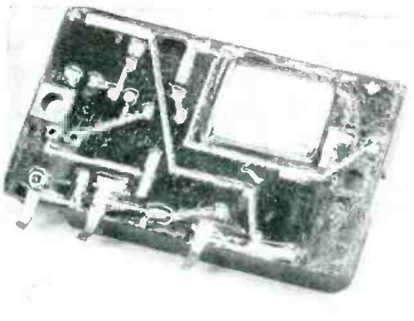
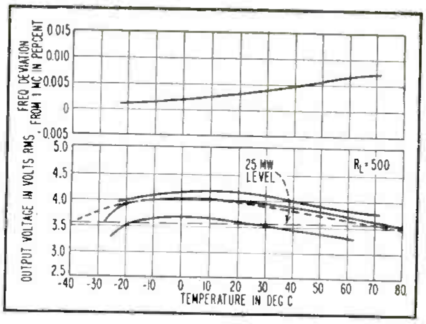


Internal construction of transistor crystal-controlled oscillator showing printed wiring and encapsulating techniques



Frequency-temperature curve (top) and output voltage vs temperature (below) for several laboratory models of the oscillator

composed of the low-pass pi network C_6 C_7 L_3.

Resistors R_1, R_2 and R_3 are necessary for current stabilization. Shunt feed is employed in the transistor collector circuit, with isolation from B+ being provided by L_2. Capacitors C_4 and C_8 serve as r-f bypasses and C_9 couples the 1-mc output to the load.

Capacitor C_3 permits fine frequency control and is adjusted so the output frequency has a nominal value of 1 mc. Resistor R_4 provides circuit protection by preventing a high current surge in the event that a loose connection should occur at the ground terminal when the supply voltage is on.

Power for the oscillator is taken from a d-c supply of either 105 or 150 volts. Since only 40 to 55 volts is needed for the oscillator circuit, a series dropping resistor R_5 has been added. This dropping resistor equalizes to a certain extent the output of transistors with different gains. The d-c input power to the oscillator is about $\frac{1}{3}$ watt.

The curves show typical oscillator output voltage versus temperature for several laboratory models and also the typical frequency-temperature relation. While output voltage depends upon the characteristics of the particular transistor in the circuit, in general, this voltage was found to fall between 3.8 and 4.05 v at room temperature.

Performance of the laboratory models indicates that the circuit will provide the desired sine-wave output over a temperature range from −20 to 85 C. While the frequency deviation is well within the specified ±0.05 percent, even better frequency stability may be obtained by using a thermistor network in place of C_3 to compensate for temperature effects.

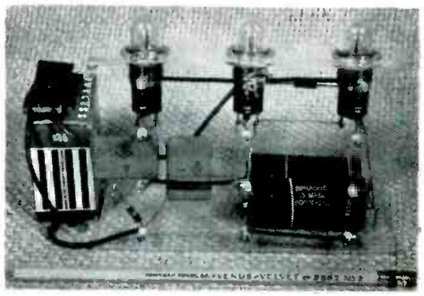
Demonstration Neon Multivibrator

By Lyman W. Orr

Dept. of Electrical Engineering
University of Michigan
Ann Arbor, Mich.

Using neon lamps, a demonstration device can be built to show three forms of multivibrator operation.

The unit pictured is a portable multivibrator demonstrator. Its small physical size and visual output makes it convenient for lecture hall demonstration. It performs three types of multivibrator operation: flip-flop, or bistable multivibrator, one-shot, or monostable multivibrator and free-running or astable multivibrator.



Three neon pilot lamps are mounted on folded plastic sheet that also supports other circuit elements

A built-in trigger generator furnishes the automatic triggering for flip-flop and one-shot operations. All important nodes in the circuit

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Sierra 185A series Average-Reading Termination Wattmeters are also offered for average-power measurement or termination on rf coaxial systems. The table at right gives models, frequency coverage, etc. No auxiliary power is required.

MODEL 195A PEAK-READING WATTMETERS				
Model	**Frequency**	**Peak Power, Kw**	**Max. Average Power**	**Connector**
195A-Z	250-1000 MC	0-1/3/10	15 watts	N
195A-X	250-1000 MC	0-10/30/100	100 watts	LC
195A-Y	250-1000 MC	0-100/300/1000	500 watts	LC

MODEL 185A AVERAGE READING WATTMETERS				
Model	**Frequency**	**Power Range, Watts**	**Max. Power Dissipation**	**Connector**
185A-15FN	20-1000 MC	0-5/15	15 watts	N
185A-100FN	20-1000 MC	0-30/100	100 watts	N
185A-500FN	20-1000 MC	0-150/500	500 watts	N

Note: 185A series accuracy ±5% full scale maximum VSWR 1.2. 195A series accuracy ± 10% full scale, pulse width 1.0 μsec minimum, repetition rate 400 pps minimum. Female connectors standard.
Sierra also manufactures calorimeter wattmeters; details on request. Data subject to change without notice.

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Average-Reading Sierra 164 series Bi-Directional Power Monitors cover 25 MC to 1000 MC with as few as two plug-in elements. Each plug-in covers broad frequency range and has full scale power ranges of 1, 5, 10 and 50 watts or 10, 50, 100 and 500 watts. Power is read direct on linear scale within ± 5% full scale. Insertion VSWR less than 1.08 (Type N connectors) except on 1 watt ranges. 50 ohm impedance available with Type N or UHF connectors. No auxiliary power required.


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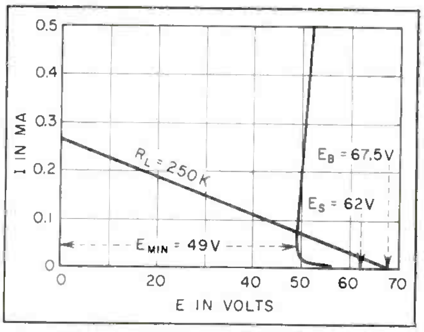


FIG. 1—Typical voltage-current relations for one type of neon tube

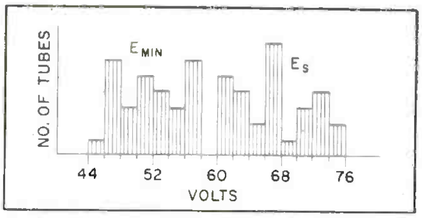


FIG. 2—Distribution of minimum running and striking voltages for one type of neon pilot lamp used in demonstrator

are brought out to access terminals on the front panel and the Lucite construction permits easy inspection of the wiring.

▶ Lamp Characteristics—The basis of circuit operation lies in the characteristics of the neon lamp. Figure 1 shows a typical *E-I* characteristic for the NE51 lamp. In this case the minimum running voltage E_{min} is 49 volts, while the striking voltage E_s is 62 volts. The 250-kilohm load line indicates an operating point of 74 microamperes when operated with a 67.5 volt battery and a 250-kilohm load. Figure 2 shows the distribution of minimum running voltage E_{min} and striking voltage E_s for a small number of lamps.

For satisfactory multivibrator operation with a 67.5-v battery, it is necessary to select lamps.

▶ Flip-Flop—The basic flip-flop circuit in a stable state is shown in Fig. 3 with tube *A* conducting and maintaining a tube drop of 49 volts. At this time tube *B* cannot conduct since the voltage across it is 56.5 volts, which is below the striking voltage.

The circuit is triggered by applying a 10-v positive pulse to the common cathode junction *K* causing the conducting tube, (in this case tube *A*) to be extinguished. At the end of the trigger pulse, tube *B* will strike by virtue of the retained 7.5-v charge on capacitor *C*, which favors tube *B* with a larger applied voltage. When tube *B* conducts, the charge on capacitor *C* reverses its polarity during a short recovery period. A subsequent trigger pulse on point *K* will extinguish *B* and cause *A* to go into conduction.

▶ One-Shot—If the anode load of tube *B* is changed to 430 kilohms, as shown parenthetically in Fig. 3, the circuit will be stable only when tube *A* is conducting. The application of a 10-v trigger pulse to point *K* causes *A* to extinguish and *B* to conduct. However, the current through *B* is reduced by the larger load resistor, and the voltage across *A* during the recovery period is now allowed to rise above *A*'s striking voltage. When *A* strikes, *B* is extinguished because of the capacitive coupling, and the circuit again becomes stable. When

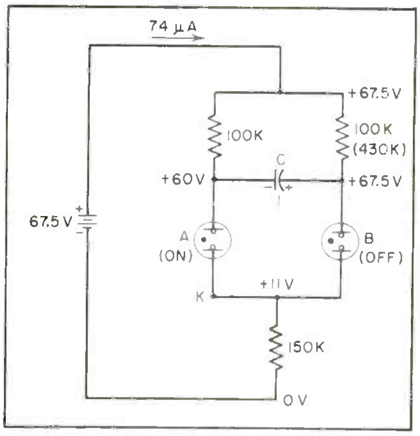
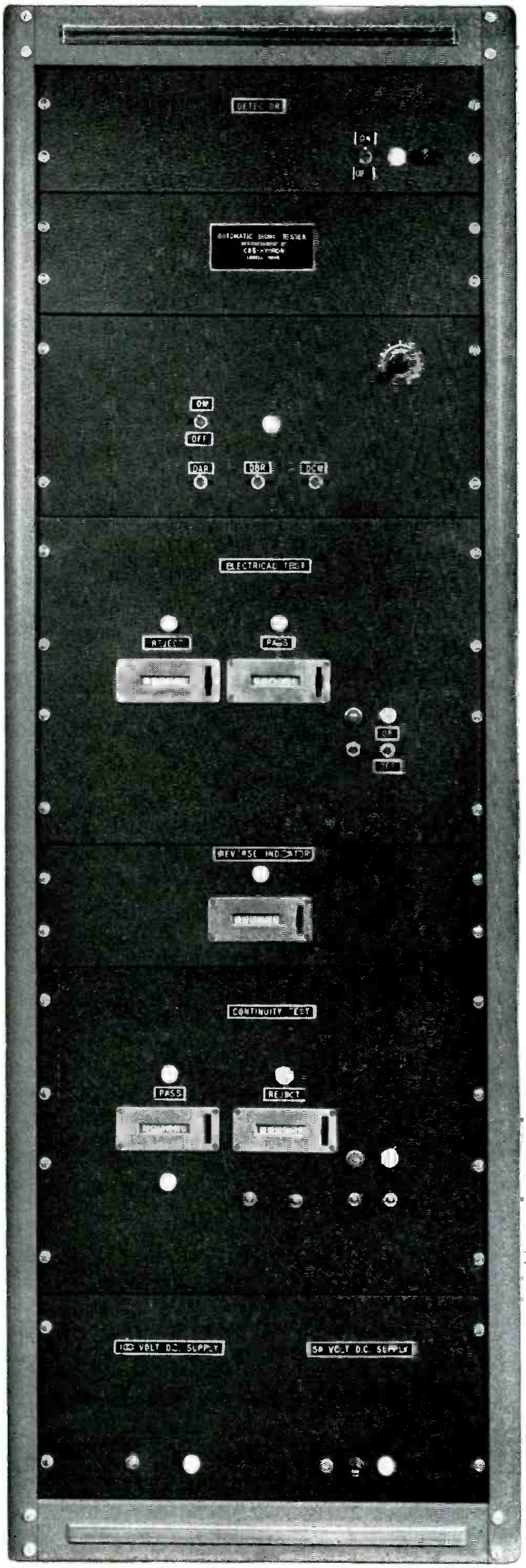


FIG. 3—Basic one-shot multivibrator circuit used in demonstrator

capacitor *C* is 1μf, the duration of *B*'s conduction is about 0.25 second.

▶ Free Running—When the original circuit of Fig. 3 is altered by changing the common cathode load to 27 kilohms, and tube *A* is conducting, a voltage will build up across *B* in excess of its striking voltage, causing *B* to conduct. At this point, *A* is extinguished by the capacitive coupling and the re-



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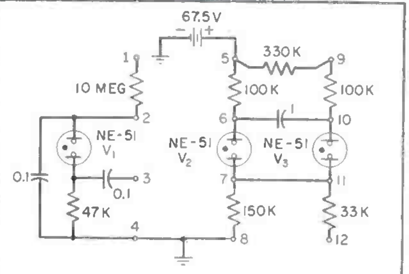

CONNECTIONS	OPERATION
5-9	FLIP-FLOP
1-5; 3-7; 5-9	TRIGGER DRIVEN FLIP-FLOP
NO CONN	ONE-SHOT MULTIVIBRATOR
1-5; 3-7	TRIGGER DRIVEN ONE-SHOT
5-9; 8-12	SYMMETRIC FREE-RUNNING MULTI
8-12	ASYMMETRIC FREE-RUNNING MULTI

FIG. 4—Demonstration multivibrator circuit with connections given

verse operating process begins.

▶ **Asymmetric**—To obtain a free-running multivibrator with asymmetric periods, the 27-kilohm resistor is retained in the common cathode and 430,000 ohms is placed in the anode load of tube *B*. The period of conduction of tube *A* is then increased to about 0.5 second, while that of tube *B* remains at 0.15 second.

The complete circuit of the multivibrator demonstrator is shown in Fig. 4. The numbers refer to the front panel connections. The shorting bars have been omitted for clarity, but the table shows the operations obtained when shorting bars are placed as indicated in the connections column. The multivibrator proper consists of V_2, V_3 and associated components. Tube V_1 and its associated circuit is a relaxation oscillator arranged to produce a positive trigger pulse at pin 3, with a repetition rate of one pulse per second.

Cardiac Analysis

SPARE TIME duty of Lockheed's IBM 650 computers is analysis for Nash Cardiovascular Foundation in Los Angeles. The heart's total activity is made up of many contractions, flutters, valve actions and other motions. Harmonic content comprises combined frequencies and amplitudes of these motions.

Oscillograms of the heartbeat wave are segmented into about 80 points from which harmonic content is determined. This technique

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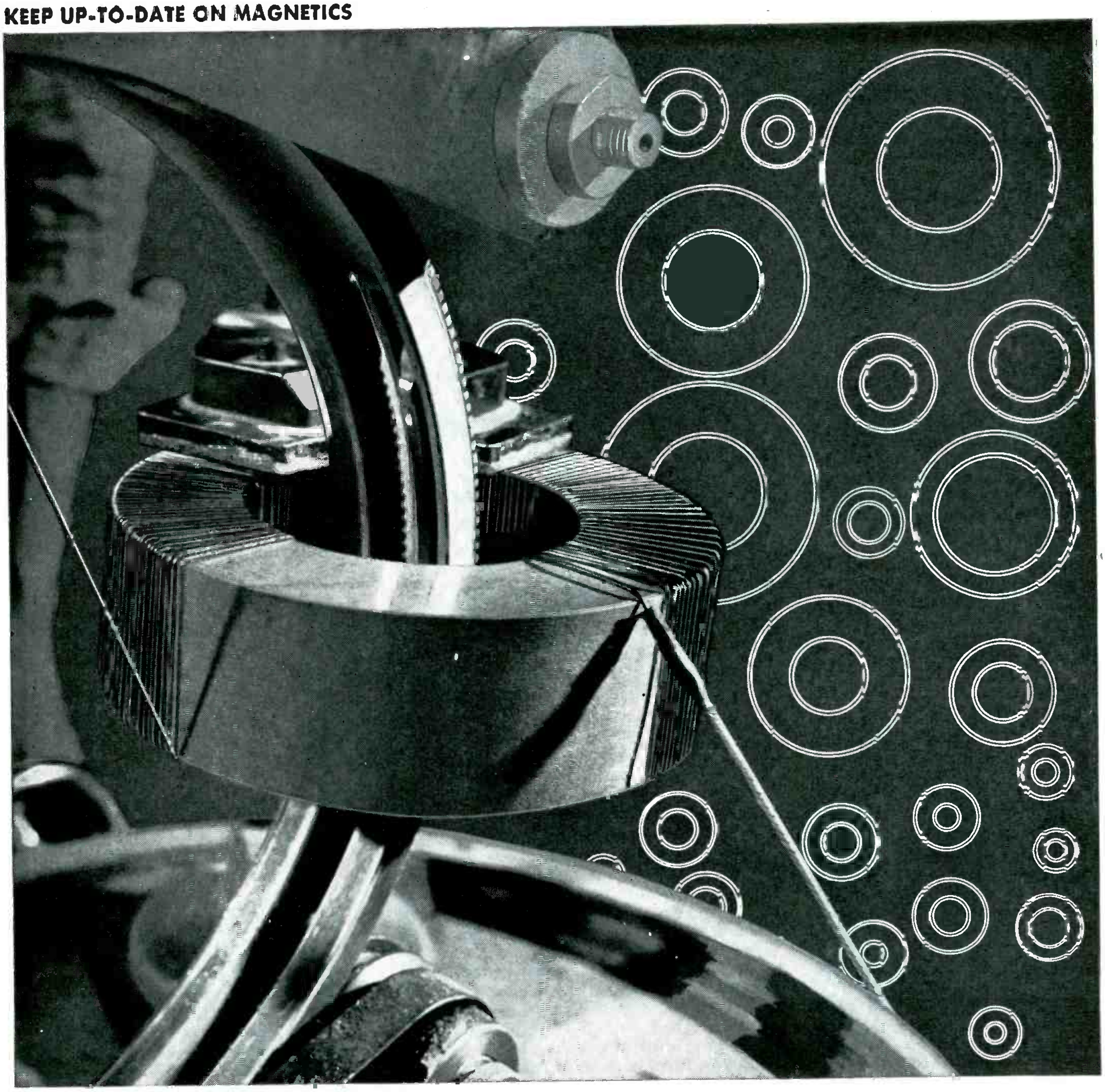

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You can find all specifications for these AIEE-standardized tape wound cores in Catalog TWC-200, a new publication which, incidentally, is the most comprehensive tape wound core text published anywhere by anybody. Your copy of this Catalog-Design Manual may be obtained by writing on your letterhead to *Magnetics, Inc., Dept. E-37, Butler, Pa.*

MAGNETICS inc.

**Paper 57-206, Proposed Size Standards for Toroidal Magnetic Tape Wound Cores. Report of the Magnetic Amplifiers Material Sub-Committee, at the 1957 Winter General Meeting, A.I.E.E.*

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replaces customary electrocardiograms, which do not furnish precise definition between normal and abnormal heart conditions. Compilation of the data is performed through the medium of punched cards that are fed into the computers.

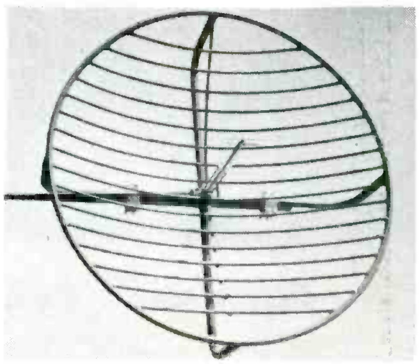
Decoupling Between Microwave Antennas

By E. F. Harris
Chief Engineer
Mark Products Co.
Morton Grove, Ill.

INFORMATION on the amount of decoupling available between parabolas that must operate close together on the same tower, particularly as repeaters, is important when planning microwave systems.

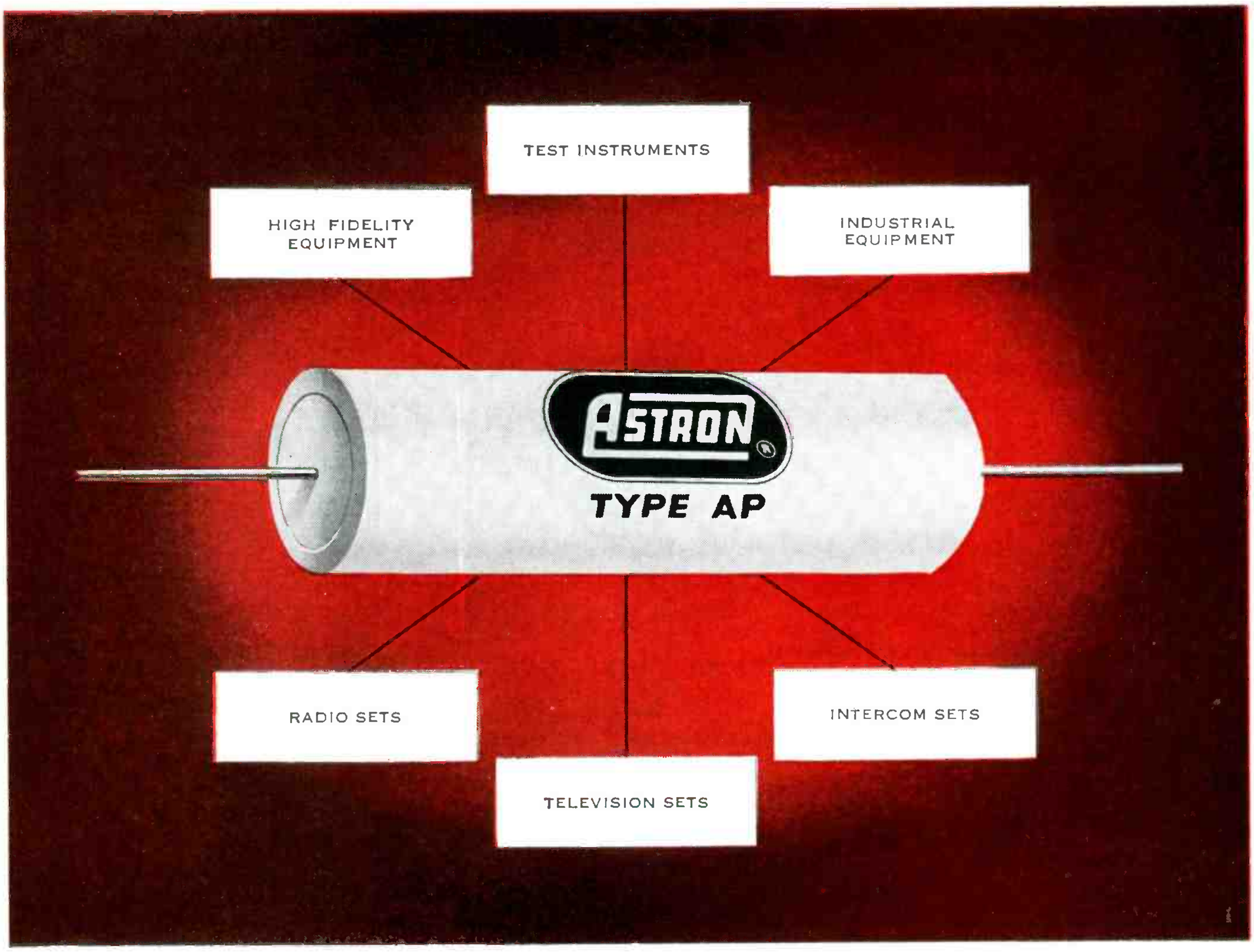
The multielement grid parabola illustrated closely reproduces the pattern and gain properties of a solid dish of the same size. Decoupling in operation at 920 mc has been measured. Tests were performed using two 6-foot parabolas.

Measurements were made in an open field with the parabolas lying on the ground facing up to simulate side-tower mounts with both parabolas facing in the same direction. A 0-db reference level was established by feeding signal generator output directly to the test receiver through the complete cable assembly used to connect to the two antenna so the cable losses were eliminated in the measurement.



Typical grid parabola type antenna

▶ **Decoupling**—Difference in levels between reference and that measured through the antennas as



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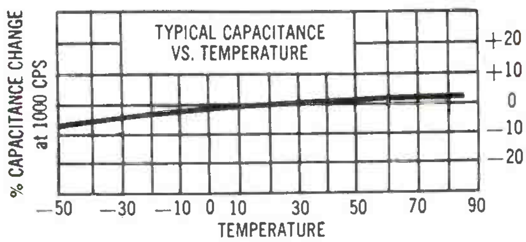

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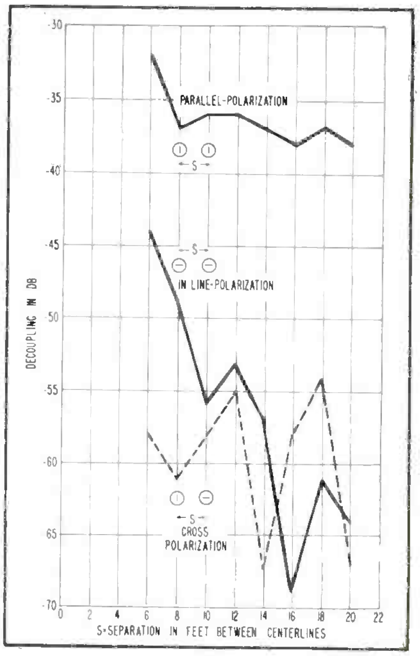
coupling medium is taken as the decoupling. Three orientations were used. Parallel polarization indicates that antennas were oriented so feed dipoles were parallel. In-line polarization implies that feed dipoles are collinear while cross polarization means that feed dipoles are cross polarized.



Graphical results of antenna decoupling tests at 920 megacycles

With parallel polarization decoupling remains constant within 2 db for all spacings from 8 to 20 feet as shown in the graph. In-line polarization provides more decoupling with some discontinuities. A maximum of decoupling was measured at 16 feet for this condition.

At close spacings, cross polarization is most effective but with greater spacings, there is little choice between the two.

Electrostyl Writer

From France comes word of an electronic typewriter that is actuated by contact between a metal stylus and the contact studs of a plastic keyboard. The equipment comprises an electric typewriter, an electronic brain and the stylus-stud combination.

▶ **Phrases**—Each stud corresponds to a sound or word and by brushing

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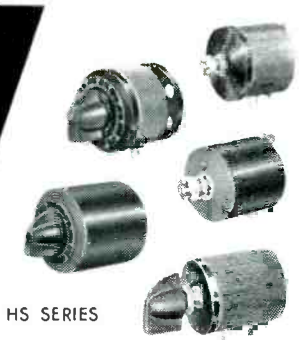

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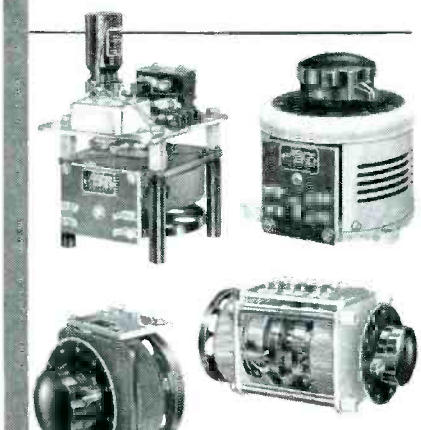

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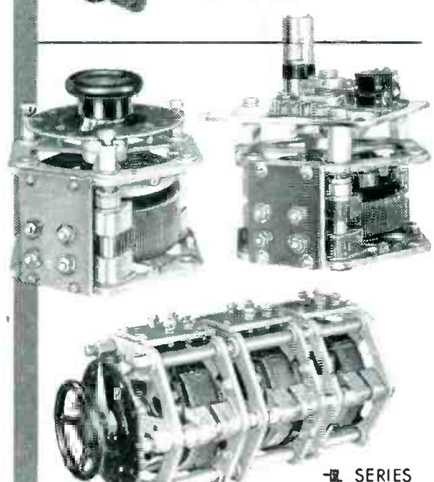

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SINGLE PHASE														
28	400/800	0–28	2.0	.056	Open	3HS02UK	Knob	0.5	0.9					
28	400/800	0–28	4.0	.112	Open	3HS04UK	Knob	0.8	1.2					
120	400/800	0–120 or 0-140	1.0	.14	Open	1HS01UK	Knob	0.9	1.3					
120	400/800	0–28	2.6	.073	Open	1RHS03UK	Knob	0.6	1.0					
120	400/800	0–120 or 0–140	3.0	.42	Open Square Frame	1HMS03UK	Knob	2.4	2.8	DM1HMS03U	28 Volt D-C	60	4.5	5.1
										AM1HMS03U	120 Volt A-C, 400 Cycles	60	4.5	5.1
120	400/800	0–120 or 0–140	7.5	1.0	Open Square Frame	1HMS07UK	Knob	3.4	3.8	DM1HMS07U	28 Volt D-C	60	5.5	6.1
										AM1HMS07U	120 Volt A-C, 400 Cycles	60	5.5	6.1
120	400/800	0–120 or 0–140	15.0	2.1	Open	1HL15UK	Knob	11.4	14.0	DM1HL15U	28 Volt D-C	60	13.2	16.2
										AM1HL15U	120 Volt A-C, 400 Cycles	60	13.2	16.2
240	400/800	0–240 or 0–280	3.0	.84	Open Square Frame	2HMS03UK	Knob	3.4	3.8	DM2HMS03U	28 Volt D-C	60	5.5	6.1
										AM2HMS03U	120 Volt A-C, 400 Cycles	60	5.5	6.1
240	400/800	0–240 or 0–280	9.0	2.5	Open	2HL09UK	Knob	12.8	15.4	DM2HL09U	28 Volt D-C	60	14.6	17.6
										AM2HL09U	120 Volt A-C, 400 Cycles	60	14.6	17.6
THREE PHASE														
240	400/800	0–240 or 0–280	3.0	1.5	Open	2HMS03UK-3Y	Knob	7.6	8.5	DM2HMS03U-3Y	28 Volt D-C	60	9.3	10.5
										AM2HMS03U-3Y	120 Volt A-C, 400 Cycles	60	9.3	10.5
240	400/800	0–240 or 0–280	7.5	3.6	Open	2HMS07UK-3Y	Knob	10.6	11.6	DM2HMS07U-3Y	28 Volt D-C	60	12.3	13.6
										AM2HMS07U-3Y	120 Volt A-C, 400 Cycles	60	12.3	13.6
240	400/800	0–240 or 0–280	15.0	7.3	Open	2HL15UK-3Y	Knob	34.5	41.0	DM2HL15U-3Y	28 Volt D-C	60	38.0	45.0
										AM2HL15U-3Y	120 Volt A-C, 400 Cycles	60	38.0	45.0
480	400/800	0–480 or 0–560	3.0	2.9	Open	4HMS03UK-3Y	Knob	10.6	11.6	DM4HMS03U-3Y	28 Volt D-C	60	12.3	13.6
										AM4HMS03U-3Y	120 Volt A-C, 400 Cycles	60	12.3	13.6
480	400/800	0–480 or 0–560	9.0	8.7	Open	4HL09UK-3Y	Knob	39.0	45.5	DM4HL09U-3Y	28 Volt D-C	60	42.5	49.5
										AM4HL09U-3Y	120 Volt A-C, 400 Cycles	60	42.5	49.5

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them with the stylus the electronic system responds by typing characters on a sheet of paper. In effect, the machine eliminates the stage of stenography between dictation and the finished letter or report.

It is claimed that a typist can easily learn to type at a speed of 12 signs a second. Sentences containing as many as 56 letter units can be written by touching the appropriate stud only once.

The brain contains 57 tubes, 10 relays and 45 coils as well as capacitors and resistors.

Rectangular Dark-Trace Tube

By K. H. J. Rottgardt and G. Heller
C. Lorenz AG
Stuttgart, Germany

Development of dark-trace tubes was treated as a classified subject in Germany in World War II. After several years of inactivity, a tube has been commercially produced designed to serve the following main purposes:

(1) To display on the tube screen for any convenient period an image produced by a single scan of the electron beam.

(2) To be applied to industrial television with raster frequencies around 0.1 cs, that is, where a picture is only displayed every ten seconds.

(3) To operate in radar ppi display units.

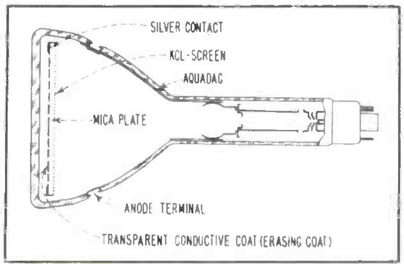
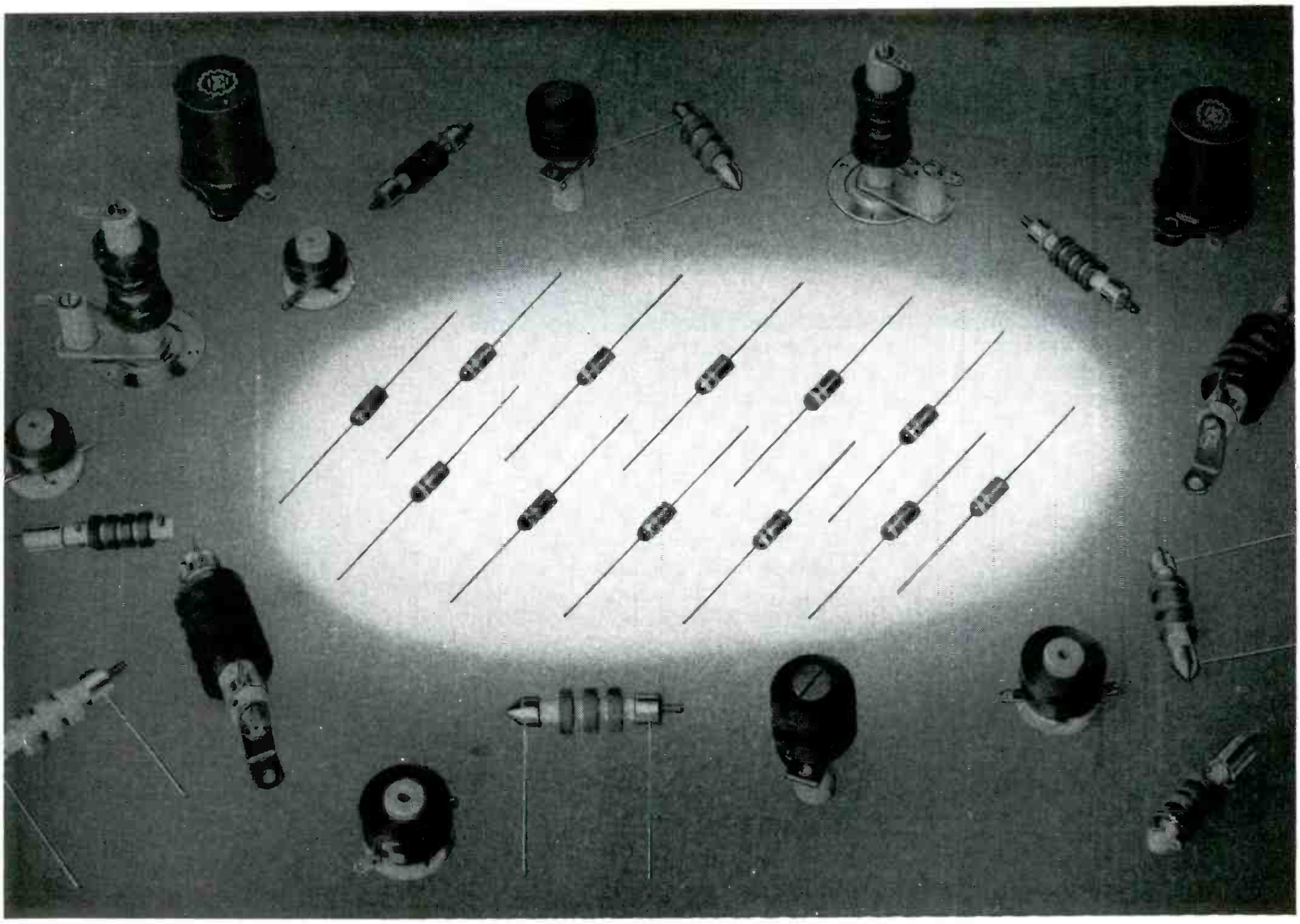


FIG. 1—Sectional view of dark-trace tube

Figure 1 shows a section through the tube. Close to the faceplate, a mica plate is mounted; a potassium-chloride coating evaporated upon this plate on the gun side is the actual tube screen. On the other side of the mica plate is a transparent, conductive layer con-



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Millen DESIGNED for APPLICATION encapsulated coils provide another advance in the r-f inductor field. Modern application requires miniature, heat and cold resistant, hermetically sealed, and abrasion resistant r-f inductor assemblies. The James Millen Manufacturing Company has pioneered many advances in the r-f inductor field, including the now standard 4 pi r-f choke, the axial lead r-f choke, and the miniature r-f choke. Developments have now made possible another advance, the No. 34301 and No. J301 encapsulated inductors—hermetically sealed—miniature size. Ambient temperature minus 55 degrees to plus 100 degrees C.

NO. J301 MINIATURE ENCAPSULATED INDUCTANCES

DESIGNED for APPLICATION miniature inductances are: extremely small (see table at right)—hermetically sealed—wound on axial lead Carbonyl cores—color coded. Coils are available in RETMA standard values plus 25, 50, 150, 250, 350, 500, and 2500 microhenries. Coils are three layer solenoids up to 350 microhenries. From 360 to 2500 microhenries coils are pi-wound. Current rating 50 to 600 milliamperes depending on coil size. Inductance ± 5%. Special coils on order.

NO. 34301 STANDARD ENCAPSULATED INDUCTANCES

Encapsulated DESIGNED for APPLICATION axial lead phenolic form r-f inductances. Hermetically sealed—heat resistant—abrasion proof—color coded. 1 to 350 microhenries available in RETMA standard values plus 25, 50, 150, 250, and 350 microhenries. Inductance ± 5%. Values available in same progression as J301 coils listed in the table at the right. Solenoid winding for 1 to 15 microhenries. Universal pi winding from 20 microhenries to 350 microhenries. Current rating 250 to 1500 milliamperes, depending on coil size. Ambient temperature range—minus 55 degrees to plus 100 degrees Centigrade. Size: 3/8 inches diameter × 7/8 inches long. Special coils on order.

COIL NUMBER	INDUCTANCE MICROHENRIES	DIAMETER INCHES	LENGTH INCHES
J301-25	25	3/16	9/16
J301-33	33	3/16	9/16
J301-47	47	3/16	9/16
J301-50	50	3/16	9/16
J301-82	82	3/16	9/16
J301-100	100	3/16	9/16
J301-120	120	3/16	9/16
J301-150	150	3/16	9/16
J301-200	200	3/16	9/16
J301-220	220	3/16	9/16
J301-250	250	3/16	9/16
J301-300	300	3/16	9/16
J301-330	330	3/16	9/16
J301-350	350	3/16	9/16
J301-360	360	7/32	5/8
J301-390	390	7/32	5/8
J301-430	430	7/32	5/8
J301-470	470	1/4	11/16
J301-500	500	1/4	11/16
J301-510	510	1/4	11/16
J301-560	560	1/4	11/16
J301-620	620	1/4	11/16
J301-680	680	9/32	3/4
J301-750	750	9/32	3/4
J301-820	820	9/32	3/4
J301-910	910	9/32	3/4
J301-1000	1000	9/32	3/4
J301-1200	1200	5/16	13/16
J301-1300	1300	5/16	13/16
J301-1500	1500	5/16	13/16
J301-1800	1800	5/16	13/16
J301-2000	2000	3/8	7/8
J301-2200	2200	3/8	7/8
J301-2400	2400	3/8	7/8
J301-2500	2500	3/8	7/8

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

MALDEN, MASSACHUSETTS, U S. A.

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nected to two terminals of which one is also the anode contact. When a voltage is applied to these terminals, the transparent coating will heat, causing the image written on the screen to be erased. The mica plate is flexibly mounted to compensate for thermal expansion. The tube has magnetic focusing, a

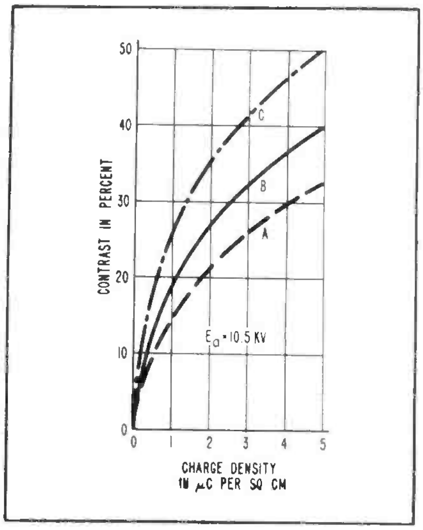


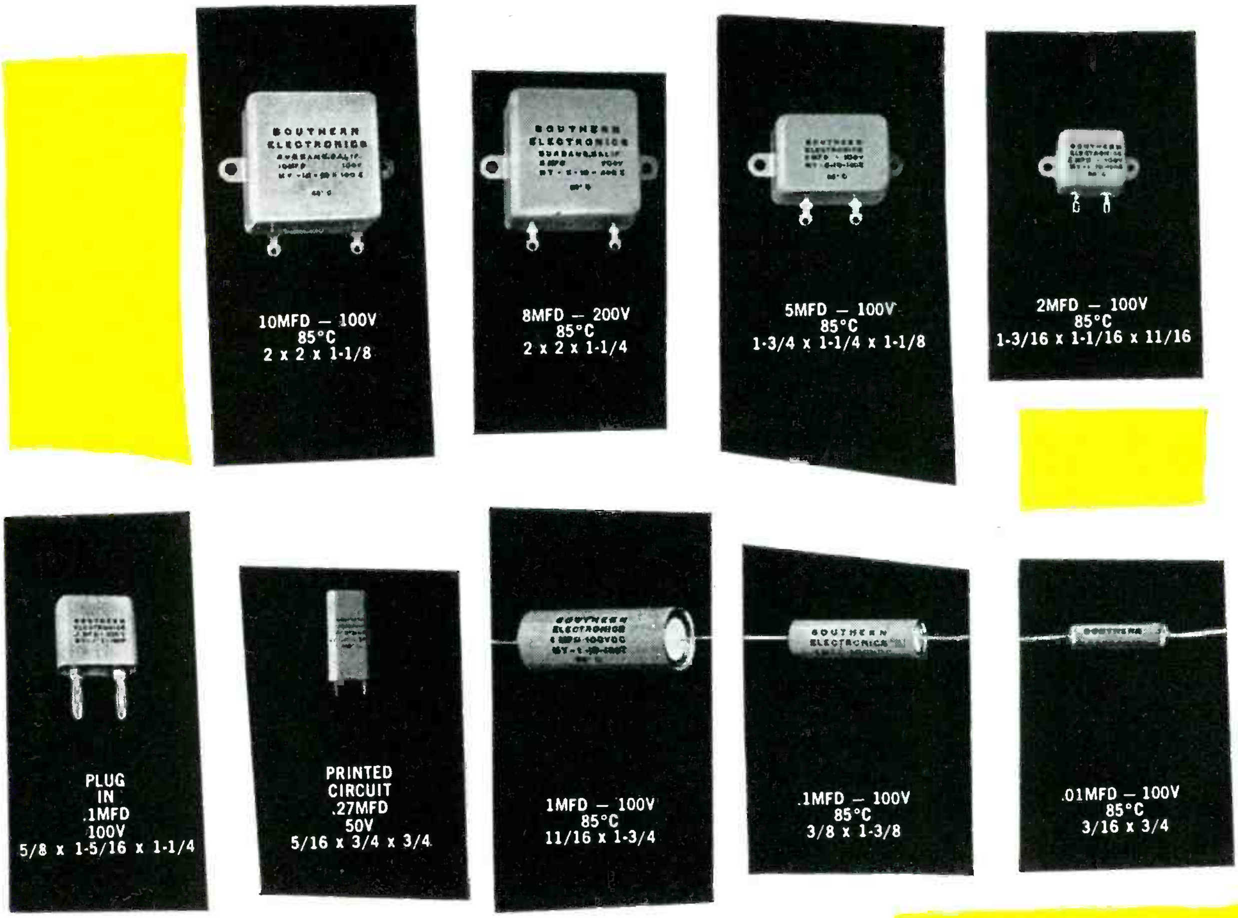
FIG. 2—Screen sensitivity of tube

70-deg deflection angle and can be operated with anode voltages between 7 and 14 kilovolts.

Sensitivity of the screen is shown in Fig. 2. The curve represents the contrast measured three seconds after a single scan with a rectangular raster, as a function of the charge density applied to the screen by the electron beam and expressed in microcoulombs per sq cm. Curve *A* denotes the minimum sensitivity of this tube type, curve *B* is the average curve for 50 tubes and curve *C* the average of the four most sensitive tubes produced to-date.

When these measurements are taken, the tube is illuminated by an external light source producing a radiant intensity of 1,200 lux on the tube screen. The light reflected from the screen is measured after conversion in a photocell. The spectrum of the light source, the photocell and a filter inserted in front of the photocell is so selected that the measured light corresponds in its spectrum to the absorption curve of the color centers in a potassium-chloride crystal.

To erase the picture written on the screen, 75 watts is applied to



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the conductive erasing coat on the mica plate. This causes the written information to fade away within ten seconds. Figure 3 shows the contrast 10 seconds after a single scan at a charge density of one microcoulomb per sq cm as a function of the power applied to the erasing coat. At 75 watts, contrast drops to zero. When the erasing voltage is switched off, the tube regains its original state within 15 seconds.

The duration of a dark-trace picture depends on the radiant intensity of light applied to the

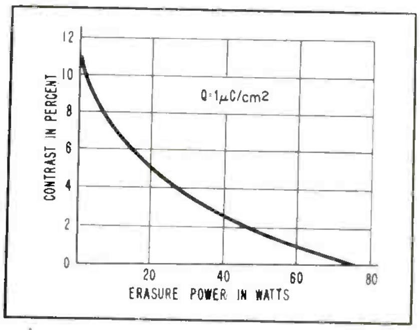


FIG. 3—Contrast 10 sec after switching off dark-trace writing beam

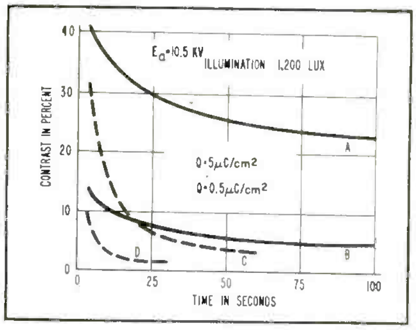
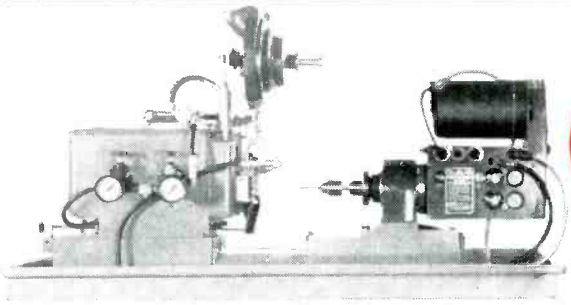


FIG. 4—Decay of contrast at room temperature (solid) and with 15-watt erasing power applied (dashed)

screen, screen temperature and initial contrast, that is, on the charge density Q of the electron beam.

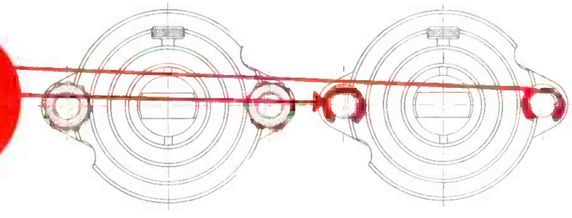
The solid curves in Fig. 4 show the decay in room temperature of two rasters of which one was written with a charge density of 0.5 and the other with one of 5 microcoulombs per sq cm. These curves were plotted while the screen was illuminated by 1,200 lux, referred to the screen area. Without any change in the illumination, rasters written with the same two charge densities Q were measured while

Waldes Truarc Retaining Rings Eliminate Machining and Parts—Cut Assembly Time on Drill and Tapper



Beco Model 410 Drill and Tapper

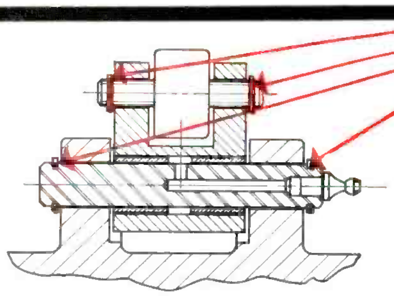
The Batchelder Engineering Co., Inc., Springfield, Vermont uses 4 different sizes of 2 different type Waldes Truarc rings in their new BECO Model 410 Automatic Drill and Tapper. Truarc rings speed assembly, reduce machining, improve design.



ALTERNATE DESIGN TRUARC DESIGN

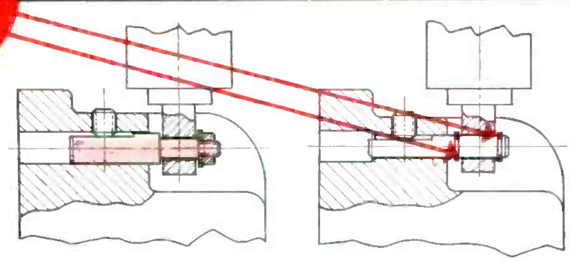
Clamp Cylinder Rod Stop Assembly

Truarc "E" Rings (Series 5133) replace stop nuts in the Clamp Cylinder assembly. They eliminate need for threading 2 rods ...the danger of cross-threading nuts...and costly rejects. Truarc Rings cut assembly time and cost.



Bell Crank Pivot Assembly

Truarc Rings (Series 5100) in Bell Crank Pivot assembly permit grease hole not possible with cotter pin fastener. Use of nuts would have increased machining and assembly costs considerably.



ALTERNATE DESIGN TRUARC DESIGN

Hopper Cylinder Anchor Pin Assembly

2 Truarc Rings (Series 5100) secure and position end of vertical air cylinder. Rings eliminate extra cost of machining 3-diameter pin, threading and undercutting... plus nut and washer. Assembly is quick and sure.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

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their contrast decayed under the thermal effect of 15 watts constantly applied to the erasing coat. Measurements of the decaying contrast are given by the dashed curves. Duration of a picture, or of its decay, can be arbitrarily varied by varying either the charge density Q or the erasing power constantly applied to the screen or both.

Brightness gradation is also essential in some industrial applications and radar display units. As shown in Fig. 5, twelve gradation steps are available in the dark-trace tube when the information written on the screen has an initial contrast of 40 percent, while only

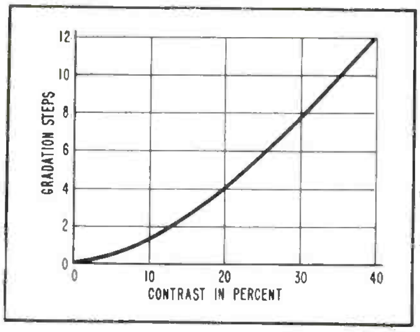
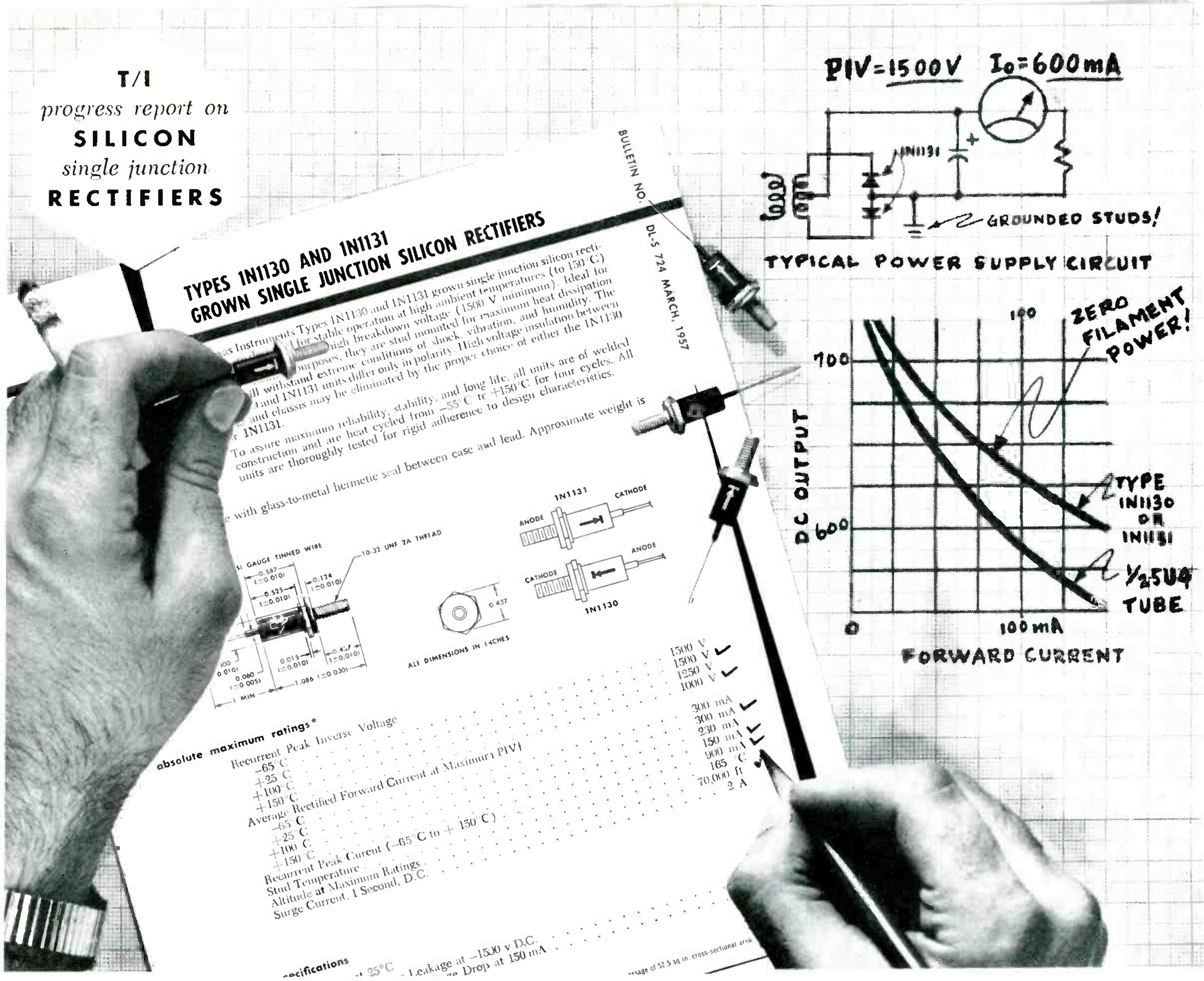


FIG. 5—Brightness characteristic

four steps can be discerned by the eye when the initial contrast is 20 percent. The contrast gradation from step to step must amount to at least 3 percent to discern each step.

Writing speed depends on the desired persistence of the picture, which can be adjusted from a few seconds with constant erasing voltage to many hours at room temperature. The writing speed can be increased by increasing beam current, resulting in an increased charge density, for any given persistence.

Since an increased beam current will impair the picture resolution, the writing speed depends also on the resolution that is required. Figure 6 shows the writing speed as a function of picture persistence for a beam current of 100 microamperes, obtained by a single scan with sinusoidal deflection currents of various frequencies. At a beam current of 500 microamperes with a persistence of about 30 seconds,



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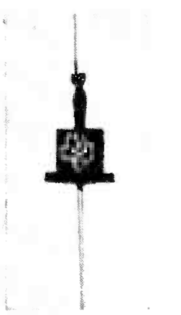
NEW TI 1500 V, 300 mA RECTIFIERS

You can replace 5R4 and 5U4 rectifiers with TI's new single junction rectifiers in many applications. In a fraction of the space, you will get instant operation at high temperatures with *zero filament power*. Here are some significant ratings of these new Texas Instruments Types 1N1130 and 1N1131 (differing only in polarity):

VALUE	AMBIENT TEMPERATURE 25°C	150°C
PIV	1500 V	1000 V
I_f (at max. PIV with heat sink)	300 mA	150 mA

Designed to meet stringent military requirements, these TI rectifiers give you the ultimate in hermetic seal protection. The standard RETMA stud is of *copper* for optimum performance and the hex base assures high-torque chassis mounting. High voltage insulation between stud and chassis can be *eliminated* by proper choice of either 1N1130 or 1N1131.



400 V, 750 mA TI TYPE 1N540
ECONOMICAL *diffused* RECTIFIER
***lower* FORWARD VOLTAGE DROP**

Reliability of your power supplies is assured by this rectifier . . . giving you cooler operation. Typically, at 150° C, they give you 0.64 V voltage drop at 250 mA and 0.20 mA reverse current at 250 V.

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a writing speed of 650 meters per second is available.

To test the effects of noise, a line-frequency controlled pulse signal was mixed with noise (20 cs to

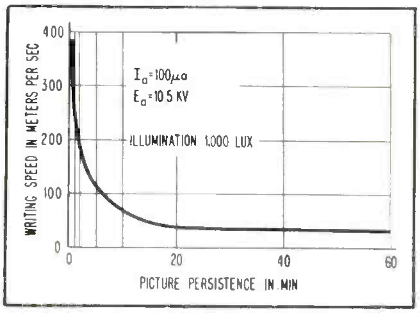

FIG. 6—Writing speed as function of required persistence

20 kc) at a ratio 1 to 0.5 of the peak value of the useful signal to the effective value of the noise signal in a mixer stage. The pulse duration of the useful signal was 10 μsec. This mixture was fed to the control grid of the dark-trace tube. Besides the vertical line produced on the screen by the signal, the rest of the screen area showed irregularly distributed dots originating from the noise peaks.

This effect was brought about by one scan. The signal was now switched off and during the next 18 complete scans, repeated in intervals of 10 seconds, only the noise peaks were allowed to be written on the screen. However, at the end of this test the useful signal was still clearly visible.

Attenuator Box Errors

By RICHARD BISHOP
Arenberg Ultrasonic Laboratory, Inc. Jamaica Plain, Mass.

IT IS DESIRED to know what error there is in the gain and impedance of a ladder of π-network resulting from errors in the individual components. These errors can be given in percentages since the accuracy of the components is thus specified.

It is assumed the errors are small enough that second-order terms may be dropped. The results work equally well for sufficiently small complex errors, such as stray capacitances might introduce.

To make the computations feasible, one section was isolated at a

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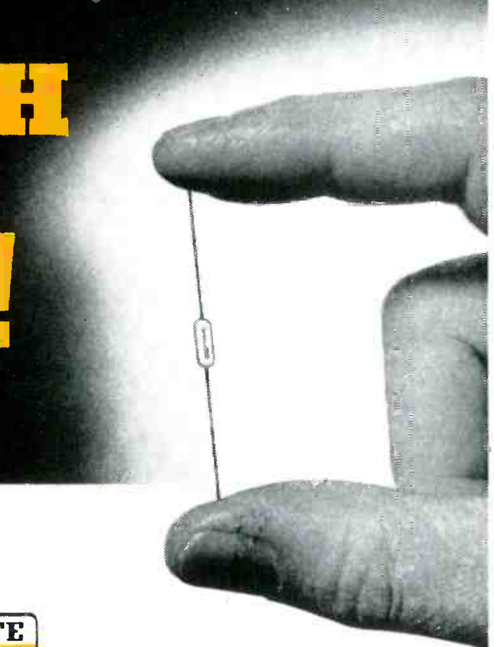

New Clevite Germanium-Silicon Alloy Gold Bonded Glass Diodes, now available for immediate delivery.

- **Better high temperature performance than germanium.**
- **Higher forward conductance at lower voltages than silicon.**

All germanium RETMA specifications can now be met at higher temperatures with these new Germanium-Silicon alloy diodes... plus increased reliability at all temperatures.

For complete information write or phone for Engineering Bulletin B-215.

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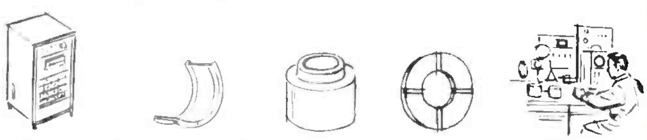

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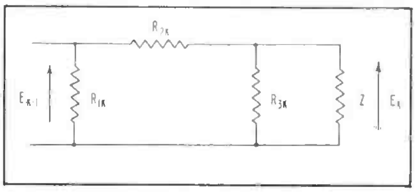

Representative section of attenuator

time as indicated in the circuit drawing. The resistors are determined theoretically by the attenuation desired, the requirements that the π be symmetric and that the input and output impedance be equal.

In practice, the resistors can be obtained with values at best within ± 1 percent of the desired values. The actual gain and input impedance are given by equations, derived from circuit analysis, involving the actual resistances and output impedance. Hence the errors in the gain and the input impedance are functions of the errors in the three resistors and the output impedance.

By expanding the formulas in a Taylor's series in many variables and retaining only the linear terms, the errors in the gain and the input impedance may be expressed approximately as a linear sum of the errors in the resistors and the output impedance. The coefficients of the linear sums will be functions of the theoretical values of the gain and impedance. The errors for several stages may then be combined by substitution and simplification of the linear formulas.

When this is done, it is found that the error in the impedance cannot be great; generally the percentage error will not exceed the percentage error in the individual resistors used.

In the linear form expressing the error in the gain it was found that the coefficients of errors of resistors in a particular stage depend

Table I—Coefficient Values

Attenuation in db	$a_k (k \neq 1)$	b_k	c_k	$\lvert a_k\rvert + \lvert b_k\rvert + \lvert c_k\rvert$
20	0.409	0.859	0.409	1.677
10	0.260	0.602	0.260	1.122
6	0.166	0.416	0.166	0.748
3	0.086	0.232	0.086	0.404
2	0.058	0.161	0.058	0.277
1	0.029	0.083	0.029	0.131

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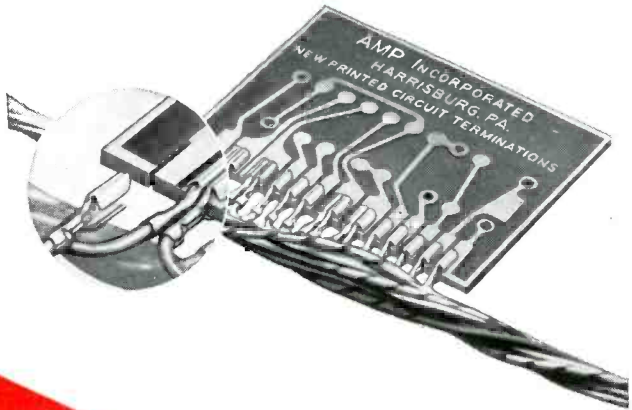

The new AMP-Edge Connector gives you . . .

. . . **greater flexibility**—your printed circuit area and completed unit are not limited by the size of connection, as found in alternate methods of edge connection.

. . . **greater design versatility**—they can be applied in any arrangement to any section of the perimeter of the printed circuit.

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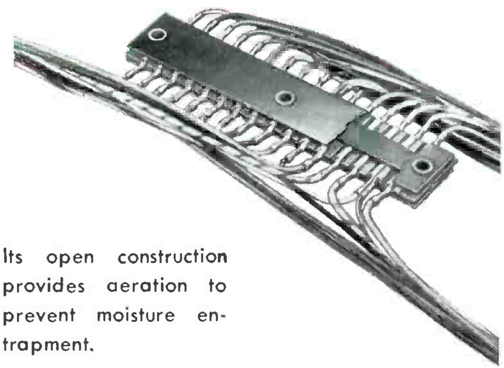

Its open construction provides aeration to prevent moisture entrapment.

For more information on AMP-Edge Connectors, contact:

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Japanese Distributor: Oriental Terminal Products Co. Ltd., Tokyo, Japan

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mainly on the gain of that stage and to a considerably lesser degree on the position of the stage in the ladder. For practical use, the latter effect may be conveniently neglected.

If percentage error in the total gain is denoted by e, the errors in the resistors R_{1k}, R_{2k}, R_{3k} of the kth stage by e_{1k}, e_{2k}, e_{3k}, respectively, and the error in the final impedance by e_o, then the linear form is

$$e = \sum_{k=1}^{n} (a_k e_{1k} + b_k e_{2k} + c_k e_{3k}) + d e_o$$

Computations yield the following values for the coefficients a_1 is always 0, d is approximately 0.5. The remaining depend on the attenuation of the corresponding stage, according to Table I.

When all stages are used in a typical unit of ten stages totaling 122-db attenuation, if all the individual errors have the worst possible values of ± 1 percent, then the error in the gain would be ± 11.2 percent, which is about ± 1 db. Since this would be a rare occurence indeed, it is best to handle the situation statistically.

Considering the manner in which the resistors are manufactured and selected, it is best to assume that they are equally likely to occur anywhere in the -1 percent to $+1$ percent range. This is certainly as bad as any other likely distribution.

Table II—Error Probabilities

Condition in Percent	Bound on error in db	Probability
$\lvert e \rvert < 1.2\%$	0.11	0.5
$\lvert e \rvert < 2.9\%$	0.26	0.9
$\lvert e \rvert < 3.5\%$	0.32	0.95
$\lvert e \rvert < 4.6\%$	0.42	0.99
$\lvert e \rvert < 5.9\%$	0.54	0.999

Under this assumption it is desired to find the distribution of e for the worst possible case with the typical unit, which would be the full attenuation of 122 db. It was found that this distribution was nearly normal with a standard deviation of 2.52 percent. Hence, the probabilities for certain errors may be found from a table of the error function. A part of that information yields the data in Table II.

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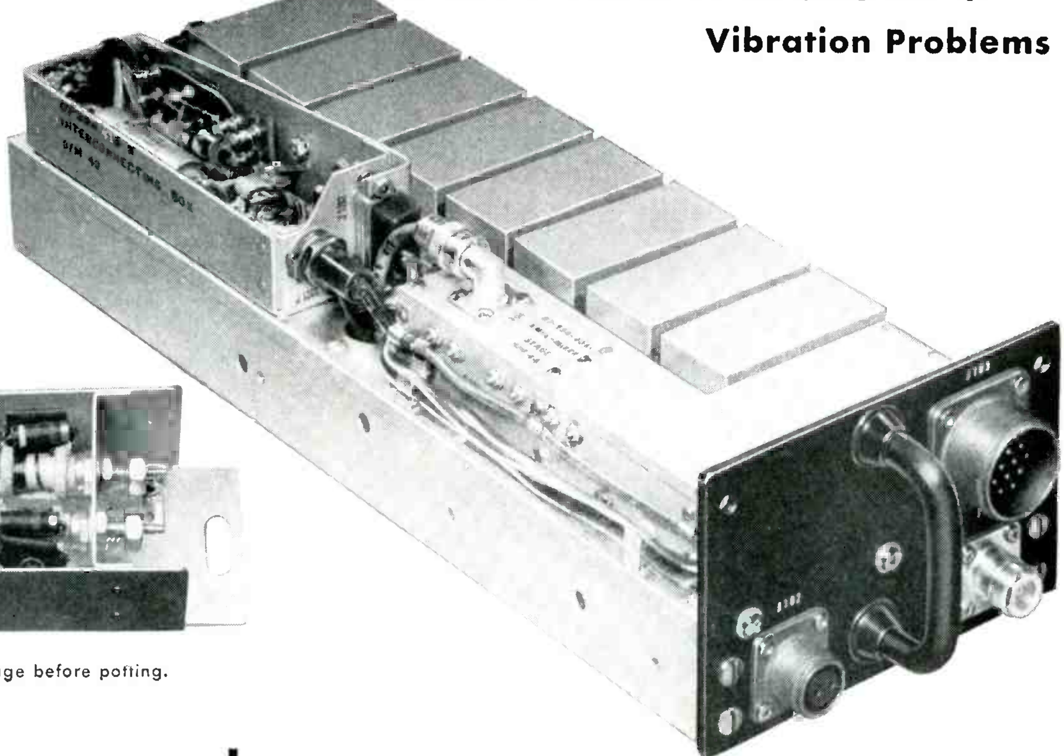

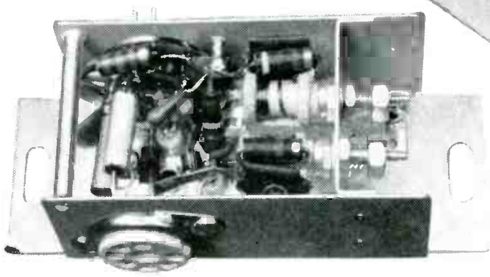

I. F. Modular Package before potting.

ELECTRICAL SPECIFICATIONS

Type: FM 300 KC Deviation

Tuning Range: 406 to 420 megacycles Plug-in assemblies to extend range to 500 mcs available

Oscillator: Crystal controlled

Sensitivity: 5 microvolts or better for 10 db quieting

Input Impedance: 50 ohms

Bandwidth: 1.15 mcs $\pm$ .1 at 3 db

Image and Spurious Response: Better than 60 db

Output: $\pm$0.5 db 40 cps to 40 kc 3 db at 100 kc 3.5 volts RMS 500 ohms closed circuit

Squelch: Adjustable squelch relay from 10 to 100 microvolts input

Power Input: Less than 50 watts. Power supplies available for 400 cycles per second 115V or 28VDC

MECHANICAL SPECIFICATIONS

Dimension: 3.6 x 5.5 x 15.25 inches. Volume 300 cubic inches

Weight: 10 pounds

Mounting: Solid mounting 9 mounting screws

Operating Environments: 15g's 5 to 2000 cycles -55° to +72°C

Bell Aircraft's recent breakthrough in Modular Packaging Techniques was utilized in this rugged, 400 megacycle receiver designed to meet the exacting vibration requirements of Bell's own missiles and guidance systems. It is immediately available for commercial or military applications where demodulated control signals for the activation of any communications system requiring a high signai-to-noise ratio, high sensitivity, high stability, and a wide audio bandwidth with low harmonic and phase distortion are needed. The receiver is equally efficient as a radio controlled receiver for guided missiles...as a ground telemetering instrument...or as either a ground or airborne communications receiver.

The modular construction of the plug-in units in this revolutionary new 400 megacycle receiver also facilitates fast, easy servicing. A comparable 500 megacycle receiver is in the final stages of development.

This is but another example of the engineering imagination of Bell Aircraft's Avionics Specialists in solving tomorrow's complex problems today.

For complete information on these receivers or any other avionic units, systems or components write, wire or phone: Sales Manager, Avionics Division, BELL AIRCRAFT CORP., Post Office Box One, Buffalo 5, N. Y.

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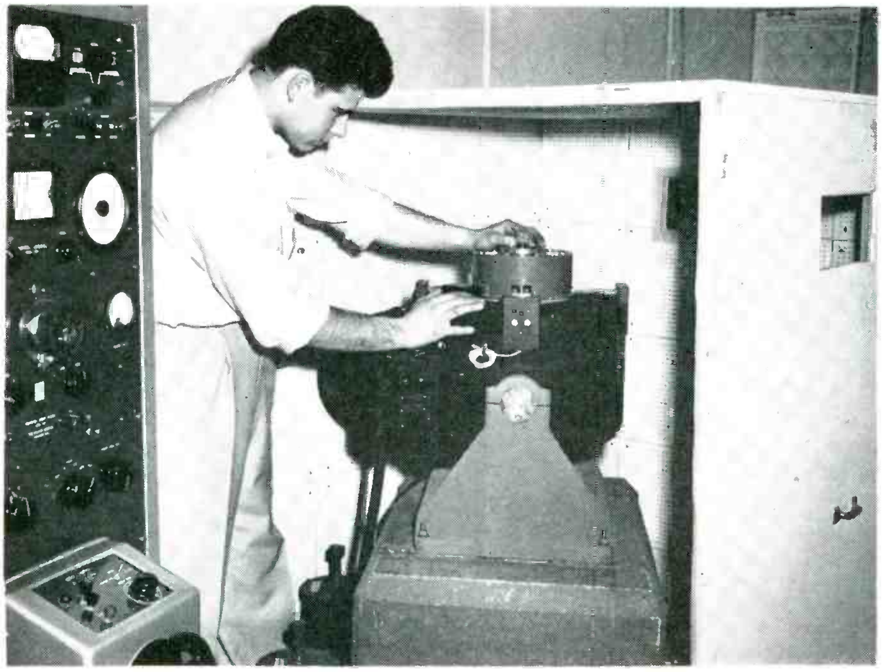
Production Techniques

Edited by JOHN MARKUS

Sound Booth Reduces Shaker Noise During Vibration Tests



Placing servo motor on shaker in preparation for severe vibration test over wide frequency range, using driving power supplied by frequency sweep cycler on Calidyne M64 control console. Many tests can be run without closing up the fourth side, particularly if this is arranged to face a wall on which the fourth side is resting with the tile facing out. Booth is easily moved away from shaker

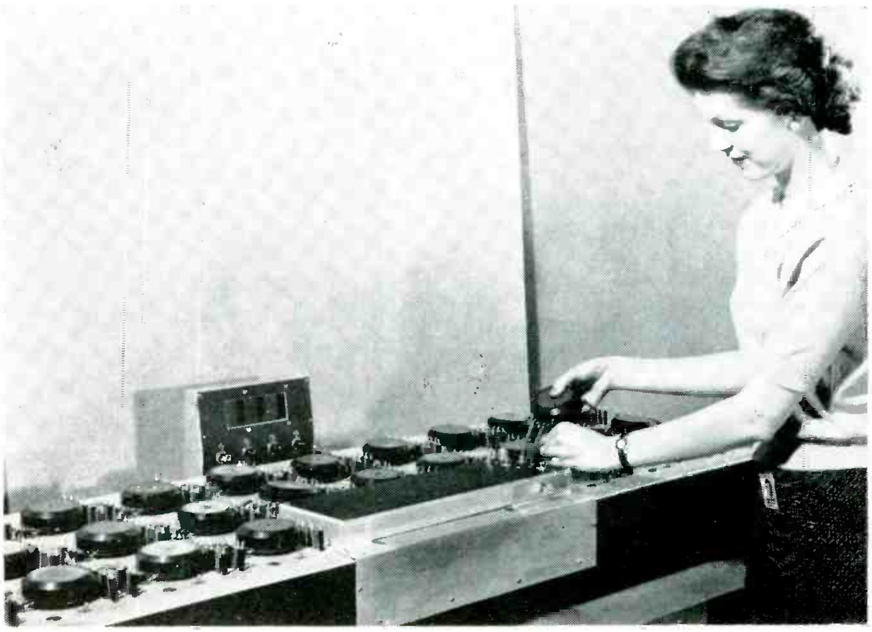
EAR-SPLITTING SOUNDS associated with frequency sweeping of a Calidyne Model C44 shaker during vibration tests of servo motors are effectively suppressed by sliding a simple sound booth over the shaker. Tests can be run now well up into the audio range without stopping production in the vicinity as workers hold their hands over their ears.

► **Construction** — The booth designed for this purpose in the Mechatrol Division of Servomechanisms, Inc., Westbury, N. Y., uses ordinary ¾-inch plywood nailed together for the three sides and the top. The fourth side is left loose, and held in position by hooks and eyes after equipment has been set up for a test. Ordinary acoustic tile is nailed to all inside surfaces of the booth. Small windows cut into two sides permit watching the test. Handles screwed to the sides of the booth serve as grips.

Transformer Turns-Ratio Tester Has Digital Read-Out

AN AUTOMATIC turns-ratio tester checks the electrical relationship between the number of turns in multiple windings of any transformer in the Baltimore Air Arm Division plant of Westinghouse Electric Corp. This machine was designed for high-volume one-type test, with some variations of parameters. It consists of an automatic turns-ratio bridge and card-controlled programmer, displaying a digital read out.

One loading accommodates 24 transformers of the same type, with up to five windings each. The machine will step ahead as long as the turns-ratio falls within limits programmed into the punched cards. If the turns-ratio does not fall within the allowable tolerance, the machine will stop, indicating the actual turns-ratio on the digital display. One indicator lamp shows



Ratio of turns between primary winding and each secondary winding of each transformer in turn appears as three-digit number in windows of box at rear. Curved prods on test leads hook over transformer terminals quickly and easily

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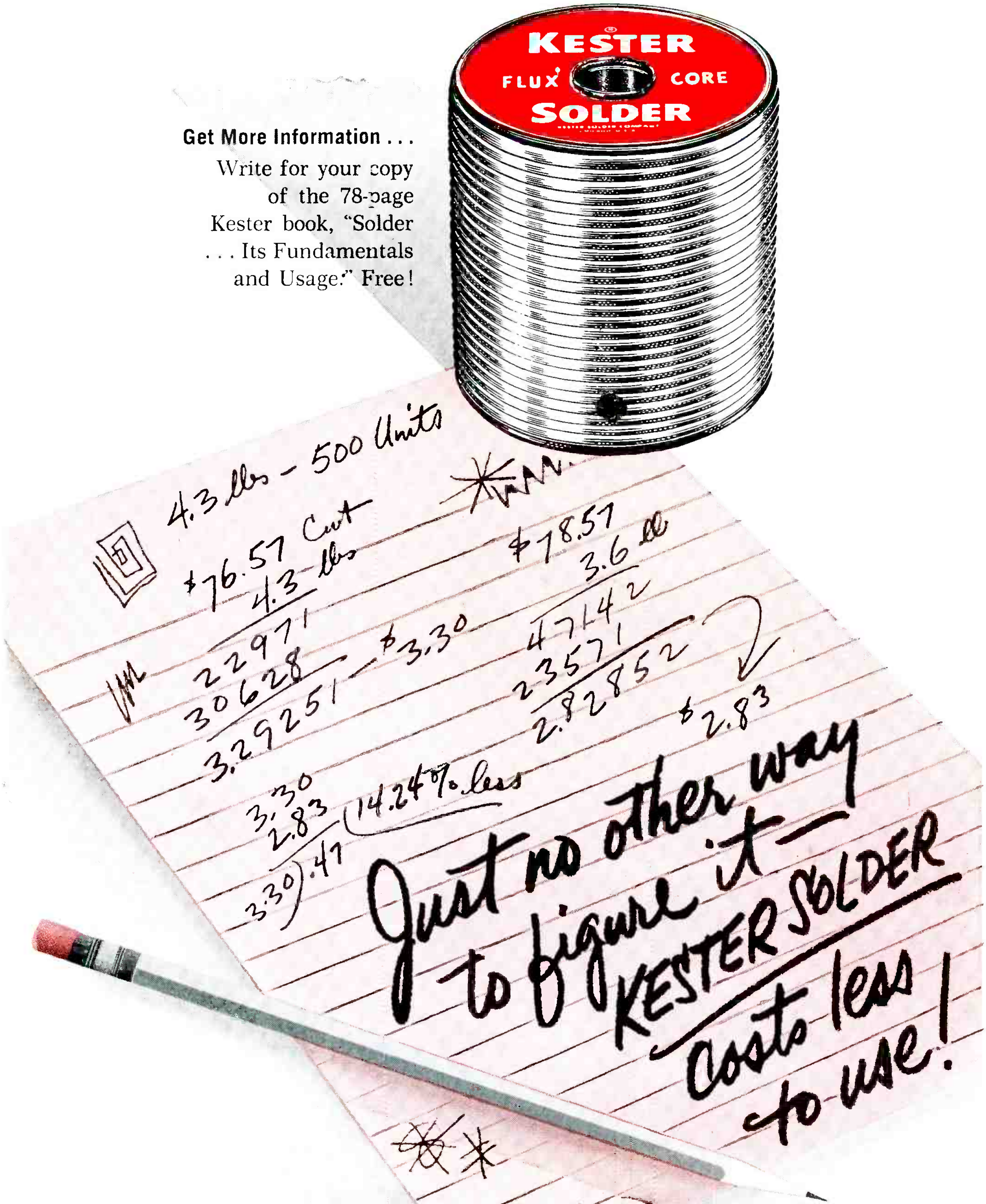

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the operator which transformer failed, and another indicator lamp shows which winding of that transformer failed.

The basic accuracy of the a-c ratiometer in the unit is ±0.01 percent of full scale. Since only three digits are read, this gives an operating accuracy of better than ±0.05 percent for normal transformer use. The transformers can be loaded onto the test instrument, tested and unloaded in 6 minutes.

The automatic turns-ratio test set enables an operator to perform turns-ratio testing ten times as fast, much more accurately and much more reliably than present manual equipment. This machine reduced the labor content of the operation by 90 percent.

Winding Servo Motor Coils On Aluminum Take-Apart Mandrel

EIGHT CONNECTED COILS for the stator of a servo motor are wound on a special ten-piece metal mandrel in the Mechatrol Division plant of Servomechanisms, Inc., Westbury, L. I., N. Y. The design permits taping the coils before they are removed from the mandrel.

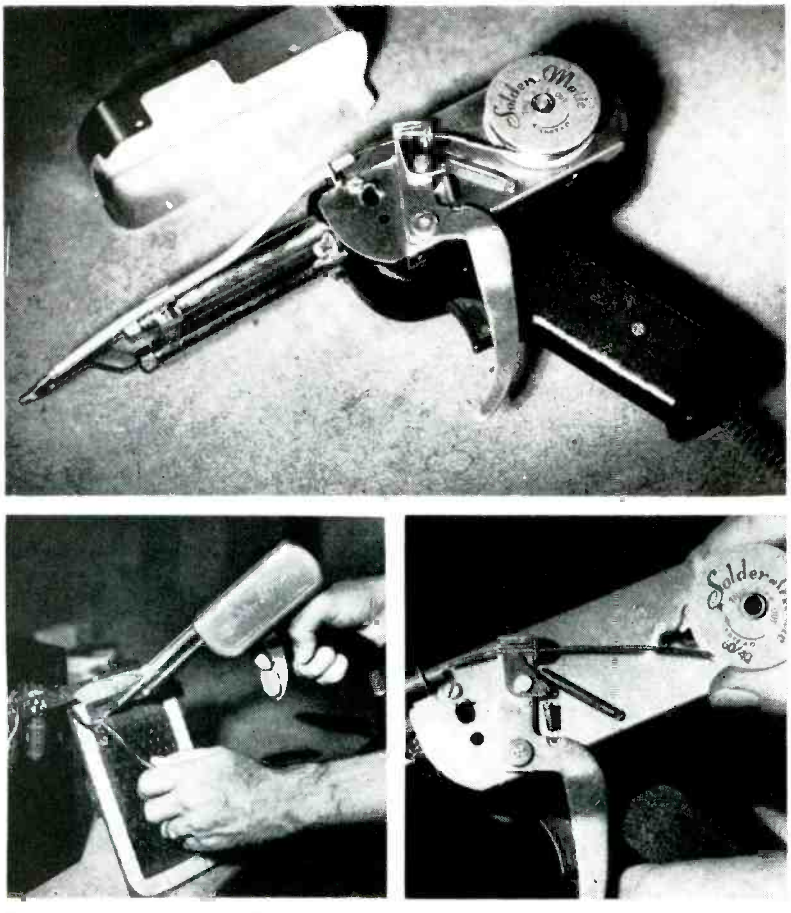
The first step in the winding operation is placing lengths of self-adhesive Teflon tape on opposite sides of the assembled mandrel, adhesive side out with the ends held by spring clips. The mandrel is then inserted in the winding machine, the magnet wire is secured to the mandrel at the starting end to anchor it and winding of the first coil is started. When the attached counter indicates the correct number of turns, the drive motor stops. The wire is then shifted to the next guide pulley and moved into the next section of the mandrel by looping through slots that give the required wire length between coil sections. After resetting the counter, the operator proceeds to wind the second coil. The procedure is repeated until all eight coils have been wound.

Winding a set of coils on take-apart mandrel. Wire is pulled through overhead tensioning pulley over end of spool at right rear on bench

▶ **Unloading** — After taking the mandrel out of the winder, the operator quickly and cleanly slits the tape between coils on each side. With a flat-blade tool, she then presses the tape tightly over each With a flat-bladed tool, she then coil to provide insulation between the coils and the sides of the stator slots.

Loosening a wing nut now permits disassembly of the ten-piece mandrel to release the group of eight connected coils. The operator

Design of the Month: SOLDER FEED



Solder-matic attachment for soldering guns feeds solder from spool through guide tube to tip of gun, in response to pull on trigger located alongside operating trigger of gun. Arrangement leaves other hand of operator free to hold work, thereby speeding soldering operations and improving quality of joints. Attachment is held in place by two long bolts which replace regular housing bolts of the approximately 4 million Weller and Wen guns now in use. Solder is furnished on throw-away spools, each holding 1/8 lb of 50-50 or 60-40 rosin-core solder. Spools can be rewound if desired. To change spool, snap off cover, remove empty spool, put on new spool, and feed solder through guide hole and trigger ratchet into guide tube; pull trigger a few times until solder emerges from tube, to complete loading. Each pull advances solder about 1/2 inch. Attachment is made by Atlas Mfg. Co., Inc., Montgomery, Ala.

FORMING GAS ATMOSPHERE FOR BRIGHT ANNEALING OF TUBE PARTS

By reacting ammonia with air in the presence of a specially developed catalyst, BAKER's Nitroneal Gas Generator produces pure nitrogen with a controllable hydrogen content, completely free of oxygen, for furnace brazing and bright annealing of stainless steel. The hydrogen content contained in the generated gas can be varied to meet the changing requirements of the electronics field, and can be maintained, within close tolerances, at any desired percentage between 0.25% and 25%. Economy is one of the major factors of this equipment. The cost of the nitrogen produced by the Nitroneal Generator is found to be many times cheaper than an equal amount of cylinder nitrogen.

Briefly, the other salient features of the Nitroneal Generator are: **Safety**—all danger of explosion is eliminated, high concentrations of hydrogen are never present; **Fully Automatic**—no operating personnel required, changes in pressure or load are automatically compensated; **Uniform Analysis**—gas composition remains constant within 0.25% of the set point; **Quick Starting**—the catalytic reaction is exothermal, there are no heating elements to prevent immediate action; **Flow Range**—operation anywhere in the range of from 25% to 100% of rated capacity without change in gas composition; **Portability**—a single unit, connections to a 110 volt line, water, air and ammonia lines and drain are all that are required; **Minimum Maintenance**—the catalyst lasts indefinitely, maintenance costs are practically nil.

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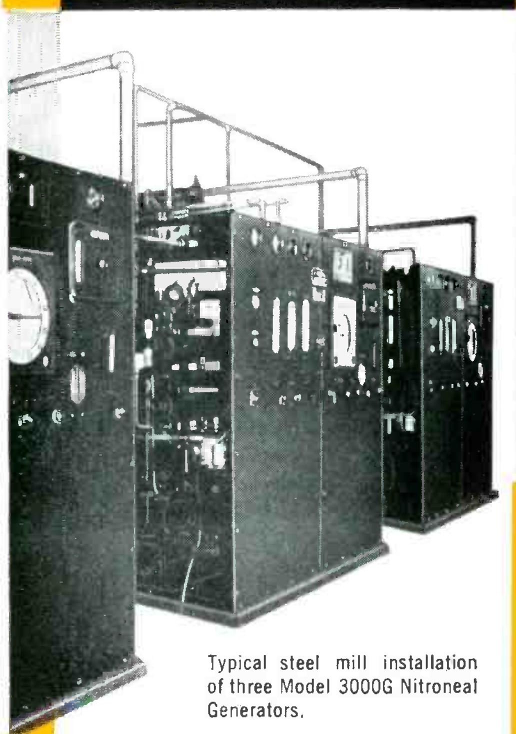
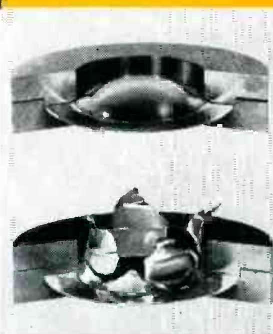


Typical steel mill installation of three Model 3000G Nitroneal Generators.



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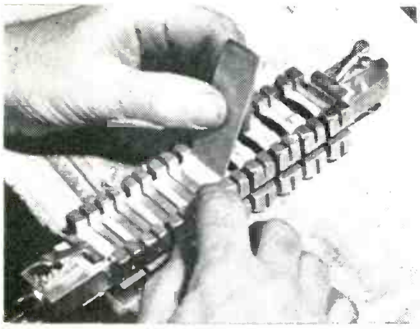
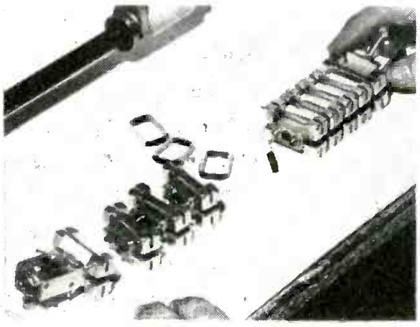


Method of folding tape over completed coil. Operator uses flat blade to lift end of tape up from mandrel and push it smoothly and tightly over coil.



Sections of mandrel are taken apart one by one to allow finished coils to drop out, after removing bolt which holds sections together

separates the sections one by one and allows the completed coils to drop out. Each section has two guide pins on one side and mating holes on the other side, to facilitate reassembly in preparation for winding the next set of coils.

The winding machine, made by Automatic Coil Winder & Electrical Equipment Co., Ltd., Winder House, London SW1, England, is equipped with a variable-speed motor controlled by a rheostat. The motor drives a disk and rubber-wheel speed reducer for the reciprocating mechanism that moves the guide pulleys back and forth at the rear of the winding machine.

Cable Tester for Fire Control Systems

COMPLEX CABLE ASSEMBLIES in airborne electronic equipment are checked out automatically in the Westinghouse Air Arm Division plant in Baltimore, with a 95 percent reduction in labor as compared to conventional methods. Each wire is tested, making sure it is connected to the correct point. The machine then proceeds to hi-pot every wire in the harness.

This machine uses two test voltages; 28 volts d-c serves for continuity tests, and 500 volts d-c for leakage tests. An electronic detector approves or rejects circuits and notifies the operator with lights.

▶ **Indicators**—A matrix chart containing the circuit identification is placed directly on the analyzer. Vertical and horizontal reference

Automatic cable harness tester, mounted on dolly, is easily moved along bench for checking chassis and cable harnesses for large airborne equipment

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lights border the matrix and keep the operator informed of the circuit under test as the machine steps automatically through the circuits. If an error exists, the machine stops. The reference lights pinpoint the circuit in error. The operator observes the open and short lights and marks the error on the matrix, then pushes the reset button which allows the machine to function. At the end of the test, the matrix shows the complete fault pattern.

▶ **Capability**—The machine is capable of testing 200 circuits for continuity, shorts and leakage simultaneously. Adapters can be added to increase the number of tests to 400, 800 or 1,200. The machine is capable of testing multiple circuits with as many as 56 common circuits.

This machine can be set to stop on continuity currents from 0.1 ampere to 2.0 amperes in five steps. It can be set to stop on leakage resistances from 200 megohms to 1 megohm in seven ranges.

The use of this machine has resulted in a 95 percent labor reduction when compared to conventional methods of checking.

Board Vibrator for Dip Soldering Machine

To load machine, operator pushes handle on top with left hand to spread out fingers of holding fixture so wiring board can be inserted with right hand. Fingers grip board when handle is released. Vibrator shakes board as it comes out of molten solder

MORE UNIFORM DIP-SOLDERED printed circuit assemblies are being obtained with a new semiautomatic dip soldering machine developed by Electronic Products Corp. of Santa Barbara, Calif. The circuit boards are dipped into dross-free molten solder which is maintained at a constant temperature. The boards enter and leave the solder bath at an angle with a progressive rolling action. The depth and length of immersion are controlled to close tolerances and excess solder is

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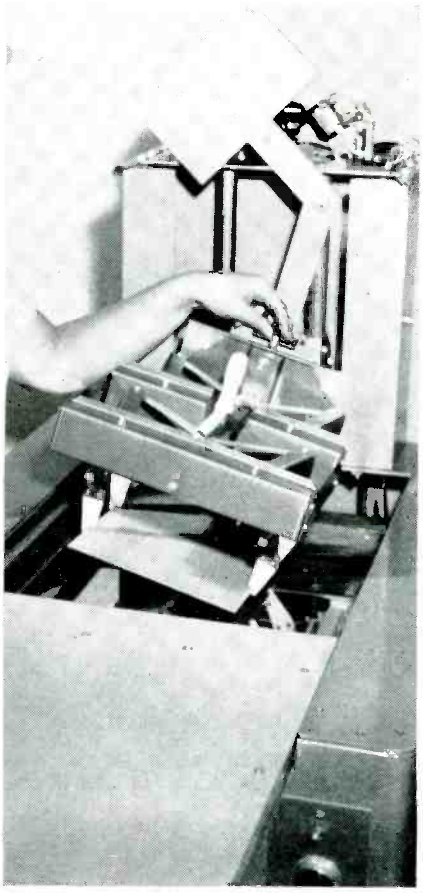
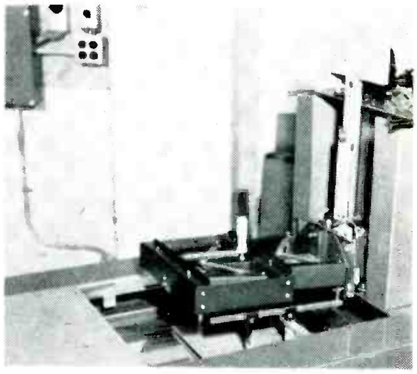
shaken from the work after being dipped.

Solder temperature is adjustable from the beginning solder melting point to 650 F and is held at the present temperature to within 3 F. Dwell time is adjustable in 0.5-second increments from 0 to 57 seconds. Production rate with a single operator and with dwell time set at 12 seconds is 120 pieces per hour.



Method of adjusting depth to which board is lowered into molten solder



Board in solder bath. Operator normally stands at left, where she can easily pull back cover to initiate soldering cycle

▶ **Operating Procedures**—The operator attaches the first circuit board to be dip-soldered to the spring-loaded holding fixture. She then pulls back the lid which normally covers the solder bath, exposing the solder and starting the cycle. Protection from solder splatter is assured since the operator must step back away from the machine when drawing back the lid. A skimmer automatically scrapes the surface of the solder to remove dross.

The circuit board approaches the solder at an angle and with a progressive rolling action. It remains in contact with the solder for the predetermined dwell time and then disengages itself from the solder, again at an angle.

During its upward travel, the circuit board is shaken in a vertical plane by an electromagnetic vibrator to remove loose solder. When the board reaches the upward limit of its travel, the operator closes the lid and reloads.

Universal Etched Circuit for Plug-In Units

By William L. Wise and Frank Bequaert
Dynac Inc., Palo Alto, Calif.

A universal etched circuit plug-in package can be used to cut engineering and production time on small lots of electronic equipment. Once a standard set of the components for building such packages is made up, no further design or production time need be spent on etched circuits or complicated sheet metal parts. If the design engineer builds his circuits directly in these packages, the job of transferring a breadboard into a production design is eliminated.

▶ **Plug-In Design** — Two standard sizes of these packages suffice for most circuits. The plug-in units are made up of a universal etched circuit board, a tube mounting bracket and a metal U frame and base plate. A standard 8-pin or

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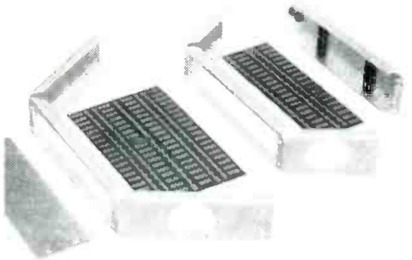
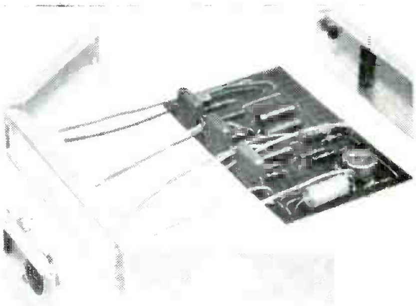


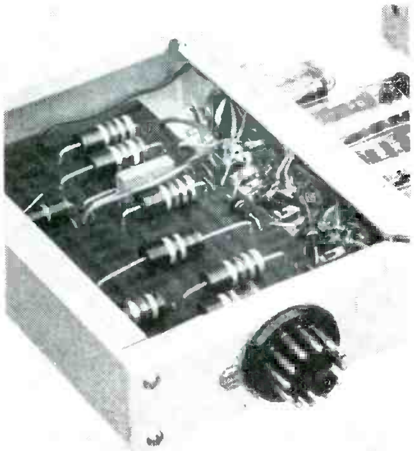
Parts of plug-in packages are, left to right: Tube mounting bracket, large metal U frame, large universal etched circuit board, small metal U frame, small etched circuit board and bottom plate

12-pin plug mounts on one end of the metal frame. The packages are plugged into sockets mounted on a regular instrument chassis.

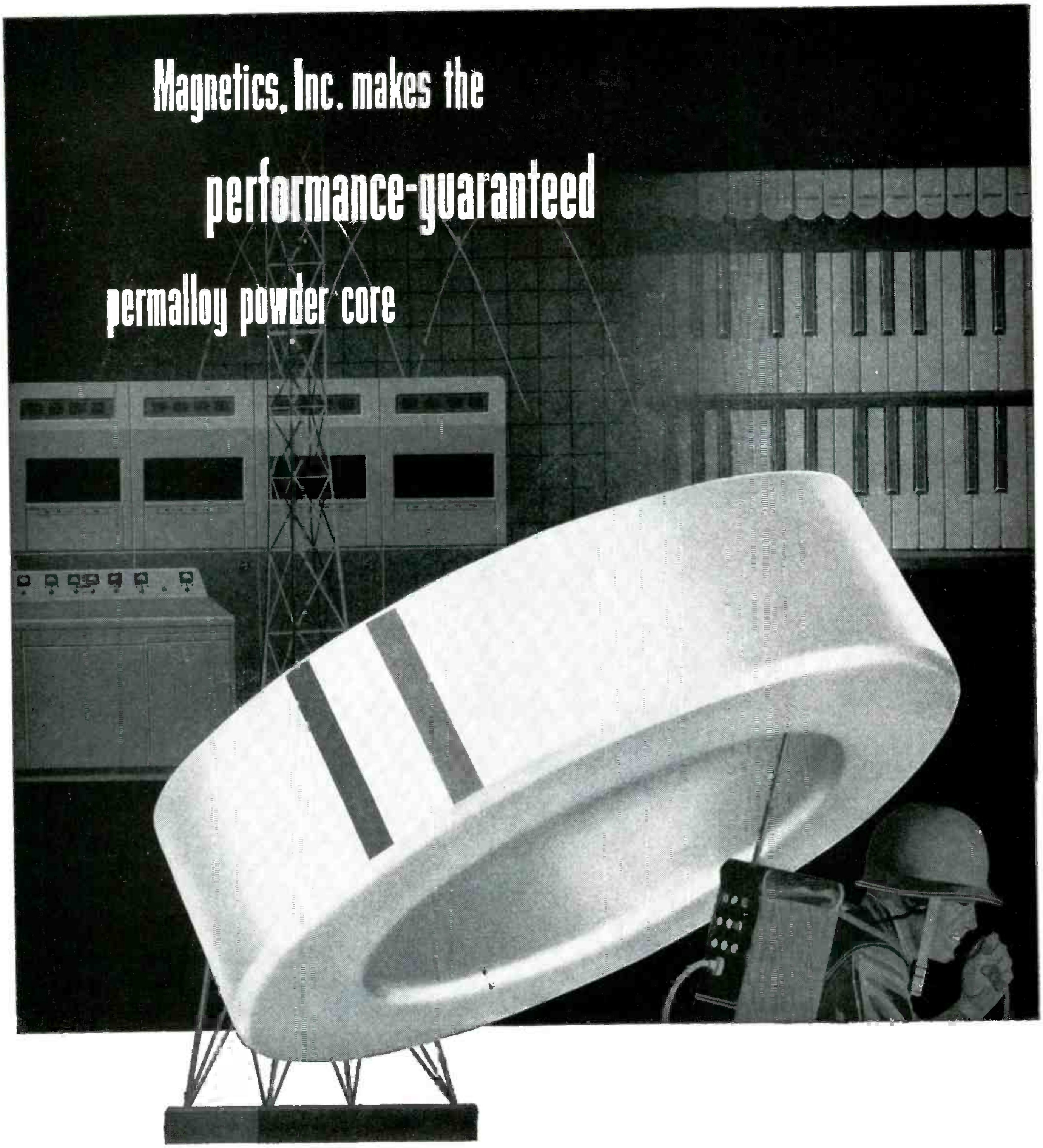
The universal circuit board is an ordinary phenolic board with the wiring configuration etched on one side by the usual drawing and photographic processes. The busses and terminals on the board allow for the neat vertical mounting of up to forty components on the larger board. The small terminals are arranged with three holes



Typical plug-in package ready for final assembly. Twelve-pin plug fits into circular hole in metal U frame



Example of completed plug-in package, holding two cathode followers, Schmitt trigger and triode gate circuit



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During its more than fifty years of lamp, electron tube and semiconductor manufacturing experience, Tung-Sol has had to overcome countless problems in glass to metal bonding. Almost every new product development and design improvement thru the years has presented new technological challenges. The resulting stockpile of experience in sealing glass to metal is one of the reasons for the high quality standards enjoyed by Tung-Sol tubes and semiconductor products.

Tung-Sol Diodes with "ring seal" construction will be supplied in the standard RETMA or JAN types. The Tung-Sol junction-forming technique features an electronically-controlled bonding cycle. The result is a consistently accurate bond which assures maximum uniformity of electrical characteristics.

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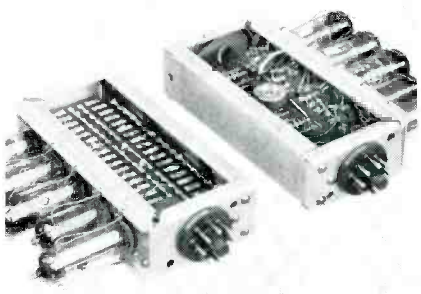
spaced such that ½, 1 and 2 watt resistors mount equally well. Holes may be drilled in the board only where needed for jumpers or component mounting.

A flat metal plate serves as the tube mounting bracket. Holes for mounting tube sockets or other components such as crystals, potentiometers or tubular capacitors are easily punched in it with hand tools. If tube clamps are needed, the edges of the plate are drilled



Two views of 300-v, 150-ma regulated power supply. Etched wiring may be hand soldered or dip soldered

and bent up to provide mounting holes for wire clamps. Otherwise the plate is left flat.

▶ **Applications**—Use of these packages has simplified final equipment layout and eliminated much of the usual work of production engineering. Usually, one plug-in unit is used for each block on an instrument block diagram. This cuts to a minimum the number of connecting wires and components necessary on the main chassis. The universal etched circuit eliminates the usual delays for drawings, photographs and etching when a separate custom circuit board is made for each circuit. Circuit changes can be made quickly, yet the board maintains the neatness and ease of wiring of custom boards.

To build up a plug-in unit, a production worker first attaches components and jumpers to the circuit board. The number of jumpers needed is usually only a few greater than when a custom board is used. The board is then dip or hand soldered. The tube sockets and other components are installed on the punched tube mounting bracket, the bracket is riveted or bolted to the metal U frame, and a plug is installed in the frame. Fitting and wiring the etched circuit board into the unit and attaching the bottom plate complete the assembly.

Air Shipment Pack for Large Magnetrons

By N. V. SUTHERLAND and W. D. MAITLAND
Industrial Engineers
Raytheon Manufacturing Co.
Waltham, Mass.

ALL LARGE MAGNETRONS must be packed with elaborate shielding for air shipment, since the powerful Alnico magnets throw out fields which can affect the accuracy of navigation instruments.

▶ **Old Pack**—Air Force specifications dictate the maximum gauss permissible outside the crates, as well as the packing procedure. The standard pack, which contractors used for several years, meets these requirements but is heavy and bulky.

Cutaway view of old pack, which used six layers of wrapped-on shielding foil

It involves wrapping 0.003-inch steel foil shielding repeatedly around a cardboard unit pack—first three times lengthwise (in the direction of the field) and then three times crosswise. The wrapped cardboard pack is placed in an intermediate wooden container which is nailed tight and wrapped again—twice lengthwise and twice crosswise. Each shielding wrap is sealed with pressure-sensitive tape. The wrapped wooden pack is then placed in a padded shipping crate and the cover is nailed on. This shielded pack gave a shipping weight of 277 lb for the 50-lb magnetron, with a crated volume of 35.3 cu ft.

Cutaway view showing magnetron in new light-weight pack providing adequate shielding for air shipment without degaussing tube magnets

▶ **Drawbacks**—The former shield material was limited in width to approximately 12⅜ inches. The required 180 feet of this strip had to be cut in four different lengths (up to 21 feet long) and taped together in four different widths. These pieces could not be handled in the shipping area without interfering with other shipping operations, hence a special area had to be set aside for the job.

An arbor had to be designed for unrolling the strip because the heavy rolls (500-700 lb) would crease and tear if rolled along the floor. Even with this, the men cut their hands on the razor-sharp edges of the strip. Gloves were provided but proved so awkward that they were discarded after a brief trial. Four men could package only four tubes per day.

▶ **New Material** — A search was initiated for a new shielding material that would permit use of two inexpensive metal boxes with covers in place of the wrapping. The required properties were found in 0.02-inch uncoated Netic steel, supplied by Perfection Mica Co. This material, like mu-metal, has a

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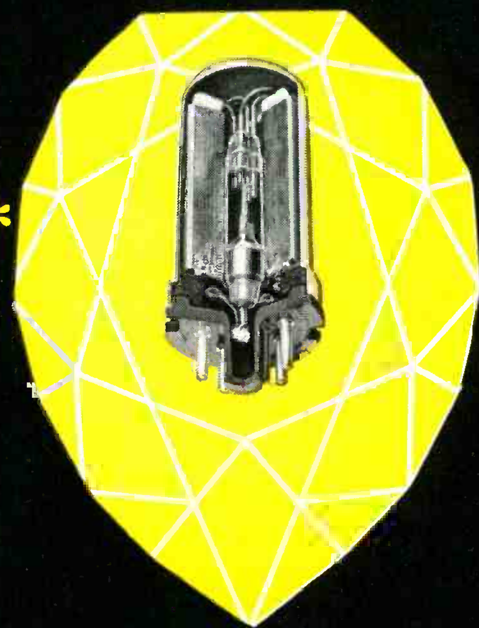

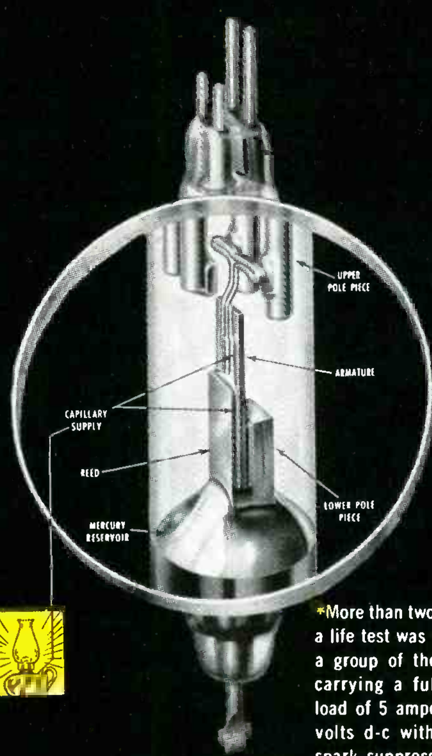

In many applications the right kind of relay will outlast and outperform any other circuit elements.

Even the most eager advocates of static switching systems—where static-magnetic and solid-state elements are used to accomplish functions usually performed by relays and other contact-making devices—now recognize this fact.

The Clare Mercury-Wetted-Contact Relay, for example, has a life of billions* of faultless operations. It requires no maintenance. It can switch from 250 volt-amperes down to a faint whisper of voltage and current. It is the best dry circuit relay in existence. More than that—it is completely free from contact bounce.

THIS is the relay that has become the main reliance of hundreds of leading designers of computing, data-processing and control equipment. For complete information write for Bulletins 120 and 122, C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: 659 Bayview Avenue, Toronto 17. Cable Address: CLARELAY.

*More than two years ago a life test was started on a group of these relays carrying a full contact load of 5 amperes at 50 volts d-c with suitable spark suppression. They have been operating continuously ever since at 5,184,000 operations a day. They are now approaching the 4-billion mark—and the end is not yet in sight.

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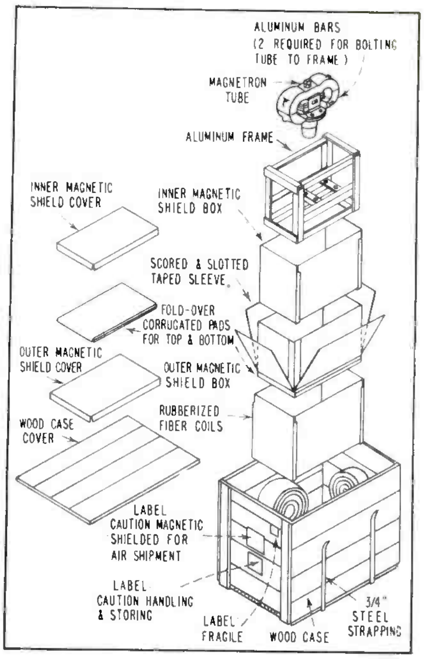
FIRST in the industrial field



Details of new magnetron pack

much lower magnetic retentivity than cold-rolled steel but is inexpensive.

Sample shield boxes of Netic steel were designed and fabricated, using lock joints throughout to eliminate welding. To keep size to a minimum, magnet proximity charts were used to plot the minimum distance permissible between magnetron and shield in each plane without danger of degaussing the magnet.

▶ **New Pack**—To support the magnetron, an aluminum bolt-on frame was devised to replace the clampboard formerly used. The weight of the tube was thus distributed as effectively as before, but the total weight and bulk were reduced. It was then possible to redesign the cushioning pads to reduce the cube still further yet maintain proper cushioning.

The magnetron in its frame is placed in the first shield box and the shield cover is taped to the box. Sleeves and pads of corrugated cardboard go over this to provide an air gap. The package now goes into the second shield box. After taping on its cover, the box is set into the wood shipping crate, where it rests against rubberized tula fiber coils glued to each inside surface of the box. Nailing, strapping and labeling complete packaging.

A sample pack sent to Wright

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Air Development Center met all specifications for gauss leakage and drop testing. As a result, the Air Force issued a waiver permitting use of the new pack for the remainder of the magnetron contract.

Since the layers are assembled telescopically without the use of wrapping, the new pack may be opened and resealed repeatedly for inspection without destroying the shielding.

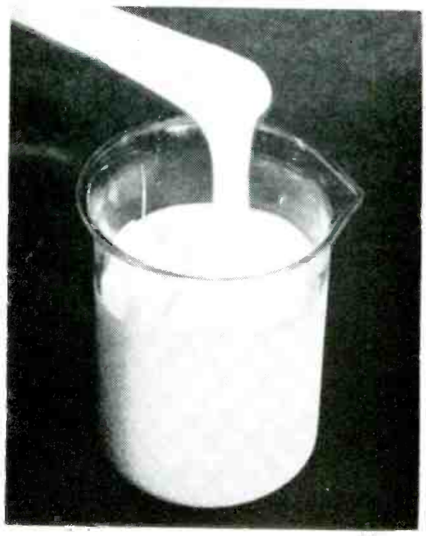
Four men can now pack 25 tubes per day as against four tubes by the old method. The new prefabricated materials give a total saving of 60 percent in packing cost. Weight has been reduced from 277 lb to 139 lb and volume from 35.3 cu ft to 12 cu ft, which means a substantial saving to the Government in air shipping and warehousing costs.

Impregnating Toroids for High Temperatures

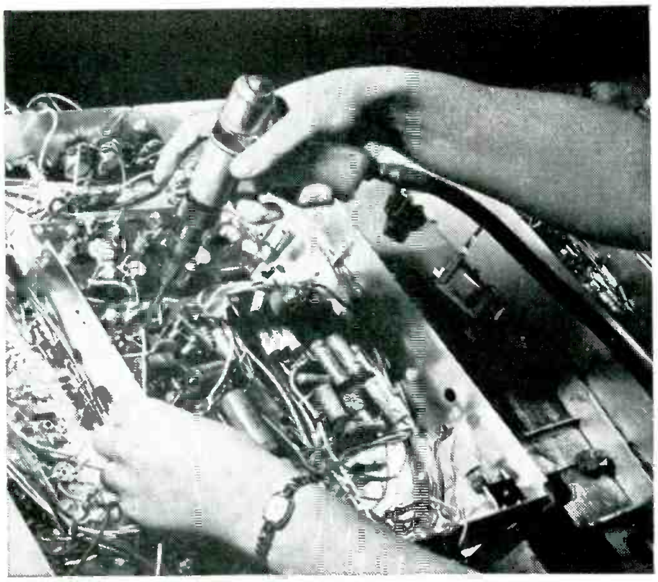
BY ERWIN O. DEIMEL
General Electric Co.
Light Military Electronic Equipment Department
Utica, New York

INCREASING USE of magnetic amplifiers, toroids and similar devices at high temperature brings with it the need for impregnating materials having extraordinary properties.

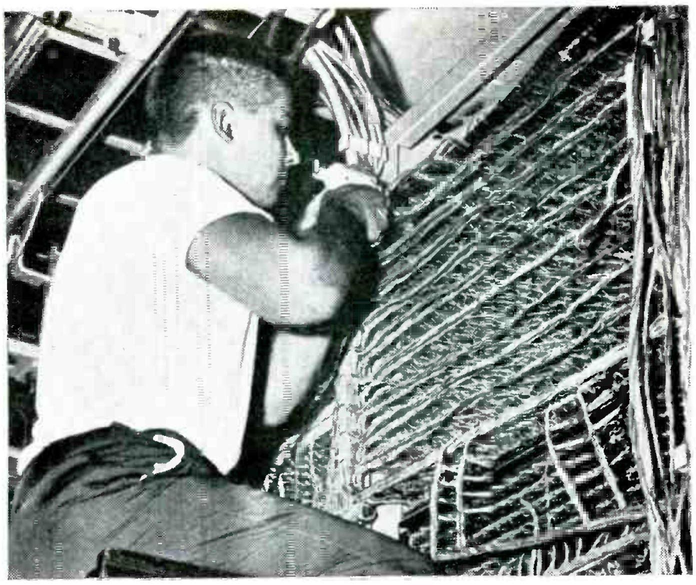
▶ **Requirements** — A satisfactory impregnating material for high temperatures is frequently required to withstand vibration as well, over



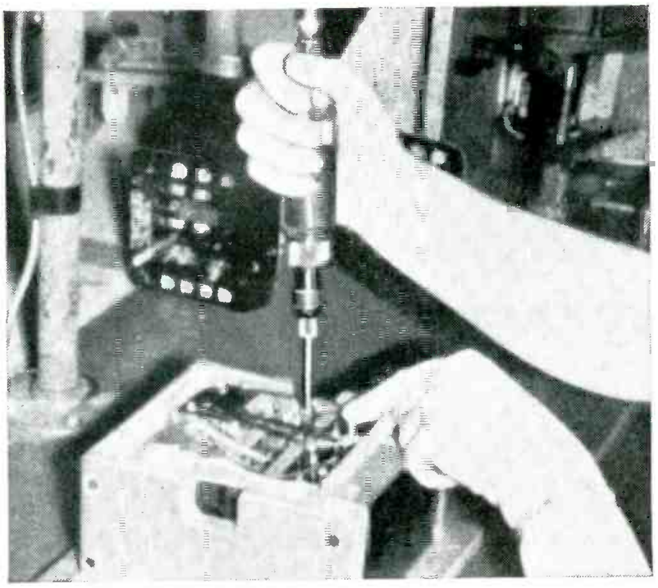
New silicone rubber as it comes from can. Uncured shelf life is 6 to 8 weeks



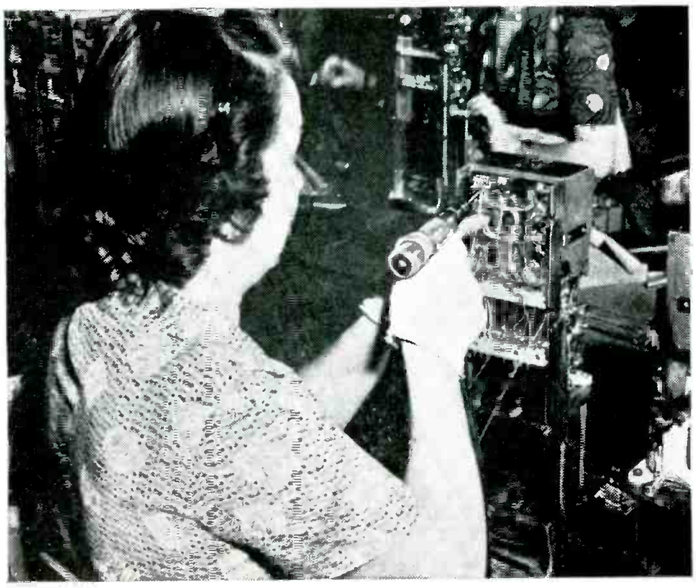
TV SETS — "Wire-Wrap" tool makes stable solderless connections.



TELEPHONE CONTROL PANELS — Small "Wire-Wrap" tool tip gets into tight places.



CONTROL DEVICES — "Wire-Wrap" tool speeds intricate electrical connection work.



COMPUTERS — Connections made with "Wire-Wrap" tool are uniform.

EVERY DAY MORE SOLDERLESS CONNECTIONS ARE MADE WITH KELLER "Wire-Wrap"® TOOLS

Five years ago Keller "Wire-Wrap" tools began saving time and materials in the assembly of electrical connections. The electronic industry was quick to see the advantages of a solderless, metal-to-metal connection that resisted vibration failure and corrosion. Today, "Wire-Wrap" tools have made well over 700 million connections without a reject.

ADVANTAGES

- SPEED—2 seconds total time per connection.
- NO OPERATOR FATIGUE—"Wire-Wrap" tool weighs only one pound.
- AIR OR ELECTRIC POWER TOOL—straight or pistol-grip handles.

WRITE FOR INFORMATIVE BOOKLET

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

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Following vacuum impregnation of magnetic amplifiers in silicone rubber, units are allowed to drip over can for short period, then placed on table to drain (as toroids are doing) before curing in oven

the full temperature range down to subzero temperatures. It must have a low vapor pressure, so that thorough evacuation prior to filling is possible. Viscosity must be such as to give good penetration, as required when filling toroids where openings through which the material must flow are small.

Shrinkage during curing must be small. If too great, the impregnant will crack. Even if cracking does not occur, high shrinkage may apply strains to the core, which is often strain-sensitive.

The coefficient of thermal expansion must be fairly close to that of the embedded material if there is to be no spalling or cracking over the required temperature range. The impregnant must have no effect on the magnet wire insulation. For example, epoxy resins with amine hardeners will damage polyester insulation unless a precise filling and curing technique is followed.

Finally, the impregnating material must have adequate electrical properties over the temperature range, especially under humid conditions, and must be practical for use on a production basis.

▶ **Silicone Rubber** — One material currently being used, capable of withstanding 500 F continuously, is Dow Corning S-2007 silicone rubber. Ordinarily uncured silicone rubbers are stiff, putty-like materials which require dilution with a volatile solvent such as xylene to

vacuum's most reliable component
Now receiving universal acceptance

BEAM SWITCHING TUBES

WHERE

Megacycle Decade Counter
Transfer Storage Counter
Time Base Generator
Frequency Divider
Events Per Unit Time
Preset Counter
Beamplexer
Pulse Height Analyzer
Automation Systems
Beacon Transponder
Teletype Decoder
Microsecond Delay Generator
Machine Control
Sorter
Sampler
Computers
Analog to Digital Converter
Memory Core Matrix Addressor
Radar
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Data Handling

WHY

Only device with 10 individual constant current outputs.

May perform the functions of 20 or more tubes or transistors.

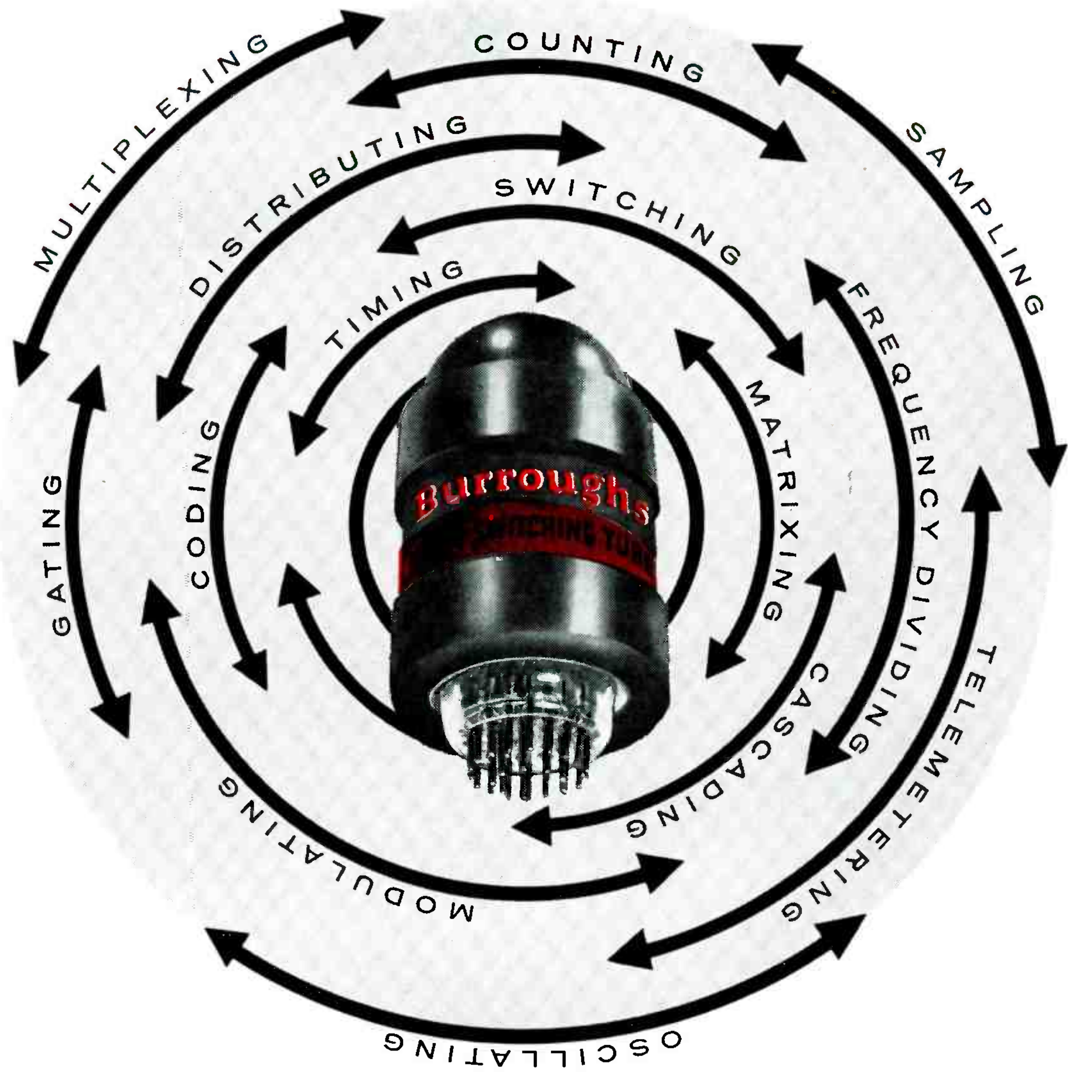
Achieves performance not practical by other techniques.

Reliability and performance at all speeds.

Compatable with tubes, transistors, cores, thyratrons, relays, **Nixie numerical indicator 6844**, and other devices.

PLUS

Shock: 375g
Temperature: .... −60° to +150°
Vibration: 20g
Speed: .... up to 20 mc
Life: ....up to 50,000 hours
Power: minimum input—useful output



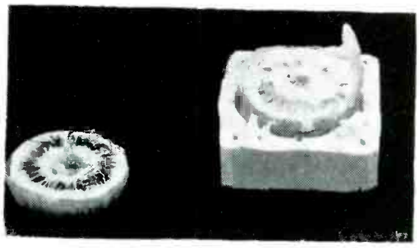
FOR FURTHER INFORMATION WRITE . . .

Electronic Tube Division

BURROUGHS CORPORATION
Plainfield, New Jersey

make them fluid. This new rubber will flow without the addition of a solvent, however. The entire mass cures to a firm rubbery consistency without loss of weight or volume. Before curing the viscosity is quite high, but this has not hindered the complete impregnation of closely wound toroids even through a layer of interwinding tape.

The procedure for impregnation is quite simple. A new batch of material must first be vacuum deaerated at an absolute pressure of about 1 inch of mercury for 1 hour. The toroids are then submerged in the rubber and pumping is continued for 2 hours. The vacuum



Toroid with inner layers cut away after encapsulating in silicone rubber, to show how rubber penetrates through tape wrapping over windings

is released slowly and filling of the toroid is allowed to take place at atmospheric pressure for 16 hours. On removing the impregnated toroids from the silicone rubber, they may be drained for a few minutes and then cured at 300-350 F for 4 hours.

From a vibration standpoint, the resilience of silicone rubber can be troublesome. At 15 g acceleration there is no difficulty, but at 25 g there is enough motion in the rubber to cause fatigue failures in fine magnet wires in a span between the toroid and nearby solder pins. The failures occur after about 5 hours vibration. This difficulty apparently has been solved by encasing the magnetic amplifier assembly in a suitable perforated metal case, which arrests the motion of the silicone rubber. Except for this one trouble area, good results have been achieved with the silicone rubber. Magnetic amplifier stacks impregnated with it have withstood vibration of 27 g for 8 hours at 200 C. Failure of other components ended the test before the impregnated amplifiers

Components of new epoxy resin. Once mixed, shelf life is about 5 hours at room temperature

gave any trouble. Vibration at low temperature has also been satisfactory. No difficulty has been encountered in a 15-day humidity test nor in a high-altitude arc-over test.

To find the insulation breakdown potential, a series of one hundred individually wound and impregnated toroids was subjected to a high potential test. The majority failed near 3,000 v, with the lowest near 1,000 v and the highest near 5,000 v.

The shelf life of the uncured silicone rubber is about six to eight weeks. This disadvantage is offset by the good electrical properties, the very high and low temperature limits and the relative ease of handling.

► **New Epoxy**—Four difficulties ordinarily encountered with epoxy impregnating resins are the temperature limitation, need for relatively volatile hardeners which limit vacuum impregnation, high shrinkage on curing and, in some cases, chemical reaction with the magnet wire insulation. A new rigid filled epoxy resin avoids all of these. Its maximum continuous operating temperature is 165 C and it does not shatter in vibration at −55 C. Its shrinkage on curing is less than 0.5 percent.

Although cost is only about one-tenth that of the silicone rubber, the new epoxy is somewhat more awkward to handle. First, 100 parts by weight of Bakelite ERL 2774 or Shell Epon 828 epoxy resin is heated to 60 C and mixed with 300 parts by weight of Alcoa T-60 325-mesh alumina filler. The mixture is deaerated for 15 minutes at 1 inch of mercury absolute pressure. Now 28.5 parts by weight of stripped grade of Dow Chemical's 4-4′ methylene dianiline hardener are melted at 60 C and stirred into the resin and filler mixture. Evacuation is continued for 5 minutes, after which the resin is removed

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Pouring epoxy resin in mold to encapsulate toroid

from the vacuum. The preheated components in their molds are placed in the vacuum chamber and held at 1 inch of mercury for 15 minutes. The resin, still at 60 C, is poured into the mold through a dropping funnel and the vacuum is released. Impregnation and curing are allowed to proceed at 60 C for 2 hours, followed by a 2-hour cure at 100 C.

The material has been found to give excellent results in vibration at −55 C and at room temperature. It has not yet been vibrated at high temperature, but static tests at 325 F seem to indicate that no difficulty will be encountered. The

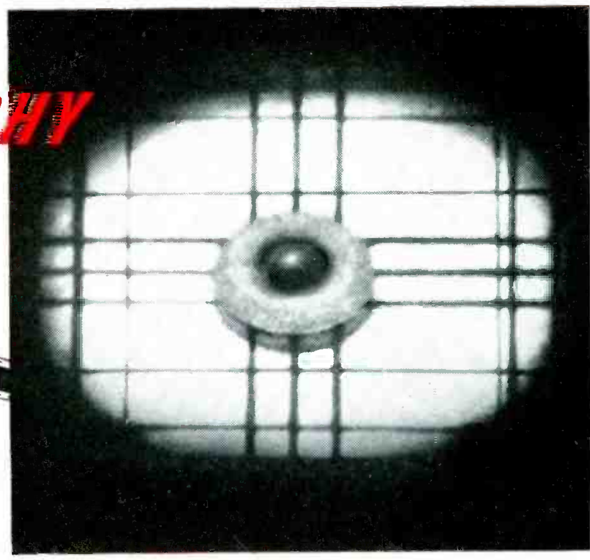
▶ **Conclusions** — The choice between these two materials is largely one of application. The silicone rubber offers a higher continuous operating temperature and somewhat greater ease of handling. On the other hand, the rigid epoxy offers greater protection in vibration and shock and has a lower material cost.

For encapsulation of complete tube circuits, a combination of both materials gives high resistance to mechanical shock. In one test, tubes were dipped twice in the silicone rubber and cured, then wired into a multivibrator circuit. After complete encapsulation in the new epoxy and curing, the unit was dropped onto concrete from a height of 30 feet with no mechanical or electrical damage.

another example of exciting work at los alamos...

FAST PHOTOGRAPHY

15,000,000 PICTURES/SECOND



Here at Los Alamos, the development of high speed photography has produced framing cameras of unprecedented framing rates and exposure times. These cameras are capable of taking as many as 90 frames at rates as high as 15 *million* frames a second. They employ the technique of sweeping the image, reflected from a rapidly rotating mirror, over a set of correcting lenses onto the recording film. This results in the effective stopping of image motion within the frame. In addition to the creation of new optical components, the construction of these cameras has involved the development of techniques for rotating mirrors of substantial size at speeds as high as 22,000 revolutions *per second.*

Used in a wide variety of research programs as well as in the Laboratory's weapon investigations, instruments such as these typify the excellent resources, in facilities and in the capability for creating wholly new experimental methods, enjoyed by the scientists of Los Alamos.

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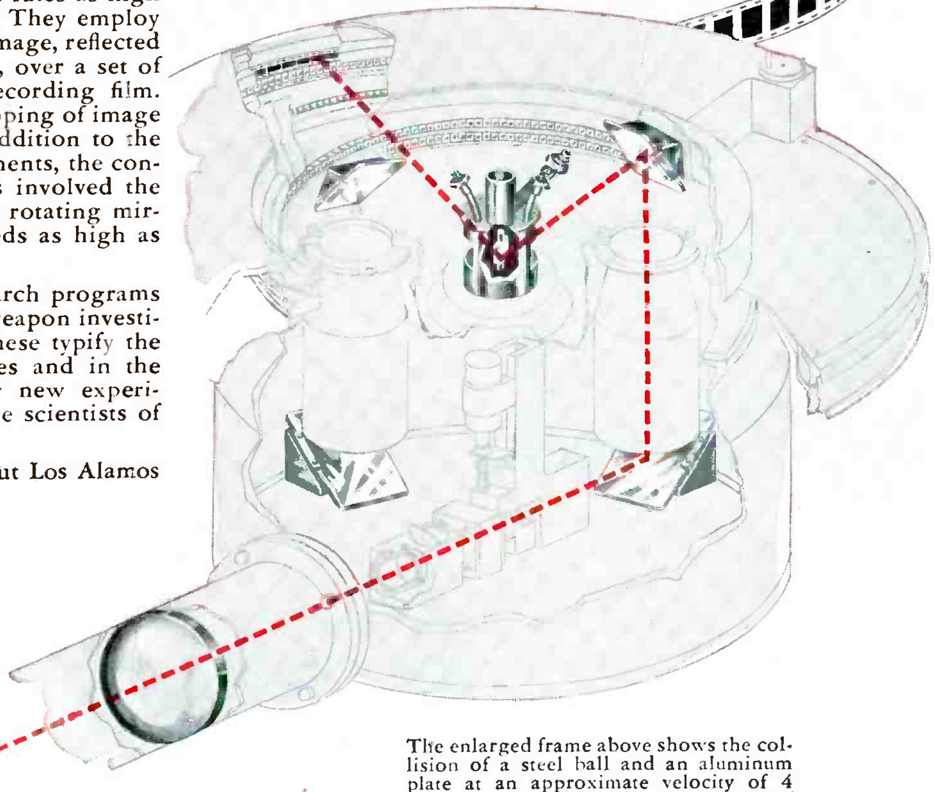

The enlarged frame above shows the collision of a steel ball and an aluminum plate at an approximate velocity of 4 millimeters/microsecond, illustrative of studies of interaction of metals at high impact velocity. The cutaway drawing shows some of the features of one of the Laboratory's high speed framing cameras.

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LOS ALAMOS, NEW MEXICO

New Products

Edited by WILLIAM P. O'BRIEN

91 New Products and 76 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

VARIABLE DELAY LINES

with application flexibility

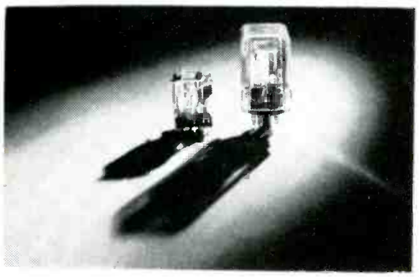
ESC CORP., 534 Bergen Blvd., Palisades Park, N. J., announces the design, development and availability of five new continuously variable delay lines for use as components or as test equipment in the facilitation of the design and development of advanced computer and radar systems.

A single control shaft, in ten turns, covers the entire delay range from zero to the maximum delay. A locking device can be supplied to lock the unit at the desired delay.

Resolution is better than 1/1,000 of maximum delay. Termination is external. Outside dimensions are 7¼ by 1 by 1⅝ in. The new units meet all applicable Mil-Specs. **Circle P1 inside back cover.**

MULTIPURPOSE RELAY

for industrial uses

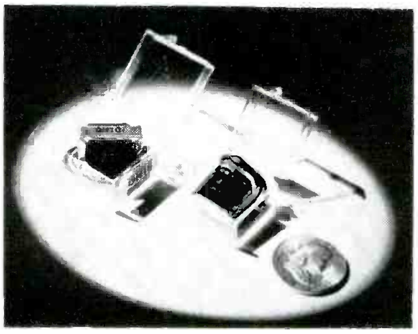


ELGIN NATIONAL WATCH CO., Elgin, Ill., has developed a new general purpose relay for commercial and industrial use. The GH series relay is available either in open construction or with a clear plastic dust-tight cover and octal or 11-pin base. It is adaptable to printed circuit and chassis mounting, taking up slightly more than 1 cu in. of space. The unit is available with both 5-ampere and 10-ampere contact ratings as an open relay and operates over a temperature range of from −55 C to +85 C. The general purpose midget-class relays are engineered for high efficiency and low price in all standard a-c and d-c voltage ratings. **Circle P2 inside back cover.**

TRANSFORMER LINE

for transistorized circuits

GRAMER HALLDORSON TRANSFORMER CORP., 2734 N. Pulaski Rd., Chicago 39, Ill., announces a complete line of miniature audio transformers for transistorized circuit applications. It consists of 32 items comprising two series. A 150-mw series is 31/32 in. high by 12/16 in. wide by ⅝ in. deep with mounting tab centers 13/16 in. The weight of the 150-mw series is 0.6 oz. A 300-mw series 13/16 in. high by 1⅝ in. wide by 13/16 in. deep with mounting centers 1⅝ in., has a weight of 1.1 oz.

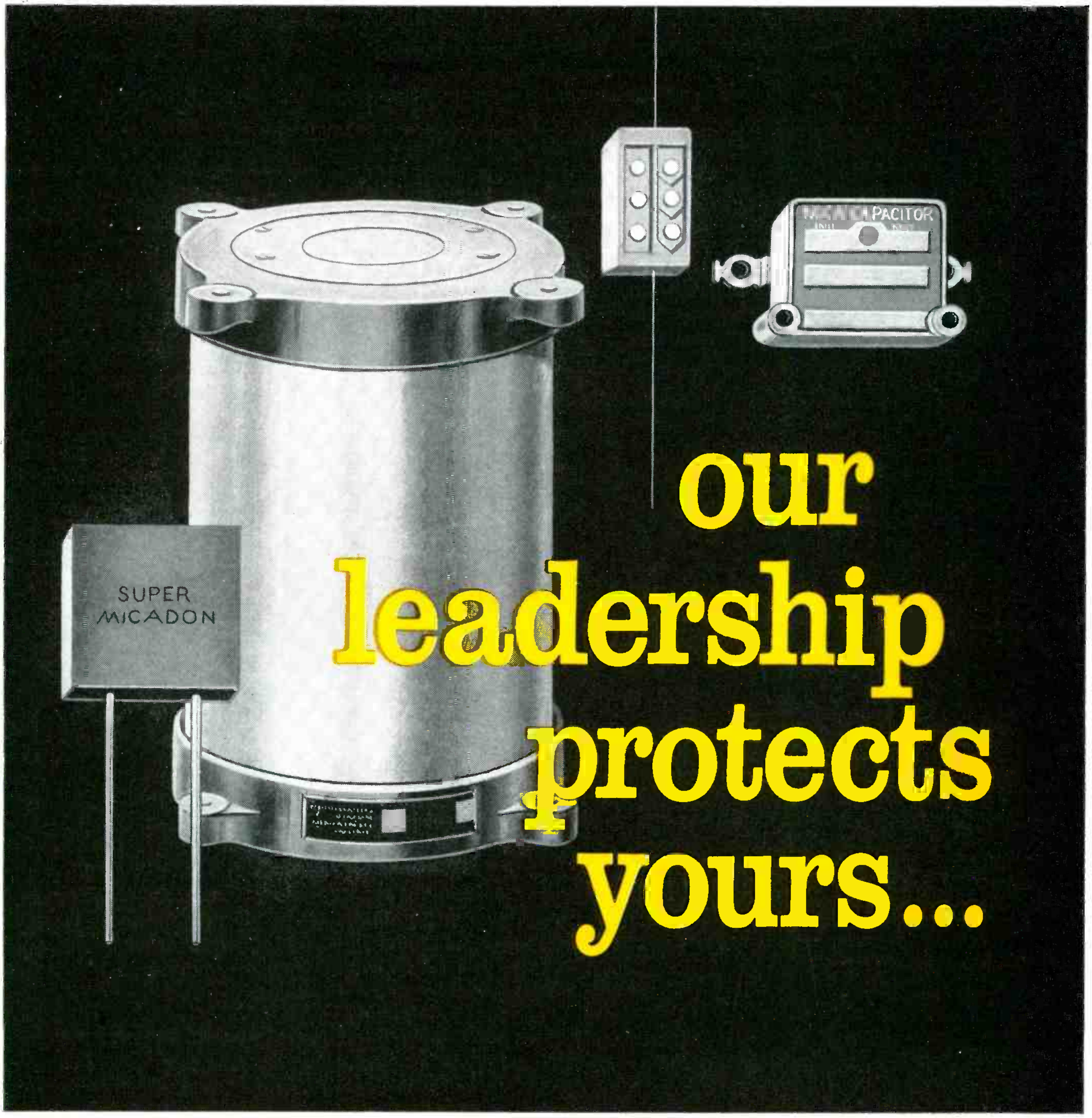


The units come individually packaged in plastic containers complete with installation instructions. Available upon request are two charts which allow instantaneous selection of the proper transformer for the specific application. **Circle P3 inside back cover.**

PREAMPLIFIER

telemetering accessory

NEMS-CLARKE, INC., Silver Spring, Md., Type PR-200 preamplifer was designed as an accessory unit for any of the company's receivers used for telemetering. Completely weatherproof, it can be located at the antenna and connected to a receiver or multicoupler in a remote location using transmission



Leadership is hard to achieve and even harder to maintain. A stroke of genius or a lucky break may put you on top, but it takes stability of organization and persistent *product dependability* to keep you there. More C-D capacitors are sold because C-D capacitors are made better—not just in one big order, but in every order every year. Our leadership is added insurance for yours, because it is based on the high quality of every CORNELL-DUBILIER capacitor since 1910.

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

Two of Thousands of C-D's Mica Types:

CERAMIC-CASED HIGH-POWER MICAS: Built to handle efficiently and economically the high kva requirements of transmitters, induction heaters, Loren circuits and a variety of other high-current equipment for military, communications and industrial applications.

"SUPER MICADONS*": An entirely new concept in quality midget mica capacitor construction. Greatly increased capacitance over that of conventional units of the same case size.

CONSISTENT HI-DEPENDABILITY
CORNELL-DUBILIER CAPACITORS

*®

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

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line such as RG-8/U. Line losses as high as 6 db (175 ft of RG-8/U) will not decrease the sensitivity of the receiving system more than a few tenths of a db. The preamplifier is completely self-contained except for the $1\frac{3}{4}$-in. power control panel designed for mounting in a relay rack with other receiving equipment. This panel, containing a switch, pilot light and fuse, supplies 117-v, 60-cycle power to the preamplifier through a two-conductor cable. The PR-200 will improve the noise figure of the 1400 receiver by approximately 1 db and the 1670-E receiver by approximately 3 db assuming lossless connecting cable. Full specifications are available. **Circle P4 inside back cover.**

ROTARY SWITCH

used in computers

UNISON PRODUCTS CO., Box 125, Clifton, N. J. The computer switch illustrated operates under environmental specification MIL-E-5400 with two output signals: 60 pulses per revolution and one pulse per revolution. Impact voltage is 28 v d-c. Accuracy on degrees is better than ± 10 sec. The complete unit is mounted in a number 10 synchro case for easy assembly along with a screwdriver slotted shaft for simple setup adjustments. For further information write on company letterhead to Mr. Edward Ward at the company.

FREQUENCY METER

fully transistorized

CUBIC CORP., 5575 Kearny Villa Rd., San Diego 11, Calif., announces a rugged, lightweight, fully transistorized frequency meter that provides accurate direct frequency measurements from 3 to 100,000 cps in nine ranges. Accuracy is independent of input voltage waveform and amplitude. The instrument's excellent sensitivity to short pulses minimizes lost counts when measuring the average frequency of random events. It is either battery or a-c powered.

For tachometry and vibration indications, an output connector on the model 503 provides all operating voltages for the model A-503-1 and A-503-2 phototransistor pickups. These pickups allow the speed of rotating machinery or the frequency of vibrating parts to be sensed using interrupted light.

For applications where tachometry is the primary requirement,

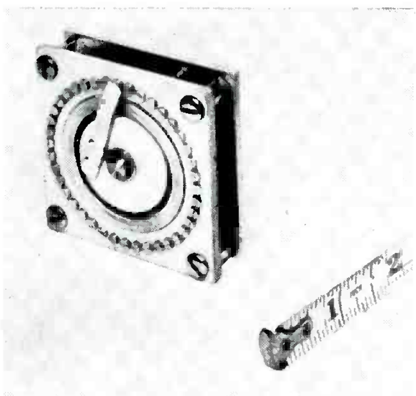
the model 503 tachometer provides calibration from 60 to 6,000,000 rpm. **Circle P5 inside back cover.**

SHALLOW SWITCH

for airborne equipment

THE DAVEN CO., 530 W. Mt. Pleasant Ave., Livingston, N. J., announces a new version of their standard switch line, series SH, with much shallower depth than heretofore available. The series may be adapted to any of the standard single pole per deck, two pole per deck, up to 15 positions shorting per pole or 8 positions, nonshorting per pole catalog items.

The unit illustrated is type SH-13-DM-48 and is $2\frac{1}{4}$ in. square by only $\frac{27}{32}$ in. in depth. In new designs of airborne, radar and missile equipments, depth is extremely important and the series

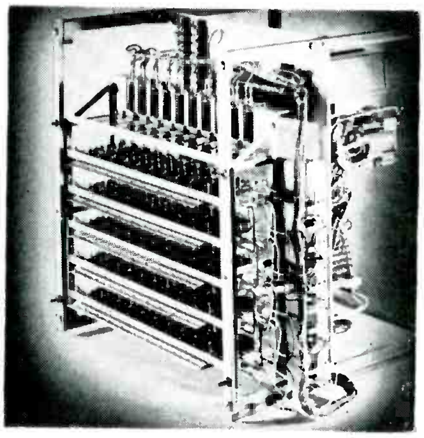


SH is designed specifically for these applications. Additional decks may be added with an increase of only $\frac{3}{4}$ in. in depth per deck. The switch panel can be made with either XXXP phenolic or silicone fiberglass (GSG). All parts are plated to withstand 200-hr salt spray. Rotors, contacts and slip rings are solid silver alloy. Shaft material is stainless steel. **Circle P6 inside back cover.**

CROSSBAR SCANNER

for data handling and reduction

JAMES CUNNINGHAM, SON & CO., INC., Rochester 8, N. Y., brings to the field of data handling and reduction, an integrated monitoring device capable of rapid sequential or programmed scanning of data points. Inherent are the func-



tional advantages of the company's crossbar switch: low contact resistance (0.02 ohm); low thermoelectric potentials, (less than 0.01 μv in the range 25 to 50 C); high leakage resistance (where necessary units with not less than 10^{12}-ohms leakage may be supplied) and excellent h-f performance (crosstalk is 65 db down at 10 mc).

First of the units is model 200SC1A, a self-contained instrument capable of scanning in response to a contact closure 200 points in sequence, one point per control pulse. The 200 points are arranged in 10 groups of 20 points each. Facilities are provided to automatically skip any group on command, to start at the beginning of any of the 10 groups, on command and to automatically stop at the end of any of the 10 groups.

The scanner utilizes the three-dimensional conductor arrangement of the crossbar switch to make selections in three coordinates. This feature results in considerable saving in space and cost. **Circle P7 inside back cover.**

CRYSTAL OVENS
for new military CR types

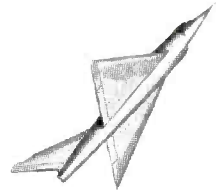
BULOVA WATCH CO., Woodside 77, N. Y., introduces its BHC-18 crystal oven series, specifically designed for the new military CR types utilizing the subminiature HC-18/U holder. The BHC-18 units will conform to the military warmup requirement of 3 minutes. The 10 and 15-crystal ovens will stabilize within ±2 C over an ambient of −55 C to below reference temperature.

This series is available in units capable of housing a single crystal, 2 crystals, 10 crystals and 15 crystals. Operating voltage for the 10 and 15 crystal units is 6 v to 115 v a-c or d-c. The single unit oven is available from 6 v to 24 v a-c or d-c. **Circle P8 inside back cover.**

MINIATURE RELAY
sensitive down to 6 mw

IRON FIREMAN MFG. CO., Electronics Div., 2838 S.E. Ninth Ave., Portland 2, Oregon, has announced a miniature relay with sensitivity down to 6 mw. Available in four header styles, the balanced armature relays operate where little power is available, as in v-t circuits. Relays are available either as spdt or dpdt. Lab tests have shown reliability in excess of a million operational cycles. In vibration tests dependability remained at 10 times gravity from 5 to 500 cps. Shock tests were delivered at 50 times gravity while the relays were in operation and they were found satisfactory at ambient temperatures from −65 C to +125 C. Relays qualify to meet or exceed military specs MIL-E-5272 and MIL-R-5757B. All pass a complete functional test in accordance with MIL-Q-5923B.

The relay's vital elements are



for
airborne
radar

DuMont Miniaturized Radar Tubes

Du Mont compact, high-resolution radar tubes save space and weight, and permit full use of miniaturization techniques in airborne and other portable radar receivers.

Available in 3" to 12" screen sizes. Magnetic or electrostatic focus and deflection. Nine-pin miniature base.

DUMONT® Industrial Tube Sales, ALLEN B. DU MONT LABORATORIES, INC., 2 Main Ave., Passaic, N. J.

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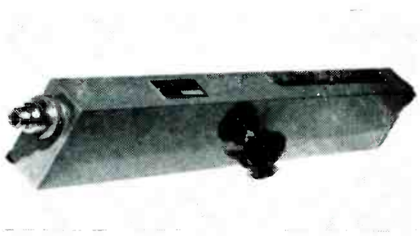
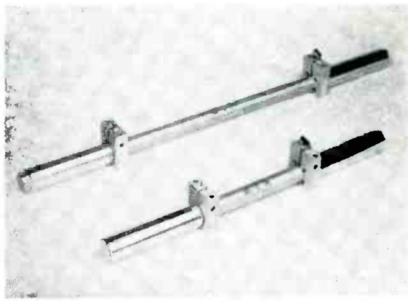
hermetically sealed in inert gas to protect them from adverse environmental conditions. Standard contact material for the product is silver, rated at 2 amperes for either 28 v d-c or 115 v a-c. Contacts comply with military specs on overload test at four times the rated current.

The four styles available include a standard dual four-pin loop header, standard eight-pin loop header, standard octal tube socket header and standard nine-pin plug-in header for use in printed-circuit applications. **Circle P9 inside back cover.**



BROADBAND ATTENUATOR
continuously variable

DOUGLAS MICROWAVE CO., INC., 252 E. Third St., Mt. Vernon, N. Y., has developed a new coaxial continuously variable broadband attenuator. The insertion loss is 1 db maximum for a 40-db unit and ½ db maximum for a 20-db unit. Operating range is any 100-percent bandwidth from the frequencies 100 to 3,300 mc. Accuracy is ±0.25 db for 100 percent frequency range and is available in type N—(⅜ in.) or (⅞ in.) line. The essentially linear scale is 7 in. long. **Circle P10 inside back cover.**



FIXED DELAY LINES
many sizes and ratings

DELTIME, INC., 608 Fayette Ave., Mamaroneck, N. Y., has announced

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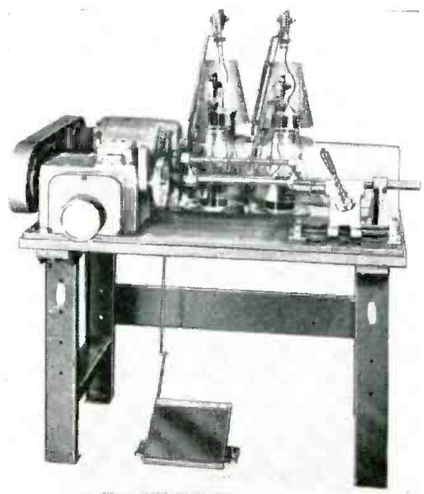
magnetostrictive fixed delay lines in a wide range of different sizes and ratings. These model 104 units are available in fixed delays from 2 μsec to 200 μsec or more. Electrical characteristics may be specified by the user. Intermediate outputs may be incorporated. These tubular units are suitable for incorporation in computer equipment and other commercial assemblies. They are resistant to shock and vibration. Terminal blocks measure only $1\frac{1}{2}$ in. by $1\frac{1}{4}$ in., while the tubular casing, dependent upon the delay factor, can be up to several feet long. **Circle P11 inside back cover.**



BOBBIN WINDER
cam operated

GEO. STEVENS MFG. CO., INC., Pulaski Road at Peterson, Chicago 30, Ill. A new cam operated heavy duty bobbin winder with oil-bath-lubricated internal gears has been announced. Model 516-AM winds field coils as well as heavy duty bobbin coils for use in solenoids, contractors, relays and the like. Maximum coil length is $4\frac{1}{2}$ in., maximum coil o-d $7\frac{1}{4}$ in. if round and $5\frac{1}{8}$ in. if square, maximum loading distance for multiple windings $18\frac{1}{2}$ in., wire sizes wound 16 to 38 and output end of spindle $\frac{7}{8}$ in. flatted shaft. High-torque slow-speed winding range is up to 1,125 rpm. For finer wire, speed is up to 1,800 rpm.

Positive drive and effortless return of winding arm to starting position is insured by one-way clutch. True alignment between

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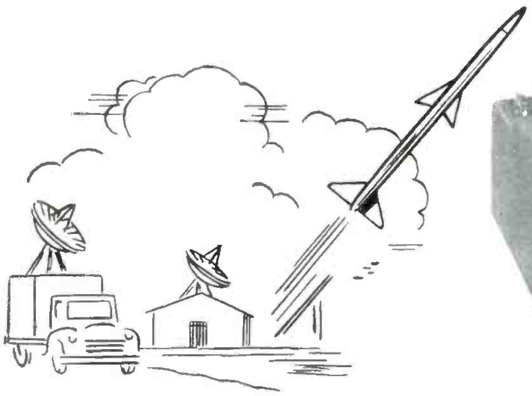
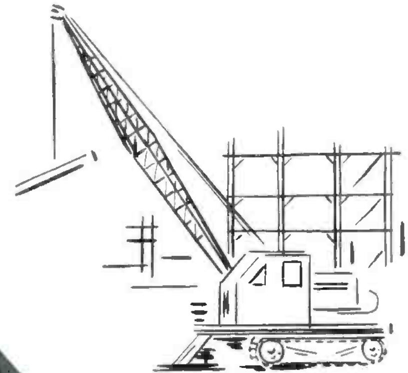
covers the oscillograph recording field





TELEMETRY APPLICATIONS

- QUICK-LOOK monitoring in the telemetry ground station permits continuous observation of missile in-flight programing results.
- ON-THE-SPOT monitoring permits making in-flight function corrections in controlled missiles or piloted aircraft.
- A NATURAL for mobile telemetry vans . . . compact, rugged, low power consumption, record is PERMANENT, no fading or fogging when exposed to direct sunlight.

INDUSTRIAL APPLICATIONS

- STRESS-STRAIN RECORDING with "first-hand" read-out during test.
- PERMANENT record obtained at test site may be stored indefinitely for purpose of future data reduction.
- PORTABLE — extremely useful for field test applications where a "multiplicity" of data must be collected with the least amount of instrumentation.
- No amplifiers required for many applications.

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Tel.: Michigan 4-1822

LONG ISLAND CITY, N. Y.
Test Equipment Sales Co.
29-46 Northern Blvd.
Tel.: Stillwell 4-7120

DALLAS, TEXAS
Arnold Barnes Co.
5526 Dyer St.
Tel.: Emerson 6716

TUCSON, ARIZONA
G. S. Marshall Co.
3686 Baker Place
Tel.: East 7-1501

REDWOOD CITY, CALIF.
G. S. Marshall Co.
2015 El Camino Real
Tel.: Emerson 6-8214

SAN MARINO, CALIF.
G. S. Marshall Co.
2065 Huntington Drive
Tel.: Ryan 1-6781

SAN DIEGO, CALIF.
G. S. Marshall Co.
3525 5th Avenue
Tel.: Cyprus 8-8234

DENVER, COLORADO
Barnhill Associates
6520 West 62nd Ave.
Tel.: Harrison 4-7733

ATLANTA, GEORGIA
E. G. Holmes & Associates
309 Pharr Road, N. E.
Tel.: Cedar 7-7801

CLEVELAND, OHIO
Electro Sales Associates
281 E. 216th St.
Tel.: Redwood 2-7444

DAYTON, OHIO
Electro Sales Associates
512 Orangewood Drive
Tel.: Walnut 5426

ORLANDO, FLORIDA
E. G. Holmes & Associates
56 W. Columbia St.
Tel.: 3-3524

tailstock and main spindle is assured by unique construction which prevents any runout. Even heavy or out-of-balance mandrels cannot fly out of machine during operation. Special triple ball-bearing arrangement assures long life and smooth running even under exceptional thrust at high speeds. Supplied with the machine are tension, winding setup, motor, automatic counter, magnetic brake, tailstock, clutch and gear chart. **Circle P12 inside back cover.**

TWO-CHANNEL SCOPE
has d-c to 15 mc range

ELECTRONIC TUBE CORP., 1200 E. Mermaid Lane, Philadelphia 18, Pa. Equipped with vertical amplifiers capable of handling any frequency from d-c to 15 mc, the model K-215 two-channel oscilloscope provides accurate triggering, viewing or recording of simultaneous phenomena on a wide range of test or laboratory procedures. Accurately calibrated sweep speeds and increased vertical deflection sensitivity permit quantitative time and amplitude measurements with accuracy comparable to that of indicating meters.

Features include 10-kv acceleration potential and transistorized multivibrator providing 1-kc square-wave calibrator. Frequency range of horizontal amplifiers is d-c to 2 mc with deflection sensitivity of 1 v d-c per cm. Two variable sweep generators have expanded ranges from 0.1 μsec per cm to 1 sec per cm. Time base is separate or common as selected by front panel control. Triggering may be either internal or external.

The K-215 dual-channel oscillo-

Bell Laboratories researchers Henry S. McDonald, Dr. Eng. from Johns Hopkins, and Max V. Mathews, Sc.D. from M.I.T., examine magnetic tape used in new research technique. Voice waves are converted into sequences of numbers by periodic sampling of amplitudes, 8000 samples per second. General purpose electronic computers act on these numbers as a proposed transmitting device might.

They send real voices on imaginary journeys

In their quest for better telephone service, Bell Laboratories researchers must explore many new devices proposed for the transmission of speech signals. For example, apparatus can be made to transmit speech in the form of pulses. But researchers must always answer the crucial question: how would a voice sent through a proposed device sound to the listener?

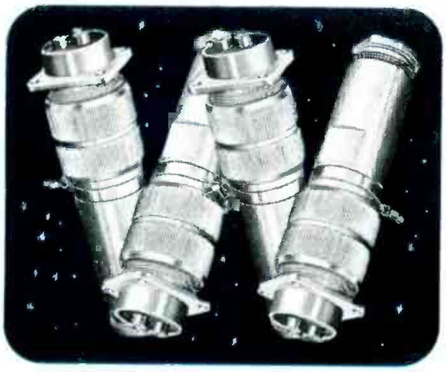
In the past it often has been necessary to construct costly apparatus to find out. Now the researchers have devised a way to make a high-speed electronic computer perfectly imitate the behavior of the device, no matter how complicated it may be. The answer is obtained without building any apparatus at all.

The researchers set up a "program" to be followed by the computer. Actual voice waves are converted into a sequence of numbers by sampling the waves 8000 times per second. Numbers and program are then fed into the computer which performs the calculations and "writes out" a new sequence of numbers. This new sequence is converted back into real speech. Listeners hear exactly how well the non-existent device could transmit a real voice.

With this novel technique, new transmission ideas are screened in only a fraction of the time formerly required. Thus valuable time and scientific manpower are saved in Bell Laboratories' constant search to provide still better service for telephone customers.

BELL TELEPHONE LABORATORIES

World center of communications research and development



scope is 21 in. wide by 17 in. high by 23 in. long and weighs 91 lb. **Circle P13 inside back cover.**

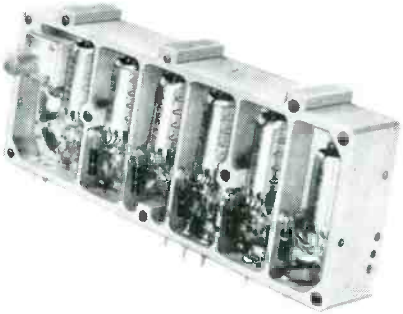
AMPLIFIER PACKAGE
for galvanometers

ALLEGANY INSTRUMENT CO., INC., 1091 Wills Mountain, Cumberland, Md. System D is a four-channel, trouble-free galvanometer amplifier package which includes power supply, and is used with wire strain gages, transducers, thermocouples and the like. It will drive even low-sensitivity, h-f galvanometers and provides excellent linearity over a wide range of input voltages.

Features include balanced input, high output (± 60 ma), phase sensitivity, high stability, low noise level, overload indication and protection and no operational delay when overloaded. It gives fine resolution with a 20-step attenuator and a unique gain control which permits full-scale galvanometer deflection for input voltages between adjacent attenuator settings. **Circle P14 inside back cover.**

DOUBLE STUB TUNERS
available in three models

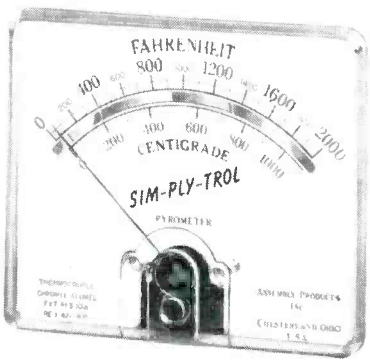
WEINSCHEL ENGINEERING, 10503 Metropolitan Ave., Kensington, Md. Three models of double stub tuners have the following new design features: (1) lengthened travel of stubs; (2) large instruction plates added showing which of six possible combinations of taps provide greatest ease of convergence for rapid matching. Frequency range for the model DS-109LL is 200 to 2,000 mc; for the DS-109L, 400 to 4,000 mc and for the DS-109, 750 to 10,000 mc. The matching range in respect to 50 ohms is limited to a maximum vswr of 7 for impedances above 50 ohms, while any impedance below 50 ohms can be matched. **Circle P15 inside back cover.**



I-F AMPLIFIER
high G type

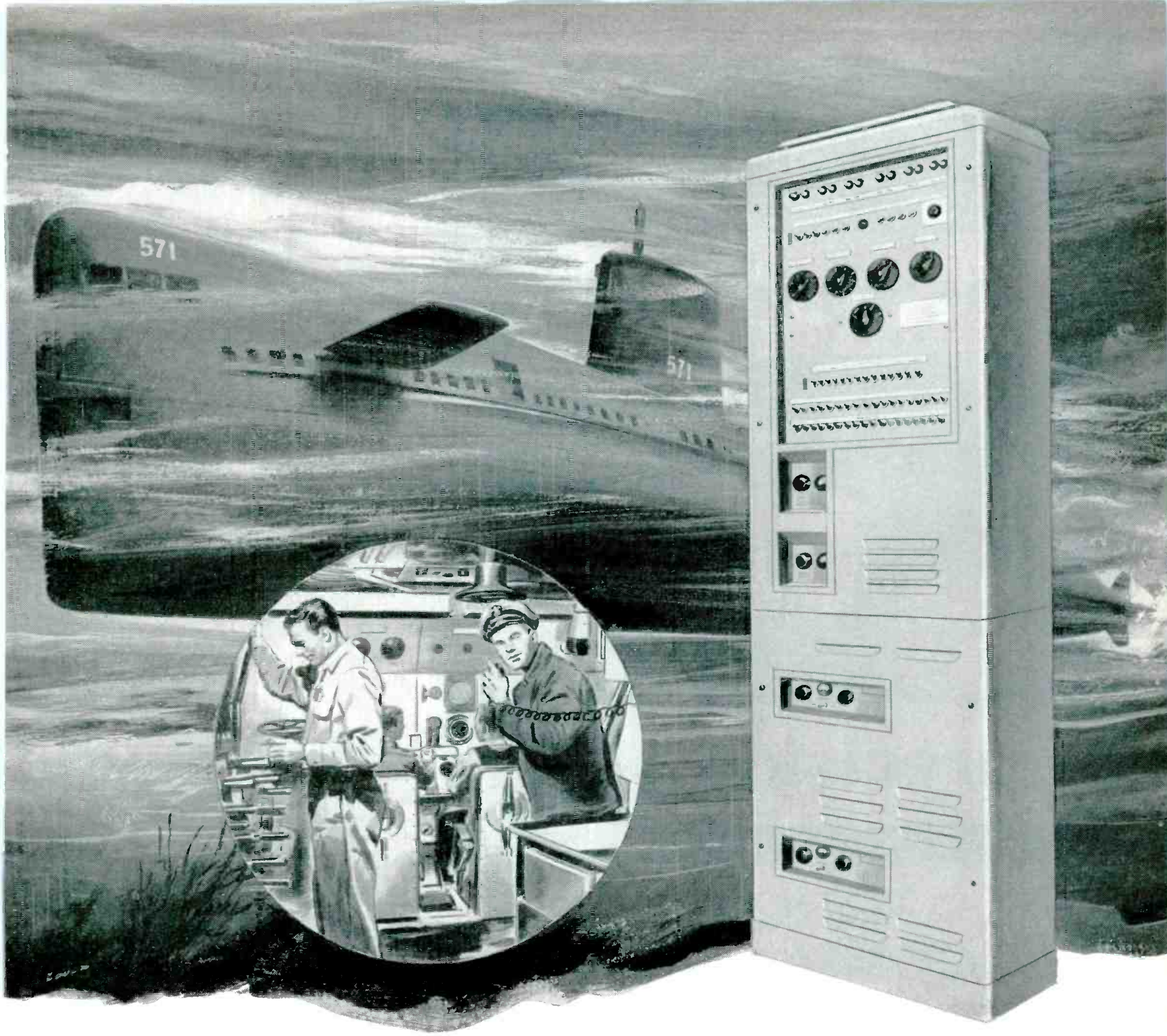
LEL, INC., 380 Oak St., Copiague, N. Y., has announced an addition to its line of radar and missle i-f amplifiers. Developed to withstand 20 g vibration at 2,000 cps, these units utilize ruggedized subminiature tubes in special castings designed for high heat conduction and minimum chassis resonance.

Specifications of the IF64D are 60-mc center frequency, 65-db gain and 10-mc bandwidth. The amplifiers can be supplied with other gain or bandwidth specifications. **Circle P16 inside back cover.**



PYROMETERS
in 21 standard ranges

ASSEMBLY PRODUCTS, INC., Chesterland, Ohio. The company's indicating pyrometers may now be read more accurately from all



To voice the world's newest submersibles

The shipboard and battle-announcing needs of a submarine pose problems that just "standard" equipment can't meet.

Exceptional ruggedness is required, both to withstand shock and to resist heat, humidity, and salt moisture.

Power must be adequate, yet compressed into the smallest possible space.

Dependability is relative to such factors as cruise distances never before attempted by underwater craft.

An example of products meeting such problems is found in the announcing equipment aboard the atomic-powered *Nautilus* and *Seawolf*, built by our associate division, Electric Boat, and "voiced" by Stromberg-Carlson. Here standard components were re-designed to the special conditions involved. On the *Nautilus*, to date, our equipment has logged more than 60,000 nautical miles without difficulty of any sort.

Similar equipments also serve the land and air arms of our country's military forces and give evidence of equal dependability under the special conditions for which they were designed.

S-C STROMBERG-CARLSON GD

A DIVISION OF GENERAL DYNAMICS CORPORATION

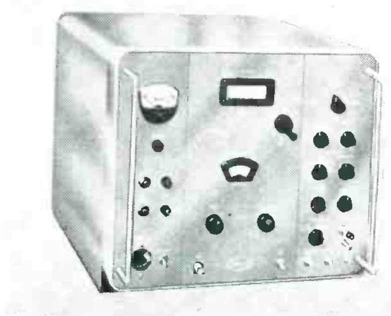
General Offices and Factories at Rochester, N. Y.—West Coast plants at San Diego and Los Angeles, Calif.

angles because they have been redesigned with mirror scales to cut down parallax effect.

These medium resistance units (4 ohms per mv) are available in 21 standard ranges. Maximum sensitivity for a pyrometer connected to one thermocouple is 300 F for full scale deflection. Standard ranges begin with −400 to +100 F, with 3,000 F as maximum range limit.

Full scale accuracy of 2 percent is standard, although 1 percent may be obained at extra cost. These pyrometers may be thermistor-compensated to maintain accuracy in spite of ambient changes. They are furnished with compensation for changes in cold junction.

Styles available include panel mounting, portable and bench models. Meters are 3¾ and 4½ in. wide. **Circle P17 inside back cover.**



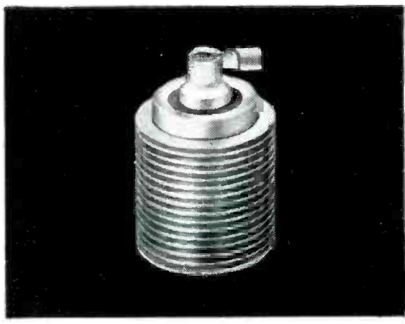
SIGNAL GENERATOR

covers 4,200 to 11,000 mc

POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N. Y. The MSG-34 ultrabroad-band microwave signal generator covers C and X band frequencies—4,200 to 11,000 mc— with a power output of 1 mw. It is equipped with Uni-Dial construction which provides complete integration and simple operation. Large, direct-reading dials indicate frequency and attenuation.

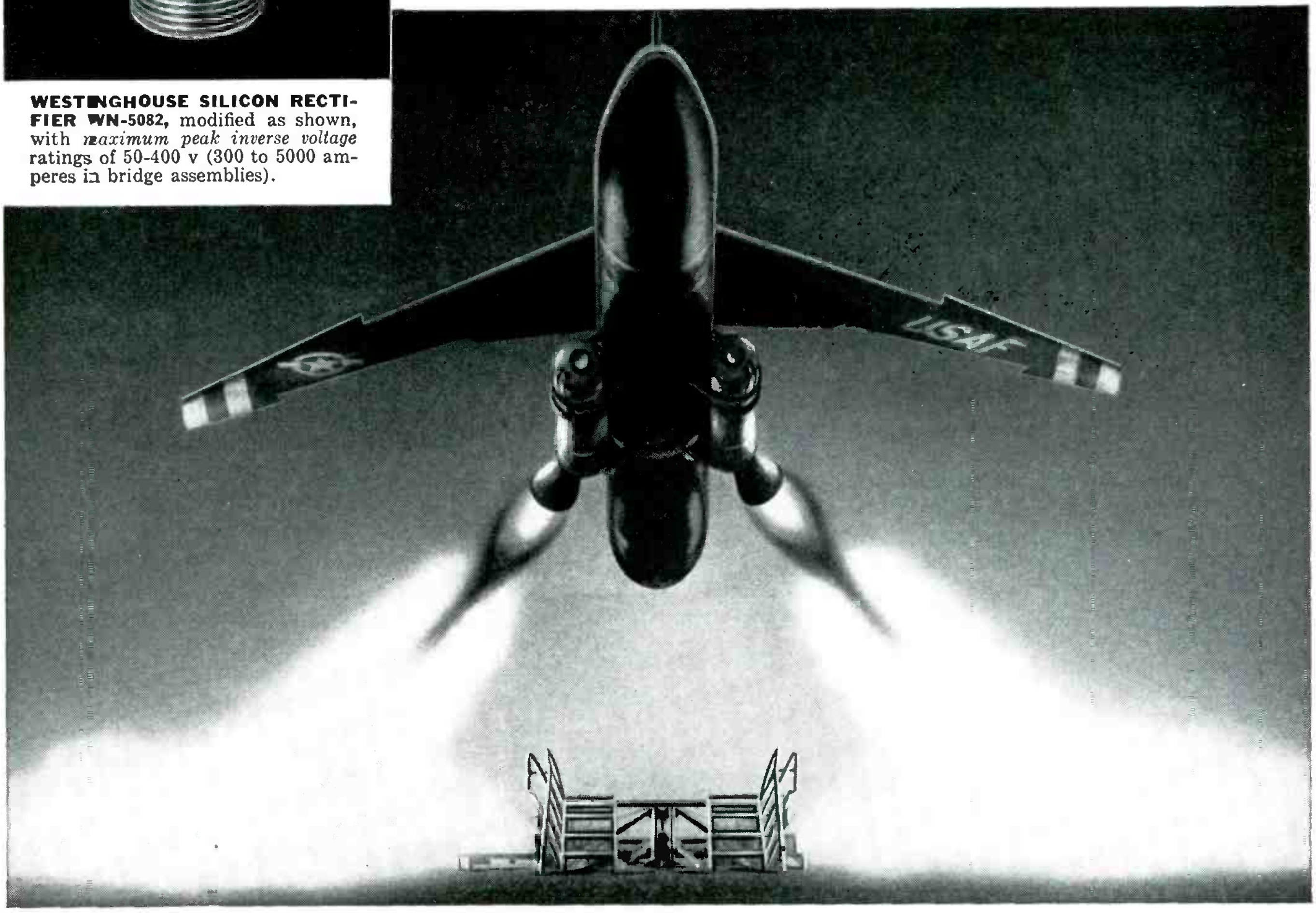
Other features of the microwave signal generator are: provision for external modulation by multiple pulses; automatically tracked power monitor and noncontacting oscillator choke.

The modulator, utilizing printed-circuit techniques, permits internal pulse and square-wave



WESTINGHOUSE SILICON RECTIFIER WN-5082, modified as shown, with *maximum peak inverse voltage* ratings of 50-400 v (300 to 5000 amperes in bridge assemblies).

JUST 5¼ OUNCES BUT IT KEEPS A HUGE GUIDED MISSILE "ON TARGET"



Westinghouse SILICON(SI) RECTIFIERS add striking power to U.S. Air Force

THE SNARK—America's first intercontinental pilotless missile cruises at fighter speeds—has a 5,000 mile-plus range. 74 feet long with warhead, its flight must be accurate—*components and equipment must not fail.*

Electronic equipment guides The Snark . . . failure-free performance is a must even under stresses and strains of severe shocks, vibration and excessive heat. *Component size and weight has been drastically reduced—without sacrificing operational efficiency.*

WESTINGHOUSE SILICON RECTIFIERS supply the DC power. Reliable yet smaller and lighter transformer-rectifier units were specially designed to convert 400-cycle three-phase AC power into 28 volts DC power. Regulated units use 12-phase self-saturating magnetic amplifiers to regulate voltage supplied to the silicon rectifiers. In this application, WN-5082 diodes are used.

Learn how new Westinghouse Silicon Diodes can provide greater reliability, higher efficiency, and save space and weight in your application. Fill in the coupon today.

YOU CAN BE SURE... IF IT'S

Westinghouse

WESTINGHOUSE ELECTRIC CORPORATION
Box 868, Pittsburgh 30, Pa.

Please send me data on the new Westinghouse WN-5082 Silicon Diode.

Please send me data on other Westinghouse Silicon Diodes. (Describe types or applications)

____

____

Name______________________________

Title______________ **Firm**______________

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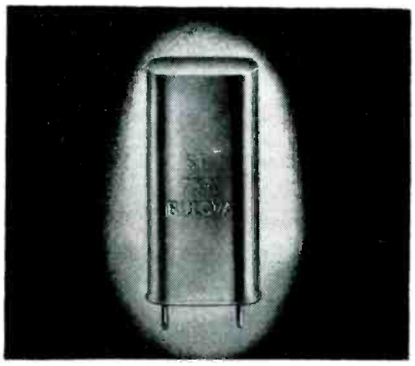
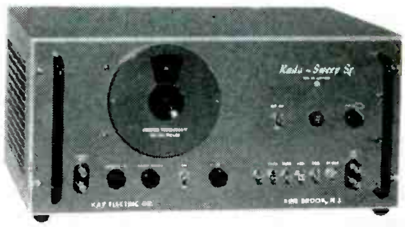
modulation from 10 to 10,000 pps at pulse widths of from 0.2 to 10 μsec. **Circle P18 inside back cover.**



QUARTZ CRYSTALS
shock-mounted units

BULOVA WATCH Co., Electronic Division, Woodside 77, N. Y., introduces a rugged, extremely stable, frequency determining element for missiles, aircraft and other applications involving extreme environmental conditions.

The ST-73X has a frequency range of 16 kc through 350 kc, with lower frequencies possible in holders of different configurations. Shock tests of 100 g and dynamic vibrations tests per MIL-T-5422, MIL-E-5272 and MIL-E-5400 standards were met without adverse results. Storage temperatures over a range of −65 C to +135 C can be coupled with an operation temperature range of −55 C to +100 C. **Circle P19 inside back cover.**



SWEEPING OSCILLATOR
with six switched bands

KAY ELECTRIC Co., 14 Maple Ave., Pine Brook, N. J. A board-band, all electronic fundamental sweeping oscillator with six switched bands, the new Rada-Sweep Sr. has 24 precise crystal markers set at customer specified fre-

The Research Laboratory in Palo Alto is particularly interested in electronic scientists and engineers who can plan today for major achievement in the future. Inquiries are invited from those possessing a high level of ability. Please address the Research and Development Staff, Sunnyvale 18, California.

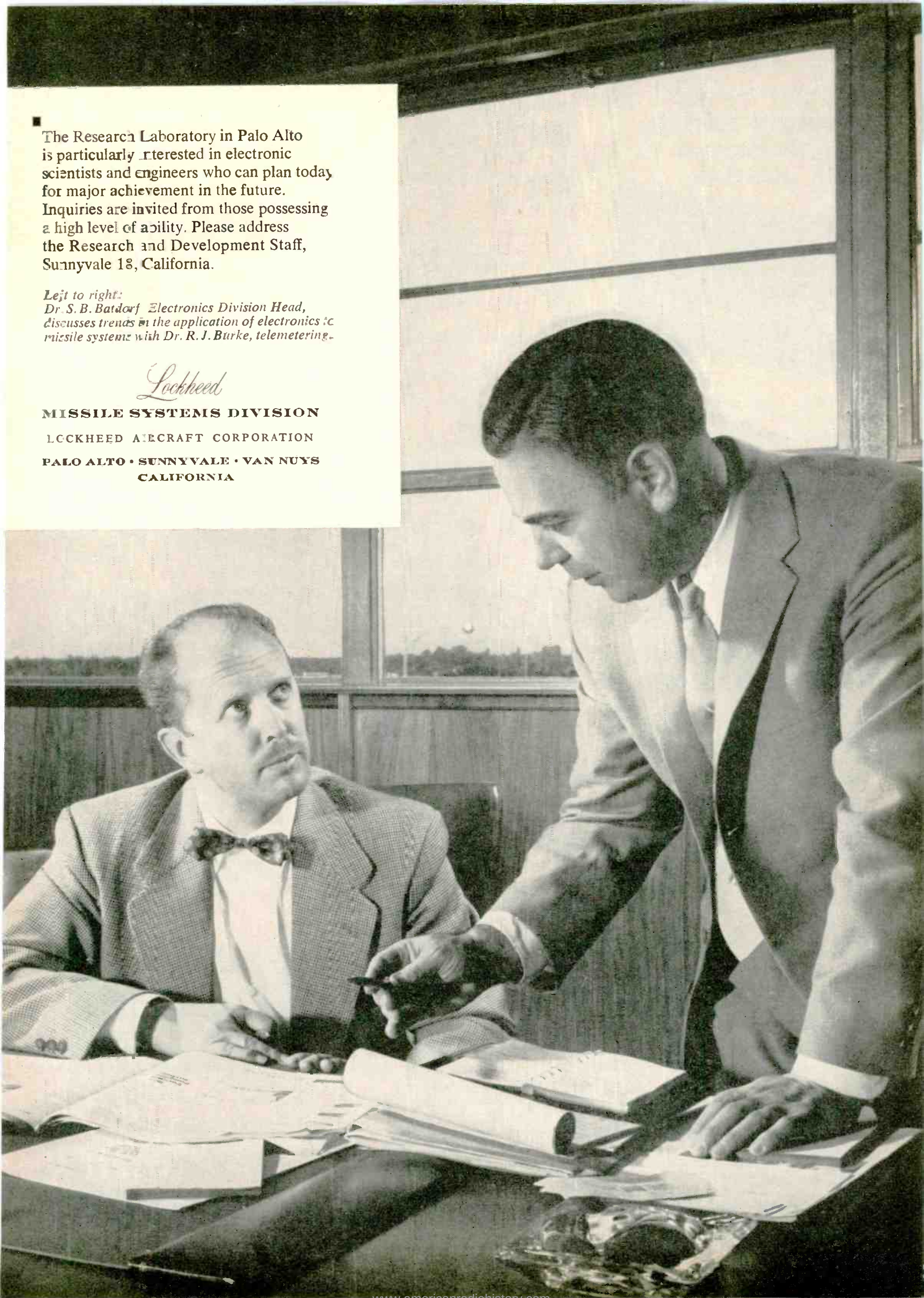
Left to right:
Dr. S. B. Batdorf, Electronics Division Head, discusses trends in the application of electronics to missile systems with Dr. R. J. Burke, telemetering.

Lockheed

MISSILE SYSTEMS DIVISION

LOCKHEED AIRCRAFT CORPORATION

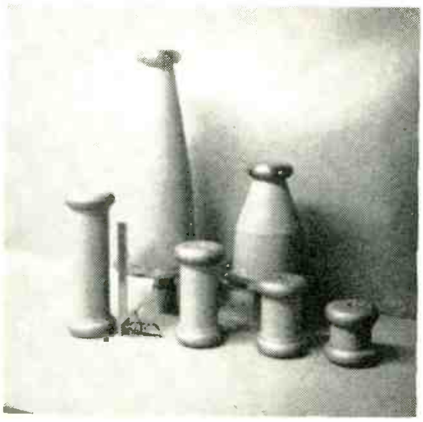
PALO ALTO • SUNNYVALE • VAN NUYS
CALIFORNIA



quencies. Center frequencies are from 1 to 260 mc. The unit is designed and built for sweeping radar i-f's up to 280 mc. It is extremely stable, has low harmonic content and is free of spurious output.

Frequency range is 1 to 260 mc center. Sweep width is 70 percent of center frequency to 100 mc; 60 to 70 mc from 100 to 250 mc. Sweep rate is variable around 60 cps; locks to line. The r-f output is 0.5 v rms into nominal 70 or 50 ohms; higher for lower frequency units. Output is held constant to within ± 0.5 db over widest sweep by agc circuit.

Also featured are up to 24 pulse-type crystal - controlled markers at customer specified frequencies, accurate to 0.05 percent. Weight of the unit is approximately 45 lb. **Circle P20 inside back cover.**



CABLE TERMINATIONS
and stand-off insulators

COMPONENTS FOR RESEARCH, INC., 937 Industrial Road, Palo Alto, Calif. New epoxy h-v cable termination, bushings and stand-off insulators are designed to meet specific space, mounting and operating conditions. The cable-to-air and cable-to-oil terminations shown are rated at 150 kv d-c with a flashover of more than 185 kv rms (260 kv peak). The stand-off insulators, which are 15, 10, 7½ and 5½ in. long are rated at 50, 40, 30 and 20 kv rms in air and 100, 90. 75 and 60 kv rms in oil with a flashover of at least 2½ times rated voltage. Special bases and caps can be provided for use at higher voltages and for special mounting requirements. **Circle P21 inside back cover.**

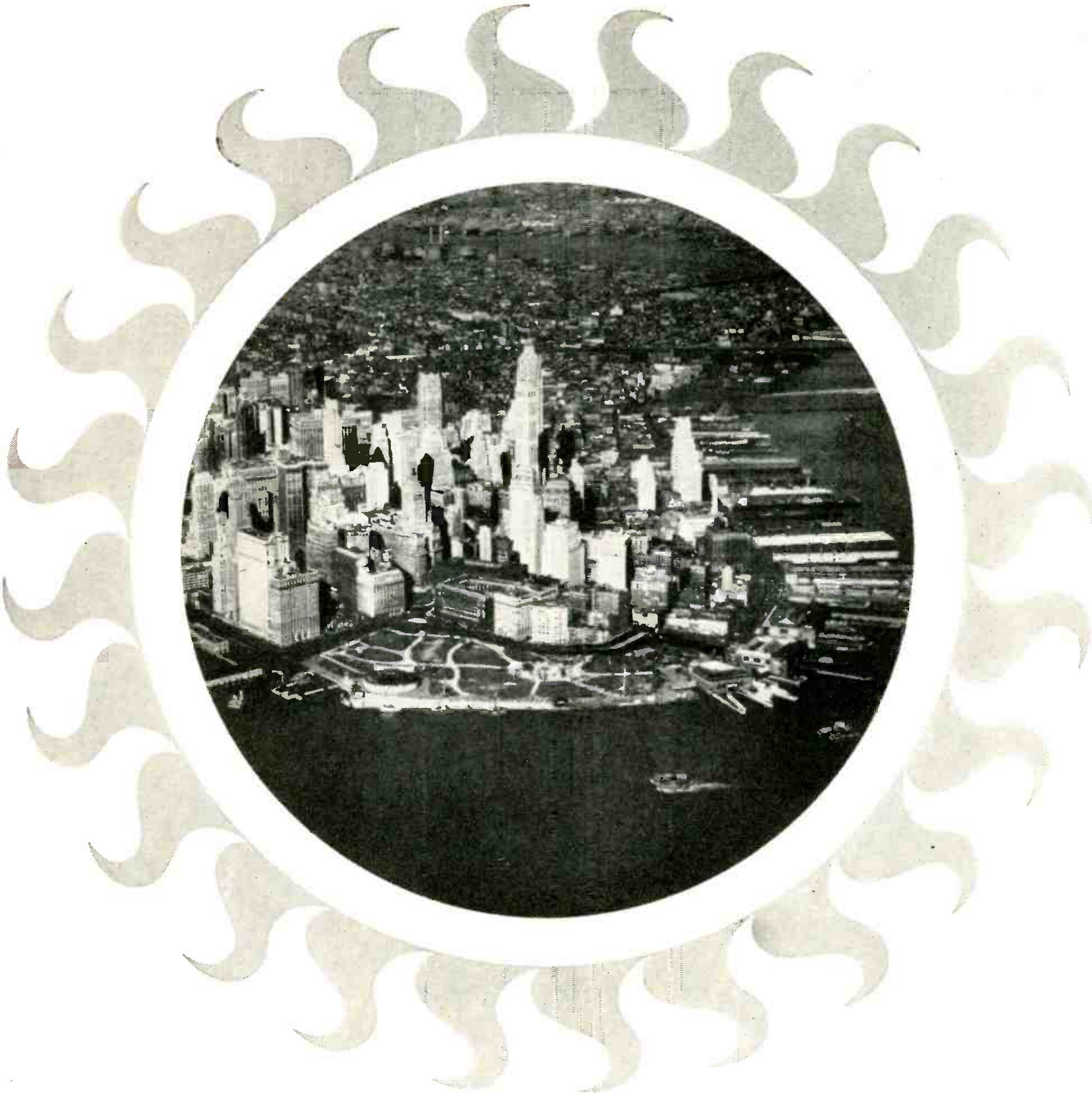
VARIABLE DELAY LINE
with 120 positions

ADVANCE ELECTRONICS LAB., INC., 249 Terhune Ave., Passaic, N. J. Type 606 series variable delay line features a time delay accuracy of ± 1 percent at any point. It may be driven by motor for automatic time tracking, has a rise time less than 4 percent and negligible overshoot. The unit consists of 120 sections of L-C m-derived networks and a 1-pole, 120-position rotary switch. The rotary switch is used to change the amount of time delay between the input and output by connecting the output terminal to any one of the 120 sections of LC networks.

The cutoff frequency in mc is equal to 38.4/D where D is the total time delay in μ sec. The time delay per step is 1/120 of the total time delay; attenuation is about 4-6 db maximum. There are 14 different models available with maximum time delay 1.2 μsec to 1,200 μsec; impedance varies from 75 to 1,000 ohms. **Circle P22 inside back cover.**

PHASE STANDARD
has a variety of uses

ACTON LABORATORIES, INC., Acton, Mass. Designed for calibrating phase meters and other phase-



measuring instruments, this phase standard can also be used with an oscilloscope to measure the phase shift in electronic circuits or to calibrate precision phase shifters. It converts an externally supplied signal (20 cps to 20 kc) into two sinusoidal signals whose phase relationship can be varied from 0 to 360 deg in four revolutions of a single control. Phase angle accuracy is ±1 deg from 20 cps to 10 kc; ±3 deg from 10 kc to 20 kc. Inherent distortion is less than 1 percent; overall distortion is dependent upon the externally supplied signal. The 0.5 to 5-v output of the instrument varies less than ±2 percent with phase shift. A self-contained regulated power supply can accept 105-125 v, 50-60 cps. **Circle P23 inside back cover.**

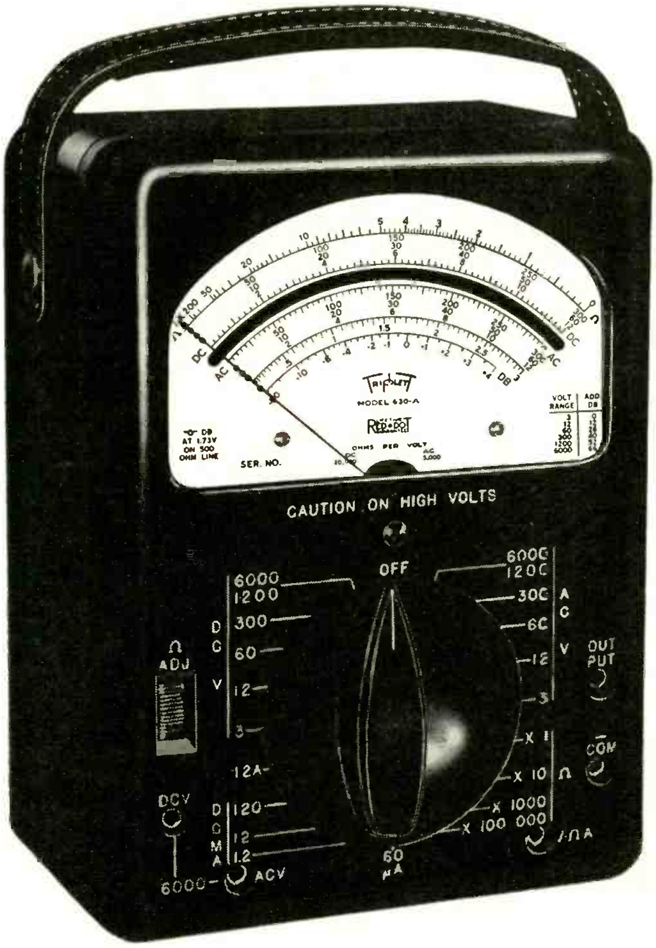
HARD-TUBE MODULATOR has wide applications

MANSON LABORATORIES, 207 Greenwich Ave., Stamford, Conn. Capable of operating a variety of magnetrons, twt's, klystrons and vacuum transmitting tubes, the new model 240 pulse modulator produces pulse voltages up to 17 kv peak at 20-amperes pulse current. Because hard tubes (two, in parallel) are used as the switch, any combination of pulse width and repetition frequency consistent with a maximum average power rating of 1,400 w is obtainable. Both the pulse width and the pulse repetition frequency are continuously variable from 1 to 10 μsec and from 20 to 10,000 pps respectively. A built-in audio oscillator provides internal control of the repetition rate, but

. . . .YOU SHOULD KNOW

THERE IS A MORE ACCURATE

VOM



1½% accuracy . . .

mirror scale

to eliminate any possible parallax and give you readings with the same laboratory accuracy that is built into the instrument.

MODEL 630-A $54.50

This VOM is truly what laboratories buy when they must have the best. Model 630-A is prized in
782 industrial laboratories
115 research laboratories
237 development laboratories
and is owned by over 300 engineering consultants and used for critical production line testing and in the maintenance of automation equipment by over 1100 manufacturers of all types of products.

TRIPLETT FEATURES:

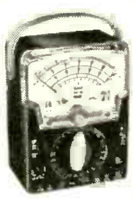
½% resistors—molded mounting for resistors and shunts allows direct connections without cabling. (No chance for shorts—longer life and easy-to-replace resistors in their marked positions.) King sized recessed knob for the single selector switch for both circuit and range—just turn and make reading.
Resistance ranges are compensated for greatest accuracy over wide battery voltage variation.

33 RANGES:

12 D.C.-A.C. Volts (20,000 ohms per volt DC, 5000 ohms per volt AC.); 5 Current Ranges; Resistance from .1 Ohms to 100 Megohms; Decibel and Output readings.

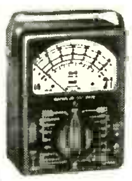
TRIPLETT ELECTRICAL INSTRUMENT COMPANY
Bluffton, Ohio

Burton browne advertising



631
Combination V-O-M—VTVM

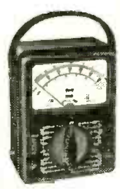
630-NA
For Best Testing Around the Lab, Production Line or Bench



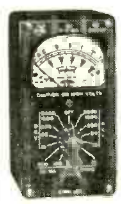
630
The Popular All-Purpose V-O-M

630-A
A Good Lab and Production Line V-O-M

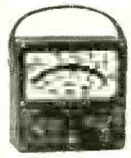
310
The Smallest Complete V-O-M with Switch



630-T
For Telephone Service



666-HH
Medium Size for Field Testing



625-NA
The First V-O-M with 10,000 Ohms/Volt AC

666-R
Medium Size with 630 Features

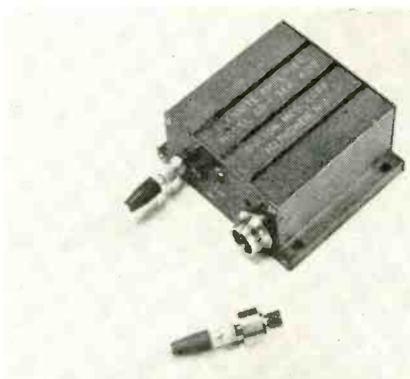
Want more information? Use post card on last page.

provision is also included to allow running the modulator from an external sine wave or trigger source. The output pulse is capacity coupled to the load. A jack for monitoring the grid-drive of the final amplifier tube is also provided.

The unit is fully self-contained, including a 15-v, 10-amperes a-c filament supply for the tube under test, and is ready for operation upon the introduction of 115-v, 1-phase, 60-cycle power. Complete details are available. **Circle P24 inside back cover.**

NPN TRANSISTORS
three new types

GENERAL TRANSISTOR CORP., Jamaica, N. Y., has available three new *npn* germanium alloy transistors intended primarily for computer applications where high speed, high current switching is of paramount importance. These new transistors are RETMA registered as 2N356, 2N357 and 2N-358. They are complementary to GT's *pnp* types 2N315, 2N316 and 2N317. **Circle P25 inside back cover.**



ACCELEROMETER SYSTEMS
for high temperature use

GULTON INDUSTRIES, INC., 212 Durham Ave., Metuchen, N. J. The Glennite AD series of high temperature accelerometer systems will operate under severe environmental conditions encountered in missile and high speed aircraft applications. Precision engineered, the units are designed for continuous operation at temperatures up to 450 F with no temperature compensation and no external cooling required. Each amplifier and cathode follower is individually potted with a plastic compound to insure performance under extreme conditions. The filament in the amplifier may be set for operation at either 6.3 or 26 v.

Four systems are available, the AD-1, AD-5, AD-10 and AD-14 with the AD-5 and AD-14 systems having a wider acceleration range and higher frequency response. Glennite connectors and cables are supplied. **Circle P26 inside back cover.**

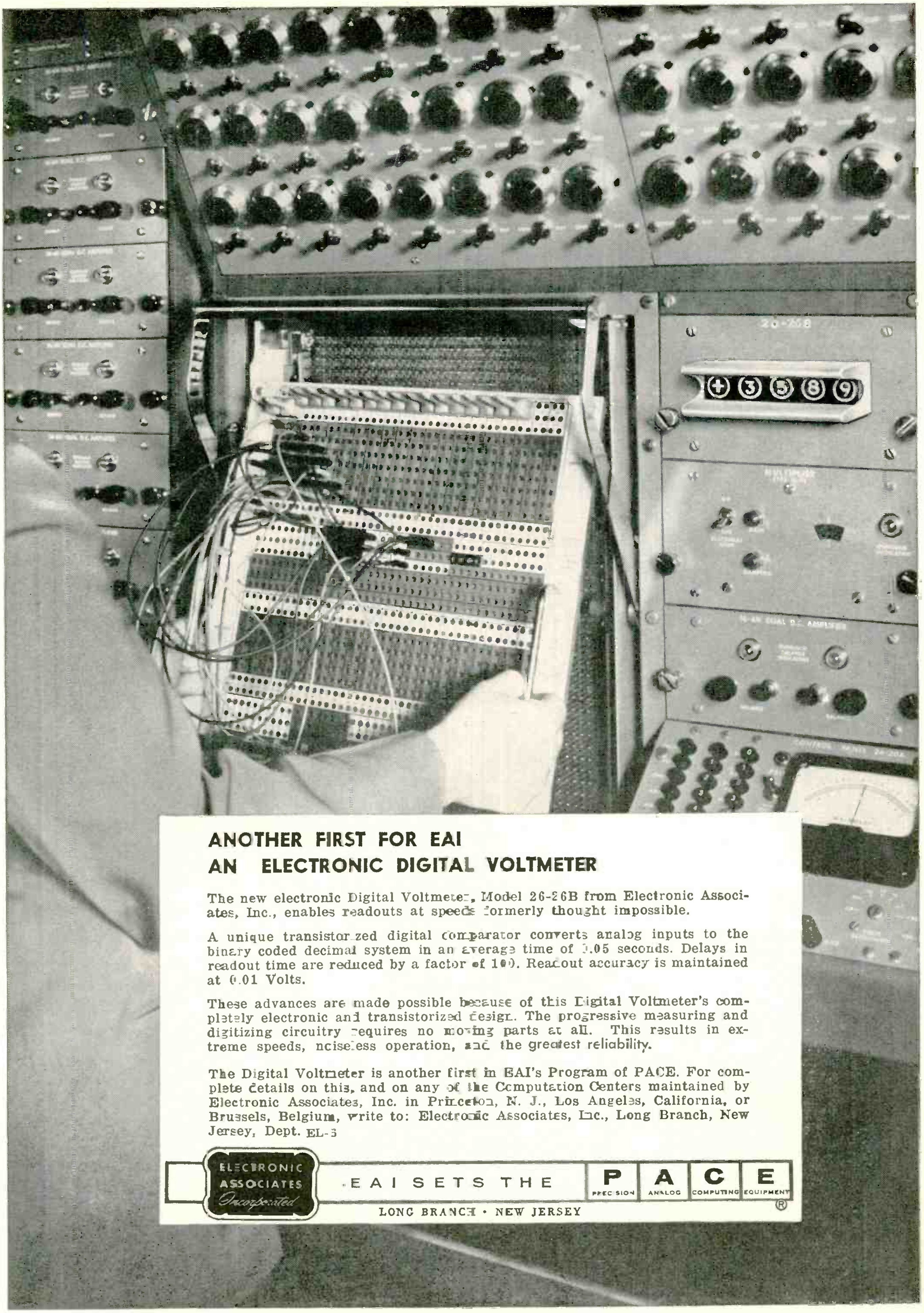
COMMUNICATIONS ANTENNA
for central station uses

MARK PRODUCTS CO., 6412 W. Lincoln Ave., Morton Grove, Ill., announces production of the new Sleeve Monopole antenna for central station applications in the communications services. The design provides an impedance bandwidth characteristic unattainable with other commercially available antennas. Model SM-150 maintains a vswr of 1.5 to 1 or better on a 50-ohm line from 148 through 174 mc.

Models are also available for the 108 to 132-mc aircraft frequencies and the 400 to 470-mc range. **Circle P27 inside back cover.**

COMPACT SWITCH
acceleration-time integrator

THE MAGNAVOX CO., 2131 Bueter Road, Fort Wayne, Ind., has developed an inexpensive, rugged acceleration-time integrating



ANOTHER FIRST FOR EAI
AN ELECTRONIC DIGITAL VOLTMETER

The new electronic Digital Voltmeter, Model 26-26B from Electronic Associates, Inc., enables readouts at speeds formerly thought impossible.

A unique transistorized digital comparator converts analog inputs to the binary coded decimal system in an average time of 0.05 seconds. Delays in readout time are reduced by a factor of 100. Readout accuracy is maintained at 0.01 Volts.

These advances are made possible because of this Digital Voltmeter's completely electronic and transistorized design. The progressive measuring and digitizing circuitry requires no moving parts at all. This results in extreme speeds, noiseless operation, and the greatest reliability.

The Digital Voltmeter is another first in EAI's Program of PACE. For complete details on this, and on any of the Computation Centers maintained by Electronic Associates, Inc. in Princeton, N. J., Los Angeles, California, or Brussels, Belgium, write to: Electronic Associates, Inc., Long Branch, New Jersey, Dept. EL-3

ELECTRONIC ASSOCIATES *Incorporated*

EAI SETS THE PACE — PRECISION ANALOG COMPUTING EQUIPMENT ®

LONG BRANCH • NEW JERSEY

switch for missile and rocket applications. The unit is completely self-contained and actuates when sustained accelerations in excess of the internal bias are applied. It is hermetically sealed and conforms to Air Force environmental specifications. An observation window and a unique reset feature facilitate laboratory testing. The switch can be adapted to a wide range of acceleration and time parameters to satisfy specific requirements.

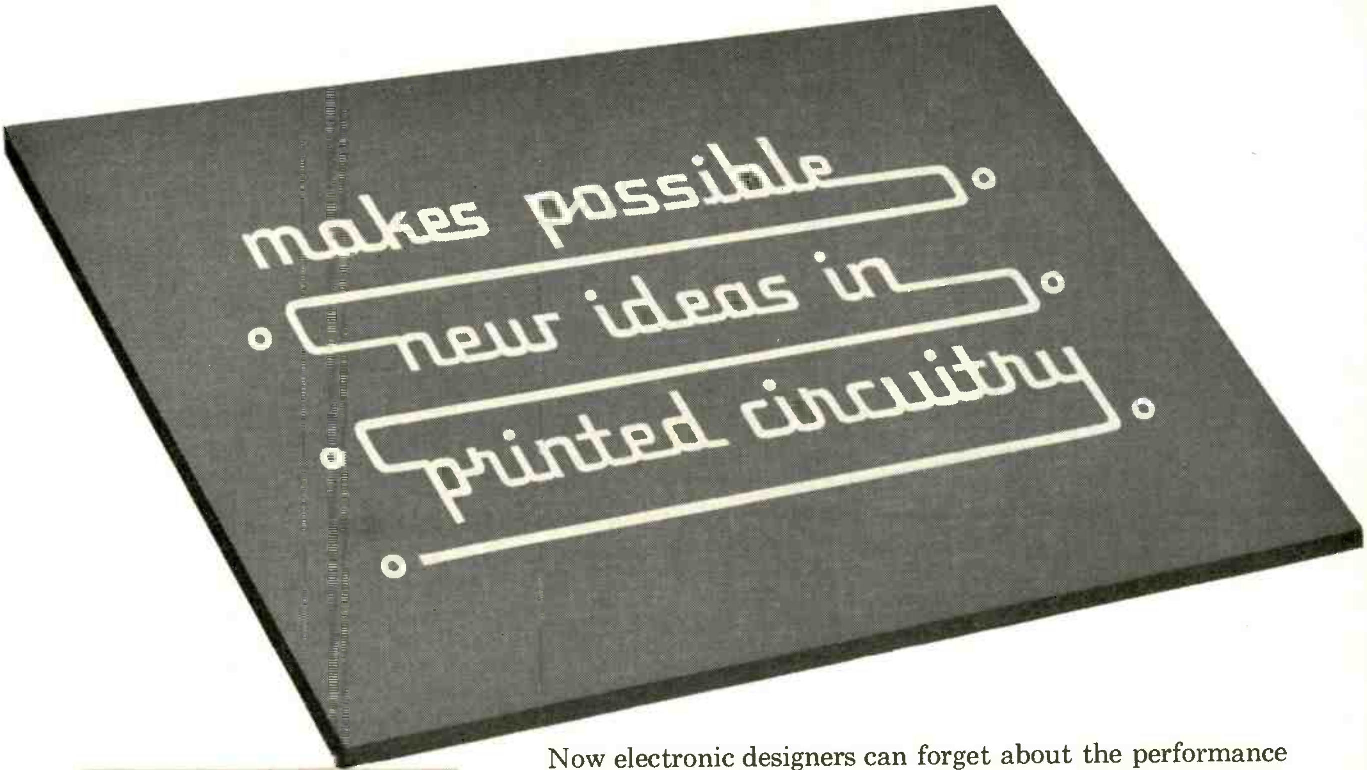
Contact closure occurs in the presently available unit when the missile or rocket has reached a velocity of approximately 460 ft per sec under conditions of sustained accelerations between 4 and 15 gravities. The pictured unit is approximately 3 cu in., and weighs approximately 9 oz. **Circle P28 inside back cover.**

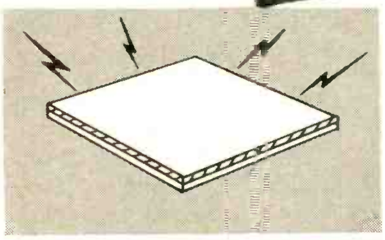
R-F VOLTMETER
covers from 0.2 to 500 mc

BOONTON ELECTRONICS CORP., Morris Plains, N. J. The new 91B sensitive r-f voltmeter features improved frequency range, sensitivity and stability. The instrument now covers from 0.2 mc to 500 mc and is useful up to 1,000 mc with reduced accuracy. Although the voltage calibration extends from 0.001 v to 3 v, the high order of zero stability and sensitivity permits detection of signal levels as low as 400 μv.

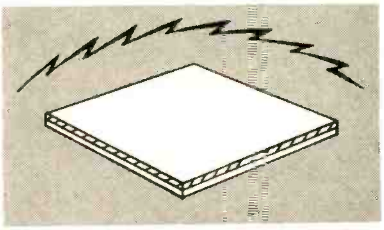
Two probes are supplied with each meter, one for general purpose high-impedance work, the other a low vswr 50-ohm probe for attaining maximum accuracy in

NEW IRC *FLUOROPLY* LAMINATE

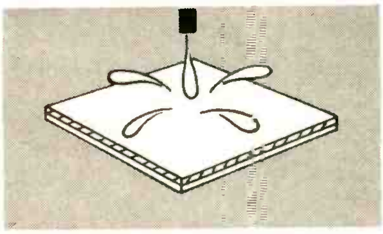




EXCELLENT ELECTRICAL PROPERTIES—High surface and volume resistivities, high dielectric strength and good high frequency characteristics.



SUPERIOR ARC RESISTANCE—Arc resistance of more than 360 sec. makes FLUOROPLY superior in high voltage and high humidity applications.



ZERO WATER ABSORPTION—FLUOROPLY's special fluorocarbon plastic base eliminates the problems of water absorption and humidity surface leakage.

Now electronic designers can forget about the performance limitations that have restricted the use of foil-clad plastic laminates under severe temperature, moisture and electrical conditions.

In FLUOROPLY Laminate Type F, IRC has succeeded in bonding copper foil to a plastic base with superior insulating qualities and unsurpassed resistance to heat and moisture. This base, a special fluorocarbon plastic, offers a combination of properties not found in any other laminate. Because it absorbs no water, it also solves the problem of humidity and surface leakage. FLUOROPLY offers all this at a low cost for the advantages provided.

FLUOROPLY is now available in 12″ x 12″ sheets with copper on one or both sides. Standard thicknesses are .031″ to 1/8″ for the base, 1, 2, 3, 5 and 7 oz. for copper foil. Special thicknesses can be supplied. Write today for complete details.

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INTERNATIONAL RESISTANCE CO., Dept. 235, 401 N. Broad St., Phila. 8, Pa. *In Canada:* International Resistance Co., Ltd., Toronto, Licensee

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monitoring h-f coaxial systems. Each probe contains a full-wave diode detector approaching rms response at levels below 0.1 v.

The combination of wide frequency response, high sensitivity, stability and ruggedness, plus ease of operation, permits application where expensive tuned amplifier or bolometer-type instruments would normally be required. **Circle P29 inside back cover.**

TEFLON MAGNET WIRE
in multipurpose kit

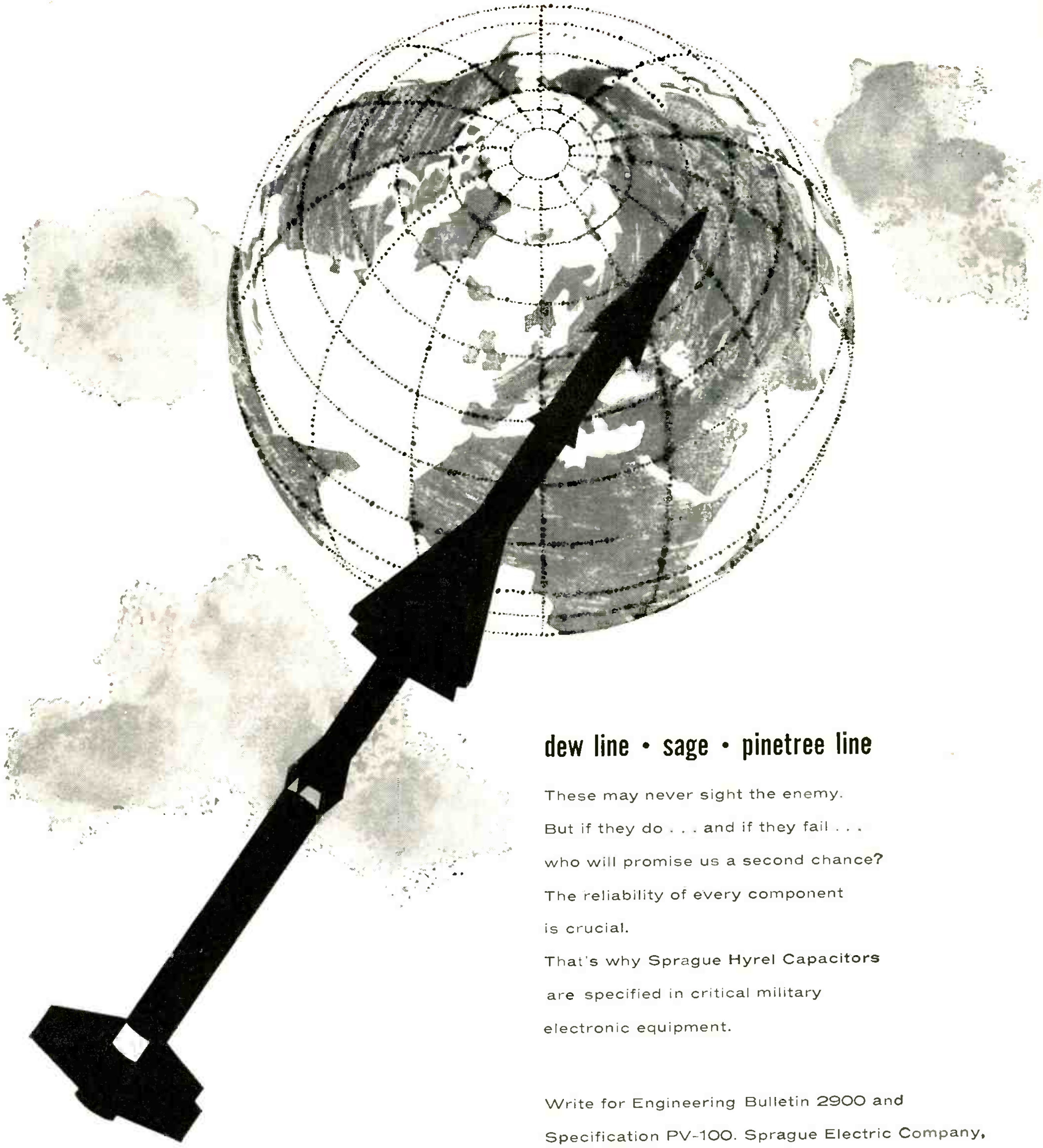
TENSOLITE SPECIALTIES, INC., 198 Main St., Tarrytown, N. Y., now offers a wide variety of gage sizes in class HT Teflon coated magnet wire in a single kit. This Teflon magnet wire kit was designed specifically for use in research and development projects where small quantities of different gage sizes are needed for prototypes and experimentation.

The kit contains an assortment of 12 miniature spools of Teflon-coated magnet wire in gage sizes 20 through 42 Awg. This wire conforms to type III, MIL-W-19583 (Navy) specifications. **Circle P30 inside back cover.**

TUBE TESTER
uses punched card system

THE HICKOK ELECTRICAL INSTRUMENT CO., 10527 Dupont Ave., Cleveland 8, Ohio. A new concept of automatic, high-speed tube testing has been produced in model 123A Cardmatic tube testing machine. The new tester utilizes a punched card system to automatically set and test to a user's specific circuit requirements.

Preselected voltages on screen,



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electronic equipment.

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Specification PV-100. Sprague Electric Company,
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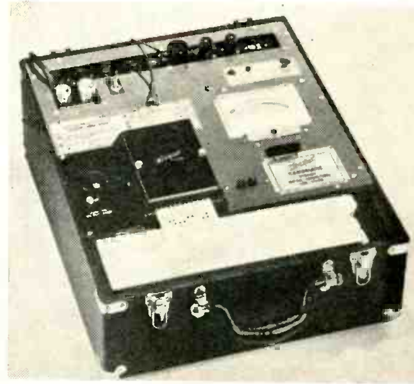
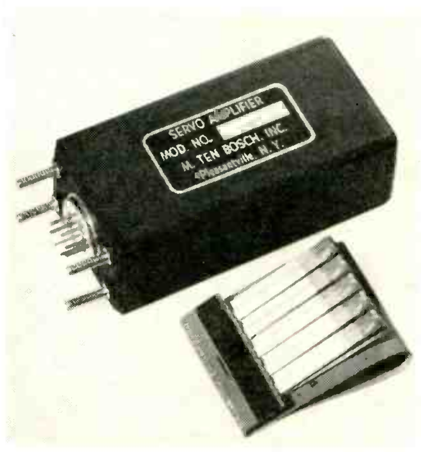


plate, grid or filament are tabulated on vinyl type cards which are inserted into the machine. These cards trip an automation mechanism to make all electrical connections necessary for testing of any receiver tube. An extremely large number of exactly controlled voltages are furnished for testing tubes in special purpose circuits. The low 0.22-v rms signal used on the grid permits testing of the newer sensitive tube types without distortion.

Tubes are checked within seconds and the simplified operation permits even unskilled personnel to run laboratory-accuracy tests on a production line basis. Literature and full information are available. **Circle P31 inside back cover.**



SERVO AMPLIFIER
transistorized type

M. TEN BOSCH, INC., Pleasantville, N. Y. Model 1800-0500 is a high temperature, miniaturized, hermetically-sealed, plug-in transistor servo amplifier. It is primarily intended to receive signals from a synchro control transformer and to operate a size 15,

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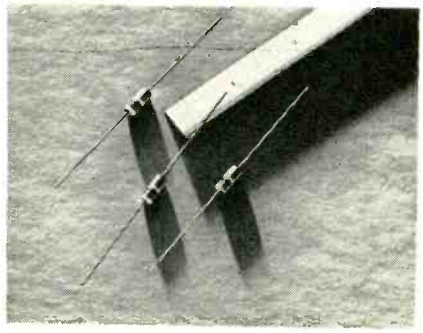
400-cycle, 6.1-w servo motor (Kearfott type R110-2) or equivalent. The amplifier is designed to exceed the environmental requirements of specification MIL-E-5400A.

The company has available a data sheet giving complete physical and electrical specifications, outline drawings and characteristics chart. **Circle P32 inside back cover.**



R-F CHOKE COILS
subminiatures in 23 values

DELEVAN ELECTRONICS CORP., East Aurora, N. Y., is now producing a standardized series of molded r-f choke coils that are more than 50 percent smaller than similar coils. The subminiature line is available in 23 items with inductance values from 0.15 to 22.0 μh. Coils measure 0.156 diameter by 0.375 length.

This series is one of six standardized r-f choke coil series available for off-the-shelf delivery. All are hermetically encapsulated in molded alkyd to provide the ultimate in environmental protection. There are 150 coils in the six series—each has exactingly defined electrical parameters. All coils conform to MIL-C-15305A.

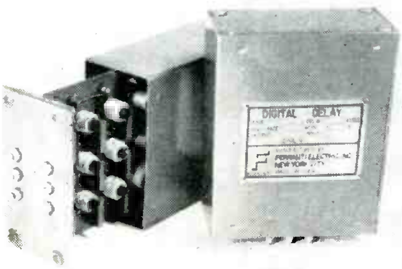
Designers will find that by incorporating these standardized coils in their circuits, they can save up to 75 percent of the engineering time formerly spent in r-f choke coil design. A fully descriptive bulletin is available. **Circle P33 inside back cover.**

CERAMIC TETRODES
two, 250-w types

EITEL-MCCULLOUGH, INC., San Bruno, Calif. Two new 250-w

ceramic and metal tetrodes have been added to the Eimac line. Designated the 4CX250K and 4CX-250M, each of these new external anode radial beam power tetrodes employ concentric uhf terminals, and represent the continued emphasis being placed on ceramic and metal construction in new tube design.

The 4CX250M has a 26.5 v filament, while the 4CX250K has a 6 v filament. Both tubes have a 250-w plate dissipation rating. **Circle P34 inside back cover.**



LATTICE NETWORK
for digital memory stores

FERRANTI ELECTRIC, INC., 30 Rockefeller Plaza, New York 20, N. Y., has announced lumped constant electromagnetic networks specifically developed and designed for digital storage, using only 1.2 elements per bit, and providing highly stable characteristics without extreme tolerances on the individual elements.

Hermetically sealed units can be supplied for any capacity up to 30 bits at digit rates up to 5 mc, for satisfactory operation over a temperature range of −20 C to +70 C. The units provide an extremely economical and compact

 For additional information on all items on this page, use post card on last page.

form of storage in this capacity range, and can readily be grouped for serial or parallel operation with rapid access. **Circle P35 inside back cover.**

TUBULAR CAPACITOR
for printed circuitry

Pyramid Electric Co., North Bergen, N. J., has announced a new plastic tubular capacitor for printed circuits. Known as type BTS, it is designed to withstand the most exacting requirements for minimum board space, close mechanical tolerances and reduced space allowances as demanded by modern electronic assemblies. Ideally suited to present day and future electronic equipment the BTS is also recommended for operation under the most severe conditions. **Circle P36 inside back cover.**

Z ANGLE METER
low impedance unit

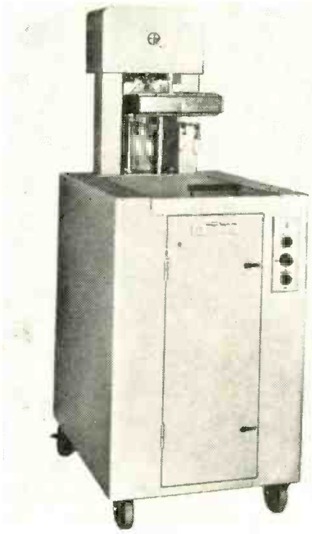
Acton Laboratories, Inc., Acton, Mass. Type 314 low-impedance Z-angle meter, featuring wide range and ease of operation, is designed for measuring low values of complex impedances in polar form. Impedance and phase angle of the unknown are determined by equating its voltage drop to that across a standard impedance of adjustable value, with the same current applied to both. A unique four-terminal arrangement, wherein current and voltage terminals are provided for the unknown impedance, nullifies the effect of lead impedance and insures accurate measurement.

The instrument has two dials from which results are read. One is calibrated in absolute magnitude of impedance in ohms; the other, in phase angle and dissipation factors. Operating over a frequency range of 30 to 1,000 cps, the type 314 has an impedance magnitude range of 0.001 to 1,000 ohms in six steps with an accuracy of ±1 percent, a phase-angle range of 0 to 90 deg (lead or lag) with an accuracy of ±1 deg and a dissipation-factor range of 0 to infinity. External oscillator input voltage can be 0 to 10 v; input impedance is 0.5 megohm. **Circle P37 inside back cover.**

LINEAR AMPLIFIER
double R-C differentiation

Tullamore Electronics Laboratory, 6055 S. Ashland Ave., Chicago 36, Ill. Model A-100 linear pulse amplifier features double R-C differentiation. The differentiation after the last stage of amplification incorporates a diode restorer to prevent base line shift. Wire-wound resistors are used throughout in stabilization and attenuator circuits. The built-in pulse generator uses a mercury-wetted contact relay to produce exponential pulses similar to pulses from associated nuclear detectors.

Pulse generator amplitude is controlled from a 10-turn helical pot. Amplifier output is linear from 0 to 100 v. A built-in amplitude discriminator, continuously variable throughout the range of the amplifier, is front-panel controlled by a 10-turn helical pot. The unit is available with preamplifiers for use with scintillation, pulse chamber, BF_3, fission or special purpose counting applications. **Circle P38 inside back cover.**



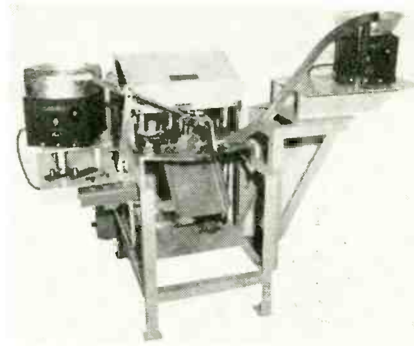
DIP SOLDERER
a semiautomatic machine

Electronic Products Corp., 322 State St., Santa Barbara, Calif. The new version of the dip soldering machine facilitates semiautomatic production of electrical and electronic assemblies and circuit boards using printed and etched circuit techniques. The machine has a capacity of 120 units per hr and requires only one operator.

Angle and depth immersion of the work in the molten solder are adjustable. Dwell time may be set at any value from 0 to 57 sec in 0.5-sec increments. Solder temperature, after adjustment, is automatically maintained at the desired temperature.

The machine is equipped with an automatic dross skimmer and a vibrator unit which removes excess solder from the work. The unit is 24 in. wide and 32½ in. deep. Cabinet surface is 39 in. above the floor while overall height of the machine is 61 in. Weight is 350 lb.

Single phase electrical power at 220-240 v, 60 cps is required. Power consumption depends upon size of solder pot used. A typical load is 2,400 w. **Circle P39 inside back cover.**

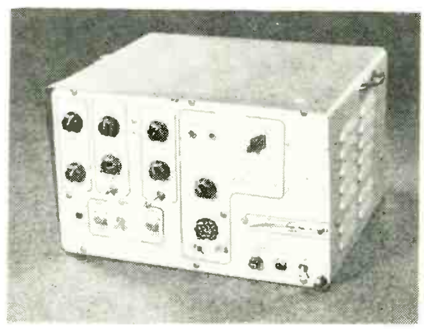


RESISTOR CAPPER
is fully automatic

HALM INSTRUMENT CO., INC., Glen Head Road, Glen Head, L. I., N. Y., has announced a fully automatic resistor capping machine. Designed for high production capping of resistor bodies with press fitted terminal caps, this machine may be tooled for a variety of resistor bodies ranging in size from $\frac{1}{16}$ in. to $\frac{5}{16}$ in. in diameter.

The machine features vibratory hopper feeds which automatically maintain full chutes for uninterrupted operation. Caps are fed at 100 per minute so that 3,000 resistors are assembled per hour.

One machine may be tooled to handle several sizes by a simple change procedure. Also available is a machine to fit end leads internally, thereby making the entire o-d of the body available for the resistance element. **Circle P40 inside back cover.**



PULSE GENERATOR
easily accessible

ELECTRO-PULSE, INC., 11861 Teale St., Culver City, Calif. An easily accessible internal design combined with simplified circuitry providing fast rise time pulses at high repetition rates, make the model 2125B pulse generator an economical instrument for use in a wide range of laboratory and test applications.

Repetition rates from 10 cps to 100 kc, variable advance or delay operation 0 to 100 μsec, variable pulse width from less than 0.1 to 100 μsec and variable amplitude low impedance output are provided.

Snap-off top and bottom plates provide complete accessibility and overhanging light shield minimizes instrument panel glare. **Circle P41 inside back cover.**

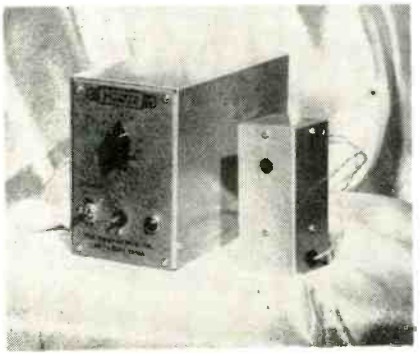


PHOTO-CONTACT RELAY
has many applications

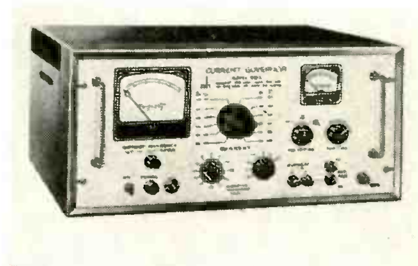
HUNTER MFG. CO., 108 South Linn St., Iowa City, Iowa. Model 330 photo-contact relay is a dpdt relay which will open or close any desired external circuit. It may be made to operate either by the interruption of a light beam directed at a photoelectric cell or by the closing of a pair of contacts which may have resistance as high as 1 megohm. Thus, it is a dual control relay for one of many possible experimental, research, production control or safety applications. **Circle P42 inside back cover.**

WWV RECEIVER
has six individual crystals

SHASTA DIVISION, Beckman Instruments, Inc., P. O. Box 296, Station A, Richmond, Calif. Model 905 WWV receiver is designed to conveniently and accurately utilize the standard time and frequency

 For additional information on all items on this page, use post card on last page.

broadcasts of the National Bureau of Standards radio stations WWV and WWVH. Features are: (1) all six frequencies selectable by a front panel switch; (2) all three audio filters selectable by front panel switch; (3) 1-μv sensitivity on all bands; (4) rugged modular construction; (5) blower cooled; (6) available in either cabinet or rack mounting. A logarithmic signal strength meter is provided for precise tuning. Price is $525 without cabinet, $550 with cabinet. **Circle P43 inside back cover.**



CURRENT STABILIZER
has varied applications

North Hills Electric Co., Inc., 402 Sagamore Ave., Mineola, L. I., N. Y. Model CG-1 current governor is a two-terminal current stabilizer and programmable electronic load. Current levels at voltages from 0 to +3,000 v d-c are selected by front panel controls in 1-ma steps from 1 to 600 ma. The stabilized current may be modulated 0 to 100 percent by an internal 60-cps sine wave or by external signals including sine wave, complex waveforms and d-c.

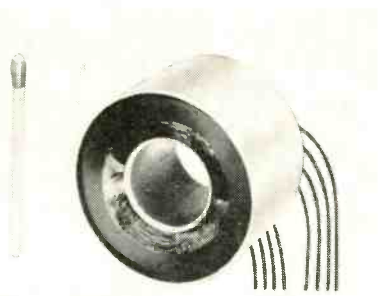
Applications include constant-current generation, programmable electronic load, transistor and tube testing, magnetic core investigation, generation of high voltage, long period sawtooth waveforms, instrument calibration, solenoid and clutch testing and power supply for magnetron and other microwave tubes.

Further technical data are given in bulletin E-1. **Circle P44 inside back cover.**

HIGH TORQUE SERVO

60 cps, two-phase unit

JOHN OSTER MFG. CO., Avionic Div., Racine, Wisc., has available a new size 15 115-v 60-cps two-phase servo with exceptionally high torque for its size and weight. It weighs 7.6 oz and delivers 1.45 in.-oz minimum stall torque. Phase 1 is 115 v and phase 2, 115/57.5 v. Speed is 3,200 rpm at no load. At stall, current is 0.060 ampere per phase and power 6.1 w per phase. The unit comes housed in stainless steel and can be built to meet MIL-E-5272A. **Circle P45 inside back cover.**

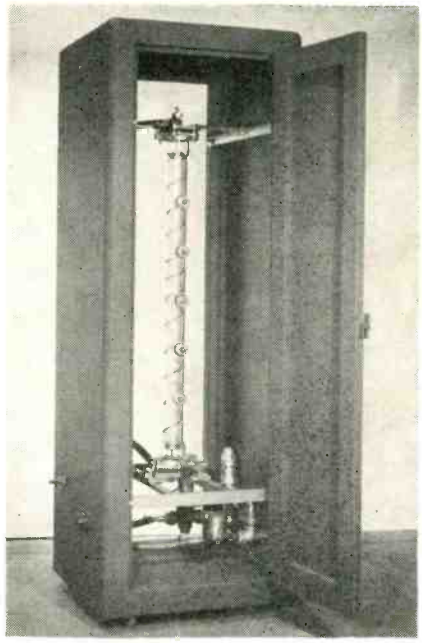


DEFLECTION YOKE

miniature, encapsulated

SYNTRONIC INSTRUMENTS, INC., 170 Industrial Road, Addison, Ill. A new miniature epoxy encapsulated push-pull magnetic deflection yoke, type Y57-P, fits all standard ⅞ in. neck diameter c-r tubes with deflection angles up to 70 deg. It is also ideal for use with transistors and withstands extreme environmental conditions. Push-pull windings with separate B+ leads permit greater circuit flexibility. Low geometric distortions are achieved by accurately formed wound coils.

The yoke is available in impedances and winding configurations suitable for transistor drive and in higher impedances for v-t circuits. Overall length is $1\frac{9}{16}$ in., o-d $2\frac{1}{4}$ in. and i-d 1 in. Residual is 0.5 percent maximum, radial error 1 percent maximum, angular error 0.5 deg maximum, horizontal coil capacity 11 $\mu\mu$f, vertical coil capacity 15 $\mu\mu$f and temperature rating 105 C maximum. **Circle P46 inside back cover.**



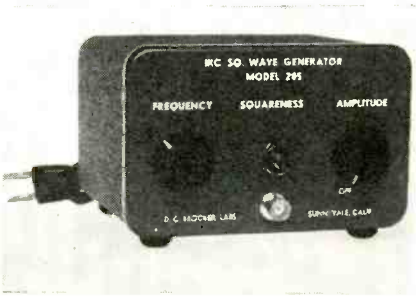
VIDEO DUMMY LOAD
uses tap water as coolant

LEVINTHAL ELECTRONIC PRODUCTS, INC., 760 Stanford Industrial Park, Palo Alto, Calif. Available with fixed resistances from 5 to 200 ohms, the model G6A dummy load can also be supplied with tapped resistances as illustrated. A 0.1-ohm noninductive monitoring resistor is included for measuring pulse current. Time constant of the unit is less than 0.05 μsec.

Using ordinary tap water as a coolant, the load can dissipate up to 50-kw average power with 9 gpm of water flow and a 21 C water-temperature rise. Peak power capacity is 100 megawatts and maximum energy per pulse

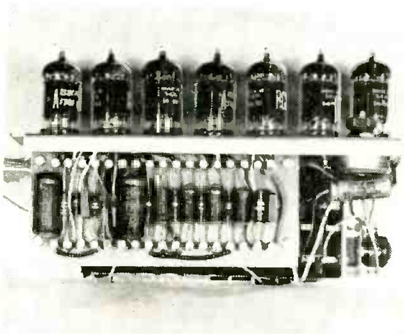
550 watt-seconds.

Weighing approximately 30 lb (exclusive of cabinet), the unit has the following dimensions: 49 in. overall length, 3 in. o-d glass tube with 5 in. diameter flanges. **Circle P47 inside back cover.**



SQ-WAVE GENERATOR
center frequency 1 kc

D. C. BROCKER LABORATORIES, P. O. Box 967, Sunnyvale, Calif. Compact and stable this variable-amplitude direct-coupled square-wave generator finds use as a modulator of signal generators and twt amplifiers. It delivers 60 v maximum peak to peak and has positive ground, 0.4-μsec rise time, 5-percent overshoot and zero to 5-kilohms internal impedance. **Circle P48 inside back cover.**



TV SYNC GENERATOR
uses magnetic binary scalers

WANG LABORATORIES, INC., 37 Hurley St., Cambridge 41, Mass. Model No. 1011 packaged to synchronizer unit will automatically generate 31.5 kc and 60-cps pulses locked to the line frequency. It will track $\pm$2-cps variations in power line frequency and can be adjusted with a single control to track power line frequencies from 40 to 70 cps.

Utilizing the magnetic binary

 For additional information on all items on this page, use post card on last page.

scaler principle, the unit draws only a few ma off 160 v supply and occupies a panel or chassis space of only 7½ in. by 2¼ in.

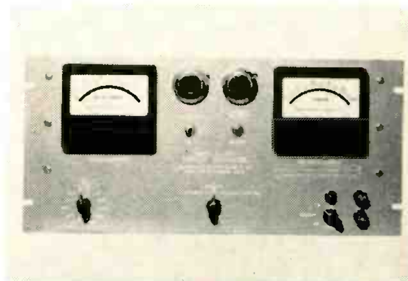
Price is $225. **Circle P49 inside back cover.**

LINEAR ACCELEROMETERS

two new series

TECHNOLOGY INSTRUMENT CORP., 531 Main St., Acton, Mass., offers a new line of accurate linear accelerometers. The 11000 series features a standard voltage output of 10 v with a 26-v, 400-cycle input. Null voltages are less than 10 mv for the voltage output.

The 12000 series features a precision potentiometer output with a resolution of 500. Linearity is better than ½ percent and hysteresis less than ½ percent. Thresholds lower than 0.001 percent can be achieved. These units have been designed to surpass all phases of the military specifications. **Circle P50 inside back cover.**



ACCELERATOR CURRENT INTEGRATOR

wide range, high accuracy

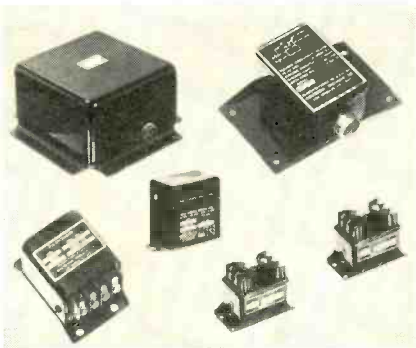
EL DORADO ELECTRONICS CO., 1401 Middle Harbor Road, Oakland 20, Calif. Model CI-100 accelerator current integrator employs a true current sampling technique which eliminates high-impedance input circuits and resulting leakage-insulation problems. Current measurements of 1 millimicroampere to 1 ma and charge measurements of from 15 millimicrocoulombs to 29 coulombs can be made with an accuracy of 1 percent through the use of analog computer-type operational amplifiers.

Other features include a charge-preset feature used to stop the

For additional information on all items on this page, use post card on last page.

accelerator beam when a predetermined charge has been reached; provision of an output voltage, proportional to accumulated charge, which may be used to operate control circuitry or data reduction equipment; and a self-contained variable decay coefficient to stimulate the decay of short-lived isotopes during beam off-target periods.

The unit contains its own power supply and is rack-mounted, 19 in. wide, 8¾ in. high and 2½ in. deep with a weight of 30lb. Power requirements are 110-130 v, 60 cps, 100 w. **Circle P51 inside back cover.**



ELECTRONIC FLASHERS
in miniaturized design

ELECTRONIC SPECIALTY CO., 5121 San Fernando Road, Los Angeles 39, Calif., has developed a line of patented miniaturized electronic flashers designed to meet the most demanding requirements of vibration, shock, temperature stability and radio noise suppression, and qualified to all applicable military specifications. The resistance-capacitance oscillators used offer performance advantages over thermal devices and motor-driven switches as they have excellent frequency stability over as much as a 14 to 30 v range, are easily temperature compensated and are maintenance free. The output contact arrangement and flasher circuit is readily adapted to any type of warning system. Standard units are available with and without radio noise suppression.

Maximum miniaturization is obtained by the company's own relay specifically designed for flasher circuits. Flashing rates, output arrangements and load capacities can be made to meet any requirement. **Circle P52 inside back cover.**

CYCLING TIMER

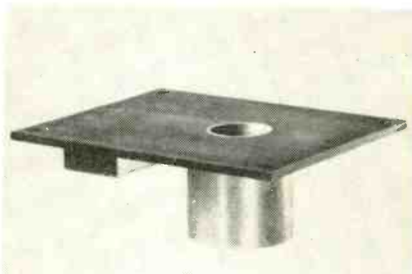
with wide range of speeds

CRAMER CONTROLS CORP., Centerbrook, Conn. A new cam timer features small size, design simplicity, low cost, and a wide range of speeds.

With contacts for 30-ampere resistive loads (and ⅓ hp) at 115 v a-c, speeds of 1 rpm to 1 rev in 8 days are offered. Faster speeds can be obtained with lower switch ratings. Switches are open blade, either spst or spdt. Three-level cams and a neutral position in the spdt switches can be supplied to permit control of up to eight load circuits with a four-pole timer.

Type 571 timer is a cycling device which operates continuously as long as power is supplied to the high-torque motor. Overall dimensions are approximately 2¾ in. sq by 2¾ in. deep including motor. Two-hole mounting is standard with one-hole center mounting optionally available. Output shaft can be supplied. Wiring terminals are quick-disconnect spade type.

The timer is available for operation on all standard voltages, 60 and 50 cps frequencies. It is designed for UL approval. **Circle P53 inside back cover.**



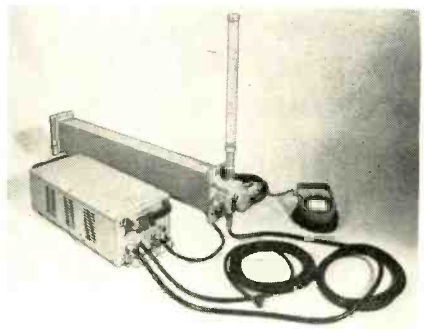
PROXIMITY PICKUP

hollow coil type

ELECTRO PRODUCTS LABORATORIES, INC., 4500 Ravenswood Ave., Chicago 40, Ill. A new hollow coil proximity pickup featuring a connector located on the coil is now offered. Ideal for counting small metal parts such as screws, nuts, washers and bolts, model 4920-AN replaces model 4920 hollow coil which did not have the detachable cable feature. As a high-frequency, carrier-operated transducer, it works on a principle similar to the military mine detector. It senses aluminum, brass or copper as well as iron and steel.

The coil can be used as part of a chute or tube carrying metal parts which can either slide or drop through. Connected by a cable to a control unit, it causes the control unit to generate d-c voltages or operate relays. The control unit can be used to actuate electromechanical or electronic counters and automatic machinery. When electronic counters are used, counting rates in excess of 60,000 per minute may be obtained.

The new pickup is available in 15 sizes from ¼ in. to over 3 in. in diameter. **Circle P54 inside back cover.**



L-BAND DUMMY LOAD

in water-tight transit case

WACLINE, INC., 35 S. St. Clair St., Dayton 2, Ohio, announces a new high-power L-band dummy load with direct indicating calorimetric wattmeter. The lightweight load element is composed of two tapered fluid elements of molded fiberglass construction which is centered inside of a four-ft long section of aluminum waveguide. A remote heat-exchanger unit pumps a constant volume of lossy liquid through the tapered fiberglass elements. The lossy liquid absorbs the microwave energy and the heat is then dissipated by the heat-exchanger unit.

The entire unit is stored in a

water-tight transit case which is constructed of light weight laminated aluminum-bound plywood. It operates in a frequency range from 1,150 mc to 1,750 mc with a vswr of less than 1.15 and is rated at 1,500 w maximum average power and 5-megawatts peak pulse power. **Circle P55 inside back cover.**

ROTARY POT

features hermetic seal

TECHNOLOGY INSTRUMENT CORP., 531 Main St., Acton, Mass., has announced a new rotary metal-film potentiometer featuring hermetic seal and providing essentially infinite resolution.

Resistance ranges are as follows: Type MFR-1 (1 in. diameter), 700 ohms to 25,000 ohms; MFR-2 (2 in. diameter), 1,000 ohms to 50,000 ohms; MFR-3 (3 in. diameter), 1,000 ohms to 75,000 ohms.

This new pot provides high accuracy; linearity less than 0.5 percent independent; less than 100-ohms equivalent noise resistance and temperature coefficient less than 0.0003 ohm per deg C. Excellent results have been achieved in extensive environmental testing. **Circle P56 inside back cover.**

LINEAR ACCELEROMETER

for aircraft and missile uses

DONNER SCIENTIFIC CO., Concord, Calif., announces its new model 4112 linear servo accelerometer. Incorporating a high-gain electromechanical amplifier in closed-loop operation, it is designed for precise measurement or control of linear acceleration over a frequency range from 0 to 25 cps, even under severe environmental conditions. It is especially suited to aircraft and missile applications where rugged construction and a high degree of accuracy are needed.

The internal servo system of the model 4112 provides resolution of better than 0.001 percent and linearity within 0.1 percent of full range. It will withstand shocks of hundreds of g and can be compensated within 0.1 percent of full scale over a temperature range of 100 C. High output levels are obtainable, thus eliminating the need for further amplification. Standard input ranges from ±0.1 g to ±20 g are available, each having a high overload capacity. **Circle P57 inside back cover.**

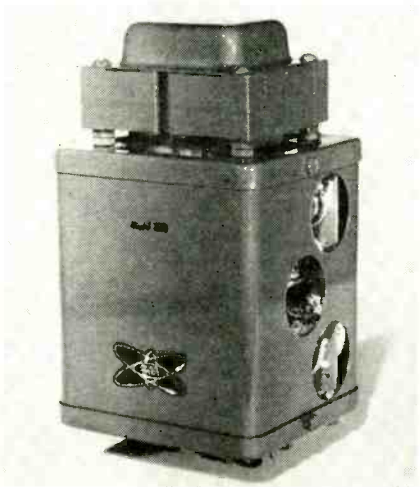
HERMETIC TERMINAL

for electronic components

LUNDEY ASSOCIATES, 694 Main St., Waltham 54, Mass., announces the new series 399 hermetic terminal for electronic components such as transformers and capacitors in the intermediate voltage range, 1,500 v operating. These are rugged, simply constructed terminals utilizing the superior properties of Teflon and silicone rubber for improved performance.

Designed to meet MIL-T-27A specifications, the terminals have an operating voltage of 1,500, test voltage of 4,000 and current rating of 10 amperes. Assembly of the terminal needs only simple tooling. Depending upon the electrode, the assembly is accomplished by clinching in a press with rudimentary jigging or by a drive fit of the electrode with a press. As an added service, Lundey Associates will install the terminals in the customers' covers. The hermetic seal is completed at the time internal leads are attached.

The series 399 is available in three electrode styles: hollow electrode with lug for minimum clearance; solid electrode with single turret; solid electrode with double turret. **Circle P58 inside back cover.**



V-R POWER SUPPLY
for photomultiplier tubes

C. J. Applegate & Co., 1816 Grove St., Boulder, Col. Model 223 Uniplug is a voltage regulated power supply for photomultiplier tubes. Output voltage is 1,500 ± 25 v. Voltage adjustment is by a slotted shaft potentiometer in the rear of the unit. Maximum allowable current drain is 1.5 ma. Line regulation is less than 0.1 percent for a line voltage shift of 10 v. Line voltage limits are 105 v to 125 v a-c 60 cps. Ripple voltage is less than 50 mv. **Circle P59 inside back cover.**

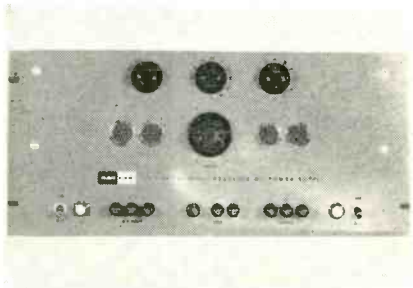
DUO-TRIODE
for 110-deg vertical deflection

Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y., has developed a new 9-pin miniature duo-triode designed to fill the need of a miniature tube for 110-deg vertical deflection service in tv receivers. Type 10DE7, featuring a 600-ma heater for series-string operation, contains two dissimilar triode sec-

For additional information on all items on this page, use post card on last page.

tions. The smaller section is a medium-mu triode with typical oscillator characteristics. The output section is a low-mu, high-perveance triode rated at a plate current of 80 ma at zero bias, a maximum plate dissipation of 7.0 w, a peak positive plate voltage of 1,000 v absolute maximum and a peak cathode current rating of 160 ma maximum.

The dual purpose 10DE7 vertical oscillator-amplifier provides the high current required for 110-deg vertical service—a characteristic not normally available from other T6½ amplifiers. Its small size also conforms readily to printed circuitry and techniques of automation. **Circle P60 inside back cover.**

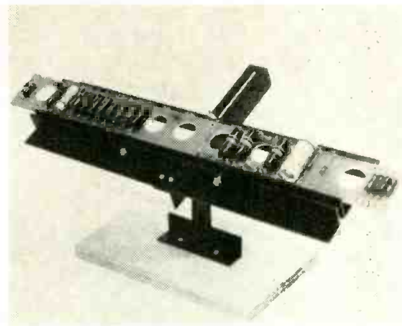


D-C POWER SUPPLY
high accuracy unit

KinTel, 5725 Kearny Villa Road, San Diego, Calif. The improved model 30B-25 power supply provides d-c from 1.02 to 302 v at up to 250 ma with ±100 parts per million long time stability, 0.01-percent load-regulation factor, 0.002-percent line-regulation factor, and less than 0.5-mv hum and noise. Direct-reading calibrated dials provide instant selection of the desired output voltage to an accuracy of 0.02 percent or 5 mv. The d-c output impedance is less than 0.01 ohm and a-c output impedance is less than 0.5 ohm to 200 kc. Response time is less than 0.2 millisec. The unit fits standard 19-in. rack mounts.

Front panel connectors provide variable bias from 0 to −150 v at 10 ma and 6.3-v a-c filament voltage at 5 amperes.

The 30B-25 is excellent for use in the design of complex electronic circuitry or wherever a precision voltage source independent of load current is required. **Circle P61 inside back cover.**



SNAP-IN VISE
for printed circuit assembly

Western Electronic Products Co., 655 Colman St., Altadena, Calif., has announced a new snap-in vise for securely holding printed-circuit and terminal boards during assembly operations. The vise requires no adjustment after it has been set for a particular board size. Slight pressure on the spring-loaded jaw by one edge of a board allows it to become engaged in the vise. A similar operation disengages the board. Positive grip is assured by a tough cork and synthetic rubber compound on both jaws. With controlled pressure exerted by the vise, there is no possibility of cracked circuit boards.

The vise has jaws 16 in. in length and is capable of holding boards up to 24 in. or longer. Width range is from 1 to 6 in. Price is $16.95. **Circle P62 inside back cover.**

BATTERIES
for microwave applications

C & D Batteries, Inc., Washington & Cherry Streets, Conshohocken, Pa. The same features which have made C & D PlastiCell and PlastiCal batteries a reliable source of power in telephone installations are now available in batteries being used for microwave communication applications.

PlastiCell is the company's standard-type lead-antimony battery, while PlastiCal represents the long-life lead-calcium battery that is built to last for 25 years. In actual microwave station service, PlastiCal batteries have required no water additions for more than a year. Plates are extra-thick (0.250 in. and 0.266 in.), with strong, uniformly cast, high-tensile lead-calcium alloy grid structure and maximum cross-sectional area bars. Exposed surface is held to a minimum to reduce wear and corrosion and increase life.

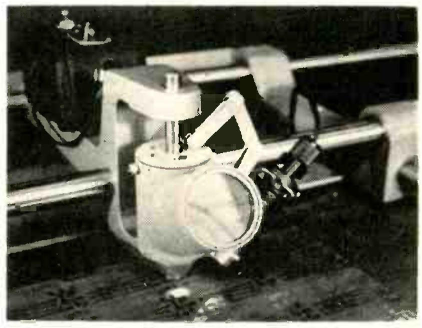
Other handy features of both transparent microwave batteries include high-low level lines for instant indication of electrolyte level; ball cage indicator (in sizes from 6 to 100 ampere hours) to show state of charge at a glance and patented Saftee-Vent to protect personnel from the danger of accidental explosions. Circle P63 inside back cover.

H-V POWER SUPPLY
silicon rectifier type

BOGUE ELECTRIC MFG. CO., 52 Iowa Ave., Paterson 3, N. J., has developed a new h-v silicon rectifier power supply for large radar sets. The unit measures 5 in. by 6 in. by 7 in. and replaces 6 type 3B24 vacuum tubes.

The power supply delivers over 3 kw at 16,000 v d-c over an operating range from −20 C to +85 C. It is hermetically sealed and has an efficiency of 98.4 percent. It increases the efficiency of the radar set since it saves a heat loss of approximately 350 w which normally would radiate to neighboring components.

Life of the new unit is rated at 20,000 hours thus reducing maintenance problems normally experienced with vacuum tubes. **Circle P64 inside back cover.**



OPTICAL SCOPE
for printed circuit puncher

WALES-STRIPPIT CORP., 345 Payne Ave., North Tonawanda, N. Y. A newly developed optical pickup device has been added to the company's fabricator-duplicator punching press for printed-circuit fabrication.

Termed the Dupl-O-Scope, the device is mounted in the stylus bracket of the duplicator to optically sight-in on a master circuit while the fabricator punches a corresponding master template. The template is then available for punching all subsequent production printed circuit boards.

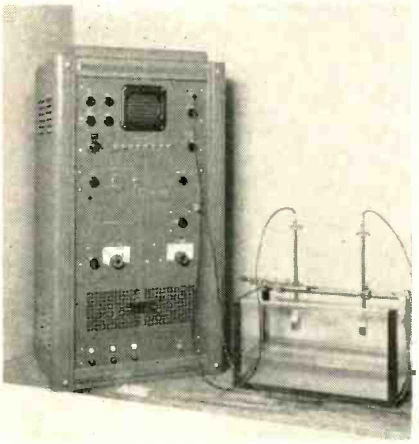
The Dupl-O-Scope is a precision casting with fixed-focus, four-power lens and prism. A standard multiring, single-cross-hair reticule permits positive centering for punching both round and shaped holes.

The new device eliminates the need for expensive layout and drilling of templates, an especially costly function for the short to medium run production plant or printed circuit user. **Circle P65 inside back cover.**

PAPER CAPACITOR
is ceramic cased

ASTRON CORP., 255 Grant Ave., East Newark, N. J. Utilizing the principle of mechanical fusion, the type AP capacitor combines a tough Steatite case with cement compound endseals forming a completely impregnable barrier against all environmental conditions. Leads will not come loose or pull out even under soldering heat and stress. Type AP capacitors are noninductive, precision-wound, paper tubulars with high insulation resistance.

The new capacitors are manufactured to insure long shelf-life and minimum capacitance change over the −40 to +85 C operating range. Small in size and weight, the AP's exceed RETMA specifications and 100-percent final inspection assures a dependable unit for the most critical applications. **Circle P66 inside back cover.**



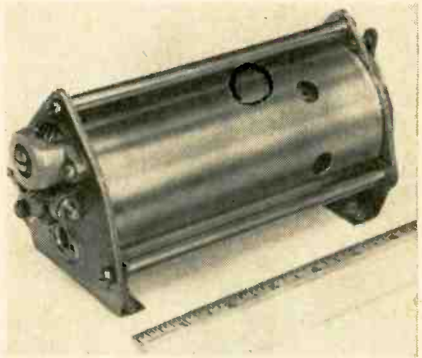
ULTRASONIC TEST SET
measures absorption, velocity

RADIONICS, INC., Burlington, Mass. Model UT-1 ultrasonic transmission test set will measure ultrasound attenuation and velocity of propagation in liquid or solid samples at frequencies from 900 kc to 6 mc. Radio-frequency pulses of variable width, repetition rate and carrier frequency excite a suitable transducer. After transmission through a coupling liquid and the sample, the sound pulses pass through a second transducer and calibrated receiver system to a special synchroscope. In the sample the sound pulse will be attenuated and will travel at a velocity which is different from that in the coupling liquid. The differential time delay is measured, which provides a simple correlation to measurement of velocity.

Variable sweep-trigger delays and a wide range of sweep durations allow very versatile pulse displays on the screen. Attenuation may be measured from zero to

81 db in 1-db steps.

Various forms of transducer arrangement for specific uses are available. Other frequency ranges are likewise available. **Circle P67 inside back cover.**



STABLE LOCAL OSCILLATOR
for radar equipment

PITOMETER LOG CORP., 237 Lafayette St., New York 12, N. Y., has developed an improved stable local oscillator (stalo) which is tunable from 1,200 mc to 1,350 mc. Frequency and phase references are provided, with short term stabilities in the order of five parts in a billion. The r-f power available is ½ w or more. These units, conforming with military environmental specifications, were developed for use in moving target indicator radars and in test equipment. Stalos covering other frequency bands are also available. **Circle P68 inside back cover.**

AUDIO POWER AMPLIFIER
for aircraft cabins

TRANSVAL ENGINEERING CORP., Culver City, Calif., has announced the TCA-10 aircraft cabin amplifier weighing less than 3 lb and measuring only 3 by 7 by 3 in. The unit is completely transistorized, uses printed circuitry and operates, without power supply, directly from the aircraft primary source. Provision has been made for two isolated inputs of 500 or 125 ohms. By the use of a simple external resistance network up to 20 isolated inputs may be used. The unit is conservatively rated at 10 w with extremely low distortion from 100 to 8,000 cps. The output matches speaker impedances of 16, 8 or 4 ohms.

Compactness and lightweight make it convenient to mount in the nose, back of the instrument panel or any other desirable position. The electronic components are sealed against moisture and dust. **Circle P69 inside back cover.**

COLLECTOR RING
is resin-bonded

THE B. A. WESCHE ELECTRIC CO., 1622 Vine St., Cincinnati 10, Ohio, is now manufacturing a new type resin-bonded collector ring. Resin bonding eliminates the need for screw fastening, providing an unbroken backing plate surface. Collector ring weight and thickness is reduced by this method.

The company also manufactures a complete line of standard collector rings ranging from 3 1/16 in. to 5 in. o-d with capacity from 15 to 100 amperes. **Circle P70 inside back cover.**

VERSATILE SCOPE
built-in quadrant switching

AMERICAN ELECTRONIC LABORATORIES, 121 North 7th St., Philadelphia 6, Pa., is now offering a versatile oscilloscope (No. 140) with built-in quadrant switching identical vertical and horizontal d-c to 50-kc amplifiers and low noise and drift, for use as output indicator with analog computers, characteristic curve generating devices and the like. The unit will operate from 105 to 125 or 210 to 250-v, 50 or 60-cps lines. Further information is available from the company. **Circle P71 inside back cover.**

MINIATURE RELAY
for military and industry

RADIO CORP. OF AMERICA, Camden, N. J., has developed a new high-temperature airborne electronic relay. The 204W1 features an active getter for absorption of residual gas and organic vapors. This assures dependable operation over an ambient temperature range of −65 C to +125 C and under low-current, low-voltage as well as full load conditions.

A six-pole, double-throw, hermetically-sealed, miniaturized-type, the 204W1 utilizes palladium contacts and is compactly constructed to meet the electrical and mechanical requirements of MIL-R-5757.

Design features include a one-piece extruded can with two integral mounting flanges safeguarding against h-f vibration, shock and salt spray.

Overall height of the 204W1 is 1¼ in. Its diameter is 1⅝ in. and it weighs less than 3 oz. **Circle P72 inside back cover.**

UHF CONVERTER
high gain, low noise

APPLIED RESEARCH INC., 163-07 Depot Road, Flushing, L. I., N. Y., has developed a new uhf converter. It has a noise figure of from 5.5 to 8.5 db in the 400-900 mc region and has a minimum overall gain of 50 db.

The converters have been specifically designed to present optimum performance for the most critical laboratory and field work in communications, telemetry, radar and monitoring systems.

The UHC-R consists of a radio-frequency amplifier and a converter unit. The equipment may be operated remotely if desired. They are available separately or can be obtained completely assembled on a standard 19-in. panel for rack mounting, with or without a regulated power supply.

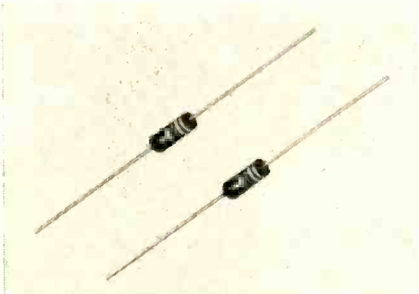
The converters are also available at other frequencies and to customer specifications, with r-f bandwidths up to 50 mc. **Circle P73 inside back cover.**

RUGGEDIZED RECTIFIER
cold cathode type

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass., announces the type CK6763 improved and ruggedized cold-cathode rectifier of miniature construction and with electrical characteristics like those of type CK5517. This type will stand a 96-hr 35-g vibration test at 320 cps without change, whereas conventional designs are destroyed after only a few hours. The tube will handle 2,800 v peak inverse at a rectified current of 12 ma and requires no heater power. **Circle P74 inside back cover.**

PRESSURE TRANSDUCERS
feature high linearity

TECHNOLOGY INSTRUMENT CORP., 531 Main St., Acton, Mass. Standard pressure ranges of the 22000 series pressure transducers are from 0 to 1 up to 0 to 100 psi absolute, gage or differential. Linearity is better than $\frac{3}{4}$ percent and hysteresis and repeatability each are less than $\frac{1}{2}$ percent. These instruments feature one or two potentiometer outputs with a minimum resolution of 750. Resolutions as high as 7,000 can be offered. Nonlinear functions can be achieved with ease. These units have been designed to surpass all phases of military specifications. **Circle P75 inside back cover.**



SILICON DIODES
available in four classes

TRANSITRON ELECTRONIC CORP., Melrose 76, Mass. Now in production are fast-switching silicon diodes with recovery times under 0.3 μsec and inverse operating voltages up to 200 v. They are available in four classes that provide recovery and forward characteristics that range from recoveries under 0.3 μsec with a minimum forward of 5 ma at 1.5 v to 1 μsec with a minimum forward of 100 ma at 1.5 v. All classes have types that can operate at 200 v with low inverse leakages.

Specifications, ratings and applications are found in bulletin TE-1350. **Circle P76 inside back cover.**

FILTER SECTION
used with d-c power supply

PERKIN ENGINEERING CORP., 345 Kansas St., El Segundo, Calif., announces the model M-709 filter section for use in conjunction with the model MR532-15A d-c power supply, to provide a ripple of 8 mv or less. This filter section is supplied on a standard 19-in. width rack mount panel, and overall dimensions of the unit are 19 in. wide by 10 in. deep by 8¾ in. high. **Circle P77 inside back cover.**

HIGH VACUUM RECTIFIER

for special applications

EITEL-MCCULLOUGH, INC., San Bruno, Calif. The 2-450A high-vacuum rectifier is intended for use in rectifier units or special applications whenever conditions of extreme ambient temperatures, high operating frequency, or high peak inverse voltages prevent the use of gas-filled tubes.

It has a maximum d-c current rating of 1 ampere and a maximum peak inverse rating of 25,000 v. Maximum peak plate current rating is 8 amperes. Overall height of the 2-450A is 14 3/32 in. and the diameter is 4½ in. Maximum plate dissipation is 450 w. **Circle P78 inside back cover.**

HIPOT TESTER

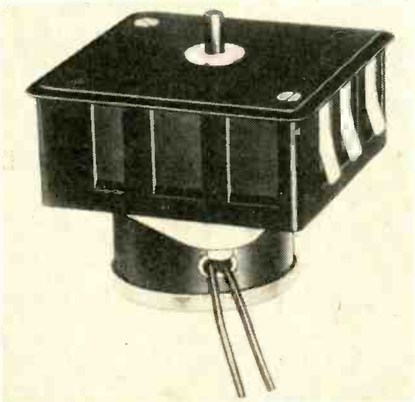
simple to operate

ADC ELECTRONICS, INC., 6765 Paramount Blvd., North Long

Beach, Calif. Very rapid production line testing of insulation in electrical equipment such as connectors, transformers, coils, relays, wire harnesses and the like, is now made possible by the use of the model 1004 simply operated Hipot tester.

A green indicator lamp on the front of the panel indicates that the unit is on and ready to operate. The test probes are touched to the device under test. If the insulation under test has a high leakage or if a voltage breakdown occurs, the high voltage is instantly and automatically cut off and the red indicator light remains on until reset by the operator.

A potentiometer is provided on the rear of the panel for the tripout adjustment of the high voltage within a range of 3 to 50-ma leakage current in the device under test. **Circle P79 inside back cover.**

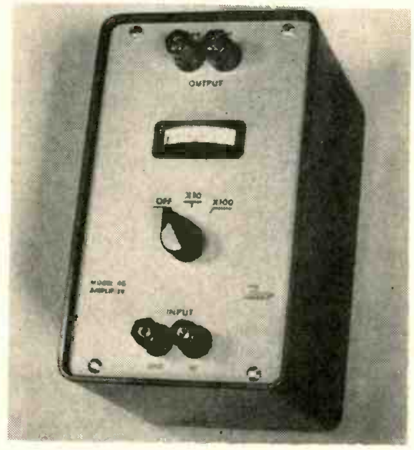


INTERVAL TIMER
new in design and operation

CRAMER CONTROLS CORP., Centerbrook, Conn., has announced an interval timer incorporating many effective design and operational innovations. For built-in applications, type 271 can be two-hole mounted or one-hole center mounted.

A durable, molded Bakelite case houses one or two spdt or spst open blade switches rated at 30 amperes, 115 v a-c resistive and $\frac{1}{3}$ hp at 115 v a-c.

The permanent-magnet synchronous motor drives precision cut cams which actuate the 30-ampere switches at full scale intervals ranging in duration from 45 sec to 6 days. Ranges shorter than 45-sec are available with lower contact ratings. Designed for high volume production, type 271 provides accurate timing and reliable operation at an economy price. **Circle P80 inside back cover.**



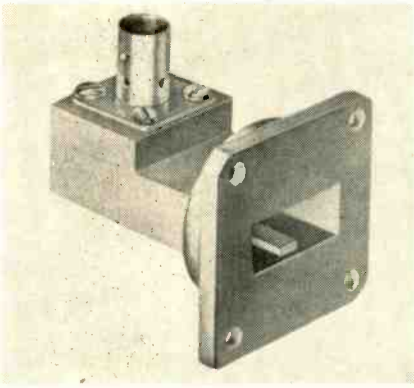
DECADE AMPLIFIER
low output impedance

ZACHARIAS ELECTRONICS CORP., P.O. Box 172, Livingston, N. J. Model 40 transistor decade amplifier provides a 10-megohm input impedance and an output impedance of less than 5 ohms. Voltage gains of 10 and 100 are stabilized to within 0.2 db from 7 cps to 400 kc. Response is down 3 db at 2 cps and 700 kc. The maximum output capabilities are 4 v rms and 25 mw. Broadband noise referred to the input terminals is approximately 10 μv. The self-contained battery power supply is metered at the front panel and permits continuous operation in excess of 500 hours.

The rugged instrument measures 7½ in. by 4½ in. by 5 in. **Circle P81 inside back cover.**

THERMISTOR MOUNTS
broadband devices

F-R MACHINE WORKS, INC., 26-12 Borough Place, Woodside 77, N. Y. Series 216 broadband thermistor mounts now cover the full waveguide frequency range from 1,120 to 40,000 mc providing an excellent match without the necessity for adjustable tuning elements. Ideal for either c-w or pulsed power meas-



urements, they can withstand overload without burnout and have an efficiency rating approaching 100 percent.

These versatile broadband mounts utilize a thermistor bead mounted inside a section of ridged waveguide which features a constant characteristic impedance over a broad frequency range.

The FXR thermistor mounts are designed for use in conjunction with power meters or other bridge circuits. The nominal sensitivity of 10 ohms per mw is sufficient to detect powers as low as 10 μw.

Complete specifications are available. **Circle P82 inside back cover.**

VTVM
accurate and durable

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1800-B vtvm has an accuracy better than ± 2 percent on all a-c and d-c voltage ranges. Its completely shielded diode probe is designed for use into the uhf range. Other features include high input impedance, d-c polarity switch, illuminated meter scale with mirror, knife-edge pointer and all input terminals

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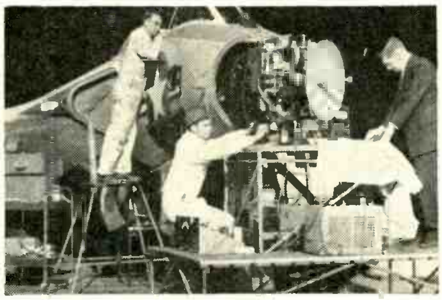
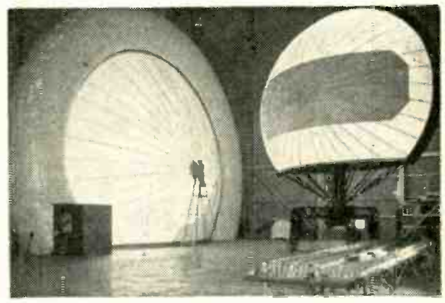
At Westinghouse-Baltimore, Engineers are making history in the electronics field. In the seven operations that comprise the Baltimore Divisions, excellent opportunities are available for engineers interested in research, design, development and production work—on airborne, ground and shipboard electronic systems, Ordnance, X-Ray, Carrier Microwave, and Induction Heating equipment. Write today and find out where your engineering experience and talents can be best put to work on tomorrow's new dimensions.

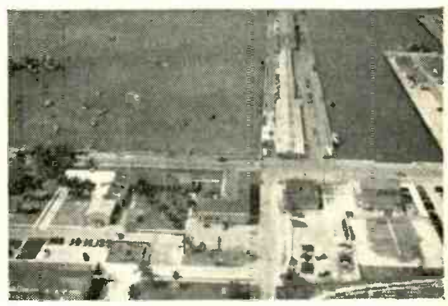


AIR ARM offers exciting projects, including the Aero-13 Armament Control System and advanced concepts in Fixed Fire Control Systems, Bomber Defense Systems, Missiles Sub-Systems, and Surveillance Radar.

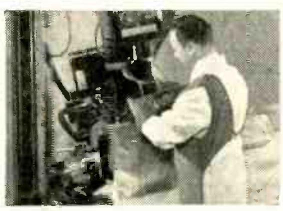


ELECTRONICS engineers revolutionized radar with the amazing Paraballoon. The Electronics Engineering Department is engaged in Communications, Missile Ground Control Engineering, Advanced Development, and Radar Engineering.

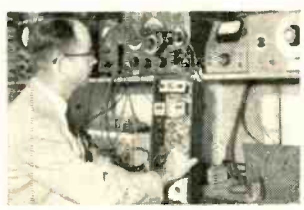
ELECTRONIC SERVICE DEPARTMENT Field Engineers service Westinghouse Air Arm and Electronics products around the world.



ORDNANCE DEPARTMENT . . . maintains a field site at Key West, Florida for testing underwater ordnance devices.



X-RAY DEPARTMENT specializes in creative engineering, as exemplified in the unique Cine-Fluorex Machine.



CARRIER MICROWAVE DEPARTMENT engineers designed and developed the small K-R All-Transistor Carrier Relaying set.

INDUSTRIAL ELECTRONICS DEPARTMENT . . . specialists in Induction Heating equipment for the metal working industry.

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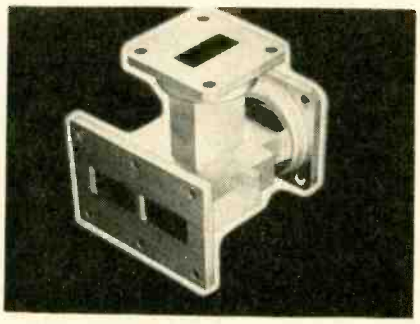
insulated from the panel allowing panel to be grounded at all times.

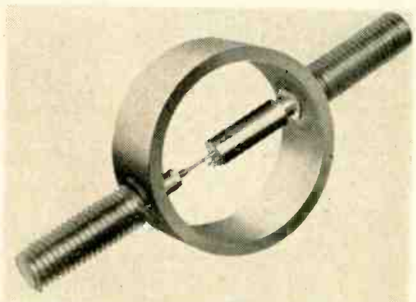
Stability has been achieved through advanced circuit design, power-supply regulation and the use of long-term stable precision components. Type 1800-B vtvm is priced at $415 complete with probe. **Circle P83 inside back cover.**



HYBRID T's

for wide range of frequencies

MICROWAVE DEVELOPMENT LABORATORIES, INC., 92 Broad St., Wellesley 57, Mass., has made available in production quantities the H-plane folded hybrid T's. They feature high performance and are available for a wide range of frequencies from 2,700 to 36,000 mc for most waveguides from 3 in. by 1 in. to 0.360 in. by 0.220 in. o-d. They are precision cast in either aluminum or beryllium copper. Normally supplied terminated in flat flanges, they are available on request with special adapters. Operational characteristics include broad bandwidth, low swr and high isolation. **Circle P84 inside back cover.**

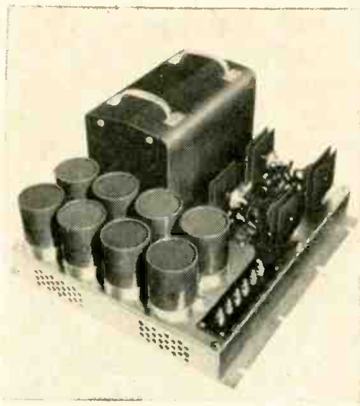


FORCE TRANSDUCER

variable permeance type

CRESCENT ENGINEERING & RESEARCH CO., 5440 North Peck Road, El Monte, Calif. A new line of variable permeance force or load transducers offers reduced sensitivity to temperature changes. The electrical sensing elements are variable permeance rectilinear transducers which are less affected by temperature changes than linear variable differential transformers or strain gages.

Repeatability is nearly 100 percent and resolution is limited only by external circuitry. When the transducer is used with a Crescent model 67 control system, full scale readout can be set for less than one-tenth of the transducer full range. Thus one instrument can be used for many different force or load ranges. The transducer senses either compression or tension force without mechanical adjustment. **Circle P85 inside back cover.**



D-C POWER SUPPLY

a new 50-ampere, 28-v type

SOLA ELECTRIC CO., Chicago, Ill., has designed a powerful static d-c power supply for military application. It has an operating load range of 10 to 50 amperes at 26 to 28 v from a 60-cps line of 100 to 130 v or 200 to 260 v; ripple voltage less than 3 percent and automatic overload protection with automatic recovery upon resumption of normal load. It fits a standard 19-in. rack, 18¾ in. high by 10½ in. deep.

The power supply and its regulation system is centered around a special Sola constant voltage transformer, with a balanced center-tapped secondary delivering practically a square wave form to two pair of 50-ampere paralleled silicon rectifiers. Brute force filtering, employing eight 20,000-μf 30-v electrolytic capacitors, holds ripple to 0.68 v rms maximum at full load.

Upon short circuit, the high reactance type transformer automatically limits current to 80 amperes and the secondary voltage collapses, reducing primary power consumption to less than 250 w. Recovery is accomplished in less than ½ sec upon removal of the short circuit.

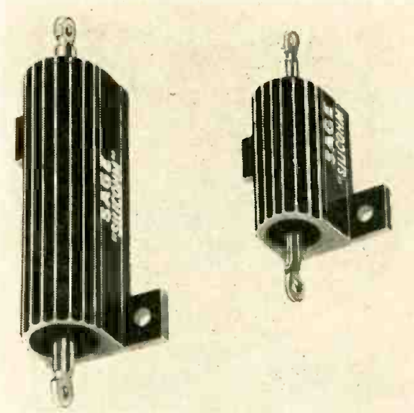
Net weight of the assembly is 134 lb. Catalog number is 28312. **Circle P86 inside back cover.**

SWEEP GENERATOR
high-power, broadband type

POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N. Y. Model ESG electronic sweep generator provides complete coverage from 1,000 to 15,000 mc at 60 cps with a power output of from 10 mw to 1 w, with seven interchangeable microwave oscillator units.

The new instrument is designed for rapid, dynamic testing of broad and narrow-band microwave systems and components such as receivers, amplifiers, preselectors, hybrid junction jammers, intercept equipment, beacons, antennas, T/R tubes, crystal mounts, fixed and tunable filters and complete radar and microwave systems.

Used in conjunction with the Polarad rapid scan ratio-scope, the instrument can make direct and instantaneous measurements of reflection or transmission coefficients, directly viewable on an oscilloscope as a go no-go device, eliminating the need for point-by-point measurements or for maintaining a constant power input to the device under test. **Circle P87 inside back cover.**



POWER RESISTORS
with less temperature rise

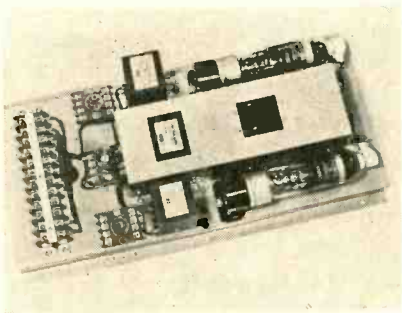
SAGE ELECTRONICS CORP., 302 N. Goodman St., Rochester, N. Y., has announced improved miniature metal-clad chassis-mounted precision power resistors, in which internal temperature rise is 25 percent less than in previous models. Reduced hot-spot temperature is achieved by the use of a filling material between the precoated resistor and the black anodized aluminum case.

Available in nominal power ratings of 25 and 50 w, these resistors will dissipate 80 percent of rated power at 40 C ambient while maintaining an internal hot-spot of only 260 C. This contrasts with the MIL-R-18546 requirement of 60 percent of rated power at 275 C hot-spot.

The company recommends derating its new units to zero wattage at 260 C ambient, insuring longer life, greater stability and increased reliability. After 1,000-cycled hours (1½ hr on, ½ hr off) at recommended load, resistance shift averages only 0.4 percent as compared with a 2-percent to 3-percent shift in previously available units.

The new resistors also offer dielectric strength obtainable up to 2,500 v rms and meet all the electrical, physical and environmental requirements of MIL-R-

\8546 and MIL-R-26B. Circle P88 ıside back cover.



THYRATRON AMPLIFIERS

for power control devices

HANSON-GORRILL-BRIAN, INC., 85 Hazel St., Glen Cove, L. I., N. Y., has announced a new line of packaged thyratron amplifiers for use in power control devices. These Thyraline amplifiers are offered with tube ratings of 2.5 through 18 amperes output current, single phase, two phase and three phase in power control devices. They can be connected for back-to-back, one, two or three halfwave operation and bridge circuits. The units meet all requirements for industrial operation and are designed for vertical panel board mounting.

Any type of motor drive positional servo, lighting or heating controller can easily be put in operation by connecting control elements, control voltages or currents, load and feedback transducers.

Thyraline amplifiers are shipped complete with Thyrapulse packaged grid circuits, circuit breakers, warmup time delays, spare plug-in sockets, power transformers and tubes. **Circle P89 inside back cover.**

SIGNAL GENERATOR

for the 10 to 420 mc range

NUCLEAR-ELECTRONICS CORP., 2632 W. Cumberland St., Philadelphia 32, Pa. Model TS-510/U is a vhf signal generator covering 10 to 420 mc in five bands. Design and construction comply with military specifications. It is available with or without transit case. **Circle P90 inside back cover.**

For additional information on all items on this page, use post card on last page.

New Literature

Copper-Mandrel Pots. Beckman/Helipot Corp., Newport Beach, Calif. Technical paper 552 discusses a practical approach to predicting, measuring and compensating for quadrature voltage and phase shift in copper-mandrel potentiometers used in a-c circuits.

The text of the 30-page, 2-color book is thoroughly supported by schematics, tables, graphs and detailed equations. **Circle L1 inside back cover.**

Facilities Brochure. Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill. The Electronic Systems Division of the company has issued a new brochure (No. 1-57) on electronic control assemblies and complex electronic gear that can be produced in large scale through this Division, and the associated activities of the company.

The new two-color, 22-page brochure contains photographs and illustrations of typical projects undertaken by E.S.D. **Circle L2 inside back cover.**

Silicon Iron Magnetic Tapes. Thomas & Skinner, Inc., 1122 E. 23rd St., Indianapolis, Ind., has released a new bulletin (DMF-4) giving descriptive data on silicon iron magnetic tapes.

The Si Fe Mag tapes discussed are available in thicknesses of 1, 2, 4, 5 and 7 mils, in less than mill quantities and in narrow widths. They are slit to customer specifications.

The bulletin also provides such information as applications, size, weights, tolerances, insulation, fabrications, mechanical and physical properties, magnetic properties, core losses and other helpful data. **Circle L3 inside back cover.**

VTVM. Acton Laboratories, Inc., Acton, Mass. Volume II, Number 1 of *Laboratory Report* is a four-page bulletin describing the new type 810 vacuum-tube voltmeter. **Circle L4 inside back cover.**

Intervalometers. Abrams Instrument Corp., 606 E. Shiawassee St., Lansing, Mich. The four-page bulletin AIC-1007 illustrates and describes the company's intervalometers, a line of adjustable precision timed pulsing devices for control systems. General specifications and functional diagram are included. **Circle L5 inside back cover.**

Magnet Wire Trade Names. Magnet Wire Division, Essex Wire Corp., Ft. Wayne 6, Ind., is offering a 16-page directory of current magnet wire trade names. Included are the various trade name designations as used and submitted by 20 magnet wire manufacturers. The directory also gives a brief general description of the physical, chemical and electrical characteristics and applications common to the ten general classifications of magnet wire.

The classifications included are enamel, Formvar, self-bonding Formvar Nylon, combinations of Formvar-Nylon, solderable films, Silicone class H, hermetic insulations and textile insulations.

An easy-to-read chart is also included in the back of this book giving a complete resume of trade names by magnet wire types, and manufacturer. **Circle L6 inside back cover.**

Spaghetti Tubing. The Polymer Corp. of Pennsylvania, 2140 Fairmont Ave., Reading, Pa. A concise story on engineering thin wall Teflon tubing as an insulation sleeving for electric and electronic components is told in bulletin BR-48. The dielectric, handling and performance advantages of Polypenco Teflon spaghetti tubing are listed along with proven applications to demonstrate its qualities. Electrical and physical property data are listed. A specification table of 26 different sizes in 10 different colors is also included. **Circle L7 inside back cover.**

Power Supplies. Harrison Laboratories, Inc., 45 Industrial Rd., Berkeley Heights, N. J. An eight-page folder illustrates and describes four series of power supplies—the 700 series with variable voltage, high current; the transistorized 800 series with low voltage, high current; the 200 series plug-in, high current; and the 400 series rack mounted, high current types. Specifications and prices are included. **Circle L8 inside back cover.**

Subminiature Ceramic Capacitors. Mucon Corp., 9 St. Francis St., Newark 5, N. J. Bulletin G-1 contains technical data on a wide range of subminiature ceramic capacitors. Included are Thinlines, uhf types, transistor circuit types and voltage-sensitive ceramic capacitors. **Circle L9 inside back cover.**

Cold Punching Laminate. The Richardson Co., 2750 Lake St., Melrose Park, Ill., has published a single-page bulletin containing a description and tentative data concerning the new Insurok XT-896 copper clad laminate for use in the radio, tv and electronic industries. Tabular material lists properties and test conditions. **Circle L10 inside back cover.**

Automation Cables. Pacific Automation Products, Inc., 1000 Air Way, Glendale 1, Calif. A four-page illustrated folder deals with electronic cable as a systems component. Topics covered include: automation and the missing link, description of a cable, quality control and testing and optimizing your system. Ordering information is given. **Circle L11 inside back cover.**

Transistorized Plug-In Counting Circuits. The Walkirt Co., 141 W. Hazel St., Inglewood 3, Calif. Catalog No. 11447 describes a new achievement in subminiaturization, the company's transistorized plug-in counting circuits. Two types are discussed: the plug-in P series and the cartridge configuration C series.

The literature contains actual-size photos and a visual diagram of physical data. Design and construction details point up the rugged resin embedment-type construction. Circuits set in this thermosetting epoxy resin make them practically impervious to shock, moisture, vibration and other environmental hazards.

Also stressed are simplicity of hook-up and typical circuit applications (with full specification charts and schematic).

The four-page publication should interest those concerned with telemetering, frequency determination, time interval origination, sequencing, counting and scaling. **Circle L12 inside back cover.**

Precision Pots. Beckman/Helipot Corp., Newport Beach, Calif. Latest modifications in specifications for the series AN and CN precision potentiometers are included in data sheet 54-12.

Physical changes pointed out are as follows: terminals are formed from heat-treated beryllium instead of being machined from brass; the rear lid is phenolic instead of Bakelite; the slider block is precision machined from laminated phenolic instead of fiber; the length of series CN pots is $1\frac{7}{64}$ in. instead of $1\frac{3}{32}$ in.

Extensive tests have resulted in the establishment of a life expectancy of 2,000,000 shaft revolutions for each series and the maximum noise rating has been set for 100 mv at 100 rpm with 1-ma slider current. **Circle L13 inside back cover.**

D-C Power Rectifiers. The Christie Electric Corp., 3410 W. 67th St., Los Angeles 43, Calif., has announced three new bulletins.

Bulletin AC-57-A contains a complete cataloging of the Stavolt automatically regulated power rectifiers of either selenium or silicon. The units discussed, available in 72 standard models with up to 15 amperes continuous capacity, are proving particularly useful as d-c sources for ground support equipment and missile testing. Models are available for uses requiring outputs from 1.5 kw to 45 kw.

Bulletin AC-57-R covers the Rectodyne, a manually controlled rectifier, for applications requiring moderately stabilized d-c voltage.

Bulletin BC-A-57-1 describes the Stavolt automatic battery charger. This precision controlled unit has proved effective in prolonging the life of batteries in industrial and military use. **Circle L14 inside back cover.**

Printed-Circuit Lacquer. Chemical Products Corp., King Philip Road, East Providence, R. I. Now available is a data sheet on a newly-developed acid-resist stop-off lacquer (R5018-blue silk-screen stop-off lacquer), which details properties and application methods indicating that a much higher percentage of continuous silk-screen printed circuits can now be obtained. **Circle L15 inside back cover.**

Magnetic Engineering. General Electric Co., Detroit 32, Mich., has released a new brochure describing the three vital functions of its magnetic engineering laboratory. The publication, in pointing out how a user can get more for his money with permanent magnets, covers the engineering activities required in evaluating magnetic circuit designs, establishing test methods and standards and investigating basic magnetic phenomena.

It also illustrates the facilities involved in accomplishing the above engineering tasks and describes how the engineering work and facilities are put to work in assisting users of magnetic materials. **Circle L16 inside back cover.**

Pulse Forming Network. AMP Inc., Harrisburg, Pa., has completed a new Capitron pulse forming network reliability report. For the technical information of electronic engineers interested in h-v pulse forming networks, the company has reproduced verbatim the data and results of a 10,000-hr reliability report as part of a life test on a production unit.

The report, indicating the performance to be five times the rated life of the network, suggests the use of AMPli-FILM dielectric in

A-MP pulse systems to insure stability, reliability and long life. **Circle L17 inside back cover.**

Pulse Generator. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif., has announced a revised two-page bulletin on the model 2125B pulse generator featuring (0.02-μsec rise time, optional delayed or advanced-pulse operation and direct-coupled output. The instrument described is designed for checking circuit transient response, development of fuses and relays, pulse condition tube characteristic studies, pulse driver for klystrons, drive for magnetic cores and the like. **Circle L18 inside back cover.**

Frequency Indicator & Printing Recorder. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif. A single-page bulletin describes the model 7341B frequency indicator and printing recorder. The unit discussed is designed for continuous monitoring with printed readings for frequency, velocity, rpm measurement and related applications. **Circle L19 inside back cover.**

Time Delay Relays. The A. W. Haydon Co., Waterbury, Conn. Bulletin TD406 illustrates and describes basic hermetically sealed time delay relays—series 6400, 11400 and 24300. Dimensional diagrams are included for the four-stud and bracket mounting types. **Circle L20 inside back cover.**

Electronic Counter. Northeastern Engineering, Inc., Manchester, N. H. A four-page folder covers the electronic counter No. 14-20FM (basic units). General characteristics, information on auxiliary plug-in units, and technical specifications are included. **Circle L21 inside back cover.**

Resistor Catalog. General Electric Co., Schenectady 5, N. Y. Bulletin GEA-6592 is a 36-page publication covering the company's full line of vitreous enameled stock resistors—both fixed and slide-wire, a wide variety of tailor-made units, vitreous enameled resistors ranging from 5 to 200 w and high-capacity resistors rated up to 1,200 w. The bulletin provides extensive selection data, ordering instructions, full product descriptions, photographs of representative resistors, ratings and other pertinent technical data.

Also included is full information on the company's wire and ribbon-wound high-capacity resistors. **Circle L22 inside back cover.**

Time-Rate Indicator. Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass., has released a four-page brochure describing the model 501 time-rate indicator. The instrument discussed is a 10-mc digital type frequency meter also useable for measuring period, time interval, total and ratio. The brochure lists the specifications and suggests uses for the instrument. **Circle L23 inside back cover.**

I-F Amplifiers. LEL, Inc., 380 Oak St., Copiague, L. I., N. Y., has released a new six-page catalog describing an expanded line of i-f amplifiers for radar and missile applications. Illustrations and specifications are included. **Circle L24 inside back cover.**

Rugged Capacitors. Vitramon, Inc., P. O. Box 544, Bridgeport 1, Conn. Catalog 57-1 illustrates and describes a line of stable, rugged, low-loss, miniature, low-noise, vaporproof, low temperature range Vitramon capacitors. It covers two interchangeable designs—the axial-lead series and the axial-radial-lead series. Ordering information is included. **Circle L25 inside back cover.**

Digitizer Kit. Coleman Engineering Co., Inc., 6040 W. Jefferson Blvd., Los Angeles 16, Calif. Technical bulletin No. CR-186 illustrates and describes the company's digitizer kit. It includes data on installation, operation, reliability, and digitizers on other servo instruments, as well as ordering information and price. **Circle L26 inside back cover.**

Precision Pots. Beckman/Helipot Corp., Newport Beach, Calif. Linearity tolerances as accurate as ±0.01 percent are specified for series D and E precision potentiometers in data sheet 54-23.

In the D series, best practical linearity tolerances are as follows: below 1,000 ohms, ±0.05 percent; from 1,000 to 4,999 ohms, ±0.025 percent; 5,000 ohms and above, ±0.01 percent. Best practical linearity tolerances in the E series are ±0.05 percent below 1,000 ohms and ±0.01 percent for 1,000 ohms and above.

As an added specification, the data sheet now lists a life expectancy of 2,000,000 shaft revolutions for each series. **Circle L27 inside back cover.**

Repeat Cycle Timers. The A. W. Haydon Co., Waterbury, Conn. Bulletin AWH RC201 contains details on the function of the three basic-miniature repeat cycle timers, along with dimensions for a-c, d-c and 400-cycle units. The sheet, replacing page 3 of the current catalog, covers timers available with cycling times from 1 to 24 hr depending on the motor used.

The new bulletin sheet is clearly blocked out, with readable size type and illustrations, including a photograph of the d-c model and dimensional drawings, with overall and mounting dimensions tabulated in charts for the three series. The bulletin becomes a part of the company's catalog. The entire catalog will be supplied if requested on firm's letterhead.

Proximity Switch. Micro Switch, a Division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. Data sheet 119 covers the 1FA1 proximity switch, a magnetic device with no moving parts for use in applications where it is desirable to detect the presence of a ferrous object without requiring physical contact. Application information, installation data and performance specifications are included. **Circle L28 inside back cover.**

Modular Digital Instruments. Electro Instruments, Inc., 3794 Rosecrans, San Diego, Calif. A new, four-page illustrated catalog giving brief specifications of a new line of modular digital instruments is now available. The catalog describes the units available and how they can be combined into single-purpose instruments such as digital voltmeters, digital ohmmeters, digital ratiometers and the like, or complete check-out systems. **Circle L29 inside back cover.**

Dual-Channel Oscilloscope. Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa. A single-sheet bulletin illustrates and describes the model K-215 dual-channel oscilloscope for d-c to 15 mc. Complete technical specifications are given. **Circle L30 inside back cover.**

Transistorized Computer. Philco Corp., 4700 Wissahickon Ave., Philadelphia 44, Pa. A 12-page descriptive brochure covers the new completely transistorized computer Transac type S-2000. The booklet features many illustrations including a 20 by 25 ft typical installation which incorporates the extremely compact basic unit containing the arithmetic, control and memory sections and also the supplemental equipment that can be added to accomplish any desired result. **Circle L31 inside back cover.**

Precision Wire-Wound Resistors. Kelvin Electric Co., 5907 Noble Ave., Van Nuys, Calif. Bulletin CB-2 describes a new line of precision wire-wound resistors featuring tension-free windings. The relaxed winding technique discussed practically eliminates resistance drift with age and shorts or opens due to thermal shock, thus providing exceptional reliability and long-term accuracy. Resistance values range from 150,000 to 8 megohms. Complete specifications, dimensional drawings and descriptive information are provided. **Circle L32 inside back cover.**

Pneumatic-Balance Camera Dollys. Studio Television Products Sales Corp., 342 W. 40th St., New York 18, N. Y. A four-page folder illustrates and describes the model PN6 pneumatic-balance camera dolly for monochrome or color equipment. Chief features, specifications and prices are included. **Circle L33 inside back cover.**

Analog Computer. Donner Scientific Co., 888 Galindo St., Concord, Calif., announces its new four-page engineering data sheet for the model 3000 analog computer. The computer's building-block design, problem-handling capacity and accessories are discussed in a comprehensive, easy-to-read manner. Complete prices, typical module combinations, and recommended computing facilities are also included. **Circle L34 inside back cover.**

Delay Line Data. Deltime, Inc., 608 Fayette Ave., Mamaroneck, N. Y., has issued a collection of technical literature presenting a selection of time delay lines based on the magnetostrictive principle. Among the models discussed are laboratory and rack-mounted units with adjustable pickup coils, semi-adjustable tubular units and fixed delay lines with delays from 2 μsec to 200 μsec or more. **Circle L35 inside back cover.**

A-C/D-C Voltmeters. Helipot Corp., a division of Beckman Instruments, Inc., Newport Beach, Calif. One hundred and twenty-six standard models of expanded scale a-c and d-c voltmeters are listed and described in data sheet 875. Specifications, photos, dimensional drawings and a convenient order table are included in the four-page two-color data sheet. **Circle L36 inside back cover.**

Coaxial Switches and Relays. Danbury-Knudsen, Inc., P. O. Box 170, Danbury, Conn. The company's extensive line of coaxial relays and switches are listed in detail in Catalog 3. Selecting and ordering have been facilitated by the listing of schematics, mechanical dimensions and electrical characteristics. **Circle L37 inside back cover.**

VHF ADF. Olympic Radio & Television Inc., 34-01 38th Ave., Long Island City 1, N. Y. A loose-leaf catalog page illustrates and describes the model AS-111 vhf automatic direction finder. Chief features and specifications are listed. **Circle L38 inside back cover.**

Bushings. Thor Ceramics, Inc., 225 Belleville Ave., Bloomfield, N. J. A two-page catalog sheet illustrates and describes both the miniature feed-through bushings and transformer and condenser bushings with a wide range of sizes and types. The devices discussed are intended for efficient low and high-frequency service. Dimensional data are included in catalog No. 152 and 153. **Circle L39 inside back cover.**

Wires and Cables. Chester Cable Corp., A Subsidiary of Miami Copper Co., Chester, N. Y. A six-page folder covers quality constructions of wires and cables for commercial and military service. Plasticord and Plasticote insulations, standard and custom-made, are discussed. The folder is fully illustrated with tabular material. **Circle L40 inside back cover.**

Laboratory Induction Generator. Sylvania Electric Products Inc., Research Laboratories, Bayside 60, N. Y. A four-page bulletin deals with the 5-kw laboratory induction generator. Illustrations, complete description and specifications are given. **Circle L41 inside back cover.**

Hand Coil Winders. Geo. Stevens Mfg. Co., Inc., Pulaski Road at Peterson, Chicago 30, Ill. Four new high-speed direct-drive hand coil winders are described and two of the machines illustrated in a catalog page now available. Technical details are given on types of windings, maximum coil o-d, maximum loading distance between winding centers, wire sizes wound, tension equipment, winding speeds, motor equipment, dial and automatic counters, magnetic brake, mounting, output end of spindle and other features. **Circle L42 inside back cover.**

Microwave Parabolic Antenna System. Pickard & Burns, Inc., 240 Highland Ave., Needham 94, Mass. A single-sheet bulletin illustrates and lists chief features and performance characteristics for a six-foot parabolic antenna system designed and developed for use in the 1,700-2,400 mc range in conjunction with mobile radio relay equipment terminals and relay stations. **Circle L43 inside back cover.**

H-F Inductor Alternator. American Electric Motors, Inc., division of American Electronics Inc., 2112 N. Chico Ave., El Monte, Calif. Bulletin 3011.3 illustrates and gives characteristics and data for the models 275 motor alternator and 250 exciter-regulator. Dimensional diagrams and suggested applications are included. **Circle L44 inside back cover.**

Pulse Calibrator. Burroughs Corp., 1209 Vine St., Philadelphia 7, Pa. Type 1810 pulse calibrator, a new instrument designed for accurately measuring current and voltage pulse amplitudes, pulse durations and rise time, is now fully described in a technical brochure. The four-page brochure shows how the calibrator operates, illustrating and explaining actual waveforms obtained from different applications of the unit. Complete theory of operation of the two sections of the calibrator (chopper section and calibration section) and specifications are included. **Circle L45 inside back cover.**

Signal Generator. Northeastern Engineering, Inc., Manchester, N. H. A four-page folder illustrates and describes the type NE-12-20-SG signal generator which is capable of producing continuous-wave or pulse-modulated signals throughout the band of frequencies from 900 to 2,100 mc. Data on applications and equipment supplied, as well as technical specifications, are included. **Circle L46 inside back cover.**

All-Transistor Amplifier. Beckman Instruments, Inc., 325 N. Muller Ave., Anaheim, Calif. Bulletin 3002 covers the model WN, a general-purpose, chopper-stabilized d-c amplifier designed to meet the high reliability standards demanded by chemical and petroleum companies for process-control instrumentation. Complete specifications are listed. **Circle L47 inside back cover.**

Permanent Magnets. General Electric Co., Detroit 32, Mich. A new 12-page catalog covers both cast and sintered permanent magnets. Publication PM-121 supersedes the former catalog, PM-100. It includes information on magnetic and mechanical properties, approximate tolerances, magnet assemblies, sales and service as well as how-to-order cast Alnico 5 and sintered Alnico 2 permanent magnets. Illustrations and engineering data provide the user with required information for various shapes available. **Circle L48 inside back cover.**

Encapsulated Miniature Yoke. Syntronic Instruments, Inc., 170 Industrial Road, Addison, Ill. Dimensional drawings, photo, design features, tables, electrical and mechanical data and complete technical description are given of new miniature epoxy encapsulated push-pull magnetic deflection yoke with deflection angle up to 70 deg and which fits all standard ⅞-in. neck diameter c-r tubes. The yoke is ideal for use with transistors. **Circle L49 inside back cover.**

Bimetal Thermostats. Stevens Mfg. Co., Inc., Lexington and Mansfield, Ohio. Bulletin 3000, describing the company's new line of Stemco type A bimetal disk type thermostats for electronic and industrial applications, is announced.

Punched for insertion in standard three-ring binders, the bulletin covers the operating principle and illustrates it with a schematic diagram, giving performance data, ratings, dimensions and construction details. Various mounting arrangements are illustrated with photographs. Both hermetically sealed and semi-enclosed styles are covered. **Circle L50 inside back cover.**

Magnetic Amplifier. Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y. Form S765 is a single-sheet mailing piece covering a magnetic amplifier suitable for controlling low-power-output devices such as hydraulic servo valves. The amplifier discussed is supplied with dual input windings to facilitate signal mixing. Additional control windings can be furnished.

The illustrated mailing piece gives tentative data, dimensional drawing and information on two of the company's other products. **Circle L51 inside back cover.**

Environmental Temperature Cabinets. Webber Corp., P. O. Box 217, Indianapolis 6, Ind. Bulletin 2-57 is a four-page folder illustrating six different models of standard, mechanically operated, subzero industrial freezers. Units discussed are available from −225 F to +350 F in sizes from 1 cu ft to 45 cu ft, front or top opening. A complete itemization of standard and optional features is listed as well as model numbers, temperature ranges, capacities, inside and outside dimensions. **Circle L52 inside back cover.**

Flexible Actuator Switch. Micro Switch, A Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill. Catalog listing BAF1-2RU18, a flexible actuator switch which can be operated from any angle except direct pull, is described in data sheet 113. Discussed are the coil-spring actuator, sealed construction, characteristics, contact arrangement, electrical rating, two mounting designs and prices. **Circle L53 inside back cover.**

Electronic Assembly Facilities. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind., has published a new bulletin describing its extensive facilities for development and manufacture of complete electronic assemblies and subassemblies, including those of the type used in missile guidance systems. The completely separate operation discussed specializes in precision manufacturing on a contract basis. A fully equipped and well-staffed design-engineering group is also maintained for research and development work in electronics and solid state physics problems. **Circle L54 inside back cover.**

Engineering Bulletins. Phillips Control Corp., 59 W. Washington St., Joliet, Ill. A durable three-ring loose-leaf binder is offered in connection with the distribution of the company's new series of product engineering bulletins.

The new engineering bulletins provide detailed descriptions, tables and dimensional drawings on Phillips standard, enclosed and hermetically sealed relays. **Circle L55 inside back cover.**

Wire Wound Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. The 12-page bulletin C-1b describes a line of tubular and flat power wire-wound resistors. It contains comprehensive data on construction, characteristics, coating, winding, insulation identification, mechanical strength, terminals and brackets. Detailed charts and graphs are shown. **Circle L56 inside back cover.**

Radiography on Subminiature Tubes. Philips Electronics, Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y. A new six-page bulletin titled "Radiography in Production Control and Inspection of Subminiature Tubes" that describes techniques used by Raytheon Mfg. Co., is now available.

The bulletin shows radiographs made of subminiature electron tubes with the new method. Drawings give details for the film holder, the electron tube holder and the production inspection installation. **Circle L57 inside back cover.**

Electronic Relays. Essex Wire Corp., Logansport, Ind. Electronic relays, open and hermetically sealed, are described in a new eight-page engineering bulletin. Complete information on application, construction and engineering specifications is presented in concise outline form. Data included are coil voltage, resistance and wattage, contact forms available and approximate weight. Detailed dimensional drawings and circuit diagrams are shown for the eight groups of relays featured. **Circle L58 inside back cover.**

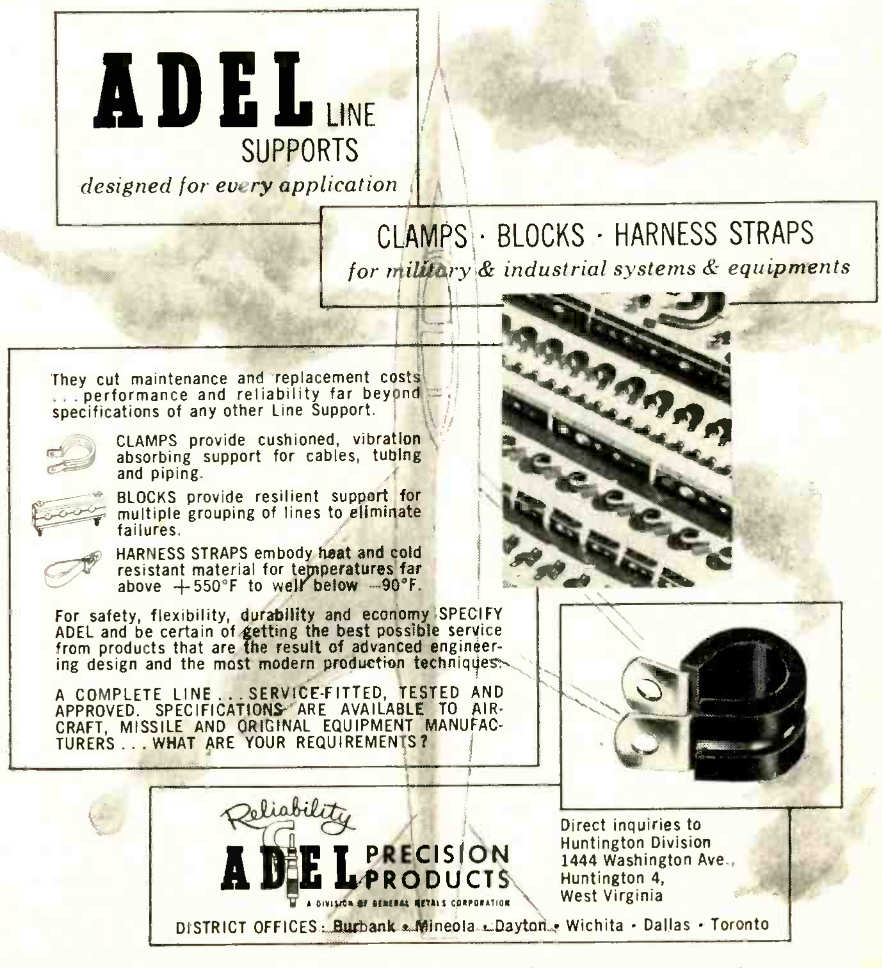
Instrumentation. Allen B. DuMont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J., have available the first issue of *Instrument Journal*, a publication devoted to electronic instrumentation and related fields, providing the latest information on developments in equipment, applications and techniques. The booklet will be published quarterly. **Circle L59 inside back cover.**

Power Positioner. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio. Bulletin No. 2500 covers the power-positioner, a new type of servo system featuring high speed, high torque and high accuracy. Chief features and information on performance, controls and applications are given. Dimensional diagrams are included. **Circle L60 inside back cover.**

Transformers and Reactors. Chicago Standard Transformer Corp., 3501 W. Addison St., Chicago 18, Ill. The 32-page catalog CT3-57 covers some 20 types of MIL-T-27A hermetically sealed transformers and reactors. Also included are a wide line of new-equipment commercial-grade transformers and reactors, as well as control and power circuit transformers. A classified index is included. **Circle L61 inside back cover.**

Cold Punch Laminate. General Electric Co., Laminated Products Dept., Coshocton, Ohio. A four-page folder deals with Textolite cold punch 11572, a high quality paper-base laminate recommended for electronic applications using high voltage at radio frequencies. Designed for standard punching or printed circuitry, the material described is ideal for automatic assembly techniques. Technical data are included. **Circle L62 inside back cover.**

Resistors and Rheostats. Tru-Ohm Products, Div. of Model Engineer-



Want more information? Use post card on last page.

ing & Mfg. Inc., 2800 N. Milwaukee Ave., Chicago 18, Ill., has available a catalog listing: resistor selection data; complete information on fixed enameled resistors; adjustable enameled resistors; oval resistors, vitreous axial resistors; Tru-Rib resistors, plus complete data on the new Tru-Ohm caged resistors; the new printed circular resistors and the new Blue X-60 series resistors.

The complete line of power rheostats is included in the catalog, with a page illustrating samples and giving information on dustproof rheostats, caged rheostats and 360-deg rheostats. **Circle L63 inside back cover.**

Count Limiter. Abrams Instrument Corp., Lansing, Mich. Bulletin AIC 1008 illustrates and describes the model CN-1A1 count limiter, a predetermining pulse counter and stop control designed for 28 v d-c use. A large detented knob and dial scale permit easy setting of any number from 1 to 120. General specifications and a functional diagram are included. **Circle L64 inside back cover.**

Transformers. Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass. A new four-page brochure describing a line of military and special commercial transformers has just been released. The components described are manufactured to customer specifications. High power pulse, hermetically sealed military and open type military, subminiture binary and toroids are some of the types described. Facilities of the manufacturing company are discussed. **Circle L65 inside back cover.**

Test Equipment. Telonic Industries, Inc., 73 N. Second Ave., Beech Grove, Ind. Colorful, and uniquely designed, this new catalog makes all material easy to read and easily accessible to the user. Catalog 7A features comprehensive sales and ordering information in addition to complete product listings, illustrations and descriptions. Complete basic specifications of all units are presented in easy-to-read form. Graphs, diagrams and special equipment data are included. **Circle L66 inside back cover.**

Metal Film Precision Resistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Catalog data bulletin B-3 illustrates and describes types MEC and MEF metal film precision resistors. Specifications and characteristics are given. Information on the company's complete line of fixed and variable resistors, including over 140 different types, is also included. **Circle L67 inside back cover.**

Miniature Magnetic Counters. Abrams Instrument Corp., 606 East Shiawassee St., Lansing 1, Mich. A recent bulletin contains illustrations and general specifications for a line of high-speed miniature magnetic counters. A dimensional diagram is included. **Circle L68 inside back cover.**

Bridge-Balance and Calibrating Units. B & F Instruments, Inc., 4732 N. Broad St., Philadelphia 41, Pa. Illustrations, outstanding features and specifications of a complete line of bridge-balance and calibrating units are presented in bulletin BBU 2-57. The units discussed provide the means to balance, calibrate, control and match strain gages and resistance type transducers to oscillograph galvanometers. They provide for the direct recording, without amplifiers, of strains, loads, accelerations, pressures, positions and other measurements required to evaluate military and industrial products. **Circle L69 inside back cover.**

Magnetic Amplifers. Litton Industries, Maryland Division, 4910 Calvert Road, College Park, Md. A 16-page product catalog provides data and specifications for 400 and 60-cycle magnetic amplifiers. **Circle L70 inside back cover.**

Lead Wire. Philadelphia Insulated Wire Co., 200 N. Third St., Philadelphia 6, Pa., has available a leaflet describing the series 120 lead wire (600 v, 200 C—MIL-W-16878, type E). The wire discussed features a silver-plated copper conductor, cross lapped Teflon tape construction and Teflon coated glass braid. Specifications and performance requirements are included. **Circle L71 inside back cover.**

Coaxial Turret Attenuators. Microlab, 71 Okner Parkway, Livingston, N. J. Memo No. 8 is a four-page mailing piece dealing with the type AV variable step attenuators with low vswr and zero insertion loss. Mechanical and electrical design are discussed and applications and attenuation values are given. **Circle L72 inside back cover.**

Control Transformers. Hindle Transformer Co. Inc., Woods Church Road, Flemington, N. J. Catalog 956 illustrates and describes control transformers of the normal reactance type. Uses and dimensional data are given. Also included are data on high reactance type control transformers and warp stop transformers. **Circle L73 inside back cover.**

Custom Molding of Electronic Products. Epoxy Products, Inc., a division of Joseph Waldman & Sons, 137 Coit St., Irvington, N. J., announces the availability of complete catalog information on their new custom molding service. This literature covers the compression and transfer techniques available for custom molding of electronic and chemical resistant products. **Circle L74 inside back cover.**

Pulse Burst Generators. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif., has available a two-page bulletin on models 2130A and 2150A pulse burst generators featuring 5-pulse coded output, 10 cps to 10 kc, 0 to 100-μsec delay, 0.1 to 2-μsec width, 0.03-μsec rise time and 50-v output from less than 93 ohms. The units described are designed for beacon simulation, word generation, f-m/f-m telemetry, transmission line test, data reduction system design and the like. **Circle L75 inside back cover.**

Want more information? Use post card on last page.

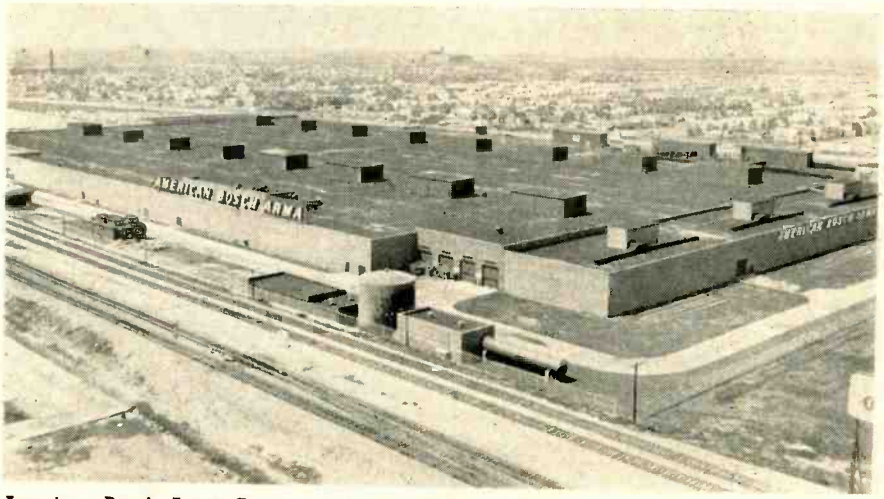
Plants and People

Edited by WILLIAM P. O'BRIEN

Electronics manufacturers expand plants and facilities by acquisition, leases or new construction. Top engineers and executives in the industry are promoted and move to new responsibilities. Scientists receive Navy Civilian Service Awards

American Bosch Arma Elects V-P's, Takes Over New Plant

CLIFTON T. FOSS, formerly vice-president and division manager, Arma Division, was recently elected a vice-president of American Bosch Arma Corp. and will be responsible for defense product planning. Foss has been with Arma since 1933 when he became a research and development engineer there. He was successively head of research and development, assistant chief engineer, and vice-president in charge of engineering before his previous position. He has a long and varied experience in the design, development and production of electronic and gyroscopic devices and missile guidance systems. American Bosch Arma will produce its inertial guidance system for the Titan intercontinental ballistic missile.



American Bosch Arma Corporation's new Chicago Division

E. D. Gittens, vice president-engineering, Arma Division, will replace Foss as vice president and division manager of Arma. Gittens has been with Arma since 1935. He rose from his starting position of junior engineer through several positions in design engineering until he was appointed chief engineer in 1951. He held that position until he was named vice president and chief engineer in 1955.

Simultaneous with these elections came the announcement that American Bosch Arma Corp. has been awarded a USAF facilities contract to operate a government-owned plant located adjacent to Chicago's Midway Airport. It covers more than three-quarters of a million sq ft of floor space. Specialized laboratory facilities including rooms having controlled atmospheric conditions, facilities for astronomical calibration, and equipment to simulate upper air conditions will be provided in the modified interior.

Other divisions of the corporation are at Garden City, N. Y., Springfield, Mass., and Columbus, Miss.

Two New Managers Named at Hughes Aircraft

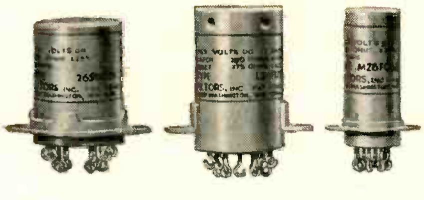
GEORGE H. MCKAIG was named manager of production planning and James T. Jones has been named manager of production engineering at Hughes Aircraft. McKaig formerly was chief, test equipment engineering, and Jones was manager, inspection and test. Both men are employed at El Segundo where the Hughes airborne electronic control system for all-weather jet interceptors is manufactured.

In his new position, McKaig is responsible for electronic and mechanical production planning including the administration of machine planning, sheet metal planning, assembly planning and other related activities. In addition, he is responsible for developing improved methods and quality of manufacturing.

Jones has the responsibility of administering and coordinating all production engineering activities in the electronic manufacturing division of Hughes, including design and development of all special factory test equipment, tooling and process engineering.

Rototest Announces Two Appointments

JOE DAVIDSON, president of Rototest Laboratories, Inc., Lynwood, Calif., announces the appointment of Albert J. Romano, as general



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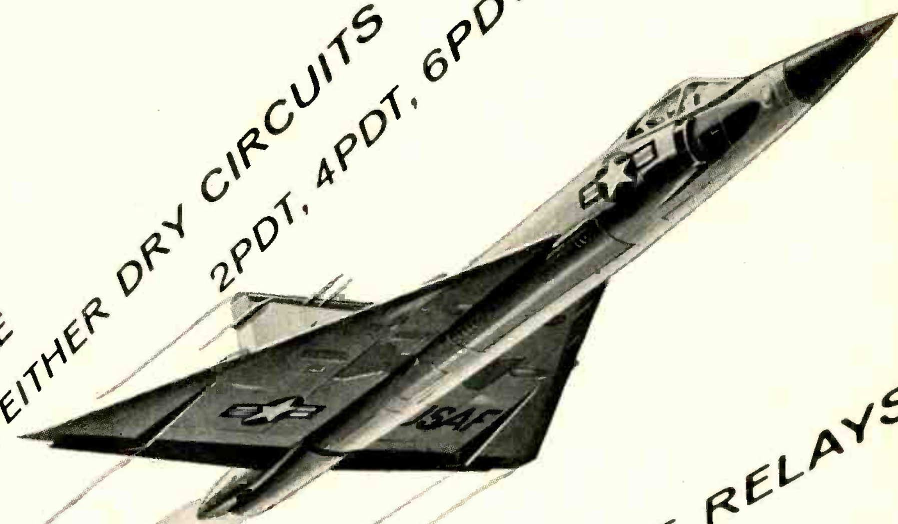

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manager, and Marty Noorland as technical director.

Romano has been a liaison and field engineer associated with the development of Rototest for the past two years. Prior to this, he was employed at Northrop Aircraft for over three years as a test engineer in the environmental test laboratory, and subsequently as a reliability engineer actively engaged in the study and correction of malfunctions in the Snark guidance system.

Noorland comes from Hoffman Laboratories, Inc., where for the past five years he was assistant department head of the test equipment design section, and section manager in charge of the Quality Control Test Section, Environmental Test Lab and Components Qualification and Acceptance Test Group.

Navy's Highest Civilian Awards Presented to Scientists


James H. Trexler


Bernard Salzberg

JAMES H. TREXLER, electronic scientist at the U. S. Naval Research Laboratory, has been given the Distinguished Civilian Service Award, the Navy's highest civilian award. The award was granted to Trexler for "exceptionally outstanding service in the field of basic research in countermeasures." He is also holder of the Meritorious Civilian Service Award.

Dr. Bernard Salzberg, formerly with NRL and now the chief scientist of Airborne Instruments Laboratory, Inc., Mineola, Long Island, N. Y., has been presented the Navy's Meritorious Civilian Service Award, the second highest award given to a civilian employee. The award was granted in recognition of his many contributions to the Laboratory's programs and to the field of electronics. Salzberg holds over 30 patents in the field of radio and electronics, and is the author and coauthor of approximately 25 papers in technical journals.

Herrick Joins Production Research as Vice-President

GEORGE Q. HERRICK has been named vice-president for research and development at the Production Research Corp.

Herrick was manager of the industrial products research division of General Precision Laboratory before joining Production Research Corp. In that capacity he was directly responsible for GPL's research and development work in the fields of industrial and military television, microwave propagation, applications of microwave ferrites, tape recording, optics, infra-red, and acoustics.

He was technical director of the office of international broadcasting of the U. S. State Department from 1945 to 1953.

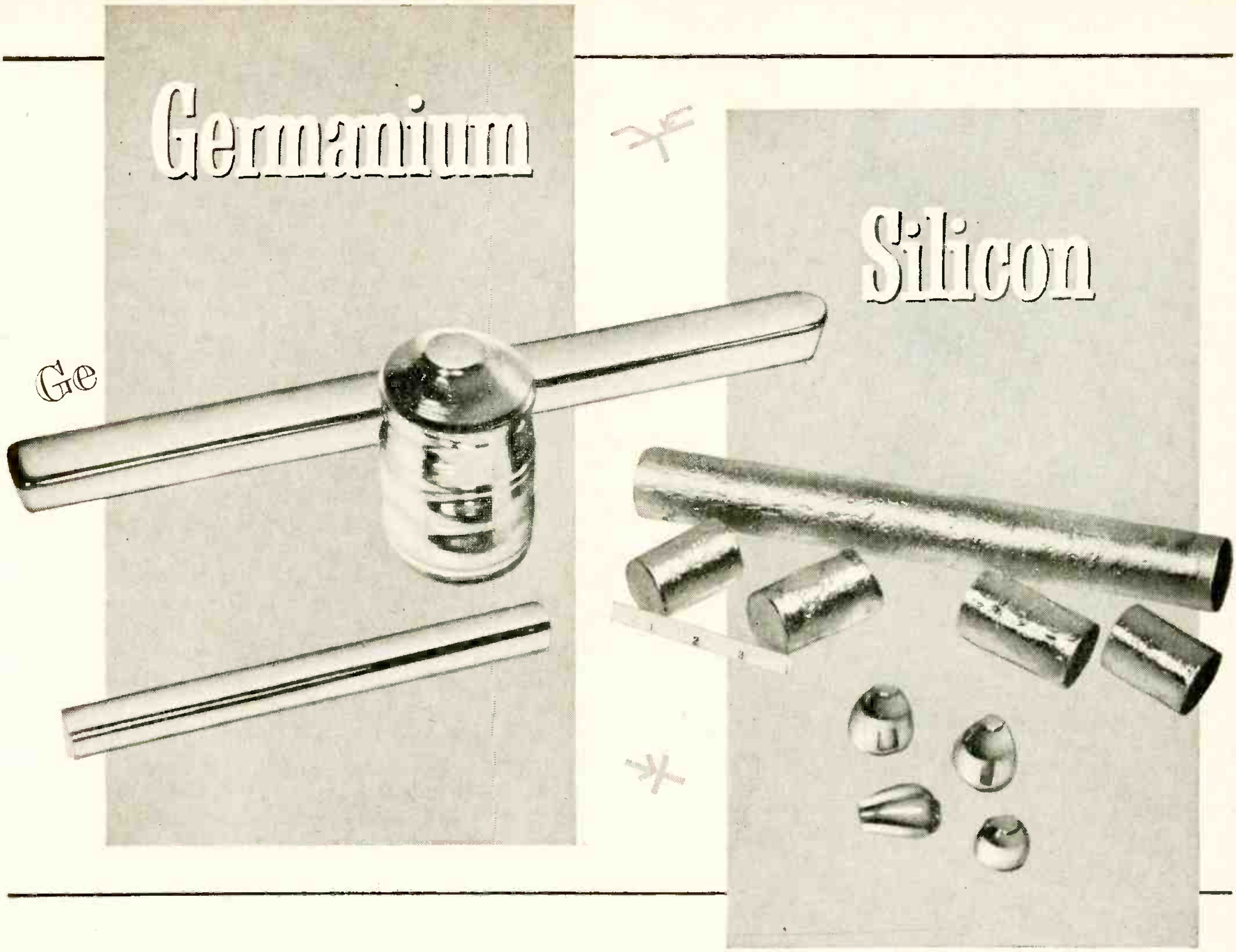
He was government director of MIT's project Troy. Herrick was responsible for the development of current forward scatter communications theories and techniques; of 1,000-kilowatt a-m transmitters for low, medium and high frequencies; of the USCGC Courier, America's floating broadcast station; of back scatter propagation measurement techniques and of 1,000-kilowatt broadband curtain antennas.


George Q. Herrick

From Project Troy has evolved the present-day Lincoln Laboratory at MIT.

Also authorized by Herrick was the Ring project, the plan to encircle the USSR with a communications and broadcast network. Costing more than $100 million, the project employs more than 66 transmitters, ranging from 50 kilowatts to 1,000 kilowatts, and a staff of 700 persons to penetrate the Iron Curtain.

During the war years, he was chief of the bureau of communications facilities for the Office of War



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Information, responsible for broadcast facilities for psychological warfare and communications networks for the OWI.

Project Sage Engineer Named

APPOINTMENT of Gerald R. Sauer as Project "Sage" engineer for RCA at Topsham, Maine, has been announced. The Maine facility is one of many forming a chain of radar defense systems across North America. SAGE means Semi-Automatic Ground Environment. Each site contains electronic computers handling data reported by Texas towers, picket ships and aircraft of the Air Defense Command.

In his new position, Sauer will direct staffing of the Topsham site with supervisory, technical and clerical personnel responsible for maintenance of the site's power building. In addition, he will formulate and institute training programs for civil service and Air Force personnel who may be assigned to the project.

GPL Reorganizes Research

RICHARD W. LEE, vice-president and director of the Avionic- Engineering Division, General Precision Laboratory Inc., Pleasantville, N. Y., has announced the appointment of Dr. France B. Berger as director of research planning, a new post. At the same time, Ivan A. Greenwood assumes the position of assistant director of research planning under the realignment of divisional responsibility.

Dr. George R. Gamertsfelder continues as director of research.

Three named as department heads are: G. Stavis, radar research; A. Block, systems analysis; and J. W. Gray, computer research.

The research reorganization will enable GPL to deal more effectively with its expanding activities in Doppler navigation and related avionic fields.

Dr. Berger was formerly head of the research department and Ivan Greenwood, associate department head. Both joined GPL after wartime research at the MIT Radiation Laboratory.

Allies Tour Military Electronics Plant

SIXTY-TWO Ordnance officers, representing 13 Allied countries and U. S. forces, recently toured the Sperry Gyroscope Co. plant at Great Neck, N. Y. Part of the advanced personnel training course, which the officers are attending at Aberdeen Proving Ground, Md., the visit included orientation talks by company officers. The officers were

Army officers, including 13 from Allied countries at Sperry Gyroscope plant at Great Neck. N. Y.

shown production of precision electronic and electromechanical military devices.

Lewis and Kaufman Ltd. Selects General Manager

Frank Mansur

FRANK MANSUR was recently named general manager at the Lewis and Kaufman Ltd., Division of International Glass Corp., manufacturers of Los Gatos brand electron tubes for industry and communications. He was formerly associated with Eitel-McCullough, Inc., and prior to that was manager of the government and commercial department of the Hazeltine Electronics Division, Hazeltine Corp., New York.

Heath Begins New Plant Construction

GROUND has been broken for the construction of a new 142,000 sq ft plant for Heath Co., manufacturer of electronic equipment in kit form. The modern one-story building will house all of the company's operations, and will be located on a 16-acre tract in St. Joseph, Mich. The company presently operates in six different locations in the Benton Harbor area.

General Atronics Expands

GENERAL ATRONICS CORP., a consulting, research and development

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firm specializing in electronics and applied mathematics, has expanded into new quarters at One Bala Ave., Bala-Cynwyd, Pa.

This company, formed in 1955, is engaged in a variety of industrial and military projects, including the development of new techniques in radar, communication and data processing; instrumentation for automation; product development; and system and operational analysis.

The move was made to provide additional laboratory facilities for scheduled development activity.

Beckman Sets Up New Department

THROUGH its Helipot Div. of Newport Beach, Calif., Beckman Instruments, Inc., announces the formation of a new unit, the contract engineering department, which will specialize in the design and production of electromechanical subsystems for aircraft, guided missiles and industrial plant control equipment.

The new department, under supervision of technical director O. C. Bixler, will design basic system units around the division's components.

Frederick Marsh, formerly chief customer engineer for Helipot, will manage the contract engineering department, having previously been employed by General Electric in the development of radar, automatic pilot and aerial fire control systems.

Kenneth Goodman, former engineering manager for the Pacific Coast Division of Aerovox Corp., replaces Marsh as chief customer engineer, responsible for the application of Helipot services to specific component requirements.

Bowers Named By Borg-Warner

ORRIN C. BOWERS was appointed chief engineer of Borg-Warner's BJ Electronics. The California firm is engaged in the development and manufacture of digital data systems, r-f test equipment and nuclear instruments.

Bowers, most recently projects manager of the electronic instrumentation division for Ramo-Wooldridge Company, has been connected with national defense projects since 1942. He was previously chief engineer, technical products division for Packard-Bell Co. At BJ Electronics he will head the engineering and laboratory groups now occupying new facilities in the recently completed 85,000 sq ft plant.

Orrin C. Bowers

General Transistor Promotes Engineers

JEROME FISHEL was recently promoted to chief engineer, Electronic Section, of General Transistor Corp., Jamaica, N. Y. He had previously been chief computer applications engineer. Prior to that he worked at transistor circuit design for Sperry Gyroscope Corp.

Charles Prawdzik has been promoted to chief engineer, Device Development Section. Previously he has held positions as a consultant engineer; chief engineer, Crystal Products Division, Tung-Sol Electric Co.; and senior physicist in charge of the selenium laboratory, Federal Telecommunications Lab., Division of IT&T.

Gulton Organizes Instrumentation Division

MONITORING instruments for geophysical equipment, high frequency telemetering systems and nuclear reactor control and monitoring circuits will be produced by a new division of the Gulton Industries.

To be known as the nuclear instrumentation division in Albuquerque, N. M., it will specialize in instrumentation for communications links, instruments and readout meters.

Division head will be Burt J. Bittner, formerly of the Sandia Corp. He has worked in the fields of telemetry antenna work and nuclear energy.

Beckman Instruments Appoints Donner

Walter Donner

WALTER DONNER has been appointed assistant director of research and engineering for laboratory instrumentation for the scientific instruments division of Beckman Instruments.

Under Dr. Wilbur I. Kaye, research director for laboratory instrumentation, Donner will be responsible for the development of a variety of electronic instruments for industrial and scientific research laboratories and will continue as chief project engineer for the division's gas analyzer group. In addition, he will be acting chief project engineer for ultraviolet spectroscopy.

Donner joined Beckman Instruments 11 years ago as an electronics technician.

McCoubrey Joins National Company

Arthur O. McCoubrey

ARTHUR O. MCCOUBREY has been appointed head of National Company's physics department.

Dr. McCoubrey has been associated with Westinghouse research laboratories since 1943 where he was active in microwave tube development, the atomic bomb project including participation in the tests at Bikini Atoll in 1946, and fundamental research in physics.

At the National Company, he will head the physics group which is currently developing an airborne model of the national atomichron—the first practical atomic primary frequency standard.

IRC Appoints Division Head

INTERNATIONAL RESISTANCE CO. appointed Frank G. Daveler division manager of the computer components division. He joined IRC in 1950 and has held the positions of chief design engineer and chief

Frank G. Daveler

mechanical engineer. He has also served as division manager of the data processing division of Fischer and Porter Co.

Telecomputing Elects New President

GEORGE P. BRUBAKER has been named president of Telecomputing Corp., manufacturers of electronic and instrumentation equipment.

Brubaker is founder and will also remain as president of Brubaker Electronics, acquired by Telecomputing Corp. As president, he will coordinate all divisions and subsidiaries of Telecomputing Corp., including Whitaker Gyro, telecomputing division, Brubaker Electronics, Inc. and Enterprise Development Co.

California Company Builds in Arizona

U. S. SEMI-CONDUCTOR PRODUCTS, INC., of Glendale, Calif., has begun construction of a 20,000 sq ft electronics plant at Phoenix, Arizona, with completion targeted for July 1.

A work force of 150 will be employed at the start with 500 contemplated within five years. The plant will manufacture transistors.

Motorola Advances Jones

ARTHUR H. JONES, who was appointed director of engineering of Motorola's National Defense Department last year, has been advanced to manager of the company's

Chicago area Military Electronics Center.

Before his association with Motorola, Jones was vice-president for engineering of Frank C. Brown and Co. of New York and Hartford. At the same time, he held posts as consultant to the Research and Development Board of the Office of the Secretary of Defense and to the Operation Research Office of Johns Hopkins University.

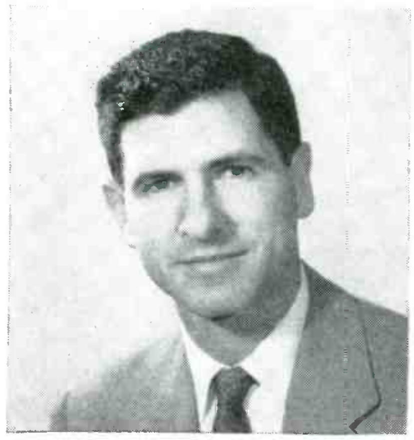
FTL Appoints Systems Engineer

GEORGE L. CURTIS was appointed systems planning engineer in the Palo Alto research and development facility of IT&T's Federal Telecommunication Laboratories. Prior to joining FTL, he was a member of the application-engineering division of Lynch Carrier Systems in San Francisco and responsible for customer applications and sales engineering in Western U.S.A. and Canada for that company. From 1952 to 1954 he was associated with Lenkurt Electric Company in design and engineering activities relating to telegraph- and radio-multiplexing equipment as well as open-wire, radio, and cable carrier.

Spencer Promoted by Wheeler

WHEELER LABORATORIES, INC., Great Neck, N. Y., announces that Ned. A. Spencer has been appointed engineer-in-charge of its new Smithtown Laboratory. Spencer joined the staff of Wheeler Laboratories in 1948 where he has been associated with the development of many microwave components such as antennas, rotary joints, oscillators and tunable filters.

In his new position, he will supervise the consultation and development activities of the new microwave antenna facility located near Smithtown, L. I., New York.



Ned A. Spencer

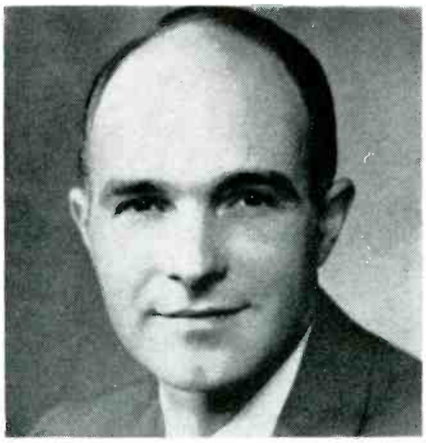
Ampex Forms Audio Subsidiary

AMPEX CORP. of Redwood City, California, manufacturers of magnetic tape recorders, plans to form a new firm which will be known as Ampex Audio, Incorporated. It will be under the presidency of Phillip L. Gundy who is a vice-president of the parent company, and has been serving as manager of the audio division. Herbert L. Brown, previously administration manager of Ampex audio division, will join the new corporation as vice-president and general manager. Others who will associate with the new concern in positions of leadership will include Austin Ellmore, chief engineer, Arthur Stoefen, manufacturing manager and Bernard Quinn, Manager of Finance.

Employing approximately 250 persons, Ampex Audio, Inc. has set July 1, 1957, as a target date to occupy the initial plant which will be a 40,000 sq ft building located on an 18 acre industrial site. The manufacturing plant will occupy 32,000 sq ft of the building while office space will take the remaining 8,000 sq ft.

The new subsidiary corporation will have its own engineering, manufacturing, marketing and finance structures, with a product line designed for the consumer market.

Filtors Appoints Research Head



Alfred H. Grebe

ALFRED H. GREBE has been appointed chief research and development engineer for Filtors, Inc., manufacturers of sub-miniature hermetically sealed relays for airborne equipment. He joined the firm in 1953, when he discontinued his own television service company.

Prior to starting his own business, Grebe was assistant project engineer for the Sperry Gyroscope Company of Great Neck, N. Y.

Foxboro Plans Plant, Fete

WORK ON a new $1.8 million plant, designed to boost production 50 percent, will be started in July by The Foxboro Co. The one-story, 175,000 sq-ft structure will mark the firm's 50th anniversary.

The firm plans to open the manufacturing-office building in mid-1958 in Foxboro, Mass. About 2,000 are employed there now by Foxboro. In all, the firm has four U.S. and three foreign plants.

Consultant Appointed at Lockheed Missiles

DR. JOACHIM W. MUEHLNER, developer of several advanced missile electronic instrumentation systems,

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has been appointed a consulting scientist in Lockheed Missile Systems division's research and development branch at Palo Alto, Calif. Muehlner joined Lockheed's missile division after more than five years as technical director of the range instrumentation development division, Army Ordnance, at White Sands Proving Ground, in New Mexico.

Previous to that he was, from July 1950 to Nov. 1952, chief consultant in electronics in the instrumentation section of Holloman AFB. As an associate of Dr. Wernher von Braun, he was chief of the h-f and telemetering laboratory in the research and development division, Army Ordnance, at Ft. Bliss, Texas, from November 1945 to July 1950.

Dalmo Victor Promotes Walters

GLENN A. WALTERS, director of research at Dalmo Victor Co., has been named a vice-president of the firm.

He will continue his present duties in the company's engineering division where he heads the research laboratory staff of 75 employees.

His efforts have been largely responsible for bringing many advanced features to the company's products and helping to maintain Dalmo Victor's position as one of the nation's largest manufacturer of airborne radar antennas.


Glenn A. Walters

Walters joined Dalmo Victor Co. in 1947 as an electrical design engineer and was appointed director of research in 1950. Before joining DV he was a research associate at Stanford University where he climaxed his study of networks with construction of a wave guide simulator.

ERA Appoints Chief Engineer


Walter J. Weiss

WALTER J. WEISS, formerly chief engineer for Industrial Instruments, Cedar Grove, N. J., has been appointed chief engineer at Electronic Research Associates, Inc., Nutley, N. J., manufacturers of tubeless and transistorized apparatus. In this capacity he will be responsible for direction of engineering design and development, quality control, test and customer service.

Philco Makes Executive Changes

LARRY F. HARDY, vice-president, has assumed a new position as vice-president in charge of consumer products divisions of Philco Corp. In this capacity, he will have general responsibility for the operations of the television, radio, appliance and automotive divisions of the company.

He joined Philco in 1932 and has held executive positions of increasing responsibility. In 1954 he was named vice-president in charge of product development. Chester C. Pond has been appointed manager of product planning of Philco's government and industrial division.

He joined the company in 1935 at Detroit where he became associated with the automobile radio group.

He served successively as manager of subcontract department and business manager of the research division after World War II. In 1951 he returned to Philco after having served as president of The International Electronics Co. and became administrative assistant to the vice-president—director of research and engineering. He later became project administrator for the government and industrial division's Navy fire control systems.

Cyrus H. Warshaw, manager of semi-conductor sales, has been appointed general sales manager of Philco's Lansdale Tube Co.

He joined Lansdale as tube development engineer in 1947. He served as sales engineer on microwave communication products for the company's government & industrial division. In 1955, he was appointed manager of semi-conductor sales for the Lansdale Tube Co. division.

Porter Acquires Federal Wire & Cable

H. K. PORTER CO., INC., has announced acquisition of Federal Wire & Cable Co., Ltd., Guelph, Ontario.

Federal products include cable for various industries. Wire is manufactured for the radio and telephonic industries among others. Among other products are automotive and special harness assemblies to customer requirements.

Babcock Moves

BABCOCK Radio Engineering, Inc., and its associated companies, have moved into their facility in Costa Mesa. The new 25,000-sq-ft plant is located at 1640 Monrovia Ave., Costa Mesa, Calif.

New Books

Radio Telemetry

BY MYRON H. NICHOLS and LAWRENCE L. RAUCH. *Second edition. John Wiley and Sons, Inc.*, 1956, 461 p, $12.00.

TELEMETRY, and more especially radio telemetry, has been increasingly important in our new scientific world during the past 12 years. The principles and major uses of remote metering have been known for some time, but it has only been since World War II that the requirements for information handling capacity of radio and wire data links have become multiplied to such tremendous magnitudes.

Myron H. Nichols and Lawrence L. Rauch have coauthored a new book which deals with this new and important field in electronics and communications. For the first time this subject has been organized in one book which gives a comprehensive discussion of the major aspects, including methods, theory and influence of noise and other errors, detail systems of multiplexing, data interpretation and applications of auxiliary instruments.

The authors present the foundations of mathematical analysis for signal multiplexing and frequency domain analysis. Various techniques for the instrumentation of telemetering systems for both frequency division and time division, including the problems of data reduction, are given. Appendices are included with solutions to a wide variety of special problems related to the field of telemetering systems.

Part 1, 12 chapters, presents the several methods of radio telemetry beginning with an introduction and historical background. Each system or method is discussed in relation to the information capacity considering bandwidth, impulse and fluctuation noise errors.

▶ **Multiplexing Systems**—The various methods of multiplexing are divided into the generally familiar categories such as frequency division multiplexing, time division multiplexing and the combinations known as double multiplexing. Each general system is subdivided in the text into the practical methods such as a-m/a-m, f-m/a-m, etc. The problems and advantages of each are discussed and compared with each other, giving the reader a well-rounded concept enabling him to apply a technique of telemetering most suitable to his needs. The requirements for data interpretation of each method are also given.

▶ **Theoretical Analysis** — Part 2, chapters 13 and 14, presents the fundamental theoretical analysis of modulation and multiplexing systems. This chapter reviews the reader in the concepts of information theory and analysis in the frequency domain. This information includes the transfer functions, impulse response of second order systems and ideal sharp cut-off filters, intermodulation problems due to nonlinearity and bandwidth requirements.

▶ **Practical Aspects**—Part 3 consisting of four chapters presents in a very practical discussion the techniques which are presently used in many radio telemetering systems. Numerous illustrations of simplified circuits and photographs of equipment make this part of the book one which appeals to the practical engineer seeking advice in the design of hardware. The four chapters are divided into the frequency division and time division systems and include the problems of data reduction as well as examples of several current data reduction systems.

The application of telemetry techniques to remote control and radio command links is treated in the last chapter of this section. This chapter does not cover the full scope of these applications but merely suggests some of the uses in this area and deals briefly with the problems.

The last part of the book is organized into 14 appendices devoted to the detailed mathematical analysis of various problems such as the comparison of several systems to the a-m link and the analysis of pam/a-m and pam/f-m systems. Other discussions involve the crosstalk problems in frequency division multiplex radio links. It is impossible in this review to give a complete picture of this important part of the book but suffice it to say that the reader has available here a ready reference to the treatment of the various aspects of the previous chapters.

In reviewing this new book, one will be impressed with the organization and broad scope of material covered. A useful bibliography is appended. This provides a rather complete list of additional books and papers which may be used for the further study of any particular facet of telemetry problems and systems which might be desired.—H. B. RIBLET, *The John Hopkins University, Applied Physics Laboratory, Silver Spring, Md.*

Mathematics and Computers

BY G. R. STIBITZ and J. A. LARRIVEE
McGraw-Hill Book Co., New York, 1957, 228 *p*, $5.00.

IT is encouraging to witness the tendency of late to find competent scientists writing for scientists in other fields as well as for the layman. The esoteric quality of many technical fields brought about by extreme specialization obscures from even the scientist working in a related field many techniques and theories which may be valuable to his work if understood and correctly applied.

The motivation for writing this book is, as stated by the authors in the preface, the hope of helping the layman to acquire an understanding of the basic concepts of scientific effort and a sympathy with its spirit.

▶ **Applied Mathematics**—The book covers in a very informal and readable style the field of modern applied mathematics, with particular emphasis placed upon the use of automatic digital computers. The technical level is somewhat variable throughout the book, but this reviewer feels that the intelligent layman will have little if any difficulty with the work. The volume offers very little new material for the applied mathematician or engineer already working in the digital computer field. However, mathematicians or engineers in other fields should find the work enlightening, easy to read and very possibly valuable in that it may stimulate their thinking relative to the application of digital computers in their work.

The book opens with an introduction to some of the basic concepts of applied mathematics. Next, the authors relate applied mathematics to numerical methods and computing aids and emphasize the importance of high-speed computing devices in creating a fundamental change in applied mathematics.

A brief account of some of the sources of problems which are being solved on digital computers is followed by a discussion of the history of computing devices and the evolution of the high-speed computers of today. The fundamentals of numerical analysis, or the branch of mathematics which treats the transformation of problems into a form so that they may be solved by purely arithmetic means, are treated in Chapter Five with stress upon the important subject of solutions through successive approximations. A glance at some of the more important digital computer components with a discussion of coding methods is the subject of Chapter Six.

Some design philosophy for digital computers is discussed next from the point of view of the computist; the engineering viewpoint is not considered to any extent.

▶ **Random Numbers**—The authors devote a chapter to analog devices and then return to digital devices with a discussion of computing with random numbers, that it, the application of some principles from the field of probability and statistics. These "Monte Carlo" methods are finding more and more application because of the availability of high-speed computers and deserve the emphasis which the authors have accorded them.

A rather superficial treatment of computer errors and some examples of our latest computers at work and at play complete this book which almost belongs in the category of bedtime reading.— D. E. ROSENHEIM, *IBM Watson Laboratory at Columbia University, New York, N. Y.*

An Introduction to Junction Transistor Theory

BY R. D. MIDDLEBROOK
John Wiley & Sons, Inc., New York, 1957, 296 *p,* $8.50.

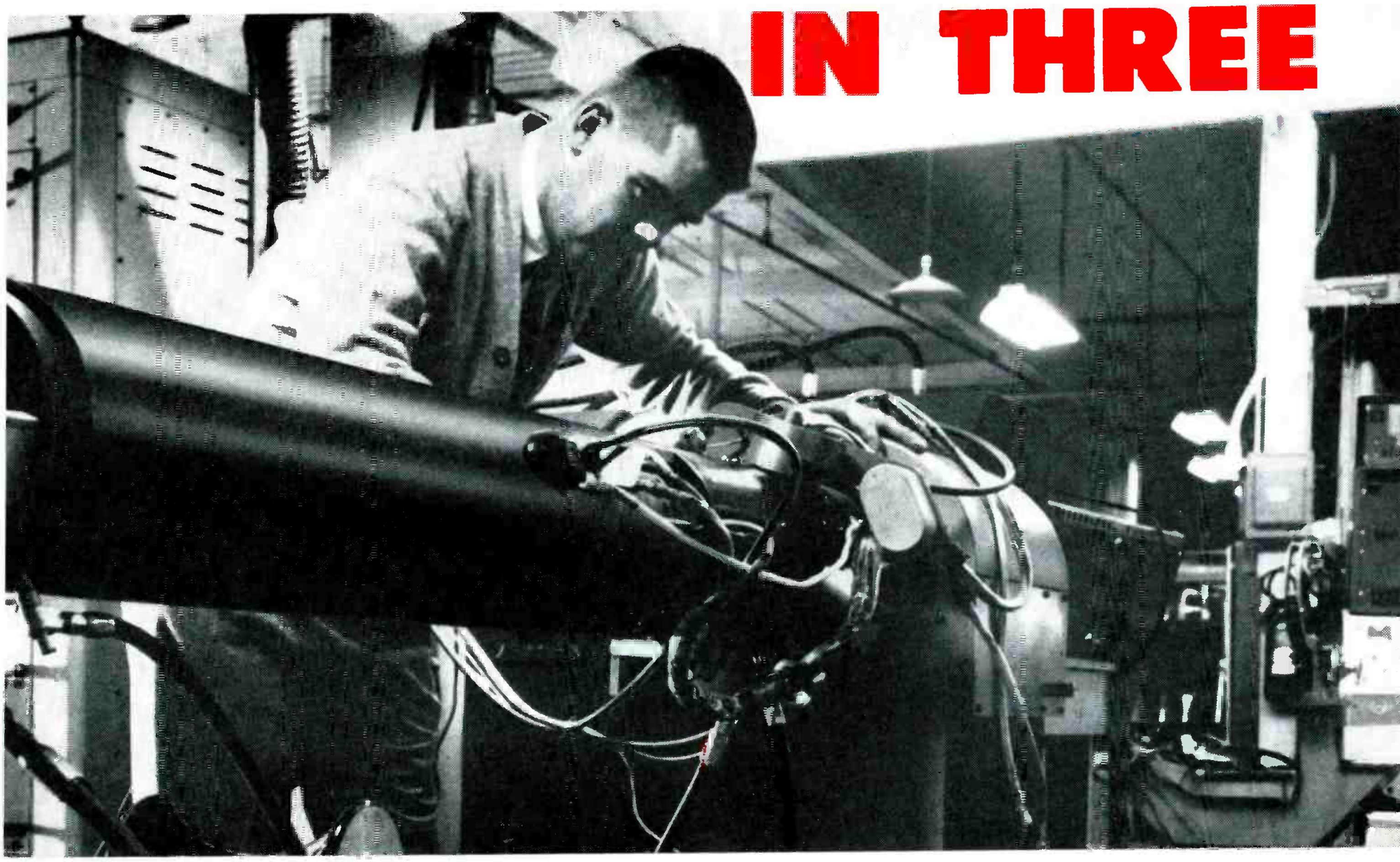
WE are witnessing an enormous increase in the application of electronic devices. Transistors are maturing every day; consequently, the understanding of basic principles of operation of solid state devices has become mandatory for practiced engineers who desire to use transistors intelligently.

From this point of view, Dr. Middlebrook's book, which aids primarily the electronic engineers and students, should be welcomed. The book discusses the theory of semiconductors and is aimed at the engineer or student not majoring in physics.

▶ **Contents**—The book is divided into three parts. Part one deals with the qualitative and quantitative semiconductor physics in which the current flow in semiconductors and boundary values for a forward-biased *pn* junction are treated in a very straight-forward and clearly understandable form. This part also contains a useful introduction which describes briefly how transistors are manufactured. This type of start gives an important feeling of the subject to the readers who are just entering the field of semiconductors.

The second part of the book is devoted basically to *pnp* transistors. Included are such topics as: general discussion of *pnp* transistors, high-frequency and feedback effects, the generalized solution of the *pnp* transistor, approximations for the diffusion admittances and finally the small-signal a-c equivalent circuit using admittance representation. Some typical numerical values are given together with other equivalent circuit representations such as the T and hybrid π

TO THE
ONE MAN IN THREE



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Continued ▶

equivalent circuits. It is the opinion of the reviewer that this chapter could be truly benefited if the author had not excluded h-parameter representation, which is presently widely used, from the description of "other equivalent circuits."

The third part of the book is rather short. It contains a modified a-c equivalent circuit for practical application and some modifications to the basic theory of the junction transistor. This part also includes two appendixes: "Justification of Approximation Made in Obtaining Boundary Conditions for Injected Minority Carriers" and "Properties of Germanium and Silicon," the latter given in the form of a one page reference table.

Part III has a limited value to a practical circuit engineer, who will find more through treatment of this portion of the book in other basic books on this subject such as "Transistor Circuit Engineering" edited by R. F. Shea and "Transistor Electronics" by A. W. Lo et al.

The book is well organized. The proper references are given at the end of each chapter. Illustrations are adequate and well reproduced. On a whole the book provides to electronic engineers the basic information necessary to become intelligently acquainted with the problems of semiconductors and therefore is worthy of recommendation.—E. KEONJIAN, *Syracuse, N. Y.*

Les Antennes

BY L. THOUREL. *Dunod, Paris,* 1956, 440 *p,* 4,800 *Fr.*

A USEFUL work on antennas has arrived from France. The book is an up-to-date synthesis of practical knowledge on antennas containing a review and description of numerous types of antennas and the necessary theory for their understanding. There are also results shown of data taken on many actual antennas.

The author, a professor at L'Ecole Nationale de L'Aviation Civile, has neatly managed to present the material, with limited description and theory and has covered the field in a little over 400 pages including graphs, sketches and bibliography.

▶ **Context**—The book opens with a review of general antenna theory and definitions such as gain, radiation pattern and radiation resistance. This is followed by a chapter on the optics of electromagnetic waves. Vertical antennas are treated with particular application to long and medium wavelengths. The chapters that follow present the theory and application of stacked arrays and directive antennas for the medium wavelengths, and half-wave antennas and the theory of directive antennas for the short waves.

An individual chapter is given to the subject of antennas of longitudinal radiation such as the helical and the dielectric antenna.

Omnidirection and wide-band antennas for vhf and uhf, such as the biconnical and discone types, as well as examples of asymetrical designs are covered. In later chapters, material is presented on radiation from orifices, electromagnetic horns and parabolas. Specialized designs such as antennas shaped large in one plane and small in the other, slot antennas, electromagnetic lenses and loops are discussed.

The appendix contains some transmission line functions and the derivation of the Smith impedance chart.

The book represents a highly competent treatment of the subject matter. In presenting a comprehensive survey of the field of antennas the author has covered the material with particular emphasis on contemporary antenna types. Data taken on particular antennas is presented at times for a verification of the theory. The treatment is supported with mathematical statements whenever desirable to supplement the text. The level of presentation is for the practising engineer or senior student.

▶ **Comparative Merits**—The reader cannot help but compare this new book with "Antennas" by John D. Kraus. Both works cover much of the same material and are developed at the same comprehension level. Fortunately the emphasis in

Continued

Mr. Thourel's book is different from Kraus' work. For example, Mr. Thourel devotes an entire chapter to the parabolic antenna including primary sources and construction of reflectors as contrasted with a briefer treatment by Kraus. Mr. Thourel on the other hand has a simplified treatment of Helical Antennas and references Kraus in his bibliography for the subject.

There are no exercise problems presented in the new book.

The advanced antenna worker will find adequate treatment given to the consideration of input impedance and bandwith. A discussion of latest antenna types includes the design of a longitudinal antenna with artificial dielectric.

The reader who is unfamiliar with technical French and is trying to obtain an introductory background in antennas may find the language a difficulty. However, lack of a reading knowledge of technical French should not be a barrier to the engineer already familiar with antenna theory and terminology. It is to this latter group that this book should have its greatest appeal as it complements existing texts and presents a reference of contemporary designs and bibliography.—LEON HILLMAN, *Director of Enginering, Automation Dynamics Corp., Englewood, N. J.*

umbnail Review

Transistor List. Derivation and Tabulation Associates, Inc., 67 Lawrence Ave., West Orange, N. J., July 1956, 18 p, $2.50. Compilation of specifications of 282 transistors of domestic manufacturers including a few from England, West Germany and Japan. Starting with the second edition, a quarterly subscription will be available for $12.00 per year.

Proceedings of the Second RETMA Conference on Reliable Electrical Connections. Engineering Publishers, GPO Box 1151, New York 1, N. Y., 1957, 103 p, $5.00. Papers on techniques, tools, materials and measurements used for electrical connections presented at Philadelphia on Sept. 11 and 12, 1956.

Womanpower. By the staff of the National Manpower Council, Columbia University Press, New York, 1957, 371 p, $5.00. Role of women in paid employment in the United States and its significance in the labor force from the viewpoint of the country's total manpower resources.

Symposium on Corona. American Society for Testing Materials, 1916 Race St., Phildelphia, 1957, 132 p, $1.25. Effects of corona on plastic laminates and methods of testing corona resistance, corona detection and measurement at 60 cps, methods of measuring energy in gas discharge and pulse method of measuring ionization.

Inventors and Inventions. By C. D. Tuska, McGraw-Hill Publishing Co., New York, 1957, 135 p, $3.75. Case histories of outstanding inventions to familiarize reader with the psychology and methods of invention and to help him protect, patent and market his inventions.

Solid State Physics: Advances and Research Applications—Vol. 3. Edited by F. Seitz and D. Turnbull, Academic Press, Inc., New York, 1957, 588 p, $12.00. Articles on semiconductor compounds and ferromagnetic domain theory are important and useful sources for those concerned with materials for electronic devices. The remainder of the articles, of which two are concerned with phase changes of various kinds and two with lattice defects, concern primarily the solid-state physicist or chemist.

Tubes for Computers. Philips Technical Library, Eindhoven, Holland, 1956, 52 p, $1.50. Technical data on the manufacturer's tubes for high and low-speed computers. Introductory portions cover multivibrator and gate-circuit operation. May be ordered directly from publisher.

Engineering Enrollment in the United States. Edited by Norman N. Barish. New York University Press, New York, 1957, 226 p, $7.50. Basic statistics on enrollment trends in various branches of engineering, including rapidity of training in past, growth rate of enrollments and graduations, kinds of engineers being trained, attrition of engineering students, etc.

Establishing an Integrated Data-Processing System. Blueprint for a Company Program. American Management Association, New York, 1956, 183 p, $4.50 (paper). How to apply computors to business and industry data processing.

Tube Selection Guide 1956-1957. Compiled by T. J. Kroes, Philips Technical Library, Eindhoven, Holland, 1956, 124 p, $1.50. Enables determination of tube types for use in new apparatus, existing apparatus and for replacement of obsolete types. May be ordered directly from publisher.

Optics. By Bruno Rossi, Addison Wesley Publishing Co., Reading, Mass., 1957, 510 p, $8.50. An amalgamation of geometrical optics and physical or wave optics, this book is planned in the modern mode. It begins with waves and derives the geometrical relationships, it then proceeds from simple to more complicated optics, concluding with a chapter on light quanta.

Continued

Backtalk

Discussion of Oscillator Stability

DEAR SIRS:

ALTHOUGH it is a little late I wish to comment on the article "VFO With Near Crystal Stability" by J. M. Shulman which appeared in ELECTRONICS for September 1956, page 230. Mr. Shulman is in error when he states that the frequency change due to phase shifts caused by the presence of harmonics are less when L is made as large as possible. Mr. Clapp has admitted that he was in error in this matter.[1] As stated by Edson, there is no difference between oscillator circuits which have equal Q's and offer equal impedances to the tube elements.

From the practical standpoint a lower L and higher C offer considerable advantage.[2] To state the points briefly, the lower L can be wound with heavier wire which has greater thermal stability thus reducing short-term frequency variations. The higher C makes the tank circuit much less sensitive to small movements of components. The high C circuit can as easily have the tank remotely located from the rest of the oscillator circuit if it is tapped to give the same impedances to the tube as the Clapp circuit.

(1) Lea, Clapp, Bernard, Correspondence *IRE Proceedings*, Aug. 1955.
(2) Bernard, W. B., *CQ* Sept. 1955.

W. B. BERNARD
Commander, USN
Arlington, Va.

DEAR COMMANDER BERNARD:

I APPRECIATE your calling to my attention the correspondence on the subject of frequency stable LC oscillators in *IRE Proceedings*, August, 1955, pages 1012-1013, and that in July, 1955, pages 875-876.

It seems to me that you and Dr. Clapp are basically in agreement and much of your "tilting" is over differences in arbitrary definitions and differences in the manner of expressing yourselves. It is agreed that stability is proportional to Q of the tuned circuit and inversely proportional to the tube coupling reactances. The controversy seems to stem from considerations of how much Q can be obtained in the different circuits, and whether the different circuits will oscillate with the same minimum values of tube coupling reactances.

Comparing the circuit of Fig. 1 in Clapp's article (August, 1954) with that of Fig. 2, if capacitors C_1 and C_2 are the same in both figures, and C_v of Fig. 1 is equal to C_x of Fig. 2, and the Q of the tuned circuits in both figures is the same, the stability of both circuits would be the same. The question is: Can all these conditions obtain at the same frequency and with a tube of the same mutual conductance in both circuits?

You say that in the circuit of Fig. 2 you used value of L 1/20 as great as that required at the same frequency in Fig. 1. If C_x in Fig. 2 was the same as C_v in Fig. 1, and if C_1 and C_2 were the same as in Fig. 1, you had to have a tuning capacitor in Fig. 2 about 20 times that of C_v in Fig. 1. If the circuit of Fig. 2 oscillated under these conditions, then its Q was at least as high as Fig. 1, and it should have been as stable.

Insofar as the problems concerned with practical construction of stable oscillators, as I see it, the advantage of the circuit of Fig. 1 over that of Fig. 2 is exactly as stated by Clapp and Edson, namely that Fig. 1 lends itself better to using reasonable values of tuning capacitance to obtain both high Q and low tube coupling reactances, in the frequency range of 1 to 10 megacycles.

The experimental work I did and the material I wrote was done shortly after the appearance of Clapp's paper in August, 1954. I have noted only one reference to actual stability test results other than those I gave. That was in the correspondence in *IRE Proceedings* of October, 1948, pages 1261-1262. I would be interested in knowing the results of your experimental work and also that of Dr. Clapp, in terms of parts per million stability achieved.

The attempt to approach a practical ultimate in stability of a variable frequency oscillator remains a matter of great interest to me for reasons which I am at somewhat of a loss to define, since I am not directly connected with this kind of work.

J. M. SHULMAN
Sunnyvale, Calif.

DEAR MR. SHULMAN:

THE IMPORTANT point in all the "tilting" that went on between Mr. Clapp and me is the admission that the stability of an oscillator is independent of the LC ratio when the impedances offered to the tube and the circuit Q are equal.

Once this concession is made it can be seen that the circuit in Fig. 1 of Mr. Clapp's August 1954 paper has no theoretical advantage over other circuits. It has one theoretical (and practical) disadvantage. As stated by Mr. Clapp on page 1297 the G_m necessary to maintain oscillation increases with the cube of the frequency. If the oscillator is to cover any appreciable frequency range the tube is much too tightly coupled into the tuned circuit at the low-frequency end of the circuit. It should be kept in mind that Mr. Clapp's 1948 paper and the part of his 1954 paper covering equations 30 to 40 are invalid.

The objection that I make to your article in ELECTRONICS is that on the bottom of page 233 and the top of page 234 you are perpetuating the principles that Mr. Clapp has admitted are in error.

From the practical standpoint the only possible advantage of the circuit in Fig. 1 is that it can use a smaller tuning capacitor than the circuit in Fig. 2. Against this must be considered the disadvantages that you need a coil of greater inductance and that one end of the coil and the lead to the coil have a very low capacitance to ground and are therefore very susceptible to frequency change due to mechanical movement.

The value of capacitance I used

CONTINUED

in my experiments are given in my article in *CQ*. These values give approximately equal products $Z'Z'_2$ which therefore require equal tube G_m's for oscillation.

The long-term stability of these two oscillators was very much the same and the temperature effects were much greater than anything else. The temperature drift was about −50ppm per deg C which is about the amount expected considering the temperature coefficients of the type of parts used. I did not have the opportunity to use a temperature oven to remove the temperature effects.

In the case of short-term variations, the oscillator of Fig. 2 showed up to be considerably better. The lower thermal inertia of the fine wire necessary for the coil for the circuit of Fig. 1 caused it to have short-term variations several times as great as that of Fig. 2.

Both oscillators were allowed to stand with heater voltage on and plate voltage off, then plate voltage was applied. In a period of 5 minutes the Fig. 1 oscillator had decreased frequency 20 ppm and the other had decreased 4 ppm.

In the quest for high stability through the mistaken idea that high L will help, many constructors have made the error of going to plastic strip-supported coils. These have a very bad temperature characteristic and what is worse they have very bad retrace characteristics. This bad retrace characteristic makes it almost impossible to compensate for the temperature characteristic.

In the case of the oscillator that you described in ELECTRONICS you did not take advantage of the only reason for using the Clapp oscillator, that is the use of a smaller tuning capacitor, since you used a 1,000-$\mu\mu$f variable in series with this small variable.

I suggest that you use this large capacitor as the tuning capacitor in the circuit of Fig. 2. If the temperature characteristic of this large capacitor is good you will have an oscillator which is more stable and more rugged than the one which you have described.

W. B. BERNARD

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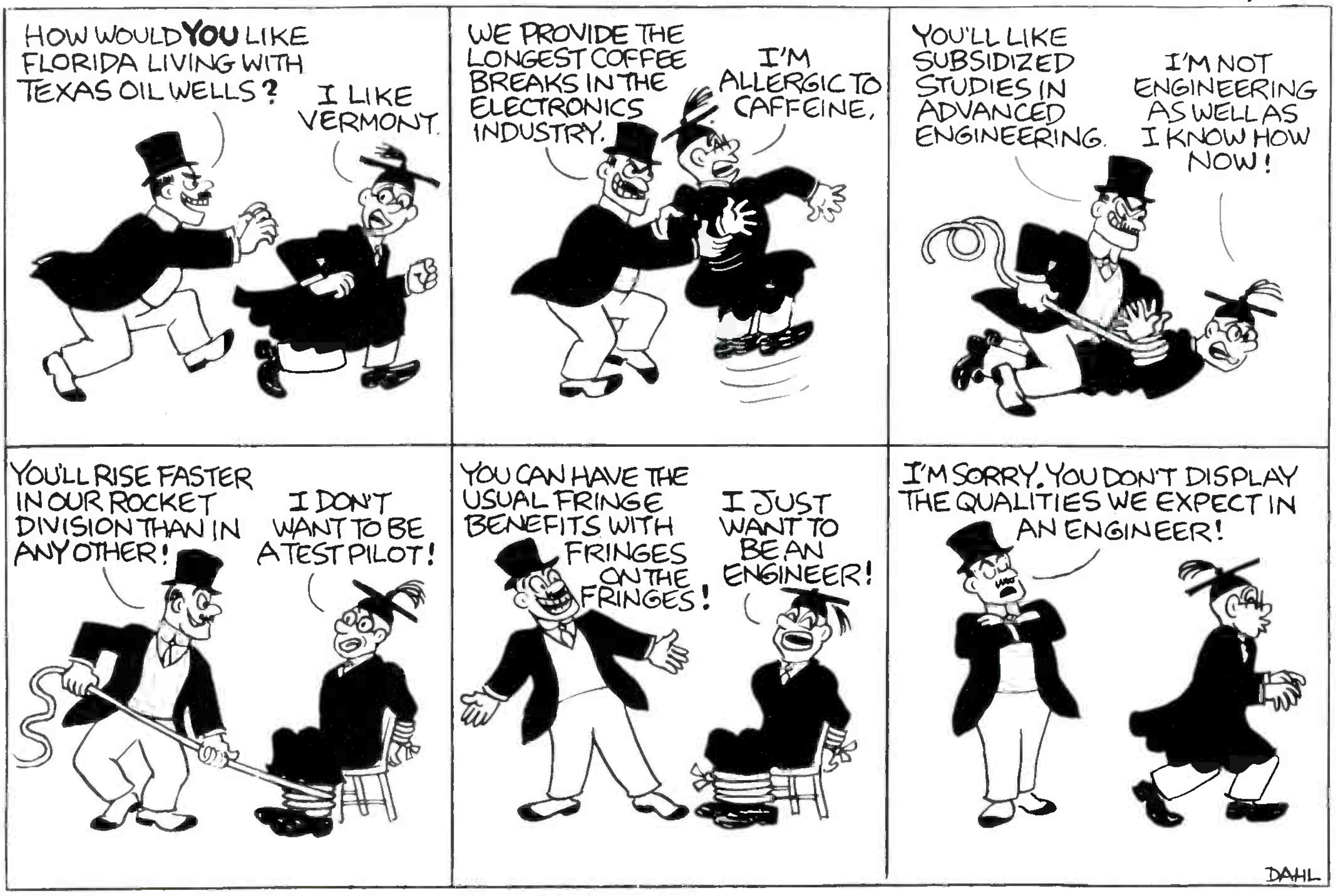

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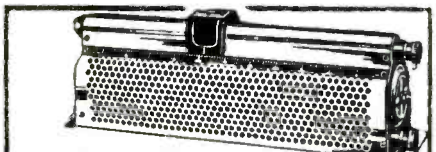

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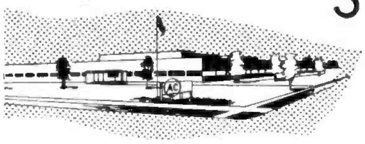

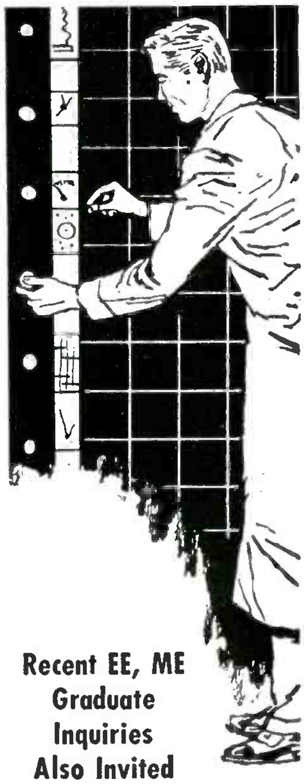

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			0-2	2-3	4-15	0-2	2-3	4-15	1-2	2-3	4-15	1-2	2-3	4-15
• ***SYSTEMS*** *(Integration of theory, equipments and environment to create and optimize major electronic concepts.)*	**AVIATION ELECTRONICS • CONTROLS**		W P	W P X	W C P X	W	W P	W C P	W P	W P X	W C P X			
	DIGITAL DATA HANDLING DEVICES	M C	P	M C P	M C P		C	C P		C P	C P			
	MISSILE WEAPONS SYSTEMS • RADAR	M W	W	M W X C P	M W X C P	W	M W C	M W C P	W C P	M W X C P	M W X C P			
	INERTIAL NAVIGATION			W C P	W C P		W C	W C P		W C P	W C P			
	COMMUNICATIONS		C P	C N P	C N P T	C	C			P	C N P T			
• ***DESIGN • DEVELOPMENT*** **MISSILE WEAPONS SYSTEMS**—Planning and Design—Radar—Fire Control—Servomechanisms—Computers		C M	W C M X	W C M X	W C M X	W C M X	W C M X	W C M X	W C M X	W C M X	W C M X			
AVIATION ELECTRONICS — Radar — Computers — Servomechanisms —Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Automation—Transistorization—Infrared—Airborne TV		W C	W C X	W C X	W C X	W C X	W C X	W C X	W C X	W C X	W C X			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control—Information Handling—Displays		M C	W M C X	W M C X	W M C X	W M C X	W M C X	W M C X	W M C X	W M C X	W M C X			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming—Digital Data Handling Devices		M	C W	M C X W	M C X W	C W	M C X W	M C X W	C W	M C W	M C W			
KINESCOPES (B & W and Color), OSCILLOSCOPES—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photosensitive Materials and Glass to Metal Sealing)			L	L Y	L Y	L	L Y	L Y	L	L Y	L Y	L	L Y	L Y
GAS, POWER AND PHOTO TUBES—Photosensitive Devices—Ceramic to Metal Sealing—UHF and VHF—Super Power			L	L	L	L	L	L	L	L	L	L	L	
RECEIVING TUBES—Tube Design—Test and Application Engineering—Chemical and Physical Development—Methods and Process Engineering			H	H	H		H	H		H	H		H	H
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave—Magnetron)		H	H	H	H		H	H		H	H		H	H
SEMICONDUCTORS—Materials research (surface studies—crystallography)—device design—circuitry—process engineering—automation.			V	V	V	V	V			V	V			V
COMMUNICATIONS — Specialized Systems — Microwave — Mobile —Aviation—Audio—Propagation Studies—Acoustics—Transducers			C N	C N	C N		C	C	C N	C N	C N			
BROADCAST AND TV—Monochrome and Color Studio Equipment—Cameras—Monitors—High Power Transmitters			C	C	C	C	C	C	C	C	C			
RELIABILITY & COMPONENT ENGINEERING				C	C		C	C		C	C		C	C
• ***SYSTEMS APPLICATION*** *(Evaluation and Planning—Design and Development—Modification—Specification)*														
MISSILE TEST INSTRUMENTATION (Data Acquisition and Processing) —Radar—Telemetry—Timing—Communications—Optics—Computers		F	F S	Z F S	Z F S	F S	F S	Z F S	F S	Z F S	Z F S			
RADAR—Airborne—Surface—Shipboard—Sonar—Fire Control		F	F S	Z F S	Z F S	F S	F S	Z F S	F S	Z F S	Z F S			
COMMUNICATIONS —Radio—HF—VHF—UHF—Microwave—Telephone—Teletype—Telegraph Terminal Equipment—Wave Propagation		F	F S	F S	F S	F S	F S	F S	F S	F S	F S			
• ***MACHINE DESIGN*** Mechanical and Electrical—Automatic or Semi-Automatic Machines			L H	L H	H	L	L H	H		L	L			

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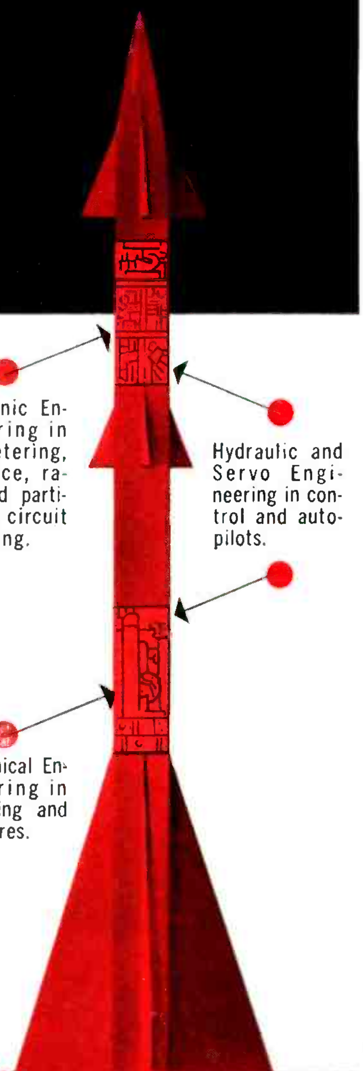

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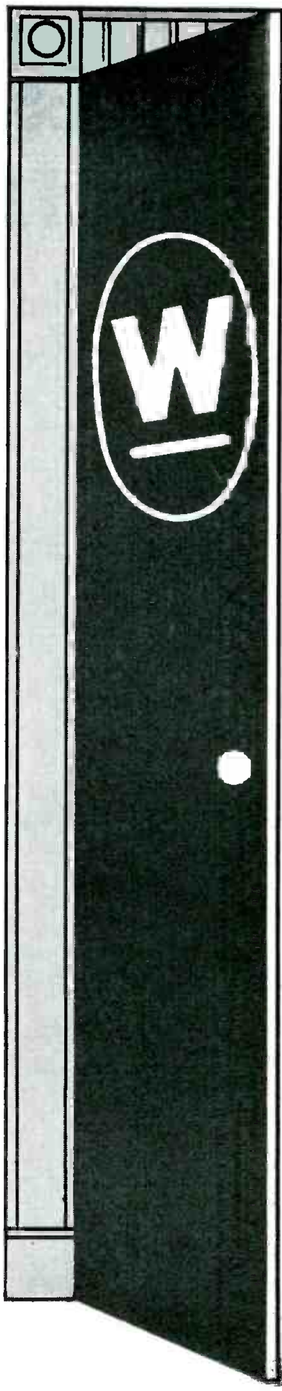

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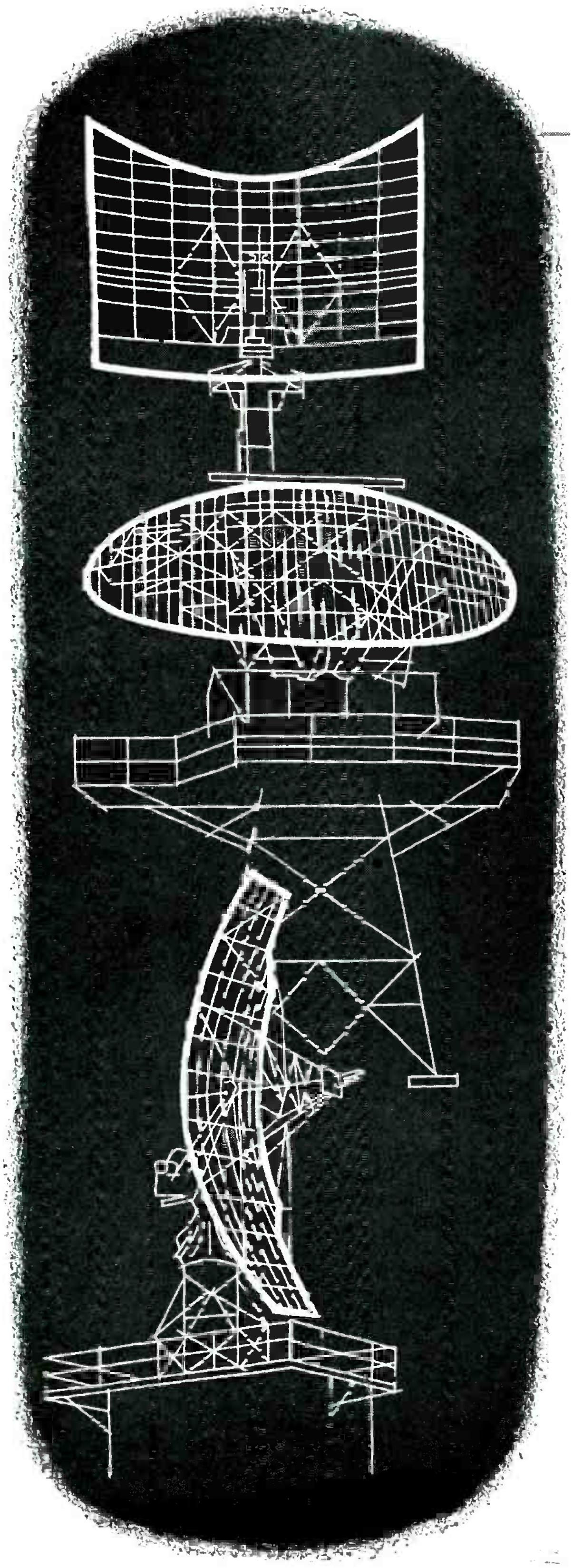

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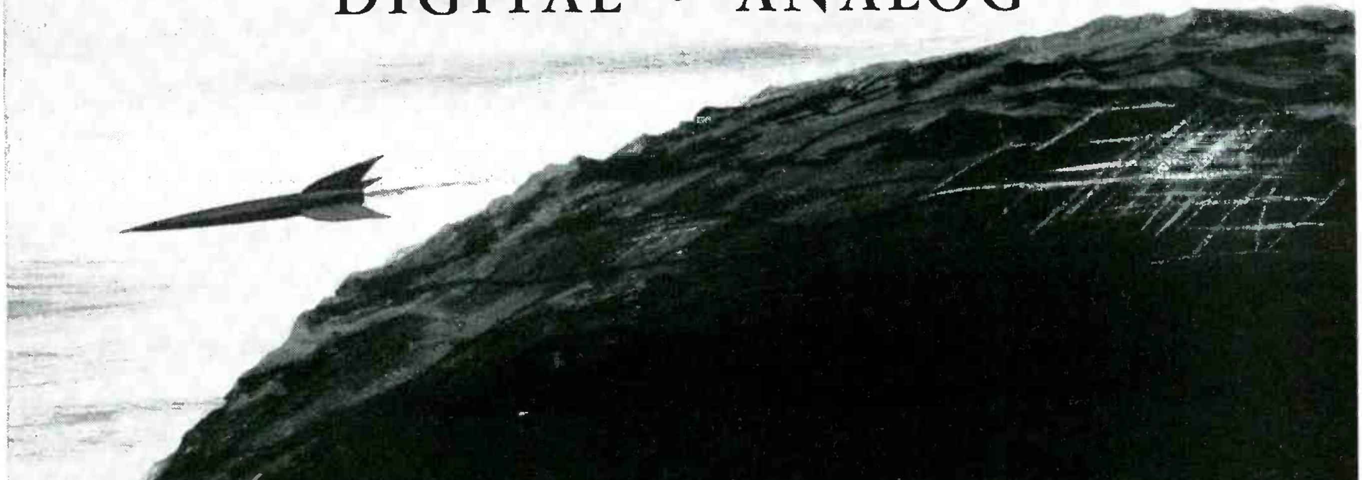

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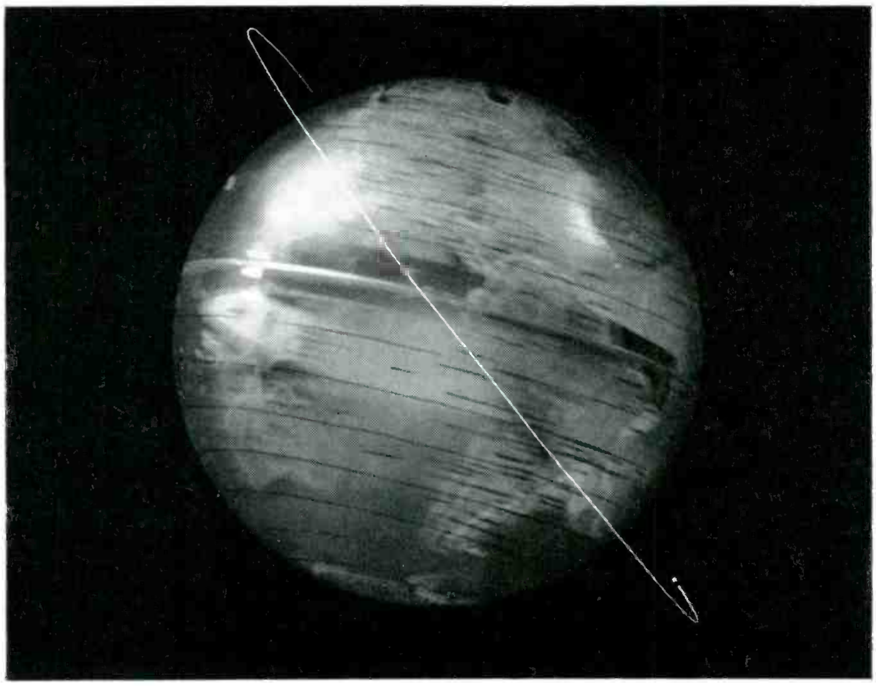

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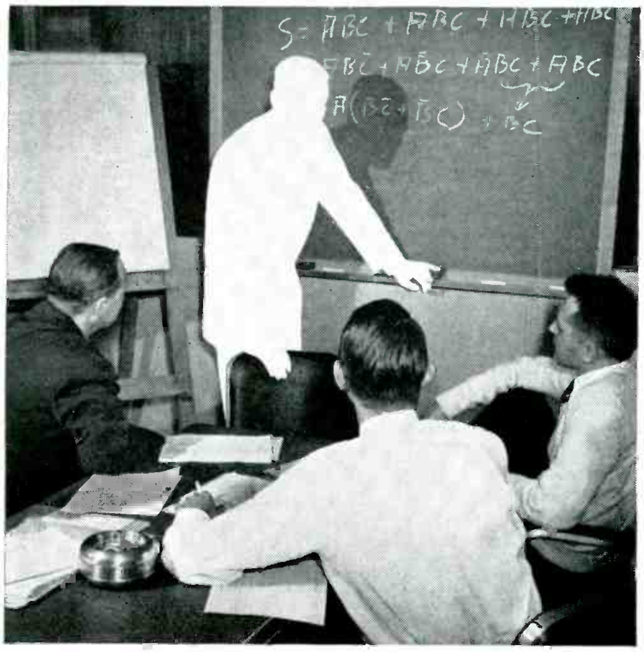
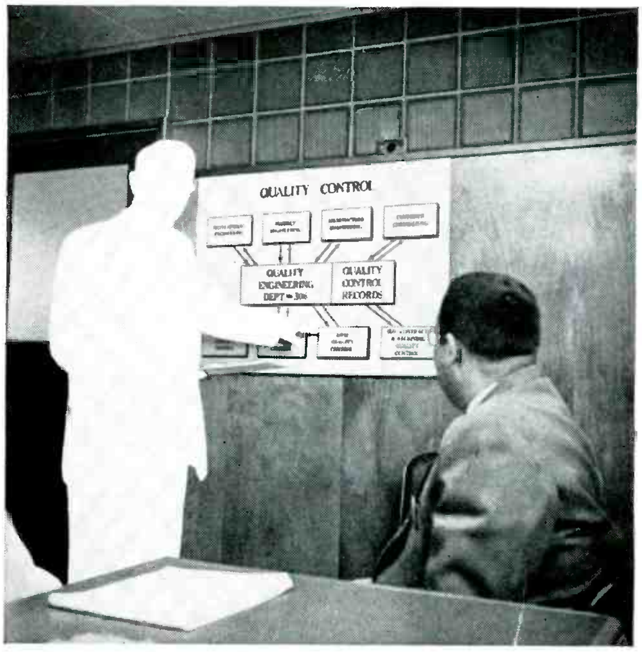


Computer Logical Design Engineer: Before his recent promotion, this man was responsible for determining the broad systems outline of an electronic computer and its interconnection with external equipment. "In this job," he says, "you tailor such characteristics as computer speed, memory, size and arithmetic structure to the requirements of the computer system." He maintained close liaison with mathematical support, circuit designers, packaging and test engineers.



Quality Control Engineer: Also promoted recently, this man worked in Manufacturing Engineering. He was responsible for the performance of IBM electronic computers and other business machines. "The problems of Quality Control in this company are endless—and fascinating," he says. "You may be concerned with transistors and cores . . . gaseous electronics . . . diffraction of alloys . . . reliability studies. *There's always something new*—in this new and progressive field!"

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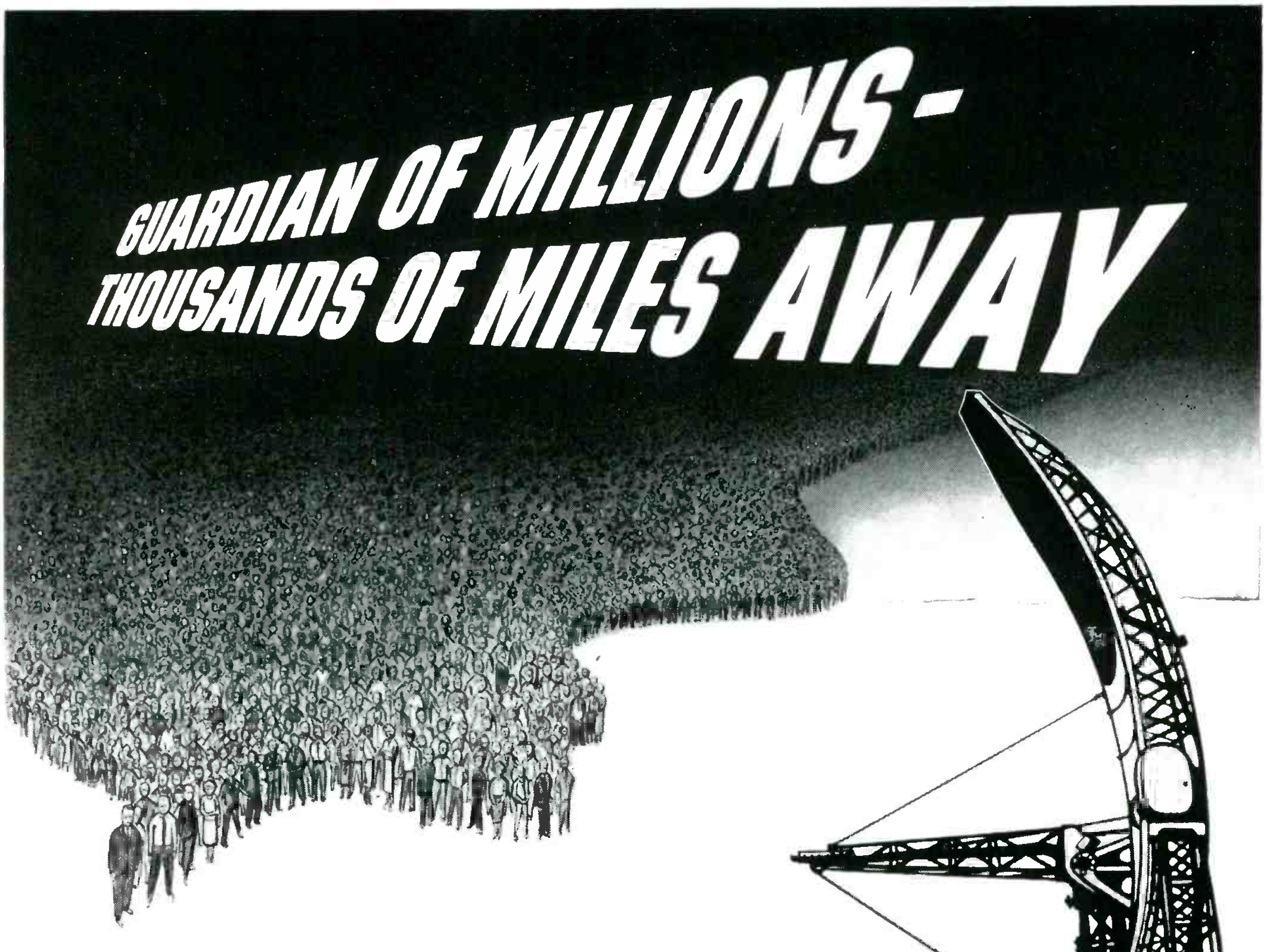

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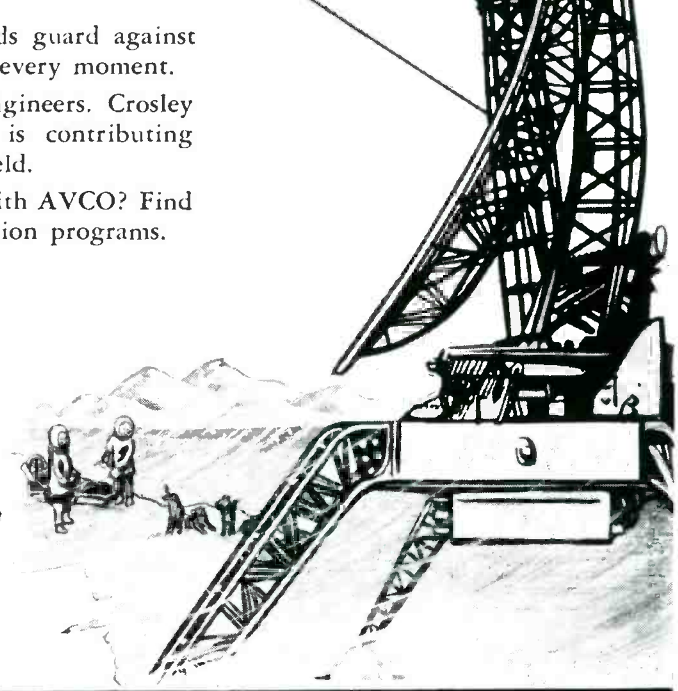

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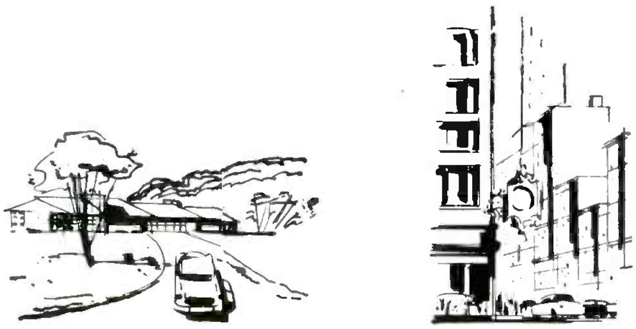

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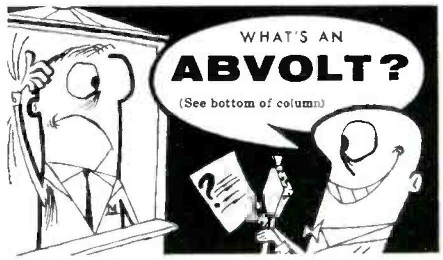

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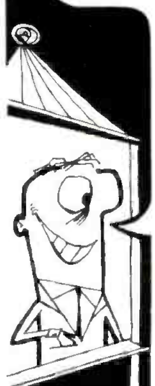

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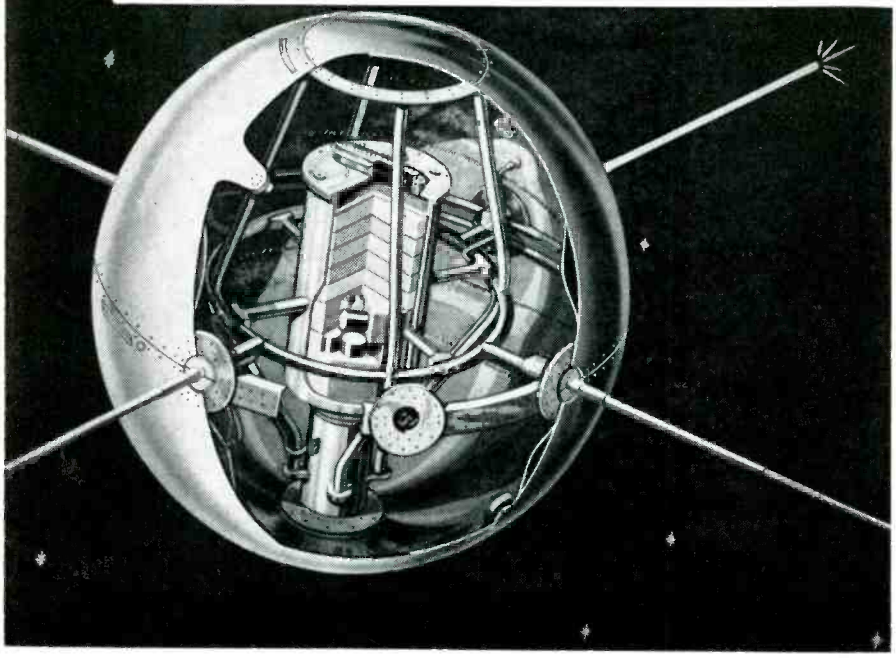

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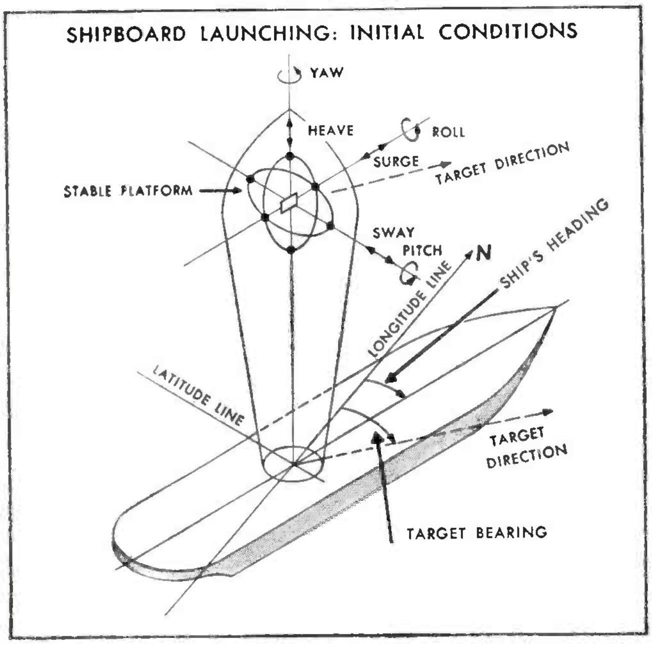

The diagram above presents the primary parameters involved in shipboard launching of a ballistic missile in its simplest form.

For Polaris, MOSD must not only surmount these initial conditions but solve fire control problems more complex than heretofore encountered. Pinpoint accuracy in missile guidance is an impressive accomplishment under the most favorable conditions. But how do you achieve it with a missile hurled from a moving platform and aimed at an object approximately 1,500 nautical miles away?

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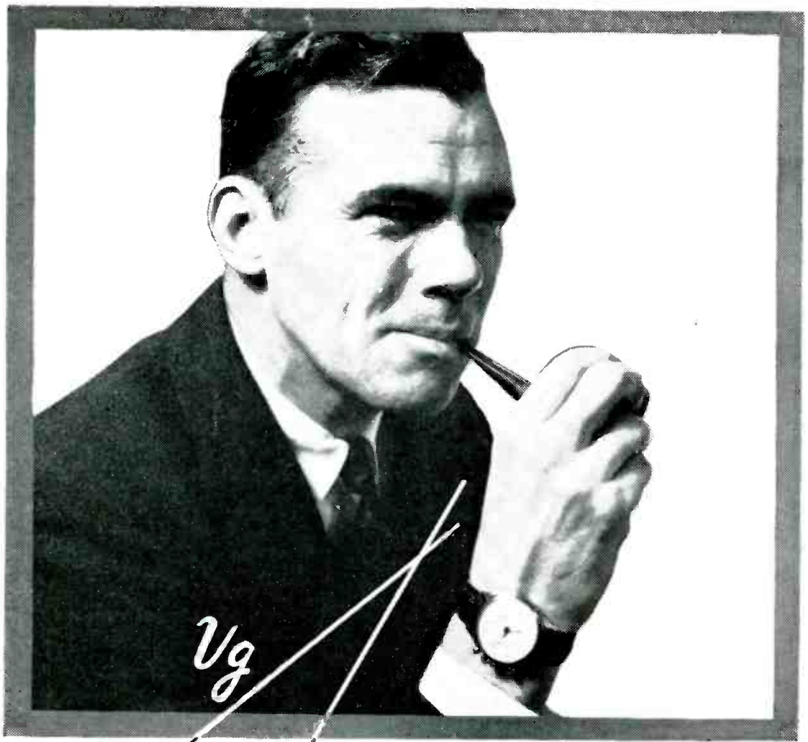

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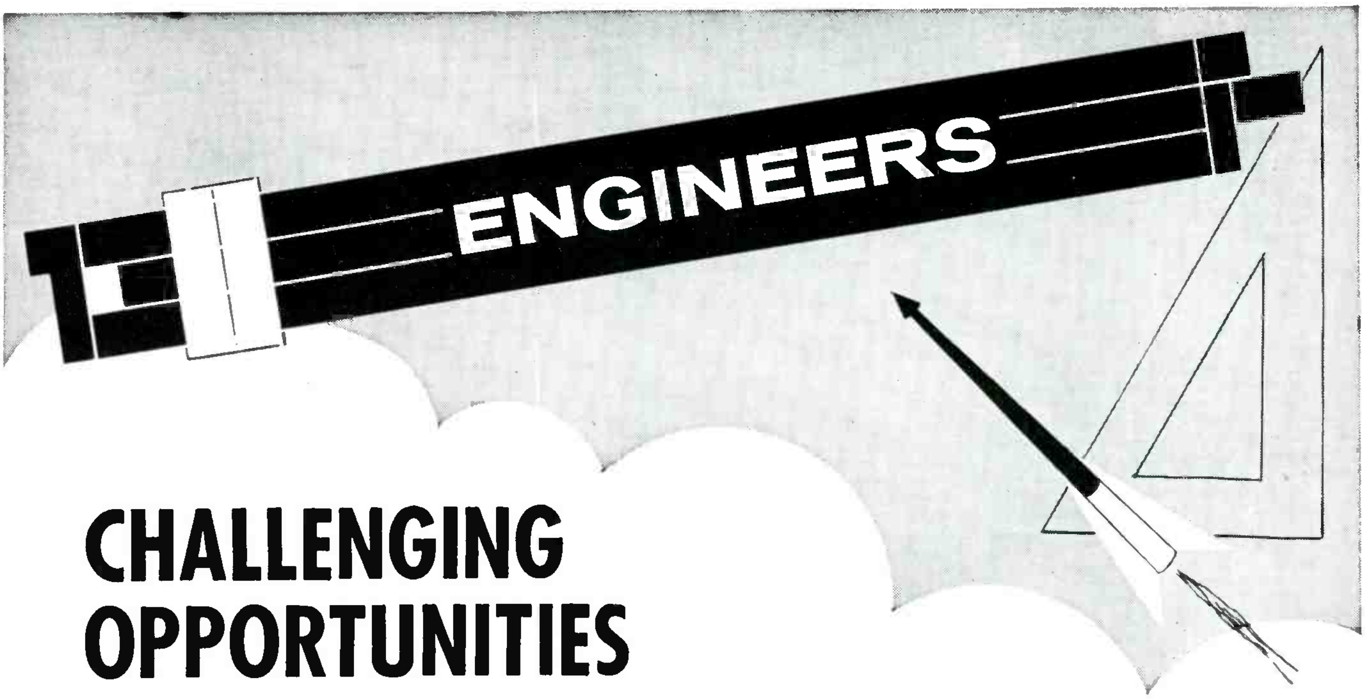

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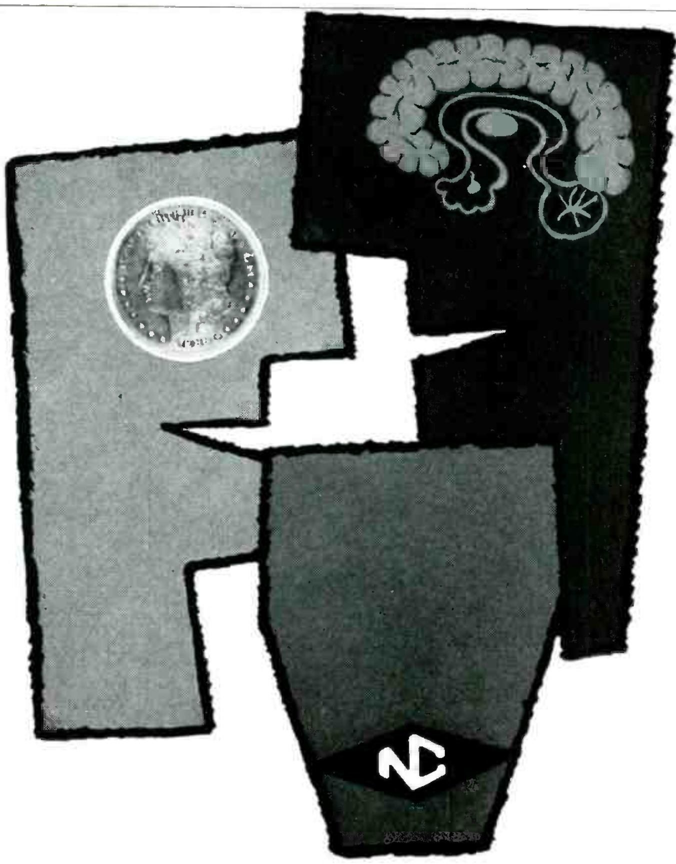

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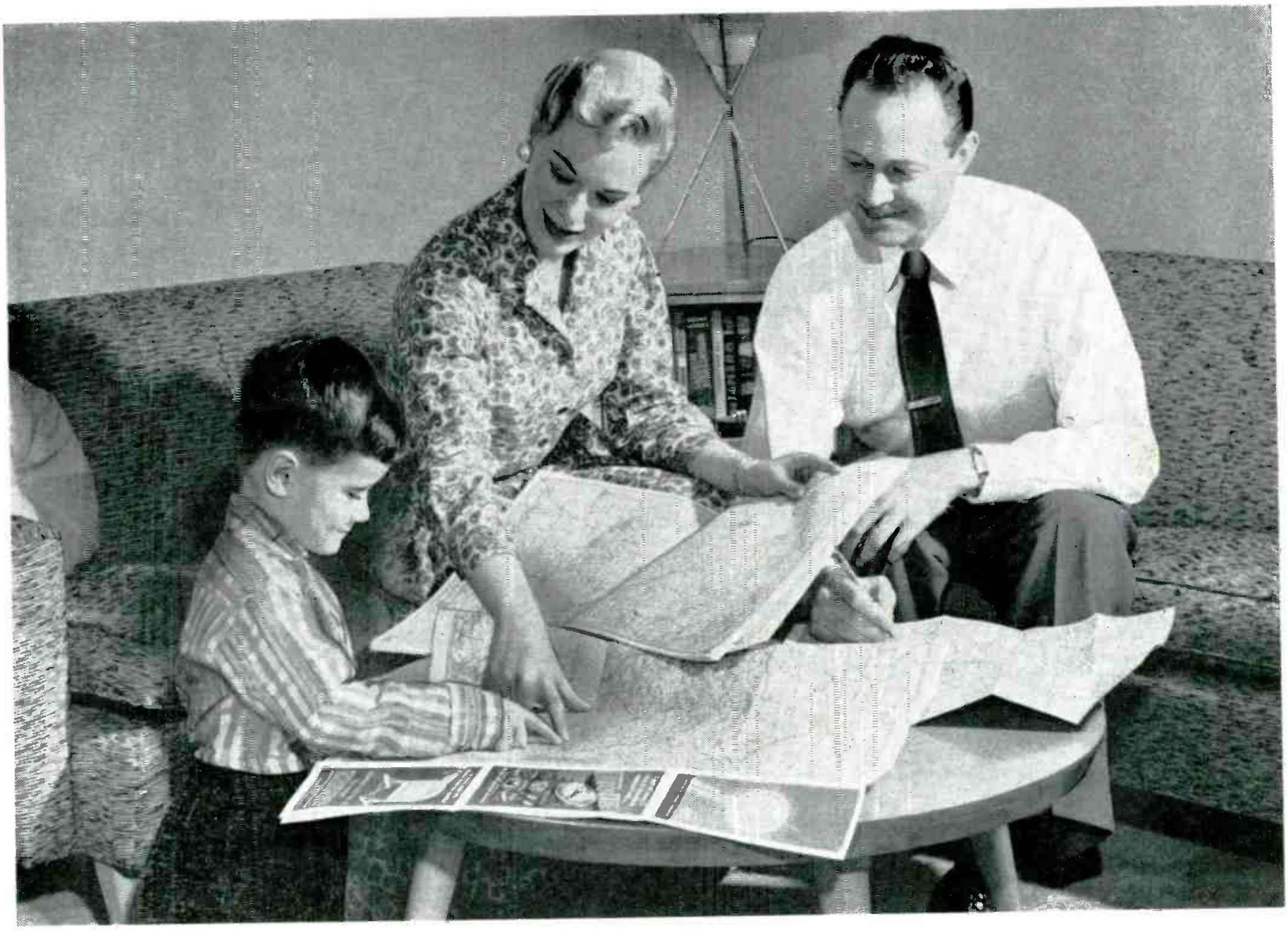

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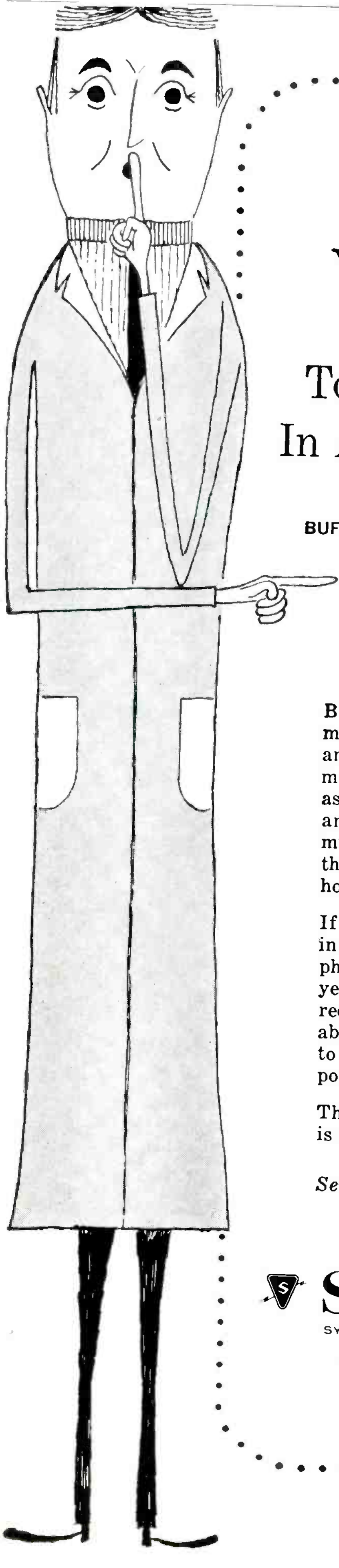

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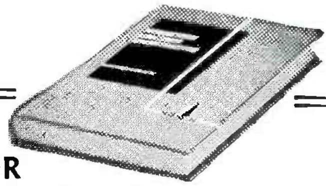

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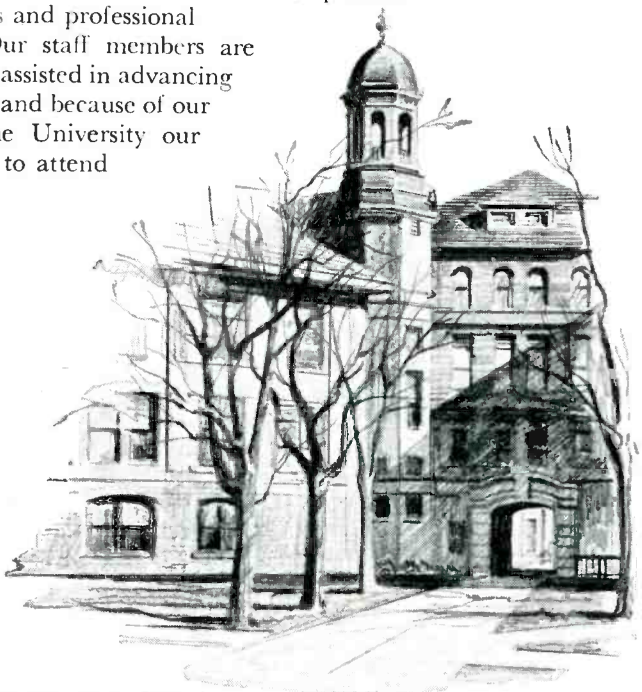

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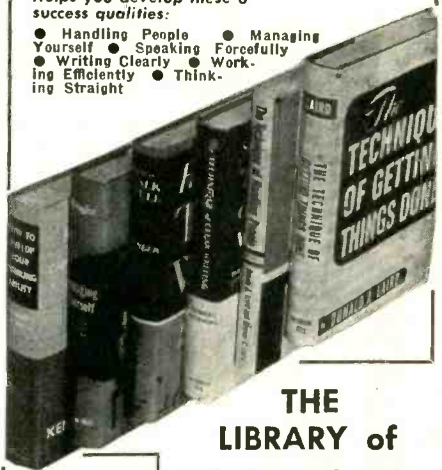

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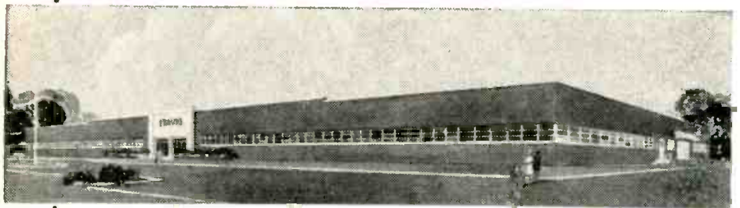

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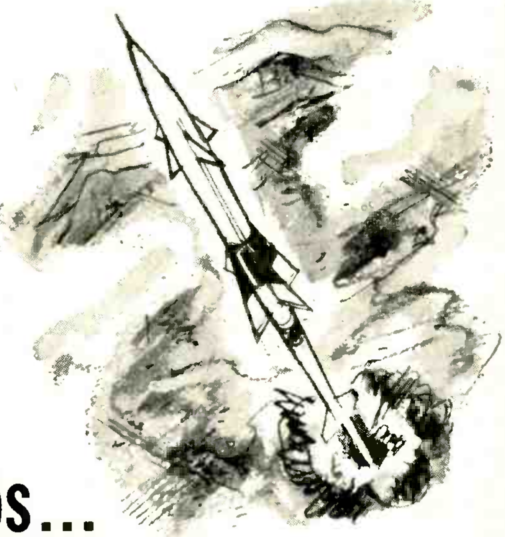

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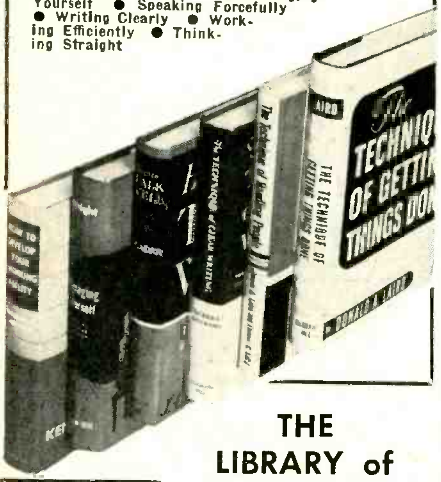

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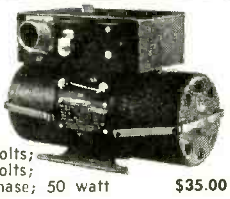

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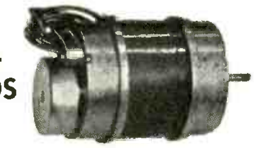

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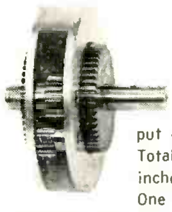

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OB2WA	2.50
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C1K/B	7.50
1AD4	.90
1B22	1.10
1B23	1.00
1B24	6.00
1B24A	12.50
1B25	1.25
1B26	1.25
1B27	10.00
1B29	2.50
1B32	1.00
1B35	3.35
1B36	3.75
1B40	2.00
1B42	12.00
1B44	15.00
1B45	22.50
1B47	4.00
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1B58	60.00
1B62	4.00
1B63A	16.50
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1N23B	.80
1N23BM	2.50
1N25	2.00
1N26	3.50
1N28	6.00
1N31	1.75
1N32	8.75
1N38A	.60
1N42	8.00
1N46	.40
1N52	.40
1N63	1.40
1N69	.40
1P21	30.00
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1P24	1.50
1P25	45.00
1P28	7.50
1P30	1.35
1Q22	40.00
1W5	.75
1Z2	2.50
2AP1	2.00
2AS15	4.75
2BP1	3.25
2B22	1.90
2B24	.80
2C33	.75
2C35	2.00
2C36/846B	25.00
2C39A	10.00
2C40	6.75
2C42	8.00
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2C46	5.00
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2C51	3.00
2C52	2.75
2C53	9.75
2D21W	1.00
2D29	.80
2E22	2.25
2E24	2.25
2E25	3.75
3E26	3.25
2E27	.60
2E32	1.00
2E41	1.50
2H21	49.50
2J22	4.25
2J31	12.25
2J32	9.50
2J34	10.00
2J36	29.50
2J39	25.00
2J48	25.00
2J49	32.50
2J50	32.50
2J51	150.00
2J54	25.00
2J56	40.00
2J61	12.50
2J61A	40.00
2J62	5.00
2J62A	40.00
2K22	13.50
2K23	12.50
2K25	10.00
2K26	35.00

2K28	$30.00
3K33	100.00
2K33A	50.00
2K34	85.00
2K39	100.00
2K41	100.00
2K42	110.00
2K43	110.00
2K44	110.00
2K45	30.00
2K46	175.00
2K47	75.00
2K48	50.00
2K50	125.00
2K54	5.00
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3B22	1.45
3B24	1.00
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3C31	1.00
3C33	6.00
3C45	5.00
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4B32	8.00
4C27	7.25
4C28	19.75
4E27	7.00
4J22	35.00
4J26	45.00
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4J28	50.00
4J29	50.00
4J30	50.00
4J32	45.00
4J34	25.00
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5R4WGA	4.00
5R4WGY	2.50
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5Y3WGTA	3.75
5ZP16	60.00
6AC7A	.80
6AC7W	.80
6AK5W	1.00
6AN5	2.25
6AN5WA	5.00
6AR6	1.35
6AS6W/5725	2.70

6AS7G	$2.50
6AU6WA	2.00
6BF7W	2.50
6BL6	24.50
6C21	15.00
6D4	1.75
6F4	2.25
6J4	1.75
6J4WA	2.00
6J5WGT	3.50
6J6W	.85
6K4	2.00
6L6WGA	3.50
6L6WGB	3.00
6L6Y	2.00
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6SL7W	1.25
6SU7GTY	2.25
6V6GTY	1.00
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D-42	40.00
RK47	3.00
V-50	75.00
V-50XR	75.00
HK-54	2.00
FG-57	8.00
QK-57	Q
QK-59	20.00
QK-60	20.00
RK-60/1641	1.25
QK61	20.00
RK-61	2.50
QK-62	20.00
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1631	1.00
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5644	6.00
5645	5.50
5646	4.00
5647	4.50
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5654	1.35
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5657	100.00
5663	1.20
5665	35.00
5667	125.00
5670	1.00
5670WA	4.25
5672	1.25
5676	.85
5683	5.75
5686	1.75
5687	2.30
5687WA	4.25
5693	4.00
5702	1.50
5702WA	4.25
5703	.90
5703WA	4.00
5704	1.25
5718	1.75
5719A	2.00
RK-5721	125.00
5725/6AS6W	2.75
5725/6AS6W/6187	4.00
5726/6AL5W	.70
5726/6AL5W/6097	3.00
5727/2D21W	1.25
5744	1.00
5749/6BA6W	1.20
5750	2.00
5751	2.00
5755/420A	6.50
5763	1.15
5779	70.00
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5844	1.25
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5853	60.00
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5879	1.25
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5896	3.00
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5902A	5.50
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5906	8.50
5907	8.50
5910	.60
5915	.50
5916	8.50
5932	3.50
5933/807W	1.50
5948/1754	150.00
5956	35.00
5962/BS101	4.50
5964	.80
5965	1.00
5977A	3.00
5981	57.50
5982	149.50
5987	9.50
5992	9.00
5993/TE-10	9.00
6005/6AQ5W	1.70
6019	300.00
6021	3.00
6021-A	4.50
6029/408A	2.00
6037/QK243	49.00
6038	8.50
6044	15.00
6046	.75
CK-6050	2.00
6073	1.50
6080	3.25
6080WA	6.00
6081/ATR407	22.50
6082	3.00
6088	1.50
6095	2.00
6096	1.30
6097	1.50
6099	1.40
6100/6C4WA	2.00
6101/6J6WA	1.75
6106	8.50
6110	5.50
6111	3.90
6112	4.50
6116	80.00
6117	60.00
6130/3C45	5.00
6136	2.50
6147	3.00
6159	3.00
6161	42.50
6169	Q
6177	75.00
6184	9.00
6186/6AG5WA	2.00
6189/12AU7WA	2.50
6199	27.50
6201/12AT7WA	3.00
6203	2.75
6205	4.50
6211	1.00
6263	10.00
6264	10.00
6280/416B	27.50
VA-6310/V260	75.00
6339	20.00
6406/QK428	200.00
6533	10.00
6788	8.50
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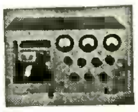
AN/APR-4
38-4000 MC RECEIVER

RDO
NAVY SEARCH RECEIVER



The RDO is a very elaborate radar search receiver greatly improved over the APR-4. The set uses APR-4 tuning units, but is much more versatile, having input metering. D.B. output meter, automatic noise limiter and greater selectivity and sensitivity. The RDO is recommended when only the very best will do. Input 110v 60 cyc.

AN/ASQ-1 AIRBORNE MAGNETOMETER

This is an airborne chart recording magnetometer. The set consists of an amplifier, oscillator, detector head, chart profile recorder, power supply. The equipment has a sensitivity of 2 gamma. The AN/ASQ-1 records on an Esterline angus recorder disturbance in the earth's magnetic field. An Indicator is provided that gives a bearing on a magnetic disturbance. Input is 28v DC. Weight about 130 lbs.

SHORAN
AN/APN-3-AN/CPN-2

The AN/APN-3 and AN-CPN-2 are Precision distance measuring installations. This equipment operates on 225 mc. The range is 250 miles with an accuracy of 25 feet. This equipment is widely used by geological companies for prospecting and mapping. Power Input is 110v 400cyc and 28v DC.

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87-17 124th St., Richmond Hill 18, New York, N. Y.

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AN/GSQ-1 SPEECH SCRAMBLER

This is a unit designed to be attached to either a radio or telephone circuit to scramble speech or code. This equipment utilizes coded cards in each terminal equipment. Unless the properly numbered card is inserted on the receiving end the speech can not be unscrambled. This provides an excellent privacy system. 24 VDC input. Mfg. Western Electric.

AN/TPS-1B
200 MILE AIR SEARCH RADAR

The TPS-1B is a very late type L-band mobile or portable air search radar. This set will detect aircraft up to 200 miles and up to 40,000 ft. The set is composed of small portable carrying cases that are bolted together to make up the set. A 7" P.P.I. and a 5" "A" scope are provided. This set is in use by the Air Force and Marine Corps. Complete sets available. P.O.R.

GROUND INSTRUMENT LANDING SYSTEM

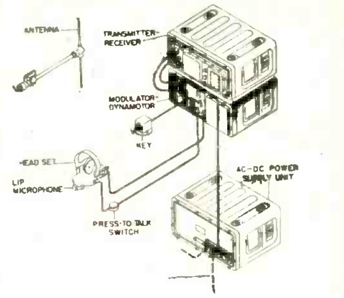
This set consists of a AN/CRN-10 localizer and a AN/CRN-2 glide path ground station. This equipment can be set up at an airport to provide a complete I.L.S. that will operate with the AN/ARN-5 and RC-103 airborne I.L.S. system to provide blind approach facilities. This system can be installed permanently or transported. Each station has complete monitoring facil. Input power is 110V 60 cyc.

AN/TRC-1-3-4
100 MC RADIO-RELAY EQUIPMENT

The AN/TRC series is a mobile portable set for duplex or simplex radio telephone point to point communication. This set will operate with the CF series carrier systems to provide multi channel operation. The TRC operates on 100 MC with an output of 10 50 watts. The set is crystal controlled. Complete sets avail. Input 110v 60 cys.

WILCOX 602A
30-200 MC CRYS. CONT. RECEIVER

The 602A receiver is a fixed freq crystal controlled communication receiver. This rec. can be tuned to any freq. in the range of 30-200 MC by simply changing the crystal and retuning the front end. There are no coils to change. The 30-200 MC range is covered in one band. Sensitivity is 5 microvolts. A squelch and automatic noise limiter is provided. Mounts in a 19" rack panel. Input 110V 60 cyc 60 watts.



MAR
POINT TO POINT RADIO SET

Portable 225-398 mc point to point 10 chan. crystal controlled voice and mew radio set. This is a very late radio set used for point to point and ground to air communication. The transmitter output is 8 watts on 10 pre-set crystal controlled channels instantly selected by a band switch. The RFC is also crys. controlled on the trans. freq. The set is Inclosed in 3 water proof shock proof cabinets that may be set up in a few minutes on location. This equipment is ideal where a reliable radio link easily transported is needed. Power input is either 24 VDC 115/230V AC or DC. Complete sets avail. Write

MISC. EQUIP.

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SCR-291-A 1.5-20 mc direction finder
SCR-399 1.5 mc-18 mc mobile radio
SCR-499 1.5 mc-18 mc field radio
SCR-508-528 28 mc. FM field radio
SCR-608-628 30 mc FM field radio
SCR-505-A field radio
SCR-694 field radio
AN/APA-11 pulse analyzer
AN/APA-17 300-10,000 direction finder
AN/APR-5 1,000-3, 100 mc receiver
AN/ARC-1 100-156 radio set
AN/GRC-9 field radio
AN/TXC-1 page printing facsimile
AN/TRC 7 100-156 mc walkie talkie

Noise and field strength measuring equipment

Test sets TS-1 THRU 800

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10,000Ω Allied plug-in 4pdt #LKHX-86 ...... $6.95
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12 vdc 70 chm 4pdt miniature $1.95

6 vdc 3pdt Clare Herm. sealed $2.95
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74 Cortlandt St., N. Y. 7, N. Y. WOrth 2-5272

Universal RELAY CORP.
THE LARGEST STOCK OF RELAYS IN THE WORLD

C. P. CLARE MERCURY WETTED CONTACT RELAYS

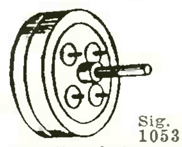
- **LONG LIFE:** Conservative life expectancy of over a billion operations when operated within ratings.
- **HIGH SPEED:** Give consistent performance at speeds up to 60 operations per second.
- **HIGH CURRENT**—and voltage-handling capacity (up to 5 amperes, and up to 500 volts).
- **CHATTER-FREE:** Mercury dampens armature vibration and bridges mechanical chatter between metal contact surfaces.

C P CLARE HGP1010: SPDT, Double Break(1W); 2 coils—1020 and 970 ohms; high pressure; hydrogen sealed; octal plug base. Operates with 15 ma on either coil; magnetic bias for operation between narrow limits; #R1026 .... 10.00*

ALL MERCHANDISE IS GUARANTEED AND MAY BE RETURNED FOR FULL CREDIT

*Prices listed with asterisk (*) are subject to QUANTITY DISCOUNTS

1-9	as quoted	50-99	15%
10-49	10%	over 100	20%



PHASE SHIFT CAPACITORS

W. E. #D150734:

Sig. Corp. Stock #2C 6996-1053A/C2. Variable, air; coupling between 4 plates equal 0.75 to 2.75 mmf; air gap 0.156"; 1⅓" x 2½" dia. overall; shaft ⅝" lg x ¼". For use with BC-1053-A; SCR545A; BC371; SCR-784; Mark 34 and other Radar equipment. W. E. Co. Drawing No's ESO-688147; ESA695412 and 7414822-1 $25.00* ea.

Send for latest Circular.

Universal RELAY CORP.
Formerly Universal General Corp.
42 WHITE ST., NEW YORK 13, N. Y. • WAlker 5-9642

TUBES

ALL TUBES ARE JAN LATE PRODUCTION AND ARE FULLY GUARANTEED. Manufactured by the foremost tube manufacturers in the U. S. A. such as RCA, GE, Sylvania, CBS, etc. Only nationaly advertised brands. Prices quoted below are for quantity purchases. This is only a minimum listing of the thousands of different types of tubes in stock and prices will be quoted immediately upon receipt of your request for quotation.

2 E22	$2.50	5641	3.50	5702WA	4.25	5932/6L6WGA	3.50	6111	4.25
2 E24	2.25	5642	.75	5726/6AL5W	.75	5933/807W	1.50	6130/3C45	4.75
5R4GY JAN	1.10	5644	4.50	5783 WB	4.50	5977	3.00	6136	2.00
6J6W	.50	5647	4.00	5829 WA	3.75	5998/421A	4.50	6189	2.25
6SN7WGT	1.35	5651	1.15	5840A	4.50	6005/6AQ5W/6095	3.50	6201	3.25
6X4W	1.00	5678	.75	5851	3.25			6310	90.00
408A WE	2.25	5691 RCA	4.50	5854	1.50	6021A	4.00	6485	1.25
805	4.00	5693	4.25	5896A	4.50	6038	4.50	9001	.60
5636A JAN	3.50	5696	.90	5899A	4.75	6073	1.75	9002	.50
5639A	4.00	5702	1.65	5915	.70	6099	3.50		

This offer is subject to withdrawal from sale and prices are subject to change without notice. This is a special offering and immediate action is suggested as the above offering is subject to prior sale. Terms: Shipments prepaid in USA when check accompanies order. Open account to well rated D&B firms.

ELECTRONIC TUBE SALES INC.

REFERENCE & PRICE GUIDE FOR INDUSTRIAL TUBES

Cross reference of old and current tube types. Gives approx. distributor cost. Also approx. resale price to ultimate consumer. Full list of cross reference and complete interchange of types of industrial classifications. Send $3.00, book sent postpaid anywhere in U. S. A.

74 Courtlandt St., N. Y. 7,
Barclay 7-5839

CONDENSERS

10 mfd.—600 V $1.19
Pyranol—Brackets Included.

.5 mfd.—600 V . . . . . $.35
Side Term. bathtub. Silicone Ins. Qua. disc.

Mfd	Volts	Price
.001	50KV	24.95
.005	15KV	9.75
.005	25KV	20.95
.005	50KV	29.50
.01	1500	.65
.012	25KV	12.95
.015	16KV	14.50
.02	8000	4.75
.02	10KV	5.25
.02	20KV	10.95
.025	50KV	32.95
.03	7500	4.25
.03	16KV	6.95
.04	17KV	8.95
.05	7500	4.25
.05	100KV	95.00
.05-.05	12KV	9.95
.05-.05	50KV	60.00
.08	12.5KV	8.95
.1	1250	.29
.1	1500	.39
.1	2000	.58
.1	2500	.79
.1	3000	.69
.1	3000	1.19
.1	4000	1.39
.1	5000	3.25
.1	6000	2.25
.1	7500	.95
.1	7500	4.25
.1	12KV	6.95
.1	12.5KV	12.50
.1	15KV	15.95
.1	20KV	19.50
.1 mfd	20KV	7.10
.1	25KV	24.50
.15	2000	.35
.125	27.5KV	27.50
2x.1	2000	.89
2x.1	6000	2.29
.2	10KV	8.50
.2	13KV	10.50
.2	15KV	13.90
.2	50KV	69.50
.25	50KV	69.50
3x.2	4000	2.85
.25	1500	.88
.25	2000	.98
.25	3000	1.45
.25	4000	1.98
.25	6000	.89
.25	15KV	15.95
.25	20KV	19.95
.25	25KV	40.00
.3	2000	.49
2x.25	2000	.98
.4	10KV	10.90
.4	37.5KV	PUR
2x.4	7500	5.25
.5	440VAC	.49
.5	600	.39
.5	1500	.59

Mfd	Volts	Price
.5	2000	1.19
.5	2500	1.29
.5	3000	2.39
.5	4000V	3.20
.5	5000	3.05
.5	7500	5.75
.5	12.5KV	37.50
.5	25KV	39.95
.5	30KV	PUR
.5-.1	2000	.39
2x.5	600	.69
2x.5	9000	9.25
1	115VAC	.32
1	500	.35
1	600	.44
1	1000	.69
1	1500	.99
1	2000	1.85
1	2500	2.20
1	3000	2.95
1	4000	4.95
1	5000	6.25
1	6000	6.50
1	6000	8.95
1	7500	7.50
1	7500	14.75
1	10KV	25 95
1	15KV	32.50
1	25KV	65.00
1	25KV	75.00
1	30KV	PUR
2x1.25	7500	20.00
1.25	330VAC	.49
1.5	15KV	49.50
2	600	.55
2	1000	.79
2	1000TLA	1.29
2	1500	1.15
2	2000	2.80
2	2500	3.45
2	4000	7.50
2	5000	12.50
2	6000	24.50
2	7500	23.25
2	10KV	59.95
2	15KV	65.00
3	1000	.98
3	2000	2.50
3	4000	8.50
3	8000	29.50
4	600	.75
4	600TLA	.95
4	600TLAD	.98
4	1000	1.10
4	1500	2.65
4	2000	3.75
4	3000	6.99
4	4000	17.50
4	5000	24.95
4	7500	59.50

Mfd	Volts	Price
4	10KV	74.50
4	15KV	PUR
5	220AC	1.19
5	330AC	1.39
5	1000	1.89
5	1500	2.45
5	5000	27.50
2x5	400	.89
2x5	600	1.19
6	600	1.69
6	330AC	1.69
6	1000	1.95
6	1500	2.95
6	2000	3.50
6	7500	63.50
7	110AC	.59
7	600	1.35
7	800	1.55
8	600	1.29
8	330VAC	1.50
8	1000	2.15
8	1000	1.39
8	1500	3.65
8	2000	6.95
8	2500	9.50
2x8	600	1.89
4x8	600	3.85
9	10KV	PUR
2x2.5-5	600	1.75
10	400	.65
10	600	.75
10	600	1.50
10	1000	3.75
10	1500	4.25
10	2000	6.75
10	2500	10.95
10	4000	PUR
10	5000	PUR
12	1000	3.50
12	2000	7.75
13.5	10KV	PUR
12	660AC	3.95
14	660AC	4.25
15	440AC	3.85
15	600	2.65
15	1000	4.10
15	1500	6.35
20	330AC	3.25
20	4000	PUR
28	1000	5.95
30	2500	13.50
32	600	3.85
40	600	5.85
59	100	4.10
50	330AC	6.50
60	4000	39.50
80	4000	45.50
100	4000	PUR

PILLAR TYPE MICAS

Mfd	Kv	Price
.00005	3	4.00
.00005	6	9.75
.0001	6	9.95
.0001	10	15.50
.0001	20	35.50
.0001	35	99.50
.00015	6	6.75
.00015	10	9.25
.00015	20	34.50
.00024	6	9.95
.00024	8	9.95
.00025	6	9.95
.00025	10	15.95
.00025	20	34.50
.00025	30	47.50
.0003	10	16.25
.00035	20	34.50
.00039	30	50.25
.0004	6	9.75
.0004	20	35.50
.0004	30	119.50

Mfd	Kv	Price
.00045	35	119.50
.0005	6	9.95
.0005	10	16.95
.0005	20	34.50
.0006	6	9.95
.00075	6	8.95
.0006	30	110.00
.00068	30	65.00
.0008	20	40.00
.001	6	11.95
.001	10	22.50
.001	15	37.50
.001	20	42.50
.001	25	57.50
.0011	35	135.00
.00124	15	37.50
.0013	15	38.50
.002	6	12.50
.002	8	29.95
.002	10	29.95
.002	15	38.50

Mfd	Kv	Price
.002	20	57.50
.002	30	85.00
.0025	25	49.50
.004	5	11.95
.004	6	13.95
.004	8	19.95
.004	20	69.50
.01	4	10.95
.01	10	47.50
.01	15	63.50
.02	3	8.95
.08	1.5	8.95
.09	1.5	8.95
.1	2	39.95
.1	4	69.50
.1-.1	250V	3.95
.115	2000	5.15

Other type transmitting mica condensers available.

TYPE "J" POTS $.65

Ohms
50 L †
100 L †
200 †
500 † *
1000 L †*
1000 † Switch
1500 †
2000 L †
2500 † *
5000 L † *

Ohms
10 000 L † *
15 000 L †
0 000 L †
25 000 L † *
50 000 L † *
75 000 † *
100 000 L † *
150 000 † *
200 000 L †

Ohms
250 000 L † *
500 000 L †
600 000 †
1 Meg L † *
1.5 Meg †
2 Meg L †
2.2 Meg L †
2.5 Meg †
4 Meg †

L = Locking Shaft * = 1/8SD † = 3/8" Shaft Plus

TYPE "JJ" POT $1.50

Ohms
1500 †
15 000 ‡
50 000 ‡
75-750 K ‡

Ohms
100 000 ‡
150 000 ‡
‡

Ohms
500 000 ‡
750-75 K †
1 Meg †
4 Meg †

MONMOUTH
RADIO LABS

Box 159 Capital 2-0121 Oakhurst, N. J.
Art Hankins, Owner

SPECIAL PURPOSE TUBES

OA2	.60
OA2WA	2.50
OA3/VR-75	.90
OA4G	.75
OA5	3.50
OB2	.60
OB2WA	2.50
OB3/VR-90	.80
OC3/VR-105	.50
OC3W	2.50
OD3/VR-150	.50
OD3W	2.50
EL-C1A	6.00
1AD4	.90
1AE4	1.00
1AF4	2.50
1AG5	2.00
1B24	6.50
1B35	3.25
1B35A	7.50
VG-1A/3	3.50
EL-1C	1.25
1B83	7.50
1P21	29.50
1P22	5.00
1P25	25.00
1P28	7.50
1Y2	5.00
2AC15	4.50
2AP1	2.00
2AP1A	4.00
2A515	4.50
2BP1	3.00
2C36	35.00
2C39	5.00
2C39A	10.00
2C39B	29.00
2C40	6.50
2C40A	26.00
2C42	8.00
2C43	8.00
2C44	.25
2C46	5.00
2C50	6.00
2C51	3.25
2C52	2.75
2D21	.75
2D21W	.85
2E22	2.00
2E24	2.00
2E26	3.25
2J51	150.00
2J52	50.00
2J54	25.00
2J59	50.00
2J61	8.50
2J62	3.00
2J64	75.00
2K25	10.00
2K26	32.50
2K28	30.00
2K29	30.00
2K30	75.00
2K33A	50.00
2K34	100.00
2K35	150.00
2K41	85.00
2K45	30.00
2K48	50.00
2V3G	1.00
2X2A	.75
3ABP1	50.00
3AP1	2.00
3AP11A	5.00
3B24	.75
3B24W	4.50
3B24WA	7.50
3B25	3.50
3B26	2.75
3B28	4.00
3B29	5.00
3BP1	2.00
EL-3C	4.00
EL-C3JA	12.50
3C23	3.00
3C24	2.00
3C33	6.00
3C45	5.00
3D22	9.50
3E22	4.00
3E29	10.00
3GP1	2.00
3J21	50.00
3J31	35.00
3JP1	7.50
3JP7	10.00
3JP12	10.00
3KP1	7.50
3X2500A3	150.00
4-65A	15.00

4B31	20.00
4B32	7.50
4C27	7.00
4C33	100.00
4C35	13.00
4D32	23.75
4E27	7.00
4J46	25.00
4J51	50.00
4J52	50.00
4J61	150.00
4PR60A	27.50
4X150A	17.50
4X500F	42.50
5A6	2.00
5AP1	5.00
EL-5B	4.00
5BP1A	7.50
5BP2A	3.00
5C22	20.00
5CP1	2.00
5CP1A	7.50
5CP7A	8.00
5CP12	10.00
5FP14	5.00
5HP1A	7.50
5JP1	7.50
5JP2A	5.00
5JP4	3.50
5JP5A	7.50
5JP11A	7.50
5LP1	12.50
5LP2A	7.50
5R4GY	1.25
5R4WGY	2.50
5RP1A	17.50
5RP11A	75.00
5SP1	40.00
5SP7	40.00
5UP7	12.50
5X3	2.00
5XP1	50.00
5XP11	50.00
EL-C6J	10.00
EL-C6L	5.00
6AC7W	.75
WE-6AK5	1.25
6AK5W	1.25
6AL5W	.75
6AN5	2.25
6AQ5W	2.25
6AR6	1.35
6AR6WA	6.00
6AS6	1.25
6AS6W	2.00
6AS7G	2.50
6AU6WA	2.25
6BA6W	1.25
6BE6W	2.50
6BL6	22.50
6C4W	4.00
6C21	14.00
6F4	2.25
6J4	1.25
6J4WA	2.00
6J6W	.85
6K4	2.00
6K4A	2.50
6L4	2.50
6L6WGA	3.25
6L6WGB	3.50
6Q5G	2.25
6S7JWGT	2.00
6SK7W	.85
6SK7WA	2.00
6SL7WGT	1.25
6SN7WGT	1.00
6SU7GTY	2.00
6X4WA	2.00
6X5WGT	1.00
7F8W	1.50
7MP7	15.00
9JP1	15.00
VX-10	4.00
12AT7WA	2.85
12AU7WA	2.85
12DP7A	25.00
FG-17	4.00
HK-24	2.00
HK-24G	2.00
26A7GT	3.00
26C6	1.10
26D6	1.50
26E6WG	2.25
26Z5W	3.00
FG-27A	15.00
FG-32	5.50
FG-33	15.00
VX-33A	5.00
35T	2.75

35TG	2.50
VX-41	5.00
FP-54	50.00
HK-54	2.00
VX-55	6.00
FG-57	7.50
RK-65/5D23	6.50
FG-67	7.50
HY-69	2.00
FG-81A	8.50
FG-95	14.00
100TH	5.00
WE-121A	1.50
WE-122A	1.50
WE-123A	2.50
WE-124A	3.50
VT-127A	2.00
FG-172	15.00
FG-190	10.00
CE-203	5.00
203A	2.50
CE-235A	5.00
FG-235A	55.00
WE-242C	10.00
QK-243	40.00
WE-244A	5.00
WE-245A	6.00
WE-249B	3.00
WE-249C	2.50
250R	4.00
WE-251A	42.50
WE-252A	7.50
WE-253A	2.00
WE-254A	2.25
WE-257A	10.00
FG-258A	75.00
WE-259A	10.00
WE-262B	5.00
FP-265	18.50
WE-267B	3.50
WE-268A	5.00
WE-271A	5.00
WE-272A	6.00
WE-274B	.75
WE-275A	3.50
WE-276A	10.00
WE-279A	150.00
WE-282A	2.00
WE-282B	3.75
WE-283A	3.25
WE-285A	4.50
WE-286A	3.25
WE-287A	3.00
WE-293A	8.00
WE-300B	5.00
304TH	10.00
304TL	10.00
WE-310A	3.50
WE-311A	3.50
WE-313C	2.50
WE-316A	.50
WE-323A	7.50
WE-323B	5.00
WE-328A	3.50
WE-336A	3.50
WE-338A	3.50
WE-339A	9.50
WE-347A	2.50
WE-348A	4.50
WE-350A	2.50
WE-350B	2.00
WE-352	15.00
WE-354A	8.50
WE-355A	8.50
WE-388A	1.25
WE-393A	3.50
394A	2.50
WE-396A	3.25
WE-403A	1.35
WE-403B	2.75
WE-404A	12.00
WE-407A	3.50
WE-408A	2.00
WE-409A	4.25
WE-417A	12.00
WE-418A	15.00
WE-420A	6.50
WE-421A	4.75
WE-429A	8.00
446A	.50
446B	1.00
450TH	38.50
450TL	38.50
464A	1.75
GL-575A	10.00
631-P1	5.00
WE-701A	1.75
707B	2.00
715C	10.00
719A	10.00

721A	.50
721B	7.50
723A/B	7.00
WE-725A	2.50
726A	4.00
726B	9.50
726C	7.50
750TL	30.00
802	2.50
804	7.00
805	3.50
807	1.10
807W	1.25
807 A	5.00
809	2.25
810	10.00
811	3.25
812	2.50
813	10.00
814	1.25
815	1.35
816	1.35
826	.75
828	8.00
829B	8.50
832A	4.85
835	2.50
836	1.20
837	1.25
845	2.75
850	7.50
866A	1.25
866JR	1.35
868/PJ-23	1.50
869B	50.00
872A	1.00
874	.75
884	.95
885	.65
913	17.50
917	1.40
918	1.50
920	2.00
922	1.75
923	1.25
927	1.00
929	1.00
931A	4.00
959	1.15
CK-1006	2.25
1237	5.50
HY-1269	3.00
1274	2.50
1614	1.50
1619	.50
1620	3.75
1624	1.25
1846	50.00
2050	1.00
2050W	3.00
ZB-3200	75.00
5528	5.00
5550	30.00
5552	55.00
5553	75.00
5556	10.00
5557	4.00
5558	5.50
5559	7.50
5560	14.00
5584	3.00
5591	2.75
5610	1.00
5633	5.00
5634	5.00
5635	5.00
5636	2.50
5636A	3.00
5637	3.50
5638	3.00
5639	5.00
5639A	6.00
5640	5.00
5641	4.50
5642	.90
5643	4.00
5644	5.75
5645	5.00
5646	3.00
5647	4.00
5650	50.00
5651	1.25
5651WA	3.00
5654	1.25
5556	4.00
5663	.95
5667	100.00
5670	2.00
5672	1.00
5675	6.85

5676	.75
5678	.75
5685	10.00
5686	1.75
5687	2.35
5687WA	4.00
5691	4.25
5692	4.50
5693	3.75
5696	1.00
5702	1.40
5703	.85
5704	1.15
5719	1.35
5720	15.00
5725	2.00
5726	.75
5727	1.25
5728	7.50
5734	12.00
5740	50.00
5749	1.15
5750	2.25
5751	2.00
5755	6.50
5763	1.00
5771	250.00
5783WB	5.00
5784	4.50
5787WA	6.00
5796	10.00
5798	15.00
5801	5.00
5803	5.00
5814	.75
5814A	1.50
5814WA	3.00
5819	25.00
5827	4.00
5828	6.00
5829	.85
5830	85.00
5836	93.00
5840	3.00
5842	12.00
5847	12.00
5654	1.00
5876	6.50
5881	3.00
5886	2.75
5894	15.00
5899	3.50
5902	4.00
5915	.50
5932	3.25
5933	1.25
5933WA	5.00
5948/1754	150.00
5962	4.00
5963	1.25
5964	1.00
5975	3.00
5977	2.50
5979	7.50
5980	6.50
5981/5650	50.00
5998	4.75
6005	2.25
6021	3.75
6021A	4.50
6028	2.00
6037	50.00
6038	7.50
6073	1.25
6080	4.00
6087	4.00
6098	6.00
6100	2.00
6130	5.00
6134	3.50
6136	2.25
6137	2.00
6146	4.40
6189	2.85
6199	30.00
6201	2.85
6236	185.00
6263	10.00
6264	10.00
6322	8.50
6328	4.85
6655	35.00
8005	4.50
8012A	3.50
8013A	4.50
8020	1.00
9001	.85
9002	.50
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9005	2.00

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How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment and/or components wanted on the coupon below, or on your own company letterhead to:

Searchlight Equipment Spotting Service
c/o ELECTRONICS,
330 W. 42nd St.
N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

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NAME .... TITLE ....

COMPANY ....

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AN/GPM-14
LAE-1, -4
TS-10C
TS-13, -15, -16
TS-19
TS-24
TS-28
TS-32, -33, -34, -35
TS-35, -39, -45
TS-47, -56, -59
TS-62, -67, -74
TS-89, -92
TS-110, -111
UHF Micro-Volter Model 10
TS-125, -143
TS-182, -184
TS-204, -218
TS-234, -235
TS-251, -261, -277
TS-268, -294C
TS-488
TSX-4SE
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I-122, -166
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IE-19
IE-35, -36

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APA, -6, -10, -11
APS-4, -6, -15
SCR-717, -720
SL APQ-13
APT-5A ART-26

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ART-13	BC-344
BC-191	BC-348
BC-222	BC-375
BC-224	CRT-3
BC-312	TCS-12
BC-314	

AIRCRAFT ELECTRONICS

ARC-1	ARC-27
ARC-3	MN-62
ARC-4	MN-55
ARC-5	LP-21
ARC-12	LP-31
ARN-6	AS313-B
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SCR 718C

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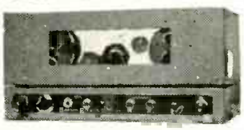
PIONEER 12142-1A
PIONEER 12143-1A, -2A
PIONEER 12132-1A, -2A
Pioneer 12117
Pioneer 12123
Pioneer 12133
DY-11, -12, -17
PE-206 5D21NJ3A



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3E29	8.25	1625	.30
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4-400A	44.00	251A	45.00
4-1000A	150.00	267B	4.95
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6C21	15.00	300B	5.00
15E	1.20	305A	2.75
24G	2.00	310A	3.50
HK24	2.00	311B	3.75
53A	5.00	313C	1.75
HY65	1.40	316A	.40
100TH	5.00	327A	3.50
VT127	1.50	328B	5.00
VT-127A	2.50	331A	7.50
F-128A	7.25	337A	4.75
VT-158	9.50	348A	4.75
211	.40	349A	5.00
227A	3.75	354AWE	19.00
250TH	21.00	356B	3.25
250TL	12.00	359A	1.50
450TH	40.00	371A	1.00
471A	4.00	372A	2.10
575A	12.00	374A	3.25
HK#654	15.00	381A	5.00
750TL	30.00	**FORCED AIR COOLED**	
801A	.35	3X2500A3	150.00
803	2.50	3X2500F3	150.00
813	8.50	4X150A	18.50
814	2.00	4X150D	20.00
815	1.25	4X150G	28.50
828	8.00	4X250B	38.00
829	3.50	5680	130.00
829B	8.00	5736	110.00
830B	.45	**WATER COOLED**	
832A	5.75	F129B	145.00
838	.70	220B	55.00
838W	4.00	508	190.00
843	.35	858	140.00
845	3.00	880	200.00
852	4.00		
864	.25		
1611	1.00		
1613	.90		

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54RWGY	$2.75	6J4WA	$2.25
5Y3WGT	1.40	6J6W	.90
6AC7W	1.00	6J6WA	1.50
6AK5W	1.20	6SK7W	.90
6AL5W	.70	6SN7WGT	1.50
6AS6		6X4W	1.35
6BF7W	2.40	7F8W	3.75
6C4W	3.75	12AT7WA	3.00
		12SX7	1.25
		5915	.50

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1AD4	6BA7	6L6Y	6V6Y
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1C6	6CL6	6SJ7	6Y6G
1G4GT/G	6F6	6SK7	7A8
2A3	6J4	6SK7GT	7C7
6AB7	6J5	6SK7GTY	7F8
6AC7	6K8GT	6SK7Y	12A6
6AG7	6L6	6SL7GT	12AH7GT
6AK6	6L6GA	6SN7GT	12AT7
6AT6			

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C1K	$7.50	FG-271	$22.00
1C	1.00	393A	3.35
2D21	.70	KU-627	7.00
2D21W	.90	677	30.00
3C45	5.75	715C	10.00
4B25	7.50	885	.75
C5B	.75	2050	1.00
EL5B	5.00	2050W	3.50
5C22	25.00	2051	.65
66M/5528	7.00	5559/FG57	9.00
FG-32	4.00	5560/FG95	16.00
FG105	11.00	5948/1754	250.00
5G154	9.00	5956/E36	33.50
VT-158	9.00	6130	4.00
FG172	15.00		

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2J21A	$4.75	4J33	$100.00
2J22	4.50	4J34	35.00
2J26	4.50	4J50	90.00
2J27	4.50	4J51	75.00
2J31	32.50	4J58	90.00
2J32	9.50	4J61	145.00
2J33	28.50	4J64	45.00
2J34	13.00	5J23	75.00
2J37	28.50	QK60	19.50
2J38	28.50	QK62	19.59
2J49	32.50	QK284	95.00
2J50	32.50	706AY-GY	14.00
2J55	45.00	706CY	15.00
2J56	45.00	714A	9.50
2J61	9.95	714AY	50.00
2J62	5.50	725A	2.75
4J21	100.00	5586	105.00
4J31	125.00	5657	105.00
4J42	25.00	5780	175.00
4J26	45.00	6177	85.00

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5517	$1.00	5719	$1.50	5977	$3.00
5588	75.00	5719A	2.75	5977A	3.00
5610	1.00	5722	3.25	5995	9.75
5633	5.75	5725	2.00	5992	12.00
5635	6.00	5726	.70	5993	9.00
5636	2.85	5726/6097/6AL5W	3.00	5995	4.60
5637	3.75	5744	1.00	6005	1.75
5639	5.75	5744WA	5.50	6021	3.85
5640	5.85	5749	1.20	6045	2.95
5641	4.75	5750	2.25	6073	1.50
5642	1.00	5751	2.00	6080	4.75
5643	4.50	5751WA	3.50	6080WA	6.50
5644	6.25	5763	1.10	6087	4.00
5645	5.75	5783	4.25	6096	1.30
5646	4.50	5784	4.75	6098CT	1.90
5647	4.50	5784WA	7.00	6099	1.40
5651	1.40	5787	4.50	6100	2.00
5651WA	3.25	5787WA	5.50	6101	2.00
5654	1.00	5794	5.00	6106	8.50
5654/6AK5W/6096	2.95	5814	.50	6110	5.50
5658	6.75	5814A	1.50	6111	3.95
5663	1.20	5814WA	3.00	6112	4.50
5670	1.00	5829	1.00	6147	3.00
5670WA	4.25	5829WA	6.50	6152	6.00
5672	1.25	5840	3.50	6159	3.00
5677	5.00	5840A	4.75	6161	45.00
5678	1.00	5844	1.40	6201/12AT7WA	3.50
5686	1.70	5845	5.00	6211	1.50
5687	2.40	5851	3.50	6263	11.50
5687WA	4.75	5854	1.30	6279/5C22	27.00
5691	4.75	5876	7.00	6280/416B	35.00
5692	5.00	5886	1.75	6386	5.00
5693	4.25	5896	3.00	7193	.20
5696	1.00	5898	7.50	8012	1.00
5702	1.50	5899	4.00	8025A	1.75
5702WA	5.85	5899A	5.75	9001	.75
5703WA	4.00	5902	4.00	9002	.50
5704	1.50	5931/5U4WG	4.75	9003	1.00
5718	1.75	5932	3.50	9004	.75
5718A	4.00	5933	1.50	9005	2.25
		5967	10.00	9006	.20
		5969	10.00		

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OB2	$ .60	5R4GY	$1.25	314A	$80.00
OB3	.75	5R4WGY	2.75	371A	1.00
OC3	.60	5Y3WGT	1.50	371B	2.50
OD3	.55	5X3	2.20	515A RCA	13.50
SB	2.00	6-4	1.00	575A	12.50
SC	1.95	6-7	1.00	705A	.65
1V	.90	6-11	1.00	816	1.40
2C53	12.50	7H4B	1.00	836	1.20
2X2	.25	15R	.30	866A	1.20
2X2A	1.00	RX21	5.00	869B	32.50
3B24	1.35	100R/8020	1.75	872A	1.15
3B24W	4.75	249B	3.00	876	.75
3B28	4.00	249C	3.00	878	.50
3B29	5.95	250R	4.95	5931/5U4WG	4.00
		267B	4.95	8013	3.00

SCOPE TUBES

2AP1	$2.75	3EP1	$1.25	5JP1A	$25.00
2BP1	5.95	5BP1A	8.50	5NP1	2.00
3AP1	2.75	5BP4	2.25	7BP1A	15.00
3CP1	1.75	5CP1	1.75	7CP1	4.99
3DP1S2	4.75	5CP1A	7.00	9LP7	10.00
3FP7	2.50	5CP11	7.00	12DP7	12.00
3GP1	2.00	5CP11A	8.50	51UCP11	25.00
3JP1	7.50	5FP7A	2.50	902P1	2.25
3W2P1	50.00	5JP1	8.75		

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SRX16	100.00	3K30	95.00	726B	14.00
2K25	12.00	6BL6	24.00	726C	13.00
2K28	24.00	6BM6	29.50	5611	40.00
2K43	100.00	6BM6A	32.50	5721	135.00
2K45	32.50	V45	P.O.R.	5981/5650	60.00
2K48	50.00	V50	80.00	6116	90.00
2K54	14.00	V82	P.O.R.	6236	160.00
		723A/B	7.00		

LIGHTHOUSE TUBES

2C39A	$10.00	3C22	$60.00	464A	$1.90
2C40	7.00	4C27	7.00	559	.40
2C42	8.75	446A	.50	8011	1.00
2C43	7.75	446B	1.24	8014A	60.00
2C46	5.00				

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1B24	$5.50	1B47	$7.00	532A	$ .25
1B24A	12.50	1B63A	18.50	709A	.50
1B35	3.50	1B58	45.00	724B	.65
1B35A	8.00	1Q22	40.00	6232	17.00
1B37	7.00	1Q23	50.00		
1B40	2.00	GA4	4.00		

DIODES

1N21	$ .45	1N25	$2.15	1N38A	$ .65
1N21C	2.00	1N32	8.75	1N44	.90
1N23B	.80	1N34A	.45	CK705	.60
1N23C	2.25	1N38	.50	6006	P.O.R.

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2G21	$2.00	6AN5WA	$4.75	6211	$1.10
6AN5	2.75	5965	1.20		

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1F	37.50	5SG	29.50
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3D	62.50	6DG	27.50
3HCT	62.50	6HG	42.50
5B	22.50	7G	42.50
5CT	34.50	7DG	47.50
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GR 620A Het. Freq. Meter	*345.00
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GR 727A VTVM (Battery Oper.)	*105.00
GR 814-P2 Filter	*15.00
GR 830A Low Pass Filter	*20.00
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GR 1176A Freq. Meter 25–60,000 cy.	*170.00
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Boonton 152A FM Signal Gen. 20–28 MC & 1–5 MC w/150R Pwr Supply	*185.00
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AN/UPM-2 Wavemeter 80–1220 Mc Accur. 1 MC	*97.50
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BC-221 Frequency Meter 125 KC-20,000 KC-Accur. .05%	*115.00
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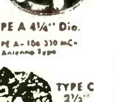
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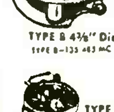
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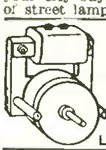

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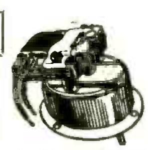

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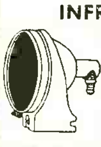

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5.18	620	3100	16800	80K	525K
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20.	655	3384	18380	90K	650K
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31.5	675	3700	19K	97K	660K
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51.78	689	3900	20K	110K	690K
55	697	4000	20441	115K	750K
63	700	4200	21K	116667	761300
74	711	4280	21500	120K	800K
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180	1056	5730	26500	190K	1.39M
182	1067	6000	27K	198K	1.4M
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310	1578	8000	38500	275K	3.673M
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320	1646	8200	39500	300K	3.9M
325	1670	8500	40K	307500	4M
330	1740	8700	43K	311K	4.23M
350	1770	9000	45K	314K	4.5M
360	1800	9100	47K	325K	4.7M
375	1818	9445	47500	330K	5M
380	1830	9500	48660	333K	5.5M
389	1900	9800	49K	333500	5.6M
390	1925	9900	50K	346K	6M
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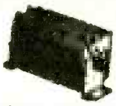

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4	3.90	7.50	11.70	16.15	27.75	49.80	31.15	69.75	84.15
6	4.50	8.85	12.90	19.30	32.85	63.90	48.45	81.90	99.90
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AC-Rectifier Transformer (Only)

All Primaries 115 & 230VAC/60cy/1Φ Input
Secondary 0-125, 150, 160, 165,* Nema Specs
TR4009* @ 5 Amp Continuous Duty $50
TR4010* @ 10 Amp Continuous Duty $72
Secondary 0-250, 300, 320, 330, Nema Specs
TR4011† @ 5 Amp Continuous Duty $65
TR4012† @ 10 Amp Continuous Duty $105
◆ Selenium F.W. Bridge Extra!

NEW "REGOVAC"® 450VDC Pckg

Regulated 250†*450VDC @ 200ma*; REGULATION 1% MIN TO MAX CURRENT RIPPLE LESS THAN 5MV. IMPED 2 OHMS AND ALSO NON REGULATED 125VDC @ 100MA. 6.3V/12A. COMPLETE CONTROLS FRONT PANEL SWITCHES PILOT LIGHT BINDING POSTS, FUSES, 4" VOLT AND MILLIAMETER (2% ACCY) RACK 8-3/4 H13D19"W or CABINET.

R200R BACK MOUNTING $135
R200C CABINET $150

"TEKAP" & 1Φ/400 cys/115v/1500 watt Regulated Power Supply Pckg Operates 115 or 230v/60 cy/1Φ input 28VDC @ 100 amps Filtered to inbuilt Regulated Inverter .90 Pf Carbon Pile Voltage Regulator. Freq Adj & Radio Noise Filter All in one Cabinet.
T41500B Basic Non-Metered Supply $650
T41500M DC & AC & Freq Metered $738

NEW DC "TEKPAK"® POWER SUPPLY T60V1ACC

HI POWER AT TRANSISTOR VOLTAGES 0to60V @ 1Amp. EQUAL TO NEW BATTERY PERFORMANCE WITH ADDED HI POWER RESERVE TO 1000 MA. NON-ERRATIC AT HI & LOW VOLTAGES. PURE DC. TWO SECTION CHOKE INPUT FILTER; RIPPLE LESS THAN 0.1%. FRONT PANEL CONTROLLED; MULTIRANGE 4" 2% ACCY VOLT & MILLIAMMETER

T60V1ACC $100.00

"TEKAP"® 3Φ/400cys/115v/750 watt & 26 v @ 250 watt with voltage adjustment. Operates 115 & 230 v/60 cy/1Φ input 28 VDC @ 60 amps Filtered to inbuilt Inverter V/adj & Freq/adj & Radio Noise Filter All in One Cabinet
T4750B Basic Non-Metered $475
T4750M DC & AC & Freq Metered $563

HI-MEG HI-VOLT NEW RESISTORS

.2 Meg/10w/10KV .... .90 @ ; 12/ $9
.75 Meg/10w/15KV MVP .... .90 @ ; 12/ $9
.8 Meg/10w/10KV .... .90 @ ; 12/ $9
2 Meg/4w/5KV "MVG" .... $1 @ ; 12/$10
2.5 Meg/5w/7.5KV MVT .... $1 @ ; 12/$10
2.5 Meg/20w/25 KV MVA .... $1.50 @ ; 12/$16
5 Meg/10w/15KV "MVP" .... $1.50 @ ; 12/$16
6 Meg/10w/15KV "MVP" .... $1.50 @ ; 12/$16
7 Meg/10w/15KV "MVP" .... $1.50 @ ; 12/$16
10 Meg/4w/5KV "MVG" .... $1.50 @ ; 12/$16
10 Meg/10w/15KV "MVP" .... $2 @ ; 12/$20
12 Meg/10w/10KV .... $1.50 @ ; 12/$16
20 Meg/30w/50KV "MVO" .... $2 @ ; 12/$20
25 Meg/25w/40KV "MVE" .... $2.50 @ ; 12/$25
100 Meg/10w/15KV MVP .... $3.50 @ ; 12/$36

MALLORY Inductuner

3 Gang UHF TV & HAM Continuous tuner Low-loss HiQ for RCVR or XMTTR & Experimenter. Cost $18 SPECIAL .79 @, 5 for $3
MILLEN ImuSeed Delay 3t/line .... $2@,3/$5
ESC #2200/0.4 uw Seed Delay 3t/line ... $2@,3/$5
CTC ImuSeed Delay 4term line .... $2@,3/$5
5 Microseed Delay Line .... $2@,3/$5

TEKAP-TABPAK® High Current Power Supplies

One Year Guarantee Variable 0-28 VDC. Completely built. Ready to go. Full Wave selenium Rectifier, Transformer Variac Pilot Light 4" Volt & Amp Meters. Switch. Terminals & Fuse. Hvy Duty Steel Cabinet Std 115V/60 Input or 220V† (3 phase) to order.

Stock Number	Continuous Rating	With Meters
T28V5A*	0-28 WVDC at 5 Amp	$57
T28V5ACC	5 Amp (1% Ripple)	84
T23VA2CC	5 Amp 0.01% Ripple	155
T28V12A	0-28 VDC at 12 Amp	138
T28V12ACC	12 Amp (1% Ripple)	168
T28V12A2CC	12 Amp 0.1% Ripple	250
T28V24A†	0-28 VDC at 24 Amp	175
T28V24ACC†	24 Amp 1% Ripple	250
T28V24A2CC†	24 Amp 0.01% Ripple	345
T28V50A†	0-28 VDC at 50 Amp	325
T28V50ACC†	50 Amp (1% Ripple)	450
T28V100A†	0-28 VDC at 100 Amp	550
T28V100ACC†	100 Amp (1% Ripple)	750
T35V16ACC	0-35V @ 16 Amp/.5% Ripple	210
T35V25ACC	0-35V @ 25 Amp (.1% Ripple)	370
T35V50ACC	0-35V @ 50 Amp (.1% Ripple)	639

Variable 0-130 VDC Completely built. Ready to go. Includes F. W. Selenium Bridge Rectifier 4" Rectangular Volt & Ammeter. Specify for 115 or 230VAC 1 phase 60 cyc input

T130V5AC	0-130 VDC at 5 Amp	$225
T130V5ACC	5 Amp (1% Ripple)	275
T130V10AC	0-130 VDC at 10 Amp	275
T130V10ACC	10 Amp 1% Ripple	369

*2" Meters: All others 4" Meters 2% Acy.

New Variable 0 to 6 & 12 Volt 12 Amp DC Power Supply

Battery Eliminator, Charger, Model RR, Plater, Aircraft, Marine or any DC Reg. Extra Hvy Duty Selenium Rectifier, 2 Meters V. & A. Dsgnd for Cont. Service and up to 20 Amp. Intermittent overload. New Model T612V12AC Special $33.00

New! Low Priced High Current Basic Supplies

Consisting of Transformer & Full Wave Bridge Rectifier mtd and wired, fused, outlet, pilot light & ventilated grill & chassis or cabinet. Ready to deliver constant DC Power. 1 yr. Gtd.

Stock Number	Continuous Rating	Basic
B28V/5A	0-28 WVDC at 5 Amp	$45
B28V/5ACC	5 Amp (1% Ripple)	69
B28V/12A	0-28 VDC at 12 Amp	90
B28V/12ACC	12 Amp (1% Ripple)	135
B28V/24A	0-28 VDC at 24 Amp	139
B28V/24ACC	24 Amp (1% Ripple)	189
B28V/50A	0-28 VDC at 50 Amp	225
B28V/50ACC	50 Amp (1% Ripple)	350
B28V/100A	0-28 VDC at 100 Amp	439
B28V/100ACC	100 Amp (1% Ripple)	600

INDUSTRIAL DC SUPPLIES

B100V1A	100 VDC @ 1 Amp	$39
B115V1.5A	115 VDC @ 1.5 Amp	52
B115V5A*	115 VDC @ 5 Amp	120
B220V5A*	220 VDC @ 5 Amp	234
B115V5ACC*	115 VDC @ 5 Amp/1% Rip	169
B220V5ACC*	220 VDC @ 5 Amp/1% Rip	333
B115V10ACC*	115 VDC @ 10 Amp/1% Rip	275
B220V10ACC*	220 VDC @ 10 Amp/1% Rip	468

* 115 & 230 VAC/60cy/1Φ Input

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Boxed and Lead Jacketed
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1N21C each $5 @, 2 for $8
1N23B each 89c @. Ten for $5
1N21 @ 20c, 1N22 @ $1, 1N21B @ $2
1N25 @ $4, 1N26 @ $5, 1M32 @ $12
MA408 Spel $3 @, Two for $5

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"TAB" TESTED **INSPECTED** GUARANTEED!!!

We Stock All Types of Tubes & Diodes From All Mfgrs!

OA2 $ .80	2A4 $1.00	2K42 $125.00	4-125 $32.00	6AG7 $0.97	6C4 $0.49	6X4 $ .39	25Z5 $ .72	250H $19.45	548 $2.00
OA3 .90	2C22 5/1.00	2K43 125.00	4E27 7.50	6AH4 .89	6C5 .69	6X5 .49	25Z6 .75	250L 19.45	571 1.49
OA4 1.45	2C26 5/1.00	2K44 125.00	4E27A 10.00	6AH6 .99	6C6 1.08	6Y6 .89	26A7 3.69	252A 14.35	725A 2.50
OB2 .72	2C33 .85	2K45 34.00	4J22 98.00	6AJ5 1.00	6C8 1.08	7C29 69.00	FG27 8.28	H254 9.35	726B 18.00
OB3 .82	2C39A 11.00	2K47 110.00	4J31 60.00	6AK5 .69	6C21 14.00	10Y 1.00	28D7 .89	254A 2.35	726C 12.00
OC3 .84	2C40 6.00	2K48 55.00	4J50 95.00	6AK6 .69	6CA7 3.49	12AT6 .59	FG33 15.00	257B 7.40	801A 4/1.00
OD3 .80	2C43 7.00	2K50 169.00	4J51 215.00	6AL5 .59	6CB6 .80	12A6 .49	GZ34 1.54	259A 21.75	805 5.00
OZ4 .50	2C44 .25	2K55 15.00	4J52 43.00	6AL7 1.29	6CD6 1.49	12AT6 .59	EL34 3.49	274A 4.75	807 1.19
C1A 10.50	2C51 2.00	2K56 60.00	4PR60 39.00	6AN5 3.39	6D4 2.39	12AT7 .89	35T 4.49	275A 3.40	808 .85
C1B 2.88	2C52 2.00	2V3 .65	4-65 15.00	6AN8 1.00	6D6 .99	12AU6 .63	35Z5 .57	276A 19.75	809 2.40
1A3 .84	2C53 9.50	2X2 3/1.00	4-125 32.00	6AQ5 .79	6D8 .99	12AU7 .69	EL37 2.49	300B 4.90	810 9.40
1A4 .79	2D21 .68	3A4 .50	4X150 19.00	6AQ6 .56	6E5 .79	12AX7 .79	TZ40 2.00	H300 19.45	811 2.50
1A5 .74	2D29 3.00	3A5 .50	4-250 36.00	6AR5 .99	6F4 2.49	12AY7 1.29	50L6 .69	303A 8.45	812 3.30
1A7 .96	2E5 .90	3B4 .66	4X250 40.00	6AR6 1.95	6F5 .63	12BA6 .65	HK54 3.85	304H 12.50	813 8.00
1AD4 1.12	2E22 2.00	3B7 2.00	4X500 45.00	6AS5 .99	6F6 .99	12BA7 .99	T55 9.00	304L 16.50	814 2.35
1AE4 .96	2E24 2.25	3B22 1.25	4-1000 70.00	6AS6 1.49	6F7 .99	12B4 .95	RK60 1.17	310B 8.50	815 1.85
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1AH4 1.14	2E26 3.00	3B24 1.50	5B 4.00	6AT6 .49	6H6 .59	12BE6 .59	HY65 2.90	316A 4/1.00	827R 100.00
1AX2 1.02	2E27 .70	3B24W 4.00	5C22 25.00	6AU4 1.29	6J 18.00	12BF6 .59	KT66 3.45	322A 57.50	829B 8.00
1B3 .78	2E30 2.00	3B27 3.00	5D21 5.00	6AU6 .59	6J4 1.72	12BH7 .99	75T 15.50	323B 13.25	832A 6.00
1B21 3.78	2E31 2.00	3B28 3.50	5D23 7.00	6AV6 .59	6J5 .59	12BY7 1.00	80 .59	339A 9.85	836 1.20
1B22A 5.00	2E32 1.22	3C22 57.00	5J29 4.00	6AX4 .79	6J6 .59	12BZ7 1.00	EM81 2.39	349A 4.95	837 1.35
1B23 5.00	2E35 2.00	3C23 3.95	5J33 5.00	6AX6 .99	6J7 .99	12CU6 1.45	EC81 1.25	350A 2.45	845 3.50
1B24 5.00	2E36 2.00	3C24 1.72	5R4 1.25	6B4G 1.39	6J8 1.39	12H6 .75	EZ81 1.05	350B 1.75	866A 1.20
1B26 1.00	2E43 1.64	3C31 1.00	5R4W 3.50	6B5 .99	6K4 2.15	12J7 .69	EC82 1.05	351A 12.75	872A .95
1B27 9.00	2G21 2.26	3C33 6.00	5T4 1.35	6B6 .89	6K6 .59	12K8 .89	83 .95	357B 43.50	884 1.15
1B29 2.42	2J21A 4.00	3C34 6.00	5U4 .59	6B7 1.29	6K7 .79	12L6 .79	83V .89	368AS 4.59	889A 75.00
1B35 3.00	2J22 3.70	3C37 19.00	5V4 1.25	6B8 1.35	6K8 .99	12SA7 .69	EC83 1.19	387A 3.95	891R 170.00
1B37 12.00	2J26 9.29	3C39 80.00	5W4 .99	6BA5 .99	6L6 1.19	12SG7 .89	EF86 1.29	394A 3.45	892 237.00
1B38 41.00	2J27 4.00	3C45 7.00	5Y3 .59	6BA6 .59	6L6Y 1.49	12SH7 .89	EB91 .81	434A 2.00	931A 4.00
1B41 48.00	2J31 9.00	3D6 .48	5Y4 .59	6BA7 .99	6L7 .09	12SJ7 .75	EC90 1.26	450H 44.00	954 10/1.00
1B42 4.00	2J32 9.00	3D21A 3.00	5Z3 .79	6BC5 .69	6N7 .99	12SK7 .75	EF94 .96	450L 44.00	955 3/1.00
1B46 1.88	2J33 19.00	3D23 5.00	5Z4 1.12	6BC7 1.10	6R7 .99	12SL7 .79	EK90 .99	460 11.50	957 3/1.00
1B53 25.00	2J34 14.00	3E29 8.00	6A 18.00	6BD4 7.00	6R8 1.59	12SN7 .69	EZ90 .79	473 165.00	991 5/1.00
1B63 19.00	2J36 24.00	3J31 35.00	6J 18.00	6BD5 1.69	6S4 .59	12SQ7 .69	EB91 .81	502X 1.50	1850A 36.00
1C 1.39	2J37 9.00	3K23 160.00	6A5 3.00	6BD6 .69	6SA7 .69	12SR7 .69	FG95 16.00	503X 1.00	2050 1.25
1D21 4.70	2J38 24.00	3K27 150.00	6A7 1.00	6BE6 .59	6SB7 1.19	12V6 .79	FG98 14.75	512X 2.00	5654 1.20
1Q5 .86	2J39 50.00	3K30 200.00	6A8 1.00	6BF5 1.08	6SC7 .89	12X4 .55	100H 6.39	522X 2.00	5691 4.70
1R4 .75	2J48 9.00	3Q4 .68	6AB4 .59	6BF6 .69	6SF5 .69	15E 1.19	100L 11.29	525X 2.00	5692 5.00
1R5 .78	2J50 49.00	3Q5 .86	6AB7 1.29	6BG6 1.49	6SG7 .79	FG17 3.49	G104 29.00	531X 2.00	5693 5.00
1S4 .78	2J55 50.00	3S4 .68	6AC5 1.00	6BH6 .79	6SH7 .69	19BG6 2.15	G105 11.00	532X 2.00	5BP1 1.50
1S5 .68	2J56 35.00	3V4 1.00	6AC7 .79	6BJ6 .72	6SJ7 .69	19T8 1.16	117L7 2.39	533X 2.00	5BP4 3.50
1T4 .78	2K22 13.00	3X2500 80.00	6AD4 3.00	6BK7 .99	6SK7 .72	T20 5.00	117N7 1.98	534X 2.00	WRITE!
1U4 .50	2K23 11.00	4A1 2.00	6AD5 1.89	6BL6 57.00	6SL7 .89	RK20 8.00	117Z3 .69	536X 1.49	FOR
1U5 .89	2K25 13.00	4A11 2/1.00	6AD6 1.29	6BL7 2.00	6SN7 .72	24G 2.00	152L 32.00	538X 1.45	LOWEST
1V .68	2K28 27.00	4B25 15.00	6AD7 1.39	6BN7 2.00	6SQ7 .74	25A6 1.19	F200 10.25	539X 2.00	PRICES
1X2A .68	2K30 125.00	4B26 7.50	6AE5 1.89	6BQ6 1.19	6SR7 .79	25A7 2.19	242 12.50	541X 2.00	C "TAB"
1Y2 10.00	2K33A 27.00	4B27 4.70	6AE6 1.89	6BX7 1.11	6T8 .98	25BQ6 1.39	245 14.75	543X 2.00	B4UBUY!
1Z2 1.40	2K39 180.00	4B32 8.00	6AF6 .99	6BY5 1.19	6U8 .98	25L6 .72	249B 3.30	544X 1.45	GET OUR
2A3 1.10	2K41 125.00	4C35 19.00	6AG5 .69	6BZ7 1.25	6V6 .90	25T 7.00	249C 4.25	547X 2.00	TUBE LIST

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(25% cooler internal hot spot)

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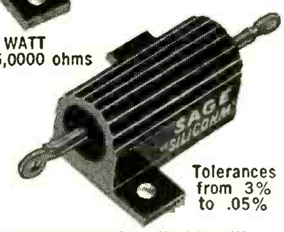
.0.3 to 60,000 ohms

25 WATT
0.1 to 16,0000 ohms



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Meet all requirements of applicable military specifications in existence or in prospect.
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If you have been stumped because miniature, chassis-mounted resistors in the past offered only 1,000 VRMS dielectric, then here's good news. Thanks to a superior, new type of filling material and new production techniques, SAGE now offers this new, improved, precision wire-wound resistor with a *standard* rating of 1,500 VRMS dielectric strength—and up to 3,000 VRMS on special order. And the cooler hot-spot means longer life, improved stability and greater all-around reliability.

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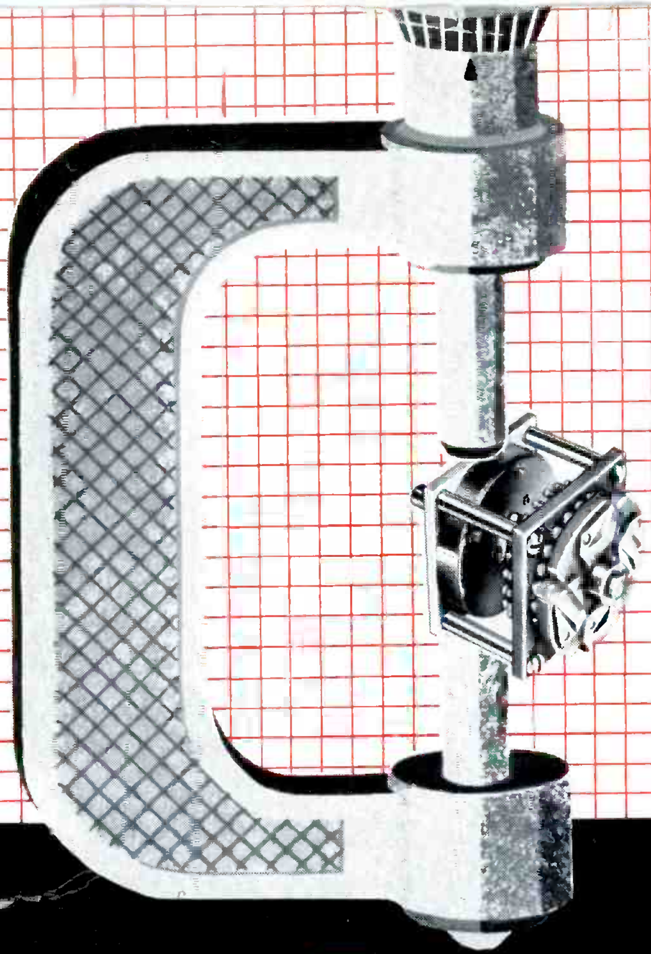

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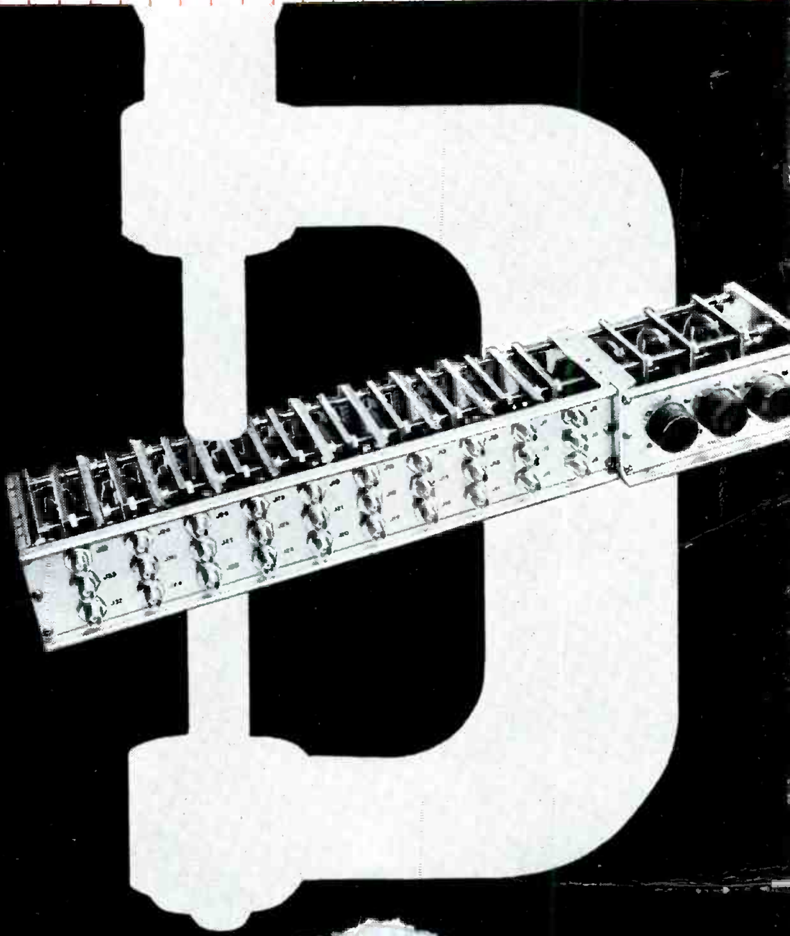

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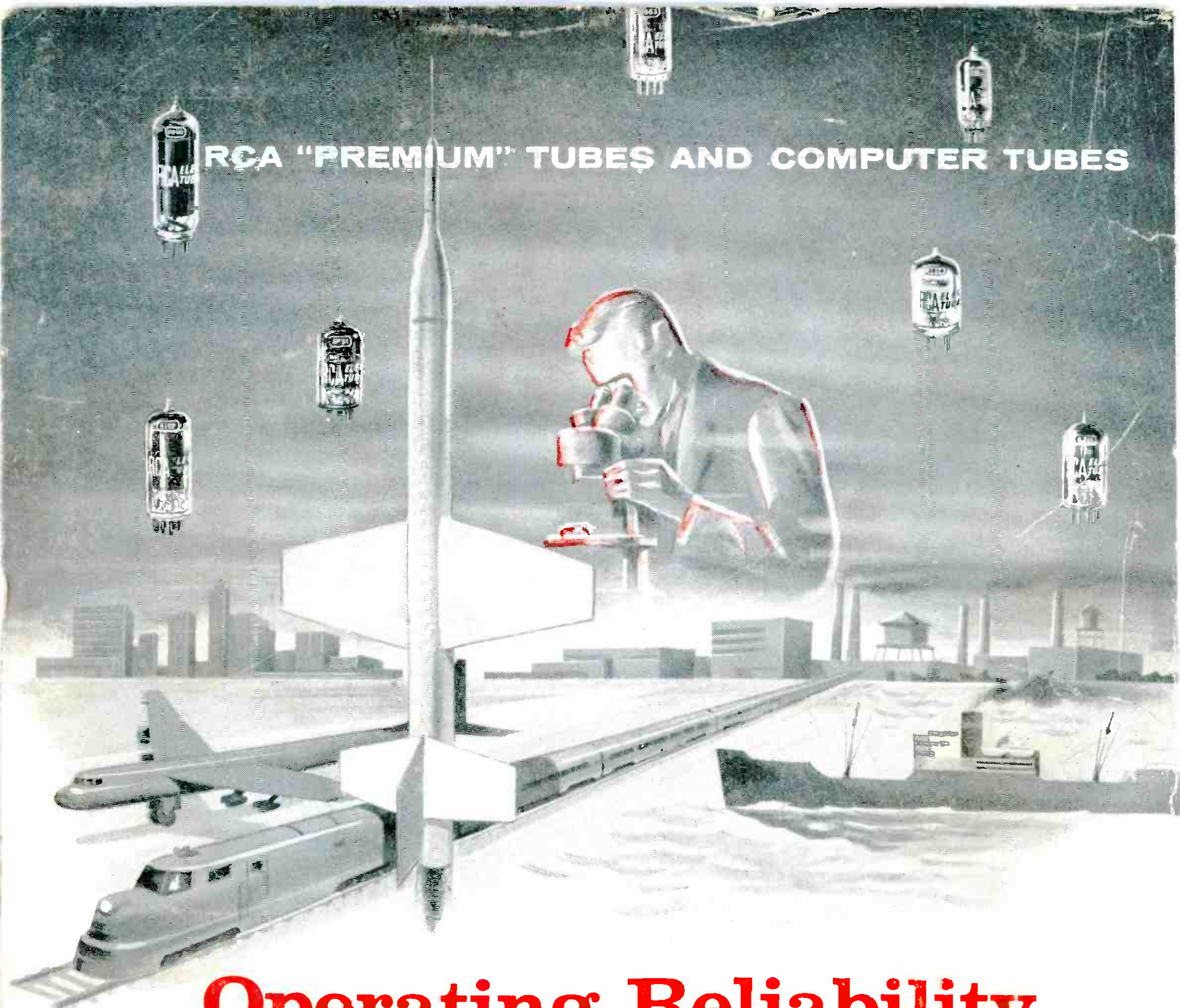
... units,



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To pace the demands for higher quality tubes in critical applications, RCA "Premium" Tubes and Computer Tubes have opened new possibilities for sustained reliability that exceeds previous levels of tube performance. Here are two important ways in which RCA insures that it *builds* QUALITY into these tubes:

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