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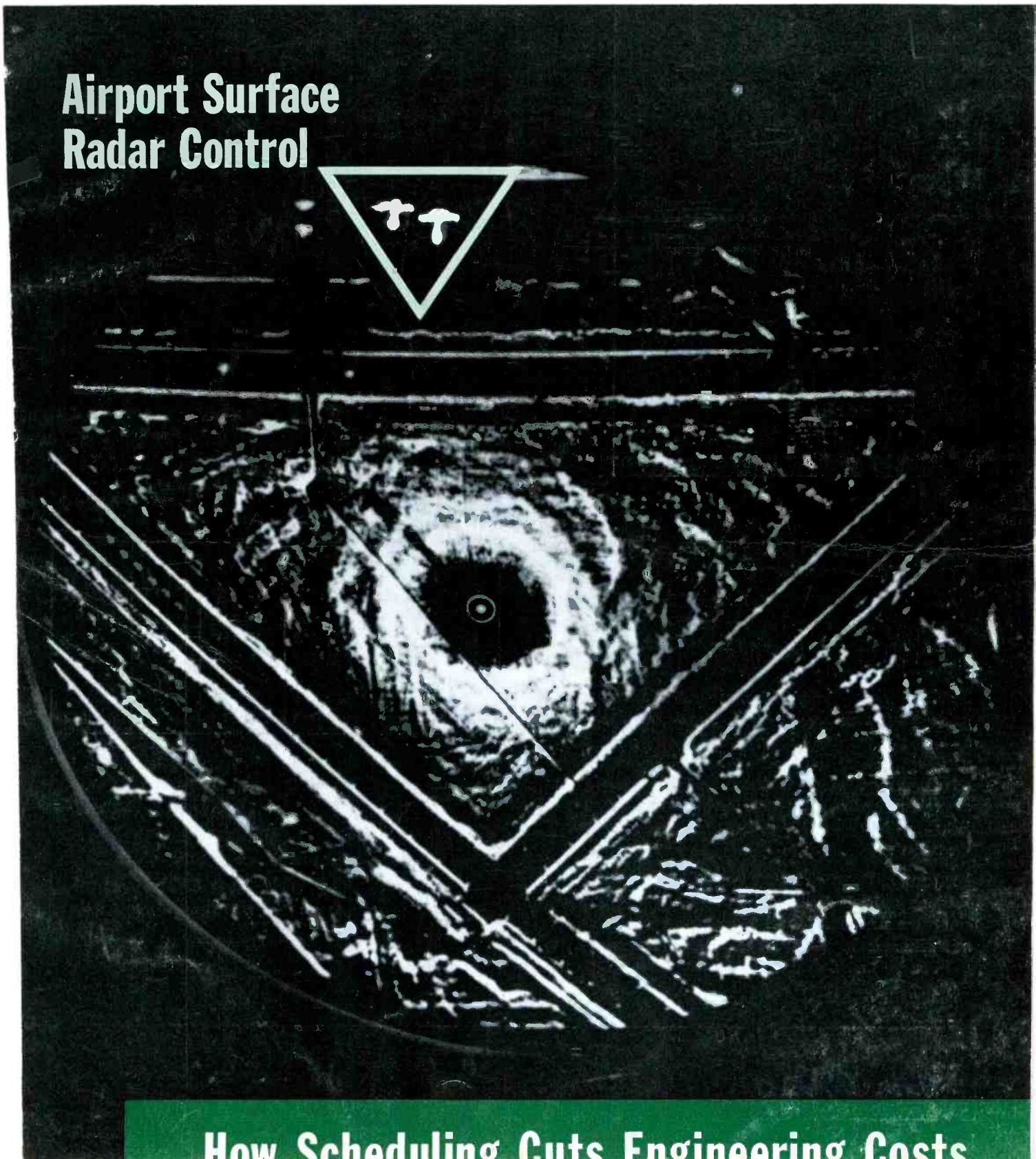
APRIL 3, 1959

electronics

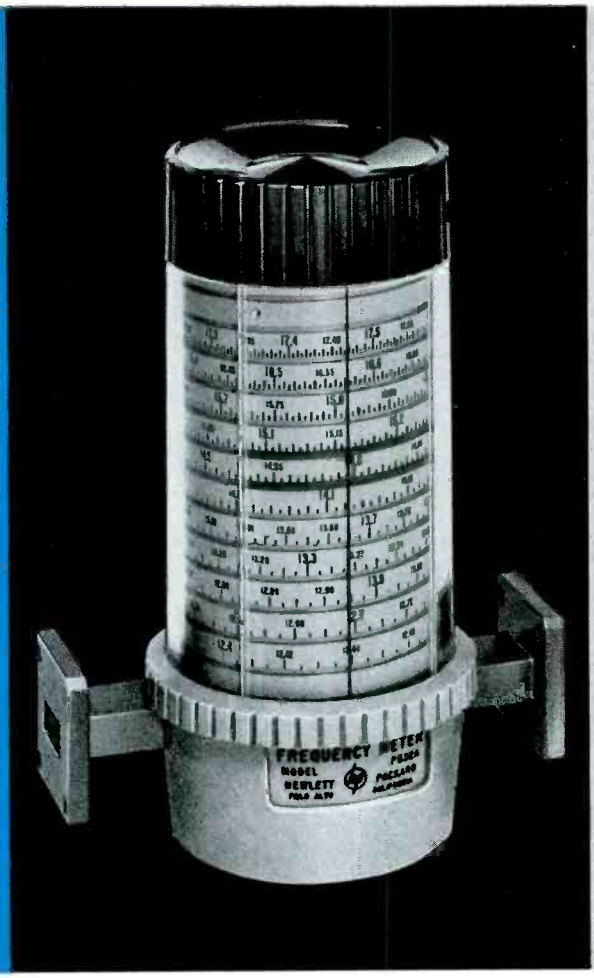
A McGRAW-HILL PUBLICATION VOL. 32, No. 14 PRICE SEVENTY-FIVE CENTS

Airport Surface Radar Control



How Scheduling Cuts Engineering Costs

Wide band, direct reading, 0.1% accuracy FREQUENCY METERS 5.2 to 40 KMC!



NEW K AND R BAND MODELS

Now hp offers you high quality, moderately-priced precision Frequency Meters covering the important J, H, X, P, K and R microwave bands.

On models 532A (X through R band) frequency is read directly in KMC on the large, precisely-calibrated spiral scale. No charts or interpolation are required. Accuracy is high, typically 0.1%.

Model 532A Frequency Meters comprise a special waveguide section mounting a high Q resonant cavity tuned by a choke plunger. No sliding contacts are used, and the waveguide section transmits virtually full power at resonance. A dip in output indicates resonance. Tuning is by a precision lead screw, spring loaded to eliminate backlash. Scale lengths of 77″ calibrated in 5 MC increments are typical.

For J and H band work (5.20 to 10.0 KMC) Model 530 Frequency Meters are offered (see Table). These instruments are similar to Model 532A except tuning is by a micrometer, and readings are converted to frequency by a chart on the instrument.

SPECIFICATIONS

Model	Accuracy	Frequency Range KMC	Fits Waveguide Size (in.)	Length (in.)	Price
J530A	0.1%	5.85 - 8.20	1½ x ¾	4	$120.00
J530B	0.1%	5.20 - 7.05	1½ x ¾	4	150.00
H530A	0.1%	7.05 - 10.0	1¼ x ⅝	3½	120.00
X532A	0.08%	8.20 - 12.4	1 x ½	4½	150.00
P532A	0.1%	12.4 - 18.0	.702 x .391	4½	210.00
K532A	0.1%	18.0 - 26.5	½ x ¼	4½	230.00
R532A	0.2%	26.5 - 40.0	.360 x .220	4½	250.00

Other specifications: Models 532A: Resetability 0.01%, backlash 0.005%, SWR at resonance 1.3:1 approximately. Dip at resonance, 1 db or more.

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

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FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

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electronics

APRIL 3, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 14

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Issue at a Glance

BUSINESS

ENGINEERING

DEPARTMENTS

For your toughest insulating problem, choose from the industry's widest range—

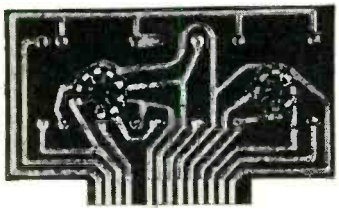
CDF DILECTO®
glass-base laminates

Teflon*, silicone, epoxy, melamine, and phenolic glass-fabric laminates. Polyester glass-mat laminates.

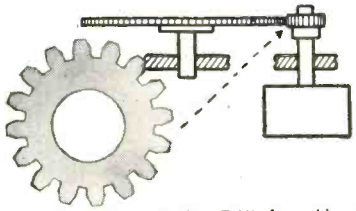
You can improve design, speed production, and save money by specifying one of the many C-D-F Dilecto grades. Whatever your application for these laminates — with fine- or medium-weave glass-cloth base — you'll find a better answer to your problem at C-D-F. (Melamine can also be made with glass-mat base.) And C-D-F offers modern machining and fabrication facilities to deliver production quantities of finished Dilecto parts to your specifications.

See our catalog in Sweet's Product Design File, where the phone number of your nearby C-D-F sales engineer is listed. For free trial samples of glass-base Dilecto, or of any other C-D-F plastics, mica, or fibre product, send us your print or your problem! Write for your free copy of C-D-F Technical Bulletin 64.

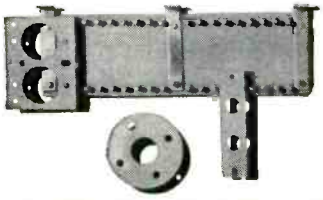
*DUPONT TRADEMARK FOR TETRAFLUOROETHYLENE RESIN



SPEED AUTOMATIC PRODUCTION of printed circuits with warp-resistant C-D-F metal-clad Teflon* and epoxy laminates. Other advantages: high bond strength of copper to laminate, superior blister-resistance in solder immersion.



HIGH-VOLTAGE (1800v.) RF ISOLATION is achieved by miniature C-D-F Dilecto gears in an aircraft receiver-transmitter switch. They also had to exhibit dimensional stability through a wide temperature range, resistance to fungus growth and thermal shock.



PRECISE MACHINING AND FABRICATION are standard benefits of Dilecto laminated plastics. These silicone glass-base parts (coil mountings, aircraft terminal board) were sawed, drilled, punched, and milled in production quantities by C-D-F and customer.

PROPERTIES OF SOME TYPICAL C-D-F DILECTO GLASS-BASE GRADES

Grade	Equivalent NEMA or ASTM grade	Flexural Strength Lengthwise (PSI)	Dissipation Factor at 10^{6} ~ Cond. A	Dielectric Strength Parallel Step x step	Insulation Resistance Cond. C96/35/90	Arc Resistance (seconds)	Maximum Operating Temp. (°C.)
GB-112T (Teflon*)	None	14,000	0.0015	65	100,000	180 +	250
GB-12S (Silicone)	G-7	28,000	0.002	60	100,000	180+	200
GB-28E (Epoxy)	G-10	70,000	0.019	65	75,000	130	150
GB-28EFR (Flame-Retardant Epoxy)	G-11	68,000	0.010	65	100,000	180	150
GB-28M (Melamine)	G-5	50,000	0.014	50	100	185	135
GB-261D (Phenolic)	G-1 and G-2	22,000	0.020	55	10,000	5	150
GM-PE (Polyester)	GPO-1	35,000	0.020	70	200	130	150

These are typical grades for typical applications. To meet special requirements, C-D-F makes many other Dilecto grades, one of which may serve your purpose better than any of these listed here. Consult the C-D-F Technical Department for expert assistance with your design problem involving laminated plastics products.

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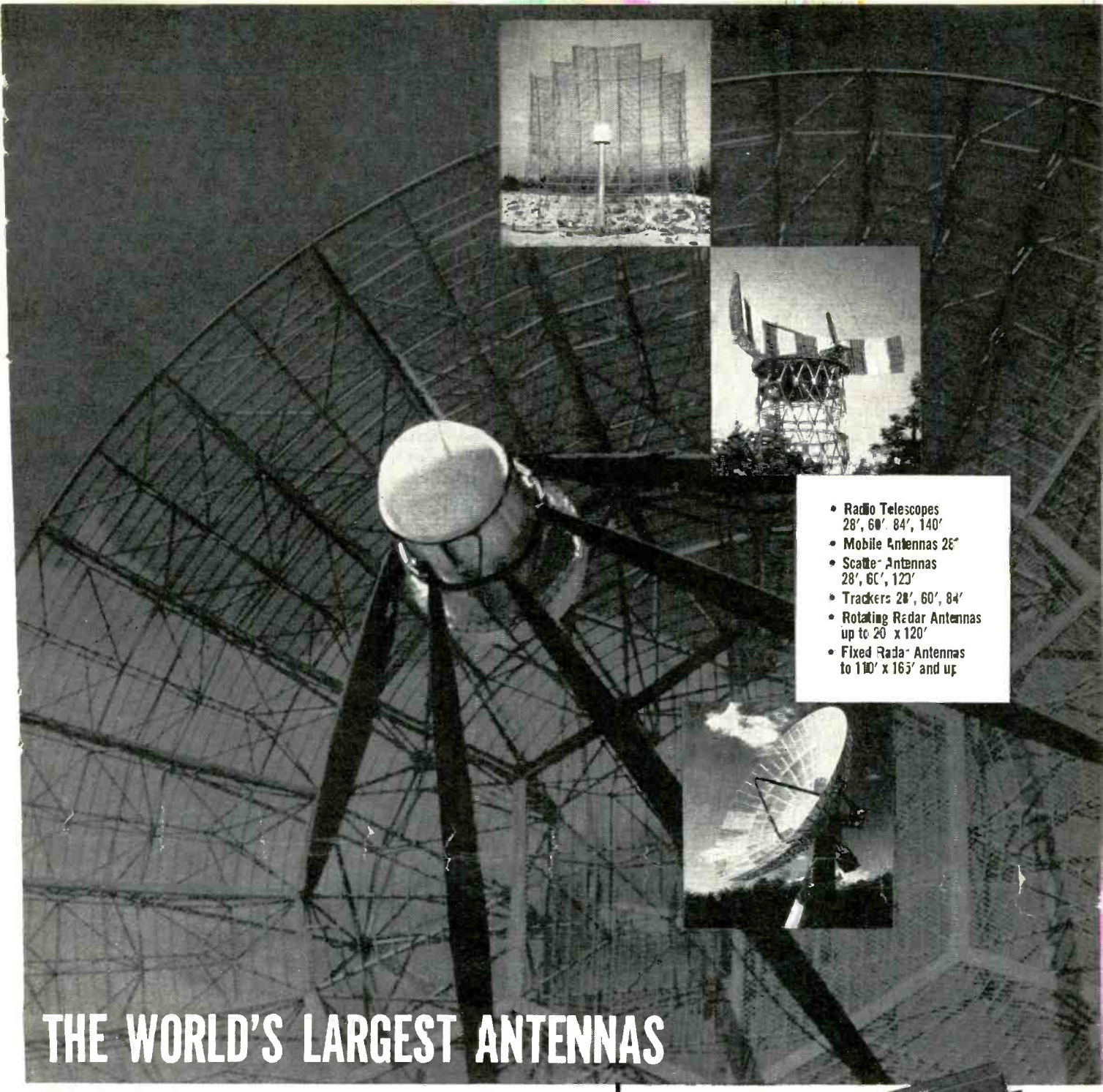

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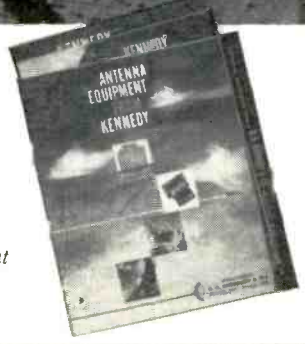

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electronics

April 3, 1959 Vol. 32, No. 14

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SHOPTALK . . .

COST SQUEEZE. The shortage of engineers and the squeeze on profits have forced the military contractor into more overall schedule and cost consciousness. To help win the competitive race, the Light Military Electronics division of General Electric almost two years ago had its engineering administrative group adapt the Navy-developed "line of balance" technique—already in use on production contracts—for control of its R&D projects.

Results: more profits, shorter laboratory-to-production cycle and greater utilization of engineers. GE's Jerome Pearlman, engineering resources utilization planner for LMED, discusses these techniques on p 24.

CONTACTS. With today's increased financial activity, more and more underwriters and brokerage firms are finding it advantageous to have staff specialists in electronics.

Gathering material for his weekly Financial Roundup column, Associate Editor Emma keeps close contact with these electronics investment specialists, as well as with other important financial people.

Emma spends a lot of time with personnel of smaller companies. A typical day may include a visit to a small plant, a chat with a security analyst, reading the day's financial publications, security offerings, annual and quarterly reports.

Emma got his experience in what makes our industry tick by working five years for one of the world's largest electronics corporations. He held a number of different slots in marketing, technical writing and public relations. A graduate of Columbia University, he was also employed in the foreign department of a major New York bank and served as a Naval officer in World War II.

Coming In Our April 10 Issue . . .

CITIZENS RADIO. Recent revision of FCC rules governing the Citizens Radio service has spurred the development of new equipment for this growing market. Of particular interest is the new class D category which limits the power input to the final r-f amplifier to 5 watts and is restricted to a-m transmission. Citizens Radio class D two-way units are being marketed at prices starting below $100.

Consultant L. G. Sands anticipates great interest in Citizens Radio with a timely article which outlines the new FCC rules and describes the technical features of the latest equipment evolving under the new specifications.

ELECTRONIC TACHOMETER. Development of steam turbine blading systems requires accurate measurement of the rotational speed of the blading system. Vibrations set up in individual blades and blade batches must be correlated with speed data for detailed analysis. For this purpose, tachometer accuracies of at least 0.01 percent are required.

J. K. Goodwin of Brush Electrical Engineering Co., Ltd., in England, describes an electronic tachometer for turbine blading applications. The devices uses high-speed Dekatron tubes for display and employs digital techniques throughout.

REDUCING DISSIPATION. A unique method of reducing plate dissipation in class A or class B audio amplifiers is described in an article by Robert B. Dome, of the General Electric Co., in Syracuse.

Dome shows how feeding an auxiliary super-audible signal to the grid of the amplifier with the desired audio signal reduces plate dissipation by almost 50 percent. The auxiliary signal must, of course, be adjusted so as not to affect the average value of the current resulting from the desired signal.

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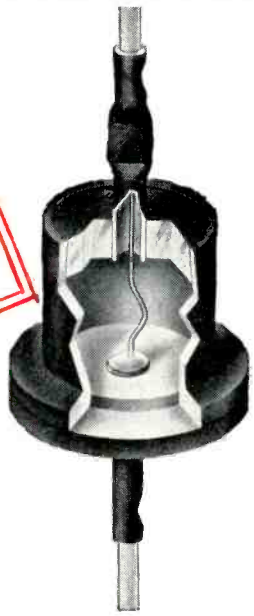

TYPE	Peak Operating Voltage −65°C to + 165°C	Ave. Rectified Current 25°C	Ave. Rectified Current 150°C	Reverse Current (Max.) at Specified PIV, 25°C
	Volts	Amps.	Amps.	μA
1N253	95*	3.0	1.0*	10
1N254	190*	1.5	0.4*	10
1N255	380*	1.5	0.4*	10
1N256	570*	0.95	0.2*	20
CK846	100	3.5	1.0	2
CK847	200	3.5	1.0	2
CK848	300	3.5	1.0	2
CK849	400	3.5	1.0	2
CK850	500	3.5	1.0	2
CK851	600	3.5	1.0	2

1N253 through 1N256 available to MIL specifications. *to +135°C

TYPE	Peak Operating Voltage −65°C to +165°C	Ave. Rectified Current 25°C	Ave. Rectified Current 150°C	Reverse Current (Max.) at Specified PIV, 150°C
	Volts	mA	mA	mA
1N536	50	750	250	0.40
1N537	100	750	250	0.40
1N538	200	750	250	0.30
1N539	300	750	250	0.30
1N540	400	750	250	0.30
1N1095	500	750	250	0.30
1N547†	600	750	250	0.35

1N538, 1N540, 1N547 available to MIL specifications. †Same as 1N1096

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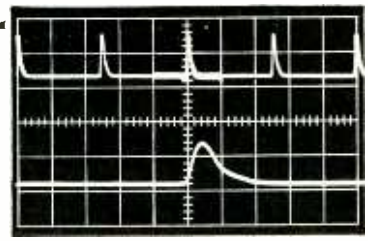
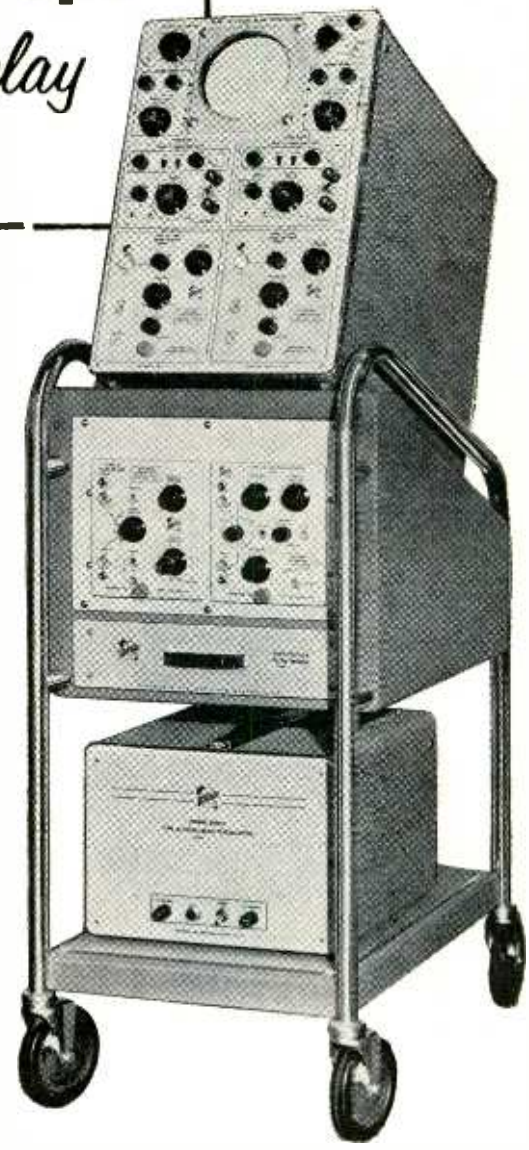
NEW DC-to-30 MC
DUAL-BEAM Oscilloscope
with Calibrated Sweep Delay
TYPE 555



SWEEP DELAY
Simultaneous display of pulse chain (upper beam) and third pulse on expanded delayed sweep (lower beam). Portion of original display that appears on faster delayed sweep is identified by trace brightening.



Two electron beams, each with its own X and Y deflection plates, help make possible a highly versatile dual-beam oscilloscope. Either of the two time-base generators in the Type 555 can deflect either beam for dual and single displays, and either can deflect both beams for a dual display on the same time base.

With one time-base generator functioning as a delay generator, the start of any sweep generated by the other can be held off for a selected time interval with a high degree of accuracy. Both the original display and the delayed display can be observed at the same time. The "triggered" feature can be used to obtain a jitter-free display of signals with inherent jitter.

Signal-handling versatility is provided by nine available types of plug-in preamplifiers, any combination of which can be used in the two fast-rise vertical channels. In addition to the many application areas opened with Tektronix plug-in preamplifiers, a three-channel or four-channel display is available through use of the time-sharing characteristics of Type C-A Dual-Trace Units in one or both channels.

Please call your Tektronix Field Engineer or Representative for complete specifications.

Characteristics

INDEPENDENT ELECTRON BEAMS
Separate vertical and horizontal deflection of both beams.

FAST-RISE MAIN VERTICAL AMPLIFIERS
Passbands—dc-to-30 mc with Type K Units.
Risetimes—12 mμsec with Type K Units.
All Tektronix Plug-In Preamplifiers can be used in both vertical channels for signal-handling versatility.

WIDE-RANGE TIME-BASE GENERATORS
Either time-base generator can be used to deflect either or both beams.
Sweep ranges—0.1 μsec/cm to 12 sec/cm. 5 x magnifiers increase calibrated sweep rates to 0.02 μsec/cm.

SWEEP DELAY—Two modes of operation:
Triggered—Delayed sweep started by signal under observation.
Conventional—Delayed sweep started by delayed trigger.
Delay range—0.5 μsec to 50 sec in 24 calibrated steps, with continuous calibrated adjustment between steps.

HIGH WRITING RATE
10-KV Accelerating potential provides bright traces at low repetition rates and in one-shot application.

REGULATED POWER SUPPLY

PRICE, Type 555 without plug-in preamplifiers **$2700**
Includes Indicator Unit, Power Supply Unit, Scope-Mobile, 4—10 x atten. probes.
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Tektronix manufactures seventeen other laboratory oscilloscopes, ten of which are also available as rack-mounting instruments.

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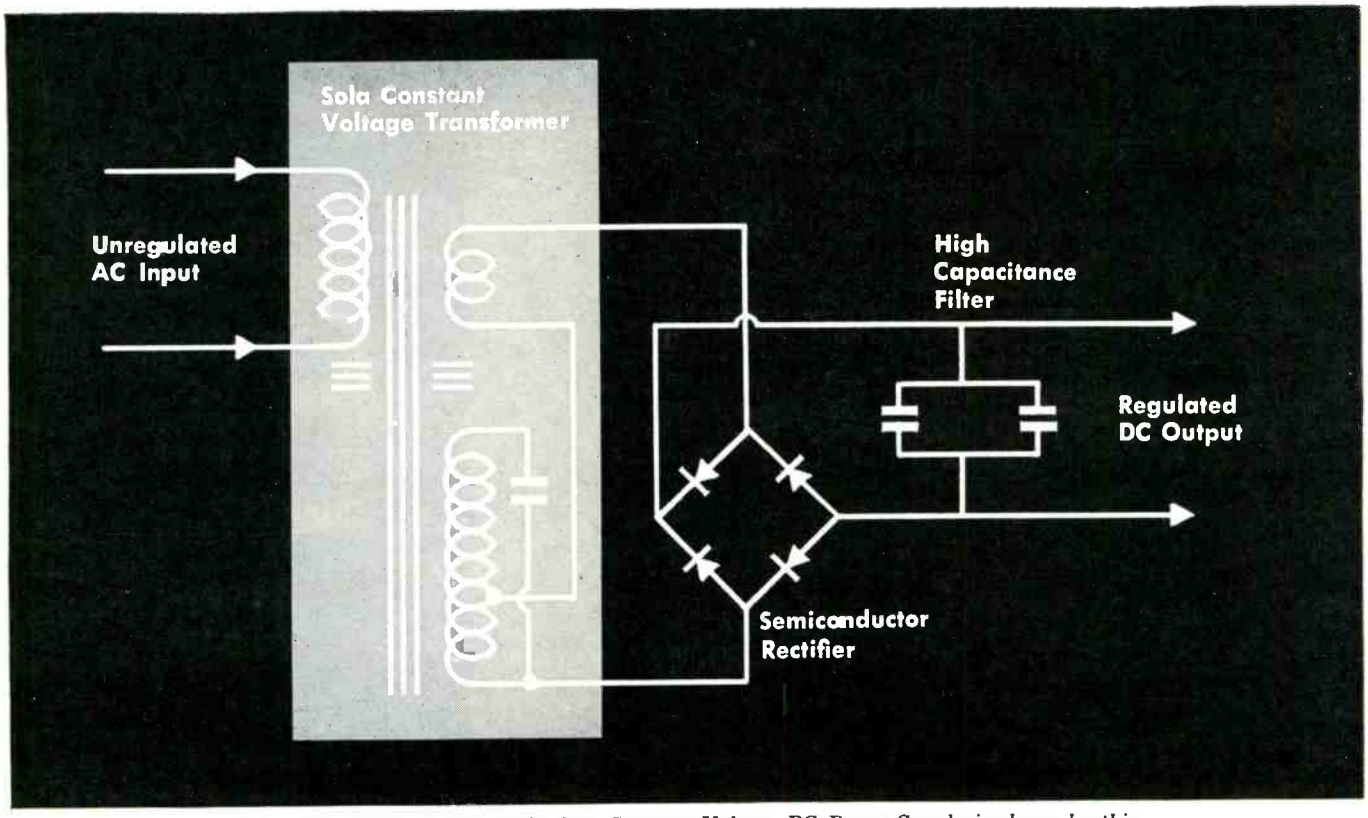


Inherently simple design of the Sola Constant Voltage DC Power Supply is shown by this general schematic diagram. Its basic simplicity of design and its reliable components make this regulated power supply rugged and dependable, both electrically and mechanically.

Just three reliable components make Sola's regulated dc power supply simple and rugged

Sola Electric Co. (an outfit where complexity-for-its-own sake wins no promotions) has combined three simple, reliable components — a special type of Sola Constant Voltage Transformer, a semiconductor rectifier, and a high-capacitance filter — to make a regulated dc power supply that is rugged and dependable.

Electrical characteristics of the special CV transformer maximize most of the advantages of the semiconductor rectifier and the capacitive filter, while virtually eliminating their disadvantages. This particularly happy combination of components gives output in the ampere range, regulation within ±1% even under ±10% line voltage variation, and ripple less than 1% rms. It handles variable, pulse, or high-amperage loads without a second thought . . . it even puts up with dead shorts.

Size? Maintenance? Cost? Sola's simplicity drive permits the units to occupy minimum space, to do without movable or expendable parts, and to sell at a reasonable price.

Simple construction, reliability and compactness are benefits common to the entire line of regulated dc power supplies. Sola designs and produces hundreds of ratings to meet widely varying electrical and mechanical requirements of equipment manufacturers; and also produces complete power supply systems to specification. It is set up to handle specific needs in production quantities. Your nearby sales engineer can supply all the facts.

In addition to custom service, Sola currently stocks six fixed-output models ranging from 24 volts at six amps to 250 volts at one amp. Six adjustable models are stocked, too.

For complete data write for Bulletin 7D-CV-235

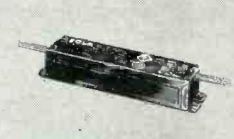
Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., Bishop 2-1414 • Offices in principal cities • In Canada, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 18, Ont.

SOLA


CONSTANT VOLTAGE TRANSFORMERS


REGULATED DC POWER SUPPLIES


MERCURY LAMP TRANSFORMERS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A precision carbon film resistor as low as 6½¢*

New Criterion

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Now, all of the outstanding advantages of a superior carbon film resistor are available to you for as little as 6½c. No longer need you let cost keep you from inclucing a precision-plus, carbon film resistor in your design plans. Far better temperature coefficient, much greater resistance to heat and moisture, longer load life . . . these are just a few of the superior characteristics of a new Criterion Carbon Film Resistor. Yet, thanks to exclusive new production processes, we can offer you this resistor at amazing low price. Here is an entirely new, **low cost** answer to the problem of reliability in computers, commercial instruments, critical circuits in entertainment equipment and many other similar applications. Check the outstanding characteristics of these resistors yourself, then write, wire or call, and let us quote you prices. Samples also available on request.

*½ watt, 1% tolerance as low as 6½c—5% tolerance less than 6c

Electra Part No.	Wattage	Mil Resistance Range	Length	Diameter
W½	½	10 ohms 5 meg	1/2″ ±1/32″	11/64″ ±1/64″
W1	1	50 ohms 20 meg	1″ ±1/16″	9/32″ ±1/32″
W2	2	100 ohms 50 meg	2-1/8″ ±1/16″	9/32″ ±1/32″

CHARACTERISTICS

Load Life—When operated at full load, but not exceeding maximum rated voltage, at ambient temperature of 40° C. for 1000 hours in cycles of 1½ hours on and ½ hour off, there is an average change of 3%, maximum change of 5%.

Moisture Resistance — When tested according to 106A MIL Standard 202A, maximum change is 4%.

Tolerance—Resistors are manufactured to customer specifications. Resistors are normally supplied in 1% tolerance and are calibrated at 25° C. (77° F.). Resistors can also be had in tolerances of 2%, 5% or 10%.

Insulation—Several layers of moisture resistant insulating coatings are baked on the resistor element to give it mechanical and electrical protection.

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Best results with faster rinsing and fewer rejects are obtained when ultra-pure, hot water is employed in washing and rinsing of transistors, diodes, and other electronic components. The Barnstead Transistor Washer conserves thousands of gallons of water each day as it repurifies the pure, hot water keeping it free of organic impurities, and submicroscopic particles to 0.45 microns. Completely factory-assembled, ready for operation.

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WASHINGTON OUTLOOK

WASHINGTON OBSERVERS have written off Sen. Leverett Saltonstall's highly-touted bill to overhaul military procurement policy.

This is the sputnik-prompted measure aimed to give the Pentagon greater flexibility in its buying practices and to cut development time on new projects.

Right from the start, the bill's proponents anticipated serious opposition because it runs counter to the traditional Congressional feeling that defense business should be spread among more contractors through formal advertised bidding.

But Republican Saltonstall of Massachusetts, and his supporters, expected to overcome the opposition. They thought pessimism stemming from Soviet space exploits would create a Congressional atmosphere amenable to a major policy change. They tried to take the edge off small business objections with a provision for tighter requirements on subcontracts for smaller firms.

The Saltonstall bill, however, has encountered more than Democratic opposition. The Pentagon has been lukewarm toward the proposal.

Then there's been unexpected Republican opposition. New York Senators Javits and Keating, for example, are incensed over their state's declining share of military business. They blame the Pentagon's trend toward negotiated procurement. Hence, they're pushing a measure to increase the volume of contracting awarded under formal advertised bidding. Delaware's Republican Senator Williams has introduced a similar bill.

- **A swap of radio frequencies** between military and civilian users may be in the offing. Under pressure from Congress and the FCC, the military is apparently willing to talk business.

  FCC wants to expand the vhf elevision spectrum from the present 12 channels to 50 in a continuous band. The give and take, presumably, would be to give the military some of the unused uhf television frequencies. FCC can feel free to do this now that a broadcasting industry group (the Television Allocations Study Organization) has reported that uhf tv is technically inferior to vhf.

  Negotiations between FCC and the Pentagon are expected to get under way shortly. Up to now, civilian broadcasters have complained that while the military has half the spectrum space, no one outside military circles really knows whether they are using it efficiently.

- **Four or five big cities** may be getting limited pay-tv soon under a new FCC order. The tests must be carried out only in the 20 cities which have at least four tv channels operating, so the public won't be deprived of choice of programs. Milwaukee, where CBS has just given up a uhf channel, is one of the most likely candidates.

  The House Commerce Committee, which has opposed any but the most limited technical tests, is expected to go along with the new order which represents an FCC compromise with Congressional sentiment. The Commission has limited each toll-tv system to one city. An existing station will set aside several hours per day for pay-as-you-see operations, and promoters expect to present sports events and first-run movies that free tv can't afford.

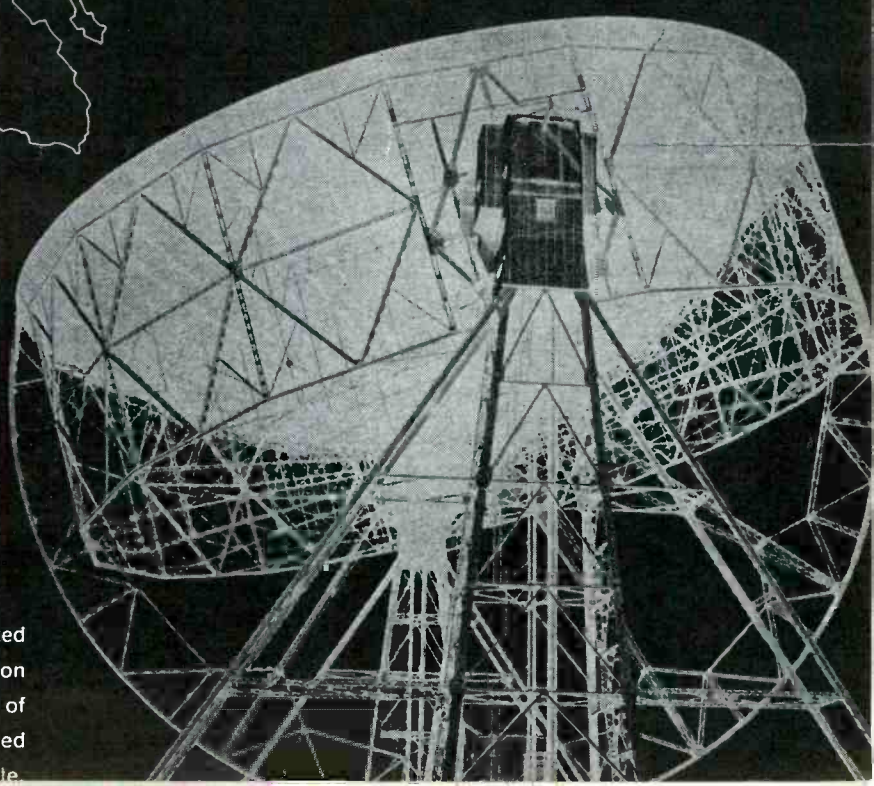
  The promoters' chief complaint about the new ruling is the FCC ban against charging the customer for special receiving equipment he will need, which means a big capital outlay for the companies.

  On the record, all tv stations are against toll systems. Privately, however, a number of them operating on marginal profits are willing to give pay-tv a try.

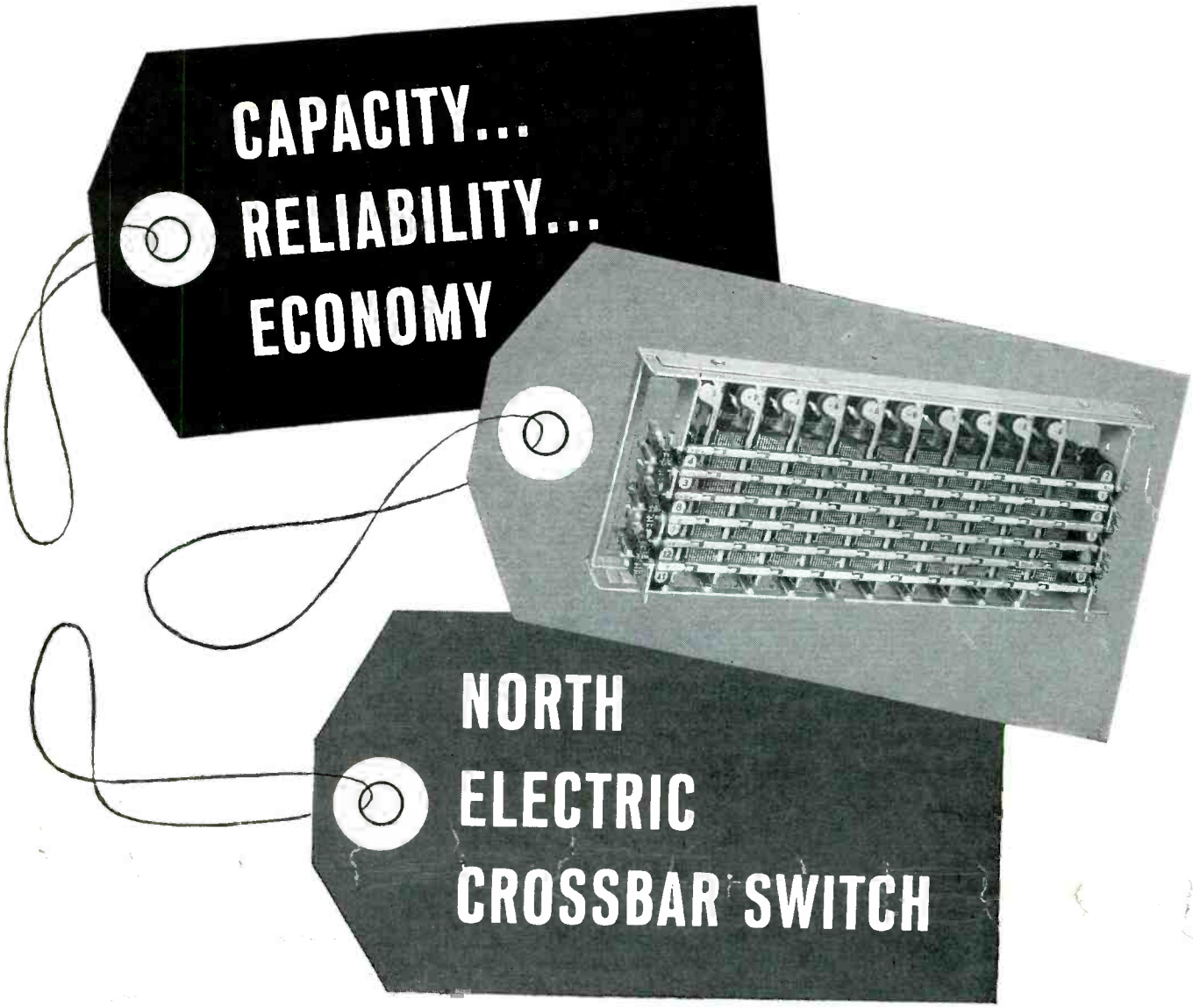
MAN'S FIRST SPACE COMMUNICATION STATION

On 12 October 1958, an historic event took place. A group of Space Technology Laboratorie engineers at Cape Canaveral, Florida, transmitted radio signals far out into space to the NASA/Air Force Pioneer space probe vehicle. The tiny receiver and transmitter in the Pionee relayed these same signals to the Space Technology Laboratories' group at Manchester University, England. • This significant experiment promises, like those earlier achievement of Morse, Bell, and Marconi, to pave the way for the use of space vehicles to relay informatio to and from points on earth. One day the entire world will view televised events as they happen. • Future experiments of this kind will undoubtedly assist mankind in his search to understand, use, and benefit from his knowledge of space phenomena. • Scientists and engineers whose interests and abilities enable them to contribute to these developments are invited to join our technical staff.

Space Technology Laboratories, Inc. P.O. BOX 95001, LOS ANGELES 45, CALIFORNI



The 250′ radio telescope pictured here is operated by a team of British scientists under the direction of Professor A. C. B. Lovell, University of Manchester, whose cooperation contributed materially to making this achievement possible.



THE NORTH CROSSBAR SWITCH PROVIDES GREATER INDUSTRIAL SWITCHING CAPACITY IN LESS SPACE—WITH TELEPHONE RELAY RELIABILITY—AT LESS COST!

Designed and built on a matrix coordinate 10 x 12 configuration, with up to 10 circuits per crosspoint, providing sequential crosspoint selection for as many as 1200 switching points, the North Crossbar Switch is the most economical switchgear available to do so much in so little space! Measuring only 22.95 inches long, by 5.35 inches wide and 8.67 inches high, two Crossbar Switches will easily mount side by side vertically in a standard 19 inch frame!

The North Crossbar Switch is being used in analog and digital computer functions, as a memory device for programming and sequencing, for high traffic communications, machine tool control and programming, data storage and reduction, digital to analog conversion, automatic test programming, computer readout, cable and circuit testing, high capacity selector switching and a host of other industrial applications.

Featuring multi-path selection, double wound hold coils, ball bearing pivot pins, the North Crossbar Switch requires minimum maintenance with virtually no moving parts or mechanical wear. Both mechanical life and contact life are in excess of 50 million operations!

Select and hold magnet coils are available for operation on 24, 48 and 100 volts D.C.

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Earnings Trend Encouraging

SPRING MAILINGS of annual reports to stockholders reveal an encouraging pattern of earnings for electronics firms. Among some of the indicators that tell how our industry is doing are:

• **Hazeltine Corp.**, Little Neck, N. Y., manufacturer of military electronic equipment, reports gross billings of $62,424,060 for 1958. Total for 1957 was $61,562,484. Net income for last year was $2,246,226 vs $2,030,612 for 1957.

• **Magnetic Amplifiers, Inc.**, New York City, reports "record net earnings" of $142,483 for last year on $2,301,800 worth of sales. The previous year's earnings were 51 percent lower—$94,184 on $1,792,839 in sales.

• Reports last month from **International Telephone and Telegraph** announced a consolidated net income of $26,600,168 for 1958. This is an increase of 19 percent over 1957's figure of $22,412,814. An important portion of last year's income was derived from government contracts. Total '58 revenues were $703,010,679.

• **Motorola Inc.**, Chicago, enjoyed a record high during the last quarter of 1958, which brought total sales volume to $216,590,325 for last year. This figure falls five percent below 1957 total of $226,361,190. Company officials say the decrease was due to a downturn in consumer sales at the beginning of 1958.

• From Detroit, Mich., **Burroughs Corp.** announces total revenue for 1958 of $294,085,078, as compared to $282,773,950 for 1957. Present backlog of unfilled orders is valued at $220 million for this year.

• **Philco Corp.**, Philadelphia, reveals slightly lower earnings for 1958 compared with 1957. Last year's sales amounted to $351,093,000, compared with $372,629,000 two years ago. The firm points out, however, that this comparison "does not show the marked improvement in the last half of the year over the recession-low first half."

• Sales by **Bendix Aviation Corp.** were counted at $619,138,095 for 1958 as compared to what company officials describe as the "record peacetime total" of $706,984,631 for 1957. Business for last year was 73 percent military, 27 percent commercial. The firm says 40 percent of all its work directly involved manufacture and design of electronic equipment.

OVER THE COUNTER

1958 BIDS LOW	HIGH	COMMON STOCKS	WEEK ENDING Mar. 13 BID	Mar. 20 BID	Mar. 20 ASKED
3¾	20½	Acoustica Assocs	29	29	44
1⅝	3	Advance Industries	3⅜	3½	4
3⅛	6⅝	Aerovox	6¾	6⅞	8
16¾	24¼	AMP Inc	25½	28	30⅜
5½	15	Appl'd Sci Princet	12½	11½	14⅜
1⅛	8⅞	Avien, A	8	8¼	9¾
6¾	24	Baird-Atomic	26¼	27	29⅞
9¾	13⅜	Burndy	16½	16½	18
6¾	9	Cohu Electronics	8¼	8⅜	9⅛
11	22½	Collins Radio, A	29¾	31½	38¾
10¼	22¼	Collins Radio, B	29¾	31½	38¾
4	7	Craig Systems	7⅞	9⅜	11¼
17⅝	25⅜	Eastern Industries	22¼	22	24⅞
1¾	8⅜	Elco Corp	8¼	8⅝	9⅞
10½	21	Electro Instr	24¾	27¾	29⅞
34	49	Electronic Assocs	45½	46	50⅞
5	11	Electronic Res'rch	19	20	25⅛
8½	12¾	Electronic Spec Co	12¾	13¼	15⅛
15¼	49½	Epsco, Inc	34½	36	46⅛
5½	9⅜	Erie Resistor	9¾	9¾	11
10	17½	Fischer & Porter	14¾	15⅜	17⅛
5½	10½	G-L Electronics	12	15	17½
12	27	Giannini	28	27¼	32
...	...	Haydu Elec Prod	5¼	5¼	6⅜
30	39½	Hewlett-Packard	42	43½	51⅞
23¼	48	High Voltage Eng	64	64½	69
1¾	3	Hycon Mfg	3⅝	4¼	5
1⅛	5⅛	Industro Trans'tor	3¾	3½	5⅜
1½	4¾	Jerrold	6⅛	5¾	6⅜
21	30	D. S. Kennedy	33¼	31¾	35⅝
3¾	29	Lab For El'tronics	35¾	36¾	42½
19¼	28	Leeds & Northrup	28⅜	29¼	32
2	3⅛	Leetronics	2⅝	2⅝	4¼
5	18¾	Ling Electronics	23	23	25⅝
16	20½	Machlett Labs	26¼	26¾	29⅞
3¼	8¼	Magnetic Amplifiers	9¾	10	11⅛
2⅞	4½	Magnetics, Inc	4¾	5¼	5⅞
4⅝	12	W. L. Maxson	13¼	13⅜	14⅝
10⅝	29	Microwave Assocs	35	40	47¼
5¼	11¾	Midwestern Instr	11	11⅝	13¾
1⅛	7	Monogram Precis'n	11	11¾	15½
3½	7¼	Narda Microwave	6¾	7	8
...	...	Narda Ultrasonics	8	8½	9⅞
9¾	16	National Company	21	21½	23⅝
14¼	56	Nuclear Chicago	41	40	44⅞
4½	7⅜	Pacific Mercury, A	11½	13¼	15⅜
10⅛	27½	Packard-Bell	35¼	40	44⅞
4¼	9⅜	Panellit, Inc	7¾	7½	8⅝
21	53¾	Perkin-Elmer	51¼	49½	54½
11⅜	19½	Radiation, A	21¾	21¾	25⅞
2⅛	7⅜	Reeves Soundcraft	7⅜	8¼	9⅝
13	32½	Sanders Associates	30½	27	33
...	...	Silicon Transistor	5⅜	7¼	12
7	12	SoundScriber	19¼	19½	21½
22¾	40	Sprague Electric	41¾	43½	48¾
26	35	Taylor Instruments	38½	36½	41⅜
5½	15	Technical Operat'ns	20	—	—
5½	15¾	Telechrome Mfg	16½	21	28¼
3¼	7¾	Telecomputing	10¾	11¾	14
1⅛	2¾	Tel-Instrument	2¾	2¾	3
8¾	16¼	Topp Industries	12¾	13¼	14⅞
3¾	10¾	Tracerlab	11½	12¾	14⅜
1⅛	3⅜	Universal Trans'tor	⅞	⅞	1¼
14¼	40	Varian Associates	45¾	46¾	53½

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

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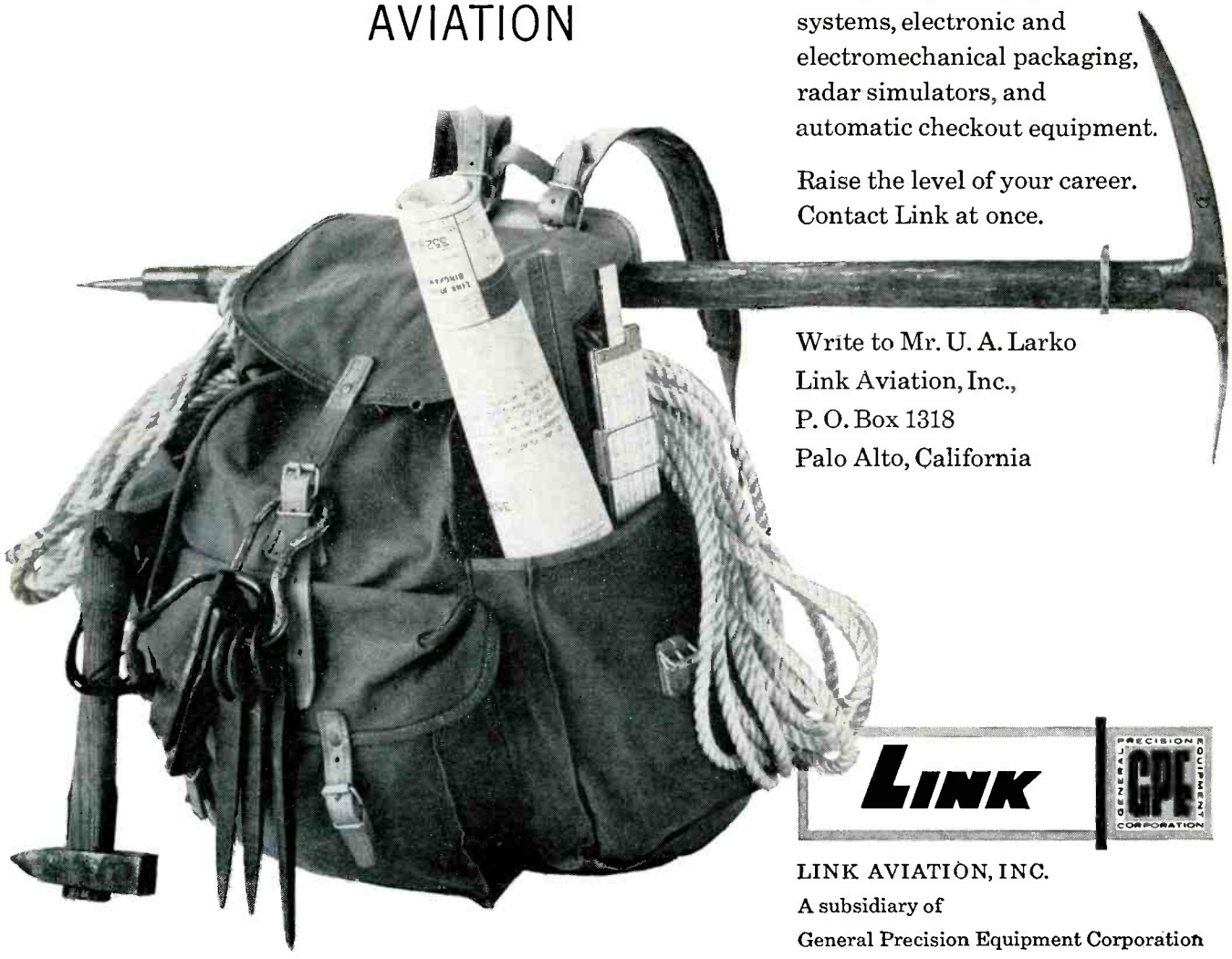

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Link Aviation, Inc.,
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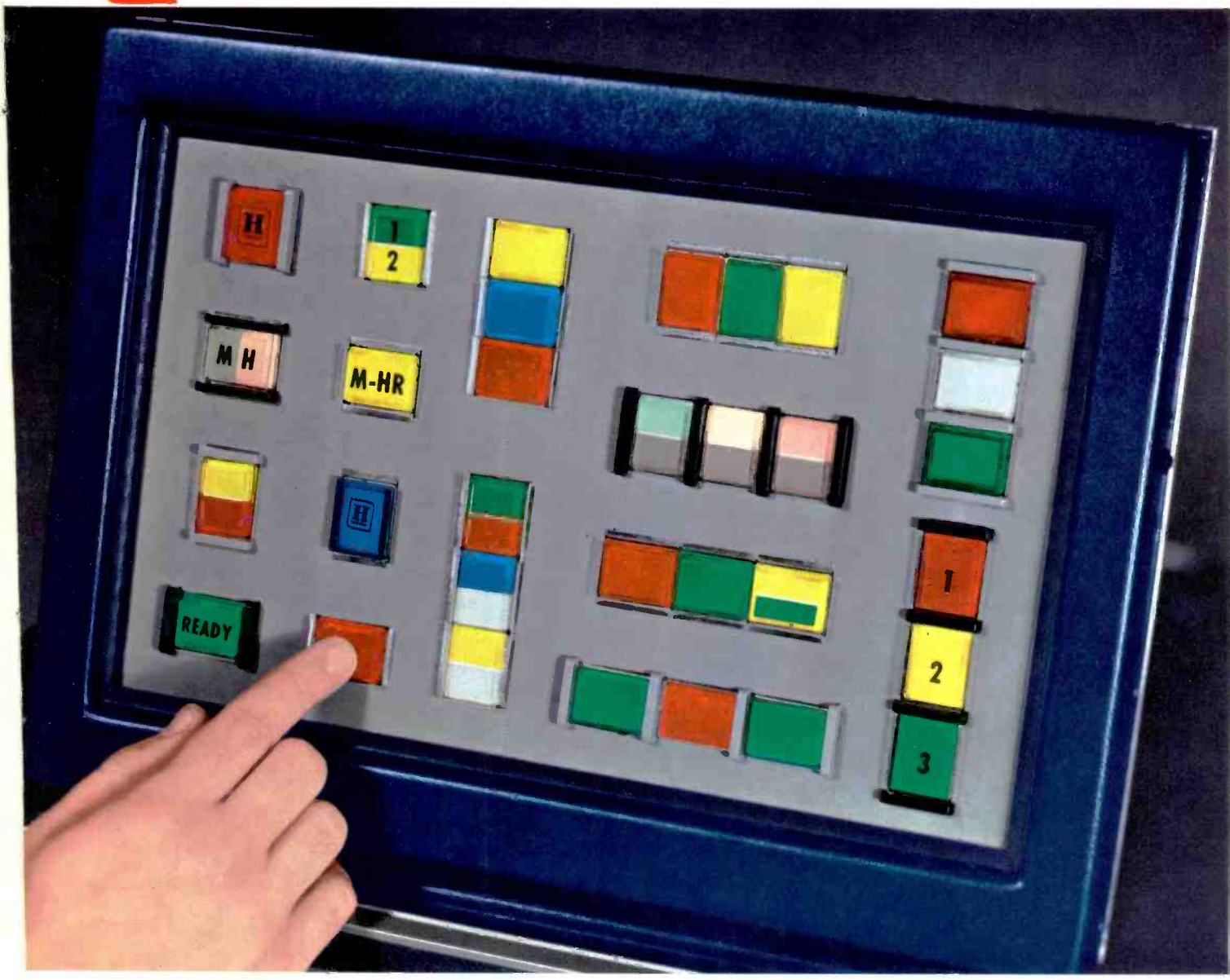


All new Series 2 lighted display and pushbutton switch devices offer new modular versatility in lighted display

The modular concept of Series 2 devices opens a new approach to design freedom in both front-of-panel lighted display and back-of-panel precision pushbutton switching. The demonstration panel shown above illustrates some of the variety in arrangement and color and labeling offered by these new devices.

Principal advantages of Series 2 units include these:

Operator-indicator and indicator units are assembled quickly and easily, *without tools*. Even the switching units simply snap into place as shown on the next page.

Units are available, flange mounted or barrier mounted, in long-flange, short-flange, long-barrier and short-barrier types. All types can be combined in either rows or columns to provide eight group-mounting schemes.

Five colors of display screens are available—red, yellow, blue, green, and white. Two, three, or four lamps can be used in each unit. Color filter caps for the lamps are available to provide projected color on white frosted screens.

Two-color display screens may be split laterally or longitudinally, in any combination of the five colors.

Assemblies built up of the desired number and type of units, snap into pre-cut rectangular slots in the mounting panels, *also without tools*.

Panels may be from 1/16″ to 5/16″ thick. Flange-mount units can be used with a mounting panel and overlay panel, or with mounting panel only.

Here is a new dimension of design freedom in illuminated switching equipment . . . an all-new system compatible with good human-factors engineering.

MICRO SWITCH Precision Switches

All new Series 2 lighted display and pushbutton switch devices offer new modular versatility in pushbutton switching

Yes, you can have the panel arrangement you want (preceding page) *and* the switch unit the application requires. At right you see a few of the hundreds of available combinations of Series 2 switch units and operator-indicator units. To attach an operator-indicator unit with a switch unit, just snap them together. All such combinations are available with or without magnetic d-c holding coil. Switch units are offered with switches from eight different MICRO SWITCH series of basic switches—"TB", "SM", "HS", Type "A", "MT", "DT", Type "Z", and "V3". Included are switches for low-energy circuits, switches for handling d-c loads of up to 10 amperes, 125 volts, and for direct control of a-c motors of up to two horsepower . . . alternate-action units, momentary-contact units, and units for control of multiple circuits.

Display screen, in four colors and white. Also available split lengthwise or across.

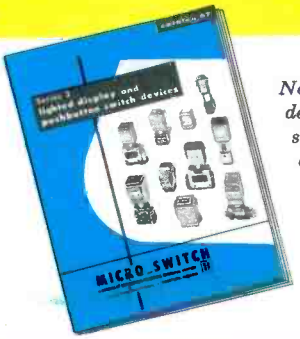
Two, three, or four lamps can be used in operator-indicator or indicator units.

Operator-indicator unit, barrier type. Unit shown has long (side) barriers. Also available are short (end) barriers, and flange-type units without barriers.

Color filters in red, yellow, green, or blue fit over lamps, permit projected-color lighting.

"SM" switch unit—one of many Series 2 switch units—snaps onto base of operator-indicator unit.

Indicator unit, long flange type. Short flange and barrier types are also available.



New Catalog 67 describes Series 2 devices in detail. Split pages aid selection of components. Contains detailed switch unit data and helpful ordering and color selection information. Sent free on request.

MICRO SWITCH . . . FREEPORT, ILL.
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MICRO SWITCH PRECISION SWITCHES

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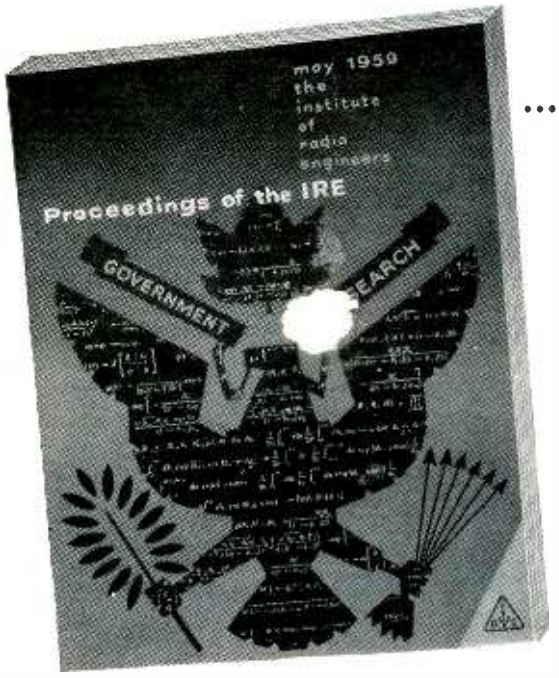

Again government projects make the news as space satellites relay world weather data and rockets orbit the sun. The *Institute of Radio Engineers* salutes government contributions to progress in radio-electronics in the *Special May Issue* of **PROCEEDINGS OF THE IRE.**

The big May **PROCEEDINGS OF THE IRE** gives deserved recognition to the government laboratories and bureaus engaged in electronics research and development, and brings to its readers information about the invaluable work being done by engineers and technicians in federal employ. Included are 40 technical papers dealing with the most important aspects of current projects.

Radio-Electronics Behind the Headlines

This Special Issue reveals how the government is meeting the challenge of creating new and better electronic devices for peaceful and utilitarian purposes, as well as how it is meeting the pressing need for advanced national defense systems. Also discussed are future safeguards for the security of the free world.

Presentation of this special issue on *Government Research* is in keeping with the IRE's policy of bringing to the world of radio-electronics the latest news of subjects of special interest and significance. Such a practical policy enables the IRE to provide a valuable service to the industry by making technical material and pertinent information available not only to its 72,000 members, but to informed non-members as well.

Read this informative report on *Government Research* in the publication that records progress. If you are not a member of the IRE, be sure to reserve a copy of the May **PROCEEDINGS,** now.

PARTIAL CONTENTS OF THIS GOVERNMENT RESEARCH ISSUE:

"The Basis of Our Measuring System" by A. G. McNish, National Bureau of Standards

"The DOFL Microelectronics Program" by T. A. Pruge, J. R. Nall & N. J. Doctor, Diamond Ordinance Fuze Labs.

"VFL Propagation Measurements for the Radux-Omega Navigation System" by C J. Casselman, D. P. Heritage & M. L. Tibbals, U. S. Naval Electronics Lab.

"Submarine Communication Antenna Systems" by R. W. Turner, U. S. Naval Underwater Sound Lab.

"Some Characteristics of Persistent VHF Radio Wave Field Strengths Far Beyond the Radio Horizon" by L. A. Ames, E. J. Martin & T. F. Rogers, Air Force Cambridge Research Center

"Phenomena of Scintillation Noise in Radar Tracking Systems" by J. H. Dunn, D. D. Howard & A. M. King, U. S. Naval Research Lab.

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"The Engineering of Communication Systems for Low Radio Frequencies" by J. S. Belrose, W. A. Hatton, C. A. McKerrow & R. S. Thain, Defense Research Board, Canada

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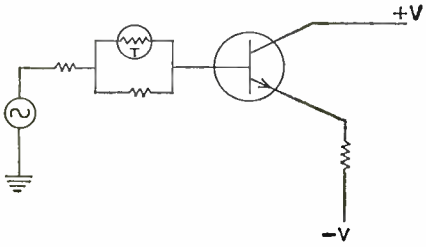
Using Thermistors

Edited by
FENWAL ELECTRONICS

—

COMPENSATING TRANSISTOR NETWORKS

It is relatively simple to extend the operating temperature range of a transistor, or to stabilize its output under temperature fluctuations. A parallel network, consisting of a thermistor and a fixed resistor, is inserted in series with the base. Since thermistor resistance increases with lower temperature, the network automatically reduces the input signal to compensate for increased transistor gain. Design-wise, the tiny thermistor inflicts no size or weight penalties.



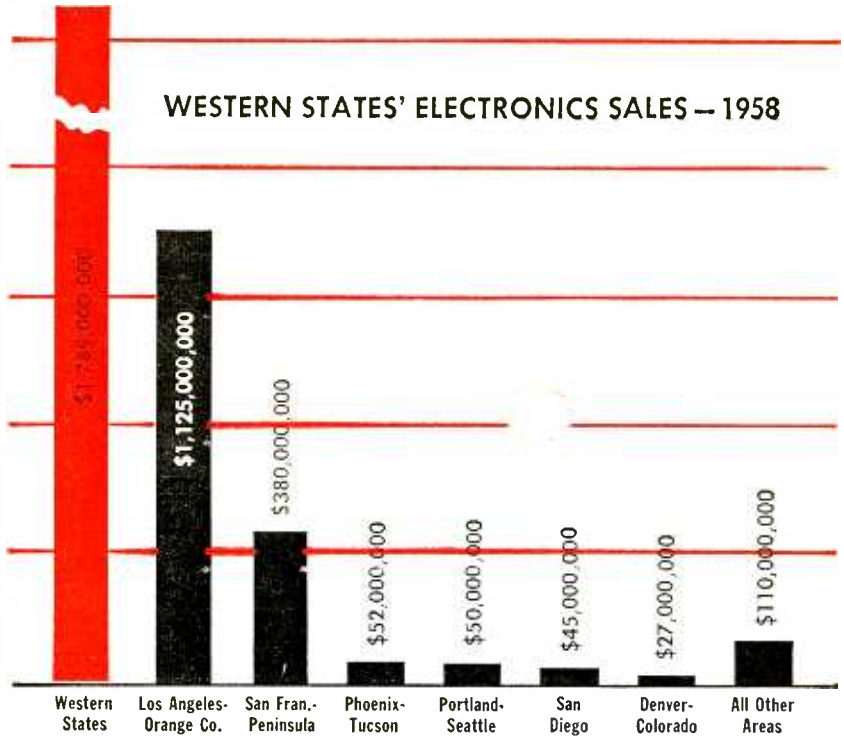
Three typical Fenwal Electronics thermistors being used for the above application are: WB11W1 (washer); LB21J1 (disc); 6B32J2 (bead). In addition, hundreds of other types are available to cover a wide range of circuit requirements. All have precisely reproduceable characteristics and extremely high stability, whether in lots of 10 or 10,000 . . . the result of the modern processing and quality control methods under which they are made. Write for Catalog EMC-2. And for thermistor engineering assistance — just ask. FENWAL ELECTRONICS, INC., 23 Mellen Street, Framingham, Mass.

Choosing the "right" thermistor is easier using the G200 Experimental Kit which contains 12 different thermistors, each with complete operating characteristics. Available from Fenwal Electronics Distributors or the Framingham plant, $19.95 net.

Fenwal Electronics

Making Precision Thermistors
to Make Your Design Ideas Come True
CIRCLE 16 READERS SERVICE CARD

MARKET RESEARCH



Western States Sales Inch Up

WEST COAST and mountain states electronics sales totaled $1.789 billion last year, a shade higher than sales of $1.775 billion in 1957, West Coast Electronic Manufacturers Association recently reported.

Electronics sales by firms in California, Oregon, Washington, Arizona, Nevada, Idaho, Utah, New Mexico, Colorado, Wyoming and Montana make up the total.

The 11 western states accounted for about 23 percent of U. S. electronics industry sales in both 1958 and 1957, according to WCEMA.

Six electronics centers contributed most of the region's 1958 sales, $1.679 billion or 93.8 percent of total.

Most important center by far is Los Angeles-Orange County, with sales of $1.125 billion or 62.9 percent of 1958 West Coast sales. San Francisco-Peninsula, with sales of $380 million or 21.2 percent, is in second place.

Sales breakdowns for the remaining centers were: Phoenix-Tucson, $52 million or 2.9 percent; Portland-Seattle $50 million or 2.8 percent; San Diego, $45 million or 2.5 percent, and Denver-Colorado $27 million or 1.5 percent. All other areas in the 11-state group accounted for the remaining sales, $110 million or 6.2 percent of the total.

The western states also had an appreciable portion of total number of electronics industry firms and employees in 1958. Group had 735 firms, 17.8 percent of the 4,100 U. S. electronics firms. Employment share of the industry total was 134,100—19 percent of 700,000, said WCEMA.

Division of number of firms and employees among the individual centers roughly followed the pattern of center sales.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Mar. 13, 1959	Feb. 13, 1959	Change From One Year Ago
Television sets	96,653	117,982	+9.1%
Radio sets (ex. auto)	275,592	278,318	+61.7%
Auto sets	109,063	107,936	+160.0%

STOCK PRICE AVERAGES

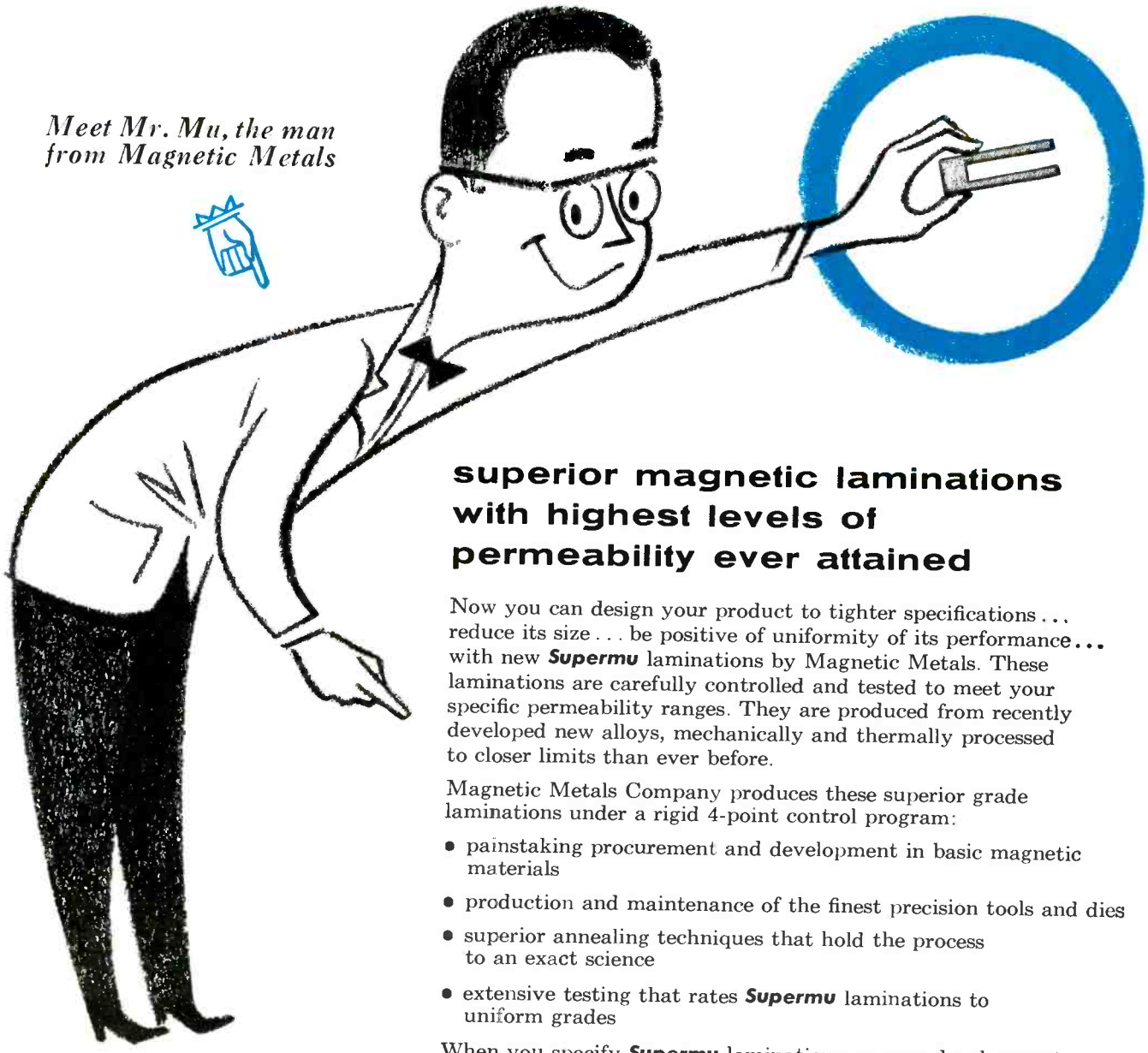
(Standard & Poor's)	Mar. 18, 1959	Feb. 18, 1959	Change From One Year Ago
Electronics mfrs.	82.42	74.56	+56.2%
Radio & tv mfrs.	99.04	81.57	+116.2%
Broadcasters	94.79	83.68	+59.3%

LATEST MONTHLY SALES TOTALS

(Add 000)	Jan. 1959	Dec. 1958	Change From One Year Ago
Transistors, value	$13,627	$16,596	+103.3%
Transistors, units	5,195	5,628	+75.8%
Rec. Tubes, value	$26,808	$25,123	+15.2%
Rec. Tubes, units	31,150	28,504	+16.2%
Pic. Tubes, value	$15,210	$12,644	+23.2%
Pic. Tubes, units	785	649	+26.2%

Supermu
LAMINATIONS . . .

Meet Mr. Mu, the man from Magnetic Metals



superior magnetic laminations with highest levels of permeability ever attained

Now you can design your product to tighter specifications . . . reduce its size . . . be positive of uniformity of its performance . . . with new ***Supermu*** laminations by Magnetic Metals. These laminations are carefully controlled and tested to meet your specific permeability ranges. They are produced from recently developed new alloys, mechanically and thermally processed to closer limits than ever before.

Magnetic Metals Company produces these superior grade laminations under a rigid 4-point control program:

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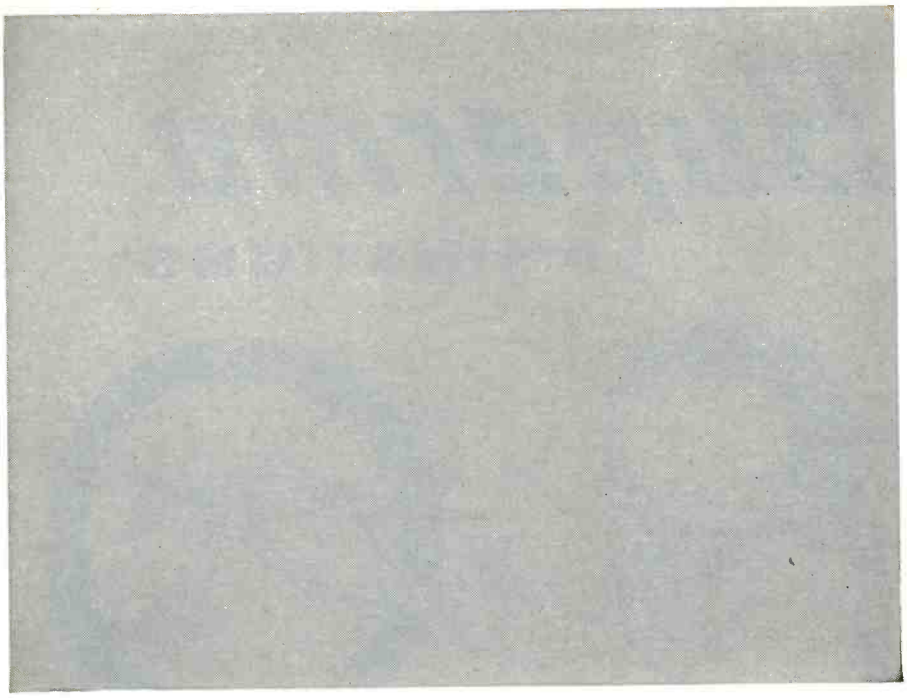

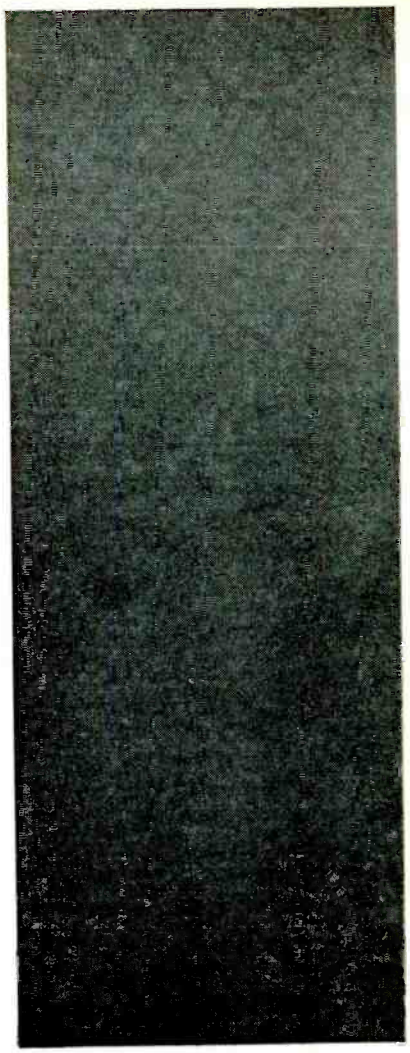

It's great to be proud of the place you work

To some engineers, a job is a job is a job. But it doesn't have to be. It *can* be a career to take pride in, the way the engineers and scientists at Autonetics do.

These young men have already made Autonetics a leader in electronics and electromechanics. For example, they designed the inertial navigation systems for the USS Nautilus and Skate and the monopulse radar system for the Air Force's F-105.

These same young men now are working on new developments—an even more advanced inertial navigation system for the first nuclear-powered Polaris-carrying submarines... the guidance and control systems for the Minuteman and GAM-77 missiles... and many more.

Today at Autonetics there is room for engineers and scientists who want to have a part in these history-making activities. Please send your resume to Mr. C. D. Benning, 9150 East Imperial Highway, Downey, California.

Autonetics

A DIVISION OF NORTH AMERICAN AVIATION, INC.
Downey, California

INERTIAL NAVIGATION / ARMAMENT CONTROL / FLIGHT CONTROL / DATA PROCESSING

Among the achievements of Autonetics' young men: the first successful airborne all-inertial navigation system... first navigation system accurate enough to guide the USS Nautilus and Skate on their historic voyages beneath Arctic ice... first successful automatic star tracking by an inertial navigation system during daylight flight... first completely maneuverable, inertially stabilized gyro platform... first successful completely automatic landing system for supersonic missiles and aircraft... first transistorized portable digital computer with "big computer" capabilities.

CIRCLE 19 READERS SERVICE CARD →

WHY Amperex® FRAME GRID TUBES ARE PREFERRED FOR

RADAR
TEST INSTRUMENTS
MICROWAVE COMMUNICATIONS
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1.

THE FRAME GRID IS APPLIED TO THE CONTROL GRID WHERE IT REALLY COUNTS, WHERE IT PROVIDES:

- BETTER VHF AND UHF TUBES
- HIGHER GAIN BANDWIDTH PERFORMANCE
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AMPEREX FRAME GRID TUBES — PROVEN FOR RELIABILITY BY MILLIONS OF TUBE HOURS (LESS THAN 0.1% PER 1000 HRS. FAILURE RATE) — ARE NOW IN FULL PRODUCTION TO MILITARY SPECIFICATIONS IN ONE OF THE WORLD'S MOST MODERN TUBE MANUFACTURING INSTALLATIONS — AMPEREX HICKSVILLE, LONG ISLAND, N. Y.

THE AMPEREX FRAME GRID CONSTRUCTION IS UTILIZED IN A LINE OF PREMIUM QUALITY TUBES FOR MILITARY SYSTEMS REQUIREMENTS AND EXACTING INDUSTRIAL APPLICATIONS.

he frame grid is the closest approach to the ideal Physicist's grid"—electrical characteristics but no hysical dimensions.

t results in:

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

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

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

AMPEREX 5847 (MIL-E-1/467)
Reliable Broadband Amplifier Pentode
- plug-in replacement for Type 404A in existing equipment
- high figure of merit

AMPEREX 6688A (MIL-E-1/1218 NAVY)
Reliable, Ruggedized, Broadband Amplifier Pentode
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- long-life cathode

AMPEREX 6922 (MIL-E-1/1168 NAVY)
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- high transconductance (G_m = 12,500 $^{+\ 2500}_{-\ 2000}$)
- low noise
- long-life cathode
- new "dimple" anode

AMPEREX 5842 (MIL-E-1/466)
Reliable, High-Gain Single Triode
- plug-in replacement for type 417A in existing equipment
- for grounded grid amplifiers
- high figure of merit
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For additional data write to Semiconductor and Special Tube Division
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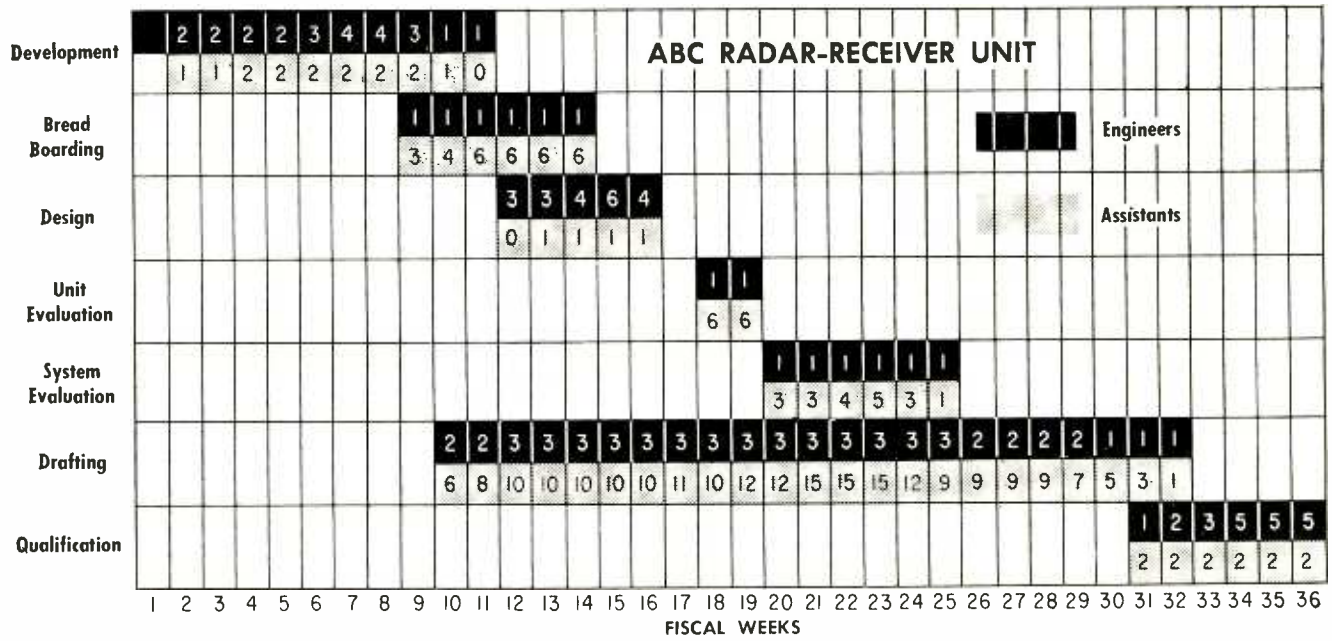


In typical Program Plan, time intervals are broken down into 36 units. Numbers indicate engineers and assistants needed

How to Cut Engineering Costs

By **JEROME PEARLMAN,** Engineering Resources Utilization Planner, GE Co., Light Military Electronics Dept., Utica, N. Y.

PROBLEMS of managing the engineering of weapons systems—or even subsystems—are becoming greater daily. Not only is military equipment getting more complex but the military customer is insisting on faster delivery.

Coping with these tighter requirements brings still another problem. Larger engineering staffs are needed. This brings in new men who, because of their limited time with the firm, lack experience.

Under these conditions, how can an engineering manager best control a project, as well as satisfy his management and customer?

For almost two years, the Light Military Electronics Department of General Electric has been solving these problems for R&D work by adapting the Navy-developed "line of balance" technique already used by LMED for monitoring production contracts.

Following this technique, the manager must (1) determine or plan the technical objective necessary to meet the operational requirements of the equipment; (2) schedule the achievement of these objectives so that military equipment can reach an operational stage as early as possible; and (3) control the money allotted to the program.

To explain the system in more detail let's use as an example a project calling for a search radar system. Specifications are given for accuracy, range, weight and volume. The system is divided into seven self-contained components (see illustration).

Outlines Objectives

After award of the contract, project engineers work up a program plan which develops and outlines the technical objectives of each component, or black box. Objectives are scheduled in time. They are further broken down into individual tasks that can be checked.

Parallel scheduling includes use of manpower and commitment of funds against material and small subcontractors. Subcontractors on a larger program would be expected to provide the same information.

This program plan is used as the basic planning document. Significant checkpoints from the plan are used to develop the milestone schedule chart which outlines the end point of individual tasks needed to achieve the overall project. These check points are numbered for the actual schedule control chart.

A measurement scheme involving the "number of weeks-to-go" to complete each individual task is used. The "line of balance" is also calculated using the weeks-to-go principle. From the program plan it is simple to calculate the "line of balance."

Line of balance = Total weeks estimated − Weeks to go/Total weeks estimated.

For example: A task is estimated to take 10 weeks. After five weeks, the remaining work is estimated to take five more weeks. Therefore 10-5/10 = 5/10. This shows that 50 percent of the work should be completed.

The actual accomplishment is calculated as follows:

Actual Accomplishment = Weeks Expended/Weeks-to-go + Weeks expended.

If five weeks have been expended and the remaining work is estimated to require seven weeks more, then 5/12 of the work is finished.

Therefore, the line of balance shows that 50 percent of the work should be completed whereas actual accomplishment tells us that only 41.6 percent has actually been finished.

The engineering manager must

then advise management that the work is behind schedule.

An alternative technique—measuring the percentage of physical work completed—was evaluated but found to be less desirable than measuring by time. It's of little value to know that 99 percent of the work is completed if the remaining one percent will cause a slippage of six weeks.

Avoids Slippage

The funds assigned to the overall program can also be subdivided. The engineering manager can monitor the technical accomplishments, schedule and costs at the same time.

Early prediction of slippage can avoid actual slippage, since there are alternatives available to a manager to avoid future problems.

For an unbiased approach, it is well to place the schedule and cost monitoring function outside the project organization. In addition, the interchange of information becomes beneficial since one schedule analyst can handle more than one project.

It is necessary that trained people be used in this function. In many cases a value judgement is required to determine the reasons underlying slippage.

Many other advantages result from this system: A complete history of each project is maintained. This allows the comparison of past projects to present ones for the purpose of bidding more accurately on future jobs.

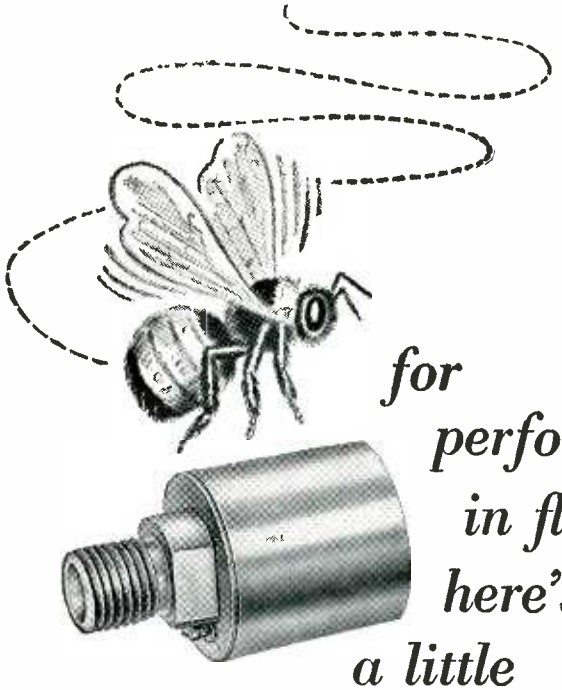
Also, comparisons can be made between current projects for shifting manpower and facilities.

Personnel evaluation is aided by having a running history of a job. Bias of personality traits can be removed from a job appraisal.

Another byproduct of this system is management planning and measurement when it is necessary to shift personnel.

This technique is one which is simple to administer and can provide an engineering manager or engineering project manager with much information he formerly lacked overall management also benefits from early planning.

Furthermore, this tool acts as a visual aid by closing the very important managerial loop of planning—and measuring technical accomplishment, schedule and cost.



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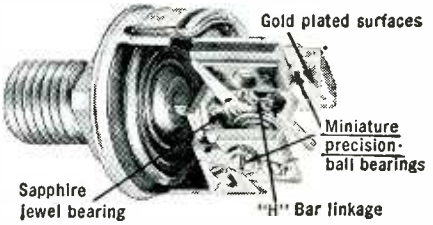
The excellent performance under environmental conditions is due to an improved "H" bar linkage between the diaphragm push rod and the potentiometer wiper arm which permits the moveable parts to be statically and dynamically in balance under various vibrations and accelerations.

Fairchild's line of Pressure Transducers include bourdon tube and capsular diaphragm types for measuring pressures from 1 to 10,000 psi, absolute, gauge, or differential. Standard units have pot pick-offs; a.c. type pick-offs available on special order.



SPECIFICATIONS AND CHARACTERISTICS			
Vibration	10 to 55 cps, 0.1" da; 55 to 2,000 cps 15g. Error less than 1%. Will withstand 25g, 10 to 2,000 cps.	Pressure Range	0-5 psi to 0-350 psi a, g or d.
		Linearity	±1.0%
Acceleration	40g in 3 planes; error less than 1%. Withstands 75g.	Size (Volume)	¾ cubic inch (1" dia x 1" long)
Shock	50g without damage or permanent calibration shift.	Temperature	—54°C to +100°C. Error less than 1% for most ranges.

For more information write Fairchild Controls Corporation, Dept. 23E

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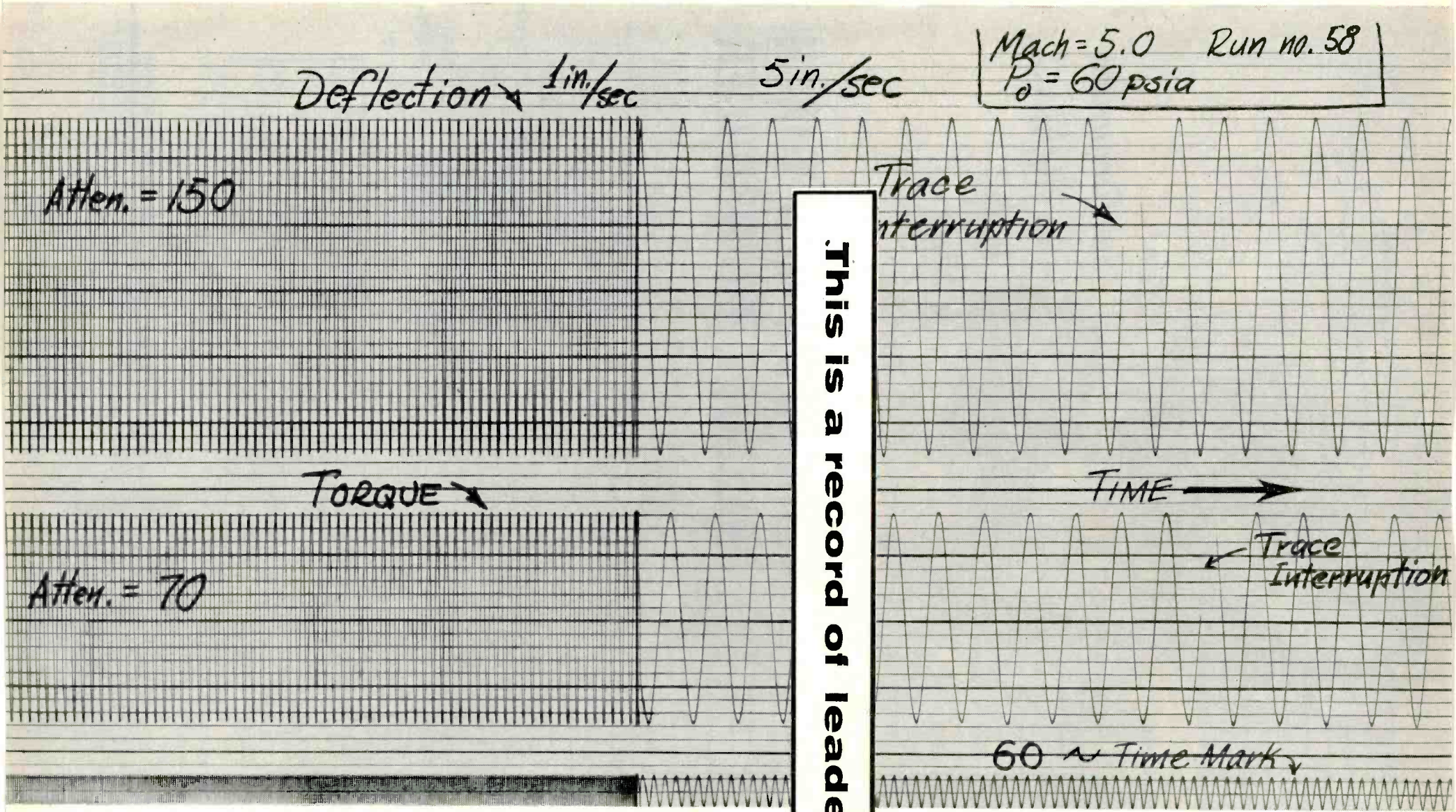


This is a record of leadership

Honeywell 906A Visicorder record, actual size. Note longitudinal grid lines and trace identification interruptions.

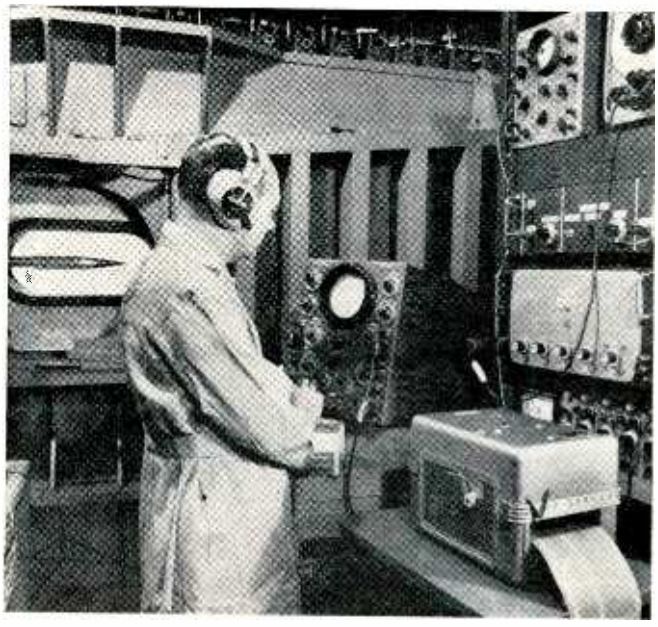
These studies of aerodynamic damping coefficients on an airframe were made by engineers at ARO, Inc. They were conducted in the Gas Dynamics Facility at the U.S.A.F.'s Arnold Engineering Development Center, Tullahoma, Tennessee, wind tunnel center of the Air Research and Development Command.The studies were directly recorded on a Honeywell 906-A Visicorder.

The problem: To measure damping-in-pitch derivatives for a clipped-delta-wing-body configuration over a Mach number range of 2.0 to 5.0 so that these measurements could be compared with the Mach number trend predicted by theory.

The set-up: A model of the delta-wing body, mounted on its cross-flexure pivot support, was forced to oscillate through a linkage by an electro-magnetic shaker. Resistance strain gauges were bonded to the input torque member and to one of the pivot supports. These gauges supplied torque and displacement signals through a carrier amplifier to two galvanometers in the Visicorder. An oscillator, driving a third galvanometer, established a time base for the oscillogram.

The values discovered through this forced-oscillation balance system experiment showed some discrepancies from values predicted by theory, because the theory pertained to simpler bodies than that used in the tests. The experiments provided a new set of data which will result in more accurate predictions for future design.

in aerodynamic research



Z. A. Woodard, Jr., ARO, Incorporated, instrument technician, operates the Visicorder in the measurement of aerodynamic damping coefficients.

The Honeywell Visicorder is the pioneer and unquestioned leader in the field of high-frequency, high-sensitivity direct recording oscillography. In research, development and product testing everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

The new Model 906A Visicorder, now available in 8- and 14-channel models, produces longitudinal grid lines simultaneously with the dynamic traces, time lines, and trace identification by means of new accessory units.

To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: Write for Visicorder Bulletin
Minneapolis-Honeywell Regulator Co.,
Industrial Products Group, Heiland Division
5200 E. Evans Ave., Denver 22, Colo.

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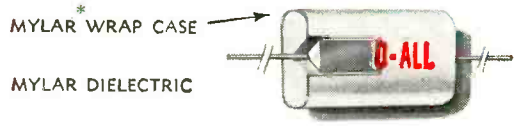
CAPACITORS

New, flat shape invites "crowding"

663 F.. for Terminal Board assembly



663 FR.. for Printed Circuit Boards

These special-purpose versions of popular Good-All Type 663UW offer great flexibility in fitting capacitance into tight spaces. They are conservatively rated and provide the same dependability and electrical ruggedness that has made the 663UW tubular a "standard of quality" for both military and instrument-grade equipment.

*DuPont's trademark for polyester film.

SPECIFICATIONS

TEMPERATURE RANGE—Full rating to 85°C; to 125°C with 50% derating.

LIFE TEST—250 hours at 85°C and 125% of rated voltage.

VOLTAGE RANGES—100, 200, 400 and 600V DC.

CLOSE TOLERANCES — Available in tolerances to ±5%.

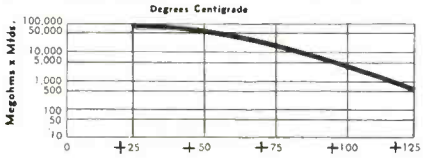
INSULATION RESISTANCE—See I.R. versus temperature curve below.

DIELECTRIC STRENGTH—Twice rated voltage for 1 minute.

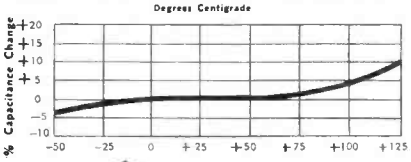
TYPICAL SIZES SHOWING THICKNESS - WIDTH - LENGTH

CAPACITANCE IN MFDS.	100 VOLTS T	W	L	200 VOLTS T	W	L	400 VOLTS T	W	L	600 VOLTS T	W	L	1,000 VOLTS T	W	L
.001	.062	3/16	1/2	.062	3/16	1/2	.062	3/16	1/2	.062	3/16	3/4	.125	1/4	3/4
.0047	.062	3/16	1/2	.062	3/16	1/2	.093	7/32	3/4	.125	1/4	3/4	.156	5/32	7/8
.01	.062	3/16	1/2	.062	3/16	1/2	.140	1/4	1/8	.203	3/8	3/4	.234	3/16	7/8
.022	.093	7/32	3/8	.140	1/4	3/4	.203	3/8	3/4	.234	7/16	7/8	.218	13/32	1 1/8
.047	.125	1/4	3/4	.156	9/32	3/4	.218	13/32	7/8	.281	17/32	1	.343	13/16	1 1/8
.1	.156	9/32	7/8	.234	3/16	7/8	.250	1/2	1	.312	19/32	1 3/8	.359	13/16	1 1/2
.22	.187	3/16	1	.250	1/2	1 1/8	.343	23/32	1 3/8	.468	3/4	1 3/4	.500	1 1/4	1 3/4
.47	.281	5/16	1 1/4	.340	23/32	1 1/4	.437	15/16	1 3/4	.531	1 3/32	2	.765	1 3/4	2
1.00	.359	3/4	1 1/2	.437	15/16	1 3/4	.500	1 1/8	2	.796	1 1/2	2 1/2	.859	1 7/8	2 3/4

Insulation Resistance vs. Temperature



Capacitance Change vs. Temperature



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Space Projects for 1969

Today many electronics firms are doing research work on systems 10 years away from operational reality. Here's a detailed report

WASHINGTON — An increasing volume of defense funds is being poured into research on advanced systems which are not likely to be operational for another decade. These include communication, reconnaissance, and navigation satellites; maneuverable space vehicles; and detection techniques based on advanced radar, optical, and infrared concepts.

Responsibility for their development has been transferred from the individual military services to the Advanced Research Projects Agency. ARPA receives appropriations directly from Congress. For the most part, however, the new agency farms out administrative responsibilities for advanced projects to the individual services.

This year, ARPA's budget totals $520 million. For fiscal 1960, starting July 1, the agency's budget will be $455 million.

Ballistic Missile Defense

Research spending by ARPA for ballistic missile defense runs at about $100 million for this year, will rise slightly in fiscal 1960. ARPA's program excludes the Air Force's Ballistic Missile Early Warning System and Army's Nike-Zeus antimissile missile system.

The ARPA-sponsored ballistic missile defense work aims at the next generation of systems to detect, track, and destroy missiles.

Bendix has a contract to build large ESAR radars to experiment with new detection techniques. These are Electrically Steerable Array Radars in which the radar beam is moved by changing the electrical energy fed to the antenna elements. The vhf ESAR can produce 50 megawatts of peak power.

NCA has a contract to build additional BMEWS-type long-range radars for testing purposes—to measure test missiles in flight.

Cornell Aeronautical Laboratory is performing very high-power radar experiments to get 50 megawatts of peak power at S-band. MIT's Lincoln Laboratory is studying reentry physics. The Air Force's Cambridge (Mass.) Research Center is working on infrared techniques.

MIDAS Project

In the infrared field, the primary project is MIDAS (Missile Defense Alarm System). This envisages the use of an infrared system installed in an earth-circling satellite.

The other angle of missile defense centers on a destructive system—a technique to destroy or neutralize oncoming missiles in the upper atmosphere. The earliest system, Nike-Zeus, presumably involves the explosion of a nuclear-tipped missile.

The highly-touted Project Argus, involving nuclear blasts at an altitude of some 300 miles, showed the possibility of an antimissile radiation belt and demonstrated how upper atmosphere nuclear detonations can interfere with radar and radio transmissions.

One more advanced ARPA project involves the ejection of high-velocity ball bearing-type particles or grains of sand to penetrate the warheads of oncoming missiles. Even more advanced projects are concerned with "electromagnetic radiation weapons"—the so-called "death rays" which military planners now take seriously.

Current research runs the gamut of low-frequency radio waves, cosmic rays, ultraviolet, infrared, and x-rays. The researchers are grappling with the problems of how to generate the energy and transmit it in small beams to a missile target. Conceivably, such radiation weapons could be used to neutralize human targets without causing permanent injuries.

Astronautics Research

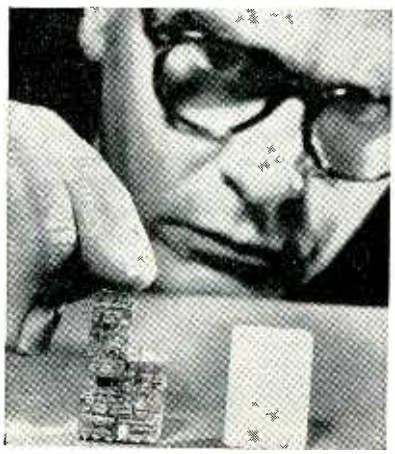
Over $300-million worth of ARPA research is in the field of astronautics. The Discoverer series of satellites are tests on how to return a satellite from orbit and biomedical experiments aimed at development of manned recoverable space vehicles.

The "Mrs. V" program aims to develop a truly maneuverable and recoverable vehicle. Included in this program is the Dynasoar boost-glide or orbital bomber. Two teams of contractors are competing on design studies: Martin, Bendix, Goodyear Aircraft, Minneapolis-Honeywell and American Machine & Foundry, and a team consisting of Boeing, GE, Thompson Ramo Wooldridge, North American Aviation, Chance Vought and Aerojet.

The Sentry WS-117L reconnaissance satellite is under development by a team of contractors headed by Lockheed.

A communications satellite system is scheduled for five more years of R&D. The program began with project Score, in December, when an Atlas ICBM placed a simple delayed repeater system into satellite orbit. More sophisticated versions have been ordered to have a communications capacity equivalent to 20 continuously available 100-words-per-minute Teletype channels.

Military Radio



All the electranic parts of this military radia are no bigger than a sugar lump. Receiver is made of micromodules, circuit building blocks developed by Army Signal Research & Development Laboratory and RCA

NOTABLE ACHIEVEMENTS AT JPL...

Months before Pearl Harbor, JPL had tested America's first liquid rocket engines using spontaneously igniting propellants. By April 1942, a simple nitric acid-aniline propulsion system was designed into and successfully tested in an A-20-A Bomber for a jet-assisted takeoff. For high-altitude atmosphere research purposes, JPL then used the hypergolic liquid rocket system in the WAC CORPORAL. Placed as a second stage on a V-2 rocket, this became the BUMPER WAC rocket that established a World's altitude record of 242 miles in February 1949.

At the request of U.S. Army Ordnance, the Jet Propulsion Laboratory now began to develop a long-range guided ballistic missile system, incorporating the proven, smooth-burning light-weight acid-aniline system. These achievements sparked the development of a whole series of rocket vehicles. In 1954, the Army accepted the JPL developed CORPORAL, which became America's first tactical guided ballistic missile system; its accuracy exceeded design requirements.

Under the direction of the National Aeronautics and Space Administration, the experienced Jet Propulsion Laboratory research and development team is now working on storable, high-performance hypergolic liquid propulsion systems with which space vehicles may soon orbit the moon and planets.

jpl

CALIFORNIA INSTITUTE OF TECHNOLOGY
JET PROPULSION LABORATORY
A Research Facility of the National Aeronautics and Space Administration
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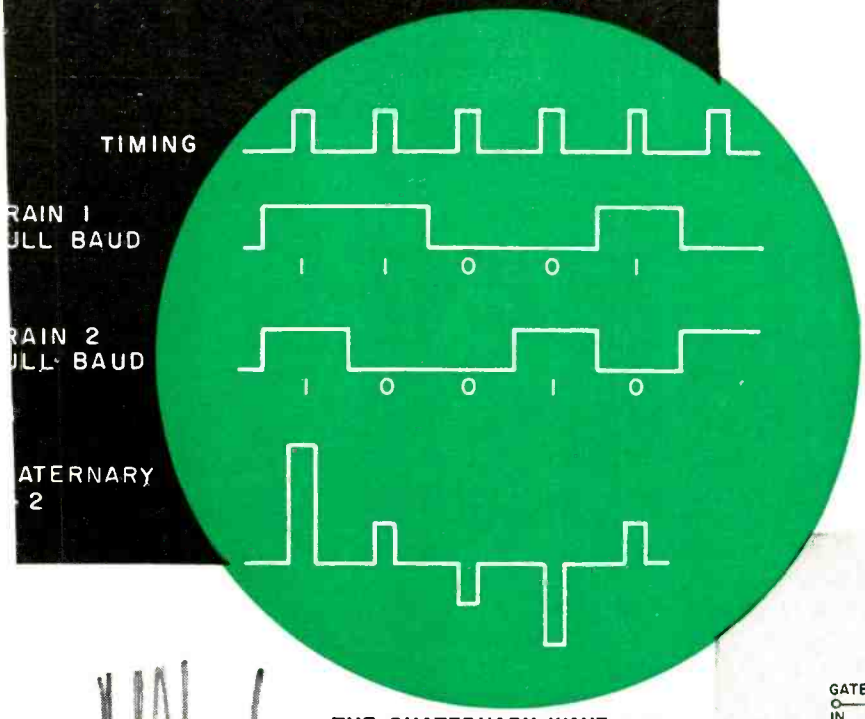
CIRCLE 24 READERS SERVICE CARD

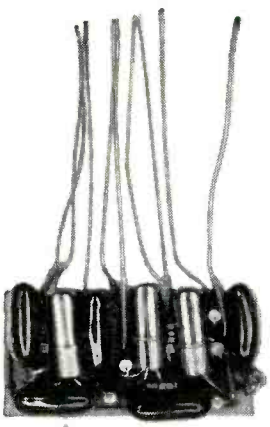
PULSE CODE MODULATION



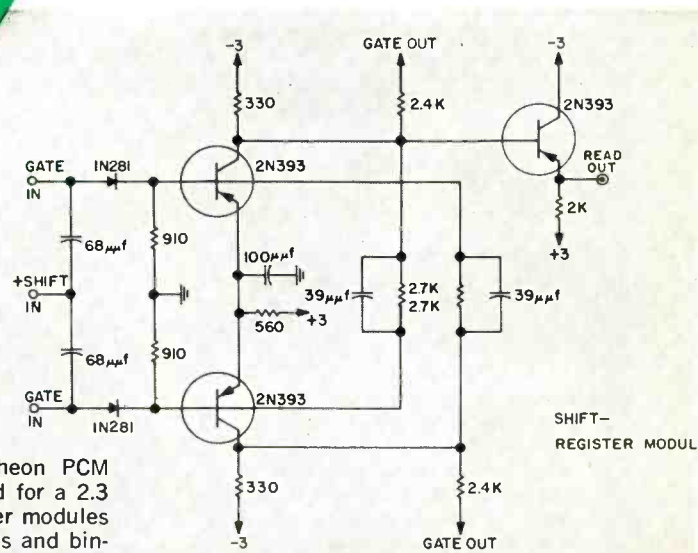
PCM is a new method of coding voice and analog information into digital form. It provides a completely digitalized message by time-division multiplexing of voice circuits. Adaptation of the technique offers advantages in signal-to-noise characteristics, signal regeneration, message security and equipment reliability not usually achieved with conventional techniques.

A 96-voice channel, fully transistorized PCM equipment for cable and radio transmission meeting rugged military requirements is now being developed by the Communications Department of Raytheon's Government Equipment Division. In this system a sampling frequency of 8,000 cycles is used. Each sample is coded in six-bit binary form, at a bit frequency of 4.6 mc. Many new circuit techniques, closely allied to high-speed data processing and computer systems are being developed for this equipment.

THE QUATERNARY WAVE combines information from trains 1 and 2, and the timing pulse regulates the width and position of the quaternary output wave. Thus, twice as much information is passed through the same bandwidth as is required for one train.



TYPICAL MOLDED MODULE used in Raytheon PCM equipment comprises logic circuitry required for a 2.3 mc shift register shown in the diagram. Other modules are used for repetitive and-or gates, flip-flops and binary-storage elements.



NEW OPPORTUNITIES WITH A FUTURE

Your background in design, development, production or manufacturing of radar, sonar, infrared, communication or countermeasure equipment may qualify you for an engineering future with Raytheon. Please write to Donald H. Sweet, Professional Personnel, Raytheon Manufacturing Company, Government Equipment Division, Wayland, Massachusetts.

Engineering Laboratories: *Wayland, Maynard, Mass.; Santa Barbara, Calif.* • Manufacturing Facilities: *Waltham, North Dighton, Mass.*

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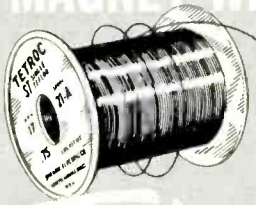
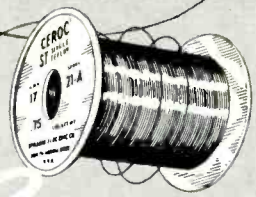


Tetroc

FOR CONTINUOUS OPERATION AT HOTTEST SPOT TEMPERATURES UP TO 200°C



Ceroc

FOR CONTINUOUS OPERATION AT HOTTEST SPOT TEMPERATURES UP TO 250°C

For continuous operation at hottest spot temperatures up to 200°C (392°F) and up to 250°C (482°F) for short periods of time—depend upon TETROC—an all Teflon-insulated wire available in both single and heavy coatings.

CEROC is Sprague's recommendation for continuous operation at hottest spot temperatures up to 250°C (482°F) and up to 300°C (572°F) for short periods of time. Ceroc has a flexible ceramic base insulation with either single silicone or single or heavy Teflon overlays. The ceramic base stops "cut-through" sometimes found in windings of all-fluorocarbon wire. Both Tetroc and Ceroc magnet wires provide extremely high space factors.

Write for Engineering Bulletins 405 (Tetroc Wires) and 400A (Ceroc Wires).

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Infrared Spots New

Climb of $10 million in sales over past two years makes infrared manufacturers optimistic about the industrial market's future

TODAY'S commercial market for infrared devices has grown to an estimated $15 million yearly. Two years ago the market total was about $5 million.

One commercial application of infrared (ir) currently in the limelight is detectors used by railroads to spot overheated boxcar bearings, or hot boxes, in moving trains.

Railroaders, who spend about $288 million annually in bearing maintenance, say these hot boxes occur at the rate of about 150 a day on a nationwide average. An infrared hot box detector can spot a bearing about to give trouble, signal the train to stop, and tell the crew where the hot box is.

Likely Markets

Present count of railroads using ir detectors is twelve. One manufacturer reports sales of more than 100 hot-box detectors at a base cost per unit of about $15,000. The firm expects to sell close to $20 million in the ir field by 1961.

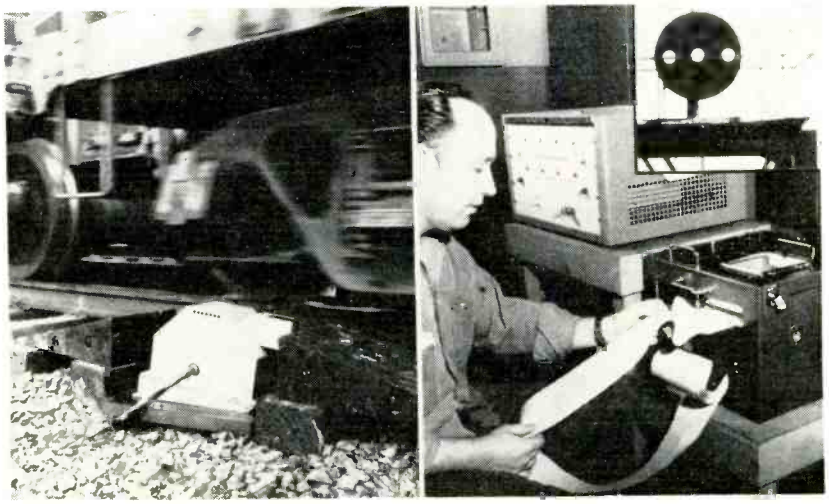
Another area holding promise for commercial ir devices is process control. There are many possible uses for temperature control by infrared equipment in the manufacture of such products as rolled metal, ceramics, plastic and glass.

Process control in petroleum and chemical plants is also mentioned as a promising area for ir gear. As these installations become increasingly automated, infrared measurements will grow in importance. A main reason is that corrosive or poisonous materials can be observed without danger to personnel or equipment. Infrared devices can also check temperatures of fluids in motion and reveal information for in-process solutions, relieving oil refiners of the need to make frequent batch samples.

Temperature of moving and rotating solid objects such as ball bearings can be measured with ir equipment. To the manufacturer this means longer machinery life and better quality control.

Potentials Seen

Medical researchers are using infrared devices to diagnose illness and advance their knowledge of the human body.



"Hot box" detector by Servo Corp. of America signals train to stop and makes a record

Markets

Manufacturers see a large potential market in process control gear but point out that commercial ir devices must be shown to potential customers as demonstrably valuable equipment. In contrast to military units, which are usually developed under government contract, the manufacturer must pay his own way for industrial R&D.

Commercial A-Power

A market that may be less difficult than industrial process control, according to some manufacturers, will come of age with increased use of atomic reactors for commercial power. The radioactive regions of a nuclear reactor are often those where exact temperature control is most needed. Infrared equipment can obtain precise readings without endangering personnel.

Large-scale production of infrared equipment has to some extent been hampered by the precise balance required between the optical and detector portions of the typical infrared device.

Proper operation depends on choice of a variety of lenses, or windows, in differing sizes and shapes depending on use, and on the crystal flakes used in the detector cell.

Rise Expected

Typical ir equipment operation often relies on two matched flakes of a semiconductor substance, usually lead sulphide. One "sees" the target object, while the other acts as a reference base for the general temperature range anticipated.

One engineer says the matching problem somewhat resembles the difficulties encountered by equipment designers in the early stages of transistor development.

Despite these and other problems, commercial infrared sales seem sure to rise encouragingly. One executive predicts a total infrared volume of more than $500 million by the early 1960's. Other industry spokesmen confirm this and estimate that about 25 percent of the total will be in the commercial and industrial fields.

Solid-Electrolyte Tantalex® Capacitors

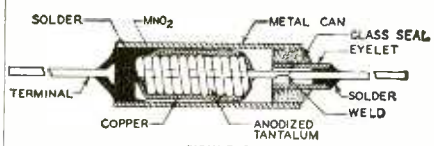


FIGURE A

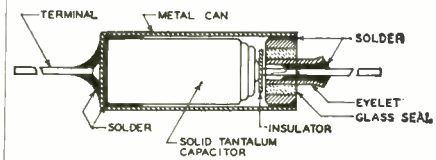


FIGURE B

The ultimate in reliability, achieved through constant research, is evident in Sprague Type 150D Solid-Electrolyte Tantalex Capacitors. True miniaturization and excellent stability of electrical characteristics make them ideal for transistor circuits in military and industrial applications.

Figure A shows a typical construction used for low capacitance values. The anode is a coil of smooth-surfaced tantalum wire which has been anodized to obtain the dielectric surface film. This type of anode is used only for fractional capacitance values.

Figure B shows a typical porous-anode, hermetically-sealed capacitor. The anode is of the sintered tantalum pellet-type which exhibits a large gain in surface area per unit volume. Thus, the resulting capacitor has a large capacitance-to-volume ratio. It cannot leak or corrode even if the hermetic seal of the outer-metal case be broken or destroyed.

These capacitors may be used wherever stable capacitance and low dissipation factors are dictated over a wide temperature range. The capacitance varies by only a few per cent from room temperature down to −80°C or up to +85°C and the dissipation factor is nearly constant. These capacitors can be used at 125°C with proper voltage derating.

Write for Engineering Bulletin 3520C to Technical Literature Section, Sprague Electric Co., 35 Marshall St., North Adams, Mass.

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- for miniature portables
- for many other miniature applications

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Check these important features:

- special polyester film and thin gauge foil
- excellent service life under severe heat and humidity
- available in ratings from .01 to 1.0 MF
- extended foil "non-inductive" design

Get these YELLOW-JACKET miniatures from your distributor without delay. Or, write for Engineering Bulletin No. 2063A to Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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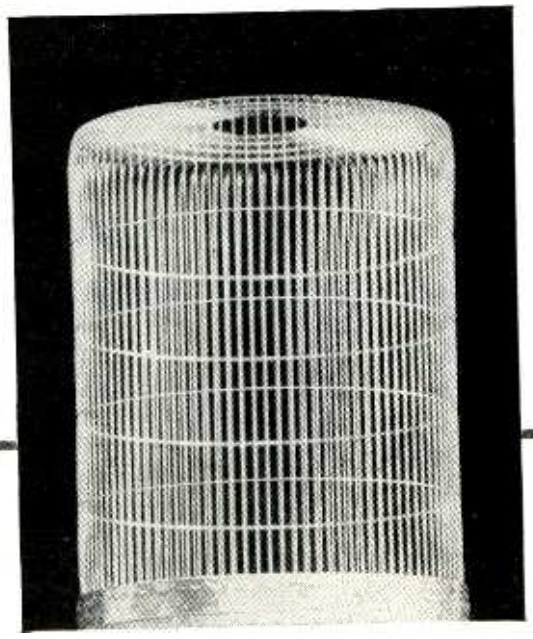
platinum clad tungsten wire is most efficient for high temperature applications



Platinum clad tungsten wire is ideally suited to modern requirements for high power vacuum tube grid and other high temperature applications. Because of its superior physical properties at elevated temperatures, tungsten provides the more rigid, refractory core material required by high power tubes; it also exhibits lower interaction with platinum. Unlike molybdenum, platinum clad tungsten is readily hot-stretched to take a permanent setting and lends itself to fabrication into grids employing conventional fixtures and spot welding procedures. Available in diameters from .001" and up. Write for Technical Bulletin.

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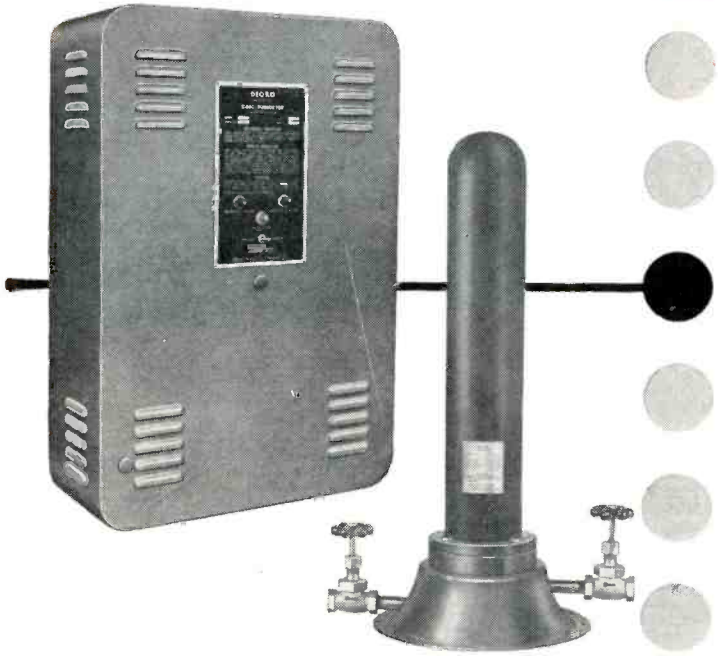
for low cost purification and drying of hydrogen and other gases



The Deoxo Catalytic Purifier is combined with an extremely efficient automatically operated drying unit to provide oxygen-free hydrogen that is ideally pure and dry. The combined units are identified as the Deoxo Dual Puridryer. It supplies hydrogen with less than one part oxygen per million — dried to a dew point of —100°F. *No inert gas purging is needed.* The Deoxo Dual Puridryer can also be used with other gases such as: Nitrogen, Argon, Helium and saturated hydrocarbons, with equally fine performance. Write for descriptive literature.

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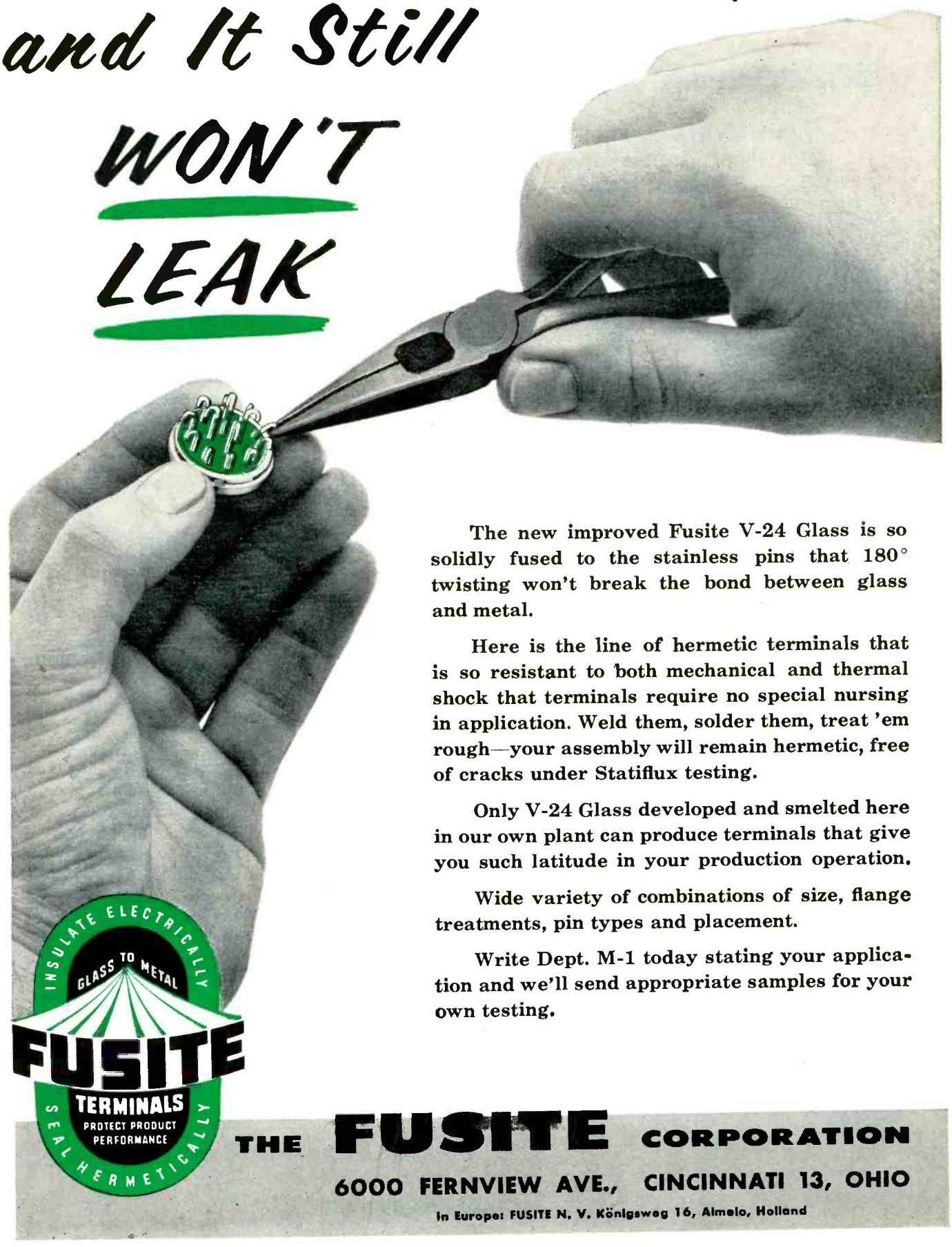

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Army Buying Field Computers

Service reveals plans for purchasing mobile data-processing equipment through 1970

ARMY HAS specific plans for steady procurement of mobile data processing equipment for field armies up through 1970.

First deliveries of prototype equipment will begin arriving at Army's Electronic Proving Ground, Fort Huachuca, Ariz., in December. Equipment will consist of machine information programs, five mobile computers (Fieldata Family) and associated communications gear. The integrated complex, Automatic Data Processing System (ADPS), will provide tactical commanders with instantaneous data.

ADPS will be for field armies what ITT's 465-L will be for the Strategic Air Command (ELECTRONICS, p 35, Feb. 27).

First prototype ADPS has been scheduled for field testing at Fort Huachuca during 1962-1963. Between 1965-1970, the Army plans to have a completely operational and more advanced system called Armydata.

Technical assistance for the program is being supplied by Ramo-Wooldridge and subcontractors IBM and Broadview Research Corp. R-W's $13.6 million contract covers a five-year period.

Five members of the mobile Fieldata Family are now under construction:

Largest is MOBIDIC (MOBIle DIgital Computer), a general-purpose digital computer, van-mounted, air transportable and completely transistorized. It is designed for use at the higher echelons of command, such as Corps, Army or Theater. Prime contractor Sylvania has received contracts from the Signal Corps for four computers totaling $6.5 million to date.

BASICPAC (BASIC Processor And Computer), primed by Philco, is a medium-size general-purpose transistorized computer designed with a large computational ability and memory storage capacity.

LOGICPAC (LOGICal Processor And Computer), also primed by Philco, is another transistorized medium-size computer. It will be used for file processing and logical operations such as logistics and personnel-type problems. Philco's contracts for Basicpac and Logicpac total $1.094 million.

Information Storage And Retrieval Device, primed by IBM, has a flexible capability for storing vast amounts of information.

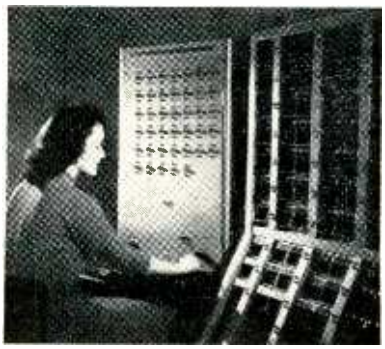
Data Coordinator, also by IBM, supervises and coordinates the operation of an ADP system in the field, and will consist of several computers and input/output devices. IBM's contracts to date total $2.6 million.

Terminal transmission equipment supports the Fieldata Family and connects the computers to the Army communication network. High speed printers, electric typewriters, paper and magnetic tape devices and graphical plotters are used to translate the magnetic and electronic impulses into understandable language.

The new computer center at Huachuca will simulate mobile tactical computers in the Fieldata Family in advance of actual field use with an IBM 709.

In addition to the Fieldata Family, the center will provide a data-processing service for other technical programs such as: designing, testing and evaluating communications-electronics systems.

Sorts Transistors



Transistors are tested and automatically classified into as many as 1,200 performance levels after Raytheon employee plugs part into test socket

TUBE PROBLEM:

The Armed Forces needed a new version of the 6J4 reliable tube type which would provide a tube life of almost 1000 hours. Existing tubes of this type had an average life of only 250 hours. In addition, this new tube had to be produced under ultra-high quality control standards.

SONOTONE SOLVES IT:

By making improvements in the cathode alloy and setting up extremely tight controls in precision, manufacture and checking, Sonotone engineers produced a 6J4WA with a *minimum* life of 1000 hours... most running *much longer.*

RESULTS:

The Sonotone 6J4WA is one of three reliable tubes now being manufactured under U.S. Army Signal Corps RIQAP (Reduced Inspection Quality Assurance Program), monitored by the U.S. Army Signal Supply Agency. And the same rigid quality standards apply to Sonotone's entertainment type tubes as well.

Let Sonotone help solve *your* tube problems, too.

Sonotone

Electronic Applications Division, Dept. TRR-49

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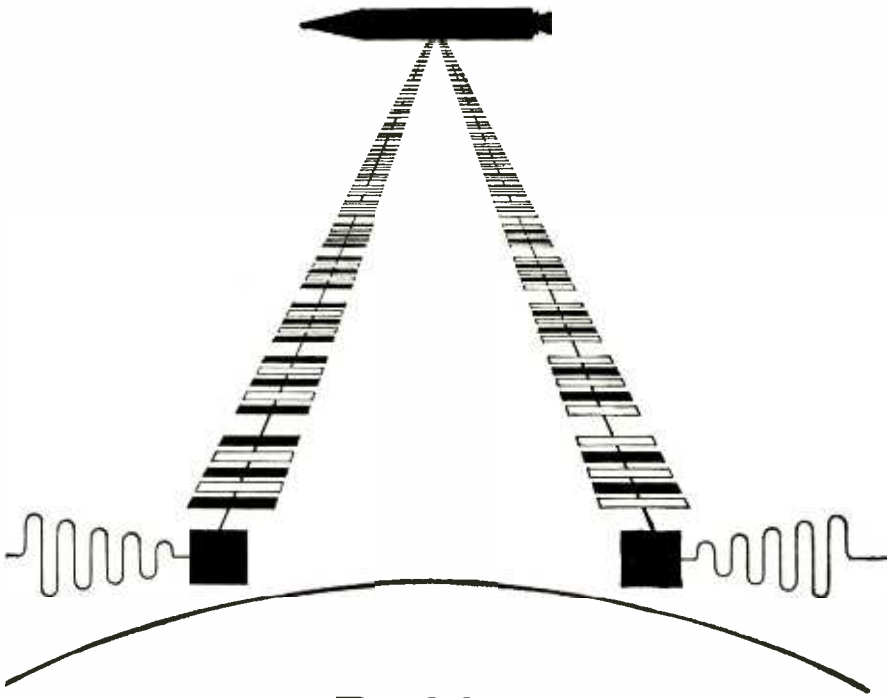

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MEETINGS AHEAD

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

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

Apr. 6-10: Instrument Show, International, 4 Tilney St., Park Lane, London.

Apr. 12-19: Aircraft and Space Communications, World Congress of Flight, EIA, Las Vegas, Nev.

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

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

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

Apr. 20-21: Analog & Digital Recording & Controlling Instrumentation, AIEE, PGIE & PGI of IRE, Bellevue-Stratford Hotel, Philadelphia.

Apr. 20-22: Instrument Society of America, Southeastern Conf. & Exhibit, Gatlinburg, Tenn.

Apr. 20-22: Man-in-Space Conf., American Rocket Society, Hotel Chamberlain, Hampton, Va.

Apr. 21-22: Electronic Data Processing, IRE Section, Engineering Society Building, Cincinnati, O.

Apr. 22: Medical Electronics, The Electro-Medical Program at the Moore School, PGME of IRE, Univ. of Penn., Philadelphia.

Apr. 30-May 1: Controllable Satellites Conf., ARS, M.I.T., Cambridge, Mass.

May 3-7: Electrochemical Society, 115th Annual Meeting, Hotel Sheraton, Philadelphia.

May 4-6: Aeronautical Electronics, National Conf., PGANE of IRE, Biltmore Hotel, Dayton, O.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 78.

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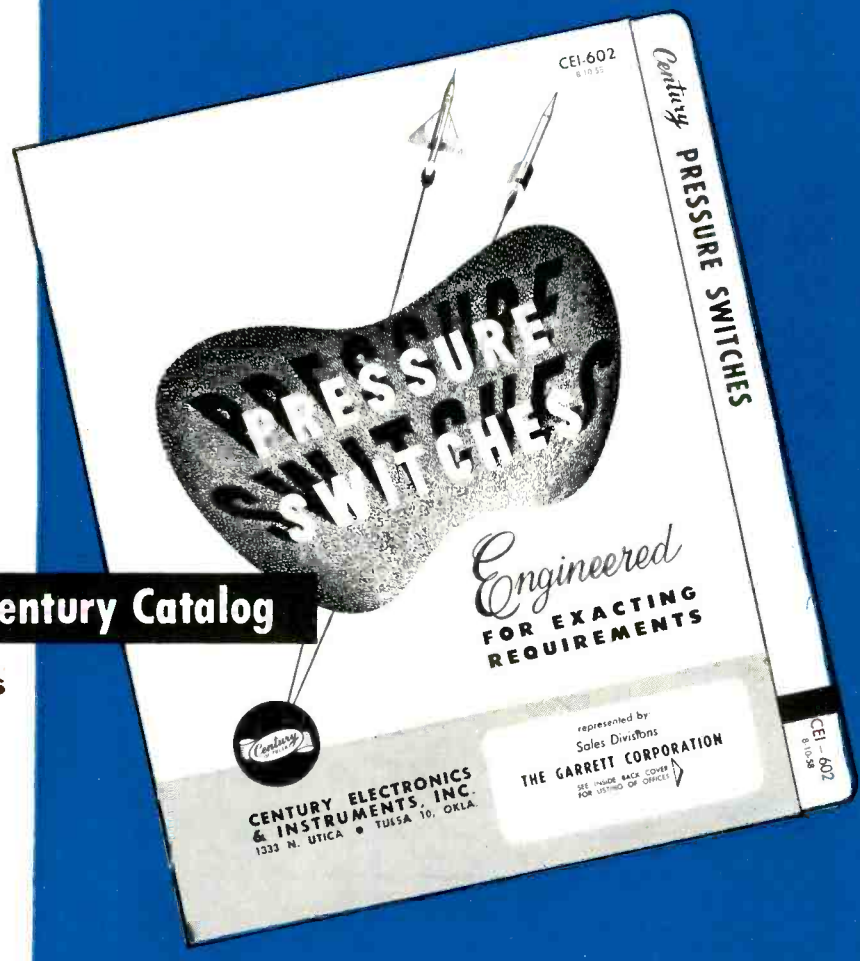

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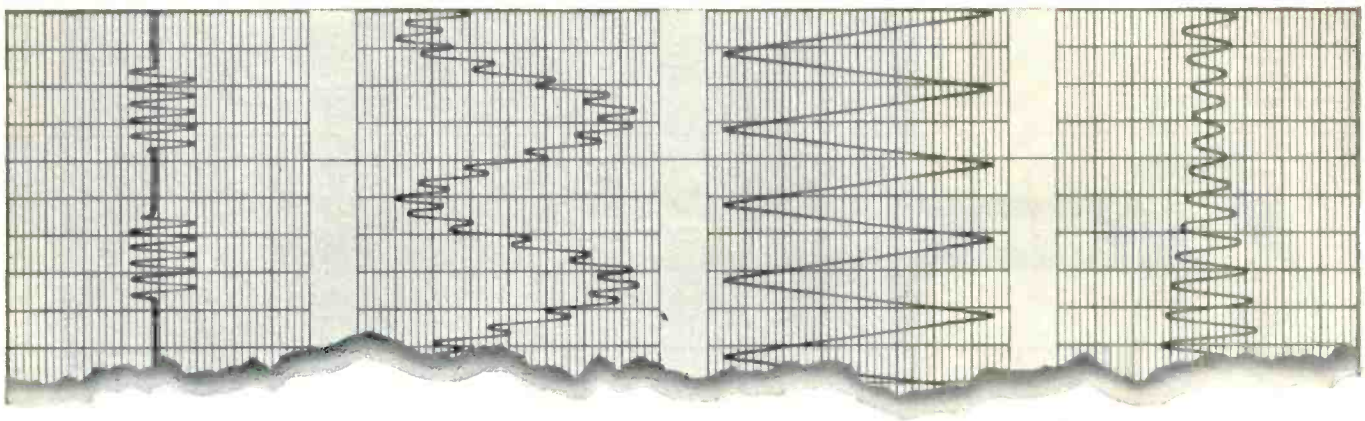

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Chart paper, pens, ink and the equipment are specifically designed to realize the full potential of the recording system. The result —highest quality chart records attainable.

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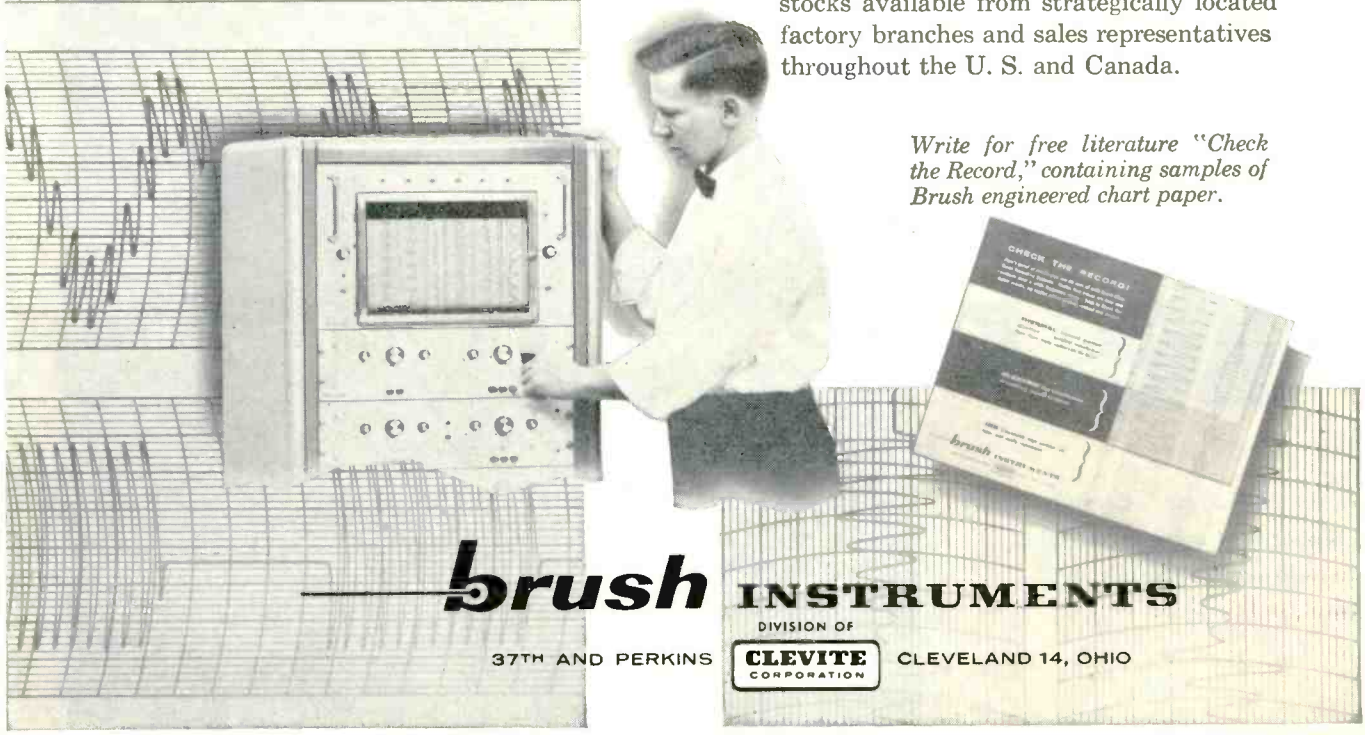
Your records are accurate, permanent, immediately usable, legible and easily reproduced when you use Brush chart paper.

For the most dependable results from your Brush equipment — make certain you specify Brush chart paper and supplies. Complete stocks available from strategically located factory branches and sales representatives throughout the U. S. and Canada.

Write for free literature "Check the Record," containing samples of Brush engineered chart paper.



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electronics

APRIL 3, 1959

Motorola multiplex transmitter used in closed-circuit test of stereophonic system for television sound

Recent Developments in Stereo Broadcasting

Multiplexing systems to permit compatible stereo broadcasting on a single radio channel now cover f-m, a-m and tv. Here are some questions the new National Stereophonic Radio Committee of EIA must someday resolve

By JOHN M. CARROLL, Managing Editor

STEREOPHONIC SOUND reproduction for the home is currently giving phonograph, tape recorder and custom audio components manufacturers their biggest boom since high fidelity itself. Factory sales of these products increased by more than $100 million during 1958. Reportedly, 10 percent of all hi-fi records sold today are stereo.

STEREO BROADCASTING TODAY — Already there is a push for stereo broadcasts. The Electronic Industries Association has formed an all-industry National Stereophonic Radio Committee to set transmission standards for possible later adoption by the Federal Communications Commission. Some 125 stations currently have some kind of stereo broadcast schedule. Most of these stations have a-m, f-m and/or tv outlets.

Today's stereocasting usually involves placing one microphone at the right of the studio stage and another at the left. These pickups are separately amplified to provide *A* and *B* sound channels. The *A* and *B* channels may also be derived from the two outputs from a stereo phonograph cartridge or the two outputs from a stereo tape recorder. Then the *A* channel is sent out over the f-m station and the *B* channel over a-m, or conversely.

Sometimes the transmissions are sent over f-m (or a-m) and over a television sound channel. Occasionally two f-m stations have teamed up for stereo broadcasting. These transmissions, however, leave much to be desired. For one thing, they are incompatible. This means the so-called monophonic listener, that is the listener with only one set, hears only one side of the program. And from the station

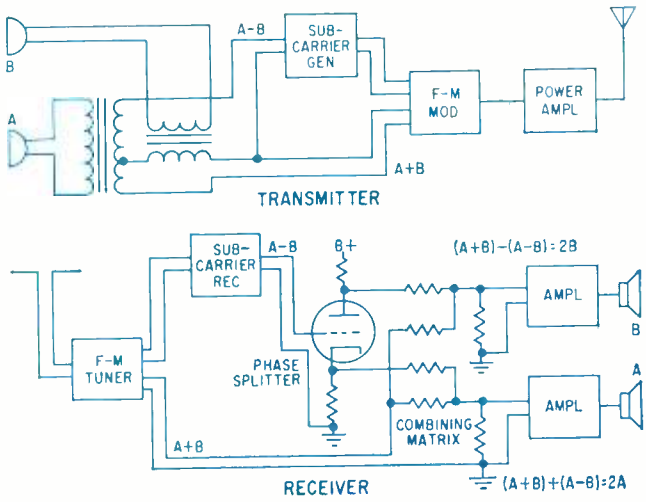


FIG. 1—Sum-and-difference f-m multiplexing arrangement used in Crosby-Harkins stereo system tests

operator's point-of-view, at least two of his broadcast outlets are tied up by a single program.

Actually, so-called "incompatible" stereo is not really so hard on the monophonic listener. Most stereo tapes and records use inputs from three microphones. The signals are mixed to form the A and B channels. Thus each "stereo" channel has some input from the center microphone so that absence of either channel is not overly objectionable.

COMPATIBLE STEREO SYSTEMS—Next step is compatible stereo capable of being sent over a single broadcast outlet. So far three basic approaches to the compatibility problem have been announced. But new proposals are being brought forth every day.

SUM-AND-DIFFERENCE SYSTEM—The sum-and-difference system developed by Murray G. Crosby, president of Crosby Labs in Hicksville, N. Y., is shown in Fig. 1 as applied to an f-m multiplex transmission setup. The system is not restricted to such an application.

The A and B channels are combined in a transformer network so phased as to yield an $(A + B)$ and and $(A - B)$ channel, both of which are transmitted. At the receiver, the $(A - B)$ channel is applied to a phase splitter after which it is both added to and subtracted from the $(A + B)$ channel in a resistive combining network. As a result, a signal $2A$ is applied to one loudspeaker and $2B$ to another loudspeaker.

The monophonic listener tunes to the $(A + B)$ channel only.

PHANTOM-CARRIER SYSTEM — A so-called "phantom" carrier system developed by Burden Associates of Mt. Kisco, N. Y., provides compatibility for the Halstead transmission system of f-m stereo multiplex. The differential amplifier, shown in Fig. 2, feeds an $(A - B)$ signal to the summing amplifier of the A channel and a $(B - A)$ signal to the summing amplifier of the B channel.

The monophonic listener hears all of the A or B channel plus the other stereo channel which is 3 db down and 180 degrees out of phase with the signal as transmitted. The stereophonic listener hears the A and B channel sound from the proper loudspeaker at twice the amplitude of the "phantom" components. Presumably a resistor matrix and attenuators could be added to obtain "pure" stereo since $(2A - B) + (2B - A)/2 = 3A/2$ and $(2A - B)/2 + (2B - A) = 3B/2$.

NARROW-BAND MULTIPLEX — A system proposed by Harold N. Parker, chief engineer of Calbest Electronics, Los Angeles, capitalizes on the fact that the human ear can discern stereo effect only at audio frequencies between 300 and 3,500 cps. This system, as applied to an f-m multiplex system, is shown in Fig. 3. Like the sum-and-difference system, this system's application is not restricted to f-m multiplex.

The stereo signal is considered to be made up of four components: left channel, 30-3,500 cps $= L_l$; left channel, 3,500-15,000 cps $= L_h$; right channel, 30-3,500 cps $= R_l$; and right channel 3,500-15,000 cps $= R_h$. Only the R_l and L_l components provide any stereo effect. The main carrier, to which monophonic

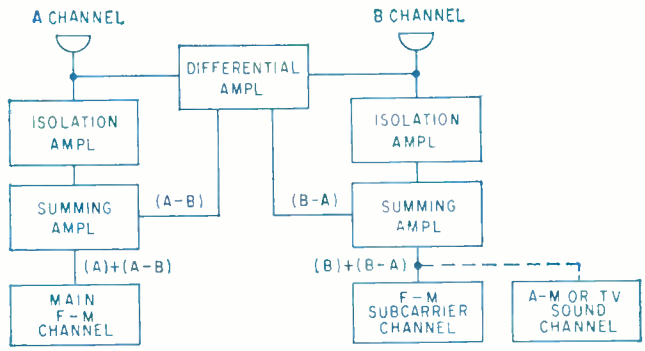


FIG. 2—Burden phantom carrier system as used with Halstead f-m multiplex plan

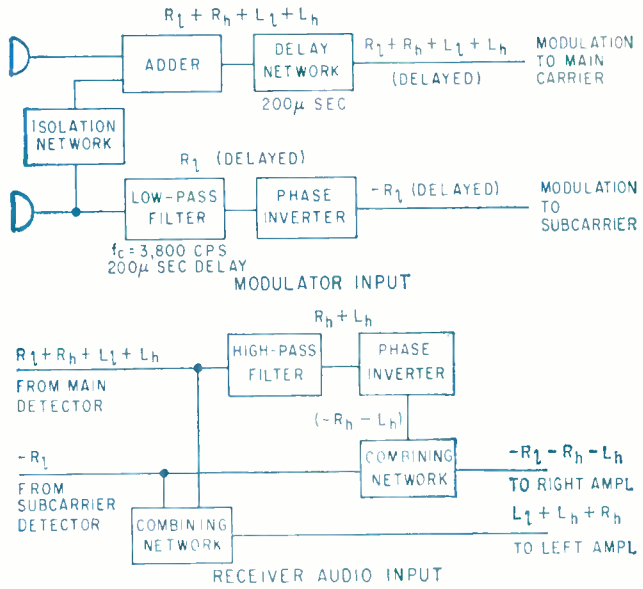


FIG. 3—Narrow-band stereo system for f-m proposed by Calbest

listeners will turn, carries all components. The subcarrier carries only $-R_l$. The stereo listener can apply $(L_l + L_h + R_h)$ to his left amplifier and loudspeaker and $-(R_l + R_h + L_h)$ to his right amplifier and loudspeaker. The phase inversion can be cancelled out and the components R_h and L_h do not participate in the stereo effect. The delay network in the transmitting equipment is needed to compensate delay introduced by the low-pass filter. Time delays in main and subcarrier channels must be within 10 μsec from 150 to 3,000 cps.

PRECEDENCE EFFECT—A stereo system described by F. K. Becker of Bell Labs. is illustrated in Fig. 4. It was developed to provide compatible monophonic reception of a-m, f-m and/or tv broadcasts and was used on the Perry Como show, Feb. 28, over NBC radio and tv, network program service over AT&T Long-Lines facilities.

The right-hand microphone is associated with the B channel and the left-hand microphone with the A channel. However, the pickup from the left-hand microphone, reduced 1.5 db in amplitude and delayed 10 millisec, is also fed to the B channel. The same crossover occurs in the A channel.

The monophonic listener thus gets full reception on either channel he tunes in. However, a psychological phenomenon known as precedence effect enables the stereo listener to get the desired depth sensation. The human ear in effect "captures" the first signal it hears from left and right loudspeakers. The "echo" or delayed signal from left and right loudspeakers appears to be reduced 8-10 db in volume. The effect operates over a time-delay range of 5 to 35 millisec.

Figure 4 illustrates use of the precedence effect for a-m, f-m and/or tv simultaneous broadcast. However, the effect might be used also with a subcarrier system.

PERCIVAL SYSTEM—The Percival stereo system proposed by Electric & Musical Industries of England takes advantage both of the precedence effect and of the fact that the lowest audio frequencies contribute little to the listener's sense of direction.

A compatible, full-fidelity $(L + R)$ signal is transmitted over the main channel with 15,000-cps response. A 100-cps control signal is used to transmit directional information. The stereo information content of the directional control signal is expressed algebraically as $L'/(L' + R')$ where the primes indicate modification of the left and right channel signals.

In the receiver, the main channel is multiplied by the directional signals to yield

$$L^* = \frac{L'}{L' + R'}(L + R)$$

Then the left signal is subtracted from the main channel to give

$$R'' = (L + R) - L''$$

Figure 5A shows how the directional signal is modified to take advantage of precedence and frequency response and to conserve bandwidth. The αf filter gives an output that increases in amplitude with frequency as does a preemphasis network. This takes advantage of the fact that the lowest audio frequencies contribute little to a sense of direction.

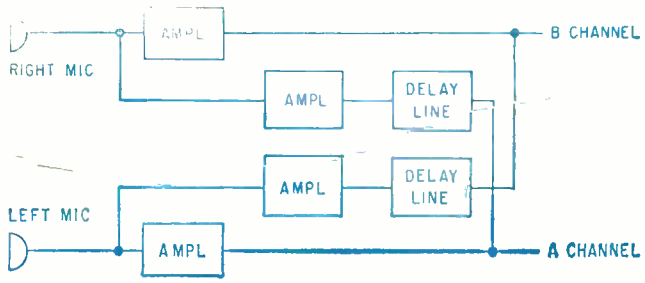


FIG. 4—Precedence-effect stereo arrangement recently demonstrated by Bell Telephone Laboratories

The signal is then rectified. The transient-emphasis network's transmission characteristic rises rapidly with the rate of rise of the audio envelope. This emphasizes the start of each sound and helps take advantage of the precedence effect.

The log-taking circuits produce outputs of log L' and log $(L' + R')/2$. The difference circuit has an output log $L'/(L' + R')$. The antilog-taking circuit delivers the 100-cps control signal $L'(L' + R')$.

For f-m transmission, the directional control signal is sent on a 22-kc subcarrier. The system can be adapted to a-m stereo by sending the directional control signal by narrow-band f-m on the a-m carrier frequency.

At the receiver, the main channel and control signals are applied to a Hall-effect multiplier. This con-

F-M MULTIPLEX GLOSSARY

DEVIATION (Δf)—The maximum frequency swing of an f-m carrier due to an audio signal applied to the modulator. For normal f-m broadcasting $\Delta f = \pm 75$ kc

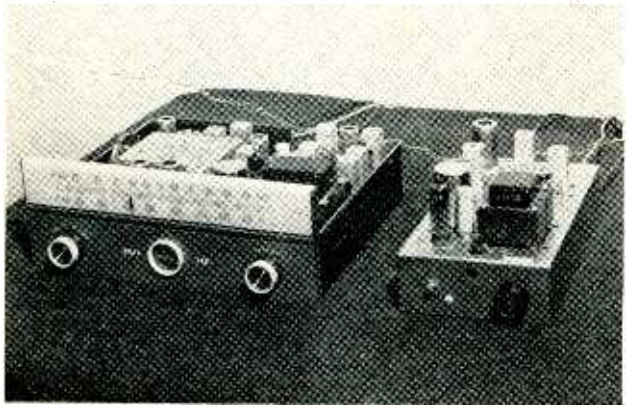
MODULATION FREQUENCY (mf)—The highest audio frequency an f-m transmission system can reproduce. Normal f-m broadcasting transmits a signal whose audio bandwidth is 50-15,000 cps

SUBCARRIER—Superaudible tone impressed on an f-m carrier to transmit some special service such as background music or stereo. Popular subcarrier frequencies are 26 and 65 kc (Harkins); 41 and 67 kc (Halstead)

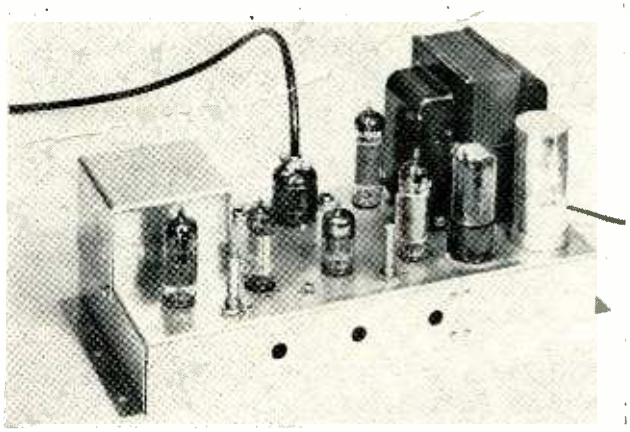
MODULATION PERCENTAGE—Part of main carrier frequency deviation due to direct modulating of main carrier or to deviation of subcarriers. Currently, the FCC requires that direct modulation of the carrier must be 70 percent $= 0.7 \times 75 = \pm 52\frac{1}{2}$ kc frequency deviation. Maximum frequency deviations of subcarrier must add up to no more than $\pm 22\frac{1}{2}$ kc (0.3×75)

MODULATION INDEX—Ratio of maximum frequency deviation to highest audio freqency capable of being transmitted. For normal f-m broadcasting $\Delta f/mf = 75/15 = 5$. As modulation index drops below 5, the signal-to-noise ratio is somewhat degraded

BANDWIDTH—Bandwidth occupied by an f-m station is a complex thing to figure. At high modulation indices $BW = \Delta f + mf = +90$ kc for normal f-m broadcasting. For modulation indices ≈ 1. $BW = \Delta f$. For modulation indices less than 1. $BW = mf$. For the last, or narrow-band case, s/n is roughly on a parity with a-m broadcasting



Stereo multiplex adapter, right, works with f-m/a-m set, left



Stereo-sound adapter used with conventional Motorola television set

sists of a Hall crystal placed in the air gap of an iron-core inductor. The directional control signal is applied to the inductor to vary the flux through the crystal. The main channel audio is applied to two opposite edges of the crystal. The product of the main channel audio and the directional control signal is taken off the other two edges of the crystal.

This system has been demonstrated to the British Broadcasting Corp. The BBC has agreed to cooperate in field testing the scheme.

RADIO TRANSMISSION—Here's a problem in transmitting stereo broadcasts over one radio outlet: f-m stereocasting would involve transmitting one stereo channel on the main carrier and the other stereo channel on a subcarrier. Question is whether f-m stations already using one subcarrier to transmit private services such as background music can fit in another multiplex channel for stereo.

HARKINS SYSTEM—A stereo transmission system devised by Dwight Harkins, president of Harkins Radio, Phoenix, in conjunction with Murray Crosby, would require the station operator to choose between private-line background music or public stereo. Harkins proposes that the $(A + B)$ channel modulate the main carrier with a deviation of ± 37.5 kc and a response of 50-15,000 cps. The subcarrier center frequency will be 50 kc and its maximum deviation ± 25 kc. Audio bandwidth for $(A - B)$ signal on subcarrier would be 50-15,000 cps.

Frequency modulation of main carrier due to the subcarrier should be 60 db below 100 percent modulation in 50 to 15,000-cps range. Crosstalk in subcarrier due to main carrier modulation should be 40 db below a 400-cps reference tone deviating the subcarrier ± 25 kc.

The Harkins system was successfully tested over KGLA, Los Angeles, in April 1958.

HALSTEAD SYSTEM—A system that would permit f-m stereocasting with private-line services has been proposed by William S. Halstead, president of Multiplex Services, New York. Transmitter exciter and receiver block diagrams are given in Fig. 6.

Halstead proposes a 41-kc subcarrier modulating

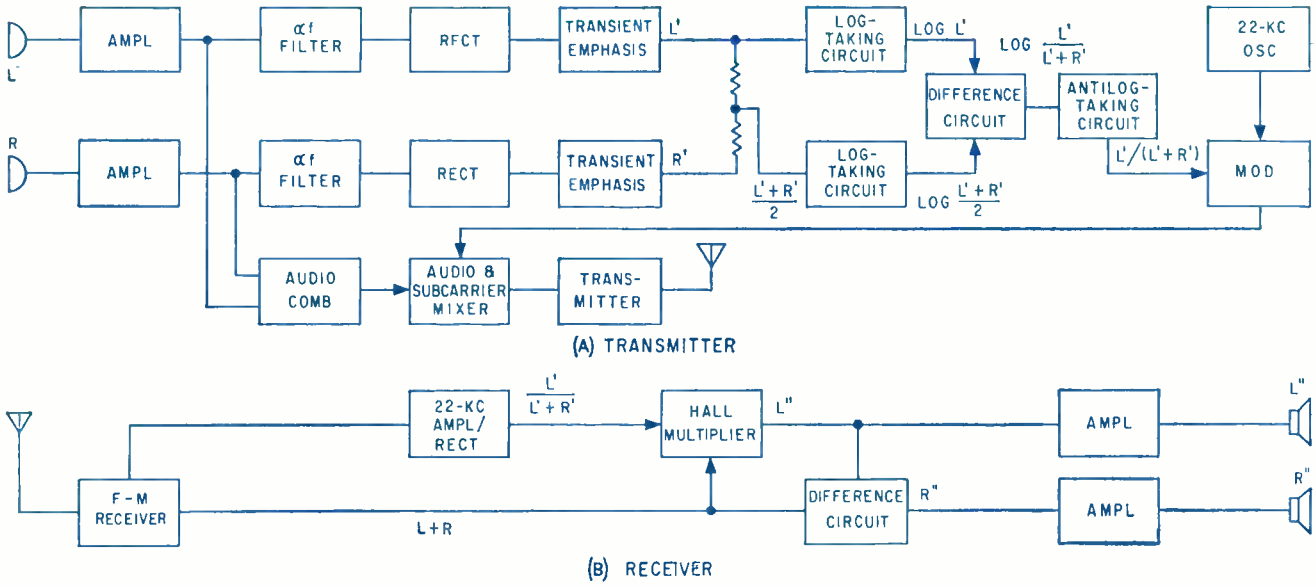


FIG. 5—Encoding (A) and decoding (B) equipment for Percival stereo system introduced by EMI of England

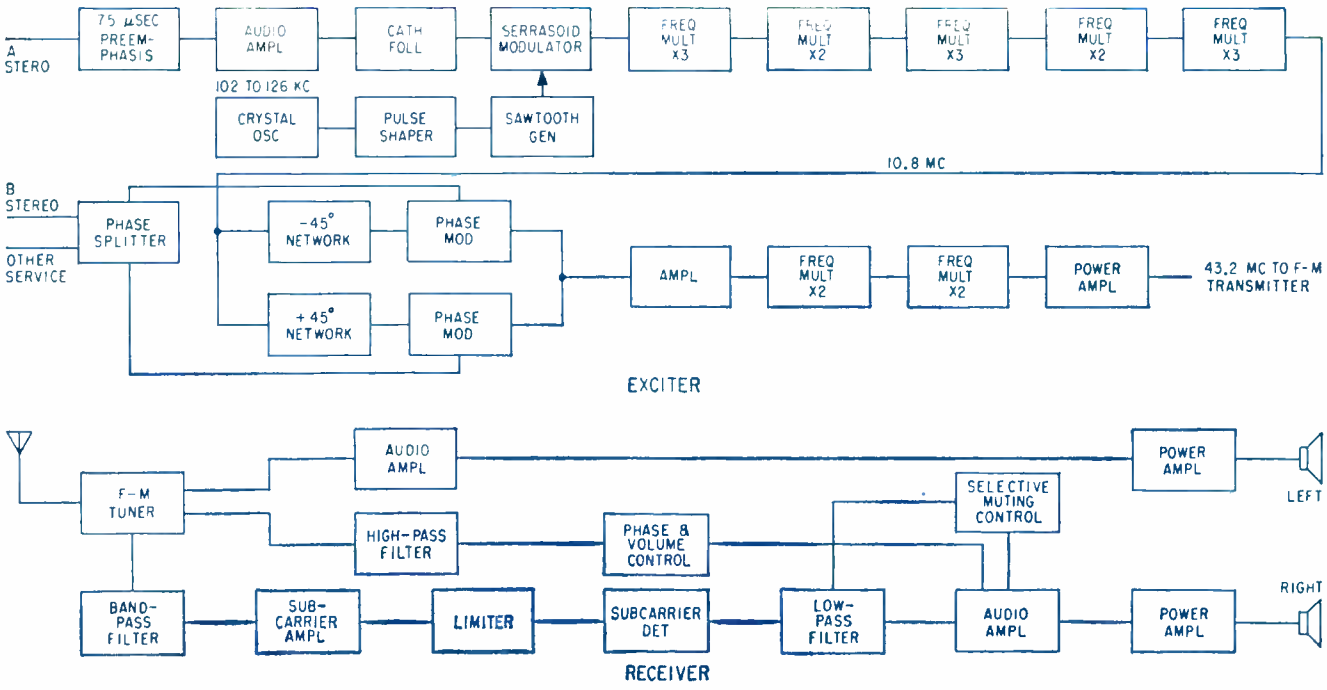


FIG. 6—Exciter and receiver used with Halstead f-m stereo system provide both stereo and private-wire service

the main carrier 15 percent. Bandwidth in the subcarrier would be restricted to about 8,000 cps with higher frequency components injected from the main channel at the receiver. A subcarrier band from 29 to 53 kc is indicated.

Background music would be carried on a 67-kc subcarrier in a band from 59-75 kc. A band from 20-25 kc is reserved for control signals such as might be required to operate the selective muting control on the subcarrier channel audio amplifier (Fig. 6).

Halstead indicates 0.3 to 0.8 percent harmonic distortion from 30 to 15,000 cps at 100 percent modulation. Subcarrier signal-to-noise ratio at a typical receiving location was 53 db.

Tests of simultaneous stereo and background music have been reported over WIP-FM, Philadelphia, and WGHF, Brookville, Conn.

CALBEST SYSTEM — Developers of the Calbest system plan to use a 27-kc subcarrier deviating ±5 kc. They specify that the main carrier modulation percentage due to the sum of all subcarriers will be 40 percent with no subcarrier contributing more than 25 percent nor deviating more than ±10 kc. Thus the system implies adding subcarriers for private-line services as well as stereocasting. Tests for the Calbest system have reportedly been arranged with KMLA-FM, Los Angeles, and WCLM-FM, Chicago.

TELEVISION SOUND—A system for stereo television sound has been proposed by Motorola and demonstrated over a closed-circuit system from WGN, Chicago. A subcarrier of 23.6 kc is selected to avoid harmonics of the television line scanning frequency, 15.75 kc. Audio response on the $(A - B)$ subcarrier (see Fig. 7) is restricted to 5,000 cps or 3,000 cps if desired. Subcarrier deviation is ±5 kc. Main carrier audio response is 12,000 cps with standard 75 μsec preemphasis at 12,000 cps. Frequency deviation due to direct modulation of the main carrier is ±21.25 kc. For normal television sound a ±25-kc deviation within a 30-kc band is specified.

PHILCO SYSTEM—The push to stereo has also caught up with a-m radio. Philco has spelled out a stereo system using a combination of phase and amplitude modulation. The Philco system is shown in Fig. 8. The A and B channels are combined in a matrix to form $(A + B)$ and $(A - B)$ channels;

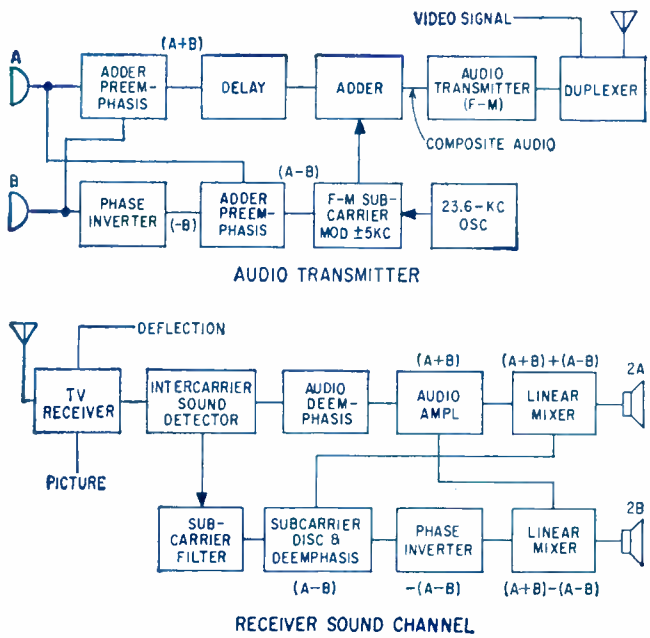


FIG. 7—Stereo setup for television sound channel as demonstrated by Motorola

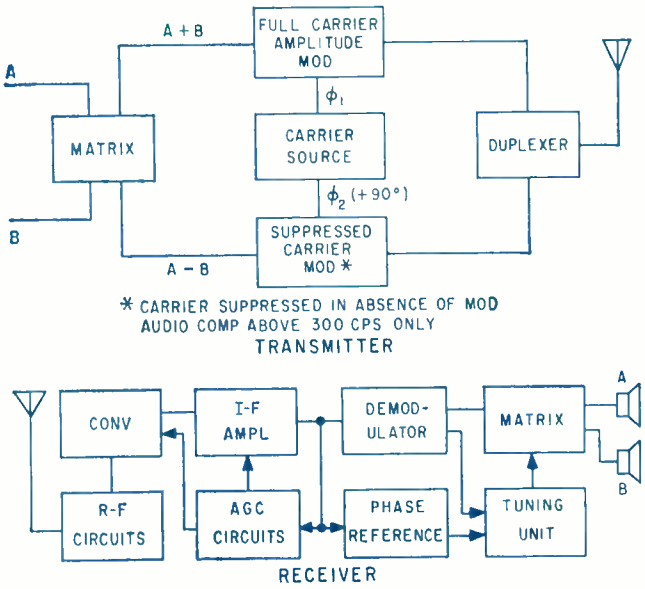


FIG. 8—Philco system for a-m stereo uses combined amplitude and phase modulation

the $(A + B)$ channel is applied to the main carrier modulator. The $(A - B)$ channel is applied to a carrier phased at 90 deg. Taking advantage of the fact that audio components below 300 cps do not contribute to the stereo effect, these are removed from the $(A - B)$ channel. This simplifies receiver tuning.

The result is that the $(A + B)$ channel is transmitted by conventional amplitude modulation and the $(A - B)$ channel, less audio components below 300 cps, by phase modulation. For monophonic transmission the carrier is at 45 deg from either stereo carrier. The stereo receiver can use either a single phase-sensitive receiver and an amplitude detector with matrix or it can use two phase-sensitive receivers. Philco reports 30-db stereo track separation at 5,000 cps. Also frequency response is 6 ± 1 db down at 100 cps from response at 5,000 cps. Philco indicates that some second harmonic distortion occurs on monophonic reception of a stereo broadcast. This occurs because of unequal positive and negative modulation peaks (0.41 unit negative, 0.82 unit positive). However this exists at frequencies between 300 and 3,750 cps only and has not been found to be objectionable.

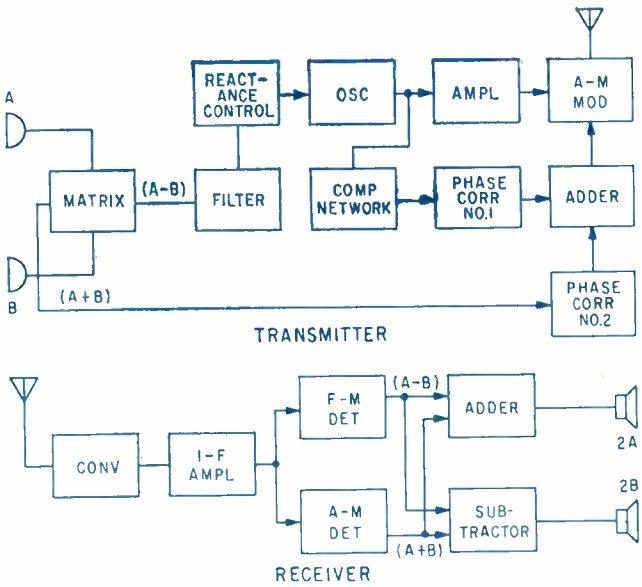


FIG. 9—Standard broadcast stereo system by Westinghouse uses a-m and narrow-band f-m

WESTINGHOUSE SYSTEM—A compatible stereo multiplex system for the standard broadcast band was recently proposed by Westinghouse. The system combines a-m and narrow-band f-m. The a-m signal is modulated to a maximum of 95 percent with an $(A + B)$ signal plus a smaller $(A - B)$ signal. The f-m signal transmits the $(A - B)$ signal. The $(A - B)$ signal is frequency limited to 300-3,000 cps by filters with a 6-db/octave characteristic. Maximum frequency deviation is 3 kc.

The system is shown in Fig. 9. The compensating network modifies the amplitude as a function of the stereo signal. It reduces crosstalk. The signal being radiated by the antenna is corrected so that a conventional a-m radio will reproduce sounds monophonically independent of stereo difference signals.

Phase corrector No. 1 equalizes phase shift so that the frequency modulation and the precorrection envelope are coincident in the transmitted signal. Phase corrector No. 2 puts the $(A + B)$ and $(A - B)$ modulations in time coincidence in the transmitted signals. This is a time-delay correction.

In the Westinghouse system, the $(A - B)$ f-m signal can be received by a conventional a-m receiver tuned slightly off frequency. This is, of course, slope detection. Thus an a-m set tuned to one side of the carrier receives $(A + B)$, the a-m modulation, and $(A - B)$, the f-m signal, yielding

$$A + B + (A - B) = 2A$$

An a-m set tuned to the other side of the carrier receives $(B - A)$, the f-m signal inverted, and $(A + B)$. This yields

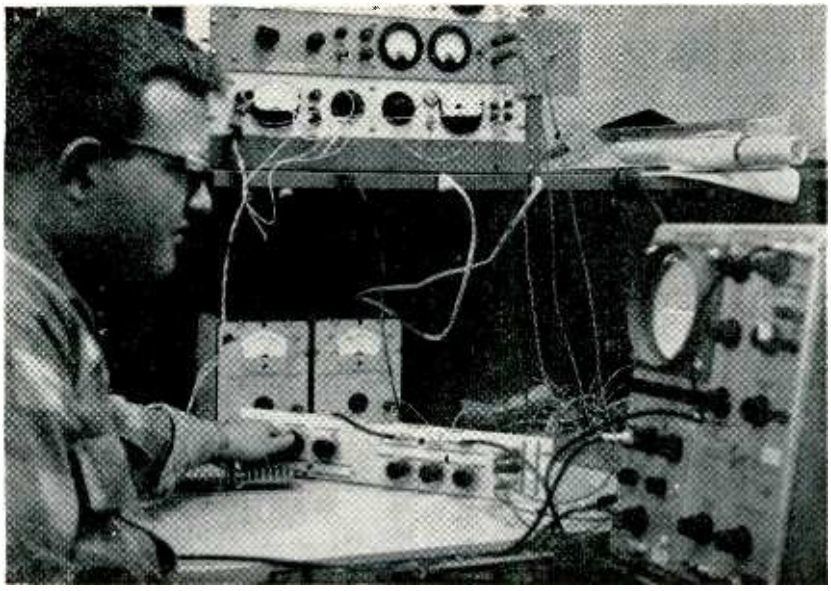
$$(A + B) + (B - A) = 2B$$

Tests are planned over KDKA, Pittsburgh.

OTHER SYSTEMS—This article cannot, of course, cover all stereo broadcast proposals. As of last month, the systems panel of the National Stereo Radio Committee had received a total of 17 systems covering tv, a-m and f-m.

Radio Corp. of America demonstrated a double-single sideband system this Fall. However RCA has recently been testing an a-m/f-m system for the standard broadcast band. The tests were conducted last month during early morning hours over WRCA, New York.

Kahn Labs of Freeport, New York, has a double-single sideband system in which the listener tunes to the upper sideband to get the A channel, to the lower sideband to get the B channel and in between to get a monophonic $(A + B)$ signal. Kahn earlier demonstrated a compatible system for transmitting on separate a-m and f-m and/or tv carriers.



Providing synchronizing signals by use of the sync blocking oscillator output

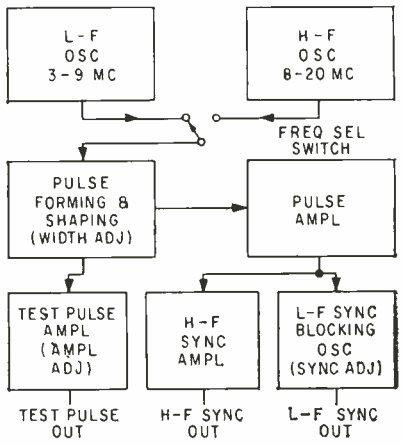


FIG. 1—Pulse generator uses two oscillators and has three outputs

Transistorized Generator for Pulse Circuit Design

Versatile instrument produces pulses with widths ranging from 25 to 35 millimicroseconds at repetition frequencies from 3 mc to 20 mc and amplitudes from zero to 2 v. High- and low-frequency Hartley oscillators drive novel pulse forming and shaping circuit

By **LEOPOLD NEUMANN,** Staff Member, M.I.T. Lincoln Laboratory, Lexington, Mass.

TESTING HIGH-SPEED digital computer circuits, using 30 millimicrosecond pulses, requires a versatile pulse source. This article describes a transistorized, variable-frequency pulse generator designed to test recently developed circuits.

The pulse generator has three outputs. One output provides the test pulse. The second and third outputs supply pulses for synchronizing oscilloscopes.

The test pulse is variable from 25 to 35 millimicrosec. This permits testing circuits with pulses both narrower and wider than the normal input pulses.

The pulse-repetition frequency of the test pulse can be varied from 3 mc to 20 mc. This allows testing the prf sensitivity and determining the h-f limits of the circuit being checked.

An internal amplitude control varies the test pulse amplitude from zero to 2 v. The amplitude sensitivity of a circuit can be determined by varying the amplitude of the test pulse.

The second output provides a h-f 50-ohm cable positive pulse. Traveling-wave tube oscilloscopes are synchronized by using this output. The third output is a l-f submultiple of the test pulse. This l-f pulse is used to synchronize conventional laboratory oscilloscopes.

As shown in Fig. 1, the pulse generator consists of two oscillators, a pulse forming and shaping circuit, three pulse amplifiers and a sync blocking oscillator.

Oscillators

When a switch is used to interchange coils in a single oscillator, poor performance results. This poor performance is caused by switch capacitive feed through. For this reason independent h-f and l-f oscillators are used.

The oscillators, Fig. 2, are Hartley type, sine-wave oscillators. Each is tunable over a 3 to 1 frequency range by capacitor C_4. Use of a 2N501 switching transistor in the oscillator circuits allows all of the transistors used in the pulse generator to be of the same type.

Resistors R_1, R_2 and R_3 control

the d-c bias of the oscillator and provide bias compensation for variation in I_{co} and β of individual transistors. Some degeneration for equalizing the gain of individual transistors is provided by R_1. The function of R_5 is to limit the maximum collector-to-base voltage to a safe value.

A spdt switch permits the output of either the h-f or l-f oscillator to be used to drive the pulse-forming circuit. Independent h-f and l-f oscillators make it possible to rapidly switch between two preset frequencies.

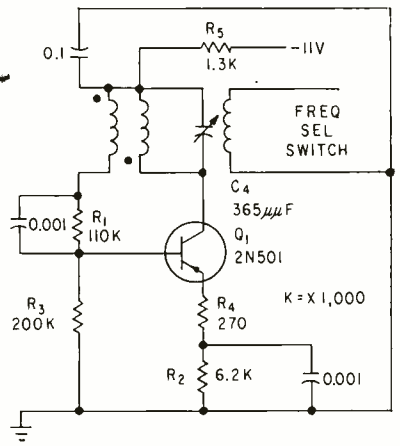


FIG. 2—Oscillator for h-f and l-f are identical with exception of coils used

Basic Pulse Circuit

The basic pulse-forming and amplifying circuit[1] is shown in Fig. 3A. When a negative step is applied to the base of Q_1, the emitter tends to follow this input voltage and causes a current in the collector load. The collector voltage rises toward the emitter voltage and the transistor saturates.

When the transistor saturates the voltage across the collector load is $(V_s - V_c - V_{cc\,sat}) = (V_s - V_{in})$ = a constant. The current drawn by the load is $i_c = (V_s - V_{in})\,[(1/R_1) + (t/L)]$. The emitter resistance can supply only a $I_{c\,max} = (V_{in} - V_{bc})/R_2$. If the input step is continued beyond the point where I_c equals $I_{c\,max}$, the transistor comes out of saturation and the collector falls to $-V_s$ with a time constant L/R_1.

However, C_1 transiently lowers the emitter impedance for changing inputs. Hence, C_1 improves gain to the leading edge of the input step by decreasing the degeneration caused by the emitter resistor.

Also, as seen in Fig. 3B, when V_c falls due to the transistor coming out of saturation, C_c pulls the base transiently more negative. Because of C_1 in the emitter, the circuit gain to this input change is high. Thus a pulse of current is fed to the collector load, tending to square off and effectively decrease the damping of the decay. If C_1 is increased the decay becomes less damped and may overshoot. In the third pulse-forming stage and in the pulse amplifiers the effect of C_1 is used to speed up the pulse fall.

When the negative input pulse is removed and the base made positive, the transistor is quickly turned off, reducing the collector current to zero. The collector then overshoots by an amount $i_L R_1$. This overshoot decays with a time constant L/R_1.

Pulse-Forming Circuit

The pulse-forming portion of the generator is shown in Fig. 4. The pulse former consists of three stages, each of which is a variation of the basic circuit just described.

Stage one of the pulse former amplifies the input sine wave. This amplifier provides the current gain necessary to drive the second pulse-former stage. Stage one also squares off the output of the sine-wave oscillator.

The stage is designed so that it does not come out of saturation until the input sine wave starts to go positive. Increased stage gain is provided by emitter capacitor C_1.

The overshoot of this stage drives the second pulse-forming stage. This overshoot has a sharper leading edge than the pulse itself. The overshoot is controlled by the collector inductor rather than the input waveform. In Fig. 5B this sharp leading edge may be observed as the continuation of the turnoff fall. The overshoot falls from zero to -1 v in three millimicroseconds, then slows down its fall rate due to the loading of the next stage.

A 40-millimicrosecond pulse is formed in the second stage. This stage has a low-inductance collector load and a large capacitor across its emitter resistor as shown in Fig. 4. The high emitter capacitance boosts the high-frequency gain of this stage so that the sharp leading edge of the first stage overshoot quickly turns on the transistor and drives it into saturation. The collector rises until the transistor is in saturation and then follows the input waveform down. When the input waveform begins to rise again toward ground, the transistor comes out of saturation and the collector inductor pulse overshoots. This overshoot (Fig. 5C) is used to drive the third stage. The positive-going output cannot be used to drive the next stage because a second positive-going ring which may occur at

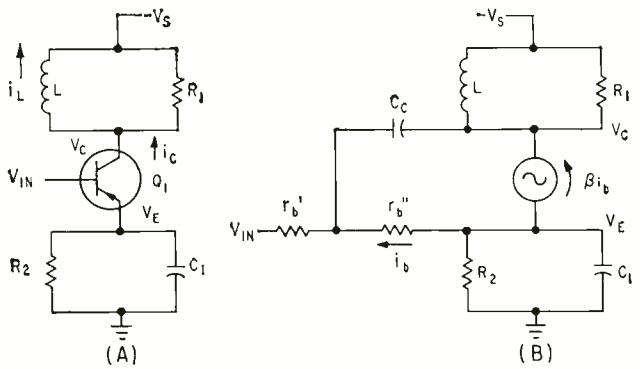


FIG. 3—Basic pulse circuit (A) and its simplified equivalent circuit (B)

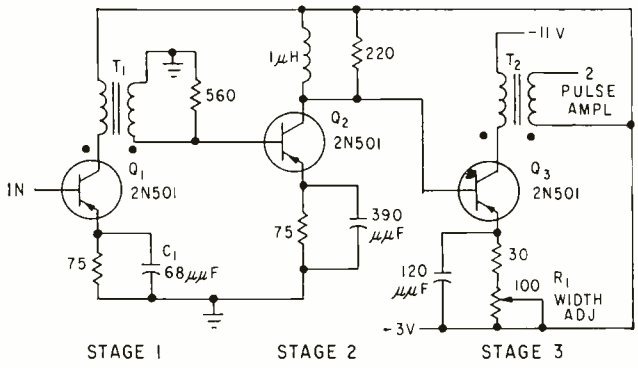


FIG. 4—Pulse former and shaper has three stages

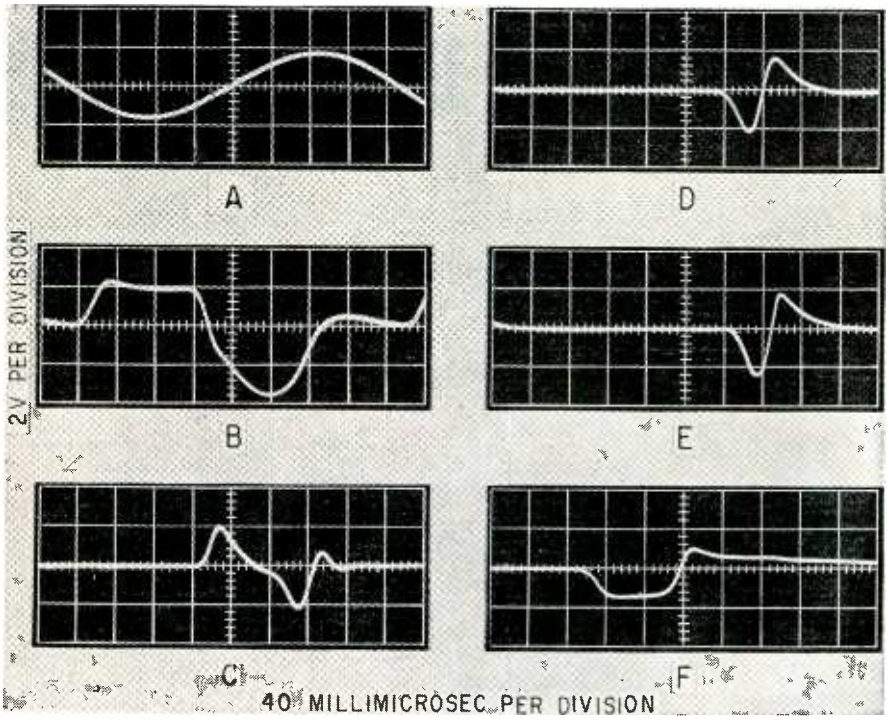


FIG. 5—Oscilloscope photos of output of oscillator (A) first shaping stage (B), second shaping stage (C), third shaping stage (D), generator test pulse amplifier (E) and sync blocking oscillator (F)

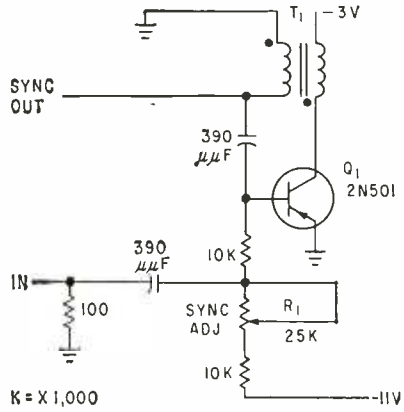


FIG. 7—Low-frequency sync blocking oscillator provides synchronizing signals for conventional oscilloscopes

low frequencies could cause false operation.

Since the collector supply voltage of the second stage (Fig. 4) is equal to the emitter return voltage of the next stage, a coupling transformer is not required between stages. Under these conditions no shift of d-c level is necessary.

The third pulse-forming stage narrows the pulse and changes it into the conventional pulse form (Fig. 5D). The variable resistor R_1 (Fig. 4) in the transistor emitter circuit provides pulse-width control. The resistor controls the maximum emitter current which determines the length of time the stage can remain saturated.

Pulse Amplifier

The pulse amplifiers amplify and reshape. In Fig. 6 a 2-v input pulse at the base of Q_1 produces 1.8 v at the emitter. The emitter will then supply 29 ma to the collector. When Q_1 is in saturation, approximately 6 v appears across the collector load. Since the collector current is of the form $i_c = V\,[(1/R_{load}) + (t/L)]$, the collector draws maximum emitter current when t equals 18 millimicrosec. With pulse rise and fall times included, a 25 to 35 millimicrosecond pulse is produced. The pulse overshoot time constant is 19 millimicroseconds.

Capacitor C_1 increases the circuit gain and its value is chosen to provide approximately critical damping to an emitter-controlled collector decay. The circuit provides a 2-v output pulse.

Three pulse amplifiers are used in the pulse generator. Two pulse amplifiers are driven by the third pulse-shaping stage. The first pulse amplifier driven by the third pulse-shaping stage provides 2 v across a 50-ohm amplitude-control potentiometer. The tap of the potentiometer is the pulse-generator output. The second pulse amplifier driven by the last pulse-shaping stage drives the sync blocking oscillator and the third pulse amplifier.

This third amplifier provides the h-f 50-ohm positive pulse for synchronizing a traveling-wave tube oscilloscope. A 500-kc to 1-mc pulse is supplied by the sync blocking oscillator to synchronize conventional laboratory oscilloscopes.

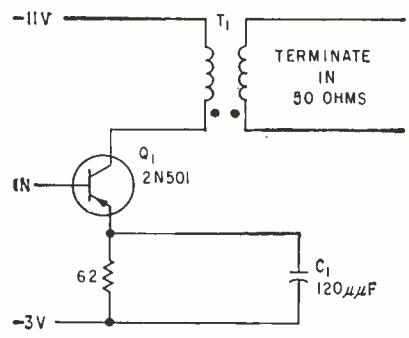


FIG. 6—Pulse amplifier uses circuit similar to last pulse former and shaper stage

Sync Blocking Oscillator

The l-f sync blocking oscillator (Fig. 7) consists of a grounded-emitter stage whose free-running period is made to lock in with the frequency of the pulse generator. This is accomplished by mixing the normal blocking oscillator feedback signal and the pulse generator output at the base of the transistor.

The free-running period is manually adjusted to a near submultiple of the pulse generator output by R_1 in the base circuit. The mixed input pulses to Q_1 cause the blocking oscillator to lock in with the pulse generator. This technique permits the single blocking oscillator to perform the large variable countdown ratio (up to 40 to 1) required to provide synchronizing signals over the entire range.

The work described here was performed under contract at Lincoln Laboratory, operated by MIT with the support of the Army, Navy and Air Force.

Reference

(1) W. N. Carroll and R. A. Coopper, Ten Megapulse Transistorized Pulse Circuits for Computer Applications, Proc of 1958 Transistor And Solid-State Circuits Conf.

A-C Computing Resolvers:

Table lists characteristics of typical size 18, 23 and 25 resolvers. The two issues immediately preceding this issue tabulated small resolvers

WHEN COMPARING data, remember that all manufacturers do not present data the same way. For example, some test data indicates the best that can be expected and some data indicates the probable performance.

Reliability is often an important factor in selecting a resolver. The larger sizes generally are more reliable as they (generally) do not require the high tolerances and small air gap—which decrease the abuse a unit can withstand—of small resolvers.

When the tuned input impedance, Z_{it}, is not listed, it may be computed from Z_i, the input impedance measured when the secondary is open. The input current and power can then be calculated from Z_{it} and the input voltage.

The stator is the input winding unless the notes column specifies the rotor. The transformation ratio, TR, is the ratio of the output to the input voltage (rotor to stator for stator input and stator to rotor for rotor input). The stator and rotor each have two windings.

When either of the two compensator winding ratios, TR_{sc} or TR_{cr}, is given, the other can be calculated from the relation $TR = TR_{sc} \times TR_{cr}$.

An X in a tabulation space indicates the column head does not apply. A blank space indicates the information was unavailable or that it can be calculated.

Although dimensions are not listed for the Arma resolvers, they do fall in the category of large resolvers.

KEY

AE	American Electronics
Kear	Kearfott
M	Muirhead
NK	Norden Ketay
V_i	Maximum input voltage
Z_i	Input Z, secondary open
Z_{it}	tuned input Z
Acc.	accuracy in % of function deviation or minutes of spread
Axis	interaxis error
TR	transformation ratio, output/input voltage
TR_{sc}	TR, stator/compensator v
TR_{cr}	TR, compensator/rotor v
θ	phase shift
Comp.	compensator winding

Table I Typical Commercial

Mfr., Model No.	Size	Diam (in)	Length (in)	Test f (cps)	V_i (v)
M, F18M6-A-1	18	1.750		1,000	25
AE, 1R23W6-711	23	2.25	3.67	60	20
AE, 1R23W6-721	23	2.25	3.67	400	100
AE, 1R23W6-722	23	2.25	3.67	400	100
Ford, 23	23	2.25	4.69	400	24
M, F23M7-A-1	23	2.250		1,000	30
NK, 113D1B	23	2.25		60	24
NK, 113D1D	23	2.25		60	90
NK, 113D1F	23	2.25		60	45
NK, 113D1N	23	2.25		60	26
NK, 113D1Q1	23	2.25		60	26
NK, 113D1Q2	23	2.25		60	26
NK, 113D2G	23	2.25		400	90
NK, 113D2E	23	2.25		400	90
NK, 113D3T1	23	2.25		400	8
NK, 113D3T2	23	2.25		400	8
NK, 113D3S1	23	2.25		350	30
NK, 113D3S2	23	2.25		350	30
NK, 113D3S3	23	2.25		350	30
NK, 113D2P1	23	2.25		500	50
NK, 113D2P2	23	2.25		500	50
NK, 113D2R1	23	2.25		400	90
NK, 113D2R2	23	2.25		400	90
NK, 113D3J	23	2.25		350	30
NK, 113D8H	23	2.25		1,000	30
NK, 113D2A	23	2.25		400	26
NK, 113D2C	23	2.25		400	90
Reeves, R600-101	23	2.250	1.993	60	100
Reeves, R600-102	23	2.250	1.993	400	100
Reeves, R601-101	23	2.250	1.993	60	20
Reeves, R601-102	23	2.250	1.993	400	100
Reeves, R601S102	23	2.250	1.993	400	100
Reeves, R601H102	23	2.250	1.993	400	10
Reeves, R601HA102	23	2.250	1.993	400	20
Reeves, R601HB102	23	2.250	1.993	400	10
Kear, 425506-1	25	2.478	1.037	400	25
Kear, Z5030-11	25	2.478	1.037	400	26
Kear, 122382-12	25	2.478	1.037	1,600	57.5
Kear, 425504-3	25	2.478	1.037	1,600	110
Arma, 5K				60	16
Arma, 1P				400	16
Arma, 03NN400				400	16
Arma, 03JJ400				400	16
Diehl, SSFPE43-1		2.500	3 11/32	400	115
Diehl, SSFJE43-1		2.500	3 11/32	400	115
Diehl, SSFJE43-11		2.500	3 11/32	60	35
Diehl, SSFJE44-1		2.500	3 11/32	400	20

Sizes 18, 23 and 25

By **FRANKLIN G. FINK,** Senior Development Engineer, Loral Electronics Corp., New York, N. Y.

Resolvers for Analog Computation—Sizes 18, 23 and 25

Z_i (ohms)	Z_{it} (ohms)	Acc. (% or min.)	Axis error (min)	TR	TR_{sc}	TR_{cr}	θ (deg)	Null (mv)	Low f (cps)	High f (kc)	Res Stator (ohms)	Res Rotor (ohms)	Res Comp. (ohms)	Notes
				1	x	x							x	Sweep resolver; rotor input
265 + j925	3,400	0.05%	3	0.975			13.5	1mv/v	10	30	185	245		Compensated
	34,000	0.20%	5	0.298			1.6	1mv/v	13	125	200	41		Compensated
970 + j5,650	31,000	0.05%	3	0.298			1.9	1mv/v	10	115	200	41		Compensated
465 + j2,585	14,700	0.1%	6	1.005		0.986	6	12			290	255	290	Compensated
					x	x							x	Sweep resolver
480 ∠78°		0.20%	5	1	x	x							x	
585 ∠61°		0.20%	5	1	x	x							x	
570 ∠79°		0.20%	5	1	x	x							x	
1,140 ∠76.3°		0.10%	5	1										Compensated
1,020 ∠81.6°		0.10%	2.5	1	x	x							x	
1,020 ∠81.6°		0.15%	5	1	x	x							x	
234 ∠83°		0.20%	5	1	x	x							x	
720 ∠80°		0.20%	5	1	x	x							x	
975 ∠86°		16′	5	2	x	x							x	
975 ∠86°		30′	7	2	x	x							x	
3,200 ∠86°		16′	5	1	x	x							x	
3,200 ∠86°		16′	5	1	x	x							x	
3,200 ∠86°		30′	7	1	x	x							x	
7,000		10′	5	1	x	x							x	Geared housing
7,000		20′	5	1	x	x							x	Geared housing
3,000 ∠86°		0.05%	2.5	1										Compensated
3,000 ∠86°		0.10%	5	1										Compensated
3,200 ∠85.7°		0.15%	5	1	x	x							x	
		0.20%	5		x	x							x	Sweep resolver
550 ∠86°		0.10%	5	1	x	x							x	
550 ∠86°		0.10%	5	1	x	x							x	
195 +j840	38,000	0.05%	3	0.975	x	x			8.3		130	140	x	
775 +j5,600	38,000	0.05%	3	0.975	x	x			8.3		130	240	x	
375 +j925	2,500	0.05%	3	0.975	0.985				20		320	240		Compensated
930 +j5,650	30,000	0.05%	3	0.975	0.985				20		320	240		Compensated
930 +j5,650	30,000	0.05%	3	0.975	1.000				20		320	240		Compensated
19 +j128	1,000	0.05%	3	0.970	0.97				25		8	6		Compensated
140 +j550	3,000	0.05%	3	0.975	0.982				30		40	30		Compensated
19 +j128	1,000	0.05%	3	0.970	0.97				25		8	6		Compensated
1,630 ∠78.5°		0.5′		0.98	0.985		1	25						Compensated
300 +j1,400		2.5′		0.49	x	x	3	20					x	
1,870 ∠71.5°		2.5′		0.488	x	x		80					x	
1,750 +j4,600		6′		0.491	x	x		96					x	
		3.5′		0.989	x	x	4°, 35′	1mv/v					x	
		3.5′		0.98	x	x	75′	1mv/v					x	
		7′		0.955	x	x	4°, 30′	1mv/v					x	
		7′		1.000			0°	1mv/v						Compensated
		1.5%	120	1.91	x	x					1,300	110	x	Rotor input
		1.5%	120	0.47	x	x					80	110	x	Rotor input
		1.5%	120	1.43	x	x					1,000	350	x	Rotor input
		1.5%	120	0.95	x	x					2.75	2.35	x	Rotor input

Outline Generator for

Simple electronic circuits produce white-outlined, variable-sized rectangle anywhere on tv screen. Means for producing edge flexing as a further attention-getting factor is included

By **GLEN SOUTHWORTH,** Chief Engineer, Station KWSC, Pullman, Washington

DURING certain types of television programs, it is sometimes desirable to call the viewers' attention to a particular portion of the television screen to emphasize certain activities or relationships.

The normal method of concentrating interest would be to dolly in on the subject or cut to a second camera for a closeup shot. These methods cannot be used when the subject matter is on slides or film clips.

Although verbal attention may be called to some portion of the screen, the better approach would be the use of a video marking device.

The generator shown in Fig. 1 produces a white rectangular outline of any dimensions that may be positioned in any portion of the television screen, thereby performing such a marking function.

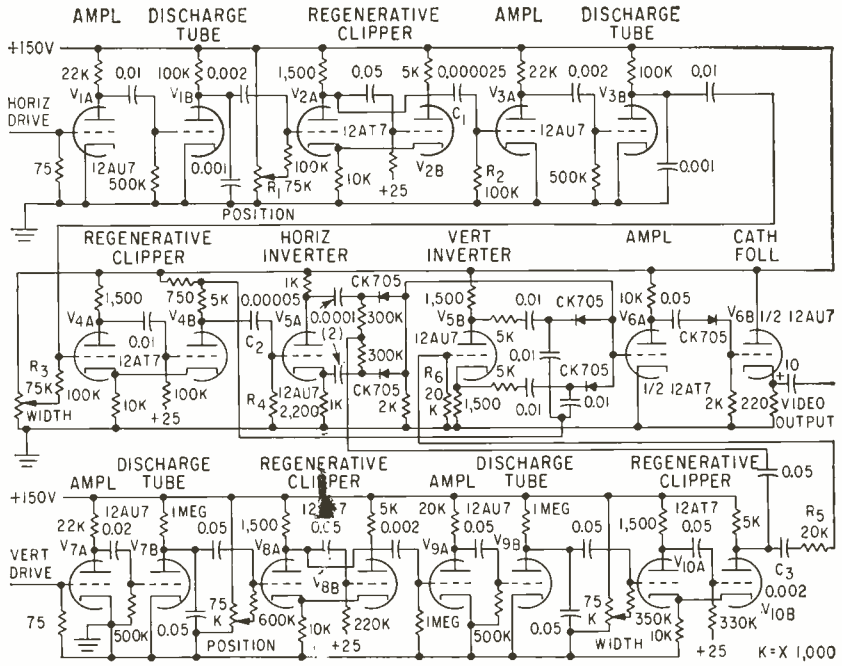


FIG. 2—Two pulse-forming chan. !s are triggered by horizontal and vertical drive pulses. The outputs are mixed in diode modulators to produce the white outline signal

Horizontal Channel

The circuits of the horizontal and television screen, thereby performcal, therefore the horizontal channel will be used for explanation purposes. An overall schematic of the generator is shown in Fig. 2.

Standard horizontal drive signals from the station synchronizing generator are applied to amplifier-inverter V_{1A}. The amplified, inverted signal is supplied to discharge tube V_{1B} whose output is a 15,750-cps sawtooth waveform.

This sawtooth is applied to regenerative clipper V_2 which in turn produces a 15,750-cps square wave whose duty cycle depends upon the setting of horizontal positioning control R_1 and the consequent grid bias of the first section of the regenerative clipper V_{2A}.

The output waveform of regenerative clipper V_2 may be used as a keying source for a horizontal wipe in conjunction with montage equipment as the duty cycle is variable over wide limits. In this generator however, it is used as a means of obtaining variable delay of the horizontal drive pulse.

The square wave is differentiated by C_1 and R_2, amplified and inverted by V_{3A}, and applied to a second discharge tube V_{3B} and converted into a 15,750-cps sawtooth. This delayed sawtooth is applied to the second regenerative clipper V_1. Varying the bias of V_{1A} by R_3 controls the width of the marking signal.

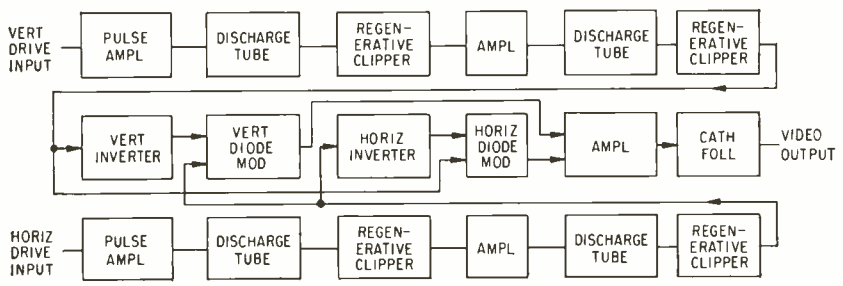


FIG. 1—Complete outline generator showing both horizontal and vertical channels

Educational Television

If the outputs of the horizontal and vertical channels are combined at this point, then the resultant pattern on the television screen will be a cross with a brighter area occurring where the two signals intersect. As approximately twice the video energy occurs at the intersection, a diode clipper may be used to remove the arms of the cross leaving only the solid intersection rectangle that may be changed in size and positioned at any desired location on the screen. This signal may be used for marking or for keying a montage amplifier.

Outline Generation

To overcome the masking problems introduced by a solid marker, two triodes V_{5A} and V_{5B} are used as an outline generator. This is done by differentiating the output of the horizontal square-wave generator V_4 by C_2 and R_1, and the output of the vertical square-wave generator V_{10} through the combination of C_3, R_5 and R_6, then applying the resultant signals to split-load phase inverters V_{5A} and V_{5B}.

The outputs of these phase inverters are applied to diode clippers that remove the unwanted positive-going portions of the pulses. Normally, this would result in two parallel vertical lines and two parallel horizontal lines appearing on the screen. However, the undifferentiated output of the horizontal square-wave generator V_4 is mixed with the output of the vertical phase inverter V_{5B}; and the output of the vertical square-wave generator V_{10} is mixed with the output of the horizontal phase inverter V_{5A}. Due to the nonlinearity of the clipper diodes, modulation takes place and the resulting output generates an outline signal with the vertical lines being approximately 0.2-μsec wide and the horizontal lines being about two raster lines.

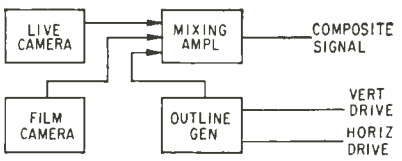
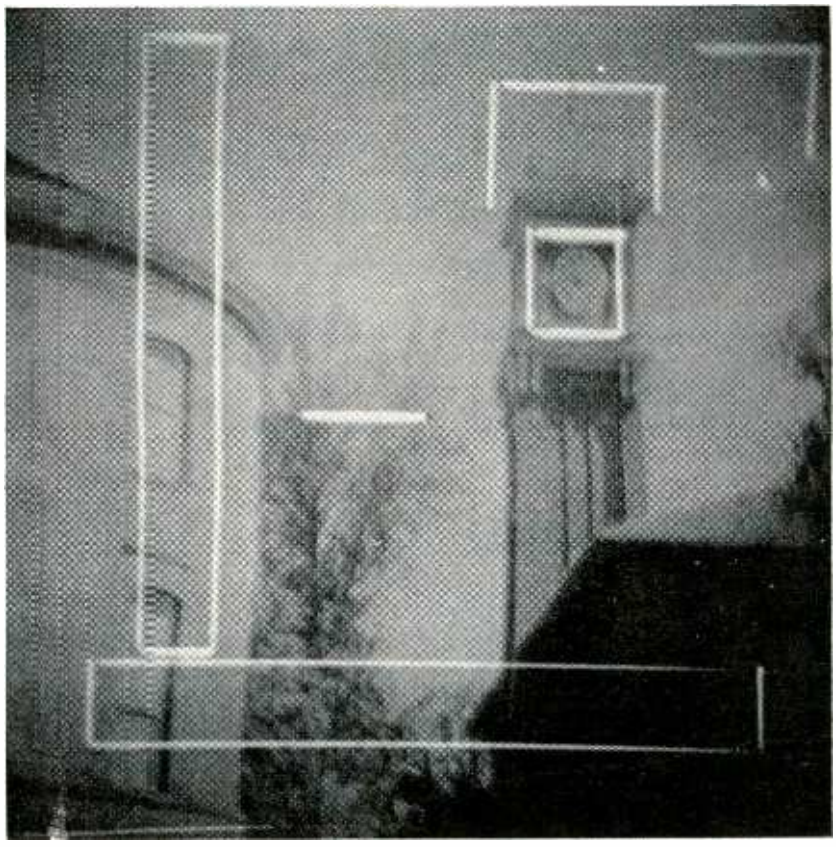


FIG. 3—Relationship of outline generator to typical video system



Multiple exposure photograph of tv screen illustrating some of the various outlines that may be achieved with the electronic outline generator

Either, or all of the sides, of the rectangle may be eliminated by applying a positive bias to the input side of the appropriate diode clipper.

The combined output of the diode modulator assemblies is amplified by V_{6A} and passed through a self-biased diode clipper to output cathode follower V_{5B}. The output of cathode follower V_{6B} is approximately 1-v peak-to-peak of white signal into a 75-ohm load.

The generated outline may be superimposed over a normal television picture either by resistive or electronic mixing procedures. Figure 3 illustrates a typical small studio setup employing a live camera and a fixed camera for slides or film pickup. A third channel is used to bring in the electronic pointer. Synchronizing pulses are added in the mixing amplifier to produce a composite video signal suitable for operating closed circuit video monitors or for modulating a transmitter.

Blanking is not included in the outline generator circuits. This is not necessary as long as all portions of the outline signal stay inside of the normal blanking boundaries. As a safety factor, its inclusion would be desirable.

Flexing Picture Edges

An additional attention-getting factor may be produced by feeding an external audio signal to the input of regenerative clipper V_2 thus causing both sides of the pattern to flex. If the audio signal is supplied to the second regenerative clipper V_4, then only the right-hand side of the pattern will flex.

Bibliography

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Fishing Sonar Uses Compact Scan System

Improved 200-kc ultrasonic system, sensitive up to a radius of 300 meters centering around a small fishing boat, detects exact location of schools of small fish vital to Japanese economy

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YOSHIMITSU KIKUCHI, Research Institute of Electrical Communication, Tohoku Univ., Sendai, Japan
and KEIJI MOCHIZUKI and ROKURO UCHIDA, Japan Radio Co., Tokyo, Japan

AN IMPROVED SONAR system operating at 200 kc is now used by fishermen in Japan to detect schools of small fish within 300 meters from a boat. The system was designed for fishing craft of the five-ton or less class.

The sonar system is also used to observe the shape and pattern of fishing nets and to determine whether the nets have been cast correctly. Observations can be made of how the fish enter or avoid the nets.

The sonar fishing gear described here is an improvement over existing systems that use a 50-kc pulse. From studies made of the attenuation constant in sea water, and propagation and reflection losses, it was found that a 200-kc system, with the same acoustical output as a 50-kc system would receive a more powerful echo from the bodies of fish up to 300 meters.

System

A block diagram of the unit is shown in Fig. 1. The system has a 600-w power output fed by the oscillator. Power consumption is 24-v d-c, 15 amps. A system of servomotors control the horizontal and vertical direction of the transducer. Ultrasonic impulses are transmitted with a sharp beam and received by a barium titanate transducer, an 80-mm dia. disk that has a resonant frequency of 200 kc. The received echo signal, indicating the presence of an underwater target, is amplified, fed to a crt and also converted to an audible signal. The transducer unit is let down in the water, either over the side of the boat or projected from the bottom of the craft.

The sonar detector has a variable operating range for two distances: zero to 150 meters and zero to 300 meters. When the controls are set manually, the unit can be made to scan horizontal sectors of either 45 deg, 90 deg, or 180 deg. The scope width is limited to within a hori-

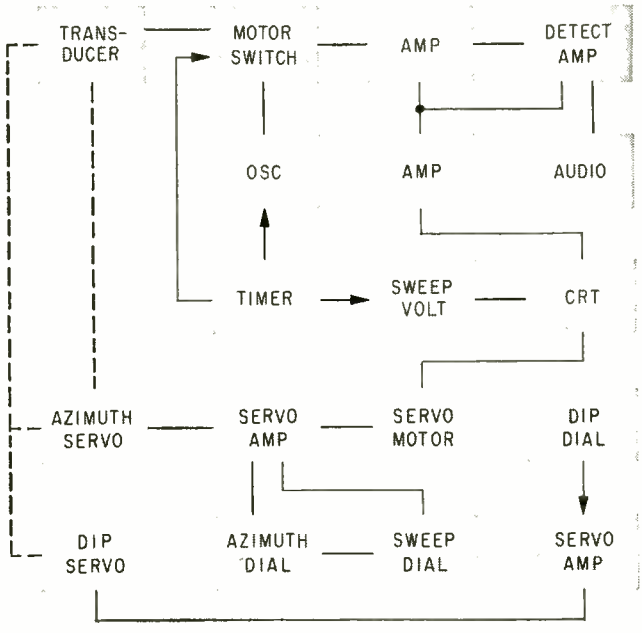


FIG. 1—Block diagram, right, of improved sonar system used by fishing agency shows transducer connections to oscillator and servomomotors. The received echo signal is amplified and fed to a crt, as in photo, or converted to audio

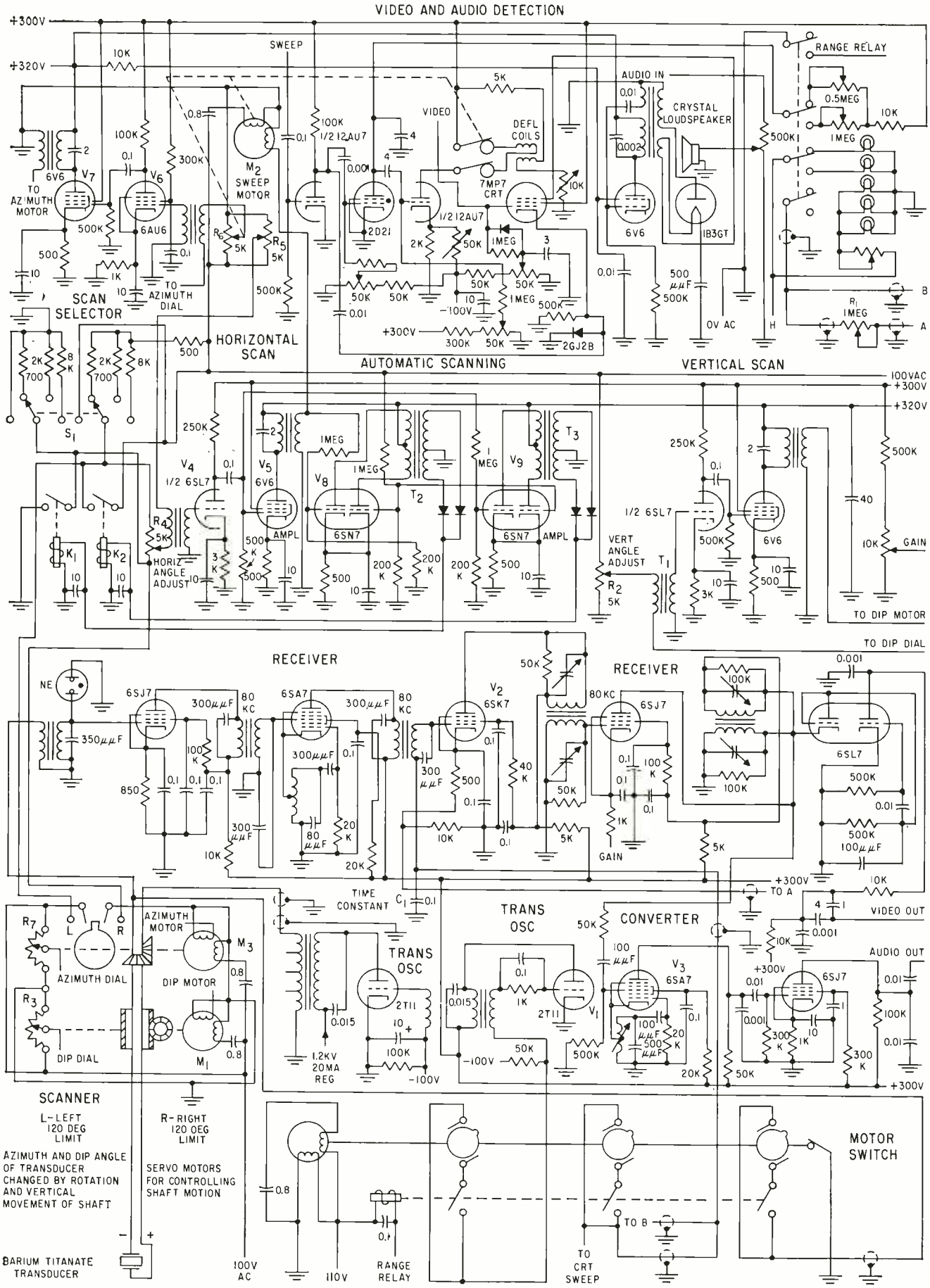
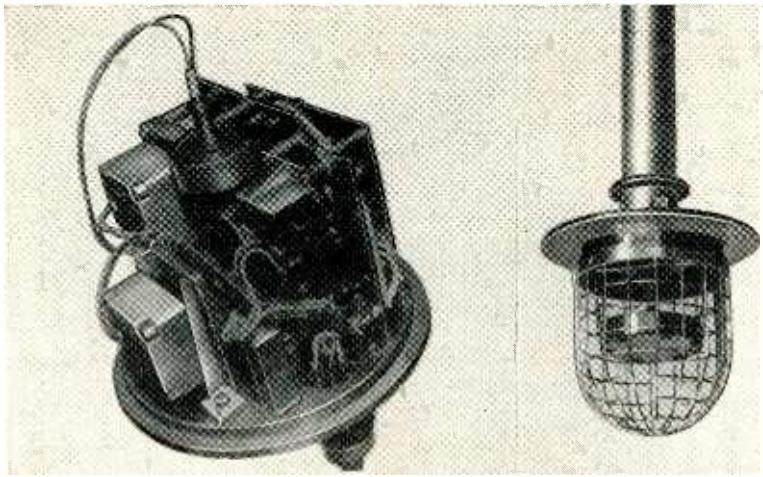


FIG. 2—Circuit diagram of sonar fish detector shows detailed circuit connections to transducer, oscillator and detection system



The left unit shows the servomotors that are contained in the upper part of the scanner. Unit at the right shows the lower part of the scanner which contains the transducer, inside of the wire net

zontal arc of 120 degrees right or left of the ship's center.

The dip angle, or vertical position, of the transducer can be set to any angle from zero to 90 deg. With a dip of 90 degrees, the sonar can be used as a normal, vertical echo sounder. When the system is operated with the transducer fixed at a dip angle between 10 to 20 degrees, sea-wave reflections are avoided in rough waters.

It takes 20 seconds to scan a horizontal arc of 180 deg. The sounding rate is 5 cps for the zero to 150-meter range, and 2 cps for the zero to 300-meter range. The beam angle is 4 deg at beam angle of half power.

The circuit diagram of the entire system is shown in Fig. 2. All control knobs are located on the front panel of the indicator unit which contains the crt and the automatic control circuits. The transmitter-receiver unit also contains the power source.

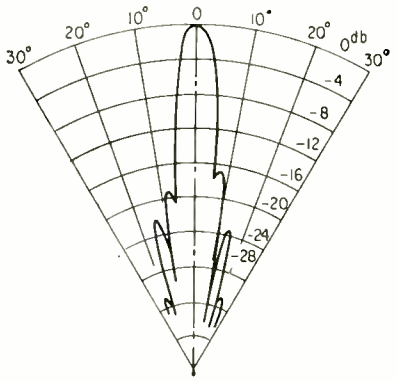


FIG. 3—Plot shows directivity of transducer

The upper part of the scanner contains servomotors that position the transducer to the set azimuth and dip angles; and the lower part of the scanner contains the transducer itself. Transducer and servo controls are connected by wires enclosed in a steel shaft that is about 2 meters long.

Operation

The ultrasonic wave is transmitted or received by one ceramic vibrator. As shown in Fig. 2, the output coil of the transmitter, the transducer and the input transformer of the receiver are connected in series. The instant the transmiter oscillates, the receiver input transformer is shorted through the motor switch and transmitting power is supplied to the transducer only. Since the input transformer of the receiver has high impedance, the received signal is developed mainly across the input transformer primary.

In transmission, tube V_1 oscillates only when the grid return is grounded by the motor switch. The pulse duration of the oscillator is 8 millisec. The motor-switch shaft revolves at 142 rpm and V_1 oscillates two times per revolution of shaft. There are two contact points above and below the shaft. The upper contact point is used for the zero to 300-meter range only.

At the instant of transmission, the capacitor connected to the grid of V_2 in the receiver is shorted. The bias voltage is dropped temporarily and sensitivity falls. Sensitivity recovers with a speed determined by time-constant of C_1 and the variable resistance of R_1. In this way an intense disturbing echo reflected a short distance from the transducer is eliminated. Since a part of the output of the intermediate-frequency amplifier is converted to the audio frequency through V_3, reflected echos are heard as audible sound.

Dip and Azimuth

The dip, or vertical, angle of the transducer is adjusted at R_2, and the 60-cps a-c supplied to the scanner causes servomotor M_1 to revolve in coincidence with the selected vertical angle.

The azimuth, or horizontal, angle setting permits alternate, automatic clockwise and counterclockwise scan. The direction of crt sweep is also changed in accordance with the direction of the transducer. When the horizontal direction control, R_4, is adjusted for scan, the unbalanced voltage generated by the relation between R_5 and R_1 is amplified by V_4 and V_5 and motor M_2 revolves to change the direction of crt sweep. At the same time, because M_2 operates the arm of R_6, an unbalanced voltage is generated as a result of the difference between the angle of the arm on R_6 and that on R_7 which is connected at the scanner. This voltage, amplified by V_6 and V_7, rotates servomotor M_3 so that both direction of transducer and sweep of the crt coincide with the horizontal-angle setting of R_4.

Automatic scanning is accomplished by relays K_1 and K_2 and the V_8, V_9 circuit. When the scope of scan is selected by switch S_1, alternate keying of the relays causes M_2 to repeat alternate clockwise and counterclockwise scan. The scanning voltage, higher or lower than the basic value depending upon the phase of the incoming voltage, is generated at the secondary windings of T_2 and T_3.

The electric motor which drives the deflection coil and the transducer is a small motor with a 6-w input. The time lag between the direction of crt sweep and that of the transducer is negligible.

Directivity plot of transducer is shown in Fig. 3.

Multiple Junction Rectifiers

Military standard silicon cartridge rectifiers can be used for many high voltage rectification needs. Table lists ratings at 100 C

By **ROBERT F. EDWARDS,** President's Assistant for Planning, International Rectifier Corp., El Segundo, Calif.

SILICON HIGH VOLTAGE RECTIFIERS have reached mass production in standard sizes, enabling producers and users to save time, paperwork and expense. In addition, the user is assured of part approval by military buyers.

These series multiple junction rectifiers have capacitance networks which prevent overvoltage failure by any one junction. Redundancy of series circuit connections give high reliability. An appreciable percentage of single junctions must short out before the whole cartridge fails. Each silicon cell is spring loaded in compression to insure that it will short if it fails.

Typical applications include missiles, radar modulators, magnetic amplifiers, X-ray high voltage supplies, overpotential testing of insulations, electrostatic precipitators and oscillation damping in welding circuits.

SPECIFICATIONS — Table I lists all types for which specifications are being written by the Signal Corps. At this writing, a specification has been issued only for 1N1731 (MIL-E-1/1172). Specifications on the others are to be issued this spring. The Signal Corps plans to leave these as single service specifications for two years for proving before making them JAN specifications.

Currents range in the military standard types from 75 to 250 ma with peak inverse voltages of 1,000 to 20,000 volts. The voltage increments are based on EIA standards. All standard multiple junction rectifiers are rated at an ambient temperature of 100 C.

Cartridge rectifiers provided with ferrule terminals for mounting into standard 30-amp fuse clips

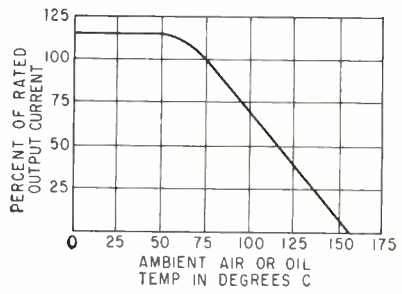
Typical rerating curves for other temperature and cooling conditions are given in Figs. 1 and 2. These curves are not part of the military standard and may vary from manufacturer to manufacturer.

Forced air convection cooling or oil cooling is employed with high current types. Standard styles are designed for normal convection cooling and horizontal mounting in air. If the rectifier is mounted vertically, a derating of 30 percent may be required.

Table I—Characteristics of Military Standard Cartridge Rectifiers

Part Number	rtridge Style	Current (ma)	Peak Inverse Voltage (v)
1N1731	3/8 ceramic	100	1,500
1N598	3/8 ceramic	100	1,000
Not Issued	3/8 ceramic	100	3,000
Not Issued	3/8 ceramic	75	5,000
1N1143A	std ceramic	75 (est)	6,000
1N1145	std ceramic	75 (est)	7,200
1N1147	std ceramic	75 (est)	12,000
1N1149	std ceramic	75 (est)	16,000
1N2139	std ceramic	75 (est)	20,000
1N1756	std high current	250 (est)	6,000
1N1758	std high current	250 (est)	7,200
1N1760	std high current	250 (est)	16,000

Fig. 1—Temperature rerating curve for standard and high-current types



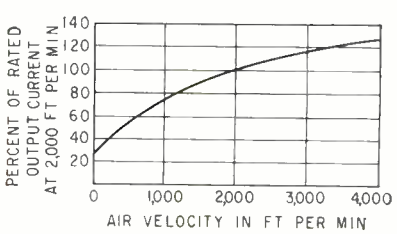


FIG. 2—Forced air cooling rerating curve for high-current types

Precision Generator for

Instrument produces two delayed pulses for establishing accurate time intervals from 1 to 10,000 μsec. Delays are adjustable in 1-μsec increments with continuous interpolation between steps. Crystal-controlled oscillator and fast preset counters reduce time-delay errors

By DONALD BRODERICK, DEXTER HARTKE and MARVIN WILLRODT,
Hewlett-Packard Company, Palo Alto, California

THIS variable time-interval standard produces two accurately controlled time delay intervals. It is particularly useful in calibrating timing circuits such as those found in radar, loran, Tacan and DME systems. It may also be used in calibrating oscilloscopes, marker generators, timing responses from computer drum storage systems, and for the precision pulse code modulation of control carriers.

Among this wide variety of applications, the digital delay generator can be used as a precision go-no-go gage for such measurements as calibrating delay lines, especially those of long delay.

The unit employs a unique application of a fast dual preset counter and an improved start and stop crystal-controlled oscillator. Pulse generators may be used to generate the desired output pulses. The oscillator always starts in synchronism with a random-time event, and no jitter is introduced in the delay intervals even though the time reference pulse occurs periodically or aperiodically.

General Operation

The overall operation of the delayed pulse generator is illustrated by the block diagram of Fig. 1.

The initiating trigger pulse can come from either an external source or from the internal rate generator. The initiating pulse triggers the unit at T_0 and simultaneously starts the 1-mc crystal-controlled oscillator that delivers 1 μsec timing pulses. The digital counters timing section counts these timing pulses and when they reach the number established by the front-panel controls, permits one of the timing pulses to pass through a gate to trigger the output pulses at the predetermined T_1 or T_2. Fifty μsecs after the second output pulse, all circuits are reset to their original state and are ready to receive another trigger input pulse.

Since the two predetermined output pulses are initiated by one of the cycles of the internal crystal oscillator, they are essentially jitter free.

Input Circuit

These circuits initiate the time zero (T_0) pulse and initiate the sequence of events producing the delayed pulses at T_1 and T_2. They also prevent the retriggering of subsequent circuits once a delay period has been started but not completed.

This circuit consists basically of an amplifier, a Schmitt trigger and a lockout gate. When the front panel switches are set for internal triggering, the Schmitt trigger is self oscillating and a square wave is present at the output. This square wave is differentiated and is used to provide a positive pulse to the lockout gate circuit. The output of the lockout gate is the T_0 pulse and also initiates the delay circuitry.

Gate Control Binary

Referring to the schematic shown in Fig. 2, the gate control flip-flop V_1 starts a rectangular gating pulse upon receiving a start pulse from the lockout gate. It stops the gating pulse upon receiving a stop pulse from the reset circuit at the termination of the longer delay interval.

Cathode followers V_{2A} and V_{2B} serve as isolation and impedance conversion coupling between the flip-flop and the three points in the circuit where the rectangular gat-

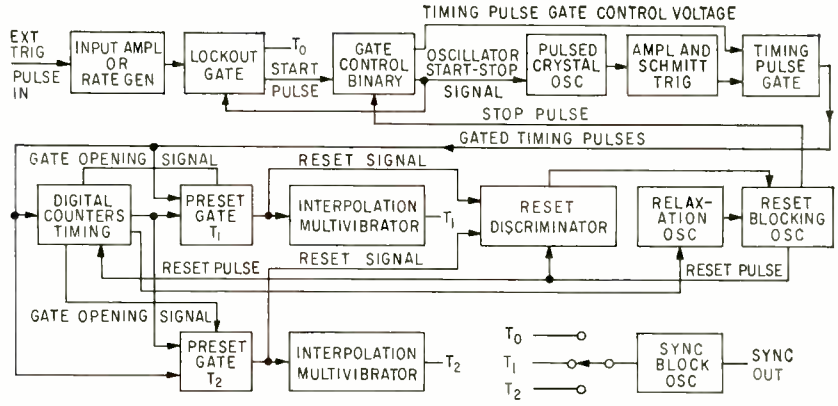
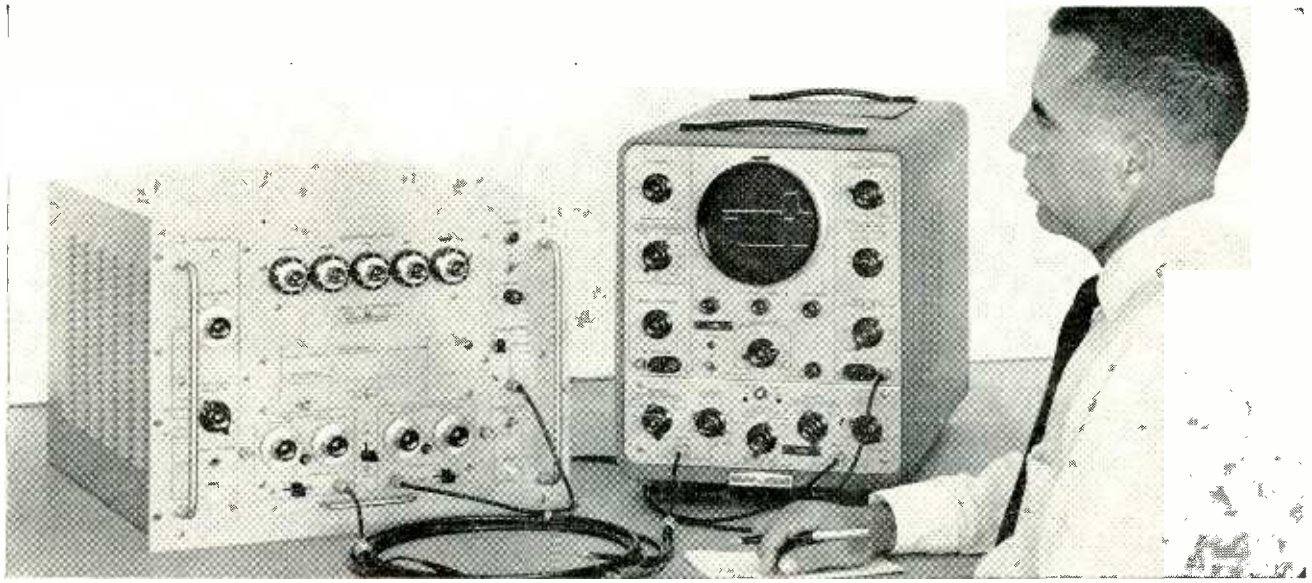


FIG. 1—Upon receiving a trigger pulse the unit generates a pulse at T_0 and simultaneously starts two independent delay periods for T_1 and T_2

Radar Range Calibration



Precision delayed pulse generator with plug-in dual pulse generator unit shown in typical test setup

ing pulses are actually used. It is necessary to keep coupling to a minimum between these three points to avoid unwanted feedback or feedthrough at the crystal frequency. The gating pulse is applied through cathode follower V_{2A} to the crystal oscillator start-stop gate V_3 and used to start and stop the crystal oscillator.

Pulsed Crystal Oscillator

For a pulsed crystal oscillator to be usable in a time interval standard, a number of stringent requirements must be met,[1, 2] such as: the oscillator must always start in synchronism with a random time reference pulse; the output must be free of undesirable transients or distortion that could cause serious timing errors (ideally this output should be zero until T_0 and then should closely approximate a c-w signal); the circuit should not support nor transmit spurious mode oscillations of the crystal; the recovery time should be short, preferably less than 10 percent of the running time; and the excitation level should remain nearly constant during the running time.

The crystal start-stop gate tube V_3 is a sharp suppressor cutoff tube. Until a gate pulse has been initiated, the suppressor voltage is zero and the tube is conducting. A negative feedback loop is completed from the junction of capacitor C_1 and crystal Y_1, through V_4 and through V_3 which holds Y_1 in a quiescent state.

At the beginning of the delay interval V_3 is cut off. This disables the negative feedback loop. A transient of short duration is developed across the bridge circuit comprised of L_1, C_2, C_3, C_1 and Y_1. Crystal Y_1 is an AT-cut crystal with a frequency tolerance of ±0.001 percent and a frequency stability

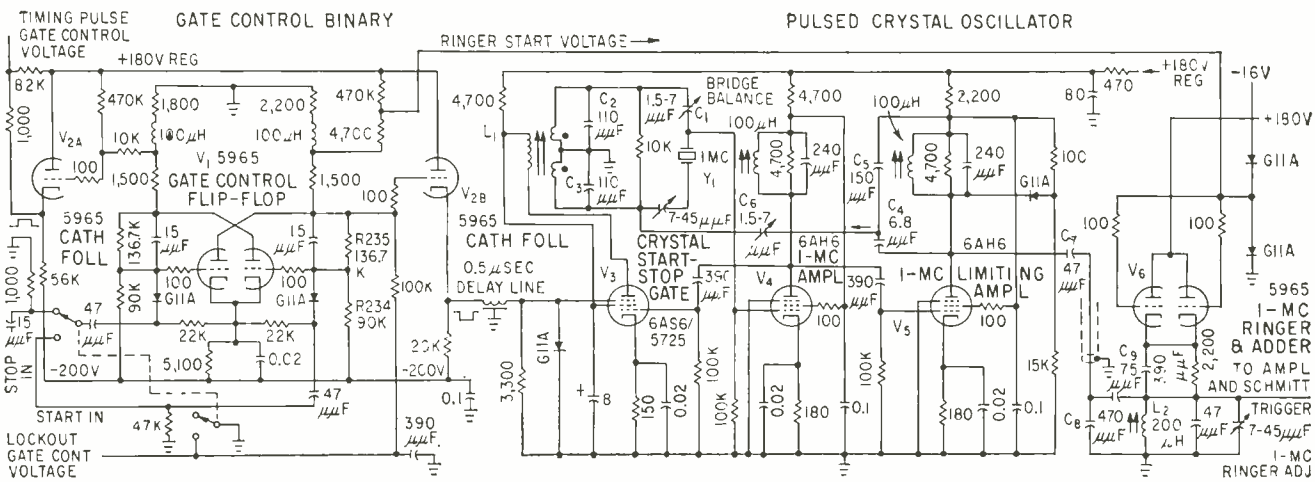


FIG. 2—Gate control flip-flop V_1 gates the pulsed crystal oscillator on at T_0 and off at the desired delay interval set by the digital counters timing circuit and controlled from the front panel

of ±0.001 percent over the temperature range from −10 to +50 C.

The crystal is shock excited into vibration and about 1 mv of crystal frequency is present at the grid of amplifier V_4 with some unavoidable distortion present in the first few cycles of oscillation. Amplifier V_4 is a straight-forward amplifier incorporating a low-Q, 1-mc resonant plate load.

Variable inductor L_1 is trifilar wound to obtain good amplitude balance of oppositely phased voltages across the center-tapped secondary. The circuit of L_1 and its associated capacitance is tuned to a frequency lower than 1 mc to obtain an inductive circuit that is necessary for shunt operation of the crystal Y_1[3].

Limiting Amplifier

A small fraction of the plate voltage of limiting amplifier V_5 is fed back in phase to L_1 through the network C_4, C_5 and C_6. Variable capacitor C_6 is adjusted to obtain a loop gain slightly greater than one so that the signal level will tend to increase for long delay periods. The limiting circuit of V_5 prevents the signal level from increasing excessively. Except for the first few cycles, the output voltage at the plate of V_5 is satisfactory for timing purposes.

Ringer and Adder

The initial part of the timing wave is developed in the cathode circuit of ringer and adder tube V_6 across a 1-mc resonant circuit consisting of L_2 and its associated capacitance.

The output of limiting amplifier V_5 is passively added to the voltage across L_2, through the network C_7, C_8, and C_9. When flip-flop V_1 is switched by a start pulse, V_6 is cut off and remains so for the duration of the delay interval.

The voltage developed across L_2 is an exponentially decaying transient with a decrement of about 25 percent in ten cycles. Thus, the timing accuracy of the first few cycles of the wavetrain is determined by V_6 cathode ringing circuit while the timing accuracy of later cycles of the wave train is determined by crystal Y_1.

The oscillator is stopped by a combination of two circuit functions. A stop trigger, derived from the digital counters timing circuit, terminates the rectangular gating pulse of crystal start-stop gate V_3 at an integral number of μsecs later than the start trigger. The time interval is determined by setting front panel delay time controls.

When plate current begins to flow through V_3, a transient of opposite polarity to that which started the oscillator appears across L_1. The amplitude, polarity and timing of this transient are such that an amount of energy is supplied to crystal Y_1 which nearly cancels crystal energy. The negative feedback loop is closed through V_3 and rapidly damps out remaining crystal energy. Within 50 μsec after receiving the stop pulse, the crystal energy diminishes to a point where it can again be started with a random time input pulse.

For delay intervals exceeding 500 μsec, the amplitude of crystal excitation will normally increase somewhat so that a longer recovery time is necessary. A conservative allowance for recovery time is the longer of either 50 μsec or 10 percent of the delay interval.

Digital Counters Timing Circuit

Again referring to Fig. 1, the crystal-controlled 1 μsec timing pulses pass through the timing pulse gate and are passed to the digital counters timing circuit where they are counted to establish the time delays selected by the front panel delay controls. When the counter has counted these timing pulses up to the selected number, voltage information is sent to open the associated T_1 or T_2 preset gate. This provides an output pulse at either T_1 or T_2.

The timing circuit employs a system of parallel drive to the counter units in order to reduce the total circuit operating time. The counters decade-count every 1 μsec timing pulse. The timing pulses pass through individual gates to the tens, hundreds, and thousands counters. These gates open so that the counters count every 10th, 100th, and 1,000th pulse respectively. Using this timing system, the time required for one decade to operate (going from a count of 4,998 to 4,999, for example) is the same as that required for all four decades to operate (going from 4,999 to 5,000).

There are two preset gates, one for T_1 output pulse and one for the T_2 pulse. Each gate is controlled by an output from the digital counters timing circuit, and in turn selects the exact timing pulse that marks the end of the selected delay period.

Interpolation Delay Multivibrator

There are two identical interpolation delay multivibrators following the preset gates. One is for T_1 output and the other is for T_2. They are one-shot multivibrators which provide an additional delay, adjustable over a 1-μsec range, to provide interpolation between the microsecond steps selected by the digital counters timing circuit.

Reset Blocking Oscillator

The reset blocking oscillator supplies the negative-going output pulse to restore the circuits of the delay generator (digital counters timing circuit) to their original starting conditions.

The reset blocking oscillator is normally triggered by the reset discriminator after the last output pulse is delivered. It may also be triggered by a relaxation oscillator circuit which operates whenever a beam is not formed in one of the counter tubes in the digital counters timing circuit.

Sync Output

This circuit is a blocking oscillator that delivers a 50-volt positive pulse that may be used for triggering oscilloscopes. The oscillator is normally quiescent and may be triggered by either the T_0, T_1 or T_2 output pulse selected by front panel controls.

The leading edge of the sync output pulse is coincident with the leading edge of the selected trigger pulse.

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(1) Britton Chance, Radiation Laboratory Series, **19**, page 145, McGraw-Hill Book Co.

(2) Britton Chance, Some Precision Circuit Techniques Used in Wave Form Generation and Time Measurements, *Rev Sci Inst*, V **17**, page 396, Oct. 1946.

(3) John P. Buchanan, Handbook of Piezoelectric Crystals, WADC Tech. Report 54-248, Section 1-364, page 236, Dec. 1954.

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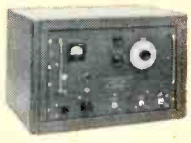

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Receiver Sensitivity Graph

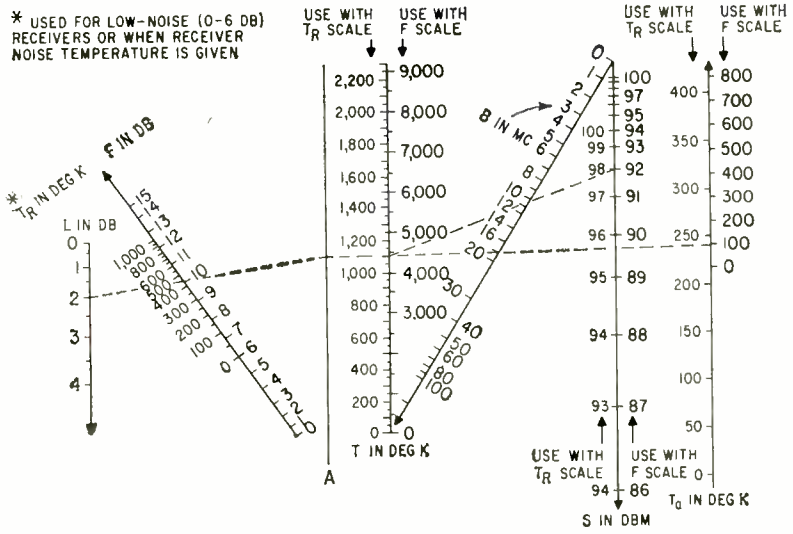
Knowing antenna temperature, receiver noise figure, losses between antenna and receiver and antenna bandwidth, it is possible to calculate the minimum detectable signal using the nomograph presented

By **T. W. MADIGAN,** Bell Telephone Laboratories, Whippany, N. J.

MAXIMUM RADAR RANGE is inversely proportional to the fourth root of the minimum detectable signal. This signal is a property of the radar receiver and is determined mainly by receiver noise figure and bandwidth, losses incurred in coupling receiver to antenna and antenna temperature.

Minimum detectable signal is considered to be the level at which average signal output is just equal to noise output of the receiver. Since many sources contribute to noise output, it is convenient to combine their effect by assuming a noise free receiver with a noise generator coupled to the input. If the power output of this generator is kTB (where k is Boltzmann's constant, T is temperature in deg K and B is effective noise bandwidth), the noise output of the ideal receiver will be kTB times the gain of the receiver. For this to be the same noise output as in the nonideal receiver, the effective operating temperature must be $T = T_a + (L - 1)\ 290 + L\ (F - 1)\ 290$ where T_a is antenna temperature, L is ohmic losses in transmission path between antenna and receiver, and F is receiver noise figure.

Antenna temperature is determined by sky temperature and by how well the antenna couples to the sky. Presence of minor lobes causes some coupling to the warm earth. Sky temperature is approximately equal to 290 λ^2 T. However, at high microwave frequencies, the presence of oxygen and water vapor absorption make sky temperature also a function of elevation angle. At high angles where the beam passes through a limited atmosphere, antenna temperatures of a few deg K are possible. Much higher temperatures will occur at low angles where the beam passes through an extended atmosphere.



Losses between the antenna and receiver include waveguide losses, duplexer losses and losses from any other equipment such as isolators, directional couplers, and filters.

The receiver noise figure includes the combined effect of r-f preamplifiers, converter and i-f preamplifiers. For low noise receivers, the receiver temperature, equal to $(F - 1)\ 290$, is sometimes given instead of the noise figure.

The full range of noise figures is given on the F scale while scale T_R contains values of F which are shifted six db and relabeled in deg K.

For greater accuracy, the decimal point of the B scale can be moved to the left and 10 db added to the S reading for each shifted digit.

Example

Given $L = 2$ db, $F = 10$ db, $T_a = 100\ K$ and $B = 10$ mc find receiver sensitivity. Draw line from 2-db point on L scale through 10-db point on F scale to index A. Draw line from intersection point on index A to 100 K point on right T_a scale. Read operating temperature of 4,400 K on T scale. Draw line from this point through 10-mc point on B scale to S scale and read sensitivity of −92 dbm.

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Airport Radar Has High Resolution

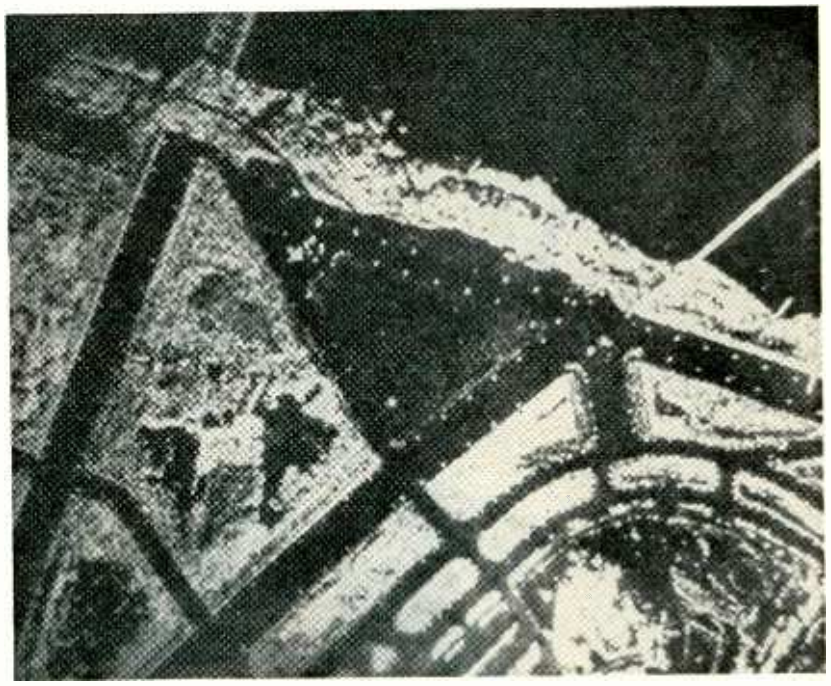
By R. F. PHILLIPS SMITH Airborne Instruments Laboratory division of Cutler-Hammer, Inc., Mineola, New York

DUAL-CHANNEL high-resolution radar permits observation and control of airport surface traffic. The display supplements or replaces visual observation of a control-tower operator and aids him during darkness and low visibility.

The Federal Aviation Agency (FAA) recently ordered ten of the special radars known as Airport Surface Detection Equipment (ASDE). The basic radar was developed for the USAF by Airborne Instruments Laboratory division of Cutler-Hammer. The USAF version (AN/FPN-31) and the FAA type (ASDE) reflect differences in application and operating philosophy between military and civilian requirements.

The dual-channel feature provides a standby channel that can be serviced without affecting the operating channel.

Because the radar sees reflections from the areas covered by vegetation or rough ground surfaces, most of the airport is visible on the display. Because the runways are dark, aircraft and other objects on them are seen against a dark background.



THE FRONT COVER. Rough airport surfaces and aircraft reflect radar energy in Airborne Instrument Lab system, so that planes are seen against dark background of runways

Resolution

Prime requirement for the radar shown in the block diagram in Fig. 1 is that it produce a PPI display of maximum resolution. The resolution achieved enables an operator to discern two separate targets of about 5 sq ft each, separated 20 ft at a range of 4,000 ft. Several design approaches contribute to its high resolution.

A high r-f (24 kmc) is used to obtain a narrow antenna azimuth beam (0.25 degree), which corresponds to 10 ft at a range of 2,300 ft. The 14,400-pps pulse-repetition frequency was chosen to produce ten pulses per antenna azimuth beamwidth. The narrow pulse (0.02 μsec) corresponds to 10 ft of range.

A special high-definition 16-in. crt (1,000 lines/dia) is used for the PPI display. Resolution of the crt is such that the smallest dot discernable is about 0.007 in. in dia. This represents a target of 75 sq ft when the radar range switch is set to 5,600 ft.

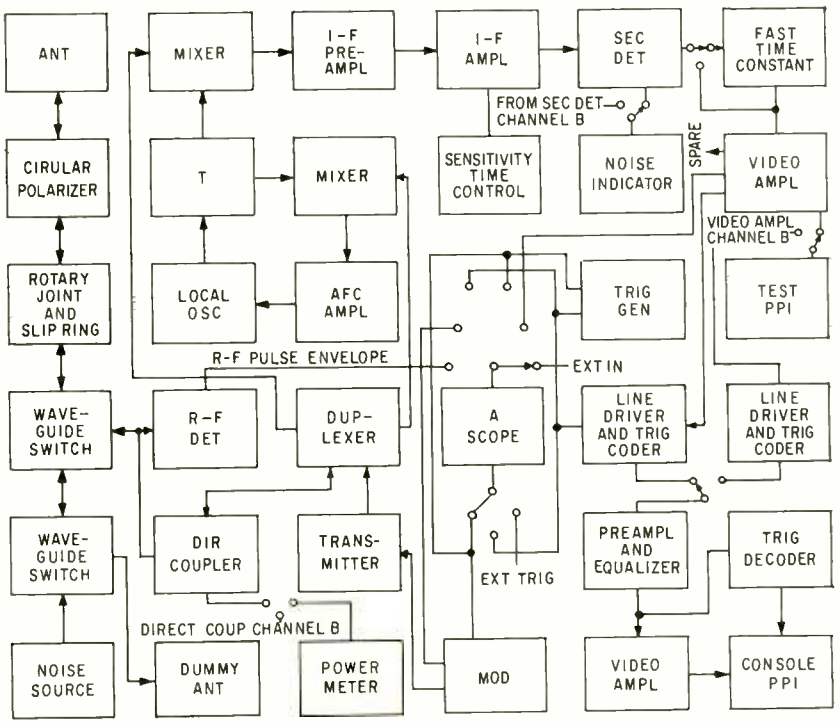


FIG. 1—Primary design goal of airport surface detection equipment was high resolution

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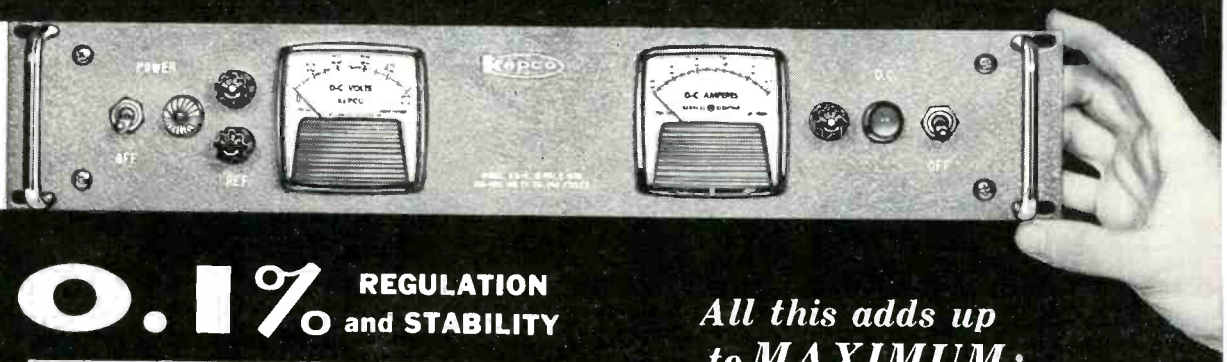

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50 kw, and antenna polarization can be either linear or circular. Circular polarization, which is normally used, practically eliminates radar return from rain.

The antenna reflector is 12 ft wide and 4 ft high, and reflector surface tolerance is $\pm\frac{1}{32}$ in. The horizontal cross section is parabolic; the vertical cross section is shaped to fan out the elevation beam. The vertical radiation pattern has a modified cosecant-squared distribution extending to 25 degrees below the horizontal for close-in coverage of the ground. For example, minimum range is 200 ft when the antenna is mounted at a height of 100 ft.

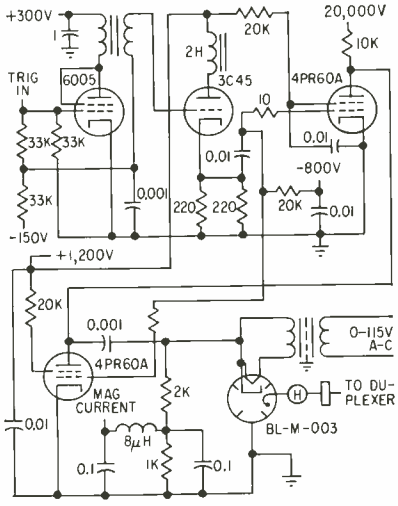

FIG. 2—Modulator supplies 0.02μsec pulses at a prf of 14,400 pps

With the 60-rpm scan rate used, the antenna must be protected from wind forces with a radome. An inflatable three-quarter sphere 17 ft in dia is used. The radome also eliminates tower vibration caused by wind buffeting and considerably reduces power required of the antenna azimuth drive motor.

Modulator

The 180-kw modulating pulse has a duration of 0.02 μsec at a prf of 14,400 pps. Because a hydrogen thyratron of adequate power-handling capability would not deionize rapidly enough to operate at this prf, the hard-tube modulator shown in Fig. 2 is used.

The modulator pulse is so narrow that the magnetron is on for only 480 cps. The radar output con-

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sists of pulse packages only 20 ft long and separated by 13 miles. Although the short pulse is difficult to generate, magnetron isolation from the load is simplified. Because of the shortness of the pulse within the waveguide, the magnetron pulse has ended before the r-f pulse reaches the antenna feed horn. Reflections from the horn are so late they cannot cause magnetron pulling.

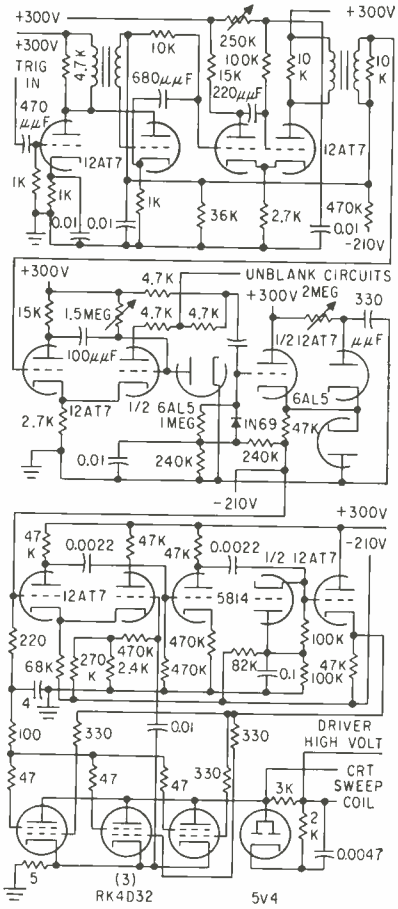
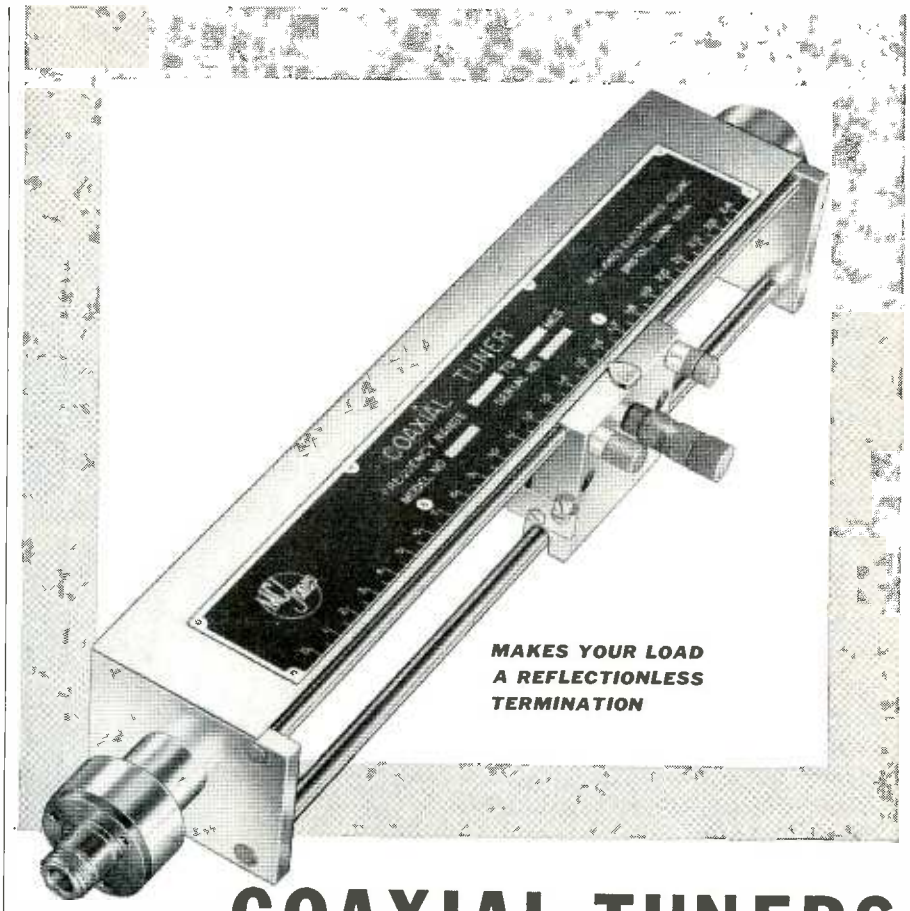


FIG. 3—Deflection yoke and sweep circuits for crt must operate at sweep lengths varying by a factor of 8 to 1

The deflection yoke and sweep circuits for the crt must operate with sweep lengths varying by a factor of 8 to 1. For example, the sweep amplifier power supply for the ½-mile range must supply 1,100 volts at 160 ma, but at the 4-mile range, it must furnish 400 volts at 270 ma. The sweep and deflection circuits are shown in Fig. 3.

Handling i-f and video signals with a bandwidth of 50 mc required distributed-type i-f and video amplifiers. There are 70 tubes in the i-f chain and 30 in the video.



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TUNE TO **VSWR 1.000**

200-4000 MCS.

DESIGNED FOR USE whenever extremely accurate RF power terminations are required. This laboratory type Coaxial Tuner will tune out discontinuities of 2 to 1 in coaxial transmission line systems or adjust residual VSWR to 1.000 of loads, antennas, etc. May also be used to introduce a mismatch into an otherwise matched system.

M. C. Jones Coaxial Tuner is designed for extreme ease of operation, with no difficult laboratory techniques involved. Reduces tuning time to a matter of seconds. Graduations on carriage and probe permit resetting whenever reusing the same termination.

SPECIFICATIONS

Impedance	50.0 ohms
Frequency Range	Model 151N 200-1000 Mcs. Model 152N 500-4000 Mcs.
RF Connectors	EIA 7/8" 50.0 ohm Flange plus adapters to N female connector
Power Rating	100 watts
Range of Correction	VSWR as high as 2 may be reduced to a value of 1.000

For more information on Tuners, Directional Couplers, R. F. Loads, etc., please write for 68-page Catalog No. 12 or see Electronics Buyers Guide or Electronic Engineers Master.

M.C. Jones **M. C. JONES ELECTRONICS CO., Inc.**
BRISTOL, CONNECTICUT

CIRCLE 39 READERS SERVICE CARD

New Tube Adopts Cantilever Design

CONSTRUCTION of the Nuvistor—RCA's new, rugged miniature tube—is basically different from other tube construction. It results in reduced size and power drain but increased performance and reliability.

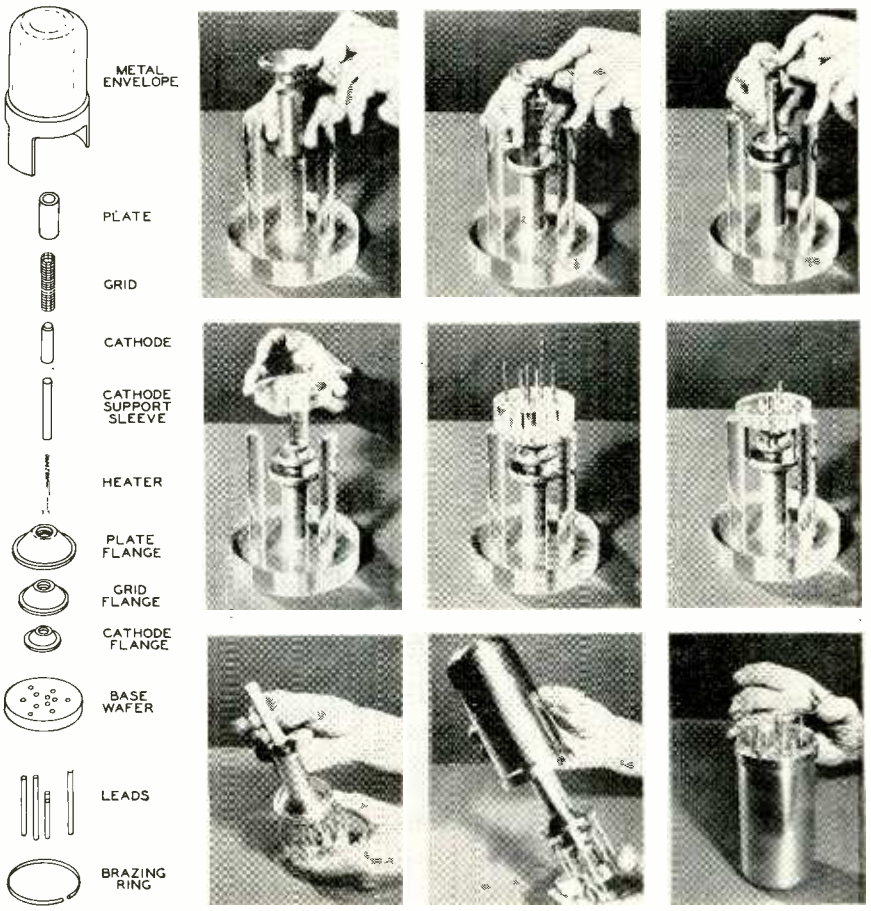
Construction

In construction of the tube, a ceramic base-wafer serves as a platform on which the array of tube electrode assemblies is erected. By supporting the electrodes from only one end in a cantilever technique, the need for mica support disks or spacers is eliminated. Each electrode assembly is held in place rigidly by a tripod-like structure. All the electrodes are small, lightweight cylinders able to withstand a high degree of shock and vibration because of their shape and low mass.

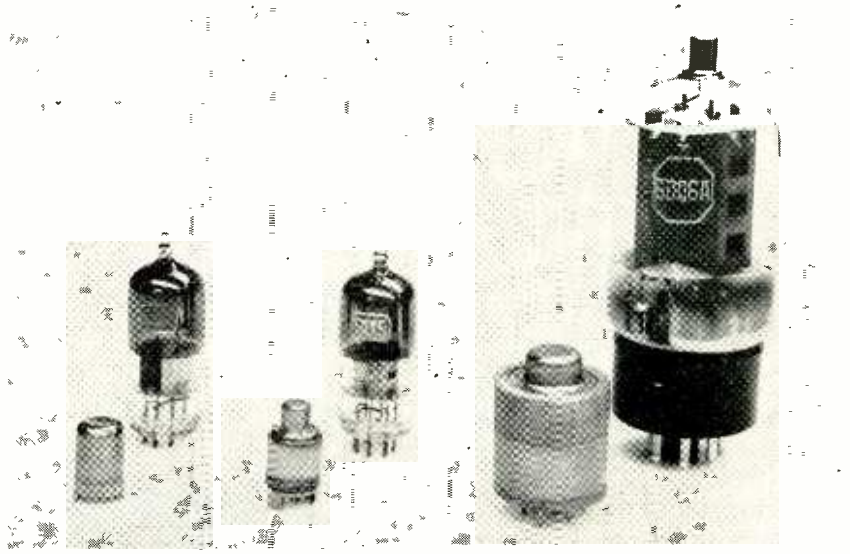
Tubes are made of ceramic materials and metals such as steel, molybdenum and tungsten. All joints are processed at about 2,000 F in a brazing furnace and then in a vacuum-exhaust furnace. Parts are thereby joined in their original strain-free positions. The technique tends to reduce greatly the possibility of short-circuits developing in the tube during operation. High-temperature processing eliminates many of the impurities and gases that are difficult to remove during manufacture of conventional tubes. These tubes cannot withstand the high processing temperatures because of the glass and mica used in their design.

Tube Types

Included in the Nuvistor developmental program are a small-signal triode, a small-signal tetrode and a beam power tube. The small-signal triode, has a 6.3-v filament. Some of its characteristics as a Class A_1 amplifier are: plate voltage, 75v; amplification factor, 32; transconductance, 10,500 μmhos and plate current, 9 ma. Maximum ratings are: plate voltage, 100 v; grid voltage, −50 v; peak positive grid

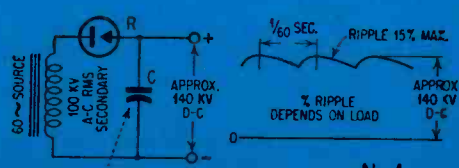


Display model shows assembly technique (top-to-bottom): loading plate and plate flange on jig; loading heater and base wafer; assembling coated cathode cup over cathode sleeve after mount brazing; loading grid and grid flange; lead-loading jig ready to drop leads into position in base wafer; assembling tube envelope and mount; loading cathode sleeve and cathode flange; assembled mount ready for brazing furnace and assembling brazing ring prior to exhaust and final seal. At left, exploded view of triode.



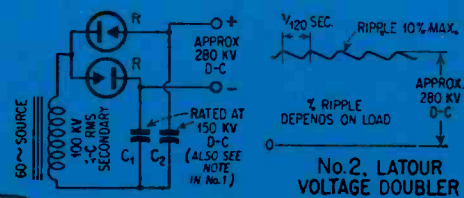
Developmental samples, left-to-right, of small-signal triode, small-signal tetrode and beam power tube compared with conventional counterparts

25,000 to 200,000 volts DC in a single unit

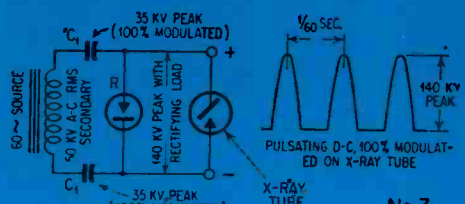


NOTE: D-C RATING APPROX. 1.5 X SECONDARY RMS VOLTAGE, viz. 150 KV D-C

No.1 HALF WAVE

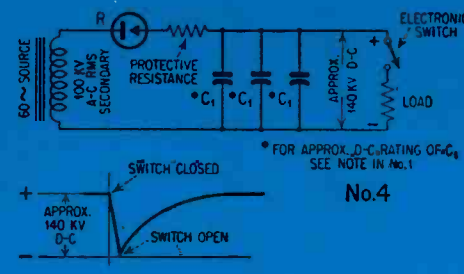


No.2. LATOUR VOLTAGE DOUBLER



IN THE CIRCUIT EXAMPLE, CAPACITORS C_1 SHOULD HAVE A RATING OF 50 KV D-C (EQUAL TO THE A-C RMS OF THE SECONDARY) DUE TO THE 100% MODULATED WAVE ON THE CAPACITORS

No.3 VILLARD VOLTAGE DOUBLER

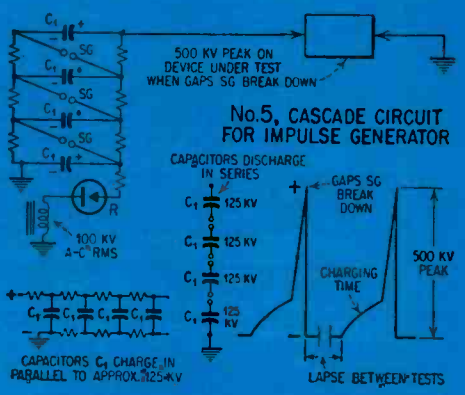


* FOR APPROX. D-C RATING OF C_1 SEE NOTE IN No.1

No.4

with Cornell-Dubilier

ULTRA-HIGH-VOLTAGE CAPACITORS



No.5, CASCADE CIRCUIT FOR IMPULSE GENERATOR

Name Your Application. State Your Voltage

TUBULARS (25 KV to 200 KV) —for betatrons, nuclear accelerators, impulse-test and cascade circuits, X-ray and other voltage-doubler circuits.

TUBULARS

- 25,000 to 200,000vDC; .001 to .6 mfd., depending on voltage.
- Cast aluminum, dual-purpose end caps, seven different styles, serve as electrical terminals and banking-mounting means.
- Long creepage path. Uniform voltage gradient. No flashover. Corona-free.
- Multi-layer paper dielectric. Non-inflammable Dykanol "G" impregnant. High dielectric constant. Non-oxidizing.

RECTANGULARS (6 KV to 30 KV) —compact-sized heavy-duty "workhorse" for continuous-duty DC filtering; also for blocking and bypassing depending on current and frequency.

TYPE TK

- 6,000 to 30,000vDC; .1 to 14.0 mfd., depending on voltage.
- Welded, hermetically sealed steel case.
- Multi-layer paper dielectric. Non-inflammable Dykanol "G" impregnant.
- Oil-filled bushings; liberal creepage distance between terminals—no flashover.
- Smallest sizes consistent with high factor of safety.

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Meeting the unusual requirements of modern military, industrial, and scientific research applications, Cornell-Dubilier capacitor designs also permit practically unlimited flexible "building block" combinations to provide values far beyond those shown in our extensive standard listings. High capacitance, higher voltage, or higher joule ratings are easily and economically obtained by parallel, series, or series-parallel capacitor bank arrangements.

For complete data, write for Engineering Bulletins 183 (TUBULARS) and 184 (TYPE TK) to Cornell-Dubilier Electric Corp., South Plainfield, N. J.

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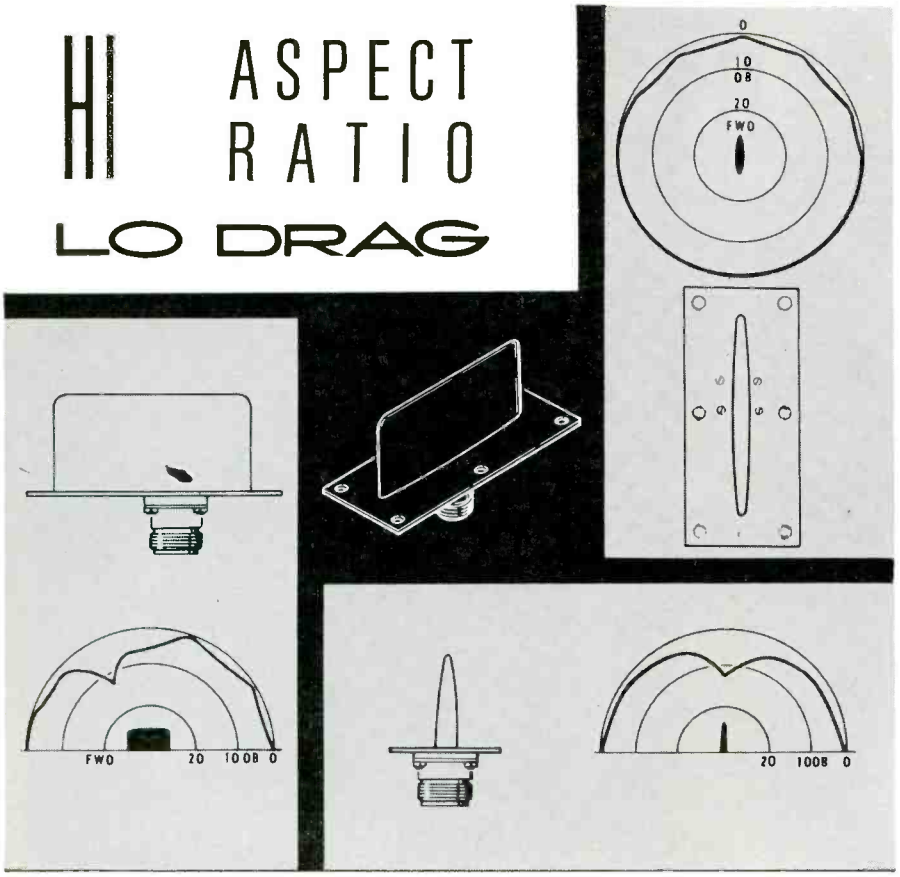

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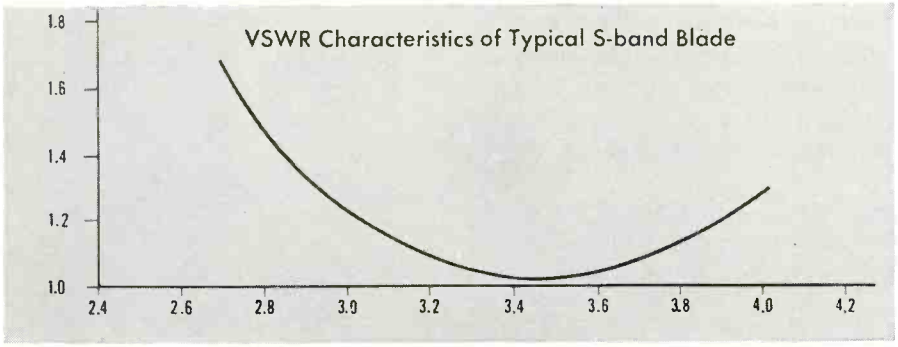

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Technical data available upon request

voltage, 2 v; plate dissipation, 1 w and peak heater-cathode voltage, 100 v.

Preliminary measurements made on the triode show that with a transconductance of 10,000 μmhos, input conductance is 200 μmhos at 100 mc and 2500 μmhos at 250 mc. These figures are comparable to those of a conventional 6BN4.

The new tube construction is readily adaptable to the micro-miniaturization module program.

Solid-State Thyratron Made Available

EVIDENCE of the fast-moving pace of the electronics field is another entry in the field of solid-state thyratrons. A tabulation of these devices published recently (p 50, March 6, 1959) included all units available commercially at that time. Within a month, another unit has appeared on the market.

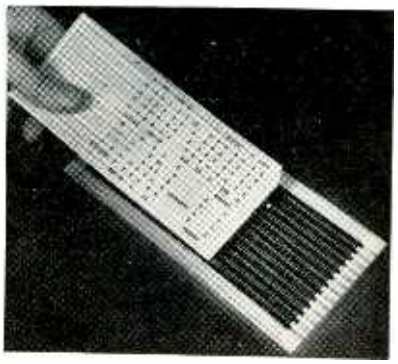
The new component is a silicon PNPN triode device manufactured by Solid State Products, Inc. of Salem, Mass. It features high-gain switching in the current range from 10 to 1,000 ma. Other characteristics are: voltage ratings to 200 v, peak current ratings to one ampere, turn-on time of about 0.2 μsec and typical current gains of 500 and

Largest Klystron

Varian Associates' VA-842 klystron is said to be the world's largest. It's 12-ft high; weighs 900 lb

power gains of 250,000 at output peak current levels up to 1000 ma.

Photorectifier Array in Production



Photorectifier array ready to receive light mask behaves like complex diode array

AT THE 1958 Electron Devices Meeting in Washington, F. L. McNamara and R. R. Billups of Lincoln Laboratory, Massachusetts Institute of Technology, described development of a photorectifier array. This was reported on in ELECTRONICS (January 30, 1959, p 46).

Rex Corp. of West Acton, Mass., has announced the commercial availability of the Rex-Array photorectifier plate based on these same principles. The firm is presently manufacturing arrays with packing densities of 100 photorectifiers per sq in. but higher densities are possible. The units show considerable promise in many application areas as described in the reference article.

Thermosetting Plastic Is Water-Clear

RECENTLY ADDED to the epoxy line of Marblette Corp. is a new thermosetting material that is crystal-clear.

The new material resists high temperatures, provides 90-percent light transmission, does not discolor and has shrinkage of only 0.0025 in. per in.

The resin is supplied as a low-viscosity liquid which does not need melting before simple blending with a liquid hardener. The resin-hardener blend has a pot life of 10 hours.

Measures
1 mv to 1000 v
from
15 cps to 6 mc

Features Accuracy 3% to 3mc., 5% above—Input Impedance 7.5 mmfds shunted by 11 megohms

BALLANTINE WIDE-BAND SENSITIVE VOLTMETER

Model 314
Price: $285

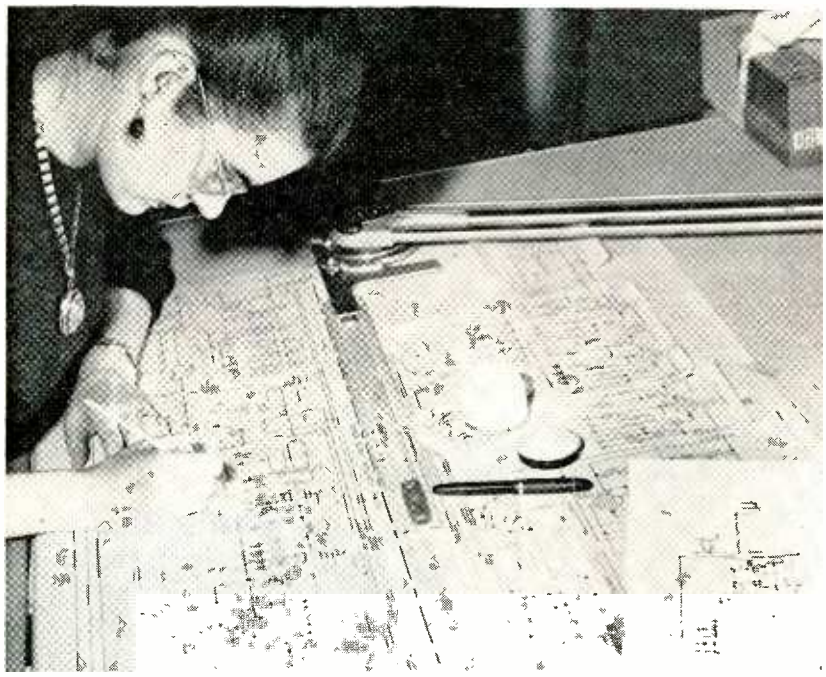
gives you these advantages:

- Same accuracy and precision at ALL points on a logarithmic voltage scale and a uniform DB scale.
- Only ONE voltage scale to read with decade range switching.
- Probe with self-holding connector tip enables measurements to be made directly at any point of circuit.
- High input impedance insures minimum loading of circuit.
- Stabilized by generous use of negative feedback.
- Can be used as 60 DB video pre-amplifier.

Write for catalog for complete information

Manufacturers of precision Electronic Voltmeters, Voltage Calibrators, Capacitance Meters, DC-AC Inverters, Decade Amplifiers, and Accessories.

BALLANTINE LABORATORIES, INC. BOONTON NEW JERSEY



Changes in existing print are roughed out with ink or colored pencil

Original drawing, altered by pasting in new sections and adding connecting lines, is used to produce film line negative

Pasteups Speed Circuit Drafting

By **E. A. OBERG,** Kaar Engineering Corp., Palo Alto, Calif.

TIME IS SAVED in the preparation of schematic diagrams with techniques similar to those used in preparing pasteups for offset printing. These techniques may be applied when the circuit of a new device is similar to that for which a finished schematic is already available.

A black line print of the existing circuit is surveyed to determine changes required. Extra prints are handy for marking. Sections to be retained are clipped out and pasted in the correct positions on drafting paper, starting from a given position such as the left side of the drawing.

Locations of new symbols are lightly sketched in pencil. These may be drawn or pasted in, using symbols from other prints, as the work progresses. New connecting lines are added. Errors can be avoided by eliminating unwanted black lines in the diagram with white paint as the work progresses.

Newly drawn sections replace parts of original which require drastic changes

Unwanted lines are eliminated with white ink

Time can also be saved by using clips from other prints to modify components. For example, if a filament type rectifier tube is to be replaced by one with a cathode, the lower half of the symbol of a cathode type tube is pasted into position over the filament.

Values of components can be similarly changed. Component reference numbers and values can be clipped from prints and pasted over existing numbers or alongside new components added to the drawings. Rubber cement is used for affixing the clips if alignment is made while the cement is wet. Another adhesive, Ree-Stik, is available in most art goods stores. This is a white latex and is pressure sensitive, permitting pasted clips to be lifted and realigned many times.

Film Prepared

The completed pasteup is sent to a lithographer or photocopy shop with instructions to produce a film line negative. The negative can be touched up by the printer. However, at Kaar the negative opaquing operation is performed on a light table in the drafting department.

The negative is carefully checked to ensure that all lines will print as intended and that no smudges or unwanted lines are on the negative. Red opaque material is used to cover pin holes or other sources of unwanted light. Partially blocked out lines are opened with a

Save time . . . insure accuracy

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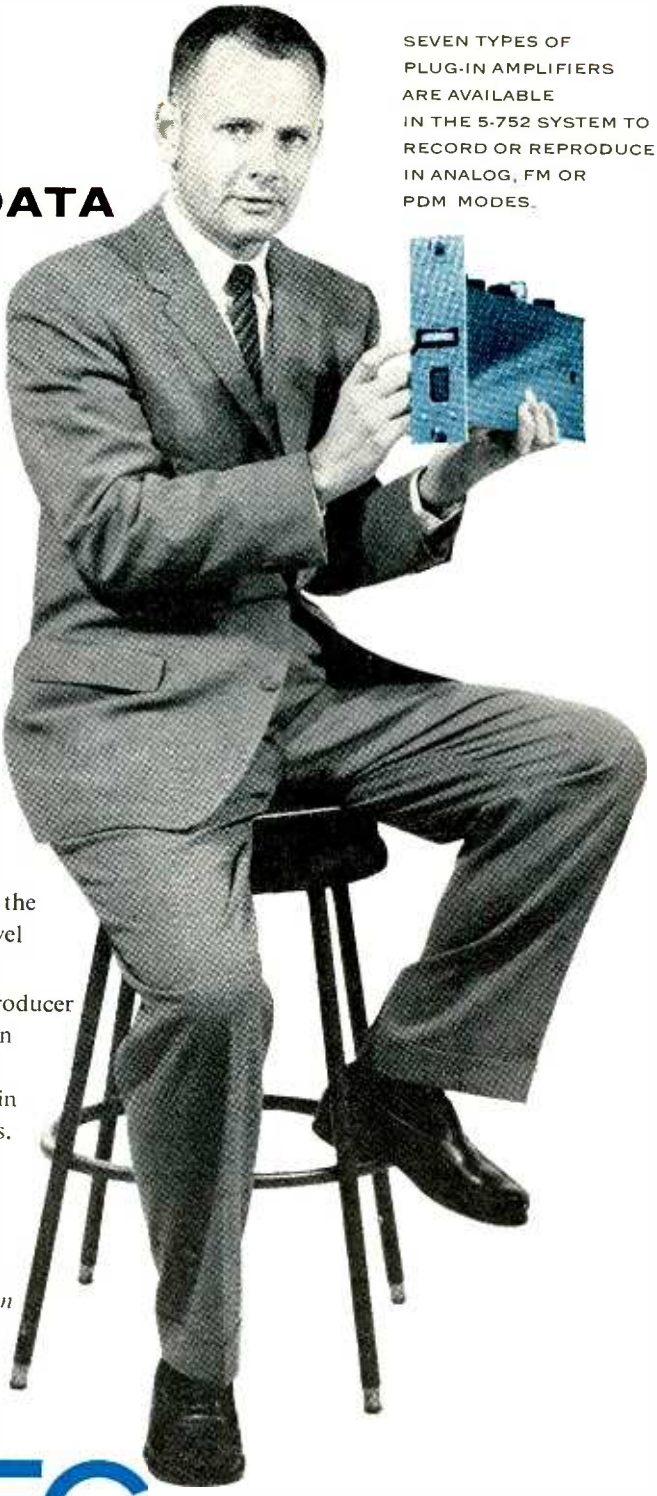
with integrated amplifier meters



SEVEN TYPES OF PLUG-IN AMPLIFIERS ARE AVAILABLE IN THE 5-752 SYSTEM TO RECORD OR REPRODUCE IN ANALOG, FM OR PDM MODES.

CEC's new record and reproduce amplifier meters mount *directly* on individual Analog or FM amplifiers of the standard 5-752 Magnetic-Tape Recorder/Reproducer System . . . to save time and assure accuracy. On *record* amplifiers, the meters allow continuous monitoring of incoming signals. On *reproduce* amplifiers they are used to monitor output signals and to provide positive indication that test data are being recorded on tape.

Mounting of the meters directly on the amplifier panels significantly reduces the possibility of stray pickup being mixed with signals and also eliminates the confusion in channel identification that often occurs when meters are remotely located. The monitor meters do not adversely affect the recorded signals or normal operation of the amplifiers.

By providing a means of locally adjusting signal and bias levels, the meters are invaluable when setting up the 5-752 prior to a test run. On Analog record amplifiers, the units can be used to monitor bias signal level by means of a front panel selector switch.

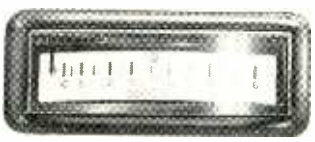
CEC's 5-752 Magnetic-Tape Recorder/Reproducer System provides up to 14 tracks of precision data recording and playback of frequencies from d-c to 100 kc. The 5-752 is widely used in industrial, medical and military applications. Among its features are all-metal-surface magnetic head stacks . . . six standard IRIG tape speeds . . . lowest cumulative flutter characteristics.

For complete information on the 5-752 system and CEC Amplifier Monitor Meters, contact your nearest CEC sales and service office or write for Bulletin CEC 1576-X36.

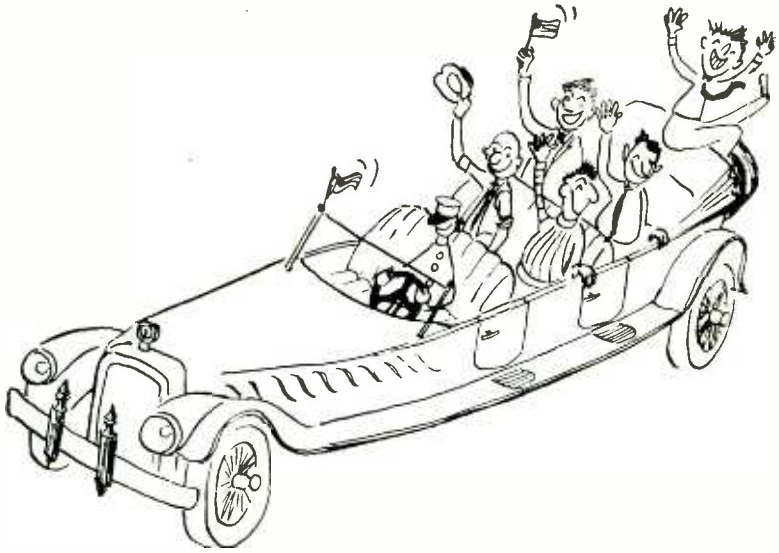
DataTape Division CEC

CONSOLIDATED ELECTRODYNAMICS *300 N. Sierra Madre Villa, Pasadena, Calif.*

FOR EMPLOYMENT OPPORTUNITIES WITH THIS PROGRESSIVE COMPANY, WRITE DIRECTOR OF PERSONNEL



METERS ARE AVAILABLE ON CEC ANALOG OR FM RECORD AND REPRODUCE AMPLIFIERS AS FACTORY INSTALLED OPTIONAL EXTRAS, OR THEY MAY BE ORDERED IN KIT FORM FOR INSTALLATION BY THE USER. KITS INCLUDE METER, NEW AMPLIFIER FRONT PANEL AND FULL INSTALLATION INSTRUCTIONS.

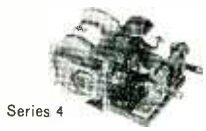


UNSUNG HEROES

We wish we could afford a newer automobile with an emblazoned banner for *each* of these gentlemen*, to tell the whole relay-using world of their accomplishments. For these are the souls who design that seldom-heralded product—the plebeian Sigma relay. Unlike more renowned Sigma engineers, they can never go home at night and say "Today I built a relay that will make history"; instead, their efforts will only keep someone's juke box, remote-controlled toy, electric blanket or burglar alarm working.

Here are five of their achievements that are about as experienced as relays can be; the "4", "5" and "41" have proved themselves since early WW II days, the others almost as long. Being old standbys also means they're for sale and deliverable in quantity.

* Perhaps you recognize the man on the spare tire as Mackinaw L. Mundane of April 1958 fame.

AC		DC
	 Series 4	Rugged, lightweight general-purpose SPDT design with adjustable pull-on and drop-out. Standard sensitivity 20 or 50 mw., rated 2 amperes resistive for 100,000 operations.
Built-in rectifiers. Operation comparable to DC performance, except for coil overload capacity and speed.	 Series 5	Dual coils, SPDT, sensitivities from 1 mw. to 2 watts. High stability and shock resistance. Available adjustments include precision DC, close differential, meter protection, break-delay, etc.
Shaded pole version, for 60 cycle positive ON-OFF operation only. Standard sensitivity 0.3 volt-ampere. Type 11F — 1 3/32" x 1 3/32" x 1" high, wt. 1 oz. max.	 Series 11	Small, low cost ($1.50-2.45) SPDT relay. Ideal for remote control units for toys and TV sets, door openers, etc. Mechanical life 100,000,000 operations. Four mtg. styles, unenclosed only.
Shaded pole SPDT design. Sensitivity 0.06 to 0.40 volt-ampere, 60 cps (specials for 16-400 cps.) Long life; quiet, inexpensive. Ratings up to 5 amperes resistive.	 Series 41	DC sensitivities 40 to 200 mw. Fast, bounce-free switching; useful for keying; speeds to 100 pps. Shock and constant acceleration up to 100 g will not cause damage.
DPDT version of Series 41, but with 0.30 and 0.50 volt-ampere standard sensitivities. Standard frequency 60 cps, specials 16-400 cps. Contacts rated 2 or 5 amperes. Economical of power.	 Series 42	DPDT version of Series 41, but with 100 and 200 mw. standard sensitivities. Can serve as output relay of many electronic controls; often used where UL approval is required. Contacts rated 2 or 5 amperes.

Bulletins on any of these Series on request.

SIGMA

SIGMA INSTRUMENTS, INC.
62 Pearl St., So. Braintree 85, Mass.
AN AFFILIATE OF THE FISHER-PIERCE CO. (Since 1939)

scratch knife. The final checkout is made by someone who is familiar with the electronic circuitry.

After the negative is ready, direct prints are made by an Ozalid or other print producing machine. The negative serves as an original drawing and may be filed. It can also be used to produce a photo offset printing plate or for direct photo printing of positive prints.

Use Optics to Orient Semiconductor Crystal

Pattern of light reflected from etch pits indicates crystal orientation

OPTICAL INSTRUMENT for orienting silicon, germanium and other monocrystalline materials is announced by Sylvania Electric Products, Inc., New York, N. Y.

A converging beam of light is projected upon microscopic etch pits in the crystal's surface. The beam is reflected from the facets of the etch pits and split into component rays equal in number to the planes in a single pit. The planes act as mirrors, reflecting the rays onto a screen. The light pattern is interpreted by the operator as to orientation.

According to the firm's Chemical and Metallurgical Division, the method reduces investment in equipment and operator training. Crystals can be prepared and evaluated in a fully lighted room in as little as 15 minutes.

Soldering Irons Center Shafts in Plastic Case

PAIR of 100-watt soldering irons are used to center and fix in place the lever shafts of precision snap-acting switches made by Unimax Switch Division, W. L. Maxson

Corp., Wallingford, Conn.

The hot irons seal the shafts in place by softening the plastic case material around the ends of the shaft and forming a bead under pressure (Fig. 1). The irons are applied to both shafts simultaneously, with matched pressure, so that the shafts are centered.

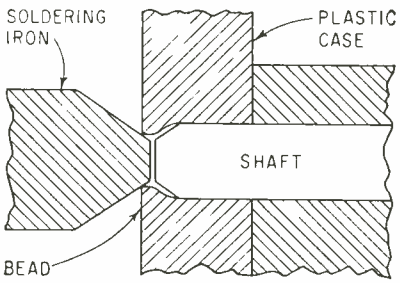
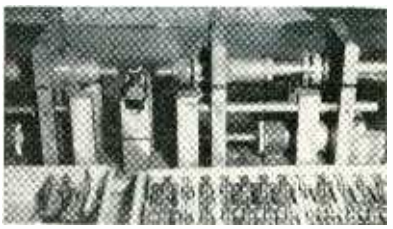


FIG. 1—Iron's heat forms plastic bead around shaped shaft end

Operator places switch on mount between irons



Side view. Air cylinders are mounted on table

The bodies of the irons are held in carriages free to move back and forth in each side of the fixture. The carriages slide on round steel bars rigid in the fixture. The carriages are fixed to the plungers of small air cylinders so that cycling the cylinders brings the irons into contact with the switch case and retracts the irons after the bead is formed.

The switch is positioned by hand on a mount which holds it between the irons and at the proper height. Iron application force is adjusted by the air regulator valves.

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Expanded Research programs to meet the most complex technological requirements of the Space Age are only one of the far-reaching objectives of the new multi-million-dollar Lockheed Research Center, near Los Angeles. Destined to become one of the nation's major research installations, its programs are broad in scope and designed to investigate new frontiers of space flight.

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On completion, most of Lockheed's California Division's research facilities will be located in this single area. The Center will provide complete research facilities in all fields related to both atmospheric and space flight—including propulsion, physiology, aerodynamics and space dynamics; advanced electronics in microwave propagation and infrared; acoustics; mechanical and chemical engineering and plasma/magneto-hydrodynamics; thermal electricity; optics; data communications; test and servo-mechanisms.

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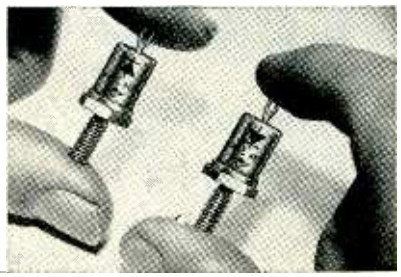
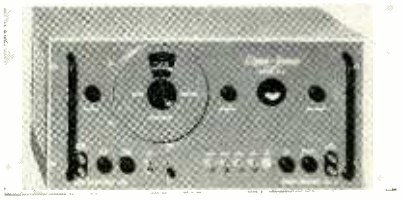


Silicon Rectifiers
1,500 piv, 300 ma

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. A line of extremely stable silicon rectifiers, rated at 1,500 piv at 300 ma, offer reverse leakages as low as 100 μa at 75 C (at rated piv of −1,500 v d-c). Maximum forward voltage drop at a test temperature of 25 C at 150 ma is 4.5 v. Designed primarily for high temperature operation, the units are stud-mounted for optimum heat dissipation, and may be operated at temperatures up to 150 C. **Circle 200 on Reader Service Card.**

Sweeping Oscillator
all-purpose

KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J. The Ligna-Sweep model CP (Cat. No. 932-A) offers the user continuously variable sweep widths over a wide range of center frequencies that

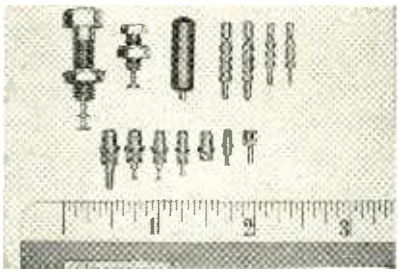


cover video, i-f and vhf in six switched bands. In addition, up to 18 crystal-controlled pulse markers (three per band) are available at frequencies specified by the user. The sweep is all electronic, and the high output is held constant over each band and the entire frequency range by a fast-acting age circuit. **Circle 201 on Reader Service Card.**

Trimmer Pot
for plug-in use

TUCSON INSTRUMENT CORP., 1050 East Valencia Road, Tucson 2, Ariz. Model H-0621-T trimmer pot enables the design engineer to use plug-in techniques in his high temperature circuitry. It has the electrical and environmental characteristics of the model H-0505-T, resistance values up to 100 K, and can operate at 150 deg at rated load. It is only $\frac{5}{8}$ in. in diameter with body length of $\frac{1}{2}$ in. The only extension is the 0.020 in. shaft extension, as the external bushing has been eliminated to conserve

length and bulk. **Circle 202 on Reader Service Card.**



Jacks and Plugs
space-saving

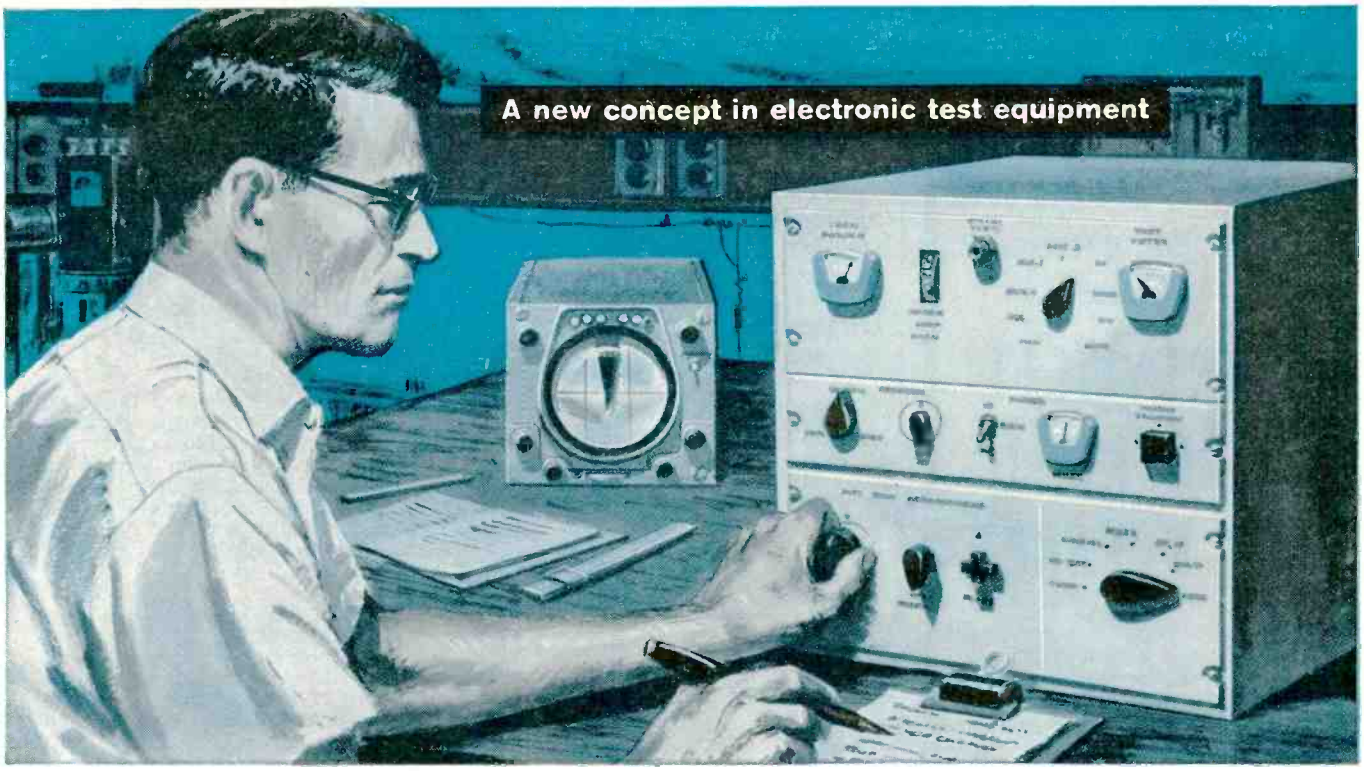
CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., announces a broad line of miniature jacks and plugs. Units are ideal for quick, space-saving patchwork on computer panel boards, and provide permanent gripping power and perfect electrical connection in many different applications. Jacks have inside diameters ranging in size from 0.046 in. to 0.170 in. Plug pin diameters range from 0.045 in. to 0.200 in. **Circle 203 on Reader Service Card.**

Meter Relay
nonindicating

ASSEMBLY PRODUCTS, INC., Chesterland, Ohio. Adjustable contacts, permitting easy changing of either control points or calibration, are now standard on the model 137 VHS (very high sensitivity) non-

indicating meter relay. Model 137 now offers all the advantages of a standard locking coil meter relay except dial indication—and is more resistant to shock and vibration. Total length including the 9-pin plug-in base is $2\frac{1}{2}$ in. **Circle 204 on Reader Service Card.**

(Continued on p 80)



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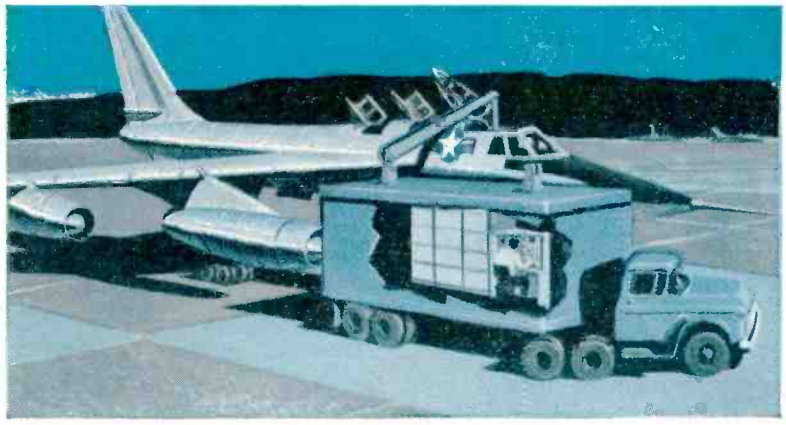
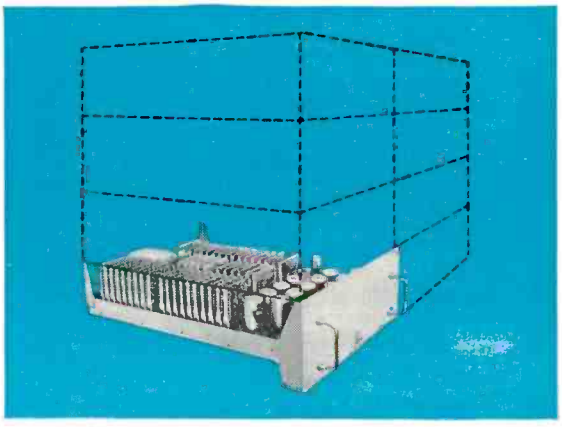


or a complete weapon checkout system . . .



with Sperry modular components

Sperry's new standardized test modules adapt to any electronic checking job

Newest trend in electronic testing is development of "universal" equipment adaptable with minor modifications to many different systems. This "building block" concept is encouraged by the armed services to eliminate the need for expensive test equipment designed exclusively for a single weapon system.

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Ready with the answer is Sperry's Microwave Electronics Company which has developed a wide range of *standardized* test components of the modular type. Physically and electronically compatible with each other, these advanced modules combine to form precision testing equipment capable of checking any kind of electronic system – either the over-all system or subsystems and components.

FOR LAB, BENCH OR FIELD

These Sperry modules require only minimum adaptation to tailor them to even the most advanced radar or electronic system. Sperry is also ready to take on the design and development of test modules to fit specific or unusual needs.

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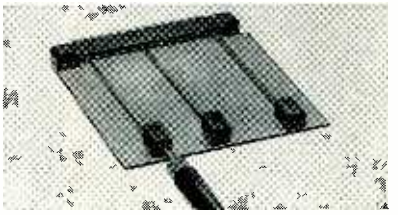

Connectors p-c test point type

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y., has announced a new series of single and multi-contact test point connectors to check printed circuitry in various applications. All types accept a standard 0.080 test probe, and have pins for right angle dip soldering to a p-c board. The body is molded of arc resistant mineral filled Melamine or glass reinforced Plaskon Alkyd (other materials available on order). Connectors can be ordered with either 1, 6 or 16 test points for easy test probe insertion. **Circle 206 on Reader Service Card.**

C-C Tv System automatic

KIN TEL, a division of Cohu Electronics, Inc., 5725 Kearny Villa

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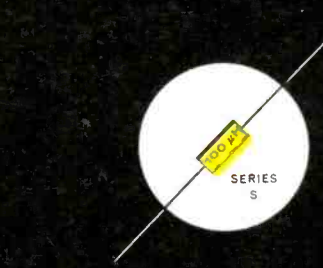

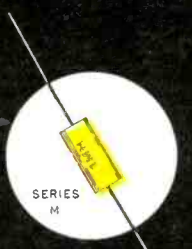

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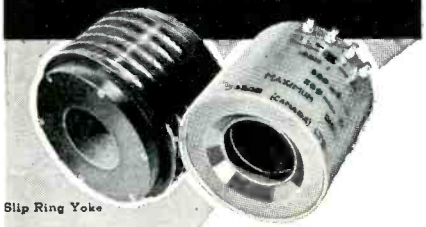

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Normal characteristics of yokes for 1-1/2 in. neck tubes are:

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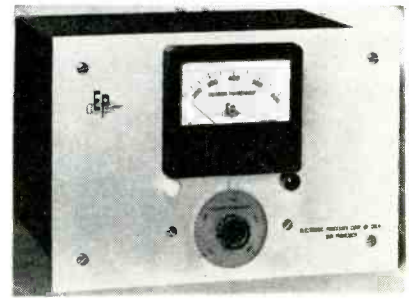

Temperature Controller proportioning type

ELECTRONIC PROCESSES CORP. OF CALIFORNIA, 2190 Folsom St., San Francisco 10, Calif. A new electronic proportioning temperature controller features independent control and indicating actions, and utilizes modular, plastic-potted electronic circuits which plug in as readily as an ordinary vacuum tube. The Electrol controller will continue to maintain proper temperature control even if physical damage should occur to the meter. It uses a resistance type sensing element and offers accuracy of indication within 2 percent of scale in ranges up to 1,000 F. **Circle 208 on Reader Service Card.**

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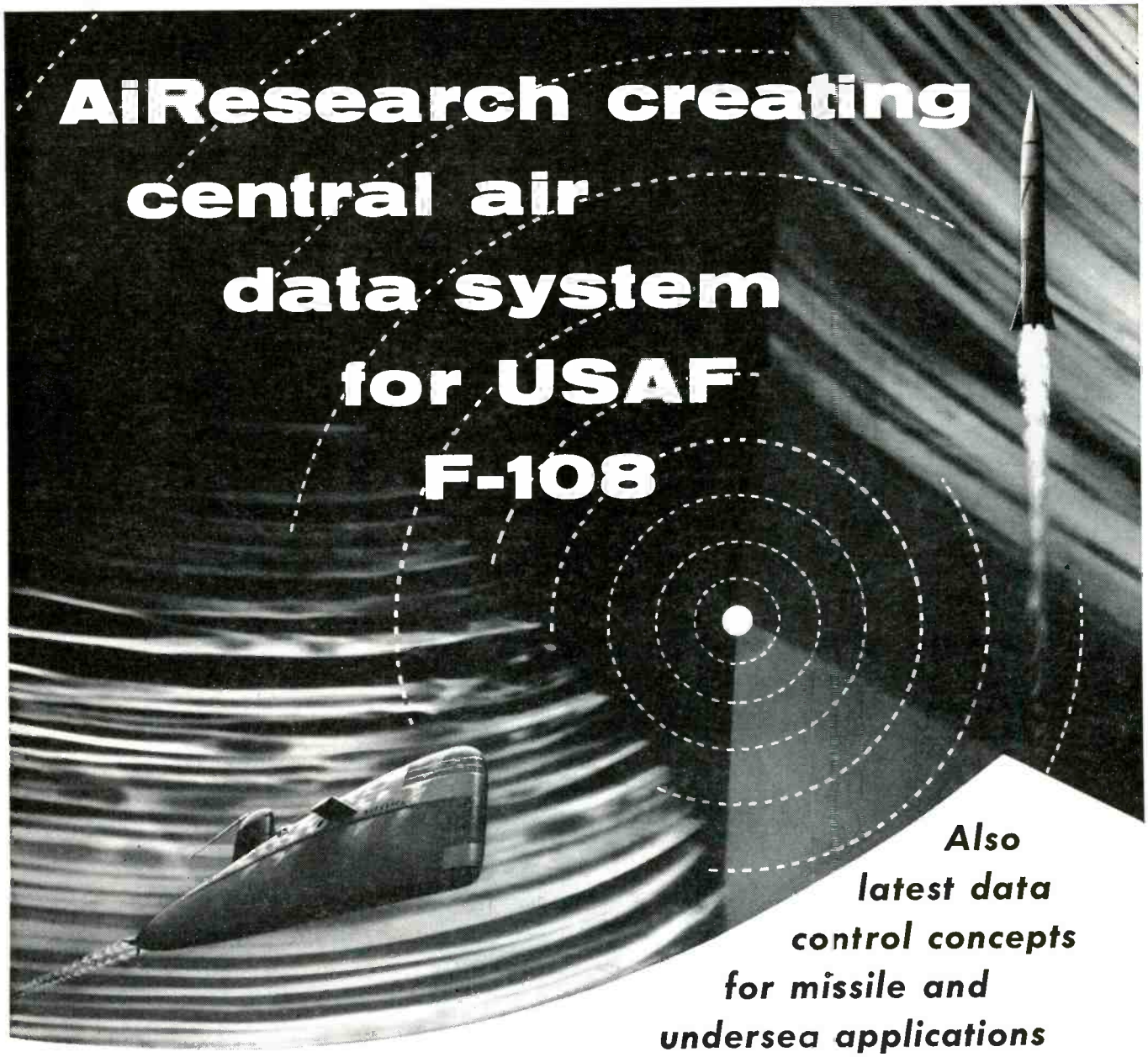

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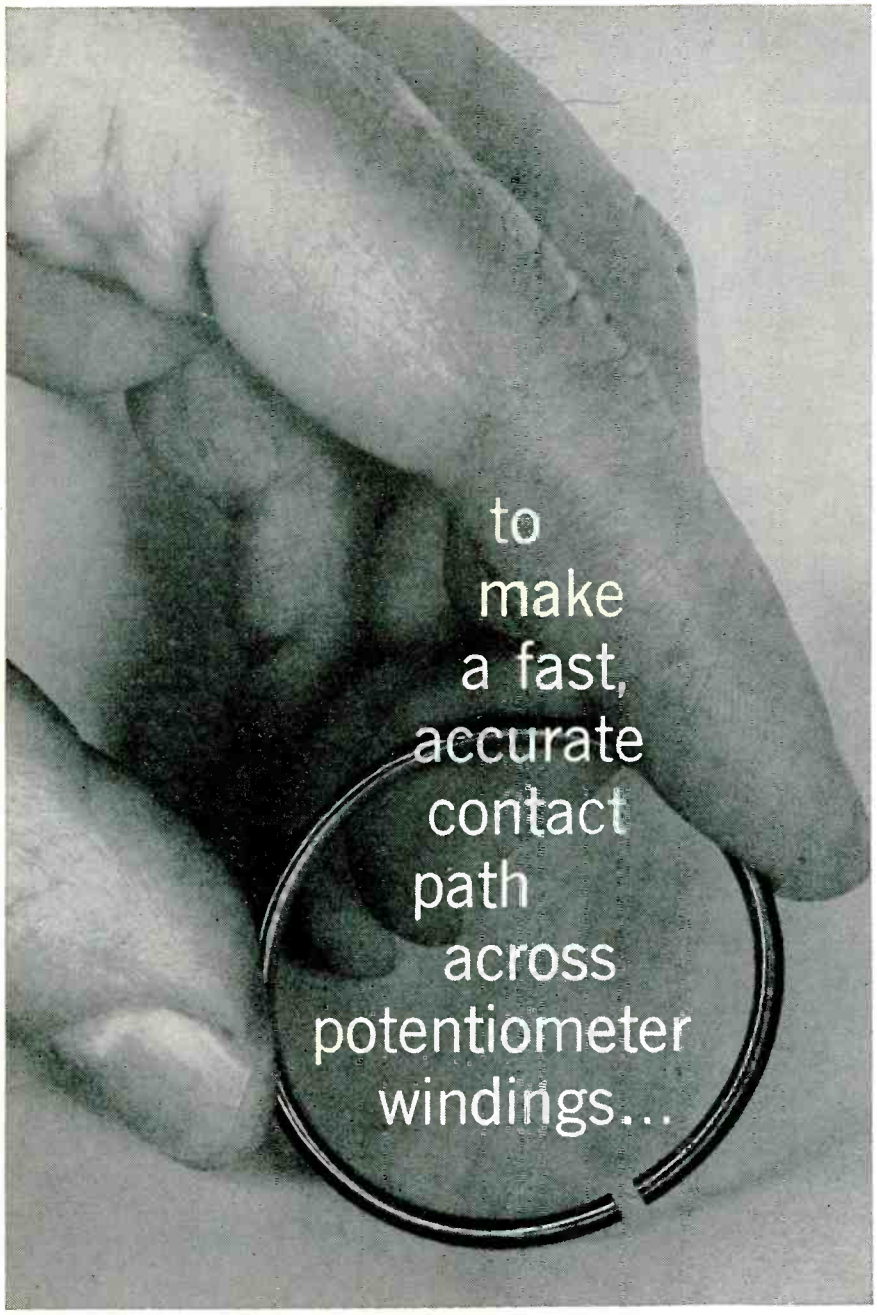

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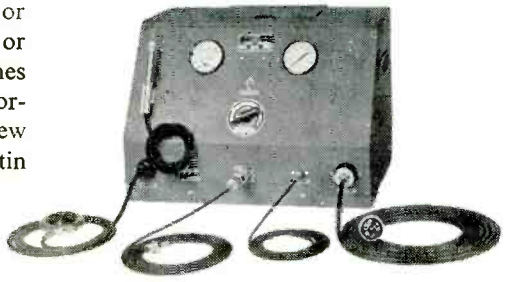
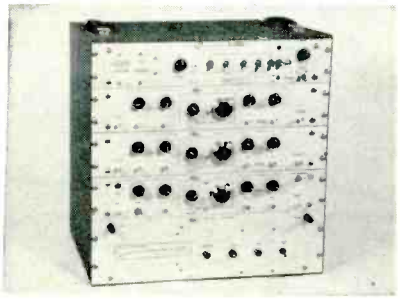


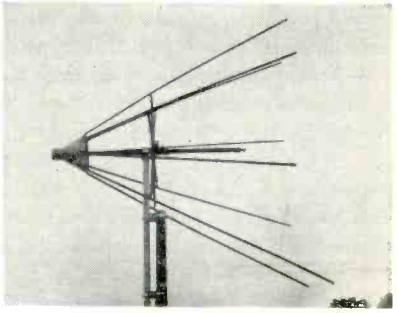
S. S. WHITE INDUSTRIAL DIVISION, Dept. EU, 10 E. 40th St., New York 16, N.Y.
Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

system because crystals have a high r-f detection efficiency and are cheaper and less subject to burnout than barretters, the model BA-7 antenna pattern analyzer requires a maximum of only 1 μw r-f power to achieve a maximum range of measurement of 45 db (r-f) in one step. Unit is useful for measuring very high power ratios such as occur in making antenna pattern measurements, leakage measurements on r-f transmission equipment, and cross-talk of r-f switches. **Circle 209 on Reader Service Card.**



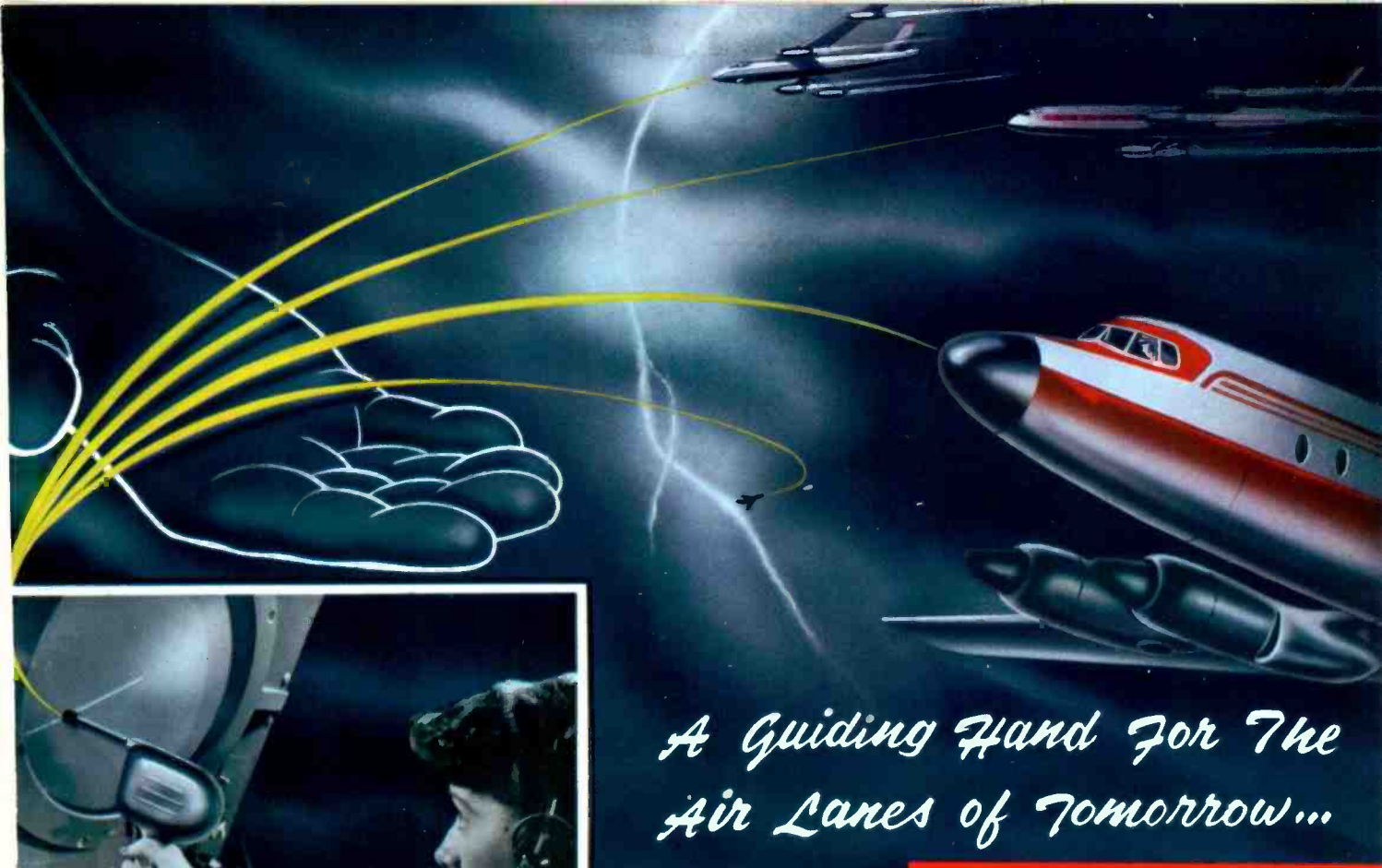
Pulse Generator
precision unit

ELECTRO-PULSE, INC., 11861 Teale St., Culver City, Calif. Model 2120A precision pulse generator produces accurate, fast rise time, low impedance pulses for a wide range of lab and test applications. It features modernized panel layout and controls and the reliability of printed circuit construction. The functionally grouped controls and BNC connectors on supplementary outputs contribute to greater ease of use. **Circle 210 on Reader Service Card.**



Broad Band Antennas
for telemetry

AMERICAN ELECTRONIC LABORATORIES, INC., 121 N. 7th St., Philadelphia 6, Pa., announces broadband antennas for telemetry,



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ABC ABP

Booker & Wallestad is a plastics molder that offers

spectacular savings

on short runs of miniature parts...

Now you can think in terms of low cost for custom molded precision parts *in any quantity.*

Booker & Wallestad has developed special methods and equipment that reduce substantially the cost of molds. Set-up charges are lower. Time as well as money is saved.

On a dollars-and-cents basis you can justify a limited quantity of controlled quality parts for development work . . . for sales samples . . . to test model changes. And when volume production is required, you benefit proportionately.

For *low-cost* precision plastics molding in any quantity, contact Booker & Wallestad—one of the nation's leading molders.

booker & wallestad, inc.

Unusual SKILL and ECONOMY in custom plastics molding...

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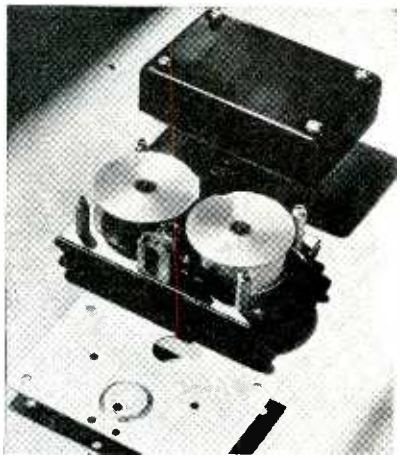
CIRCLE 54 READERS SERVICE CARD

countermeasures and other applications. These units can be built to operate in the spectrum from 20 mc to 6,000 mc. Bandwidths of approximately 10:1 are easily obtainable. Gains on the order of 8 db are normal. **Circle 211 on Reader Service Card.**



Tape Programmer 13-channel

BEATTIE-COLEMAN, INC., 1000 No. Olive St., Anaheim, Calif. The MLPR-13 has a storage capacity up to 160 ft of 35 mm Mylar tape, giving a program duration of 10.6 minutes at a transport speed of 3 ips. It is an electromechanical device designed to control up to 13 functions at precisely timed intervals. A sensing device reads pulses through slots punched in a 35 mm insulating tape which is drawn past the sensing device. Entire unit is housed in a metal case, 8 in. long, 5 in. high and 3 in. deep. **Circle 212 on Reader Service Card.**

Sweep Oscillator broad-band

KAY ELECTRIC CO., Maple Ave., Pine Brook, N. J. The Rada-Sweep Sr. is a broad-band, all-electronic sweeping oscillator with 24 crystal-controlled markers. The fundamental-frequency sweeping oscillator has six switched bands . . . is designed and built for sweeping radar i-f's at center frequencies between 1 mc and 260 mc as specified by the customer. The Rada-Sweep Sr. is extremely stable, has low harmonic content, and is completely free from spurious signals. **Circle 213 on Reader Service Card.**

SAVE TIME MONEY

Get Expert HELP- on Electronic Design, Development and Production

We design and produce both simple and complex components and assemblies, Electronic, Electro-Mechanical and Mechanical for commercial and military applications in Radio, Television, Telecommunications, Computers, Radar, Guided Missiles and allied fields; also, Pulse Amplifiers, Triggered Circuits, Wide Band Circuits, Toroidal Windings and Transformers. Write for brochure giving complete information.

These are Typical of the Products we Manufacture

Growth Opportunity for ELECTRICAL ENGINEERS

To meet the growing demand for our services, we offer Electrical Engineers steady employment, high base salary plus profit sharing, paid vacation, group life and hospitalization insurance, sick leave policy, retirement program, etc. Located on shore of Lake Erie. Fishing, boating, swimming at your doorstep. Ideal community life. Thirty minutes from Buffalo via thruway. Replies held in strict confidence.

forbes and wagner, inc.
347 CENTRAL AVENUE
SILVER CREEK, N.Y. • TELEPHONE 650

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"GREATEST INVENTION SINCE THE WHEEL"

"ZIPPERTUBING"

THE MODERN ECONOMICAL METHOD OF PRODUCING ELECTRONIC CABLES!

MILITARY APPROVED

74 TYPE

Standard with overlap construction. Material may be certified to MIL-I-7444A. Colors are amber and black.

PERFORATED TYPE

Available in any of the above type material at slight additional charge. Invaluable as an easy method of branch-outs.

SH SHIELDED TYPE

A new method of laminating metal surfaces to the inside of Zippertubing provides instant custom shielding at a great savings of time, weight and cost. This revolutionary development is of tremendous importance to the entire electronic industry at this time.

Permits on the Spot Construction of custom cabling

Tying and Lacing Eliminated —(90% time saved)

Temperature Range from 50°F to 2000°F

Simplifies the Job— Offers ease of application

Reduces Time and Labor Costs

Send for beautiful Free Catalog,

Full Technical data, Prices, and

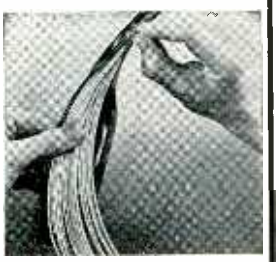
Explanation of how to apply "Zippertubing"

GENERAL PURPOSE TYPE

Standard without overlap. Manufactured from MIL-I-631 material. Available in black or clear and other colors.

63 TYPE

Standard with overlap construction. May be certified to MIL-I-631C. Grades A, B, or C Class I; Category 1. Extra High Temperature material also available (125°C). Colors are amber and black.



UNITED AIRCRAFT SUPPLY CORP. Dept. EW-1

5637-43 West 63rd Place, Chicago 38, Illinois

PHONE POrtsmouth 7-1500 FAX-KCG

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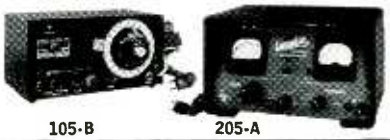
Earn Extra Income in MOBILE-RADIO MAINTENANCE!

It's now a big business (over 1,400,000 installations) . . . fast-growing (an increase of 235,000 units from June, 1957 to December, 1958) . . . specialized . . . and high paying!

Learn how to turn this opportunity into cash—write today for free booklet "HOW TO MAKE MONEY IN MOBILE-RADIO MAINTENANCE!" It's published as a service to radio engineers by Lampkin Laboratories, Inc., manufacturers of the well-known 105-B Micrometer Frequency Meter and 205-A FM Modulation Meter.



105-B 205-A

LAMPKIN LABORATORIES, INC.
Instruments Div., Bradenton, Fla.

At no obligation to me please send "HOW TO MAKE MONEY IN MOBILE-RADIO MAINTENANCE."

Name_____

Address_____

City_____ State_____

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electronics BUYERS' GUIDE

keep it at your fingertips!

ABC ABP

electronics BUYERS' GUIDE

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330 WEST 42nd ST. NEW YORK 36, N. Y.

Literature of

MATERIALS

Insulating Tapes and Fabrics. Continental-Diamond Fibre Corp., Newark, Del., has available five new bulletins describing CDF woven-glass-base insulating tapes and fabrics. **Circle 250 on Reader Service Card.**

Die Cuts. M&C Products Co., 4917 Cottman Ave., Philadelphia 35, Pa., has available a brochure on a new type of pressure sensitive tape die cuts, used on printed panel circuit work. **Circle 251 on Reader Service Card.**

Glass-To-Metal Seals. The Carborundum Co., P. O. Box 311, Latrobe, Pa. A 16 page booklet covers a wide line of glass-to-metal seals. It also discusses the engineering help available on hermetic-seal problems. **Circle 252 on Reader Service Card.**

Ceramic Magnets. D. M. Steward Mfg. Co., Chattanooga, Tenn., has issued a four-page, two-color bulletin (No. 1-59), describing its Barium Ferrite material F-300. Magnetic data, curves, design information are given. **Circle 253 on Reader Service Card.**

COMPONENTS

Transistor Switching Circuitry. Navigation Computer Corp., 1621 Snyder Ave., Philadelphia 45, Pa., has available a 16-page booklet entitled "Notes on Transistor Switching Circuitry". **Circle 254 on Reader Service Card.**

Selenium Rectifiers. Syntron Co., 241 Lexington Ave., Homer City, Pa., announces a ten-page catalog of selenium rectifiers for efficient, economical a-c to d-c rectification in a wide range of sizes. **Circle 255 on Reader Service Card.**

Selenium Photocells. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif. An 8-page catalog entitled "Selenium

the Week

Photovoltaic Cells" describes a complete line of self-generating photocells. For a free copy, request bulletin PC-649A on company letterhead.

EQUIPMENT

VFO. Technitrol Engineering Co., 1952 E. Allegheny Ave., Philadelphia 34, Pa. Model 1011 variable frequency oscillator with a frequency range from 100 cps to 5 mc is described in a new technical bulletin. **Circle 256 on Reader Service Card.**

Power Supplies. Kepco Laboratories, Inc., 131-38 Sanford Ave., Flushing 55, N. Y. Catalog No. B591 describes a complete line of voltage and current regulated power supplies including transistorized, magnetic and vacuum tube types. **Circle 257 on Reader Service Card.**

CCTV Transmitter. Television Utilities Corp., Colonial Ave., Corona 68, N. Y. A 4-page brochure describes the Scan-A-Graph — a closed circuit tv transmitting instrument operated without a camera, special lighting or trained personnel. **Circle 258 on Reader Service Card.**

Instrumentation. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Avenues, Philadelphia 44, Pa., has available an index of instrumentation literature of three general types: product, technological and application. Ask for bulletin G2-1a.

FACILITIES

Temperature Measurement. Cardinal Instrumentation, 4201 Redwood Ave., Los Angeles 66, Calif. Data sheet UTB 101 describes the Uni-Temp B temperature measurement system and components. Brochure discusses the company's consultation service for complete custom engineering and quotations. **Circle 259 on Reader Service Card.**

HR-92 X-Y
RECORDER

Flat bed — Full Chart visibility

Unitized Construction

Critically damped response

Simplified control panel

Clip-on pen — Interchangeable for multicolor traces

Standard 8½ x 11 paper

Unconditionally guaranteed for one year.

RUGGED "All Purpose" X-Y RECORDER

The HR-92 is a null-seeking servo-type plotter designed to draw curves in Cartesian coordinates on regular 8½ x 11 graph paper. It employs conventional chopper amplifiers, 2-phase motors and a potentiometer rebalance. Reference voltages are furnished by mercury cells. Control panel has zero set and continuously-variable attenuator for each axis. Separate standby and power switches are provided. The two axes are electrically and mechanically independent. By moving an internal jumper lead, a high impedance potentiometer input can be made available.

SPECIAL FEATURES:

- Amplifiers easily removed if servicing ever becomes necessary. Electrical connections all contained in two plugs for each amplifier.
- Each amplifier channel (including transformer power supply) independent of rest of system.

WRITE FOR:
New X-Y Recorder Circular #717-3 showing complete specifications and photographs.

houston instrument corporation
1717 Clay Avenue · Houston 3, Texas
CA 5-6964

CIRCLE 58 READERS SERVICE CARD

Bradley Corp. Consolidates

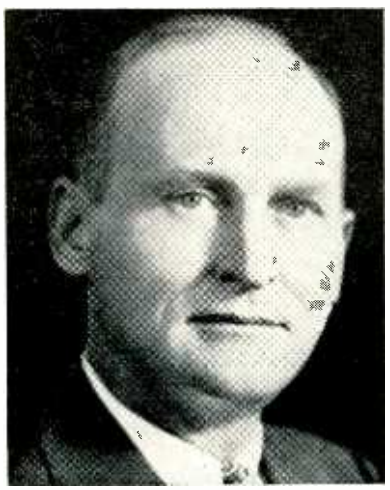
BRADLEY SEMICONDUCTOR Corp. recently moved into new headquarters in downtown New Haven, Conn., merging under one roof the production operations which were formerly divided between two separate plants. The general Bradley line of selenium and copper oxide rectifiers, modulators and arc suppressors has for a number of years been manufactured at the company's former main building, while the newly-introduced Redtop silicon diode has been coming from a nearby subsidiary plant.

The new building has been designed to the company's specific needs, and comprises 30,000 sq ft on one level, ample for the company's present 160 production personnel. Tooled with modern equipment for developing, testing and producing electronic components in the semiconductor field, the new facility also emphasizes efficiency in receiving and shipping. The 2½-acre corner site allows for considerable future growth.

Known as Bradley Laboratories until it adopted the more descriptive name last year, the company has for 17 years been supplying components to such firms as Sperry, Bendix, IBM, Raytheon, Burroughs Corp. and others.

According to its founder-president, Charles D. Bradley, the corporation now expects to expand from the components field into the production of electronic equipment. Plans are also afoot to develop a new transistor for the rapidly growing transistor market.

Another reason for the present expansion, says Bradley, is the pressure of current military projects which call for many of the company's existing designs for missilery applications of the future.



Cinch Appoints Pool President

ANNOUNCEMENT is made of the appointment of E. J. Pool as president of the Cinch Mfg. Co., Chicago, manufacturers of electronic components.

Pool joined the sales staff of Cinch some thirty years ago. For the past five years he has been vice president and general manager and prior to that vice president in charge of sales.

IRC Merges With Subsidiary

CIRCUIT INSTRUMENTS, INC., wholly-owned subsidiary of International Resistance Co., was recently merged with IRC. Its name has been changed to International Resistance Co., Circuit Instruments Division.

The St. Petersburg, Florida, division manufactures miniature single and multiturn precision pots for use in guided missiles, vital automation and atomic installation electronic equipment, and other related devices.

Palmer Joins Epsco-West

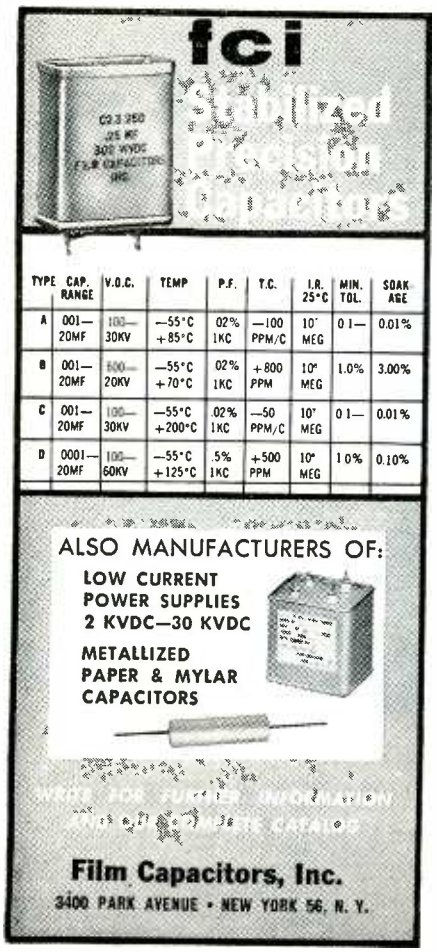
IN ANAHEIM, Calif., Epsco-West recently hired Charles Palmer as a senior applications engineer. In this capacity, he will be in charge of applications of Epsco standard products for industrial and military use in the western United States.

Palmer was formerly a staff engineer with BJ Electronics, Santa Ana, Calif., where he specialized in the problems of securing digital readout information from f-m or analog type transducers.

Promote Four At Vitro Labs

FOUR staff scientists recently received promotions at Vitro Laboratories, West Orange, N. J., a division of Vitro Corp. of America.

The men and their new positions



TYPE	CAP. RANGE	V.D.C.	TEMP	P.F.	T.C.	I.R. 25°C	MIN. TOL.	SOAK AGE
A	001— 20MF	100— 30KV	—55°C +85°C	02% 1KC	—100 PPM/C	10⁷ MEG	01—	0.01%
B	001— 20MF	500— 20KV	—55°C +70°C	02% 1KC	+800 PPM	10⁶ MEG	1.0%	3.00%
C	001— 20MF	100— 30KV	—55°C +200°C	.02% 1KC	—50 PPM/C	10⁷ MEG	01—	0.01%
D	0001— 20MF	100— 60KV	—55°C +125°C	.5% 1KC	+500 PPM	10⁶ MEG	10%	0.10%

ALSO MANUFACTURERS OF:

LOW CURRENT POWER SUPPLIES 2 KVDC—30 KVDC

METALLIZED PAPER & MYLAR CAPACITORS

WRITE FOR FURTHER INFORMATION AND COMPLETE CATALOG

Film Capacitors, Inc.

3400 PARK AVENUE • NEW YORK 56, N. Y.

CIRCLE 59 READERS SERVICE CARD

4027

NOW A TWO-PART MIXTURE FOR IMPREGNATING AND MOLDING ALL ELECTRICAL WINDINGS

NOW—an epoxy mixture, formerly in three parts, now comes complete, ready to mix and use in TWO PARTS. Nothing else to buy!

This remarkable mixture, designated as Acme Star Compound 4027, is immediately self-extinguishing on molded units, even after repeated exposure to flame! Cures hard and tough. Has excellent mechanical and thermal shock resistance. Viscosity low enough for thorough impregnation at process temperatures. Very good adhesion to metals and other materials used in coil construction. For Data Sheets write us attention G. F. Garrity, Divisional Sales Manager.

THE ACME WIRE COMPANY

NEW HAVEN, CONN.

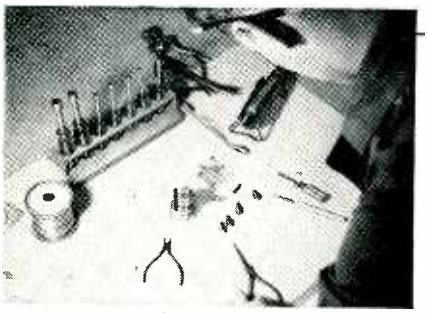
MAGNET WIRE • COILS • VARNISHED INSULATIONS
INSULATING VARNISHES AND COMPOUNDS

LIVE BETTER ELECTRICALLY

CIRCLE 60 READERS SERVICE CARD

Applications Unlimited!

with CAMBION® Electronic Components



. . . from prototype

. . . to product

"Quality that Follows Through"

Here are electronic components you can depend on to back up your new design ideas . . . help you to precisely duplicate prototype performance in hundreds of thousands of production units. CAMBION *guarantees* you the identical high quality component in production lots that you get in small lots for research and development.

CAMBION'S advanced engineering and manufacturing facilities back that guarantee at every stage of production. All CAMBION components are made from certified materials. They're given rigorous electrical and mechanical tests, carefully measured for dimensional accuracy, subjected to severe environmental tests. Superior products of today's finest quality control methods, *all* CAMBION components meet or surpass government specifications.

The following pages illustrate typical components from the various broad CAMBION lines. Available as standard units, or custom-made to your specifications, they're unconditionally *quality-guaranteed* in lots of 1 or 1,000,000. For smoother progress during development . . . higher profits in production, choose CAMBION components. Write for details. Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Massachusetts.

CAMBRIDGE THERMIONIC CORPORATION

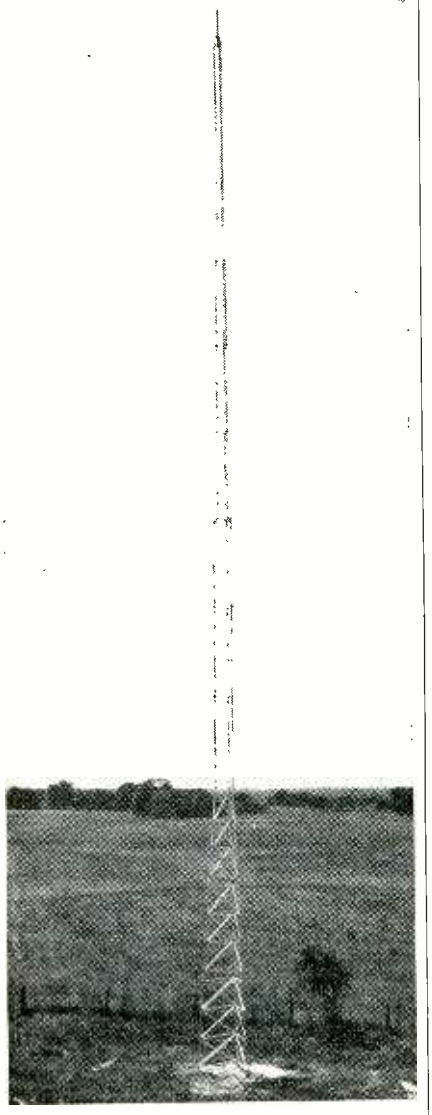
CAMBION

The guaranteed electronic components

Every Component 100% Engineered

CIRCLE 61 READERS SERVICE CARD

New ROHN
SELF SUPPORTING
COMMUNICATION TOWER



★ 120 ft. in height, fully self-supporting!
★ Rated a true HEAVY-DUTY steel tower, suitable for communication purposes, such as radio, telephone, broadcasting, etc.
★ Complete hot-dipped galvanizing after fabrication.
★ Low in cost—does your job with BIG savings—yet has excellent construction and unexcelled design! Easily shipped and quickly installed.

FREE *details gladly sent on request. Representatives coast-to-coast.*

ROHN *Manufacturing Co.*
116 Limestone, Bellevue, Peoria, Illinois

"Pioneer Manufacturers of Towers of All Kinds"
CIRCLE 62 READERS SERVICE CARD

include: Charles K. Raynsford, chief engineer; Edward M. Coan, development engineering department head; A. W. Speyers, product engineering department head; and John F. Reeves, systems analysis department head.

At the West Orange Laboratory, scientists are engaged in physical, chemical and electronics R&D in such fields as missile guidance, digital data processing, high temperature processing, electrokinetics, radioactive waste disposal, reactor fuel reprocessing, special coatings processes and advanced instrumentation.

Essex Names V-P

JAMES A. MONTLLOR has been appointed vice president of Essex Electronics, Berkeley Heights, N. J., manufacturers of delay lines, coils, r-f chokes and pulse transformers. He has been with Essex since 1945 as chief engineer, and he will retain that title as vice president of the company.

He was previously employed by the Allen B. Cardwell Co., Western Electric Co., and Automatic Mfg. Corp.

Stavid Opens Western Office

STAVID Engineering Inc., Plainfield, N. J., announces the opening of a western operations office in Lancaster, Calif. Primary function of the new office is to handle technical and administrative matters con-

COUNTER-MEASURES ENGINEERS

Work on America's most advanced weapon systems.

At North American Aviation, such top-level projects as the B-70 and F-108 weapon systems have created unique careers with a tremendous engineering potential.

We have immediate openings for specialists and systems engineers in the field of electromagnetic and infrared countermeasures. Specialized areas include high power traveling wave tube analysis, receiver techniques, system logic, infrared systems design, and antenna and radome development. Experienced engineers are needed to establish requirements for countermeasures systems and to evaluate new components and techniques and their application to advanced systems.

Minimum requirements are actual experience in countermeasures plus B.S. degree in EE or Physics.

For more information please write to: Mr. F. D. Stevenson, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF
NORTH AMERICAN AVIATION, INC.

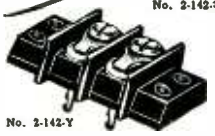
INCREASED INSULATION BETTER CONNECTIONS

JONES BARRIER Terminal Strips

Leakage path is increased—direct shorts from frayed terminal wires prevented by bakelite barriers placed between terminals. Binder head screws and terminals brass, nickel plated. Insulation, molded bakelite.

No. 2-142

No. 2-142-¾ W



No. 2-142-Y

Shown: Screw Terminals—Screw and Solder Terminals—Screw Terminal above, Panel with Solder Terminal below. For every need.

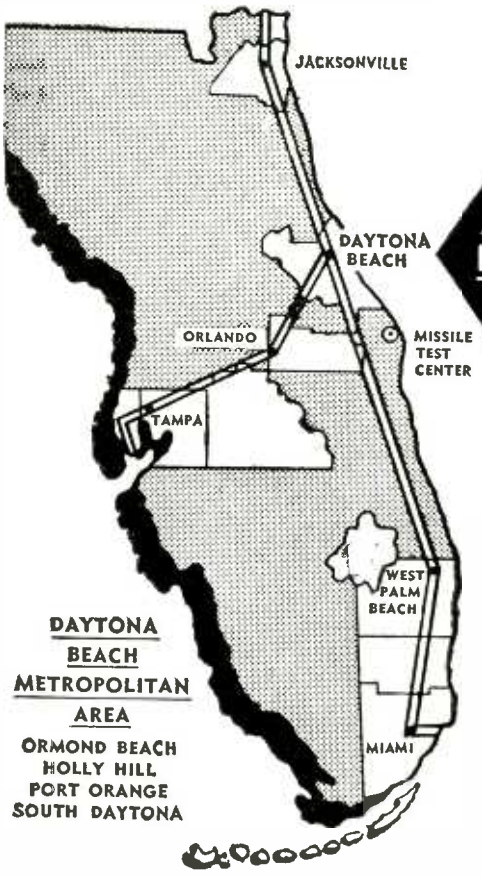
Six series meet every requirement: No. 140, 5-40 screws; No. 141, 6-32 screws; No. 142, 8-32 screws; No. 150, 10-32 screws; No. 151, 12-32 screws; No. 152, ¼-28 screws.

Catalog No. 22 lists complete line.

Jones — HOWARD B. JONES DIVISION, CINCH MANUFACTURING COMPANY, CHICAGO 24, ILLINOIS, DIVISION OF UNITED-CARR FASTENER CORP.

CIRCLE 64 READERS SERVICE CARD

ATTRACT AND HOLD TECHNICAL PERSONNEL



STRATEGIC LOCATION FOR GROWTH INDUSTRIES

DAYTONA BEACH FLORIDA

Metropolitan Area Industrial Sites

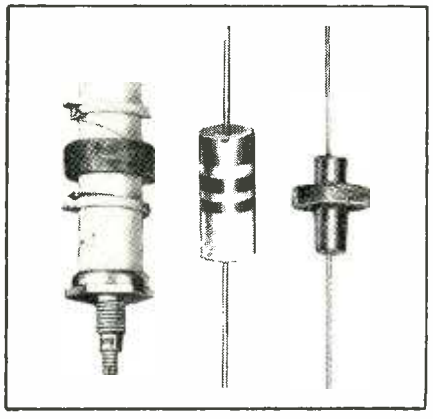
Daytona Beach, the east-to-west terminal on the north-to-south route of the projected Federal Limited Access Freeway System, gives industry a plus for the future.

Write for new 101 page Industrial Brochure

R. H. MILES, MGR.
INDUSTRIAL DEPARTMENT
CHAMBER OF COMMERCE
DAYTONA BEACH, FLORIDA

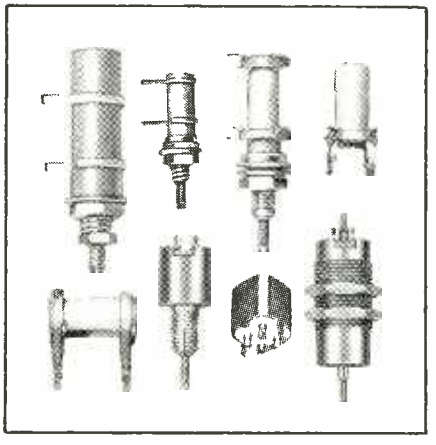
CIRCLE 65 READERS SERVICE CARD

Guaranteed Quality on the Production Line



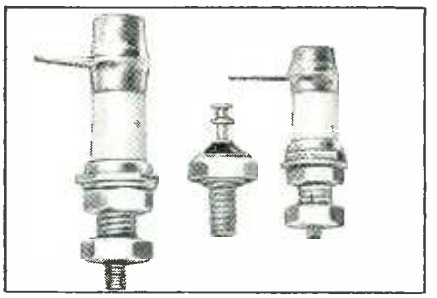
COILS AND CHOKES

Large family of standard wound coils and chokes covering a wide range of inductances minimizes need for "specials". Rated in preferential values with color coding. Wound on ceramic, paper phenolic, or molded phenolic coil forms. All windings varnish impregnated. Studs on ceramic forms securely mounted by special CAMBION process. Ten-coil development kit available with overlapping ranges from 2 μh to 800 μh. Custom-wound types also available to meet specific needs in printed and conventional circuits.



COIL FORMS

Wide variety of compact, standard slug-tuned types . . . a style to meet every requirement of printed and conventional circuits. Horizontal and vertical models with forms of ceramic, paper phenolic. Ceramic threaded-stud types available with Perma-Torq® positive-lock tuning. Shielded types in single- and double-tuned models. All types available wound to customer specifications. Kit containing 3 each of 5 popular types of CAMBION coil forms with silicone fiberglas collars, Perma-Torq lock, and ring terminals.



CAPACITORS

Subminiature units with advanced design tuning that permits wide capacity ranges. Supplied complete wiih single mounting studs and lock for tuning element. Fixed stand-off types also available. All capacity elements epoxy-embedded for maximum resistance to moisture.

SPECIFICATIONS

Brass . . . QQ-B-626a
Ceramic . . . Grade L5A . . . JAN-I-10
Paper Phenolic . . . MIL-P-3115B
Silicone Fiberglas . . . MIL-P-997

Plating:

Silver . . . QQ-S-365
Tin . . . MIL-T-10727
Cadmium . . . QQ-P-416
Nickel . . . QQ-N-290

For details write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass.

Every Component 100% Guaranteed

CIRCLE 66 READERS SERVICE CARD

if...

you are an experienced electronic engineer, you will find more challenging work...more job stability... more chance for creative satisfaction... more diversified projects, at

SPERRY
GYROSCOPE
COMPANY
A DIVISION OF SPERRY RAND CORP.
Great Neck, Long Island, New York

For confidential interview, contact Mr. J. W. Dwyer
Employment Manager
Fieldstone 7-3665

Project Managers in Missiles, Radars and Countermeasures Engineering

nected with work being performed at Edwards Air Force Base.

Company has named Dan Semels, formerly field evaluation manager, to the new position of western operations manager.

News of Reps

Dynamic Gear Co., Inc., Amityville, N. Y., adds two sales reps: **Don Smith Sales Co.** of Seattle, Wash., will handle the company's line in the Washington-Oregon area. **Vance & Villani** of Detroit will cover the state of Michigan.

General Precision Laboratory, Inc., Pleasantville, N. Y., appoints three organizations as sales reps for its closed-circuit tv equipment:

Broger Instrument Sales Co., Inc., Brookline, Mass., is covering Maine, Massachusetts, Rhode Island, Vermont, New Hampshire, and Connecticut except for Fairfield County.

Arrow Technical Sales, Osseo, Minn., is named for Minnesota, North Dakota, South Dakota and northern Wisconsin.

Illinois Electronic Systems, Evanston, Ill., represents GPL in northern Illinois, southern Wisconsin and northern Indiana.

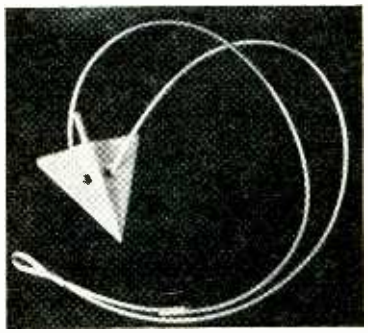
Lawrence C. Freeman & Associates, with offices in Montclair, N. J., has been appointed manufacturers' rep for both General Communication Co. and Railway Communications, Inc. Its territory is the New York City, Long Island, and New Jersey areas.

Ace Electronics Associates, Inc., Somerville, Mass., appoints three new reps: **Engineering Services Co.** of St. Louis, Mo., for the Iowa, Kansas, Missouri and Nebraska areas; **Jackson Edwards Co.** of N. Hollywood, Calif., for the southern California and Arizona areas; **Hytronic Measurements, Inc.** of Denver, Colo., for the Wyoming, Colorado, Utah and New Mexico area.

Lawrence Research & Electronics, Detroit, Mich., is appointed rep for Amplifier Corp. of America, covering the states of Michigan, Indiana, Illinois, and Wisconsin.

HOLD IT!

with a UNIVERSAL GROUND ANCHOR



This new, scientifically designed Ground Anchor answers the demand for a smaller, lighter, and more reliable device for securing such equipment as Radomes, Missile Launching Platforms, Communication Masts, and Portable Shelters.

In official tests, the Universal Ground Anchor has held over 20,000 times its own weight. It can be driven into all types and conditions of soil in less than 3 minutes using a simple drive rod and sledge hammer. Power tools may be used for installing as many as 60 Anchors per man hour.

- ELIMINATES DIGGING
- SOIL STRENGTH UNDISTURBED
- HIGH STRENGTH-WEIGHT RATIO
- VERSATILE
- DEPENDABLE
- ECONOMICAL
- SELF-ORIENTING

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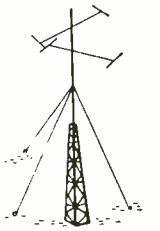
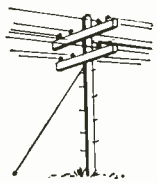
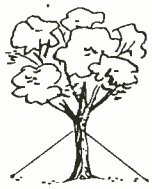

MASTS


PORTABLE SHELTERS


AIRCRAFT


UTILITY POLES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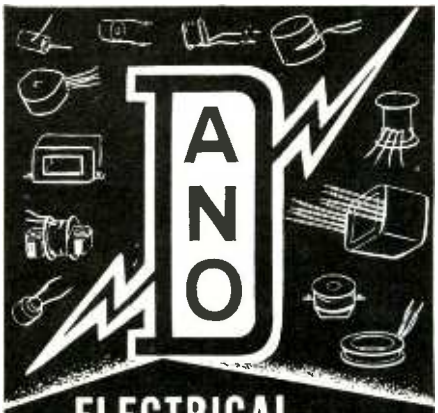

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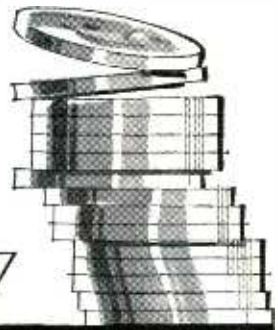

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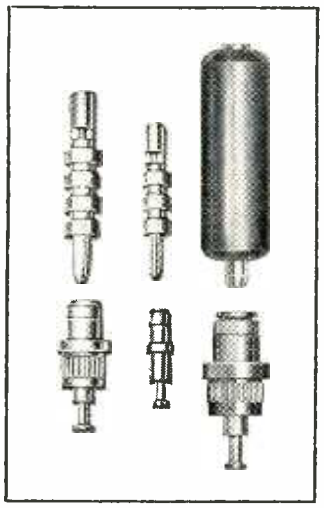

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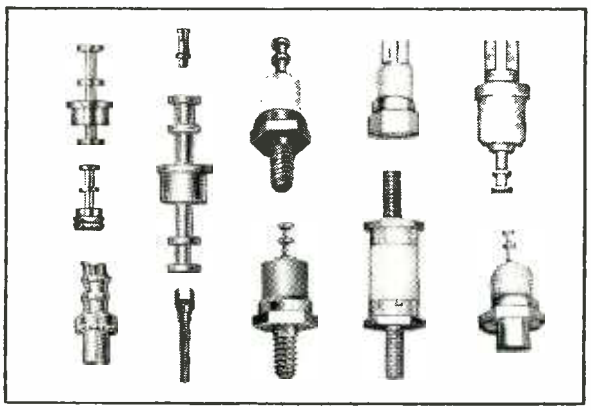

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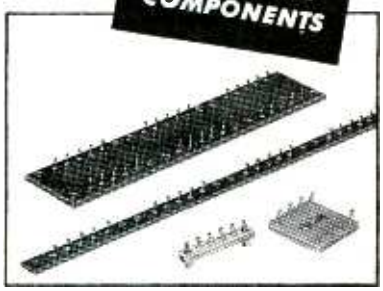

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SPECIFICATIONS

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Plating:

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Cadmium . . . QQ-P-416
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Glass-Fabric-Epoxy . . . MIL-P-18177

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- Temperature stability at constant ambient ±.5°C
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- Choice of heater voltages. 6.3V to 115 AC or DC
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COMMENT

For Standard Terms

This is a plea for standardization in the electronics industry by one who has no vested interest. Our marketing and product development work has been very much hampered by two misnomers which influence any conclusions drawn from generally available industry data:

Industrial as opposed to consumer or military markets. There seems to be no generally accepted definition on this. Some include military, and some make a distinction between *industrial* and *commercial*. In fact there seems to be no general agreement on market terminology except the distinction between military and other (non-military). We see many evidences of damaging conclusions drawn as a result of this confusion.

Diodes and *rectifiers*, referring to solid-state devices. There is no agreement as to where the line is drawn, and thus the distinction becomes misleading since almost everyone has a different place to draw it.

I am sure that there are many other cases of vague or inaccurate terminology, involving concepts, which you are aware of in the electronics industry . . .

JAMES E. JUMP
JAMES E. JUMP & ASSOCIATES
GREENWICH, CONN.

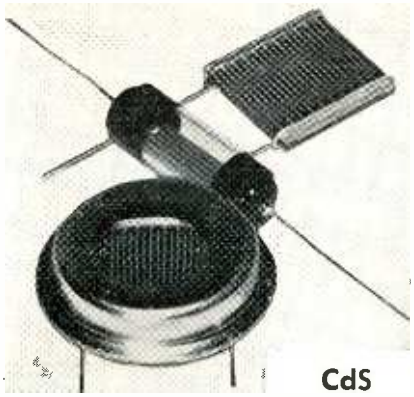
Atran

In ELECTRONICS (p 15, Nov. 28 '58) we note a tabulation of various missiles with other pertinent information. In this tabulation the word Atran is utilized in a generic sense.

Please be advised that the term Atran is a trademark of Goodyear Aircraft Corp., and is registered for "automatic guiding systems for aerial vehicles" . . .

J. G. PERE
GOODYEAR AIRCRAFT
AKRON, OHIO

We actually used the word—which is an acronym for "automatic terrain recognition and navi-



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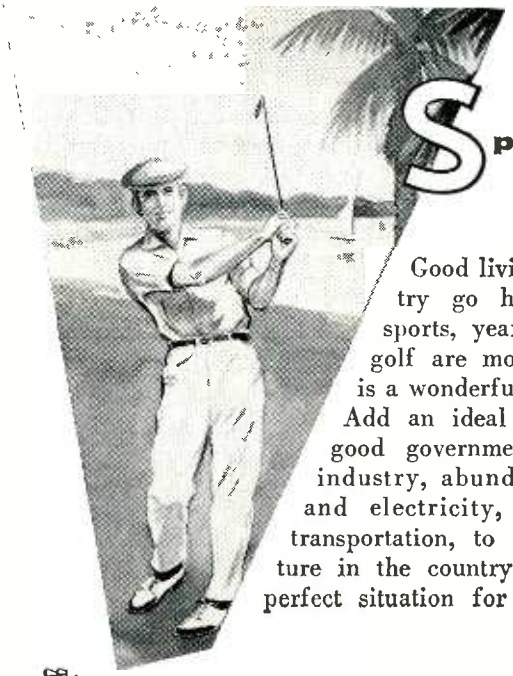

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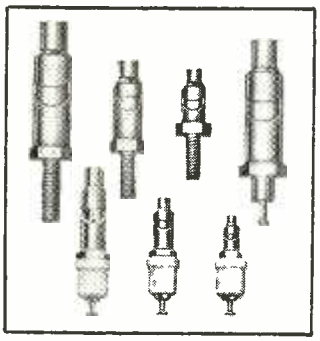

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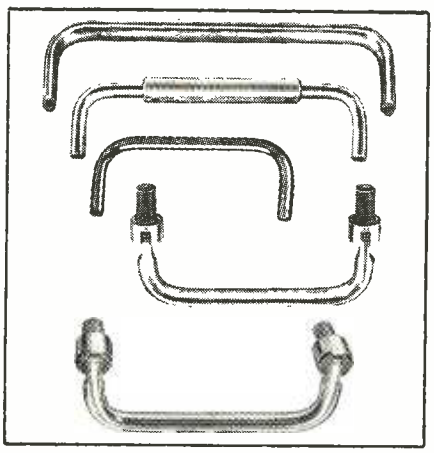

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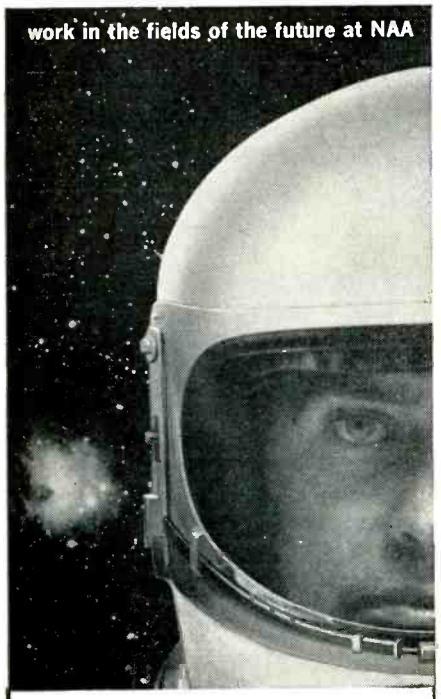

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gation"—in its own highly specific sense. Guidance for both the vehicles listed under it in the Nov. 28 tabulation was provided by Goodyear, although the Regulus II has since been cancelled. We knew, of course, that Atran was a Goodyear development.

Receiver Sensitivity

I read with interest the article on receiver sensitivity (p 52, Jan. 23). I am sure that the chart presented will prove a useful tool, although the authors are somewhat in error in neglecting the effect of antenna temperature on receiver sensitivity. It is true that with noise figures attainable in the past, the error in neglecting antenna temperature is insignificant. However, with the advent of very-low-noise receivers (i.e., masers and mavars), antenna temperatures can no longer be neglected.

I am sending you a technical memorandum I have written on the subject . . .

T. W. MADIGAN
BELL TELEPHONE LABORATORIES
WHIPPANY, N. J.

Author Madigan's nomograph on this subject, "Receiver Sensitivity Calculator", appears in this week's issue on p 62.

Microwave Hazards

The material ("Researching Microwave Health Hazards", p 49, Feb. 20) should become the common knowledge of all personnel who work within areas of possible dangerous radiation levels.

Reference to the numerous incalculable parameters of the living cell structure and their resonant properties leads the reader to a thoughtful consideration of the hazards of personal exposure . . .

C. W. WILKINSON
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Such thoughtful consideration, understandably, was one of our reasons for writing the article. And judging by our mail, the material we published is being passed along to persons active in microwave work.

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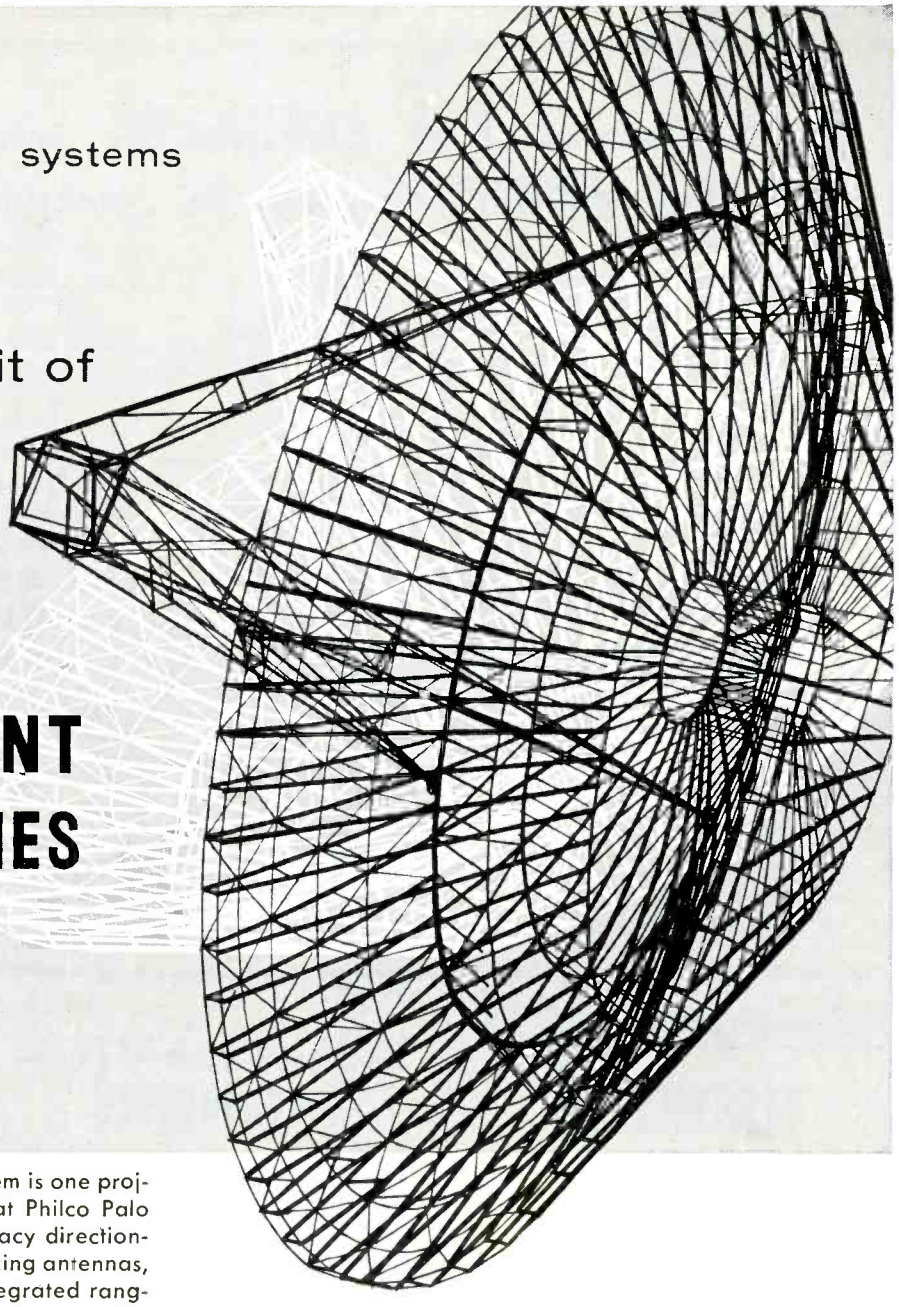

An all-new, complete Space Tracking System is one project now under design and construction at Philco Palo Alto. The project encompasses high-accuracy direction-finding antennas, large passive slave-tracking antennas, high power transmitting antennas and integrated ranging equipment.

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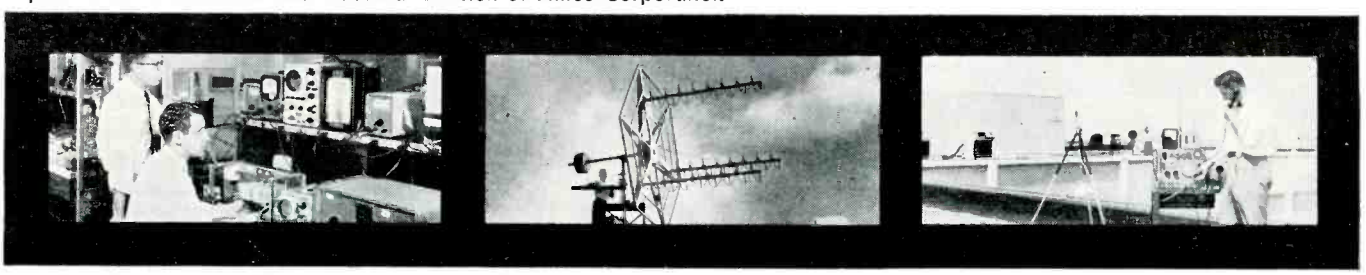

Measuring phase stability vs. temperature during prototype equipment development

Developmental helical antenna, part of sophisticated new direction finder system

Pattern measurements—vital to development on microwave dish antenna

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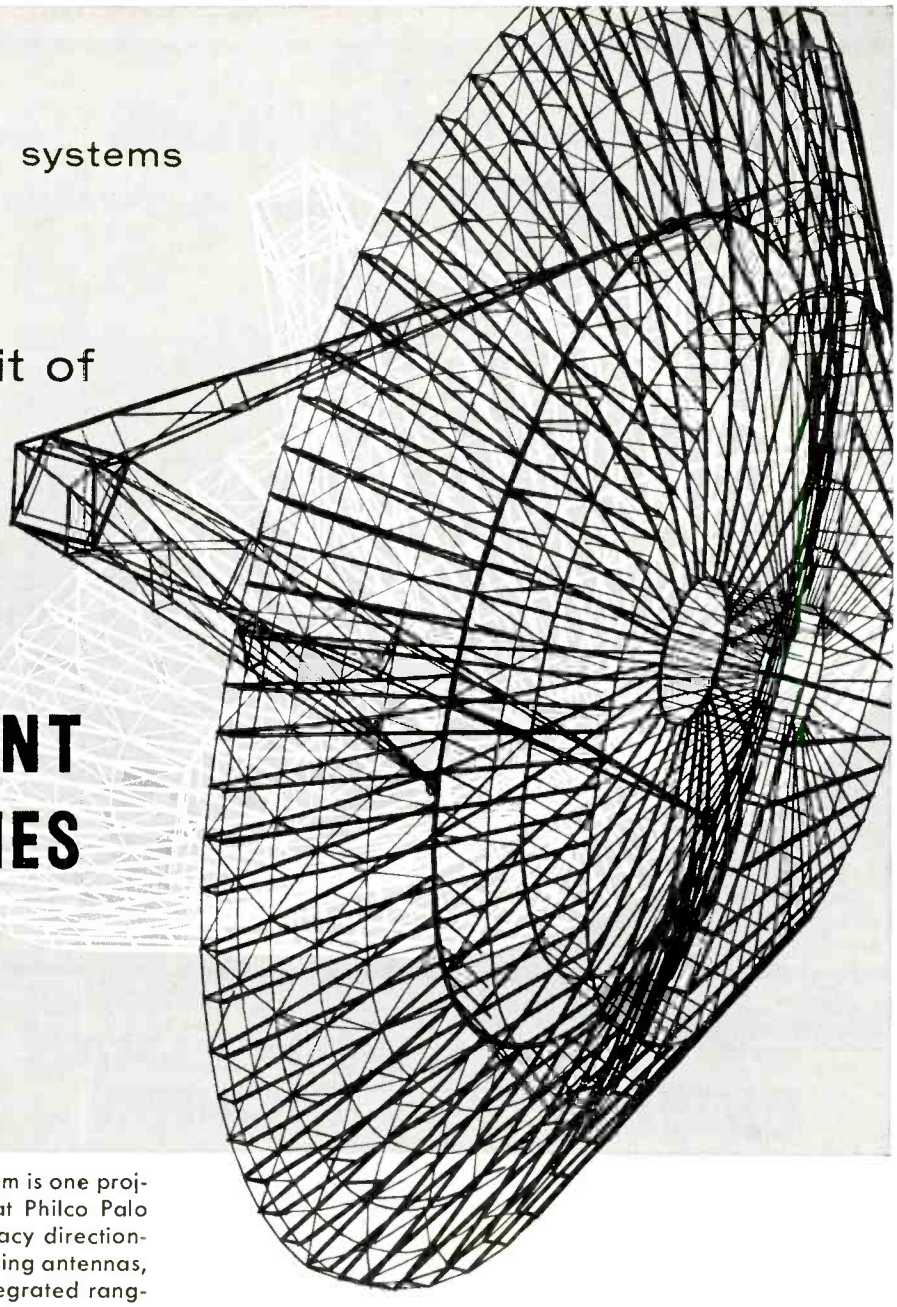

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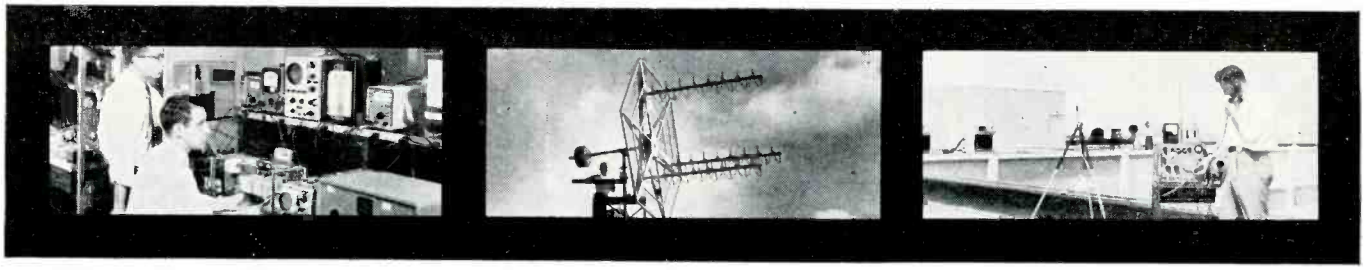

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MANUFACTURER'S REPRESENTATIVES

FOR
WIDE BAND
VIDEO & IF AMPLIFIERS
With
INSTRUMENTS for INDUSTRY

In anticipation of increased territorial assignments, we seek Representatives for Chicago, Pittsburgh & Minneapolis/St. Paul areas—for the promotion of our standard product line.

Excellent growth & remunerative potential. Interested parties should contact—

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IN THE ELECTRONIC INDUSTRY
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CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

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Full azimuth and elevation sweeps, 360 degrees in azimuth, 210 degrees in elevation. Accurate to 1 mil. over system. Complete for full tracking response. Including pedestal drives, seisyns, potentiometers, drive motors, control amplidynes. From stock delivery. Ideal for antenna pattern ranges, radar systems, radio astronomy, any project requiring accurate response in elevation and azimuth.

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CAA No. 4264 Ltd. HA 9-2925

SEARCHLIGHT Equipment Locating Service

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used electronic equipment and components not currently advertised. (This service is for USER-BUYERS only). No charge or obligation.

How to use: Check the dealer ads to see if what you want is 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 LOCATING SERVICE

c/o ELECTRONICS—Classified Advertising P.O. Box 12, New York 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.

NO CHARGE • NO OBLIGATION

SEARCHLIGHT EQUIPMENT LOCATING SERVICE, c/o Electronics, 330 W. 42nd St., New York 36, N. Y.

Please help us to locate the following used equipment:

.....

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NAME..... TITLE..... COMPANY.....

STREET..... CITY..... ZONE..... STATE..... 4/3/59

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INDEX TO ADVERTISERS

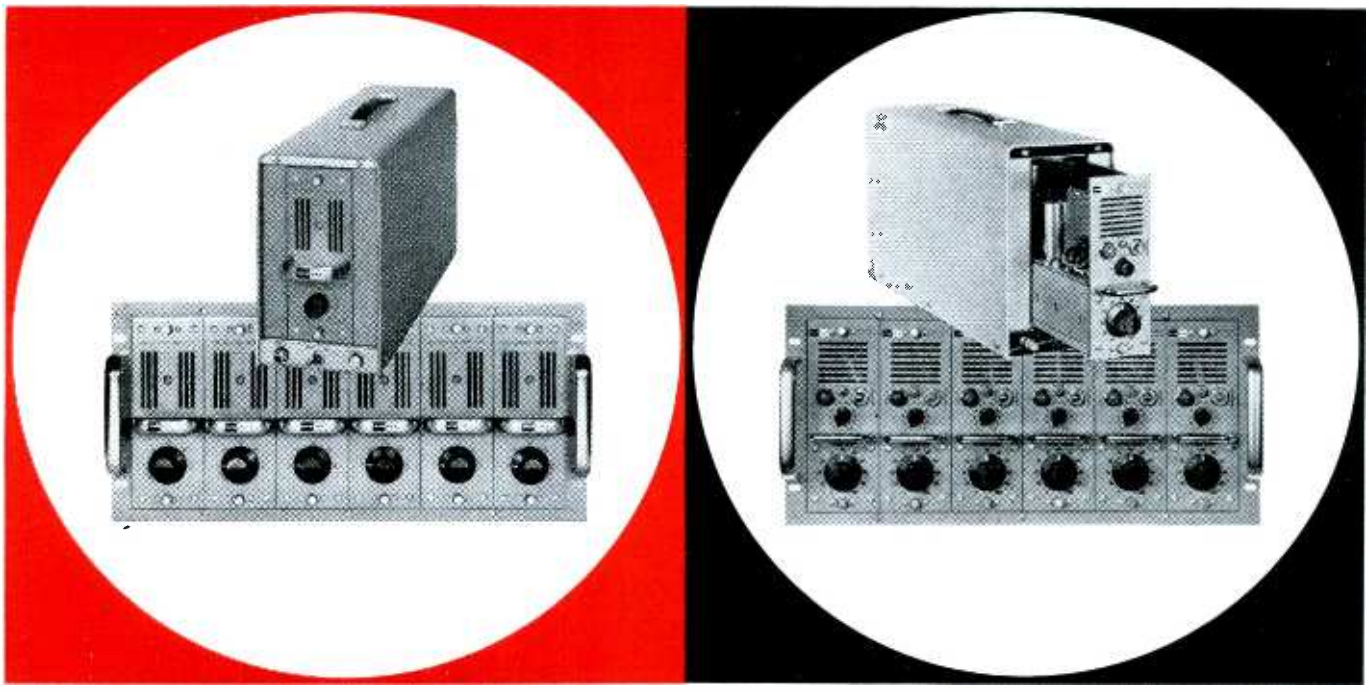
CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

• See advertisement in the June, 1958 Mid-Month ELECTRONICS BUYERS' GUIDE for complete line of products or services.

This index is published as a service. Every care is taken to make it accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.

AMPLIFY MICROVOLTS WITH STABILITY... measure strain, temperature, other phenomena, to 0.1% with a KIN TEL DC amplifier



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

160 db DC, 120 db 60 cycle common mode rejection with balanced or unbalanced input ■ Input completely isolated from output ■ Input and output differential and floating ■ 5 microvolt stability for thousands of hours ■ 0.05% linearity, 0.1% gain stability ■ Gain of 10 to 1000 in five steps ■ >5 megohms input, <2 ohms output impedance ■ 10 volt at 10 ma output ■ 100 cycle bandwidth ■ Integral power supply

Ideal for thermocouple amplification, the Model 114A differential DC amplifier eliminates ground loops; allows the use of a common transducer power supply; drives grounded, ungrounded or balanced loads; permits longer cable runs; and can be used inverting or non-inverting. The 114A can be mounted in either single amplifier cabinets or six amplifier 19″ rack adapter modules. Prices: 114A – $875, six amplifier module – $295; single amplifier cabinet – $125.

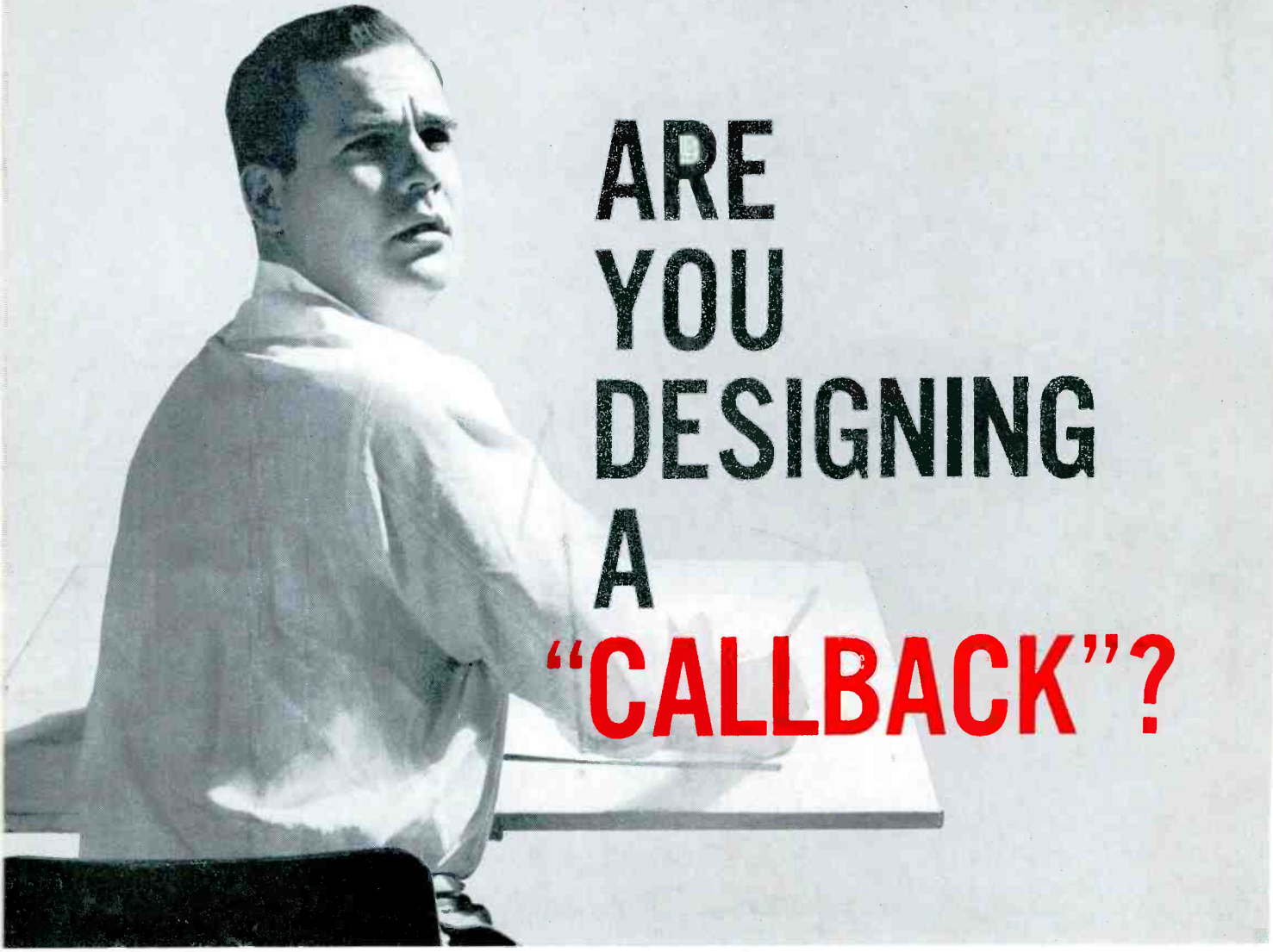
WIDEBAND, SINGLE ENDED DC AMPLIFIERS AMPLIFY DATA SIGNALS FROM DC TO 40 KC WITH 2 MICROVOLT STABILITY

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

Millions of cumulative hours of operation have proved KIN TEL Model 111 series DC amplifiers to be the basic component for all data transmission, allowing simple, reliable measurement of strain, temperature and other phenomena. DC instrumentation systems – with their inherently greater accuracy, simplicity, and reliability than AC or carrier systems – are made entirely practical by the excellent dynamic performance, stability, and accuracy of KIN TEL DC amplifiers. Price: 111BF–$625, six amplifier module–$295, single amplifier cabinet – $125.

5725 Kearny Villa Road, San Diego 11, California

KIN TEL
A DIVISION OF
COHU
ELECTRONICS, INC.



ARE YOU DESIGNING A "CALLBACK"?

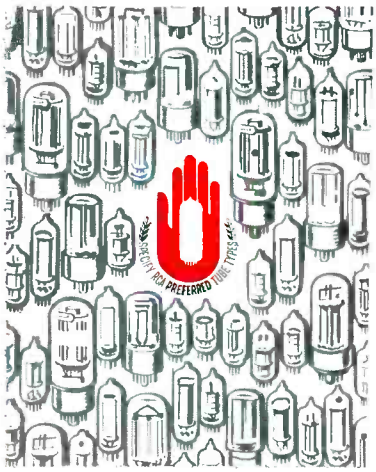
Or, are you wisely designing "around" a dependable easy-to-obtain-in-the-field Preferred Tube Type?

Some day, the tv or radio set you designed is going to need service. Some day, a service dealer is going to have to replace a tube type you specified. Can the service dealer replace with a *stock* tube? That is one of the big tests of an original design.

There are more than a thousand tube types you can design "around". But, the majority of today's tv and radio circuits employ less than a hundred of those types. For good reason, too. Over the years those *preferred* types have proven to be tops...in quality...in versatility...in reliability and replaceability.

If the tubes you specified for your design are Preferred Tube Types, you can bet that field replacement will not be a problem. If not—it may mean a "callback" and a customer who begins to doubt his choice of sets. Help keep them sold with Preferred Tube Types.

Your RCA Field Representative has the complete story of how you benefit by using Preferred Tube Types. Call him at the RCA Field Office nearest you.



RCA FIELD OFFICES

EAST: 744 Broad St., Newark 2, N. J.
HUmboldt 5-3900

MIDWEST: Suite 1154, Merchandise Mart Plaza
Chicago 54, Ill., WHitehall 4-2900

WEST: 6355 E. Washington Blvd.
Los Angeles 22, Calif.
RAymond 3-8361

RADIO CORPORATION OF AMERICA
Electron Tube Division — *Harrison, N. J.*