NOVEMBER 1, 1957

electronics

engineering edition

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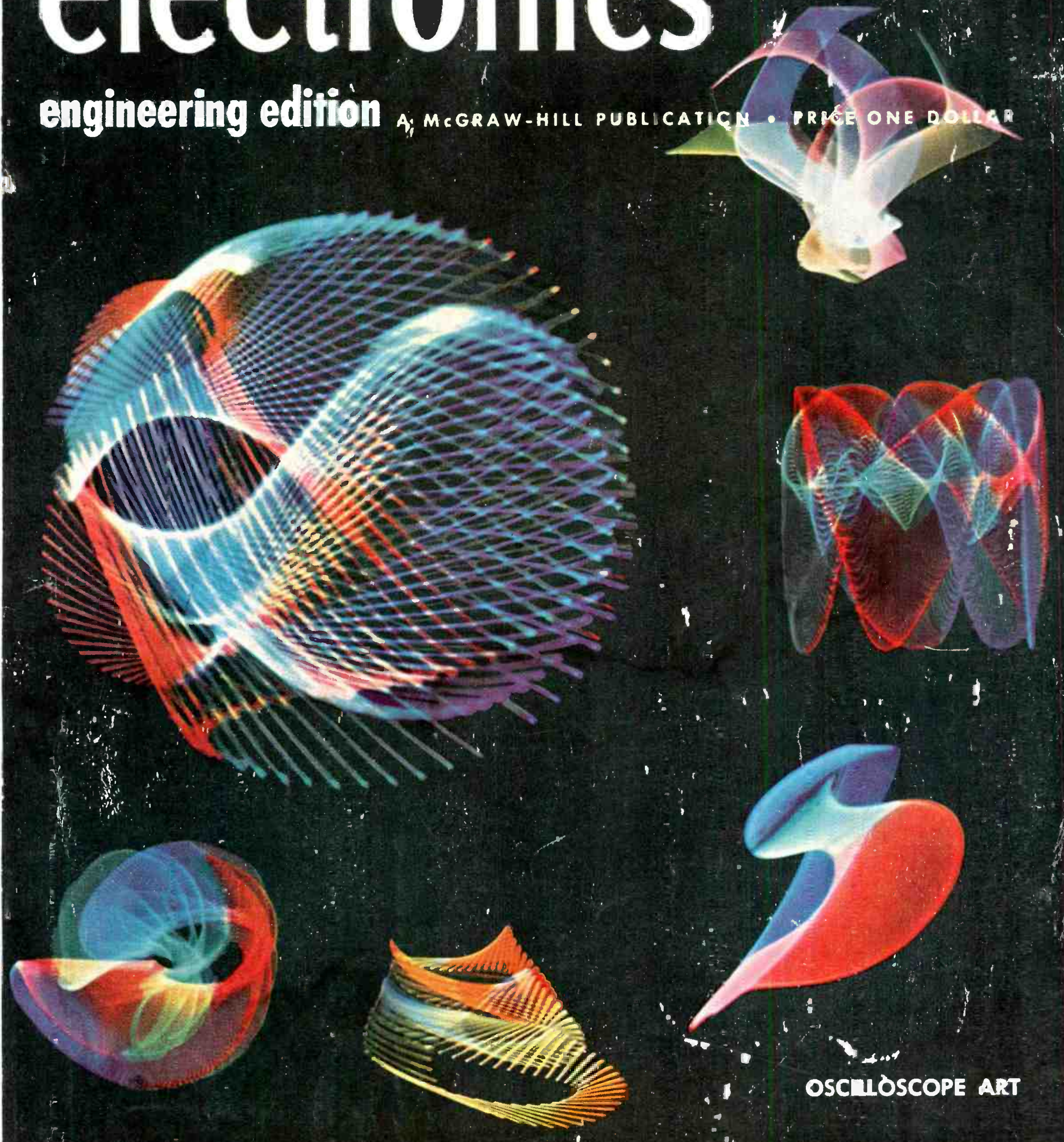


OSCILLOSCOPE ART

DO-TS

Deci-Ouncer Transformers

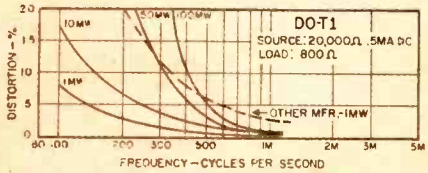
REVOLUTIONARY TRANSISTOR TRANSFORMERS

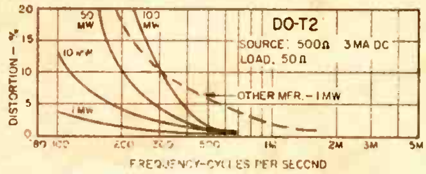
of unequalled power handling capacity and reliability

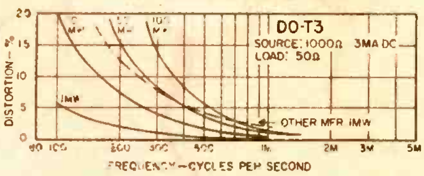
Hermetically Sealed to MIL-T-27A Specs.

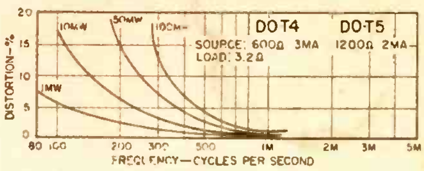
TYPICAL DO-T PERFORMANCE CURVES

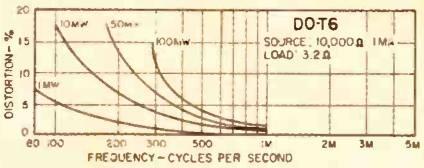
Power curves based on setting output power at 1 KC, then maintaining same input level over frequency range.

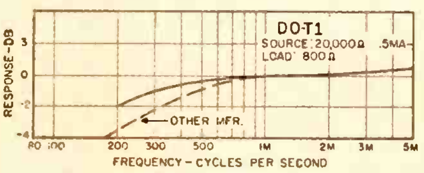


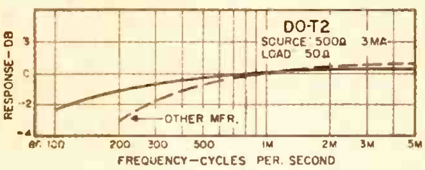


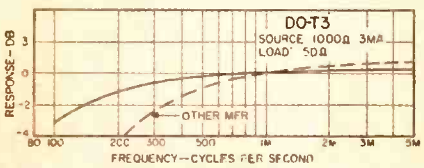


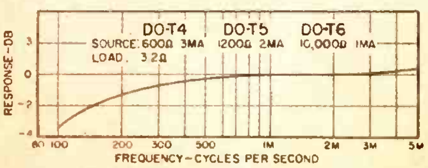










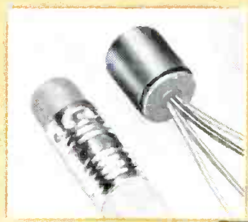


*DO-T units have been designed for transistor application only . . . not for vacuum tube service. **Pats. Pending

Conventional miniaturized transistor transformers have inherently poor electrical characteristics, perform with insufficient reliability and are woefully inadequate for many applications. The radical design of the new UTC DO-T transistor transformers** provides unprecedented power handling capacity and reliability, coupled with extremely small size. Twenty-five stock types cover virtually every transistor application*. Special types can be made to order.

High Power Rating . . . up to 100 times greater.
Excellent Response . . . twice as good at low end.
Low Distortion . . . reduced 80%.
High Efficiency . . . up to 30% better.
Moisture Proof . . . hermetically sealed to MIL-T-27A.
Rugged . . . completely cased.
Anchored Leads . . . will withstand 10 pound pull test.
Printed Circuit Use . . . (solder melting) plastic insulated leads.

ACTUAL SIZE



DO-T CASE Dia. . . . 5/16"
Length . . 13/32"
Weight . . 1/10th oz.

Type No.	MIL Type	Application	Pri. Imp.	D.C. Ma.‡ in Pri.	Sec. Imp.	Pri. Res.	Level Mw.
DO-T1	TF4RX13YY	Interstage	20,000 30,000	.5 .5	800 1200	850	50
DO-T2	TF4RX17YY	Output	500 600	3 3	50 60	60	100
DO-T3	TF4RX13YY	Output	1000 1200	3 3	50 60	115	100
DO-T4	TF4RX17YY	Output	600	3	3 2	60	100
DO-T5	TF4RX13YY	Output	1200	2	3.2	115	100
DO-T6	TF4RX13YY	Output	10,000	1	3.2	1000	100
DO-T7	TF4RX16YY	Input	200,000	0	1000	8500	25
DO-T8	TF4RX20YY	Reactor 3.5 Hys. @ 2 Ma. DC				630	
DO-T9	TF4RX13YY	Output or driver	10,000 12,500	1 1	500 CT 600 CT	800	100
DO-T10	TF4RX13YY	Driver	10,000 12,500	1 1	1200 CT 1500 CT	800	100
DO-T11	TF4RX13YY	Driver	10,000 12,000	1 1	2000 CT 2500 CT	800	100
DO-T12	TF4RX17YY	Single or PP output	150 CT 200 CT	10 10	12 16	11	500
DO-T13	TF4RX17YY	Single or PP output	300 CT 400 CT	7 7	12 16	20	500
DO-T14	TF4RX17YY	Single or PP output	600 CT 800 CT	5 5	12 16	43	500
DO-T15	TF4RX17YY	Single or PP output	800 CT 1070 CT	4 4	12 16	51	500
DO-T16	TF4RX13YY	Single or PP output	1000 CT 1330 CT	3.5 3.5	12 16	71	500
DO-T17	TF4RX13YY	Single or PP output	1500 CT 2000 CT	3 3	12 16	108	500
DO-T18	TF4RX13YY	Single or PP output	7500 CT 10,000 CT	1 1	12 16	505	200
DO-T19	TF4RX17YY	Output to line	300 CT	7	600	19	500
DO-T20	TF4RX17YY	Output or matching to line	500 CT	5 5	600	31	500
DO-T21	TF4RX17YY	Output to line	900 CT	4	600	53	500
DO-T22	TF4RX13YY	Output to line	1500 CT	3	600	86	500
DO-T23	TF4RX13YY	Interstage	20,000 CT 30,000 CT	.5 .5	800 CT 1200 CT	850	100
DO-T24	TF4RX16YY	Input (usable for chopper service)	200,000 CT	0	1000 CT	8500	25
DO-T25	TF4RX13YY	Interstage	10,000 CT 12,000 CT	1 1	1500 CT 1800 CT	800	100

‡DCMA shown is for single ended useage (under 5% distortion—100MW—1KC) . . . for push pull, DCMA can be any balanced value taken by .5W transistors (under 5% distortion—500MW—1KC)

UNITED TRANSFORMER CORP.

150 Varick Street, New York 13, N. Y.

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EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

electronics engineering edition

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ISSUE AT A GLANCE

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CONTENTS continued

electronics

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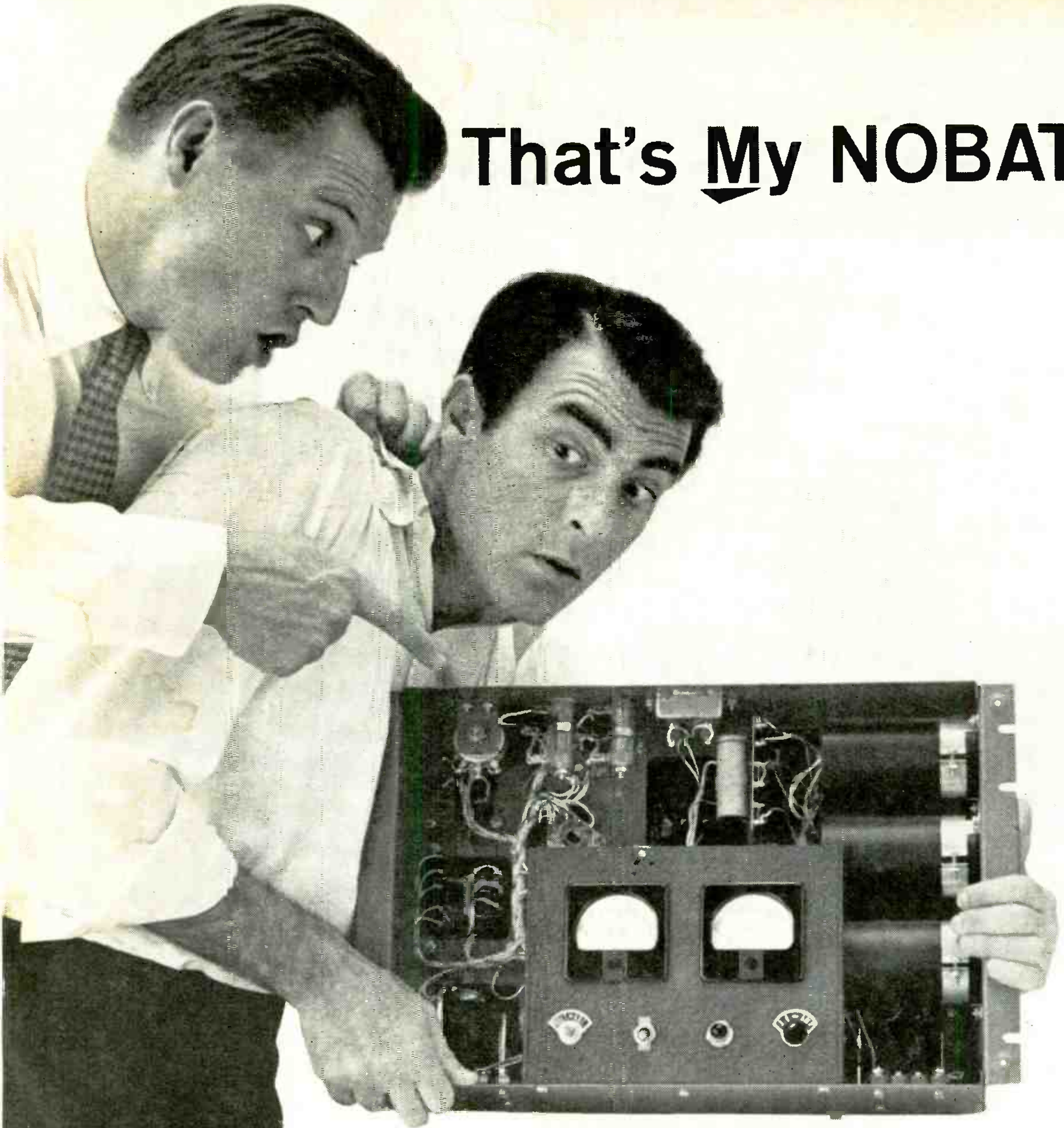


Regulated DC Sources for Low-Voltage High-Current— 6, 12, 28, 48, 125, 200 Volts at 5 to 75 Amps.

For a reliable *sustained* low-voltage DC supply, delivering the power that covers most laboratory and many industrial applications, and with voltage variation held within ±0.2% ... these Nobatrons just can't be matched —by anything, anywhere.

Nobatrons are in use, by the thousands, all over the world. Many of them have been in operation continuously over a span of years. Conservative design and generous specifications insure long life—especially for wound components.

So effective is the Sorensen regulating principle in correcting line and load drops that output has the stability of a battery supply over extended periods. And the disadvantages of batteries—recharging, acid handling, fixed voltage, temperature problems—are eliminated.

Over-voltage protection is assured by a special safety diode that impels a voltage drop in case of filament failure, with other protective devices safe-guarding all components against power surge.

Most units are designed for rack-mounting, and with cabinets for bench use.

Let your local Sorensen representative give you complete data on these Sorensen DC Nobatrons or write directly for specific information. Please address **SORENSEN & COMPANY, Inc.,** *Richards Avenue, South Norwalk, Connecticut.*

TYPICAL SPECIFICATIONS Model E-28-5* (illustrated)

Output Voltage	28 VDC, Adjustable ±10% with rated accuracy	**Load Range**	0.5 to 5 Amps at Rated Accuracy; accuracy decreases to around ±0.5% for no load.
Input Voltage	95-130 VAC, single phase, 50/60 cycles.	**Ripple Voltage**	1% RMS at 60 cycles. Filters available to reduce ripple to 0.1%
Regulation Accuracy	±0.2% against line from 105 to 125 VAC Input; ±0.2% against load.	**Time Constant**	0.2 second
		Size	Rack height 12¼″ Cabinet Size 21¾″ x 14″ x 15″

*Write for data on other models and capacities.

Sorensen — CONTROLLED POWER FOR RESEARCH AND INDUSTRY

F.M. DEVIATION
Directly Measured

with this time-saving and accurate MARCONI instrument

If you *haven't* a deviation meter you can use the Bessel Zero or "Disappearing Carrier" method of measurement; this, however, requires complex monitoring equipment, an accurately-known modulation frequency, and, finally, mathematical interpretation of results.
With the compact and easy-to-use Marconi Deviation Meter, the modulation frequency need not be known and deviation is read *directly* from the panel meter.

F.M. DEVIATION METER
MODEL TF 934/2

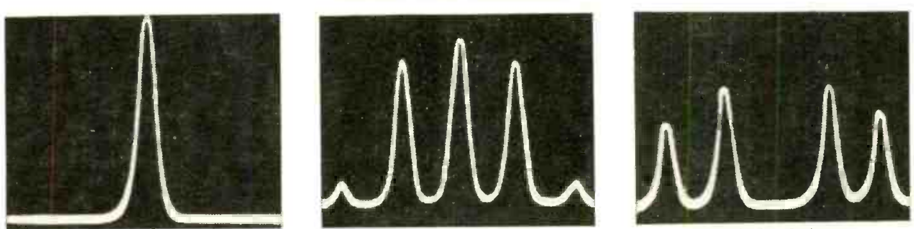
Carrier Frequency Range:
2.5 to 500 Mc.

Deviation Measurement Ranges:
5, 25, and 75 kc full-scale.

Accuracy of Deviation Measurement:
±3% from full-scale to half-scale for modulation frequencies up to 12 kc; ±6% up to 15 kc.

Tubes:
6AK5, 6AL5, 6C4, 6X5, OB2.

BESSEL ZERO METHOD



Unmodulated Carrier — *Modulation Index 1.3* — *Modulation Index 2.4 The Carrier "Disappears"*

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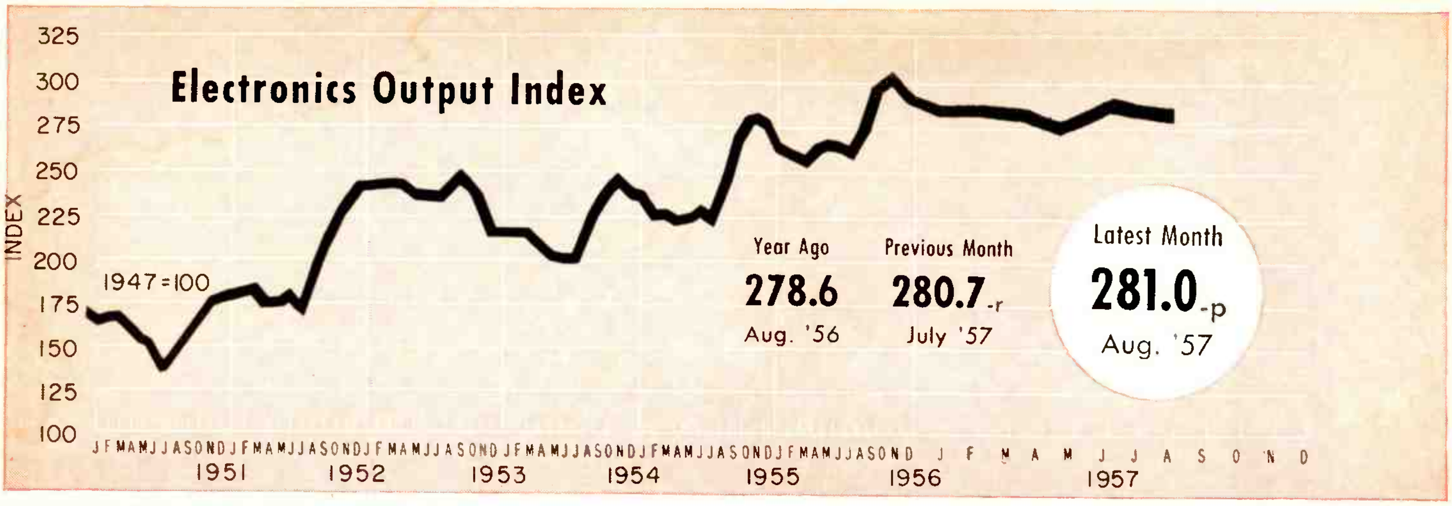
Circle 68 Readers Service Card



FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month	Previous Month	Year Ago
	August '57	July '57	August '56
Television sets, total	673,734	360,660	612,927
With UHF	88,615	55,401	90,419
Color sets	nr	nr	nr
Radio sets, total	965,724	612,588	990,845
Auto sets	301,971	256,279	198,087

RECEIVER SALES

(Source: RETMA)	August '57	July '57	August '56
Television sets, units	510,097	426,334 -r	566,158
Radio sets (except auto)	710,553	597,484	681,152

RECEIVING TUBE SALES

(Source: RETMA)	August '57	July '57	August '56
Receiv. tubes, total units	43,029,000	33,077,000	43,948,000
Receiv. tubes, value	$34,886,000	$27,042,000	$34,507,000
Picture tubes, total units	930,296	491,935	1,099,605
Picture tubes, value	$17,984,185	$9,835,586	$19,628,837

INDUSTRIAL TUBE SALES

	Quarterly Figures		
(Source: NEMA)	Latest Quarter	Previous Quarter	Year Ago
	2nd '57	1st '57	2nd '56
Vacuum	$10,191,621	$11,224,707	$7,680,250
Gas or vapor	$2,758,630	$3,332,357	$2,983,488
Magnetrons and velocity modulation tubes	$17,177,922	$15,359,108	$16,254,025
Gaps and T/R boxes	$1,589,670	$1,409,463	$1,238,469

MILITARY PROCUREMENT

(Source: Defense Dept.)	1st '57	4th '56	1st '56
Army	$69,381,000	$56,185,000	$40,490,000
Navy	$21,426,000	$34,210,000	$28,700,000
Air Force	$159,829,000	$145,962,000	$124,828,000
Total—Electronics	$250,636,000	$236,357,000	$194,018,000

BROADCAST STATIONS

(Source: FCC)	Latest Month	Previous Month	Year Ago
	July '57	June '57	July '56
TV stations on air	522	519	499
TV stations CPs—not on air	132	132	116
TV stations—new requests	78	79	42
A-M stations on air	3,095	3,079	2,922
A-M stations CPs—not on air	155	159	119
A-M stations—new requests	340	322	263
F-M stations on air	531	530	530
F-M stations CPs—not on air	31	31	19
F-M stations—new requests	25	24	7

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	July '57	June '57	July '56
Aeronautical	51,463	49,699	49,639
Marine	64,067	63,844	57,529
Police, fire, etc.	23,550	23,270	20,943
Industrial	36,261	35,711	30,776
Land transportation	9,652	9,592	9,027
Amateur	163,994	160,000	149,032
Citizens radio	28,864	27,931	19,253
Disaster	347	347	327
Experimental	797	788	722
Common carrier	2,856	2,790	2,356

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	July '57	June '57	July '56
Prod. workers, comm. equip.	395,600-p	394,200	379,700
Av. wkly. earnings, comm.	$75.85 -p	$79.59 -r	$73.30
Av. wkly. earnings, radio	$75.05 -p	$76.97 -r	$72.83
Av. wkly. hours, comm.	39.1 -p	40.4 -r	39.2
Av. wkly. hours, radio	39.5 -p	40.3 -r	39.8

SEMICONDUCTOR SALES ESTIMATES

	August '57	July '57	August '56
Transistors, Units	2,709,000	1,703,000	1,315,000

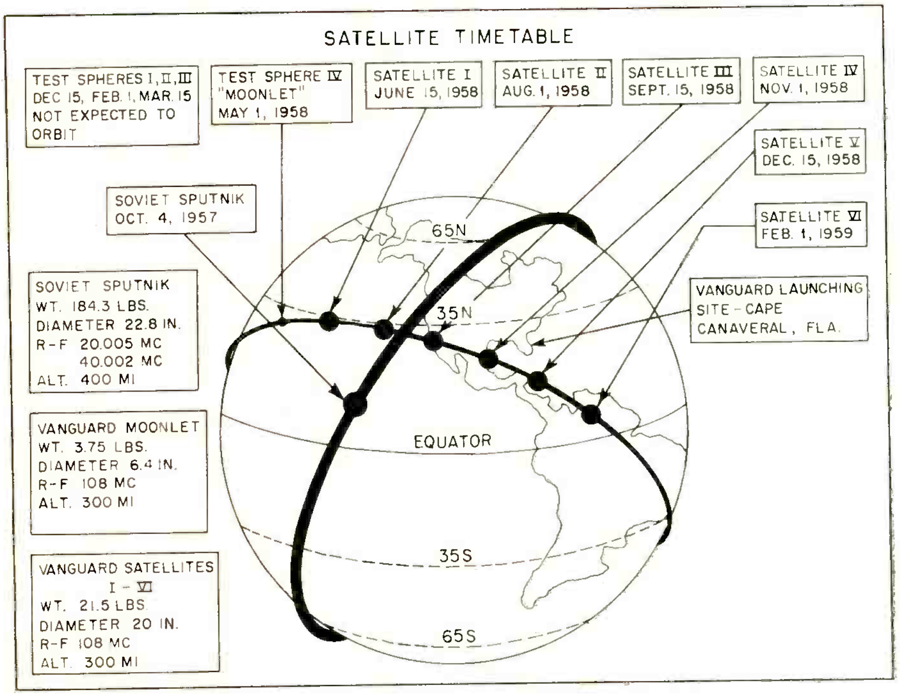
STOCK PRICE AVERAGES

(Source: Standard and Poor's)	August '57	July '57	August '56
Radio-tv & electronics	47.28	51.56	57.84
Radio broadcasters	60.63	64.78	73.49

p—provisional r—revised nr—not reported

FIGURES OF THE YEAR

	TOTALS FOR FIRST EIGHT MONTHS 1957	1956	Percent Change	1956 Total
Television set production	3,756,533	4,365,060	—13.9	7,357,029
Radio set production	8,765,606	8,216,707	+ 6.7	13,981,800
Television set sales	3,746,834	3,839,718	— 2.4	6,804,756
Radio set sales (except auto)	4,947,006	4,648,707	+ 6.4	8,332,077
Receiving tube sales	297,281,000	303,004,000	— 1.9	464,186,000
Cathode-ray tube sales	6,236,890	6,837,728	— 8.8	10,987,021



U. S. satellite orbits are yet to be filled, but . . .

Vanguard's Center Gets Rehearsal

Although unprepared for Sputnik, computer men gained valuable information

VANGUARD'S Computing Center has had a live and unexpected dress rehearsal in satellite orbit computations since Oct. 4 when the Soviet *Sputnik* highballed without warning into space.

Although ahead of schedule in preparation for *Vanguard*, the IBM center—under contract to the Naval Research Lab—was not yet prepared to go into high gear.

By 2:00 a.m. Saturday, the center's IBM 704 computer was running. But reliable information to feed into it was scarce.

Directional orientation for both visual (Moonwatch) and Minitrack radio monitoring systems were set up for a satellite going in an east-west orbit from 35 degrees north latitude to 35 degrees south. *Sputnik* had been launched at a 65-degree inclination from the Equator and was careening up and down the Minitrack and Moonwatch stations in an almost north-south path.

Radio reception was ruled out for hours because *Sputnik's* transmitting frequencies were too low for Minitrack. Frequency changes had to be made and visual equipment reoriented north and south.

▶ **Sightings**—Visual observation reports began trickling in to the Smithsonian Astrophysical Observatory at MIT from observatories and universities. They were unreliable on two counts: they came from extreme latitudes like Alaska and Australia where exact coordinates were not known; and secondly, there was no assurance the observer had seen the actual satellite. *Sputnik's* nose cone and third-stage rocket were also caught up in orbits making already dubious sightings less usable still. Several sightings fed into the programmed 704 were promptly rejected by the computer as false.

By Tuesday afternoon, Oct. 8, the ten Minitrack stations had been converted to receive on 20.005 mc and 40.002 mc and nine stations had been heard from. But even this data was not completely reliable. One station received a steady signal from the satellite for 45 minutes—almost half way around the globe. Extremes of the signal were sky waves, giving erroneous positions.

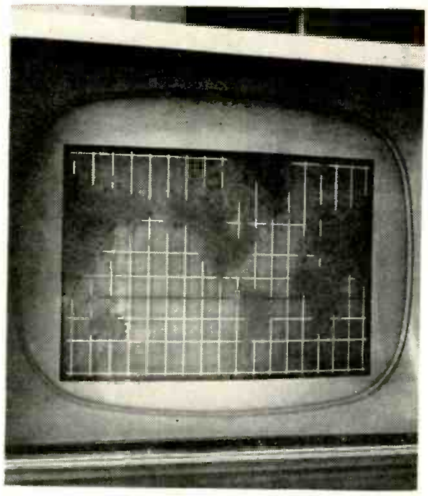
▶ **Computations**—By carefully culling all data sent in, a minute-by-minute orbital computation was made 64 hours and some 2 billion calculations after the computer was started. Altitude and orbit shape were not clear but schedule and itinerary predictions have checked out with reasonable precision.

Data sources are ten Minitrack receiver stations, 150 teams of Moonwatchers with twelve optical tracking cameras and the volunteer observatories and universities throughout the world.

Visual observations go to the Smithsonian Astrophysical Observatory at MIT while Minitrack data is sent in to NRL in Washington. From there, screened data is passed on by teletype to IBM's Vanguard Computing Center.

Recorded on punched-paper tape, data is fed through a tape-to-card converter and into the already-programmed computer.

The 704 is able, with only three accurate positions, to arrive at an orbit. Once an orbit is established, the launching site can be pinpointed.



Visual presentation of orbiting satellite appears on IBM's type 780 cathode ray tube display unit

Punched-Tape Robot Performs at NEC

Rumors of new assembly machines heard as one prototype makes operating debut

HARD-WORKING committees chalked up another success as the Hotel Sherman doors closed on the National Electronics Conference in Chicago. Final attendance was close to that for previous years. Once again, engineers enjoyed and profited from the quiet and leisurely pace of this show, in contrast to the noise, the crowds, and the rush-to-see-it-all of the annual IRE convention in New York.

▶ **On Duty**—A total of 230 booths this year had 879 scheduled attendants. In addition, top executives of many firms were to be seen at their booths, available for positive answers at management level to supplement the technical information provided by their engineers and sales staffs. As a result, booth coverage probably set an all-time high for the industry, and visitors seldom had to wait for answers to questions.

▶ **Get-Around Gimmick**—With exhibits spread through rooms on four different levels, some badly broken up by partitions, NEC management had a real problem in guiding and luring visitors to the most remote booths. Their highly effective solution—six time clocks and a redhead.

At the main entrance was a display table packed high with door prizes, a stack of time cards and charted instructions for reaching the time clocks at the remote corners of each room. A filled-in card, validated at each clock, was tossed into a barrel for the grand drawing at the end of the show. The curvaceous guide was strategically stationed at the stairs to the furthermost lower room, to coax dog-tired engineers down that last flight for coverage of 32 more booths. Success of this planning was evidenced by essentially uniform aisle popu-

(Continued on page 10)

Computers Approach 5,000 Mark

Over 103 types now available for research and commercial applications

METEORIC RISE in the rate of computer investments sharply spotlights substantial computer growth. From ten million dollars per year invested in 1953, the rate rose to one hundred million dollars in 1956. Within the next few years expenditures should mushroom to one billion dollars per year.

This growth is reflected in a report on digital computers issued recently by the Office of Technical Services of the Department of Commerce. By early summer over 4,900 computers had been manufactured.

▶ **Cost**—Computer costs range from $16,800 for the 46-tube Litton 40, a portable differential analyzer, to $4,200,000 for the giant 30,000-tube RCA Bizmac. Of 103 computers surveyed nine units cost more than $1,000,000 while 21 cost less than $100,000.

▶ **Tubes**—Like computer costs, tube quantities vary from 30,000 in the Bizmac down to 40 in Logistics Research's ALWAC 800. Thirteen computers possess in excess of 5,000 tubes, but 33 have less than 1,000.

To ease replacement problems efforts have been made to standardize tube types in computers. For example, the 10,000-tube IBM 702 has three tube types, the 9,800-tube NORC has 20 and the 6,100-tube IBM 705 has ten.

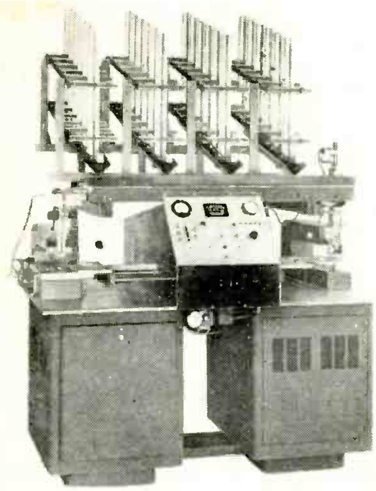
▶ **Transistorization**—According to the report a trend toward transistorization is not yet apparent. Only three models, the IBM 608, the Livermore Automatic Research Calculator (LARC) and the Philco Transac S 1000 are completely transistorized. But nineteen other units, most notably the Lincoln TX2, employ some transistors.

Largest number of transistors are the 25,000 found in the TX2. National Bureau of Standards' SEAC, a general purpose scientific calculator, supplements 2,229 tubes with three transistors.

▶ **Crystal Diodes**—Consumption of crystal diodes in digital computers is considerable. The Bizmac uses 70,000. Twenty-two other models use in excess of 10,000. Less than 16 models have fewer than 1,000.

▶ **Arithmetic**—Speed of arithemetic operations varies considerably for different units.

Circle 69 Readers Service Card



Drilling is done at the right and insertion of components at the left, under step-by-step control of punched paper tape in left-hand base cabinet of Design Tool Corp's Auto-Board. Hoppers at top, holding 24 different values of axial-lead components, release components one at a time as called for by tape

Business Briefs

▶ **Litton Industries**, Beverly Hills, Calif. and **Aircraft Radio**, Boonton, N. J., announces merger plans. Under the proposed agreement, subject to stockholder approval, Aircraft Radio stockholders will be offered choice of six-tenths share of Litton common or 0.23 share of Litton $100 par 5-percent cumulative preferred for each share of Aircraft Radio common. In September, Litton Industries announced plans to purchase Maryland Electronic Manufacturing of College Park, Md. Payment was to be made with Litton stock, but amounts were not disclosed

▶ **Standard Coil Products** overcomes past loss operations. Net profit for July and August was about $160,000. Further increases are expected in future months. A net loss of nearly $1.5 mililon was registered in 1956. Profit improvement reported due mainly to program to end loss in Standard's Tuner Division. Program included cutting overhead, expenses and salaries and finding new markets

▶ **F. C. Huyck & Sons** plans increased concentration on instruments, control devices and other products for industry. For this reason company sold its blanket and cloth plant in Vermont

▶ **Credit Union National Association** (CUNA) reports that employees of electronic firms recently organized six more credit unions to provide 4,100 members with low cost credit facilities. Electronics manufacturing groups now have 108 credit unions. New credit unions were organized at **Applied Electronics**, San Francisco, Calif.; **Antennavision Manufacturing and Engineering**, Phoenix, Ariz.; **Radio Television Products**, Grass Lake, Mich.; **Crosley-Avco**, Evandale, Ohio and **Philco Corp.**, Sandusky, Ohio. In addition, the National Electronics Federal Credit Union was organized at Malden, Mass.

lation on all parts of the exhibit floor.

▶ **Rumor and Fact**—Multistation automatic assembly machines are running a poor second to women on tv assembly lines, with the result that some machines are gathering dust in odd corners of plants, according to convention-floor gossip. Dark horse is the more complex but more flexible single-station machine which puts in one part after another under control of punched tape.

Prototype of one such machine was actually running in Design Tool Corp.'s booth. Under control of easily punched paper tape, this robot drills required holes one after another in one board while inserting parts in a previously drilled board. A tiny belt conveyor brings axial-lead components to the insertion head from 24 hoppers each having a release solenoid controlled by the tape. Loading and unloading of boards are manual, but board positioning is entirely automatic. Changeover to new board design is achieved simply by putting in new paper tape, since 24 different values of components can take care of most board requirements.

A machine similar to this one but guided by punched cards rather than tape (ELECTRONICS, p 19, Aug. 20, 1957), is now in actual operation, with a market version being readied for a price tag in the $100,000 range. It uses belted reels of components in place of hoppers, all feeding a single insertion head.

Still another machine of the flexible single-station type is rumored to be nearing completion behind locked doors in a midwestern research lab, under a development contract with an as-yet unknown manufacturer.

▶ **Signal Corps Role**—All of these new machines are no doubt based in large part on experience acquired by GE in building ACAS for the Signal Corps, even though this granddaddy of the centralized-brain assembly machines now rests idly in the firm's Utica plant. Industry has thus taken up on its own the campaign by the military for automatic production equipment that could be set up and changed over within minutes to meet changing military needs in an emergency. Such fast changeover is needed when hundreds of different boards must be made for a missile control computer.

(Continued on page 12)

Nominal Performance Characteristics of Typical SPRAGUE Magnetic Shift Registers

OPERATING FREQUENCY Maximum (kc)	0-25			0-100			0-200		
Recommended (kc)	0-20			0-90			0-190		
VOLTAGE SIGNAL LEVEL	4	15	30	4	15	30	4	15	30
SHIFT PULSE Nominal Operating Current (ma)	160	160	160	140	200	200	220	220	220
Voltage Drop per Stage (v)	3.4	8.0	9.5	8.0	10.0	13.5	6.8	6.0	9.5
Duration (μsec at ½ amplitude)	7.0	6.5	5.8	2.0	2.0	2.5	1.2	1.2	1.2
Rise Time (μsec)	1.8	1.8	1.8	0.8	0.8	0.8	0.3	0.3	0.3
Fall Time (μsec)	0.9	1.8	0.9	0.8	0.8	0.8	0.3	0.3	0.3
Peak Pulse Power (watts)	.55	1.5	1.6	1.12	2.0	2.7	1.5	1.4	2.1
INPUT PULSE Amplitude (ma)	15	10	5	15	10	15	15	10	10
Duration (μsec)	10	10	10	3	3	3	2	2	2
PARALLEL OUTPUT PULSE Amplitude (ma)	4	16	32	5	18	30	4.5	16	30
Ratio (min.)	10:1	10:1	10:1	10:1	10:1	10:1	8:1	8:1	8:1
Load Impedance (ohms, min.)	2000	6000	25,000	1800	8000	15,000	10,000	10,000	18,000
DIODE TYPE (or equivalent)	T-7	T-7	T-7	T-7	T-7	T-5	T-7	T-5	T-5
ENGINEERING DATA SHEET	9111	9113	9115	9121	9123	9125	9131	9133	9135

core-diode type magnetic shift register assemblies

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All standard packages are characterized by terminal spacing that simplifies external mounting of semi-conductor diodes, or they can be permanently packaged as integral assembly components in Sprague special designs.

Single and multiple stage register assemblies are available with read and write provisions to meet most system requirements. Standard designs can easily be modified with additional windings to perform various logical operations.

For Data Sheets on core-diode type magnetic shift register assemblies, write the Technical Literature Section, Sprague Electric Company, 35 Marshall St., North Adams, Massachusetts.

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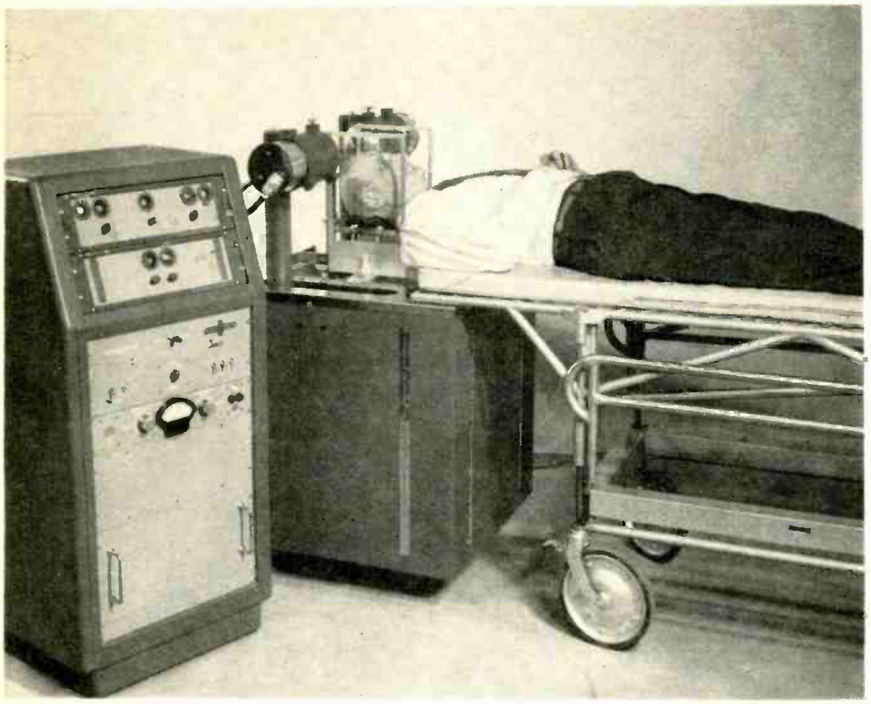


BRAIN TUMOR detector, that uses a radioactive arsenic source, is one of the new electronic devices shown at the Massachusetts General Hospital this month when three major groups gather in Boston to hear . . .

Doctors Evaluating Electronics

Keynote of conference: new medical concepts based on a highly-developed technology

AN IMPORTANT annual conference, taking place in Boston this month (Nov. 6-8), is coming closer and closer to bridging the gaps between doctors, engineers and biologists. The major groups sponsoring this conclave: The Instrument Society of America, The American Institute of Electrical Engineers, The Boston Chapter of The Professional Group of Medical Electronics of the IRE and the Medical Physics Group of Boston, will see and hear about new devices that are exploring breakthroughs in medical electronics. But more than that, they have raised their sights on a new concept of medicine.

The tenth Annual Conference On Electrical Techniques in Medicine and Biology has planned specific sessions that will appraise electronic devices used to study nerve kinetics, blood flow and membrane potentials.

▶ **Problems**—Despite the great strides that have been made in medicine since the beginning of the second World War, unsolved problems in medicine are great and pressure on the doctor to get his work done is greater than it has been in the whole history of the medical profession. The demand for treatment is greater than hospital facilities will allow, despite the huge medical centers that have multiplied during our generation. There are just not enough skilled and properly trained doctors to take care of our demands. There are not enough hospital beds to accommodate patients. Labor costs are rising too, and the big problem here is to free skilled men and women of medicine from routine tasks so that they may better devote their skills and training to more complicated tasks.

▶ **New era**—Medicine has now reached the stage that can no longer get along without a technology that will handle the doctors work more efficiently. Up to very recent times, progress in biological research has been accomplished by using methods and techniques that are comparable, in a way to the methods of production used during the early stages of the industrial revolution.

Up to recent years medicine hasn't had its share of the electronics technology because medicine has been small business, not able to afford the research necessary to develop medical electronics as it should be developed. But medicine is now growing slowly and surely into big business that is spending more and more electronics money for biological research.

Plane Maker Turns to Instruments

Circuit analyzer is first electronic product to be marketed by Republic Aviation

MILITARY aircraft manufacturers are looking beyond expanding missile business to replace lost plane sales.

Several months ago Republic Aviation began to market an electronic circuit analyzer. A number of other electronic test equipment items, now under development, are expected to be released for sale shortly.

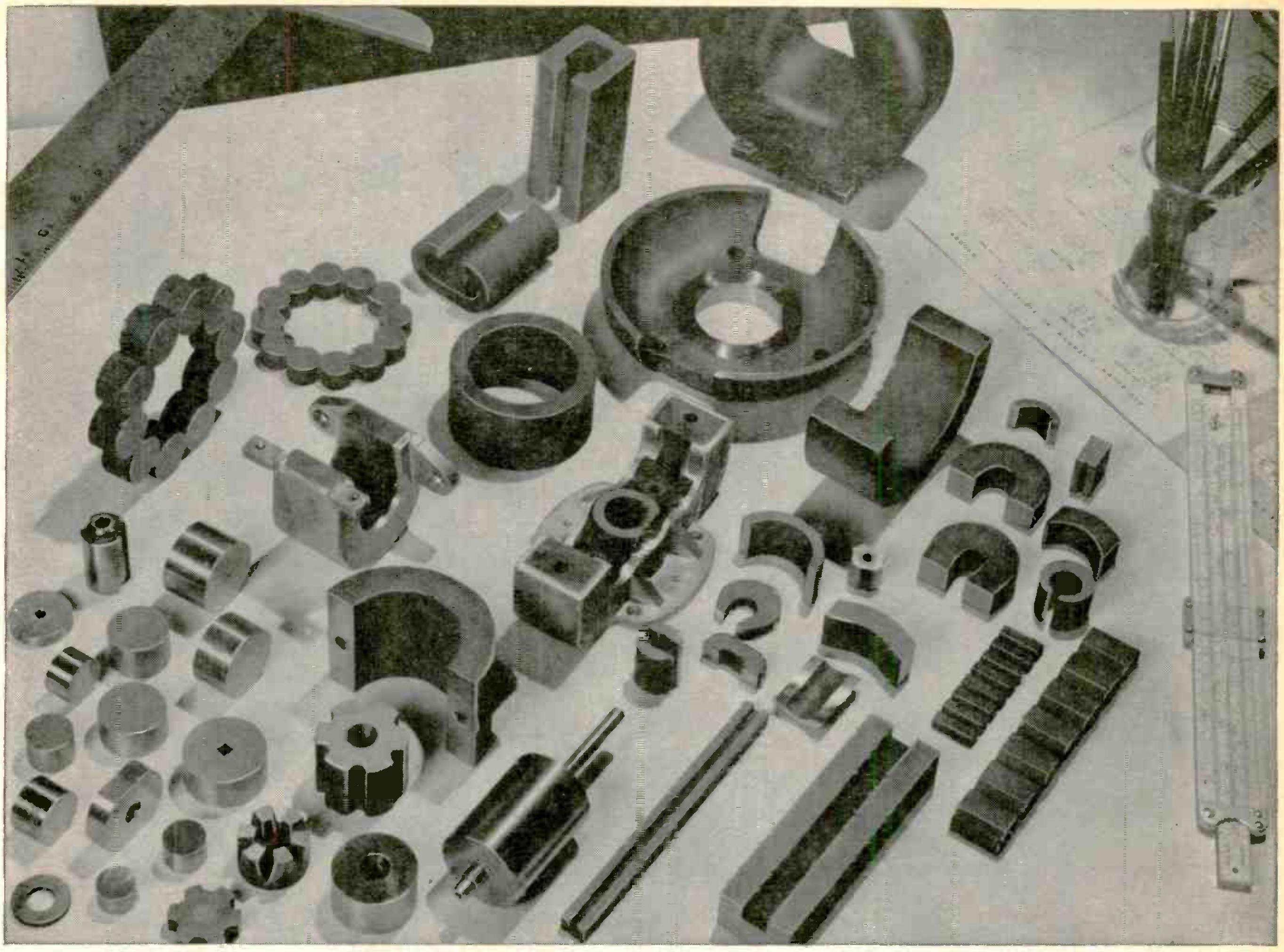
Also, for years Republic has made many electronic test instruments for its own use. Until now, no efforts were made to produce for sale because of pressing aircraft orders.

▶ **Personnel**—The growth of the electronics tooling department illustrates the new emphasis on electronics at Republic. In three years it has grown from 12 to 124 members.

As this department does only development work and limited manufacturing, a separate electronics manufacturing department, and possibly a special electronics division, is in the offing.

Here's how the circuit analyzer works. Circuits are harnessed to

(Continued on page 14)



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Engineering Data

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BULLETIN GC-106 C

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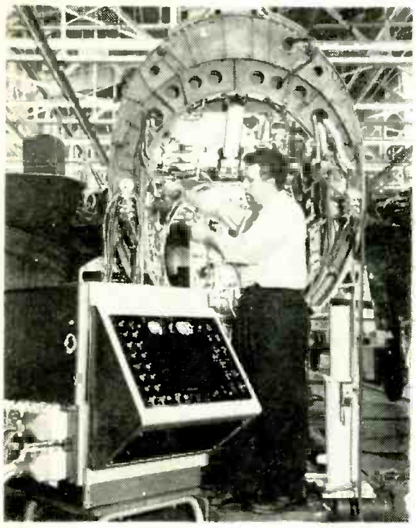


Circuits of F-85 interceptor being checked with 400-circuit automatic analyzer

the analyzer which first checks every circuit under test, lighting up to indicate malfunctioning ones. Then the instrument tells the nature of the trouble—short, ground open or reversed connection, weak insulation.

▶ **Capability**—The analyzer comes in five different models with capacity to test assemblies of 100, 200, 400, 800, and 1,200 circuits. The portable 100-circuit model can be used in the field.

One advantage of the analyzer is speed in circuit checking and resultant labor savings. If all circuits are ok they can be checked out in a few seconds on the small models and in a few minutes on the largest.

One circuit testing job used to take a minimum of 75 hours at Republic when a bell or light system for checking individual circuits was used. The same job, including setup time, now takes four hours. Furthermore, unskilled workers can quickly be taught to do the job.

Versatility has been achieved through use of removable program boards. If one analyzer is being used to check different circuits, separate program boards are wired for each circuit.

▶ **Market**—Aircraft, electronic and television, missile, computer and automotive manufacturers as well as ship operators have indicated interest in the analyzer.

Military Electronics

▶ **Development** and production of a 16-in. all-glass cathode-ray tube for military use is announced by Westinghouse. Equipment to house the tube, designated 16AKP7, is less complicated since there is no need to insulate the cone of the tube from its surroundings

▶ **Nearly** 6,000 people at Tglin Field, Fla. watched a heat-seeking Sidewinder pursue and destroy a 5-in. rocket fired from an F-100

▶ **Shock waves** that reach speeds of 100,000 mph and produce temperatures of higher than 100,000 degrees C are being created in a hydromagnetic shock tube built at Lockheed's research and development center, Palo Alto, Calif. To produce the wave, a large high-voltage charge is rapidly discharged from a bank of condensers at one end of the shock tube, creating a bubble of superheated gas. Expansion of the gas bubble produces a high-velocity and intensely luminous shock wave that flashes down the tube. The wave is boosted to the tremendous speeds and temperature by external magnetic fields which interact with the high-current discharge

▶ **Single spindle,** five-axis profile milling machine recently underwent performance and acceptance tests by USAF. The five axis machine in addition to conventional longitudinal, transverse and depth motion, can be tilted in both longitudinal and transverse directions plus numerous combinations of the two. All five motions are continuously and simultaneously controlled and synchronized by magnetic tape

Is This the Year for Stereo?

Despite strong public interest in stereo sound, many in hi-fi industry remain cautious

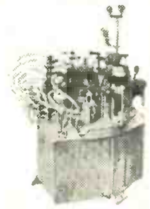
THE past few months have seen most of the major phonograph record companies giving the green light to full production of stereophonic magnetic sound tapes. They have also been marked by the first public demonstrations in a score of years of single-groove stereo disks. Upon hearing stereo for the first time, one observer at the New York hi-fi exhibit in October was heard to remark, "This is what I expected hi-fi to be in the first place!"

▶ **Downbeat**—Despite the all-out support of the giants of the record industry, and in the face of consumer interest, many hi-fi manufacturers are bearish about stereo's future. Only about one-third of the exhibitors at the New York show are pushing stereo at all. Attitudes of the other range from cautious optimism to downright pessisism.

Many of them recall that stereo sound has been on the scene in one form or another for over two decades, but never caught on with

(Continued on page 16)

KĀHLE machines for faster, more precise semiconductor production



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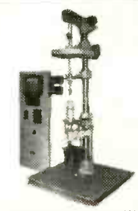

CRYSTAL GROWER
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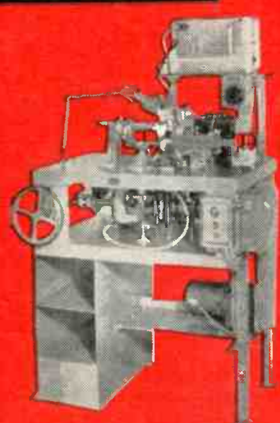

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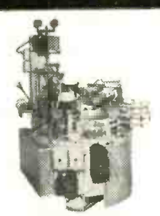

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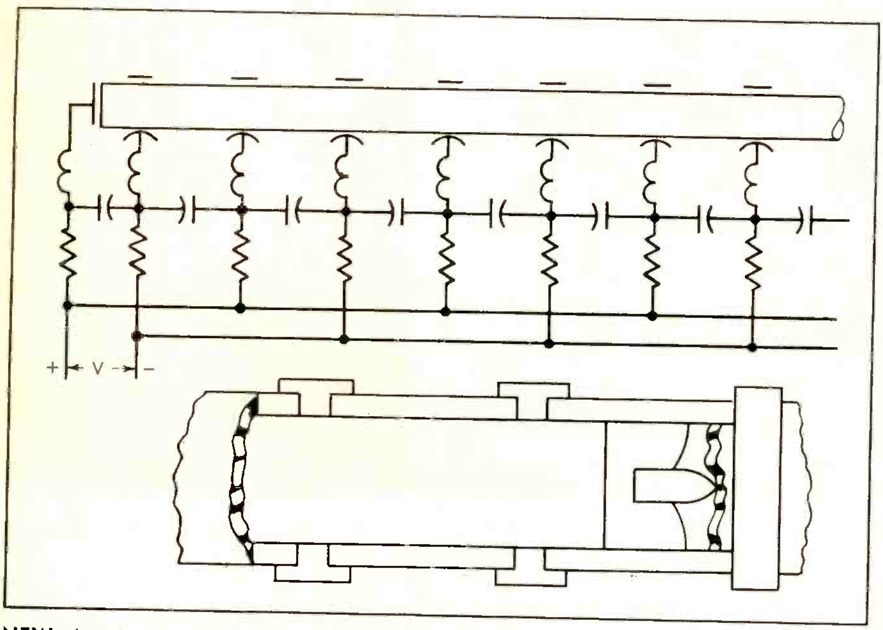
the public. Some cite the rather lukewarm results of the stereophonic promotion in motion pictures.

► **Upbeat**—At the annual convention of the Audio Engineering Society, however, which ran concurrently with the New York show, the tremendous interest in stereo was in evidence throughout the program. In addition to one afternoon and evening being devoted exclusively to the topic, stereo was alluded to in numerous other papers. Some of the subjects included stereo standards and duplication, stereo disks, three-speaker stereo using a phantom circuit, pseudo stereo, stereo reverberation, three-channel stereo recording, stereocasting and stereo reproduction in the home. The minority of stereo proponents at the show claimed capacity crowds for all of their demonstrations, which in turn sparked the writing of orders from distributors and dealers. They point out further that one company which introduced stereo tape several years ago, has been making original masters in stereo ever since and has a huge supply of material in the vaults to meet expected demand. One of the more active independents now has 50 items in its tape line and expects to jump the number to 75 by the end of the year. This firm's ratio of tape sales is reported to run about 90 percent stereo against about 10 percent monaural.

► **Platters**—Feeling in some quarters is that stereo can never reach the mass market with tape alone, and most disk manufacturers are engaged in research aimed at a stereo record. Several such systems developed in Europe have had a careful going over from American firms. Manufacturers have also indicated interest in a recently announced U. S. system. At least one company is known to have imported equipment for experimental use. A major record producer is reported to be developing another system.



NEW electric gun accelerates projectiles to 30,000 feet a second as . . .

Missile Research Gets Hotter

Mass accelerators, shock guns test materials; wind tunnels simulate 15,000 F temperatures

SPEED-PRODUCED heat and materials problems are roadblocks which designers of missiles, rockets and supersonic aircraft must hurdle. Electric guns, shock tubes and super wind tunnels used in aerodynamic research produce a demand for instrumentation effective at extreme temperatures and speeds.

► **Electric Gun**—One electric gun, designed at a GE missile nose testing lab, can accelerate a 20-gram projectile to 30,000 feet per second, twice the limit of explosive propellants.

Actually, the wind tunnel is an electrical-arc mass accelerator. It consists of a long gas-filled barrel with a series of ring electrodes alternatly charged positive and negative. As the projectile passes each electrode, the gas filling the barrel is ionized behind the projectile by an intense electrical discharge.

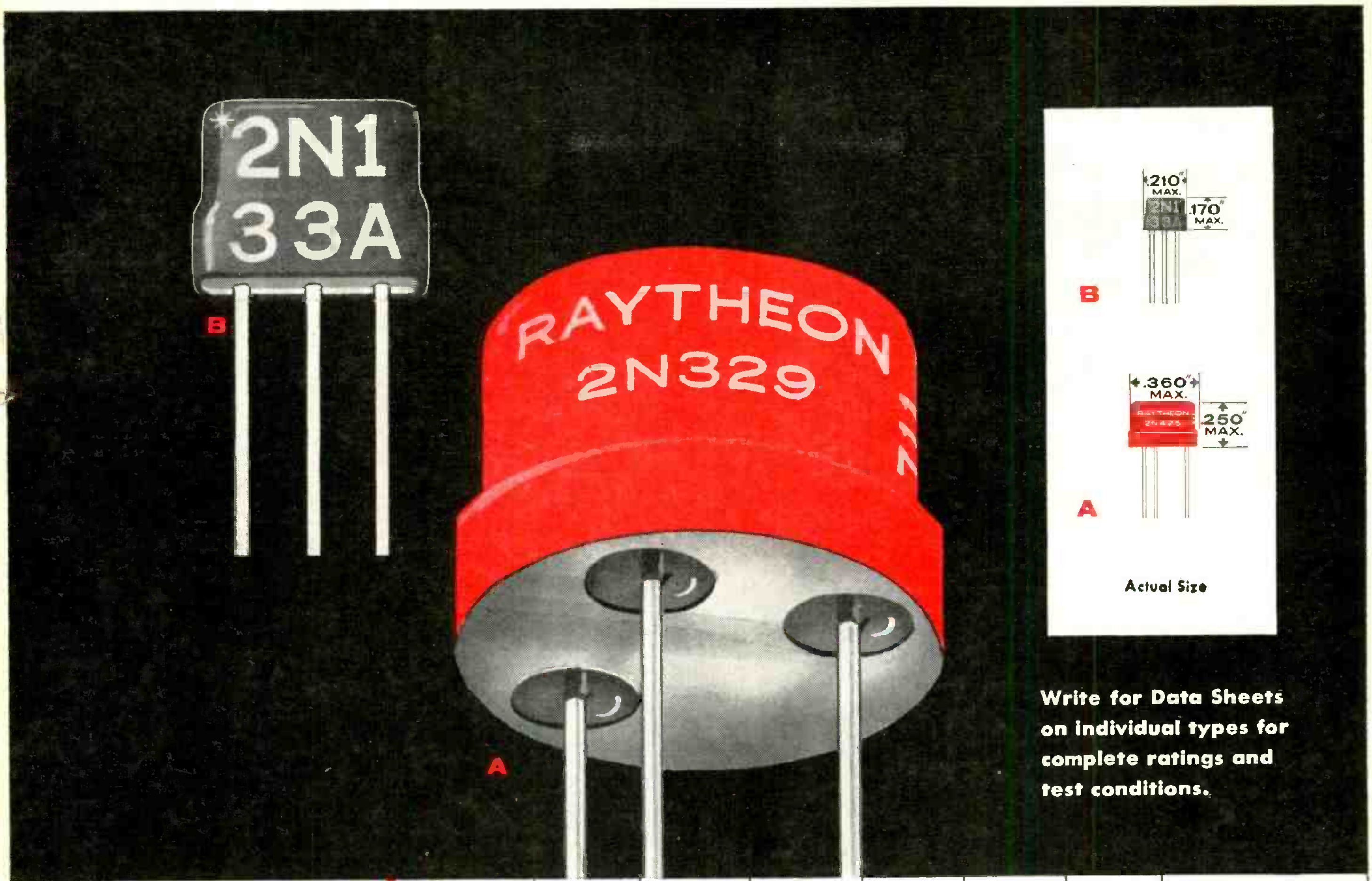
One researcher believes the mass accelerator could be used as a weapon because of its terrific speed. He noted that 30,000 feet per second is sufficient to break through gravity.

► **Shock tubes**—Some shock tubes are longer than 100 feet. They simulate high speed flight by bringing a powerful shock wave to the target. They require instrumentation and recording equipment able to operate in the millionth-second range. One built at Avco Research Lab produces a shock wave of 18,000 mph and a temperature of 15,000 F, sufficient to vaporize metal.

The wave is produced by placing a sturdy diaphragm between the shock tube and an explosion of compression chamber. When the diaphragm is broken, the shock wave is released into the low-pressure side.

► **Wind tunnel**—McDonnell Aircraft recently built a full-scale wind-tunnel facility which simulates conditions at 5,000 mph. It can test 15-foot-long structures at

(Continued on page 20)



GENERAL PURPOSE RADIO FREQUENCY TRANSISTORS

Type	Case	V_{CE} max. volts	$f_{\alpha b}$ ave. Mc	Beta ave.	C_{ob} ave. $\mu\mu f$	r_b'' ave. ohms	Dissipation Coefficient In Air °C/mw	Dissipation Coefficient In Sink °C/mw
2N413	A	–18	2.5	25	12	70	0.4	0.18
2N414	A	–15	6	40	12	80	0.4	0.18
2N416	A	–12	10	60	12	90	0.4	0.18
2N417	A	–10	20	80	12	100	0.4	0.18

IF AND RF RADIO RECEIVER TRANSISTORS

Type	Case	Circuit Usage	V_{CE} max. volts	C_{ob} $\mu\mu f$	Gain db
2N481	A	Osc.	–12	12 ave.	—
2N482	A	IF	–12	12±2	31*
2N483	A	IF	–12	12±2	35*
2N484	A	IF	–10	12±2	39*
2N485	A	Conv.	–12	12 ave.	26‡
2N486	A	Conv.	–10	12 ave.	30‡

Type	Case	Circuit Usage	V_{CE} max. volts	C_{ob} $\mu\mu f$	Gain db
2N413	A	Osc.	–18	12 ave.	—
2N413A	A	IF	–18	12±2	31*
2N414A	A	IF	–15	12±2	35*
2N414	A	Conv.	–15	12 ave.	26‡

*Maximum Available Gain @ 455 kc ‡Conversion Gain @ 1 Mc

AUDIO RADIO RECEIVER TRANSISTORS

Type	Case	Circuit Usage	Supply Voltage max. volts	Power Gain Class A db	Power Gain Class B db	Dissipation Coefficient In Air °C/mw	Dissipation Coefficient In Sink °C/mw
2N359	A	Output	–16	40*	37‡	0.36	0.15
2N360	A	Output	–16	37*	34‡	0.36	0.15
2N361	A	Output	–16	34*	31‡	0.36	0.15
2N362	A	Driver	–16	41♦	—	0.36	—
2N363	A	Driver	–16	37♦	—	0.36	—

*@ 50 mw, 9 volt supply ‡@250 mw, 9 volt supply ♦@ 1 mw, 9 volt supply

All ratings taken at 25°C. All types are hermetically sealed.

Unless otherwise indicated all data taken at V_{cc} = –6 volts, I_e = 1.0 mA

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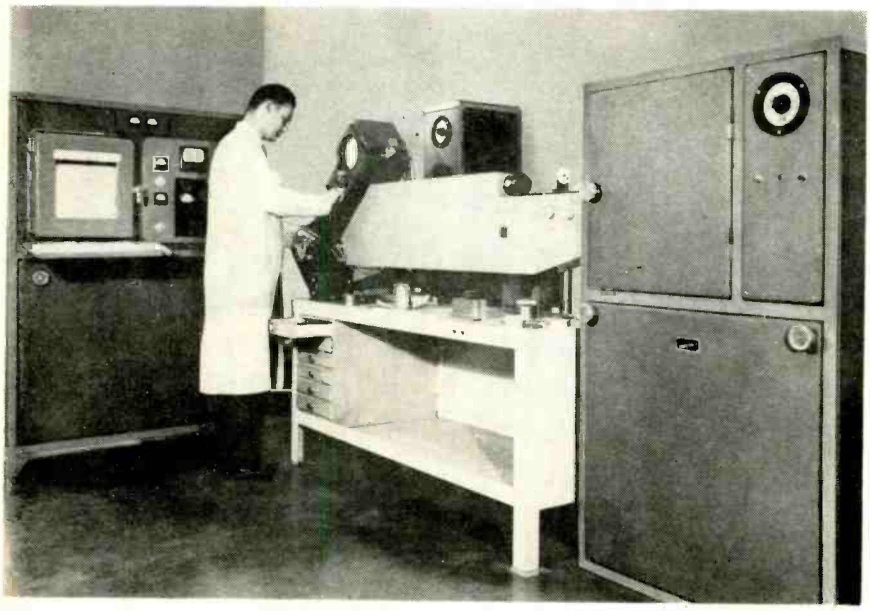
1,000 F and smaller pieces at 1,500 F, approximating 15,000 F and 5,300 mph at 90,000 feet altitude.

ARDC's new "Hot Shot" wind tunnel simulates flights of 11,000 mph at 15,000 F in order to investigate missile skin-cooling methods. Cornell Aeronautical Laboratory is planning an installation to realistically test aircraft and missiles in an airflow of 10,000 mph and 9,000 F, according to reports.

▶ **Flight tests**—Instrument and equipment makers, who provide flight-test engineers with tools, are pushing at high temperature, high-pressure barriers as well. Consolidated Electrodynamics, for example, recently announced a water-cooled pressure picup adapter which allows the transducer to operate at 2,000 F.

Analyzer Identifies Automatically



From left to right, metal anlyzer consists of amplifier and recorder cabinet, direct reading head in front of automatic control cabinet, quartz spectrograph, and electrostatic-screening cabinet

Machine gives direct-reading of spectrum values obtained from electrical measurement

A FRENCH-DESIGNED metal analyzer that permits direct and instantaneous identification of specimens automatically is being introduced this week at the Metal Show in Chicago.

Unlike spectrographic analyzers which use as many multiplier phototubes as there are lines in the spectrum to be recorded, the Spectro-Lecteur uses only two multiplier phototubes, says Intercontinental Electronics Corp.

One multiplier phototube views a characteristic line of the basic metal in the alloy. The other travels automatically along the focal plane of the spectrum, stopping at selected lines for a determined length of time according to a prearranged program.

▶ **Direct Reading**—In photographic-analysis, measurement of the density of the plate gives the value of the ratio of the characteristic spectrum line of the basic metal in the alloy to the spectrum of one of the other element contained in the alloy. However, in the Spectro-Lecteur's direct-reading method, this ratio is obtained through electrical measurement of potentials across the terminals of capacitors loaded by the multiplier phototubes. The ratio is then recorded on the chart continuously.

Analysis of a metal alloy including six elements can be completed within 57 seconds, says Intec.

▶ **Advantages**—The Spectro-Lecteur is reported to have these other advantages:

- It successively records all the elements according to their own period of stability.
- Changeover from analysis of one alloy to another with a different base metal can be done within two minutes.
- Maintenance is easy because there are only two electronic circuits.
- Installation takes two days.

Britain Pushes Airborne Controls

Exhibition features flight data systems, navigational aids and transistor devices

BRITAIN'S shift from aircraft to guided weapons is today spotlighting control components. This means the British electronics industry is now playing a larger role in the manufacture of guided weapons than the aircraft industry.

So says Aubrey Jones, Minister of Supply, in commenting on the exhibits of control components at last month's exhibition of the Society of British Aircraft Constructors.

Typical exhibitors were Ferranti, English Electric, Plessey, Elliott Bros., Dowty Equipment, and H. M. Hobson, to name a few of the 400 firms that have been engaged in guided weapons development.

▶ **DIAN System**—One important navigation feature at the show was the integrated DIAN system introduced by Decca Navigation Co. of London. The system comprises the Decca Navigator System for short-range positioning; Dectra long-

(Continued on page 22)

NEW T/PLOTTER CUTS VIBRATION TEST TIME 50% to 75%

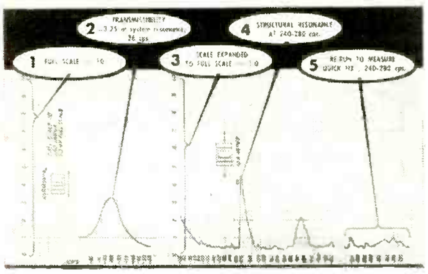
Automatically Plots Detailed Curves of Transmissibility

Immediate evaluation of system transmissibility is made possible by the new Barry-Insco T/Plotter which automatically draws a continuous curve of transmissibility. The T/Plotter eliminates data processing and conversion, and ends laborious point-by-point recording, calculating, and curve plotting. And because the recorded curve is *continuous*, there is no danger of missing significant peaks through arbitary choice of points in the plotted curve.

How it works

Vibration pickups on the shaketable and on the test specimen feed their a-c voltage outputs into identical amplifiers and rectifiers in separate channels of the T/Plotter. The instrument's servo system responds to the difference between the two voltages, which is a measure of transmissibility.

Fast scan over the entire frequency spectrum quickly shows resonance points, and slow scan provides detailed analysis of these resonances, (see curves below).

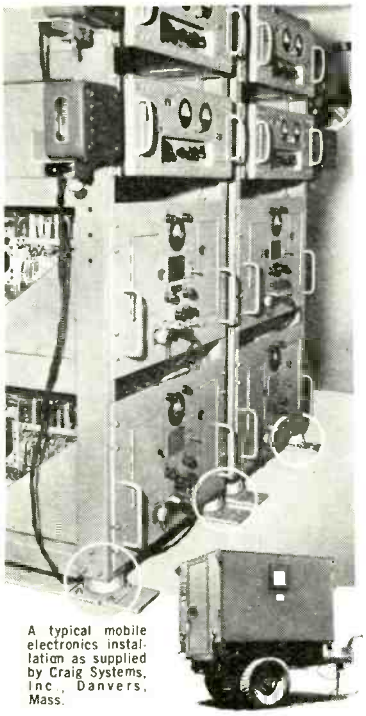


Measurement range

The T/Plotter can be set for full-scale ranges of 0.2, 1.0, 10, and 100. Any standard laboratory vibration pickup can be used. Frequency range is from 5 to 4000 cps. Accuracy is ±2% to 2000 cps, ±2½% above 2000 cps. Chart speed is variable from 6 to 960 inches per hour, in 16 steps.

Released time for laboratory equipment and personnel, resulting from the faster and more accurate measurements possible with the T/Plotter, expands the capacity of present lab facilities — without adding space, shaketables, control or metering apparatus to existing equipment. Write for Bulletin 57-04 that tells how you can cut vibration-test time 50 to 75%.

How to design for RELIABILITY UNDER SHOCK and VIBRATION



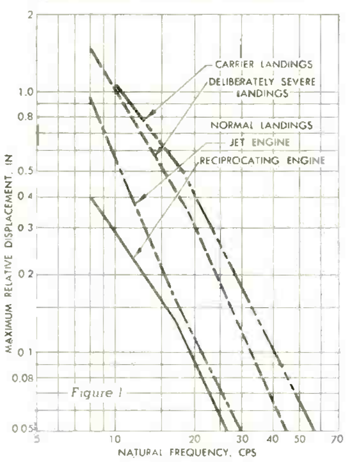
A typical mobile electronics installation as supplied by Craig Systems, Inc., Danvers, Mass.

▶ FOR VEHICULAR SERVICE

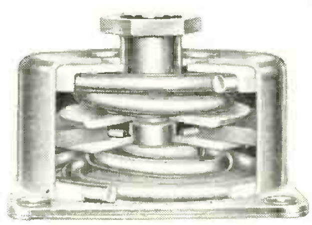
To protect electronic gear against road shock during travel over rough terrain, Barry Cup-mounts supporting equipment racks of mobile air-traffic-control units combine effective protection against high-impact shock with efficient isolation of vibration frequencies above 45 cps. This isolates the structural resonances of the vehicle, with no amplification of vibration from tires and springs. In other applications, these mounts protect against the high transients of gun-fire shock. Details of load ratings, sizes, and characteristics — with useful data on choosing Cup-mounts — are yours in Barry Product Bulletin 56-02, free on request.

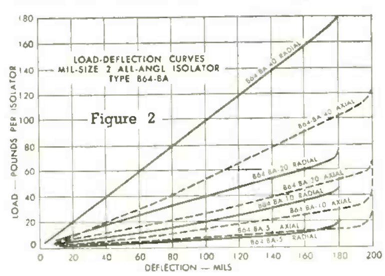
▶ FOR AIRCRAFT SERVICE

LANDING-SHOCK CURVES



To protect sensitive electronic equipment in jet aircraft against landing shocks, while maintaining in-flight vibration isolation, mounts must be able to withstand the severe conditions indicated by the curves of Fig. 1, plotted from actual measured landing shocks. ALL-ANGL Barry Mounts, having natural frequencies above 25 cps, keep shock displacements within reasonable limits. Load-deflection curves, for this family of isolators that give protection under high thrust loads applied in any direction, are shown in Fig. 2. For complete performance data on ALL-ANGL Barry Mounts, write for Data Sheet 57-02.





BARRY CONTROLS INCORPORATED

BARRY MOUNT

SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

707 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

range navigation system and doppler navigation for positioning in areas where on ground facilities exist.

In the composite DIAN scheme, navigational information from all three systems is displayed on the same presentation unit. This reduces size, weight and complexity of doppler components. The Decca doppler system incorporates a wind memory system said to be more accurate than other systems based on storage of ground speed and drift.

Computer unit in the Decca system is completely transistorized with a-c transistor servos driving integrating motors and resolvers.

▶ **CADF System**—An improvement in vhf and uhf direction-finding systems is seen in Standard Telephones and Cables commutated automatic d-f system. In this system site errors are reduced by a factor of ten. Use of a wide baseline in the antenna system results in an improvement of three on a given suppression of horizontally polarized pickup in the Adcock d-f system.

The CADF system consists of 18 omnidirectional antennas operating either between 100-156 mc or 225-400 mc and placed uniformly about the circumference of a 45-ft metal counterpoise with a reference unipole antenna mounted in the center.

Output of each antenna is successively switched by diode switches at 30 times a second to one receiver, while output of the reference antenna is connected to a second receiver. Output of receiving system is mixed and demodulated; a sine wave is obtained with a frequency of the antenna switching cycle whose phase varies with azimuth. By comparing this with the reference signal in a phase comparison circuit, the bearing to an accuracy of 0.5 to 1.5 degrees is presented on a crt.

▶ **Airborne ssb**—An airborne ssb h-f transmitter/receiver is in prototype production by Mullard. Other companies are known to be working on such a system in Britain, but Mullard's 12-channel unit has successfully completed flight trials which showed the 300-watt transmitter output to be equivalent in range to a dsb carrier of 2.5 kw.

The Mullard system uses controlled-carrier ssb modulation compared with usual American use of suppressed carrier.

▶ **Devices**—Here are some of the other featured devices at the British Aircraft Show:

Hydraulic jet control valve by Ferranti Ltd. operating at supply pressure of 1,500 lbs/sq in. control effected by two sets of replacable potted control coils which give a differential output pressure of 80 lbs/sq in./ma plus or minus 1 lb/sq in./ma in one model with a maximum of 700 lbs/sq in. In a second model 140 lbs/sq in./ma is obtained with a maximum of 1,000 lbs/sq in. where only one set of coils is used. In both models the hystersis loop only results in a maximum deviation of 1.5 percent of maximum current.

Also by Ferranti—a 300 GM viscously damped shorted-turn accelerometer covering the range plus or minus 25 g with a sensitivity of 0.23v/g and a linearity of better than 2½ percent. It consists of a symmetrical laminated core. The center limb carries the energizing coil and the two outers the secondary coil. A shorted turn of copper which is the inertia mass is mounted on retaining springs.

(Continued on page 24)

FCC Actions

▶ **Allocates** 1,200 kc of spectrum space between 150.8 and 152.0 mc for use of the nongovernment land mobile service

▶ **Allows** Radio Corp. of Puerto Rico to build a radiotelephone station for communication with the Dominican Republic by tropospheric scatter

▶ **Permits** Western Union Telegraph to establish subscriber rates for class M full-descriptive service on football games of the National Professional Football League

▶ **Amends** tv assignment tablemoving channel 13 to Hibbing, Minn., and substituting channel 9 for channel 13 in Bemidji, Minn.

▶ **Grants** All-American Cables & Radio new license to land and operate two submarine cables connecting New York City with the Panama Canal Zone, with an intermediate landing at U. S. Government Reservation, Guantanamo, Cuba

▶ **Changes** Domestic Public Radio Service Rules to permit operation of microwave auxiliary stations at fixed points in addition to present mobile operation

▶ **Expresses** regret at the death of former FCC Commissioner and Chairman Wayne Coy, "whose contribution to the progress and development of electrical communication in our country is recognized by all"

▶ **Publishes** a 1,485-page report of the Network Broadcasting Study ordered by Congress in 1955. Report includes a recommendation that the Commission forbid any licensee's owning more than three vhf stations in the nation's top 25 markets

NEWS FOR USERS OF HEAVY-DUTY ELECTRICAL AND AUDIO CONNECTORS

Announcing

THE ACQUISITION OF THE Macson Company

BY Elco Pacific

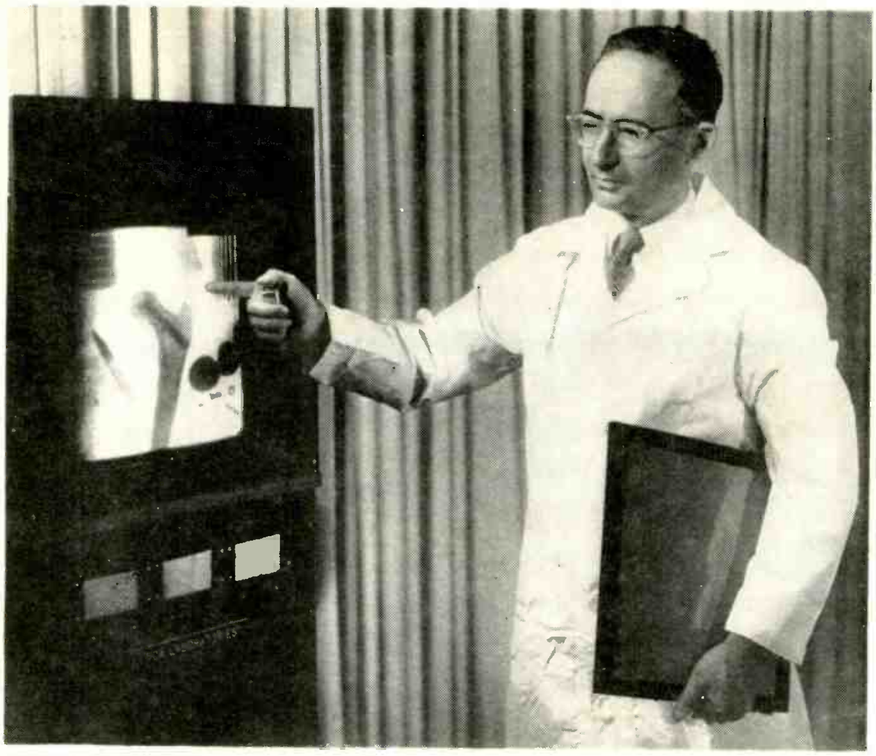
The news is out—and it's good news! Elco Corporation's wholly-owned subsidiary, Elco Pacific, has acquired the Macson Company. Macson has for years manufactured heavy-duty electrical and audio cable connectors which were judged on quality and reliability for commercial and military use; and based on these considerations, Macson has established an enviable reputation. These connectors have found great acceptance in equipment used in such diverse classifications as . . .

- **Audio and Hi Fi Equipment—where heavy-duty connectors are required**
- **Geo-Physical—waterproof heavy-duty power-connectors in oil-well drilling**
- **Computors—in power-supply equipment**
- **Motion Pictures—in heavy electrical light, sound, camera installations**
- **Power Supplies for Military Equipment of various natures**
- **Construction—electrical drill, compressor, etc. power equipment**
- **Trucking—in electrical cabling of trucks to trailers**
- **Electrical Power Supplies for any miscellaneous heavy-duty use**

With the acquisition of Macson, Elco is adding this complete line of power and audio connectors to its own present line; and in addition, Macson's facilities will give Elco the opportunity of serving you on the West Coast with on-the-spot service which your rapidly expanding industrial area requries. Yes, Elco now covers the continent from East to West; and wherever you are, whoever you are . . . Elco stands ready to serve you better!

ELCO PACIFIC, Macson Division, 3260 Motor Avenue, Los Angeles, Calif.

HOME OFFICE & PLANT, "M" Street below Erie Avenue, Philadelphia 24, Pa.



DEMONSTRATION gear reveals in lighted room specimens such as thigh bone with pin because . . .

Panel Amplifier Shows X-ray Image

Experimental thin screen can multiply x-ray brightness by 100 times, hold it for viewing

FOR SEVERAL YEARS medical electronics has been striving to perfect equipment that will give doctors a clearer view of what goes on inside the human body.

Now RCA announces an electronic amplifying panel which presents a bright x-ray image for up to 30 seconds after only a short exposure to the x-ray source. The thin screen reportedly multiplies by 100 times the brightness of certain medical x-ray images.

▶ **Advantages**—Researcher Benjamin Kazan (in picture) describes the amplifier as comparable in size and thickness to conventional fluoroscope screens, and with these other special capabilities:

- Greater visual contrast to allow easy viewing in rooms with moderate lighting.
- Reduction of the subject's x-ray exposure by holding of a bright image.
- Erasing in less than a second to present a new image immediately.
- Expedient filming of the x-ray image from the amplifying panel.

▶ **Application**—A variety of applications may result from the experimental panel. For example, says Kazan, "a thin panel which presents a bright x-ray image after only a short exposure to the x-ray source and holds it up to half a minute, might be used to provide immediate visual information for the surgeon during certain types of operation.

"This might be done in such operations as the pinning of a hip, in which the location of the pin must be carefully determined by observation. At the present time, such checking during the operation is normally accomplished by recording the x-ray image on film, hurriedly developing the film outside, and rushing it back into the operating room."

He adds that x-ray amplification on a thin, large area panel can be easily viewed and manipulated, and is free of complex auxiliary equipment.

▶ **Materials**—Panel consists of a "sandwich" of two materials in adjoining layers between transparent electrodes. One layer—photoconductive powder—conducts current only when exposed to x-rays. The other—an electroluminescent material—emits a bright light when an electric current is passed through it.

Voltage is applied across the sandwich. When an x-ray pattern strikes the photoconductive layer, it acts as an electrical valve—allowing current to pass through to the electroluminescent layer, which emits light corresponding to the x-ray pattern.

Apparatus is entirely experimental now and is being demonstrated for the medical profession. Demonstration gear with 12-in. screen showing the effectiveness of amplifying panel would have to be adapted for actual operating room model. An amplifying screen that permits continuous viewing of motion with low-level x-rays is a long-range objective.

British Tv Reaches 97% Of Population

Radio Show closing marks new industry era: setmakers offer innovations to keep up demand

WHEN BRITAIN'S National Radio Show at Earl's Court, London, closed the doors on its 330,445 visitors at the end of a 10-day exhibition last month, it marked the coming of age of British television.

Coverage by the BBC now reaches 97 percent of Britain's 50-million population. The rival commercial ITV (Independent) service expects 85 percent saturation by 1958 and 90 percent by 1960.

This growth has brought demand

(Continued on page 26)

There's a standard PERKIN model for your every need!

PERKIN...THE LEADER in tubeless magnetic amplifier regulated DC POWER SUPPLIES

IMMEDIATE DELIVERY FROM STOCK

No Moving Parts • No Vibrating Contacts

In addition to the 28 volt models featured at the right, the following units are also available:

OTHER 28 VOLT MODELS

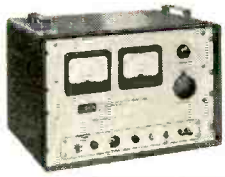
Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
28-5VFM	0-32 V	5	20% (24-32 V range)	115 V 1 phase	2%
28-10WX	24-32 V	10	±½%	100-125 V 1 phase	1%
28-15VFM	0-32 V	15	20% (24-32 V range)	115 V 1 phase	5%
28-50WX	24-32 V	50	±½%	230 V* 3 phase	1%
MR2432-200	24-32 V	200	±½%	230 V* 3 phase	1%
MR2432-300	24-32 V	300	±½%	230 V* 3 phase	1%
MR2432-500	24-32 V	500	±½%	230 V* 3 phase	1%

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

6, 12, 115 VOLT (NOMINAL) MODELS

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

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


Model MR532-15A

2-36 VOLTS @ 15 AMPS SPECIFICATIONS

Regulation: 5-32 Volt Range: ±½%
2-5 Volt and 32-36 Volt Range: ±2%

AC Input: 105-125 Volts, (for 2-32 V.DC), 110-125 V, (for 32-36 V.DC), 1 phase, 60 cps (8 amps)

Ripple: 1% rms max. (@ 36 volts and full load. Increases to 2% @ 2 volts and full load).

Remote Sensing • Vernier Control


Model M60V

0-32 VOLTS @ 25 AMPS SPECIFICATIONS

Regulation: ±1% @ 28 Volts (Regulation increases to 2% over range of 24-32 volts; does not exceed 2 volts over 4-24 volt range. Not stabilized for AC line changes.)

AC Input: 115 Volts, 1 phase, 60 cps (12 amps).

Ripple: 1% rms (@ 32 volts and full load—2% rms max. @ any voltage above 4 volts).

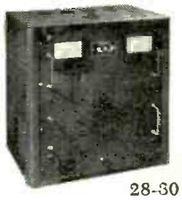

Model MR1040-30A

5-40 VOLTS @ 30 AMPS SPECIFICATIONS

Regulation: ±1% (over entire 5-40 volt range)

AC Input: 100-130 Volts, 1 phase, 60 cps

Ripple: 1% rms

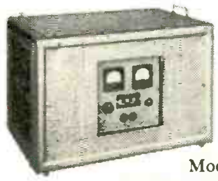

Model 28-30 WXM

24-32 VOLTS @ 30 AMPS SPECIFICATIONS

Regulation: ±½%

AC Input: 100-125 Volts, 1 phase, 60 cps (20 amps). (Unit rated for DC output of 28 volts ±10% for 95-130 volt input.)

Ripple: 1% rms


Model MR2432-100XA

24-32 VOLTS @ 100 AMPS SPECIFICATIONS

Regulation: ±½%

AC Input: 208, 230 or 460 Volts, ±10%, 3 phase, 60 cps (14, 12 and 6 amps respectively). 230 volt input will be supplied unless otherwise specified.

Ripple: 1% rms

NEW YORK AREA OFFICE:
Sales and Warehousing:
1060 Broad Street
Newark 2, New Jersey
MArket 3-1454

NEW ENGLAND AREA OFFICE:
46 Amesbury
Lawrence, Massachusetts
MUrdock 3-3252

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Representatives in Principal Cities

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for tv sets to about 1.5 million a year.

▶ **Tubes**—Changes most evident at this year's show were in tube size and cabinet shape. Now the 17-in. tube is the most popular. But manufacturers are considering introducing 21-in. tubes with 90 or even 110-degree scanning.

Although there is industry speculation about the Gabor flat tube, it is generally felt that the industry's investments in plant for existing types will make it hard for such a revolutionary design to compete economically for many years.

▶ **Costs**—Keenness in cutting costs to the minimum is shown in the trend towards eliminating the tv fine tuner, incorporating afc circuits instead. In another line of attack, the radio industry is launching a "second tv set" campaign to sell 14-in. portables, and is providing f-m gear in many tv sets for about $15 more.

F-m broadcasting has been a slow starter in Britain. BBC has 12 stations operating and 5 more under construction, which are designed to give 96 percent vhf f-m coverage, but the estimated audience is only 5 percent.

Manufacturers are pushing vhf, hoping to open up a new market. They have even put it in automobile radios. But at a price of $150, compared with $60-$90 for regular auto sets, the going will be hard.

▶ **Transistors**—Britain is in the first stage of using transistors in home receivers, with only one U. K. company at present making power transistors. U. K. production of all transistors is estimated at about 1 million a year, compared with 80 million electron tubes. At the radio show, only about six transistorized products were displayed, all of these being portable radios or phonographamplifiers.

Printed circuits are gaining wide commercial acceptance, with at least 30 sets at the show incorporating them.

Meetings Ahead

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

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

Nov. 6-8: Tenth Annual Conference on Electronic Techniques in Medicine and Biology, ISA, AIEE, Sheraton-Plaza Hotel, Boston, Mass.

Nov. 11-13: Third Instrument Conference and Exhibit, PGI, Atlanta, Biltmore Hotel, Atlanta, Ga.

Nov. 11-13: Third Instrument Conference, IRE, PGI, Biltmore Hotel, Atlanta, Ga.

Nov. 11-13: 1957 Radio Fall Meeting, EIA (formerly RETMA) King Edward Hotel, Toronto, Canada.

Nov. 13-14: Mid-America Electronic Convention, IRE Municipal Auditorium, Kansas City, Mo.

Nov. 13-15: Assoc. of Tech Writers and Editors and Society of Tech Writers, Joint National Convention, Hotel Statler, N. Y. C.

Nov. 13-15: Industrial Audio-Visual Exhibition, N. Y. Trade Center, N. Y. C.

Nov. 15-16: Northeast Electronics Research and Engineering Meeting, NEREM, Mechanics Bldg., Boston, Mass.

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

Dec. 4-5: Professional Group on Vehicular Communications, Annual Meeting, Statler Hotel, Washington, D. C.

Dec. 9-13: Eastern Joint Computer Conference, IRE, ACM, AIEE, Park Sheraton Hotel, Washington, D. C.

Dec. 18-19: Electronic Industries Conference (formerly RETMA) on Maintainability of Electronic Equipment, Univ. of Southern California, Los Angeles.

Jan. 6-8: Fourth National Symposium on Reliability and Quality Control, Hotel Statler, Washington, D. C.

Solid Supplies Power For Missile Guidance

Doughnut of black, plastic-like solid propellant will be used to drive gyroscopic devices to be produced by Sperry Gyroscope. The gyroscope it drives, on table, can be accelerated up to speeds of 50,000 rpm in 0.2 seconds

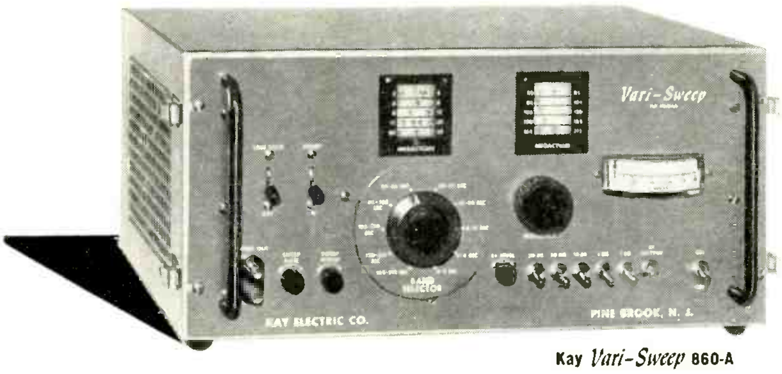
Industry Shorts

▶ **Bus control**—London transport officials expect to test BESI this month. BESI is the Bus Electronic Scanning Installation that officials believe may "revolutionize the control of buses in congested cities." On one of London's busiest routes cameras will be located at scanning points. Each bus will have a panel of reflectors which will transmit a signal in code as it passes each scanner. This will give the bus number. Inspectors will tell where and when buses are bunching by tracking the progress of buses from one scanning point to another.

▶ **Moon tv**—Moscow Radio said a few months back that under favorable conditions a rocket could carry instruments to the moon within 5-10 years.

SWEEPING OSCILLATORS for RADAR and TELEMETERING IF's 1-1,200 mc by

KAY ELECTRIC



Kay *Vari-Sweep* 860-A

The Kay sweeping oscillators are a line of high level lab and field test instruments designed for the alignment of radar and telemetering IF strips from 1 to 1,200 mc. The line offers a wide choice of precision-built units which are simple to operate, highly stable, and extremely flexible.

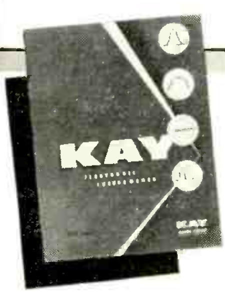
- **Wide Range, Wide Sweep**
- **High Output**
- **Fundamental Frequency**
- **Constant Output (Fast-Acting AGC)**
- **Continuously Variable Centers**
- **Fixed, Crystal-Controlled Markers**
- **All Electronic Operation**

Instrument	Cat. No.	Range	Sweep Width	RF Output	Markers	Price†
Vari-Sweep	860-A	2-220 mc (center)	Contin. Variable to 60% center freq. below 50 mc; 30 mc plus, above 50 mc.	1.0 V rms AGC'd, 70 ohms	None	$695.
Vari-Sweep Model IF	866*	4-120 mc (center)		1.0 V rms AGC'd, 70 ohms	11 Fixed Crystals 1 Variable. Direct reading dial	$950.
Vari-Sweep Model Radar	865*	10-145 mc (center)		1.0 V rms AGC'd, 70 ohms	11 Fixed Crystals 1 Variable. Direct reading dial	$950.
Mega-Sweep	110-A**	50 kc-950 mc	50 kc-40 mc	100 mv at 50 ohms	None	$495.
Rada-Sweep	380-A*	2 Switched bands 20-40 mc; 50-70 mc	2 Switched bands, Wide 20 mc, Nar. 3 mc	250 mv rms, 70 ohms	9 Fixed Crystals	$395. (with 4 crystals)
Rada-Sweep Sr.	385*	1-260 (center)	70% of center to 100 mc; 60-70 mc from 100-250 mc	0.5 V rms AGC'd, 70 ohms	Up to 24 Fixed Crystals	$545. (plus crystals)

**Other Mega-Sweeps to 1200 mc; and with Markers.

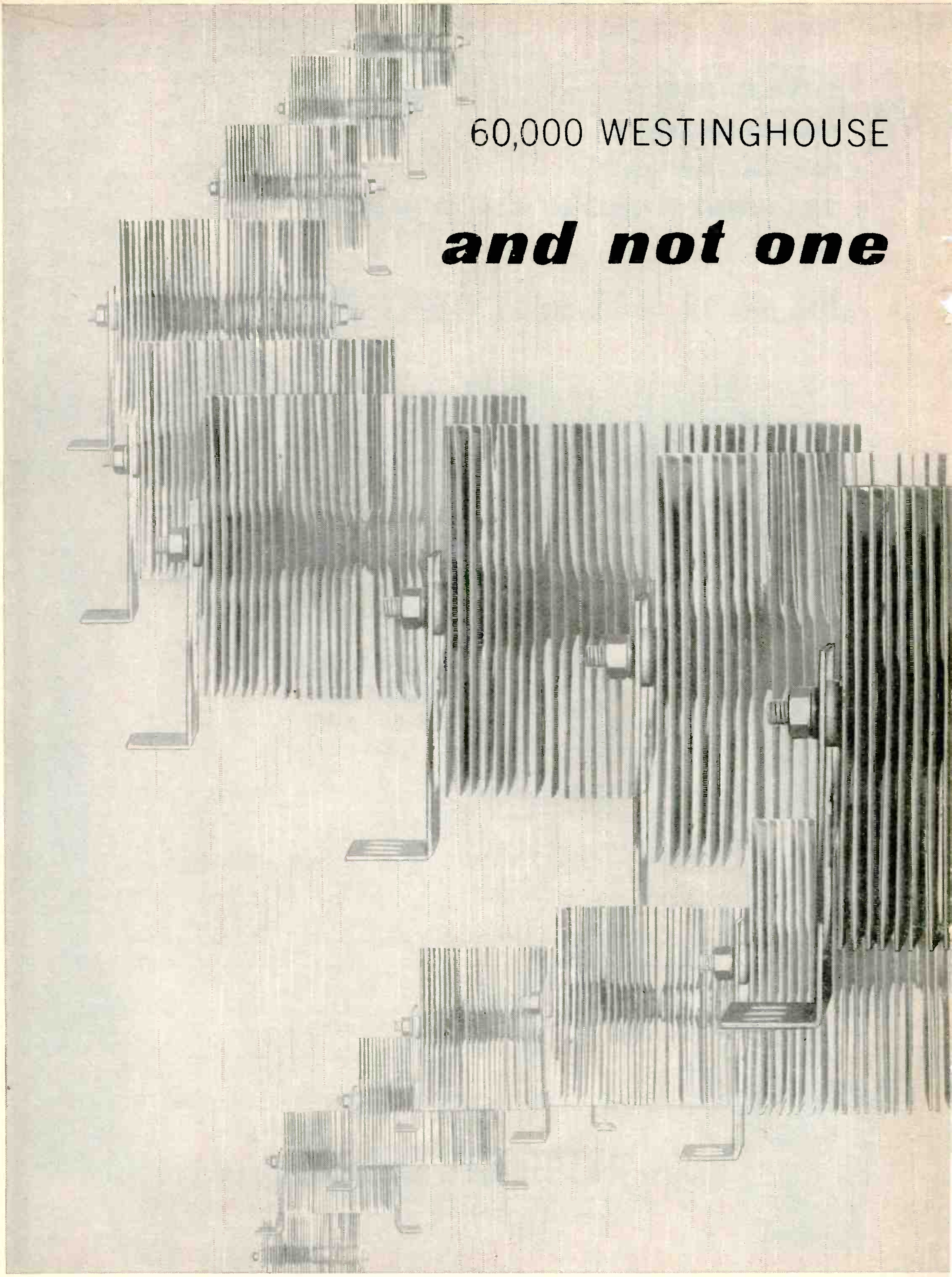
*Wider sweep widths, additional crystal markers available on special order.

† All prices F.O.B. Pine Brook, N. J.



For Literature and Detailed Specifications, Write:

KAY ELECTRIC COMPANY
14 Maple Avenue, Pine Brook, N. J.
Dept. E-11 CAldwell 6-4000


60,000 WESTINGHOUSE
and not one

RECTIFIERS INSTALLED FOR ONE CUSTOMER

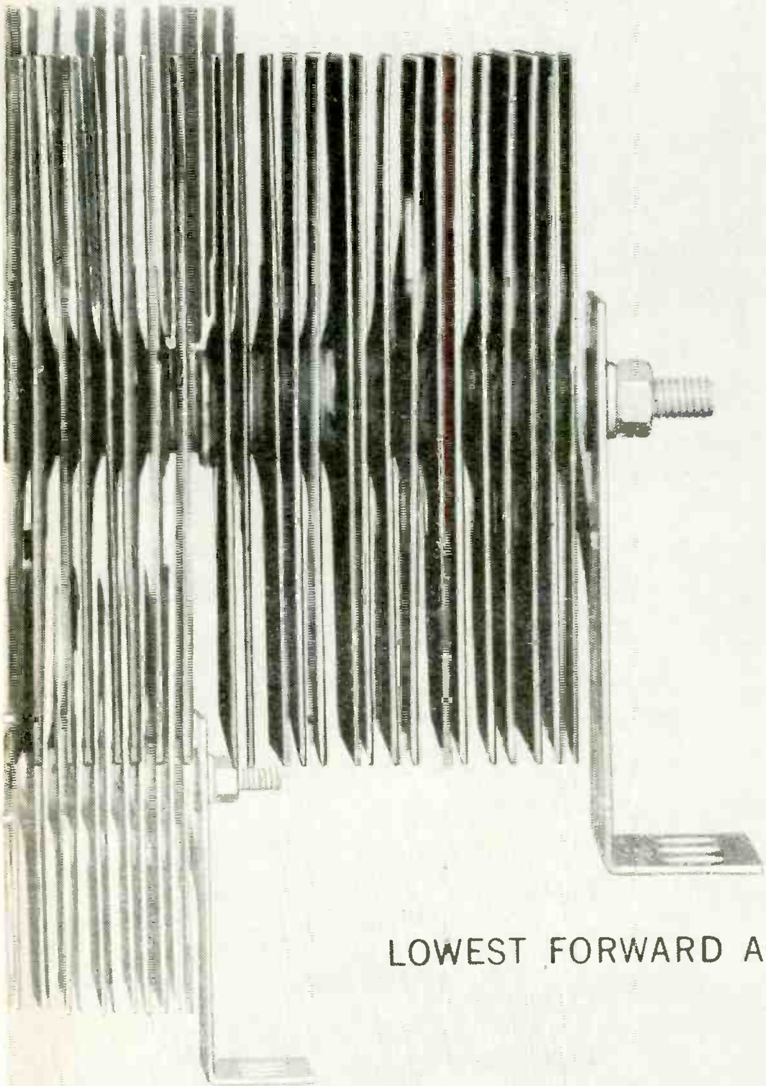
case of field failure

The selenium rectifier stacks furnished for one Westinghouse customer have proved so successful in world-wide installations that they have standardized on Westinghouse units. In over three years, not one Westinghouse unit has been a field failure—or caused a failure of operation.

Extensive life tests prove that in 20,000 continuous hours of service, the change in forward voltage drop of Westinghouse rectifier cells is less than 5 percent. Reverse leakage actually decreases with use. This superior performance . . . with up to 90 percent conversion efficiency . . . is assured by the vacuum evaporation deposit process and carefully controlled manufacturing conditions in making Westinghouse selenium cells.

For complete design and application information, call your Westinghouse sales engineer. Or write Westinghouse Electric Corporation, P. O. Box 868, 3 Gateway Center, Pittsburgh 30, Pa.

J-22070



LOWEST FORWARD AGING RATE IN THE INDUSTRY

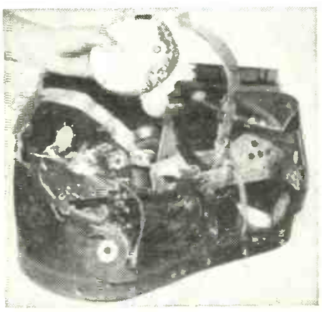
YOU CAN BE SURE...IF IT'S

Westinghouse

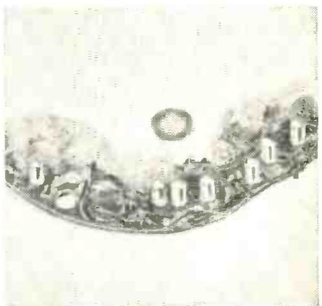
a "Voice"... at 18,000 MPH... From Its Orbit In Space!

Philco SBT's Still Operate After 126-Mile Plunge To Earth In Early Satellite Flight Test!

Circuit cards carrying Philco SBT's were recently sent aloft in a flight test at White Sands. The rocket attained an altitude of 126 miles . . . fell back to Earth (landing on a granite boulder). Although the housing was badly smashed . . . all Philco SBT's (except one . . . which was lost at point of sphere puncture) continued to operate with original performance characteristics!



Smashed metal housing in which Philco Surface Barrier Transistors fell 126 miles during early Satellite vehicle flight test.

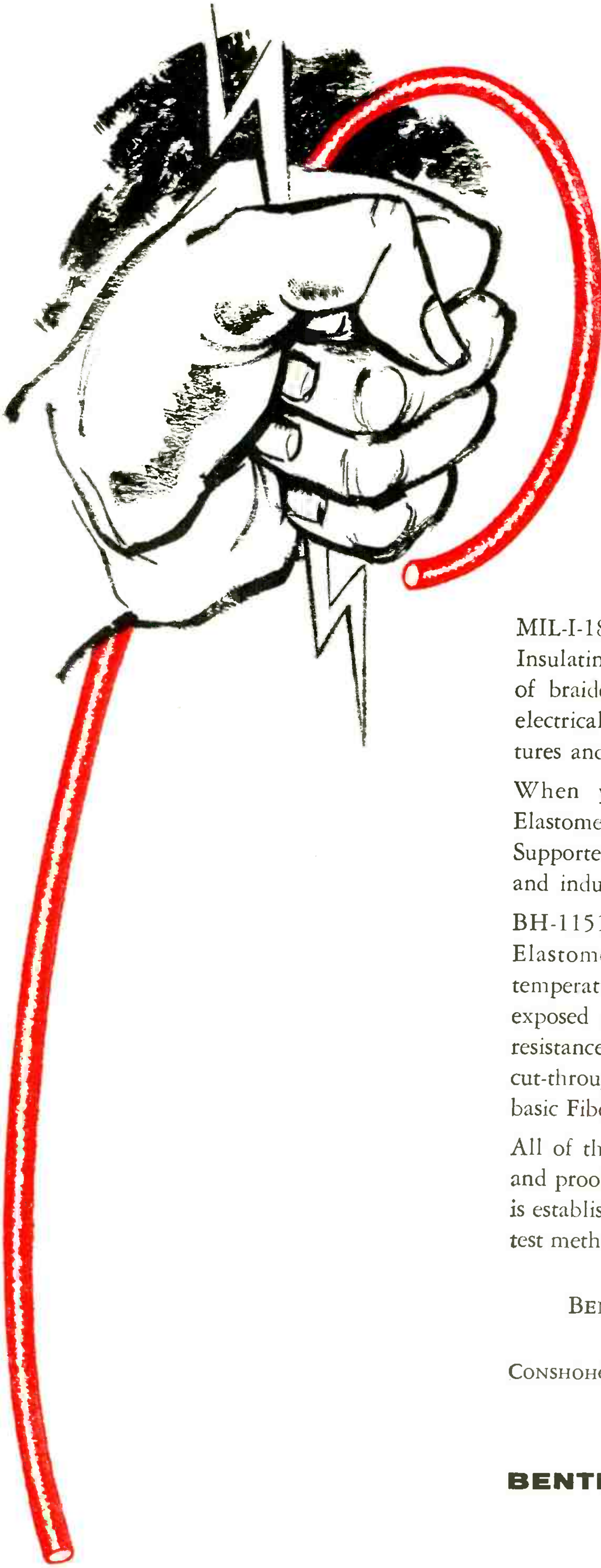


Close-up of actual circuit card, with plastic covering cut-away to show Philco SBT's . . . still intact and operable!

Write, wire or telephone for complete information on all Philco transistors.

PHILCO® LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA



For all the stringent requirements of MIL-I-18057A

BH "1151"

MIL-I-18057A is a functional type test — for Class H Insulating Sleeving. It sets the standard for performance of braided Fiberglas Silicone Elastomeric sleeving in electrical insulating systems subjected to high temperatures and mechanical stress.

When you specify BH-1151 Fiberglas Silicone Elastomeric Sleeving, it meets these high standards. Supported by long record of service in both military and industrial applications.

BH-1151 combines the superior qualities of Silicone Elastomer — extreme low temperature and high temperature flexibility, resistance to degradation when exposed to high temperature, chemical inertness, and resistance to crazing — with the support, resistance to cut-through and dimensional stability offered by the basic Fiberglas braid.

All of these properties are required by MIL-I-18057A and proof of BH-1151's ability to meet these standards is established by data obtained in each of the prescribed test methods. These data sheets are available on request.

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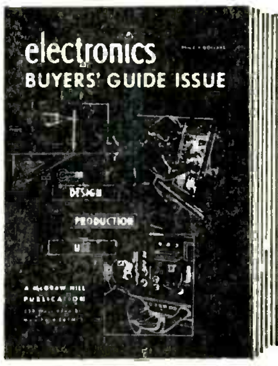

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COMPLETENESS: 1070 pages of products, manufacturers, trade names, manufacturers' representatives, and professional services.

ACCURACY: The entire electronic industry is questionnaired from scratch each year. For the 1957 GUIDE, there were 181 changes, 586 deletions (of the deletions, many were due to mergers and name changes), and 872 additions. Total number of manufacturers increased to 4013 from 3727 in 1956. 87 new products were added in 1957 for a total of 1773.

USE: Whether you are concerned with the design, production, or use of electronic circuitry, turn to the listings of the **electronics** BUYERS' GUIDE. Here you will find the page numbers that refer you to catalog-type advertising, specially prepared to supplement the listings and give you the technical information you must have to specify and purchase electronic and allied products.

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Mobile electronic systems can function under the most difficult environmental conditions (MIL-E-5272*), by using highly specialized mobile air conditioning equipment.

Custom air conditioning is our business at Ellis and Watts. For example, we recently designed and built MIL-AC air conditioning equipment for trailer-mounted F-11-F operational flight trainer simulators. They develop 10 tons of cooling capacity at 130° F., using no water. These units are only 24″ wide and can be mounted anywhere to suit specific space requirements. This equipment is designed for an unusual 3-zone air distribution system to maintain constant temperature and humidity in computer, instructor and trainee sections—each with a different varying load condition.

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

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

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

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Announcing

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—a new type of broadband,

high power.........

QK520
AMPLITRON
TYPICAL OPERATION (PULSED)

ANODE VOLTAGE	40 kV
ANODE CURRENT	35 amps
PEAK POWER OUTPUT	800 kw
AVERAGE POWER OUTPUT	1200 watts
EFFICIENCY	55%
OPERATING BAND (± 1 db)	1225–1350 Mc
PEAK POWER INPUT	80 kw
PHASE STABILITY WITH ANODE CURRENT	1°/amp

The Amplitron is a new type of tube developed by Raytheon, capable of power amplification at microwave frequencies. Amplification is obtained over a broad range of frequencies with no mechanical or electrical adjustments required. This device is a derivative of the magnetron and retains many of its advantages—such as high operating efficiency, construction simplicity, small size, light weight, low operating voltage. Where efficiency counts in high-power systems, the broadband Amplitron has applications of major significance.

The Amplitron uses crossed electric and magnetic fields, a reentrant beam produced by a magnetron-type cathode, and a non-reentrant broadband circuit matched at either end to external circuits.

ADMIRAL'S PALO ALTO LABORATORY DEVELOPS EQUIPMENT FOR CAMERA STABILIZATION

The art of aerial photo-reconnaissance requires absolute camera stability to obtain the fine detail needed to discern small objects from great altitudes. Even with an automatic pilot in control, the plane itself is far too unstable for reconnaissance work, and additional stabilization is required.

Now Admiral has developed equipment that automatically compensates for the slightest deviations. Electronic signals from gyros are appropriately modified and distributed as needed to stabilize each of the various camera mounts. The accuracy of the gyro signals is fully reflected in the mechanical adjustments of each camera platform. Moreover, Admiral has applied subminiaturization techniques to reduce size and weight to half of the original requirement specifications.

This system was developed in Admiral's Palo Alto Laboratory by the Advanced Development Section, Government Laboratories Division. Complete information concerning the Laboratory's capabilities and current activities is available to qualified persons.

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Circle 4 Readers Service Card

Fast, convenient, dependable

precision wave analyzers frequency-selective voltmeters

Sierra 121A Wave Analyzer

Sierra now offers exactly the instruments you need for wave analysis, wire carrier and microwave subcarrier applications.

Sierra 121A Wave Analyzer is a highly selective, double superheterodyne receiver covering frequencies from 15 KC to 500 KC and providing wave analysis data directly in voltage and dbm at 600 ohms. The instrument offers the selectivity required for use with new single sideband carrier systems.

Sierra 158A Wave Analyzer is similar but covers frequencies from 500 KC to 10 MC.

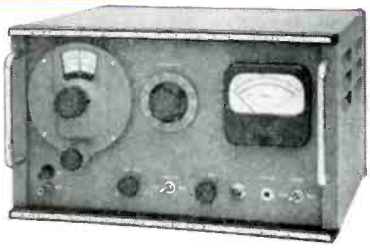
Both analyzers have high selectivity, accuracy of ± 2 db, spurious response at least 50 db down, and a signal-measurement range of 77.5 μv to 97.5 volts. The instruments are supplied in cabinet mountings which are readily adaptable to relay rack mounting.

SPECIFICATIONS — SIERRA VOLTMETERS

Model	Frequency Range—kc	Selectivity		Accuracy		Direct Reading in dbm	
		Down 3db	Down 45db	Frequency	Measuring	Balanced	Unbalanced
101C	20-500	± 550 cps	± 2900 cps	Note A	± 3 db	Note D	600 ohms
103B†	3- 40	± 400 cps	± 3000 cps	± 0.5 kc	± 3 db	Note D	600 ohms
104A	5-150	± 300 cps	± 1500 cps	± 1 kc	± 3 db	Note D	600 ohms
108B	15-500	± 550 cps	± 2900 cps	± 3 kc Note B	± 2 db Note C	135 ohms Note D	600 ohms
114A	100-800	± 550 cps	± 2900 cps	Note A	± 3 db	Note D	600 ohms

All Sierra Carrier Frequency Voltmeters feature built-in calibration oscillators and circuits for level calibration, have aural monitoring jacks, and (except 103B) are furnished with Sierra Model 149A Precision Spiral Scale Dials.

† Contains carrier re-insertion oscillator for monitoring suppressed carrier systems. Furnished with planetary drive dial. Note A. Ranges from ± 2 KC at low end of dial to ± 3 KC at upper end. Note B. ± 1 KC in the 48 KC to 256 KC region. Note C. ± 1 db for + 30 db to —40 db attenuator steps on 135 ohm balanced measurements. Note D. All models may be converted for 135 and 600 ohm balanced line measurements by convenient plug-in bridging transformer, Model 130D.

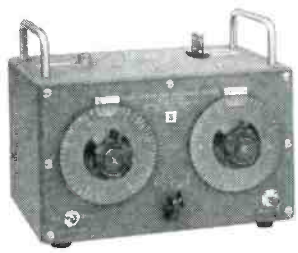


Sierra 101C Carrier Frequency Voltmeter

For carrier system and other field or laboratory work between 3 kc and 800 kc, Sierra offers 5 accurate, stable, tuned vacuum tube voltmeters. All are direct reading in voltage and dbm at 600 ohms from —80 dbm to +42 dbm.

Line Bridging Transformer

Model 130D Dual Impedance Line Bridging Transformer converts VTVM and wave analyzer inputs from single-ended to balanced operation. Covers 3 kc to 500 kc, bridges both 135 and 600 ohm balanced lines.



Impedance Meter, Line Fault Analyzer

Sierra 166 Impedance Meter (at left) measures impedance on high noise circuits, 30 kc to 300 kc; measures on "hot" lines through coupling capacitor. *Sierra 124 Line Fault Analyzer* pin-points shorts, opens or grounds on open wire lines. Direct reading, range ½ to 200 miles, accuracy ¼ mile.

Data subject to change without notice.

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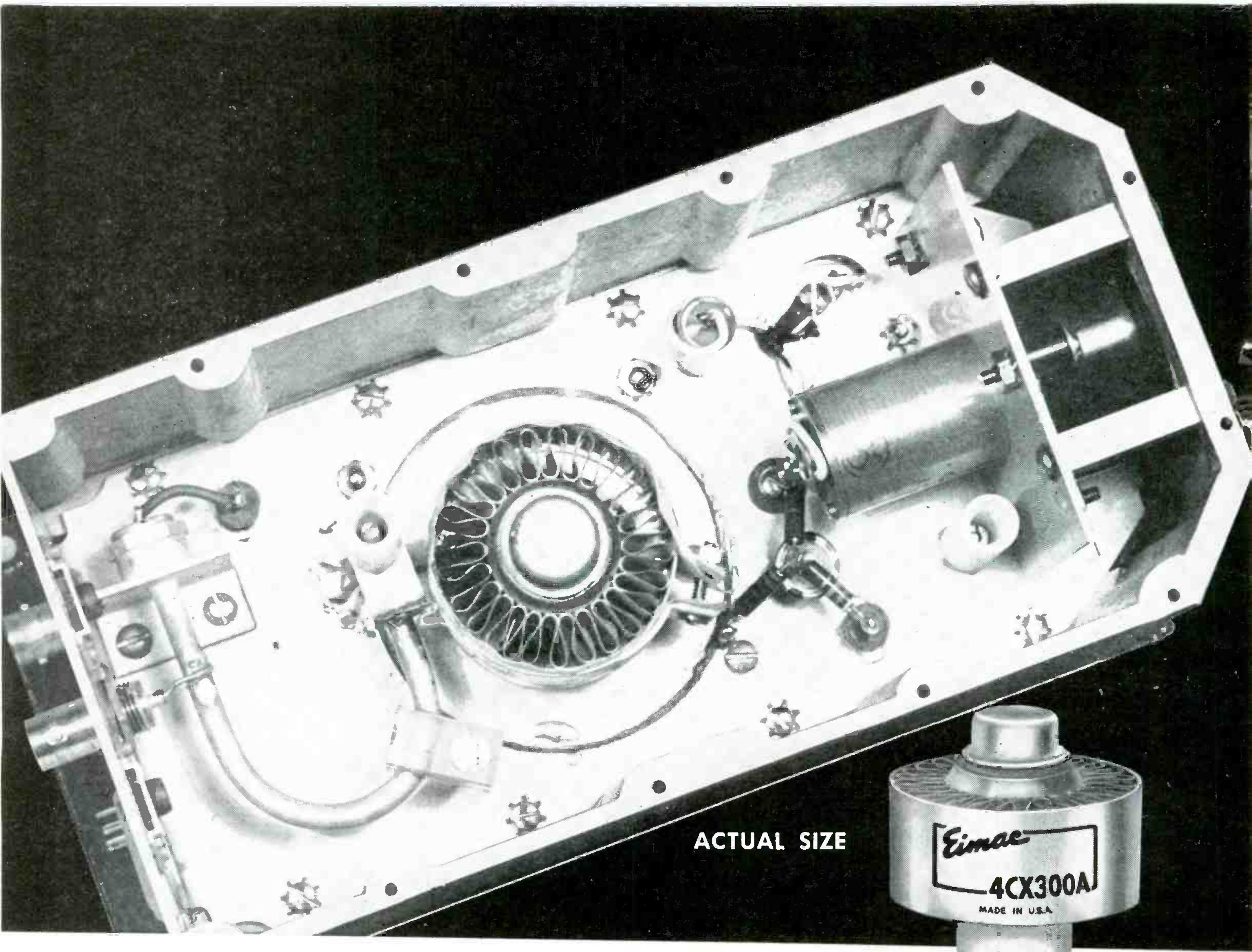

Compact, rugged RADIATION, INC. airborne telemetering RF amplifier features EIMAC ceramic 4CX300A tetrode

Less than 1% amplitude modulation caused by mechanical excitation is noted at 100G, 6 milliseconds shocks or at 20G's vibration from 20-2000 cps in the new rugged Radiation, Inc., 50w telemetering RF amplifier. It is tunable through the 215-245 mc range to 70,000 feet altitude with the same outstanding dependability as at sea level. The amplifier is a space-miser, too, as illustrated in its actual size photo above.

To meet these environmental, electrical and physical specifications, exacting Radiation, Inc., engineers selected the Eimac 4CX300A ceramic power tetrode for the final amplifier. This 300 watt tube conservatively generates the RF output of the Model A-3052-1 amplifier with only 2 watts driving power.

The 4CX300A offers the advantages of dependability and performance inherent in the extensive Eimac ceramic transmitting and receiving tube family.

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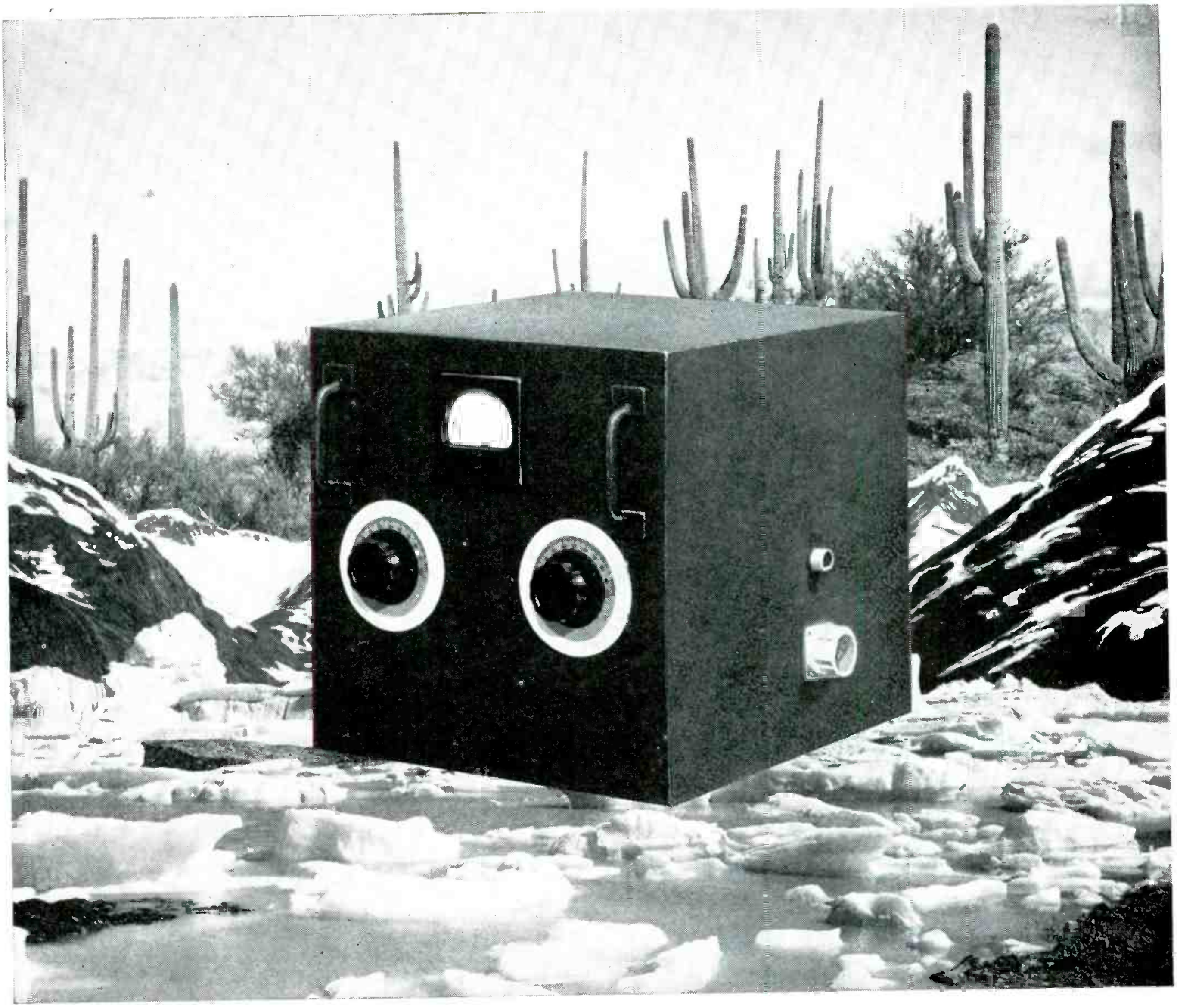
SAN BRUNO · CALIFORNIA
Eimac First with ceramic tubes that can take it

Eimac ®

4CX300A RF power amplifier or oscillator
Class-C Telegraphy or FM Telephony

MAXIMUM RATINGS

D-C Plate Voltage	2,500 max. volts	D-C Plate Current	250 max. ma
D-C Screen Voltage	300 max. volts	Plate Dissipation	300 max. watts
D-C Grid Voltage	−250 max. volts	Screen Dissipation	12 max. watts
		Grid Dissipation	2 max. watts



PROBLEMS: How to keep black-boxed equipment operating in sub-zero temperatures—and how to dissipate the box's heat when air cooling is impossible. Answer: Monsanto's OS-45, the most efficient coolant/dielectric from −65°F to 400°F.

Coolant/Dielectric for air-borne electronic equipment . . . usable from −65°F to 400°F: Monsanto's OS-45

If you are miniaturizing electronic equipment and need a coolant that

- is pumpable from −65°F to 400°F
- is an excellent heat-transfer medium
- has surprisingly good dielectric properties . . .

you'll find OS-45 tailored to your needs.

Monsanto's OS-45 is a coolant/dielectric that meets the most severe problems presented in "black boxing" electronic equipment for today's supersonic planes and tomorrow's missiles. It has an excellent service life and remains pumpable over the extreme temperature range of −65°F to 400°F.

A silicate ester, Monsanto's OS-45 is safe to use and is compatible with most materials used in electronic construction.

TO HELP YOU consider the possible uses of this new coolant/dielectric in miniaturization, we will be glad to send you Technical Bulletin O-123. Write, wire or mail coupon today.

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Please send me Technical Bulletin O-123 which describes OS-45 completely.

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Mumetal shields will give instant relief to interference caused by extraneous magnetic fields. This material can cure many troubles—solve many a problem for you.

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

A fund of technical data on shields and other applications for Allegheny Ludlum Mumetal is available—let us help with your problems.

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

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- Write for complete 62 page catalog today.

Typical Bushing Mounted Controls


Miniaturized 3/4" diameter composition


15/16" diameter composition


15/16" diameter composition with SPST switch


1-1/8" diameter concentric tandem tone switch and composition variable resistor with SPST on-off switch


1-1/8" diameter composition with SPST switch


1-17/64" diameter 2 watt wirewound

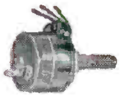

1-17/32" diameter 4 watt wirewound

Typical Ear-Mounted Controls


Molded shaft twist ear mounted 15/16" diameter composition


Hollow shaft twist ear mounted 15/16" diameter composition for screwdriver adjustment


Twist ear mounted 15/16" diameter composition with flatted shaft for push-on knobs

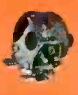

Twist ear mounted 15/16" diameter composition with SPST switch

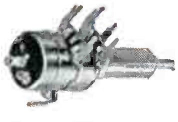

Twist ear mounted 15/16" diameter pre-set tandem


Miniaturized clinch ear mounted composition

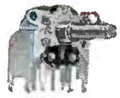

Miniaturized clinch ear mounted composition with SPST switch

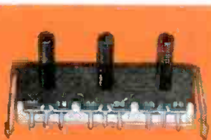
Typical Printed Circuit Controls


Solder or clinch ear mounted 15/16" diameter composition with flush shaft


Bushing mounted 15/16" diameter concentric tandem composition with SPST switch


Self-supporting snap-in mounted 15/16" diameter composition


Self-supporting snap-in bracket mounted 15/16" diameter composition with SPST switch


Self-supporting snap-in mounted compact 3-section multiple composition

Terminals For Wire Wrapping


Bushing mounted 15/16" diameter composition with SPST switch.

Typical Military Controls


Miniaturized 3/4" diameter 1/2 watt composition


15/16" diameter 1 watt composition


15/16" diameter composition with water-seal between shaft and bushing and bushing and panel


1-1/8" diameter composition


1-1/8" diameter 2 watt composition


1-17/64" diameter 2 watt wirewound with locking type bushing


1-17/32" diameter 4 watt wirewound

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Variable resistors shown 1/3 actual size

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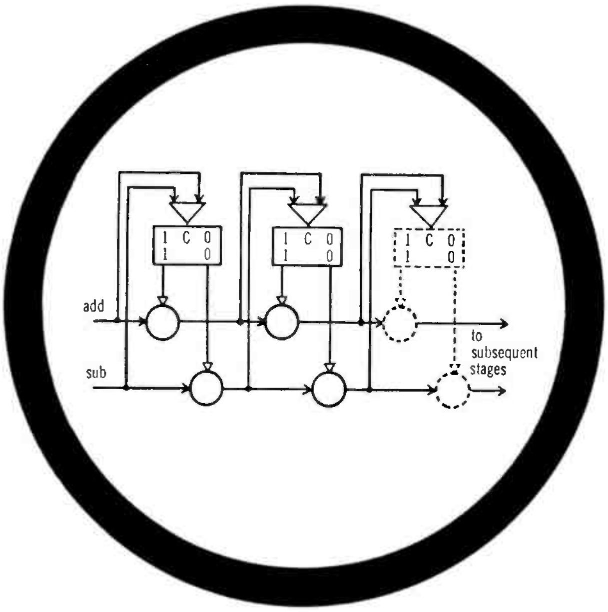
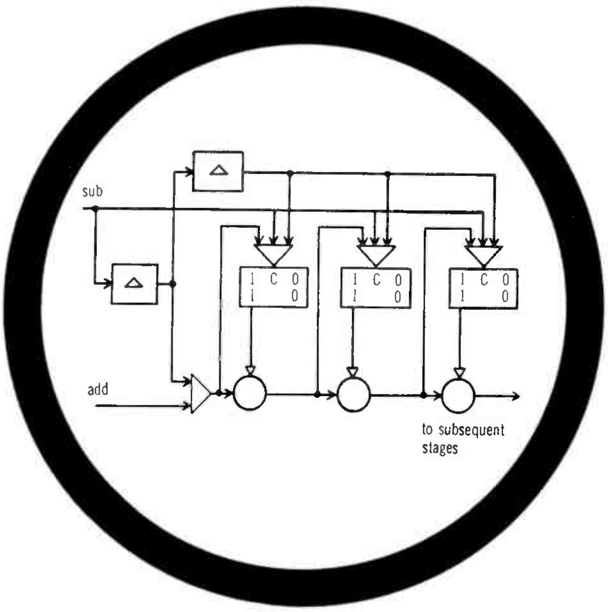
Burroughs digital techniques for the laboratory



2 ways to make a bidirectional counter



The block diagram is a two-dimensional representation of a designer's logical solution. Burroughs Pulse Control Equipment carries this representation one step further . . . into individually packaged hardware which permits the block diagram to be brought to life in a matter of minutes. Thus logical designers can concentrate on design, eliminate days of wasted breadboard time.

The two two-way counters illustrated are ideal examples of solutions readily proved with Burroughs Pulse Control Equipment. With either solution in block diagram form, the designer selects the proper Burroughs "blocks", sets them up in a standard rack, and interconnects them according to the flow lines in the diagram itself. Converting to the other counter design takes little more time than does redrawing the block diagram.

In addition to providing Pulse Control Equipment for proving solutions, Burroughs provides a complete problem solving facility ready to serve you. A call to Burroughs can bring you both a solution to your logical problem and a demonstration of how Pulse Control Equipment can speed their proof . . . at no cost to you. Or, write for Bulletin 236.

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FEATURES

Tough, lightweight shell: Strength comparable to mild steel, yet weighs only 1/3 as much.
Anodic coating: Gives shell toughness of case-hardened steel. Takes up to 1800 volts to penetrate coating.
"Sandwich" insulation: Silicone laminate floats between two rigid discs. Silicone disc absorbs shock, lets contacts align themselves freely; rigid discs impart just the right amount of restraint. Gives all advantages of both flexible and rigid mountings.
Chamber sealing: Silicone insulation disc positively and completely prevents water, gas, moisture or dust from passing into shell.
Wide range of pin and socket configurations: Configurations from 2 to 100 poles available. Within each form size all inserts are interchangeable and reversible.

Environmental Limits of Pyle-Star-Line connectors	
Temperature	—80 F. to 225 F.
Pressure	300 PSI External, 200 PSI Internal
Chemical Resistance	Most acids, most alkalis, oil
Corrosion Resistance	Salt Spray: 300 days without failure
Dust Resistance	Exceed requirements of MIL C-5015C
Shock Resistance	50G Minimum
Vibration	Exceed 20G to Method II of Mil C-5015C
Humidity & Moisture Resistance	Exceed Class E. Spec. of Mil C-5015C
Air Leakage	Meet Class E Spec. of Mil C-5015C

Write today for complete specifications.

the PYLE-NATIONAL company

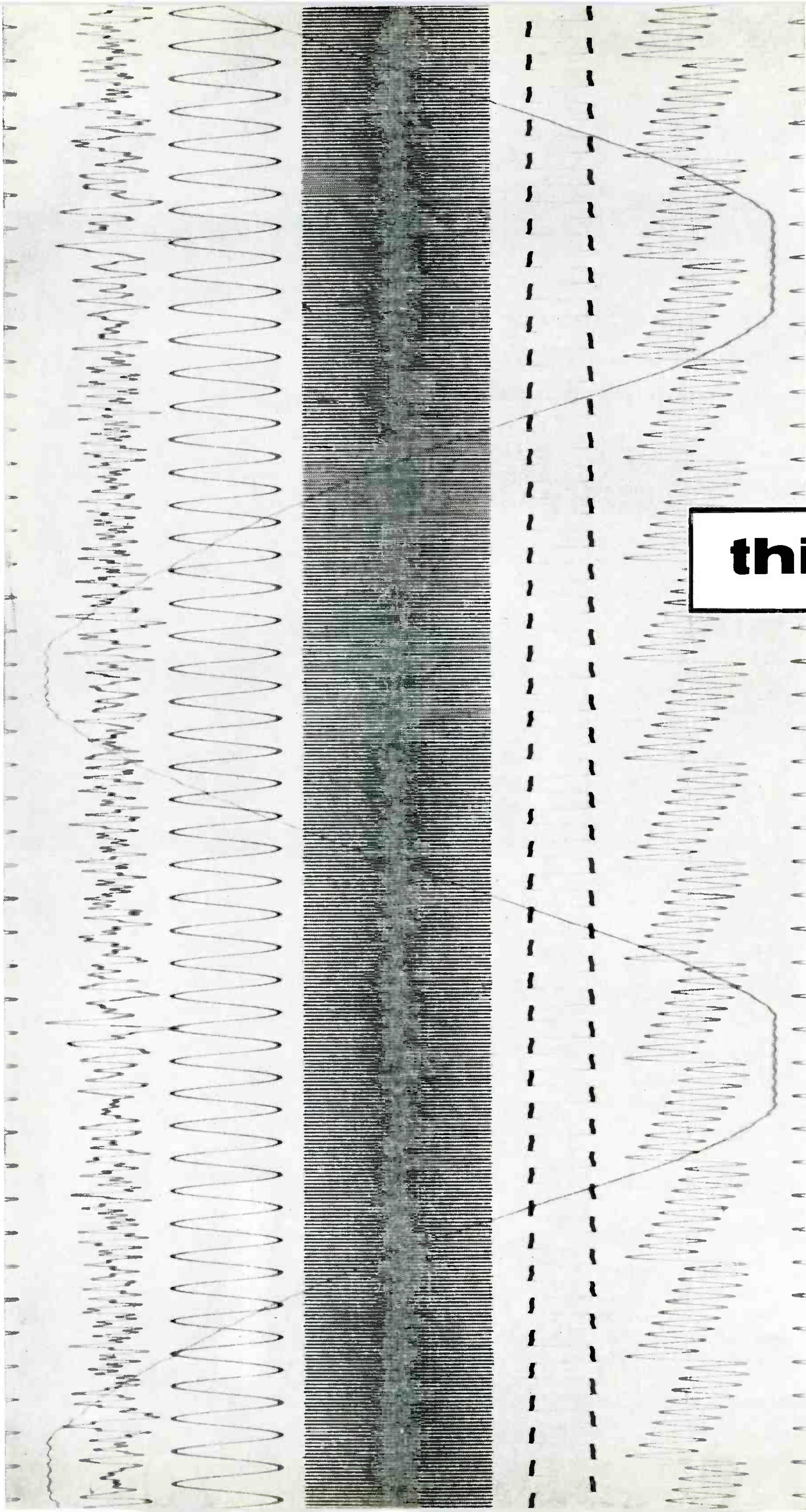
Where Quality is Traditional

1330 North Kostner Avenue, Chicago 51, Illinois

District Offices and Representatives in Principal Cities of the United States

CONDUIT FITTINGS • CIRCUIT CONTROLS • LIGHTING EQUIPMENT

Circle 10 Readers Service Card



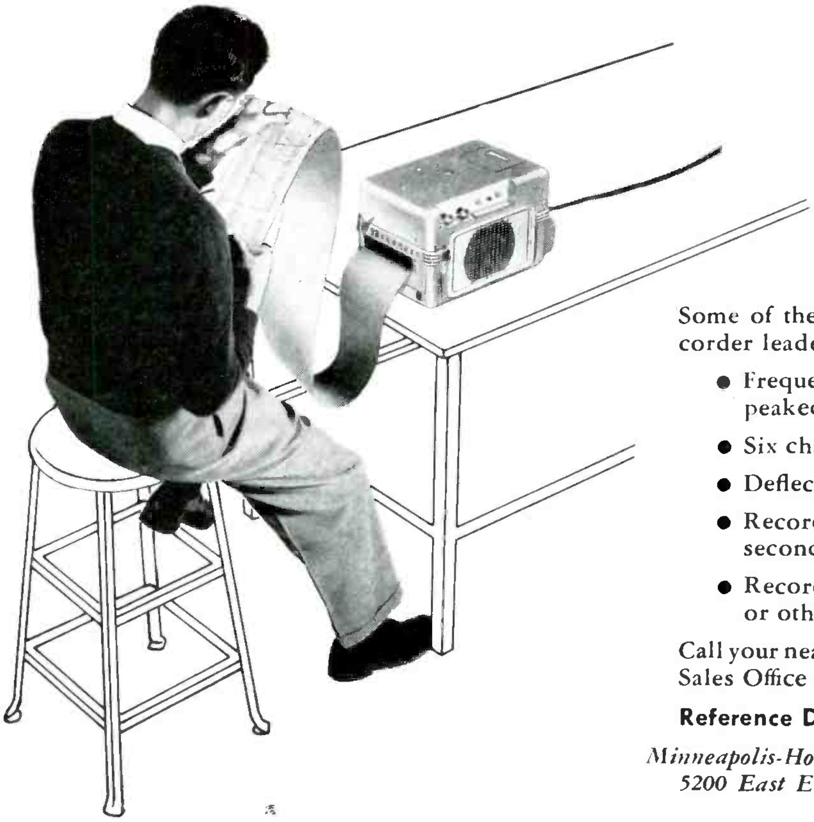
this is

This Visicorder Oscillograph record* is a symbol of the leadership that is typical of Honeywell engineering. In laboratories all over the world the Visicorder's instantly-readable direct records are showing the way to new advances in rocketry, control, computing, product design and component test and in nuclear research.

*reproduced actual size, unretouched

The Model 906 Visicorder is years ahead of the trend. It is the first oscillograph that combines the convenience of direct recording with the high frequencies and sensitivities of photographic-type instruments. The Visicorder alone among oscillographs lets you monitor high-speed variables as they go on the record.

a record of leadership



Some of the general features which give the Visicorder leadership in the direct-recording field are:

- Frequencies from DC to 2000 cps without peaked amplifiers or other compensation
- Six channels plus 2 timing traces on 6″ paper
- Deflection 6″ peak to peak; traces may overlap
- Record speeds 0.2, 1, 5, and 25 inches per second, minute, or hour
- Records require no liquids, powders, vapors, or other processing

Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: Write for Visicorder Bulletin

Minneapolis-Honeywell Regulator Co., Heiland Division, 5200 East Evans Avenue, Denver 22, Colorado.

MINNEAPOLIS
Honeywell

Heiland Division

NEW

oblique plier with the exclusive Klein Shear Cutter

Patent applied for

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

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

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

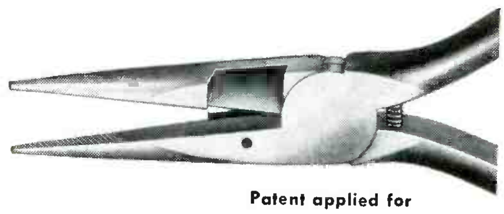
This plier is supplied with a coil spring to keep the handles in open position. Can also be had with Plastisol dipped handles if desired.

Write for full information

KLEIN LONG NOSE SHEAR CUTTING PLIERS

Patent applied for

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



Patent applied for

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

ASK YOUR SUPPLIER

Foreign Distributor:
International Standard Electric Corp.
New York

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

Circle 12 Readers Service Card

Circle 13 Readers Service Card→

DU PONT

Better Things for Better Living . . . through Chemistry

ELECTRONIC DESIGN NEWS

LATEST PROPERTY AND APPLICATION DATA ON

TEFLON® tetrafluoroethylene resins

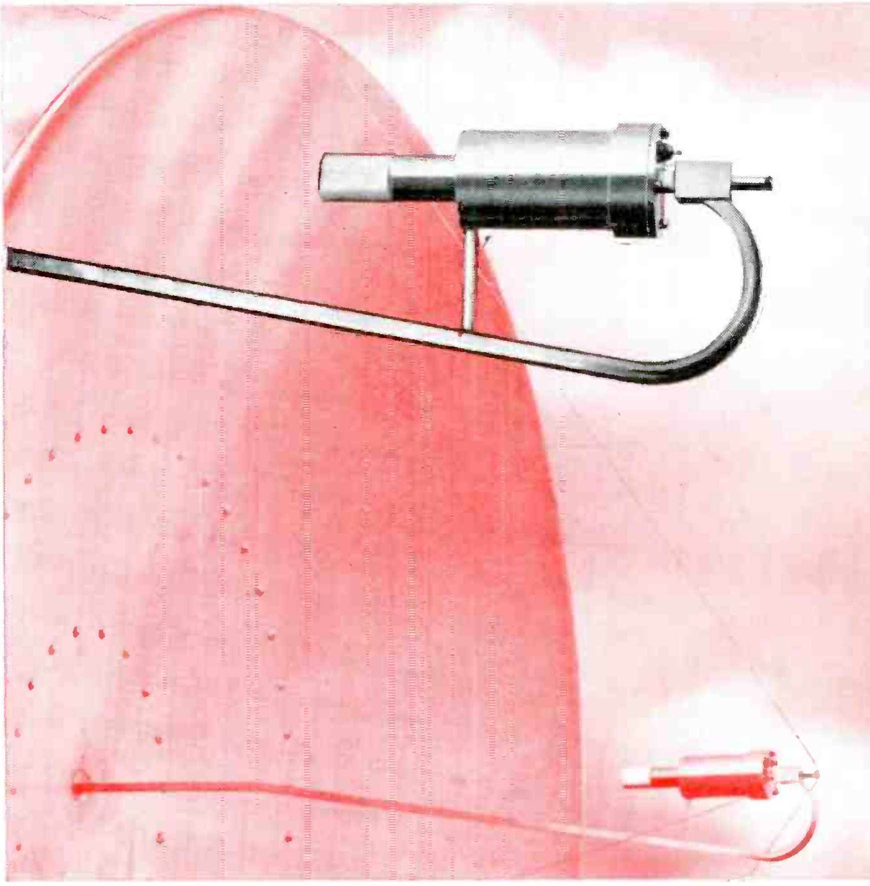
Impedance-matching weather protection of Du Pont TEFLON® tetrafluoroethylene resins featured in new variable-polarization K-band antenna

Du Pont TEFLON tetrafluoroethylene resins are uniquely qualified as materials for making the matching devices and radome used in the feed system of the new Diamond K-brand antenna. The 16,000 mc radar signal passes through an impedance-matching and weatherizing system based on components of a TEFLON resin, and is reflected from the accurate parabolic dish. The .027″ wall of the radome matches the horn to space.

No other material could compare with TEFLON resins for this highly critical electronic application. They are unaffected by outdoor weathering and have so little moisture absorption that their dielectric constant remains unchanged under all humidity conditions. The very low dielectric constant of TEFLON resins gives the material its excellent matching characteristics. They are rated at 2.1 from 60 cycles through the super-high frequency range and have a power factor of under 0.0003 from 60 cycles to over 10,000 mc, so that the loss figure in transmission is very low. Dirt has no tendency to stick to the naturally "slick" surface. TEFLON is unaffected by heating to 260° C.

With this system, the plane of polarization can be varied a full 90° by Faraday rotation. Use of a TEFLON resin overcomes the impedance-matching problem. Moreover, no orienting effects are produced by radomes of this resin. VSWR of the antenna is less than 1.2: 1 over the required ±1% frequency band.

For your own designs, you are invited to take a closer look at the many outstanding advantages of Du Pont TEFLON tetrafluoroethylene resins in electronic applications. The coupon will bring you details.



RADOME of a TEFLON resin matches impedance of feed horn to space and provides protection against weather. Wave-guide impedances at input and output of ferromagnetic rotator in the feed are matched with minimum insertion loss by internal cones of a TEFLON resin. (Made by Diamond Antenna and Microwave Corp., Wakefield, Mass.)

Tapes made of TEFLON® tetrafluoroethylene resins provide high dielectric strength

Tapes made of TEFLON resins are strong, smooth and easy to handle. They have a dielectric strength of 500 to 4,000 volts, depending on thickness. Arc resistance is high, too; no carbonized path is formed by a surface arc. Tapes of TEFLON resins make high-grade electrical insulation which "snugs down" easily, conforms to sharp corners and odd shapes, and becomes tighter as temperature rises.

TEFLON®

is a registered trademark . . .

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the tetrafluoroethylene resins discussed herein. This registered trademark should not be used as an adjective to describe any product, nor should it be used in whole, or in part, as a trademark for a product of another concern.

SEND FOR INFORMATION

For additional property and application data on Du Pont TEFLON tetrafluoroethylene resins, mail this coupon.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept.
Room 17-11-1, Du Pont Building, Wilmington 98, Delaware

Please send me more information on Du Pont TEFLON tetrafluoroethylene resins. I am interested in evaluating these materials for ____________

Name ____________

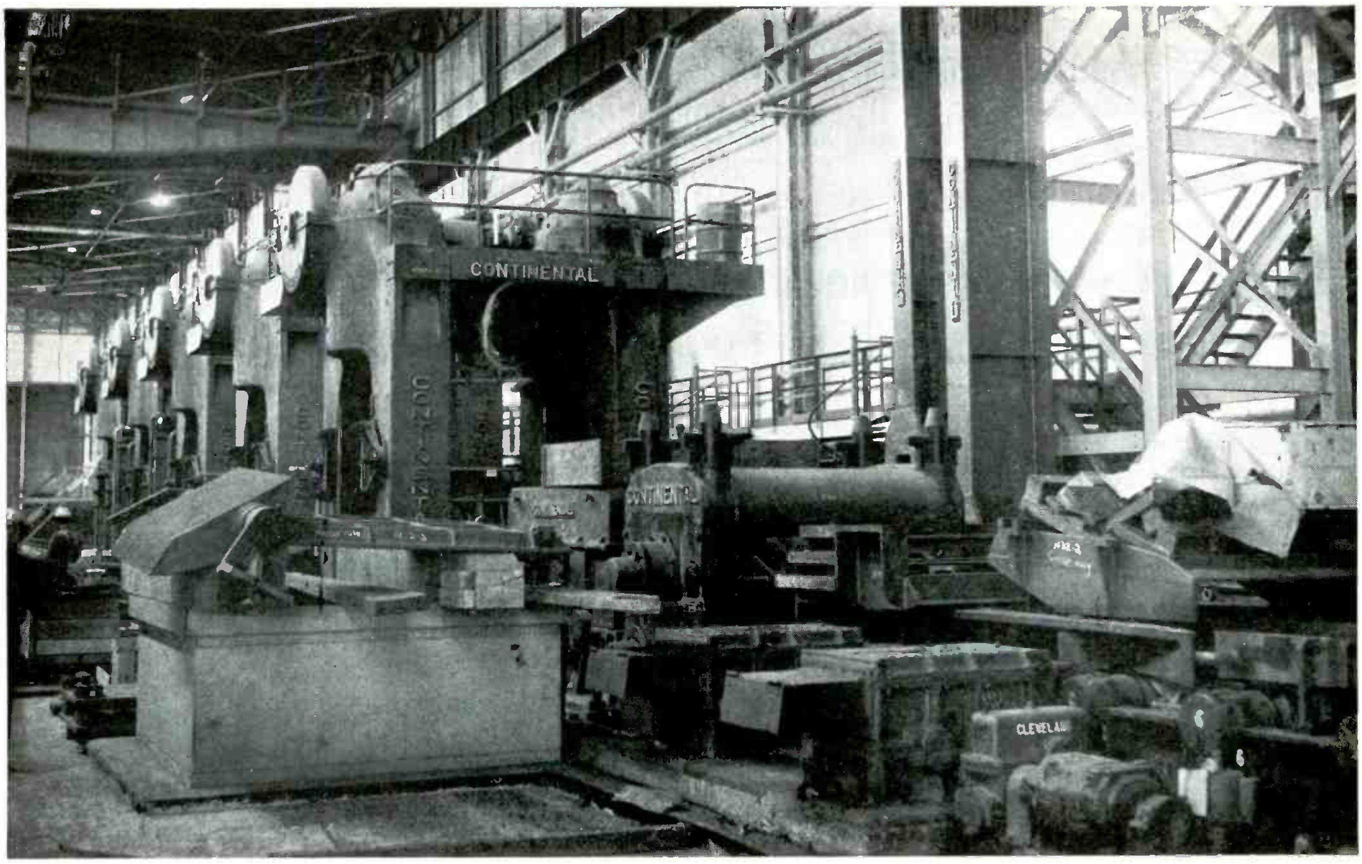
Company ____________ Position ____________

Street ____________

City ____________ State ____________

Type of Business ____________

In Canada: Du Pont Company of Canada (1956) Limited, P.O. Box 660, Montreal, Quebec



Now Under Construction...

New Production Capacity for Armco Oriented Electrical Steels

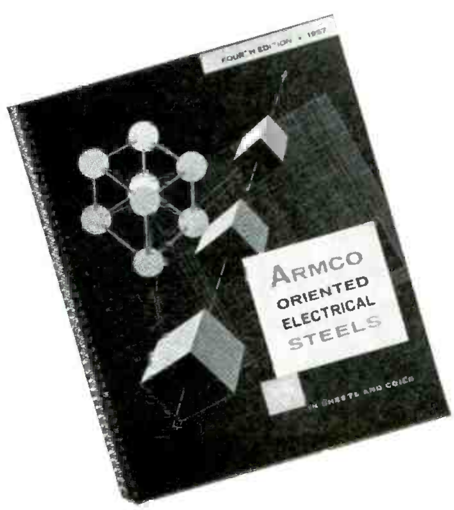
To help meet the growing demand for performance-improving oriented steels, Armco Steel Corporation is expanding production facilities for these grades. Completion of the expansion program is scheduled for 1958.

Armco pioneered development of the oriented electrical steels that have created new standards of efficiency for transformer design and operation. The new production capacity is a continuation of Armco's cooperation with the electrical industry to produce more and better steels for improved electrical and electronic equipment.

DESIGN DATA ON ORIENTED GRADES

The fourth edition of the catalog, "Armco Oriented Electrical Steels," contains extensive, up-to-date design information. More than 40 pages of graphical data on magnetic properties enable designers to make the most effective and economical use of these special Armco Steels.

This useful manual shows how stacked or wound cores made of Armco Oriented Electrical Steel can improve the performance and cut the cost of your products. Write us today for a free copy. Just ask for the manual, "Armco Oriented Electrical Steels—Fourth Edition, 1957."



ARMCO STEEL CORPORATION

2277 CURTIS STREET, MIDDLETOWN, OHIO

SHEFFIELD DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

Circle 14 Readers Service Card

Circle 15 Readers Service Card→

Eccofoam
Plastic Foams

Foam in Place! Pack in Place!

Liquids Powders Sheet Stock

Eccofoam PS is a series of low weight, extremely low loss polystyrene plastic foams of adjusted dielectric constant. It finds use in microwave lens, waveguide and antenna applications.

Eccofoam Hi K 1000F is a one-part pack-in-place adjusted dielectric constant ultra high temperature foam of a ceramic base. It is available in dielectric constants 2.0 through 6.0 and is capable of continuous operation at 1000° F. Being a one-part system it is very simple to use. It is silver in color. This material is also supplied in sheet form.

Eccofoam Hi K 625D is a one-part epoxide "pack-in-place" artificial dielectric foam. It is available in a range of dielectric constants from 2.0 to 7.0. It is useable at 500° F. continuously. Higher temperature usage is also possible. Samples have been subjected to 1000° F. Supplied in a form resembling damp sand. A one-part system, no mixing of components is required. Sheets of this material are also available.

Eccofoam DPT is a one-part "pack-in-place" epoxide foam useable to 500° F. when fully cured. No mixing is required. It is used as received, packed or tamped into cavity to be filled and cured at moderately elevated temperature. The finished foam is extremely fine and uniform.

Eccofoam PT is one of a series of pack-in-place epoxy foams. It can be cured completely at room temperature and then is capable of use at 300° F. continuously, or 350° F. for short periods. The bulk density of Eccofoam PT is about 20 lbs./cu. ft. It is extremely fine and uniform in structure. It is supplied in two components resembling damp sand. Used as a potting compound, for sandwich structures, a light-weight adhesive or caulking compound, for thermal insulation and light weight structures.

Eccofoam FP is rigid polyurethane foam-in-place liquid resin. Upon addition of a catalyst, it expands and finally cures to a rigid thermosetting unicellular foam of specified density. It can be processed completely at room temperature. Volumes of several cubic feet of excellent structure can be made in one pouring due to the very low exotherm developed.

Eccofoam S and Eccofoam FS respectively, are rigid and flexible polyurethane foam sheets. Eccofoam S is available in a wide range of densities. Both will withstand a wide temperature range.

Eccofoam LM is a one-part pack-in-place type ceramic foam which when cured will produce a very fine grained, rigid foam structure of 18-20#/cu. ft. Thermally stable at 1200° F. It exhibits very low dielectric loss over the entire temperature range of use.

Write for Technical Bulletins on Any of these Materials

Eccoseal
Impregnating Resins

EPOXIDES — POLYESTERS

LOW LOSS HIGH TEMPERATURE NON-FLAMMABLE

Eccoseal W28G, a one-part epoxide, intended primarily as an impregnant for transformers and coils. Also used as a casting resin. Has excellent high temperature properties. Impregnated units have operated continuously at 200° C. (392° F.) and for short periods as high as 250° C. (482° F.) It is solvent-free and requires no catalyst addition. Cures to a thermosetting plastic; vacuum treatment assures complete filling of windings. Adhesion to a variety of materials is outstanding. Shrinkage is very low.

Eccoseal W19 is a low viscosity epoxide impregnant and casting resin. It can be cured at room or elevated temperature. It is used to embed small items or impregnate large windings.

Eccoseal W44HT polymerizes 100% by weight into an excellent high temperature, completely non-flammable solid. Manufactured as a light brown, low viscosity liquid, with good wetting characteristics. Long pot life when properly catalyzed. Stable as an impregnant over the temperature range −90° F. to +400° F. A high dielectric strength material with relatively low dissipation factor.

Eccoseal High Q is a low loss impregnant and coating used for a wide variety of R.F. and Microwave applications. It is a resin in solvent solution. Thinner supplied for dilution. Based on polystyrene, its coatings have excellent moisture resistance, low dielectric constant, low loss, and high insulation resistance. Used as a lacquer for RF coils, as a reinforcing medium to up-grade paper, fabric and wood. It is a general purpose coil dope.

Eccoseal W66 is an epoxide impregnating resin which is stable at 600° F. Supplied as a relatively low viscosity liquid and is used with Catalyst #17.

Eccocoat
Plastic Surface Coatings

Liquids and Powders — for Brushing, Dipping, Spraying, or Dusting!

Eccocoat EC 200 is a general purpose spray, brush, or dip epoxide surface coating. It can be cured at room temperature or rapidly at elevated temperature. Surface coatings of Eccocoat EC 200 are of a quality heretofore obtainable only in baked finishes. It is clear; its films are transparent.

Eccocoat Powder HP is a one part epoxy system composed of a finely divided powder. The method of use is to suspend the powder in a flowing gas stream such as air and to dip therein preheated components or circuits. The powder melts in place and coalesces to a smooth thin film. Multiple films can be applied by reheating and redipping. Final cure is accomplished after applying the proper coating thickness. Excellent adhesion and moisture resistance are outstanding characteristics. Temperature capability is 450° F.

Eccocoat PCA is used as a spray coat and cement for printed circuit boards. It is an effective cement for bonding components to the boards. This is usually combined with the coating procedure. Excellent bond strength is achieved even against glass components. Field tests indicate that Eccocoat PCA cemented boards are capable of withstanding accelerations in excess of 100 G's without failure.

Eccocoat C26 is a clear epoxide surface coating which has exceptional high temperature properties. It can be used continuously at 500° F. and for short periods up to 600° F. Surface resistivity is above 10^{15} ohms at room temperature and remains above 10^{14} even at 500° F. Moisture and chemical resistance is outstanding. For example, prolonged exposure to Skydrol at high temperature is not harmful. Eccocoat C 26 is applied by dip, brush, or spray.

Write for Technical Bulletins

Eccobond
Adhesives, Cements and Sealants

Liquid, paste or powder

Highly Resistive or Conductive!

Eccobond 55 is a low viscosity epoxide adhesive for joining metal, glass, ceramics and plastics and for crack filling. It can be cured at room temperature or for rapid cures at elevated temperature. The adhesive is white in color (other colors available) and is rigid when cured.

Eccobond 45 is a controlled flexibility epoxide adhesive. It is designed for use where shock and peel resistance are desired. Cures at room temperature or more rapidly at higher temperature. Adhesion to metals, glass, ceramic and plastic: excellent.

Eccobond 76 is an epoxide adhesive and sealant capable of continuous use at 500° F. and for short periods at 600° F. It is used to bond metal, glass, ceramic and high temperature plastic compositions. The aircraft industry uses Eccobond 76 as a metal to metal structural sealant. The material has excellent resistance to chlorinated hydraulic fluids, e. g., Skydrol 500. Eccobond 76 is supplied as a highly viscous liquid. When mixed with Catalyst #14, a powder, it is a non-flowing paste. Final color is black.

Eccobond Solder 56C is a plastic cement which when cured has extremely low electrical resistance. It can be cured at temperatures as low as 120° F. in 2 hrs. or in a matter of a few minutes at elevated temperature. Supplied in paste form, the cement will not flow when applied. It adheres tenaciously to metal, glass, ceramic and plastics. It is used for making electrical connections where hot soldering is impractical, for example, to nichrome wire, or conductive plastics and at locations which cannot be subjected to high temperature.

Eccobond Paste 88 and Eccobond Powder 98 are one-part adhesives which are applied and then merely heated to effect cure. Simplicity of use is the big advantage. Both are outstanding at high temperatures. Eccobond Paste 88 has replaced riveting and soldering in many applications.

Eccomold
Laminating Resins

Low-loss! Non-flammable! Ultra high temperature!

Eccomold L65 is a laminating resin of low loss and low dielectric constant used in applications where outstanding electrical characteristics are required—radomes, dielectric support pieces, printed circuit boards, etc. It is a thermosetting material. Parts made from it withstand 300° F. continuously.

Eccomold L44 is a resin for use with glass reinforcement to produce laminates of outstanding electrical qualities. Laminates of over 50% by weight glass loading are structurally and electrically sound at temperatures in excess of 200° C. Readily pigmented to a variety of colors with excellent surface finish. It will not support combustion.

Eccomold L28 is a general purpose epoxide laminating resin. Cures at room temperature (Catalyst #9) or higher heats (Catalyst #11) to produce high strength laminates. Used in conjunction with fiberglass cloth or mat. Matched metal, vacuum bag or wet layup can be used. Catalyst #11 is recommended for long pot life in production applications and/or where high temperature properties are needed in the finished laminate.

Eccomold L266 an epoxide laminating resin with outstanding high temperature properties. Fiberglass laminates made with it will withstand 500° F. continuously, or 600° F. for short periods.

Eccostock
Plastic Rods and Sheets

High Temperature — Light weight
Low Loss
Adjusted Dielectric Constant

Stycast 0005 — Plastic rod and sheet for RF and Microwave insulation. This is a specially developed clear plastic material featured by low dissipation factor, excellent high and low temperature stability and machining ease. It is available in rods and sheets.

Stycast Hi K is a series of plastic rod and sheet stock of adjusted dielectric constant. Dissipation factor is low. It is intended for RF and Microwave applications. The material is white and opaque. It is available as standard material in the following dielectric constants: 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15. Standard rod sizes are 1, 2 and 3 inch diameters. Standard sheet thicknesses are ½ and 1 inch. Other dielectric constants and sizes are available on special order. From 10^6 to 10^{10} cycles the variation in dielectric constant is ± 0.15 maximum; dissipation factor is below 0.001. Volume Resistivity — greater than 10^{14} ohm-cm³. Dielectric Strength — greater than 500 volts/mil.

Stycast Lo K is low dielectric constant, low loss and low weight thermosetting plastic rod and sheet for RF and Microwave insulation. It is specifically designed for use in coaxial, waveguide and antenna support problems. Due to low dielectric constant, reflections in transmission lines are minimized.

Eccostock R25 is epoxide rod and sheet stock capable of operating at 500° F. Readily machinable, it has a variety of uses, including bobbins for coils and resistors, terminal boards and insulators. It can be cemented easily.

Eccostock R19 is epoxide rod and sheet which is featured by machining ease and moderately high temperature properties. The material is useable continuously from −100° F. to +350° F. Physical and electrical properties are outstanding.

Eccostock R20 combines light weight, machining ease, good dimensional stability and good high temperature properties. The material is completely unicellular; moisture absorption is negligible. Operating temperature range is from −100° F. to +350° F. Its specific gravity is 0.61.

Ecco Reflector and Ecco Luneberg Lens

3" 7" 12" 18" 36" Diameters   Target cross sections to 56,000 sq. ft.

The Ecco Luneberg Lens is a variable dielectric constant device of spherical contour which focuses an incident plane electromagnetic energy wave to a point on its surface, or conversely produces a plane wave from a point source. There are many unique applications for the Ecco Luneberg Lens; one important application is rapid wide angle scanning of a radiation beam by moving a small feed over the surface of the stationary lens; another is an efficient electromagnetic energy reflector.

The Ecco Reflector is effective as a passive target for radar energy. It has a large radar cross section which is essentially constant over a wide conical viewing angle. The Ecco Reflector is compact, rugged, light in weight and easily installed. It is broadbanded throughout the microwave frequency range. The reflector is based on the Ecco Luneberg Lens. Energy incident upon the lens is focused and reradiated in the direction from which it originated. In this respect, it is similar to a corner reflector. The Ecco Reflector is far superior to the corner reflector for wide angle coverage; it has a radar cross section approximately eight times that of a circular corner reflector of the same radius.

on Any of these Materials

Plastics for Electronics

Emerson & Cuming, Inc. 869 Washington Street, Canton, Mass.

Emerson & Cuming, Inc.

Plastics for Electronics

SHORT FORM CATALOG

This, our general, short-form catalog, contains a brief listing and description of some of the materials we have available. More detailed information on those listed below as well as our other products is available in individual brochures on each of the various lines mentioned, and we will be very pleased to supply you with any of these or any other information you may desire upon request.

Eccosorb
Microwave Absorbers

For Free Space Rooms — 50 Mc thru Microwaves!
Flexible or Rigid — Waveguide Absorbers!

Eccosorb FR is a series of broadband rigid foam microwave absorbers for use in "free space" rooms. Antenna measurements made in a room lined with this absorber are comparable to those made at an outdoor test range. It reflects less than 2% of normal incident energy over the design frequency range, i.e., reflectivity is down greater than 18 db. Selected pieces can be supplied at less than 1% reflectivity. It is effective against parallel, perpendicular and circular polarizations. The absorber is white surfaced for good lighting conditions and is extremely light in weight. Outdoor exposure has no harmful effect on absorber performance. Eccosorb FR is supplied in blocks 1′ x 3′. Thickness is dependent upon the longest wavelength at which it is to be effective. Power dissipation exceeds 2 watts/sq. in. Self-extinguishing after exposure to flame.

Eccosorb AN is a light weight flexible foam sheet broadband microwave absorber. Used mainly for lining antenna nacelles and enclosures, it can readily be cemented to or draped over items which produce undesired reflections. It reflects less than 2% of normal incident energy over the design frequency range. Eccosorb AN is equally effective against parallel, perpendicular and circular polarizations and is relatively insensitive with respect to incident angle.

Eccosorb CHW is a series of broadband anechoic chamber absorbers for use in the v.h.f. u.h.f. and microwave regions, offered in three standard types. It is composed of light weight pyramids, mounted on a rigid foam base and is broadbanded. For example, Eccosorb CHW 560 is effective at 50 mc. and at all higher frequencies, extending even into the microwave region. Thus, an anechoic chamber which uses Eccosorb CHW 560 can be used to make v.h.f., u.h.f. and microwave measurements, simultaneously if desired. This opens the possibility of simultaneous checking of several complete systems installed in an aircraft or missile.

Eccosorb CH is a series of broadband absorbers for use in microwave darkrooms. Reflecting less than 2% of the energy incident upon its surface, this absorber permits antenna measurements to be made indoors with the same reliability and none of the weather uncertainty of outdoor measurements. It is light weight and flexible — composed of enmeshed, rubberized fibers and supplied in sheets, 2 feet by 2 feet. Thickness is dependent upon the longest wavelength at which the absorber is effective. The surface is white in color for good light reflection.

Eccosorb MF is a series of plastic rod and sheet which is used in waveguide as absorbers, attenuators, terminations and loads. Over the entire microwave frequency range these materials have a high total dissipation factor. Attenuation per unit length is, therefore, high.

Eccosorb Panelling offers a prefabricated large size portable absorber panel which because of its light weight can readily be moved from place to place and erected within minutes. The panels are offered in convenient sizes and individual panels can be readily locked to adjoining ones to present a continuous absorber wall and electrical screen.

Eccosorb RM is a flexible sheet absorber which is broadbanded throughout X band and can be used at 600° F. It can be contoured to compound curves and can be cut into smaller pieces. When properly installed Eccosorb RM is completely moisture tight.

Eccosorb Caps are metallic housings lined on the inside with an appropriate Eccosorb product. They are used to cap or cover a radiating antenna 1.) to confine the radiated energy within the cap and 2.) to terminate the antenna in essentially free space conditions. Eccosorb Caps are provided with a Type N bulkhead connector so that a probe can be attached internally to monitor antenna output. They can be supplied to cover the frequency range from 200 MC to 30,000 MC.

Eccosorb HT is a broadband microwave absorber useable to 1200° F. It is supplied as light weight ceramic blocks. Because of its high temperature capability, Eccosorb HT can be used where high power levels must be absorbed.

Write for Technical Bulletins

TRANSFORMERS *Inc.*

Ratiometer

...*accurate to five parts per million!*

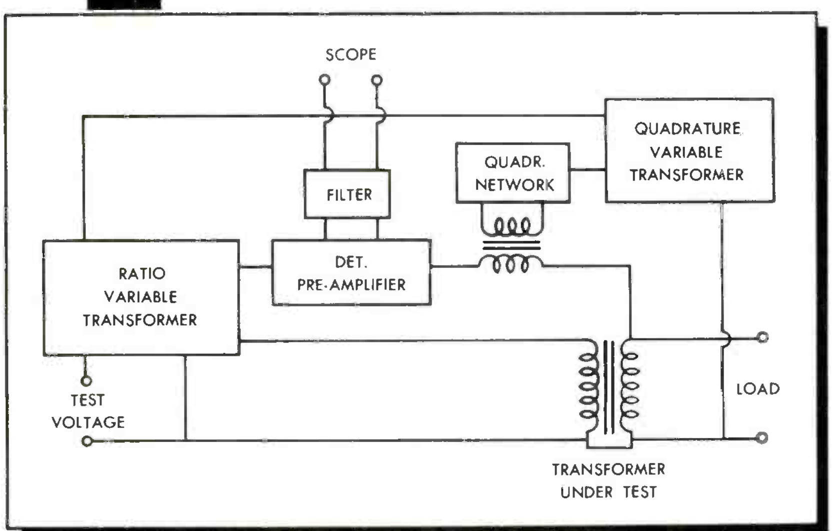
REFERENCED TO UNITY RATIO

The Transformers, Inc. Ratiometer is a precision instrument to measure any voltage ratio from 0.000001 to 1.111111. Transformer ratios can be accurately measured at "no load" and under full load. Two models are available:

MODEL 204 is designed for use between 200 cps and 2,000 cps. It is supplied with plug-in units for 400 cps operation.

MODEL 206 is designed for use between 40 cps and 1,000 cps. It is supplied with plug-in units for 60 cps operation.

Plug-in units for any other frequency are supplied to order.



The Ratiometer consists of two precision variable transformers, a calibrated quadrature injector, a filter, and a pre-amplifier. Block diagram indicates connections of the various components within the instrument.

ACCURACY

Five parts per million referenced to unity ratio.

MAXIMUM VOLTAGE

Model 204	120 V	200 cps
	180 V	300 cps
	240 V	400 cps and over
Model 206	80 V	40 cps
	120 V	60 cps
	240 V	120 cps and over

PRICE

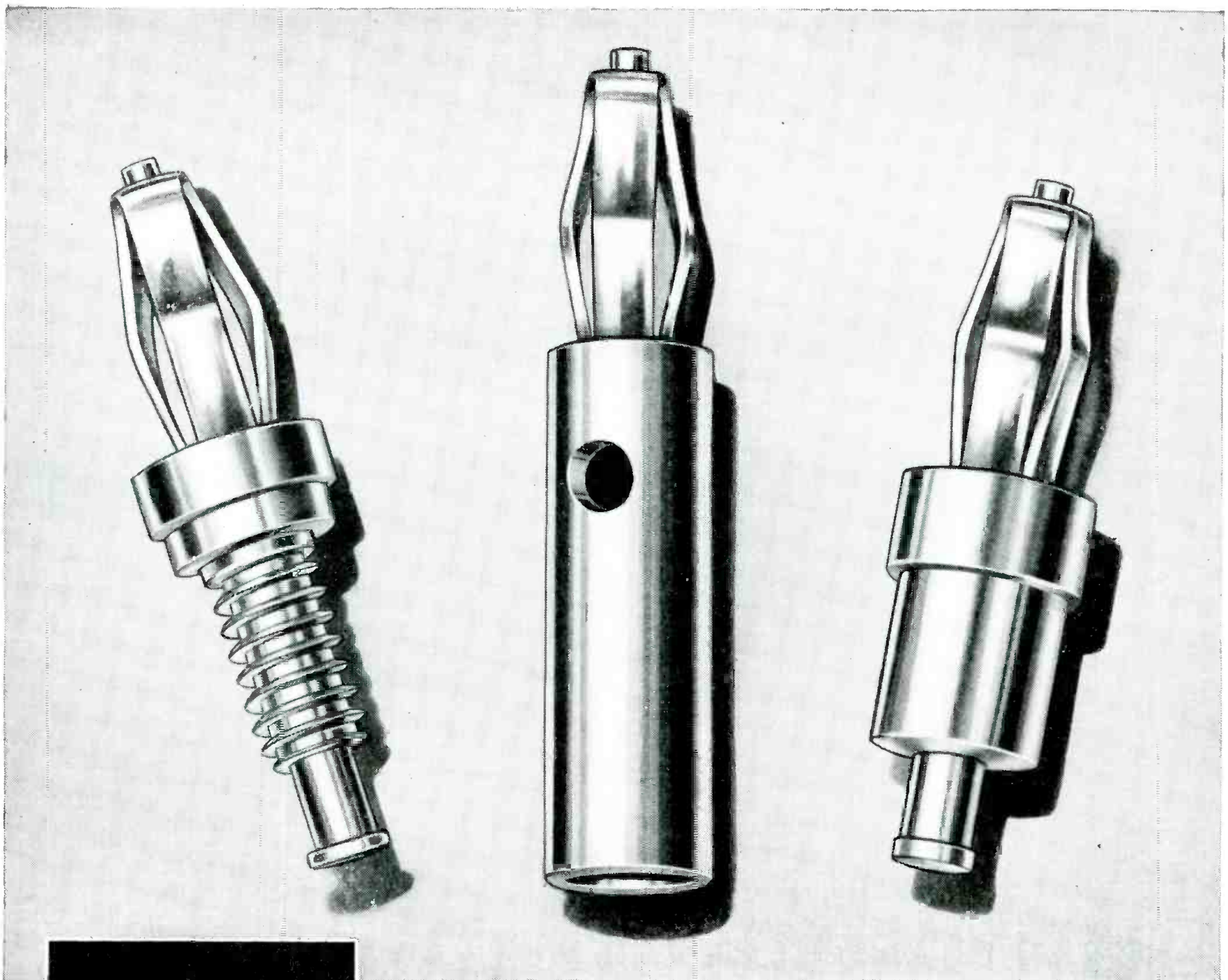
Model 204 Ratiometer, complete with 400 cps plug-in filter and quadrature units **$865**

Model 206 Ratiometer, complete with 60 cps plug-in filter and quadrature units **$1235**

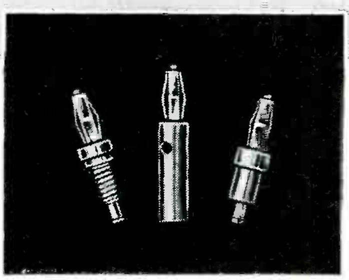
For additional information, ask for Bulletin #204

TRANSFORMERS, INCORPORATED

200 Stage Road, Vestal, N.Y.



6 times enlargement



Actual size

Ucinite Miniature Banana Pins

Heavy resistance to torque is a big feature of Ucinite miniature banana pins. The springs are mechanically riveted over and the large area around the tip of the pin is bonded by solder.

Pins are available in a variety of types, for assembly by staking . . . with nuts and washers . . . with soldered tails . . . with multiple plug-in features. Springs are designed to fit .093 sockets.

Built to withstand rough usage, Ucinite miniature banana pins are available in cadmium, silver or gold plate.

For further information, call your nearest United-Carr representative or write directly to us.

ELECTRICAL ASSEMBLIES
Ucinite
RADIO AND AUTOMOTIVE

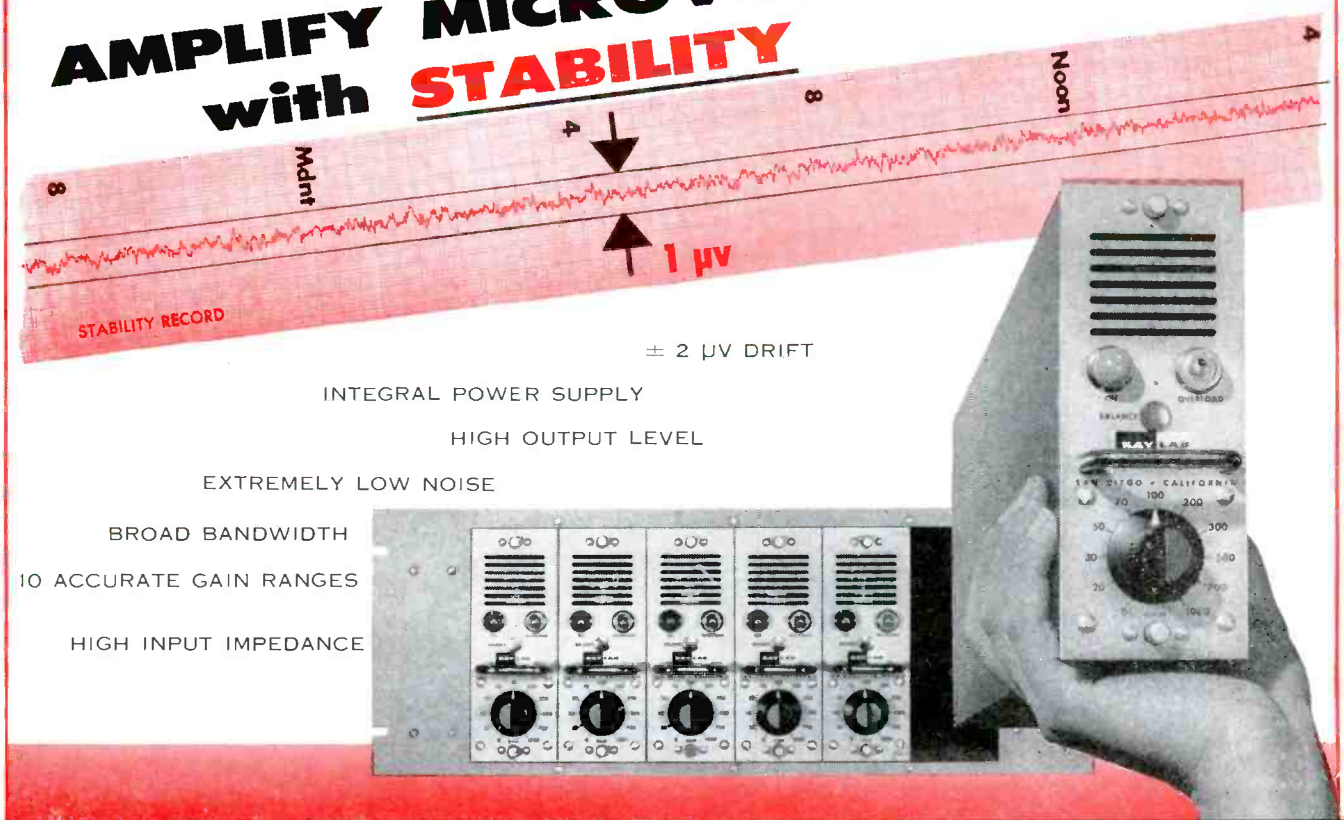
The UCINITE CO.
Newtonville 60, Mass.
Division of United-Carr Fastener Corp.

Specialists in
ELECTRICAL ASSEMBLIES, RADIO AND AUTOMOTIVE

KIN TEL
[KAY LAB]

FOR DRIFT-FREE DC INSTRUMENTATION

AMPLIFY MICROVOLTS with STABILITY



± 2 μV DRIFT

INTEGRAL POWER SUPPLY

HIGH OUTPUT LEVEL

EXTREMELY LOW NOISE

BROAD BANDWIDTH

10 ACCURATE GAIN RANGES

HIGH INPUT IMPEDANCE

The **KIN TEL** Model 111 amplifier provides maximum stability and the lowest drift of any commercially available broadband d-c amplifier. It is the end result of years of research in the field of chopper stabilized broadband d-c amplifiers. Thousands of **KIN TEL** amplifiers are in daily use. The Model 111 incorporates **KIN TEL's** proven chopper amplifier circuitry and provides ten extremely precise, feedback controlled gain ranges. Several feedback loops assure high accuracy, stability and uniform frequency response. The completely new and unique circuit provides rapid recovery from severe overloading and unsurpassed dynamic performance—unaffected by load or gain changes.

The Model 111 is available in a single-unit cabinet or in a six-unit rack-mountable module. The amplifiers are extremely compact; the six-unit module occupies only a 19-inch rack width.

APPLICATIONS: The Model 111 is ideal for permanent low level d-c instrumentation, telemetering, or as a strain gage amplifier, transducer amplifier, scope preamplifier, recorder driver amplifier, or general purpose laboratory amplifier.

SPECIFICATIONS

Gain	0, 20, 30, 50, 70, 100, 200, 300, 500, 700, 1000
Gain Accuracy	± 1% DC to 2 KC
Input Impedance	100,000 Ω
Output Capability at DC	0 to ± 35 V where R_L > 1000 Ω 0 to ± 40 MA where R_L is 10 to 400 Ω
Output Impedance	Less than 1 Ω in series with 25 μh
Equivalent Input Drift	± 2 μv with regulated line
Equivalent Input Noise	0 to 3 cps, less than 5 μv peak to peak 0 to 750 cps, less than 5 μv RMS 0 to 50 kc, less than 12 μv RMS
Chopper Intermodulation	Less than 0.1%
Linearity	Better than 0.1% to 2 KC
Frequency Response	± 3% (0.3 db) DC to 10 KC, less than 3 db down at 40 KC

Power Requirements:	
Amplifier	117 V — 60 cycles — 70 VA
Cabinet	117 V — 60 cycles — 15 VA
6 Unit Rack Adaptor	117 V — 60 cycles — 45 VA
Dimensions: Amplifier Unit	2⅔" wide, 7⅝" high, 14⅝" deep
Rack Adaptor for 6 Units	19" wide, 8¾" high, 18¼" deep
Net Weight — Amplifier	11 pounds

PRICE: Amplifier Unit	$550.00
19-inch Rack Adaptor for 6 amplifier (with fans and connectors)	200.00
Cabinet for single amplifier (with fan and connector) is available.	

...the Standard in chopper-stabilized instruments

STABILITY *locked in!*

WITH CHOPPER AMPLIFIERS

KIN TEL
[KAY LAB]

Representatives in all major cities.

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

ENDS STRIPPING, CLEANING— SOLDERING COSTS!

Sodereze—Phelps Dodge's isocyanate-type* magnet wire—provides:

1. *Low temperature* soldering—no damage to copper conductor.
2. A balance of physical, chemical and electrical properties permitting replacement of existing film wires.
3. Resistance to heat and solvent shock for safer wax or varnish treatment.
4. Excellent resistance to alcohol and most solvents.

Phelps Dodge Sodereze was designed to keep pace with industry's growing need for magnet wires that handle easily, reduce over-all costs and fit a variety of exacting design requirements.

The versatility of Sodereze not only permits its use wherever solderable wires are required, but allows replacement of conventional film wires.

* Isocyanates, when combined with other resins, form Polyurethanes that can be balanced in properties to give the maximum in performance as a magnet wire insulation. Several years of research have been spent on Phelps Dodge Sodereze to accomplish this result. A patent application covering Phelps Dodge isocyanate-type magnet wire has been filed.

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

PHELPS DODGE COPPER PRODUCTS
CORPORATION

INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA

Circle 21 Readers Service Card

Telephone Relays

Midget Relays

Keying Relays

Rotary Relays

Sealed Relays

Sensitive Relays

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Stepping Relays

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We maintain complete distributor stocks of the following makes:

Advance Relays	**Phillips Controls**
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We Anticipate Your Relay Needs

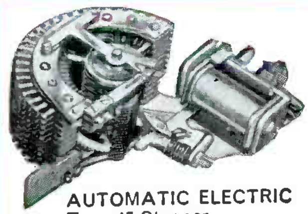
Relay Sales cannot get better delivery from manufacturers than you. Relays now in stock were ordered as long as 10 months ago and selected by men who have specialized in supplying relays to the industry for many years. The items illustrated are typical of hundreds of thousands in stock. They are available in all popular coil ratings and contact arrangements. Why wait for relays? Call us today!

Write or Phone for Same Day Shipment

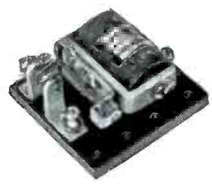
Phone: West Chicago 1100

RELAY SALES, INC.

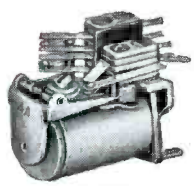
P.O. BOX 186-A **West Chicago, Ill.**



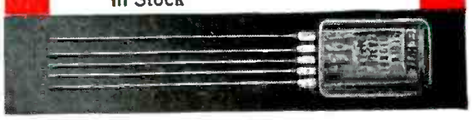
AUTOMATIC ELECTRIC
Type 45 Stepper
Wide Selection



STRUTHERS DUNN
Keying Relay
Many Types in Stock



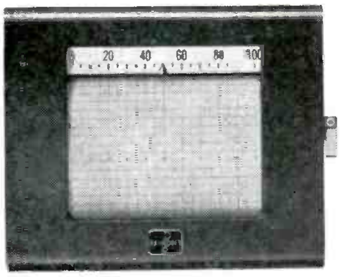
PHILLIPS CONTROL
9QA Midget for Sub Chassis
Mounting. Many Others
in Stock



(Actual Size)
NEOMITE-ELGIN
Sub Miniature Hermetically Sealed Relay. All Advance Types in Stock

Circle 23 Readers Service Card

BRISTOL DYNAMASTER* ELECTRONIC RECORDERS...for research and testing



Bristol High-Speed Dynamaster Electronic Recorder

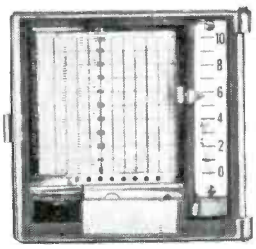
high-speed (0.4 sec.) recorder

. . . accurately follows the rapidly changing variables found in dynamic testing procedures such as those used in wind tunnel research, rocket and jet engine testing, and scientific laboratory work. Maintains same high accuracy, sensitivity, and precision as conventional speed recorders.

These other precision instruments by Bristol can also help you in aircraft and missile testing and development projects:

Dynamaster 2-pen Recorders
Dynamaster Function Plotters
Dynamaster Extended Range Recorders
Dynamaster Adjustable Span Recorders

Ask us for complete data on these instruments today.



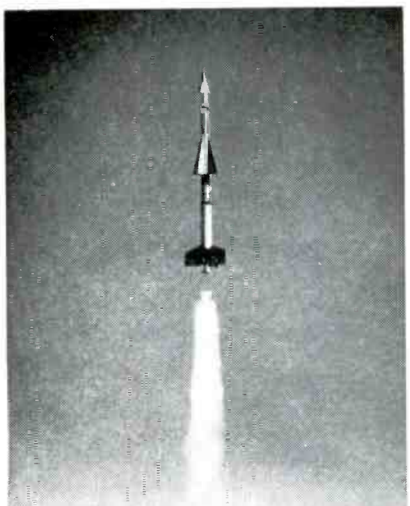
Bristol Series 663 Miniature Dynamaster Recorder

first true motor-driven self-balancing electronic potentiometer and bridge instruments in miniature size

Three-inch strip chart, full plug-in flexibility, ½ of 1% of scale accuracy, low dead band (0.15%), and high-torque motor-driven null-balancing are features of the Bristol Series 663 Dynamaster miniature instruments.

Plenty of motor torque for operating alarm contacts, retransmitting slide-wires, electric control contacts.

Bristol offers the widest selection of miniature plug-in instruments on the market — pneumatic, telemetering types; electronic self-balancing recorders, indicators. Find out about Bristol miniatures today!



BRISTOL socket screws help Army Nike blast off!

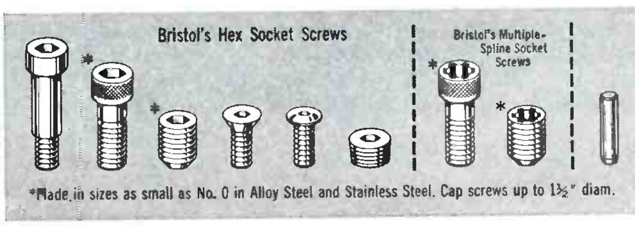
*T. M. REG. U. S. PAT. OFF.

BRISTOL MULTIPLE-SPLINE SOCKET SCREWS prove reliability in missiles, aircraft, electronic equipment

They meet the most exacting requirements for holding power against shock and vibration. The Bristol-originated Multiple-Spline socket allows these screws to be wrenched up exceptionally tight without danger of stripping the socket.

Bristol Multiple-Spline socket screws, both set and cap, are ideal for critical applications in aircraft, missiles and guidance equipment—like the famous NIKE (left)—communications and control equipment of all types—wherever ability to take extra wrenching torque is a factor.

Find out about them from your industrial distributor today.



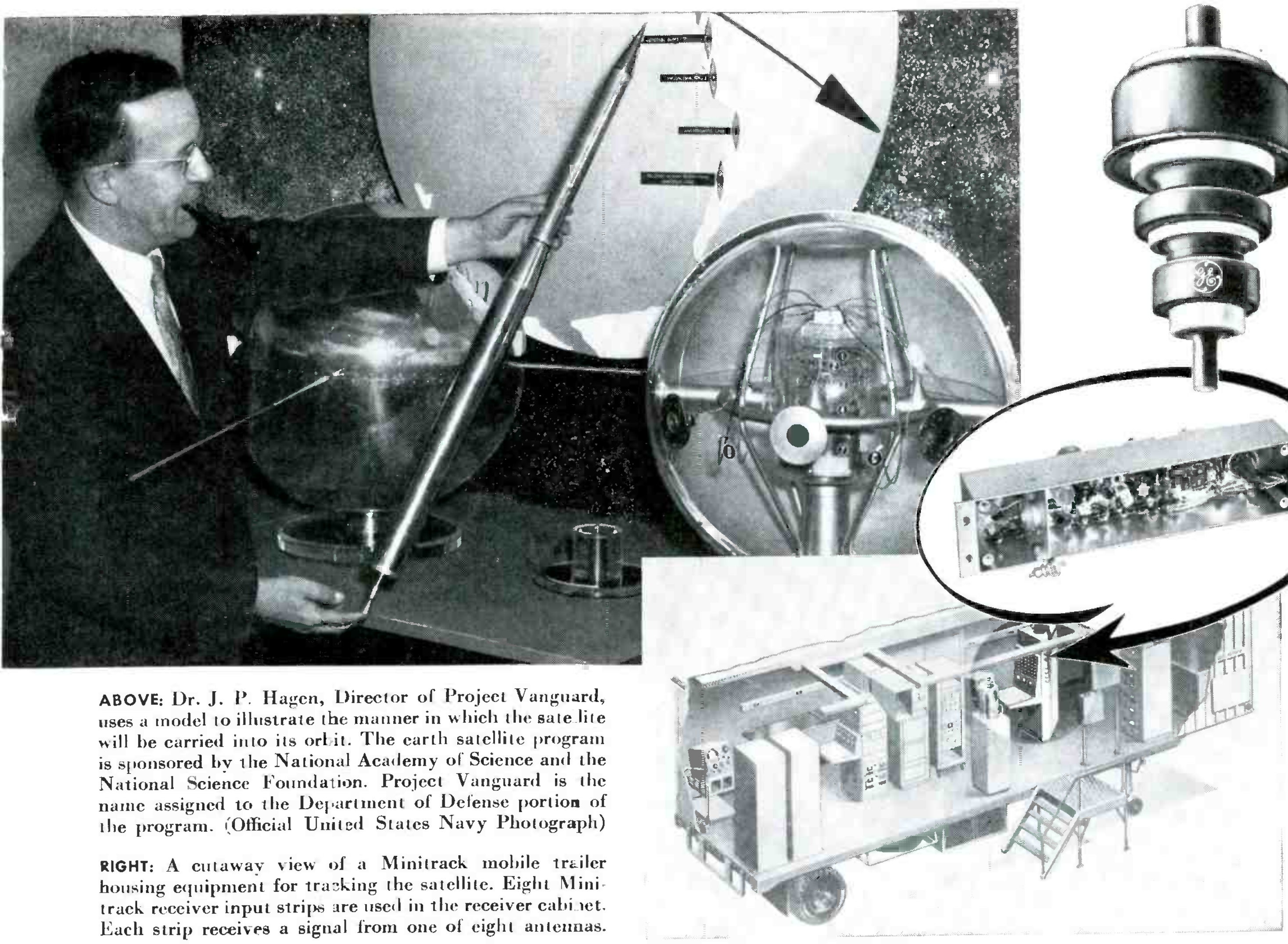
WRITE FOR complete information

. . . address requests for further data on any Bristol product to The Bristol Company, 152 Bristol Road, Waterbury 20, Connecticut.

7.30

BRISTOL *Precision Products for Modern Manufacturing*

AUTOMATIC CONTROLS · RECORDERS · TELEMETERS · SOCKET SCREWS
CHOPPERS AND HIGH-SPEED RELAYS · AIRCRAFT PRESSURE-OPERATED DEVICES



ABOVE: Dr. J. P. Hagen, Director of Project Vanguard, uses a model to illustrate the manner in which the satellite will be carried into its orbit. The earth satellite program is sponsored by the National Academy of Science and the National Science Foundation. Project Vanguard is the name assigned to the Department of Defense portion of the program. (Official United States Navy Photograph)

RIGHT: A cutaway view of a Minitrack mobile trailer housing equipment for tracking the satellite. Eight Minitrack receiver input strips are used in the receiver cabinet. Each strip receives a signal from one of eight antennas.

GL-6299 low-noise G-E triode is designer's choice for Minitrack System of tracking Earth Satellite

ACTUAL SIZE

When the satellite is launched in 1958 as part of a United States program for the International Geophysical Year, it will be followed in its orbit by a unique tracking system. This system, known as Minitrack, was designed by the U.S. Naval Research Laboratory and built by Bendix Radio Division, Bendix Aviation Corp. The system uses General Electric tube Type GL-6299 in a major role.

The tracking system consists of a transmitter in the satellite, and a series of receiving stations strategically placed to intercept the radio signals.

This transmitter will have an output power of as low as 10 milliwatts. Consequently, a circuit had to be designed to provide low-noise amplification of the signals. The low-noise G-E GL-6299 was picked for the R-F stage in this circuit because of its ability to provide sufficient power gain to prevent any significant contribution by the mixer stage to the over-all receiver output noise.

The designers of the Minitrack System took advantage of the tube's exceptionally low noise figure of only 2.5 db at 108 mc. Additional advantages realized were receiver input strips with greater inherent stability, freedom from neutralizing requirements, and ease of alignment procedure.

Ratings of the GL-6299, based on performance results of the triode as a Class A_1 grounded-grid, coaxial-type RF amplifier with a 10-megacycle bandwidth include: a noise figure of 4 to 5 db at 400 mc.; 8 db at 1200 mc.; and less than 13.5 db at 3000 mc.; a gain of 17 db at 1200 mc. and 10 db at 3000 mc. Successful completion of extended life tests is responsible for the recent increase in tube warranty from 500 to 1000 hours, with no increase in price.

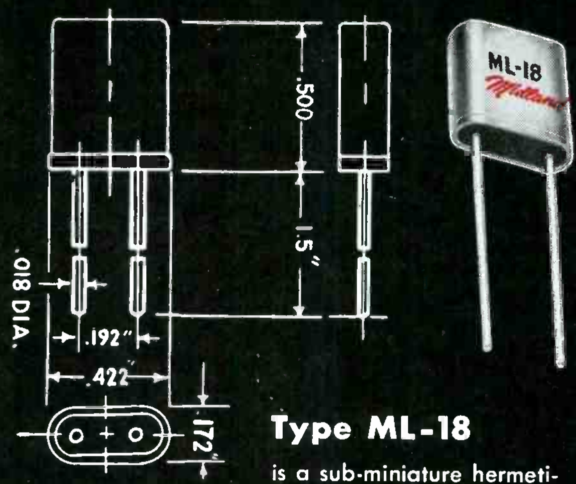
For detailed literature or application assistance, contact your regional power tube representative, or write to *Power Tube Department, General Electric Co., Schenectady, N. Y.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

9545-8481-4

Circle 27 Readers Service Card

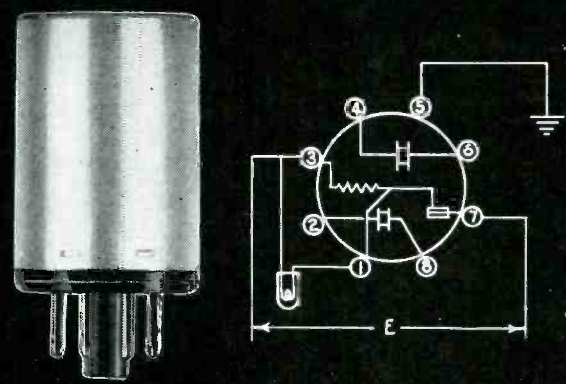


Wire pin diameter: .017 ± .001
Wire pin length: 1.500 ± .062
Fixed pin diameter: .040 ± .002
Fixed pin length: .234 ± .030

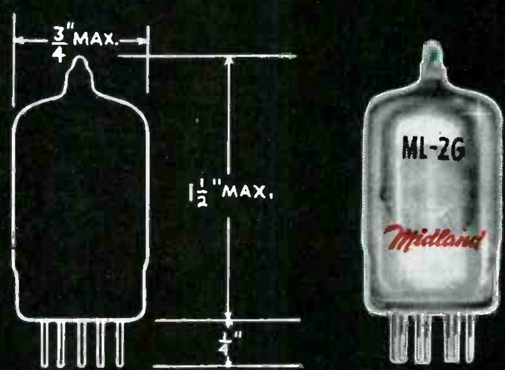
Type ML-18

is a sub-miniature hermetically sealed crystal unit with glass and metal base. Available with fixed pins or wire leads.

Range:
5.0 mc — 150.0 mc



Standard Octal Base Crystal Oven for ML-6 or ML-13 crystal units: Oven accommodates one or two crystal units. Available in 1¾" or 2½" tall can. Furnished in 6, 12, 27 or 115 volt. Temperature setting tolerance accurate to ± 1°C. Operative temperature calibrated at any desired temperature between 60°C and 100°C.

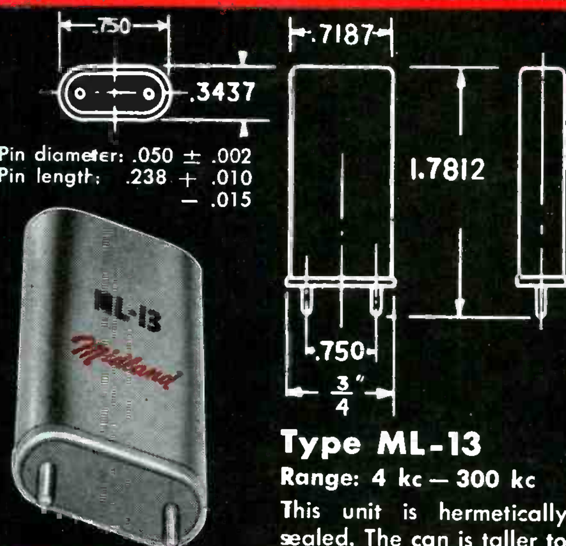


Pin diameter: .040 ± .002
Pin length: .250 ± .030

Type ML-2G

a new all glass, 7-pin miniature.

Range:
200 kc — 150.0 mc



Pin diameter: .050 ± .002
Pin length: .238 + .010
− .015

Type ML-13

Range: 4 kc — 300 kc

This unit is hermetically sealed. The can is taller to accommodate the low frequency crystal blank.

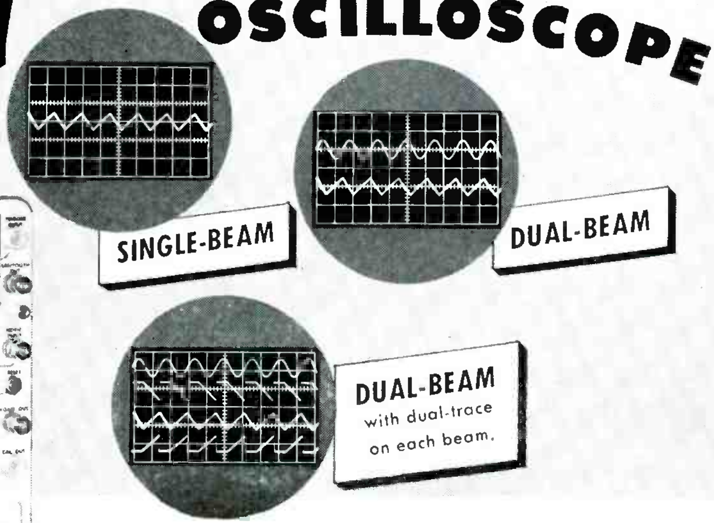
MORE HIGH QUALITY CRYSTALS HAVE BEEN PRODUCED BY Midland THAN BY ANY OTHER MAKER IN THE WORLD!

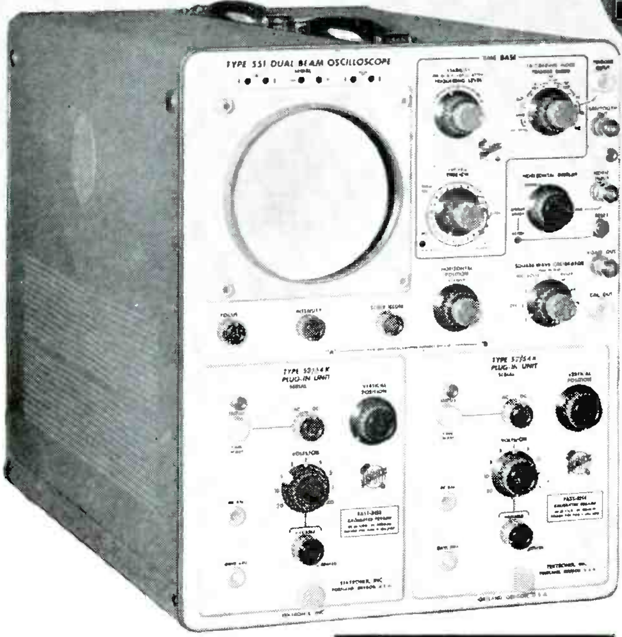
When absolute accuracy in frequency control units must be rigidly maintained—entrust the job to Midland. You are assured of years of quality manufacturing experience plus constant advanced research in critical problems. Midland crystals used by the Military Services are consistently found to surpass military specifications in precise, constant and unfailing performance.

Check with us on all your crystal needs . . . and any special requirements.

Midland MANUFACTURING COMPANY 3155 Fiberglas Road Kansas City 15, Kansas

New TEKTRONIX® DC-to-25 MC DUAL-BEAM OSCILLOSCOPE





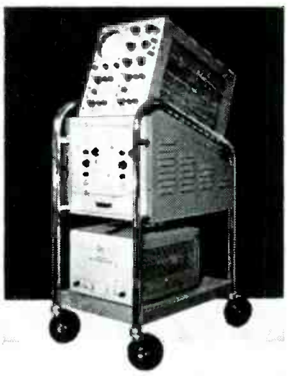
Price, without plug-in units **$1725**

Type 500/53 Scope-Mobile **$108**

Type 53/54K
Fast-Rise Plug-In Preamplifiers,
each **$125**

Type 53/54C
Dual-Trace Plug-In Preamplifiers,
each **$275**

Prices f.o.b. Portland, Oregon



TYPE 551

The new Tektronix dual-beam cathode-ray tube used in the Type 551 has two electron guns, each with a pair of vertical-deflection plates. A single pair of horizontal-deflection plates is common to both beams. The two wide-band main vertical amplifiers are designed for Type 53/54 Plug-In Preamplifiers, offering a high degree of signal-handling versatility in both channels. Both beams are simultaneously deflected at any one of the many sweep rates provided by an accurately-calibrated time-base generator.

The Type 551 can be used as a single-beam oscilloscope or as a dual-beam oscilloscope. In addition, a four-channel display is immediately available through the time-sharing characteristics of Type 53/54C Dual-Trace Plug-In Units . . . at passbands of dc to 22 mc. Other available Type 53/54 Plug-In Units extend the working range of the Type 551 into applications requiring high dc-coupled sensitivity, differential input, and narrow-band microvolt sensitivity.

CHARACTERISTICS

WIDE-BAND VERTICAL AMPLIFIERS

Main-unit vertical-amplifier risetimes — 0.012 μsec. Balanced delay lines, signal delay 0.2 μsec each amplifier.

Characteristics with Type 53/54K Plug-In Units

Risetimes — 0.014 μsec.
Passbands — dc to 25 mc.
Deflection factors — 0.05 v/cm. 9 calibrated steps from 0.05 to 20 v/cm.

Characteristics with Type 53/54C Plug-In Units

Risetimes — 0.016 μsec.
Passbands — dc to 22 mc.
Deflection factors — 0.05 v/cm. 9 calibrated steps from 0.05 to 20 v/cm.
All Type 53/54 Plug-In Units can be used with the Type 551.

WIDE-RANGE SWEEP CIRCUIT

24 accurately-calibrated sweep rates from 0.1 μsec/cm to 5 sec/cm.

5X magnifier is accurate at all sweep rates. Variable control provides for continuous adjustment from 0.02 μsec/cm to 12 sec/cm.

Single Sweep — lockout provision prevents further triggering after a single sweep . . . for transient photography.

Versatile Triggering — from either channel internally or from an external signal, or from the line voltage. Triggering from the positive or negative slope of the triggering signal, ac or dc-coupled, with an ac-coupled position that rejects low frequencies. Automatic triggering, amplitude-level selection with preset or manual stability control, and high-frequency sync.

OTHER CHARACTERISTICS

Square wave amplitude calibrator, 0.2 mv to 100 v, frequency about 1 kc.
Separate power supply, electronically regulated.
10-kv accelerating potential on new Tektronix dual-beam crt. 6-cm by 10-cm linear display area. (4-cm by 10-cm each beam).
Beam-position indicators for both beams.

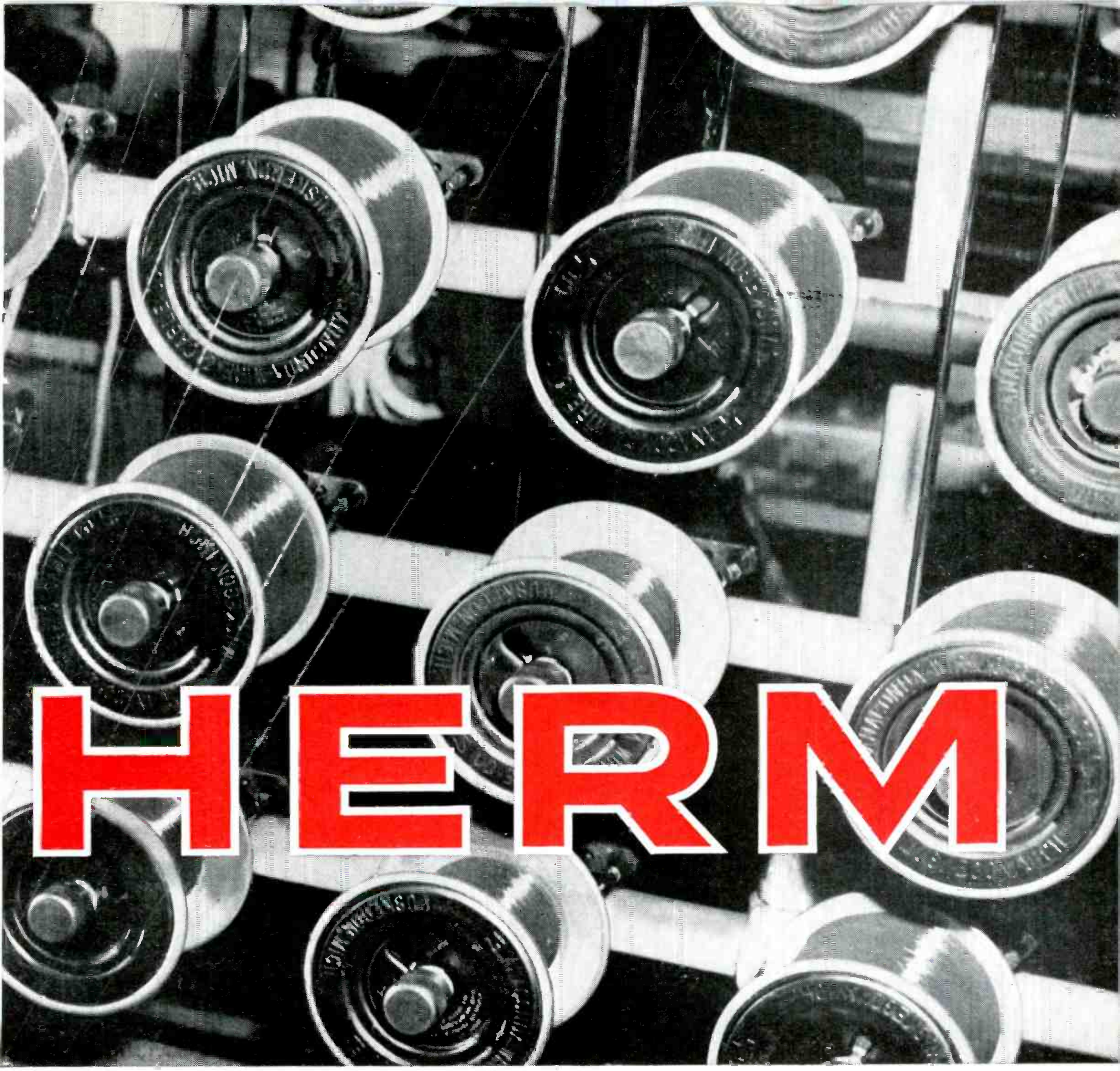
ENGINEERS — interested in furthering the advancement of the oscilloscope? We have openings for men with creative design ability. Please write Richard Ropiequet, V-Pres., Engineering.

Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon
Phone CYpress 2-2611 • TWX-PD 311 • Cable: TEKTRONIX

Regular shipments of the Type 551 are expected to begin during January, 1958. However, your Tektronix Field Engineer or Representative quite likely will be able to arrange a demonstration somewhat sooner. Please keep in touch with him for current details.

Circle 29 Readers Service Card



polyester film-coated to meet new AIEE requirements

temperature over the range of 105°C to 155°C.
Available in single and heavy film thickness in AWG sizes from 15 through 25.

Free Technical Bulletin on Anatherm Magnet Wire is available. Simply write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y. 57373

ASK THE MAN FROM **ANACONDA**®
ABOUT **ANATHERM MAGNET WIRE**

LIVE BETTER ELECTRICALLY

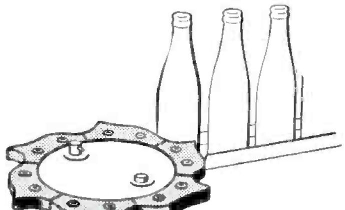
TAYLOR Shop Talk

Laminated Plastics
Vulcanized Fibre

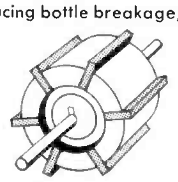
TAYLOR FIBRE CO.
Plants in Norristown, Pa. and La Verne, Calif.

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

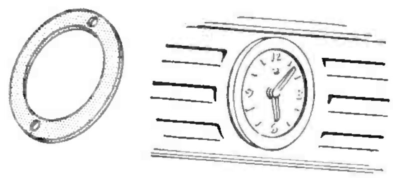
Tips for designers



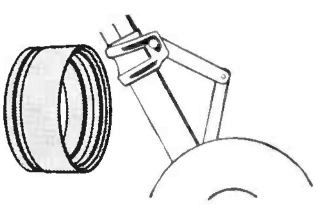
Indexing cams to position bottles under filling machines are made of Taylor Grade CEF phenolic laminate . . . replacing metal cams, they save money by reducing bottle breakage, avoiding rust.



Gas pump impeller unit is fabricated of Taylor Grade LE-6 phenolic laminate . . . economical, light-weight, wear-resistant . . . chosen because of strength, stability.



Automobile clock is securely and economically mounted on inside surface of metal dashboard, with a spacer fabricated from Taylor vulcanized fibre.

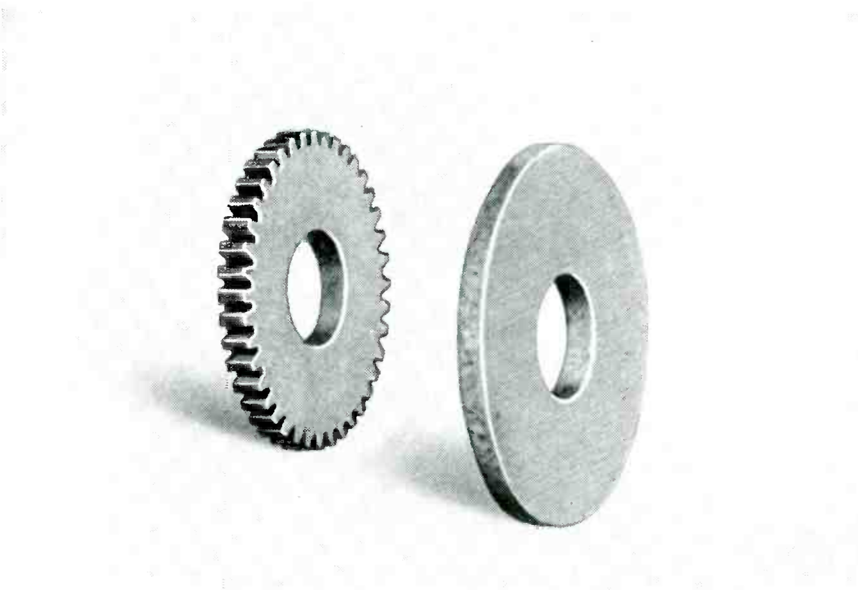


Aircraft landing gear bearings are fabricated of Taylor Grade LE-6 cotton base phenolic laminate to meet requirements of dimensional stability, wear resistance and low moisture absorption.

TAYLOR'S NEW COPPER-CLAD LAMINATE

Cu-246

...is now available for your volume production of printed circuits. High purity rolled copper surface is adaptable for all circuit production methods. Cu-246 is produced in all standard sheet sizes... in thicknesses from .020″ to .250″.



Special purpose gear is fabricated of Taylor Grade CEF phenolic laminate for Hadley Gear Mfg. Co. Taylor punches the gear blank to an I.D. tolerance of ± .001″ . . . material was selected for its excellent punchability, good machineability, moisture resistance and impact strength.

Taylor delivers precision parts

. . . *geared to your production schedule*

The inside diameter of this gear blank was punched to a tolerance of ± .001″ by Taylor's Fabrication Division—an example of the close tolerances which Taylor can meet. Taylor has special techniques and facilities for handling this type of work—acquired through years of experience in fabricating all kinds of laminates.

Taylor Grade CEF phenolic laminate was selected as the material for the gear blank—to take advantage of this laminate's excellent punchability and machineability as well as its moisture resistance and impact strength.

You can put Taylor's facilities and techniques to work improving your product. Taylor can deliver precision parts, such as this gear blank, fabricated to your most exacting specifications . . . geared to meet your production schedule.

When you have a problem of material selection or close-tolerance fabrication, or product design, check with Taylor. Chances are that Taylor's staff of home and field office specialists can help you in any or all of these essentials to a good product. Call or write your nearest Taylor sales office for a discussion of your requirements.

Circle 31 Readers Service Card

Circle 32 Readers Service Card →

Electron Tube News
—from SYLVANIA

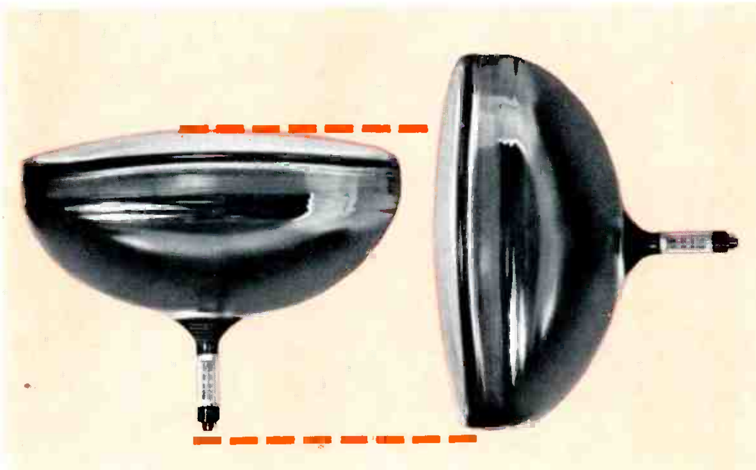
Creating New Design Trends—Everywhere in Electronics

IN 110° PICTURE TUBES . . .

Sylvania goes into production on the 24AMP4, a 24-inch 110° picture tube that fosters new concepts in set design

In 24-inch tubes—Sylvania applies the 110-degree deflection design to 24-inch picture tubes. The result is a tube 6″ wider than it is long. The new dimension permits interesting new concepts in TV chassis design as well as in cabinet styling. The new 24AMP4 presents a new opportunity for TV receiver manufacturers to score again with 110-degree TV sets.

The new 110° 24-inch tube weighs 26.5 pounds, some 6 pounds less than its 90° predecessors. It measures 15 5/8 inches in length, 3 1/2 inches shorter than 24″, short neck, 90° tubes. Useful width is 21 7/16 inches. Picture area is approximately 332 square inches. It does not require an ion trap. The 24AMP4 employs a 6.3 V., 600 ma. heater and external conductive coating is rated at 2000 to 2500 uuf.

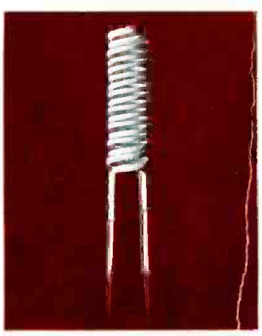


Sylvania's new 24-inch 110° picture tube, type 24AMP4, is 6 inches wider than long

In 21-inch tubes—Sylvania continues to lead the way in 110-degree, 21-inch picture tubes with the 21CQP4, the shortest 21-inch picture tube on the market. The tube measures 14 7/8 inches in overall length and weighs 20 pounds. The new shorter length in this Sylvania original is made possible by the new non-ion trap gun with electrostatic focus that reduces tube length up to a full inch.

IN CATHODE-RAY TUBE DESIGN

Sylvania develops a 450 ma. 6.3 volt heater for "cooler" TV receivers using series string heaters



New heater uses straight tungsten wire

Sylvania, trend setter in electron-tube design, has developed a 450 ma., 6.3 volt heater for picture tubes. The new heater meets the needs of portable TV receiver designs and lowers component costs. It reduces heat with total set power savings of 18 watts and permits use of a lower wattage, less expensive series resistor.

Here are some of the outstanding features of the new heater development:

- Double helical coil is wound from straight rather than a coiled tungsten wire as in other 450 ma. heaters.
- Rigid mechanical structure virtually eliminates tendency of heater to sag away from cathode cap and cause slow heating and low emission.

Following are the Sylvania tube types that employ the new heater design:

In 90° tubes—14XP4, 14XP4A, 17BKP4, 17BKP4A, 17BSP4, 17CEP4, 21CDP4, 21CDP4A, 21CKP4.

In 110° tubes—17BYP4, 21CSP4.

IN SPECIAL CR TUBES . . .

Sylvania expands its line of cathode-ray tubes for commercial and military use

Sylvania announces an expanded line of cathode-ray tubes for both military and commercial applications. The additional types now or soon available include the 3JP7, 7AB series, 5AHP4A and 5AHP7A, 10WP7, 12SP7D, 5UP1 and 3RP1.

Sylvania is also now featuring its line of conventional and special picture tubes for studio monitors and closed circuit TV. The types range in size from 8 inches through 24 inches.

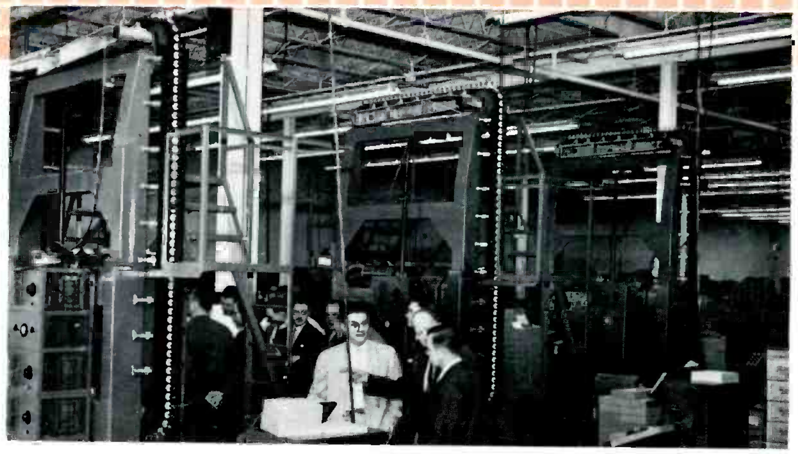
The entire Sylvania cathode-ray tube line incorporates electron guns with more precise parts made to 50 percent closer tolerances. This assures better performance and longer life whatever the application.

Sylvania's 7ABP7A–cathode-ray tube

Creating New Design Trends—

IN 100% TUBE TESTING . . .

Sylvania develops new automation equipment that makes possible full five-minute pre-heat testing of every receiving tube it makes



Sylvania customers view giant automatic tube tester

Sylvania now subjects each and every receiving tube it manufactures to an automatic five-minute pre-heat and tapping test. This gives added protection against shorts, noise, gas and other tube defects and reduces rejects on receiver-assembly lines.

At Sylvania's Williamsport plant, the giant machines shown, designed and built under the direction of Sylvania engineers, do the testing automatically. The tubes are loaded on a continuously rotating conveyor belt. Before the belt journey is completed, every tube is subjected to the pre-heat and tapping test. Then the tubes are automatically repacked for shipment.

This final extensive and intensive quality program at Williamsport combined with testing activities at each individual receiving-tube plant are reasons behind the high quality of Sylvania tubes.

IN TELEVISION . . .

Sylvania 6CK4—New Low-Mu Triode for Vertical Deflection Amplifier Service

Sylvania type 6CK4 is a low-mu triode designed for service as a vertical deflection amplifier in TV sets featuring wide-angle picture tubes and high cathode-ray tube accelerating potential.

Design factors including a T6 bulb provide a safety factor for conservative, reliable operation in such applications.

Ratings of type 6CK4 include 2,000 volts peak positive plate, a plate dissipation of 12 watts, and an average cathode current of 100 ma.

Average Characteristics:	
Plate Voltage	250 Volts
Grid No. 1 Voltage	−26 Volts
Plate Current	55 ma.
Transconductance	6500 UMHOS
Amplification Factor	6.7
Plate Resistance (Approx.)	1,000 OHMS
Grid Voltage for IB equals 0.5 ma.	−50 Volts
Plate Current at EC equals −38 VDC	10 ma.
Zero Bias Plate Current: EB equals 100V, EC equals 0 (instantaneous values)	125 ma.

New 110-degree damper types, 6DA4 and 12D4, have high peak current

Sylvania's new 110-degree damper types 6DA4 and 12D4 feature high peak current capabilities, low tube drop and adequate peak inverse plate voltage rating to make it a most desirable damper for 110° deflection. The 12D4 is a half wave rectifier for 600 ma series string usage. It is the 12-volt version of the 6DA4.

Maximum Ratings (Design Maximum System)	
Peak inverse plate voltage	4400 volts
Plate dissipation	5.5 watts
Steady state peak current	900 ma.
Average plate current	155 ma.
Tube voltage drop for IB-250 ma.	20 volts

Sylvania introduces the 6/8CY7 as a combined vertical deflection oscillator and amplifier in TV receivers

Sylvania adds the 6/8CY7 to its TV tube line as a supplement to the 10DE7. The new tube combines two dissimilar triodes in one T6½ envelope for use in 90-degree short neck picture tube circuits. The oscillator section features a high mu triode.

Maximum Ratings	Oscillator Section	Output Section
Plate dissipation	1.0 watts	5.54 watts
Peak-positive pulse plate voltage	—	1800 volts
Peak cathode current	—	120 ma.
Average cathode current	—	35 ma.

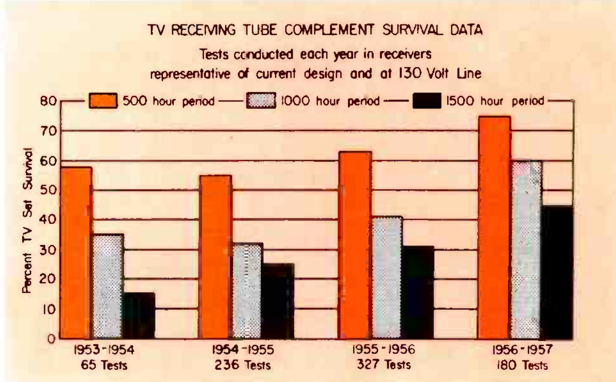
Everywhere in Electronics

IN TV LIFE TESTING RESULTS...

Percentage of Sylvania TV receiving tube complements surviving 1500 hours has tripled since 1954

Today Sylvania TV receiving tubes are setting new records in life tests. The percentage of TV tube complements surviving 1500 hours of operation at high line conditions has tripled since 1954 and is now at the highest rate in Sylvania history. This means assurance of a better field history as well as substantial savings in line operations for receiver manufacturers.

The overall survival rate for Sylvania TV receiver tubes has increased steadily through the years. In the past year alone there has been an average increase of 15 percent in TV tube complement survival. This represents the largest increase since 1953 and is a combined achievement of Sylvania's Dynamic Testing Program and better TV circuit design. Under the Dynamic Testing Program, individual Sylvania receiving tube types are evaluated in actual circuit environments in current TV set designs. Sylvania's Joint Engineering and Manufacturing Committee, JEMC, meets weekly to keep testing specs current. This kind of extraordinary care for receiving-tube quality is why Sylvania tubes last longer.



Increasing life of Sylvania tubes is a combined achievement of the Dynamic Testing Program and refinements in TV circuit design for better reliability

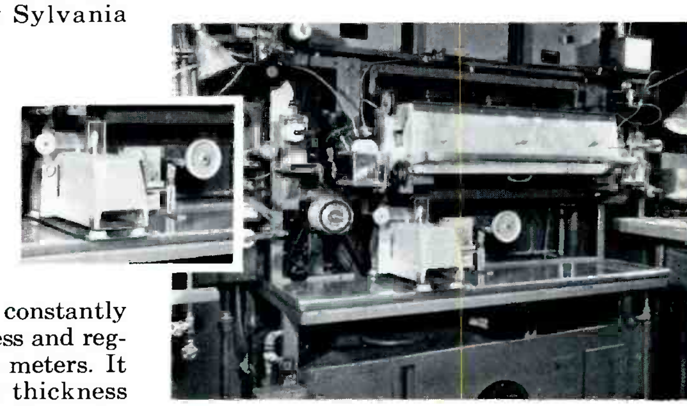
IN PROCESS CONTROL...

Sylvania uses an electronic micrometer to control filament coating thickness

Precise control of heater wire coating is of paramount importance in producing top-quality electron tubes. Proper coating means longer tube life and higher emission.

Sylvania controls filament coating thickness to the most exacting tolerances with an electronic micrometer.

The photoelectric device constantly monitors the coating process and registers thickness on electric meters. It immediately detects any thickness deviations and automatically stains the improperly coated heater wire with colored dye. The material can then be easily identified and rejected.



Sylvania's electronic micrometer automatically controls filament coating thickness. It automatically stains improperly coated heater wire with colored dye

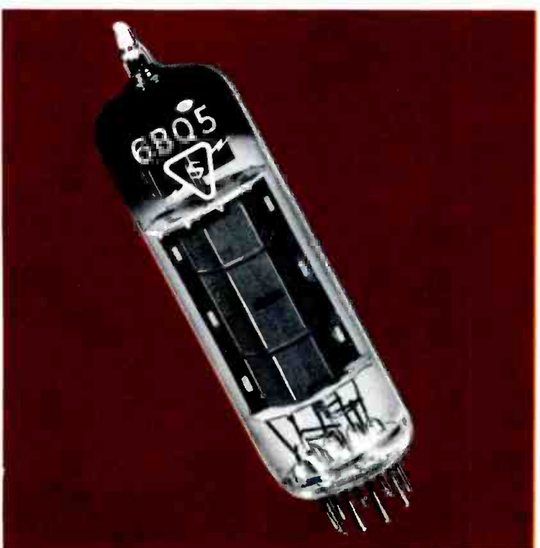
IN AUDIO TYPES...

New audio power pentode, type 6BQ5, has high sensitivity

Now Sylvania offers its version of one of the world's finest high-fidelity audio power amplifier tubes. Type 6BQ5 features high power output at extremely low distortion.

The high power sensitivity of type 6BQ5 makes it especially attractive.

The T6½ bulb used by this type is a desirable feature in compact high-fidelity equipment.



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New York 19, N. Y.

Creating New Design Trends—
—Everywhere in Electronics

IN COMPUTER TUBES...

Sylvania expands the availability of types 5963 and 5964 to meet rising computer demands

Now Sylvania is ready to meet fully the heavy demands from electronic computer manufacturers for types 5963 and 5964.

Type 5963 is a T6½ duotriode featuring high zero bias plate current. The tube is used as a frequency divider as well as in computers.

It performs dependably in intermittent operation. The sharp cut-off twin triode has individual cathode connections for separate operation of each section. It has a center tapped heater for 6.2 or 12.6 volt operation.

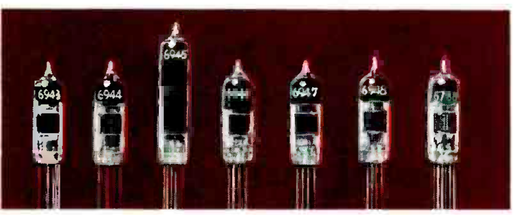
Type 5964 is a T5½ duotriode also featuring high zero bias plate current as in the 5963. The medium mu twin triode maintains its emission capabilities for long periods of operation under cut-off conditions.

	Computer Service Cutoff Conditions	Zero Bias Conditions
Type 5963		
Plate Supply Voltage	150 volts	150 volts
Grid Voltage	-15 volts	0 volts
Plate Circuit Resistance	20,000 ohms	20,000 ohms
Grid Circuit Resistance	47,000 ohms	47,000 ohms
Plate Current	0	5.1 ma.
Type 5964		
Plate Supply Voltage	150 volts	150 volts
Grid Voltage	-10 volts	0 volts
Plate Circuit Resistance	20,000 ohms	20,000 ohms
Grid Circuit Resistance	47,000 ohms	47,000 ohms
Plate Current	0	5 ma.

IN GUIDED MISSILE TYPES...

Sylvania builds its new guided missile line to meet the most severe requirements

Despite new extremes in heat, shock and vibration as today's missiles fly



higher and faster, Sylvania's guided missile line is meeting top performance standards.

Behind this outstanding record stands one of the most comprehensive tube developmental programs in the industry. It incorporates radical new tube designs, new materials and techniques to offer the most reliable tubes obtainable today for missile service.

Sylvania now has the following guided missile types available:

Type No.	Description
6943	Sharp cutoff RF pentode
6944	Semi-remote cutoff RF pentode
6788	Pentode audio voltage amplifier
6945	Audio beam power pentode
6946	Medium mu single triode
6947	Double, medium mu triode
6948	Double, high mu triode

SYLVANIA

Please send additional information on the items checked below.

- ☐ Type 24AMP4
- ☐ Type 21CQP4
- ☐ 450 ma. 6.3 v Heater Picture Tubes
- ☐ Special Purpose C-R Tubes
- ☐ Type 6CK4
- ☐ Types 6DA4 and 12D4
- ☐ Type 6/8CY7
- ☐ Type 6BQ5
- ☐ Types 5963 and 5964
- ☐ Guided Missile Line

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Use this handy business reply card to request additional information on these important new Sylvania developments

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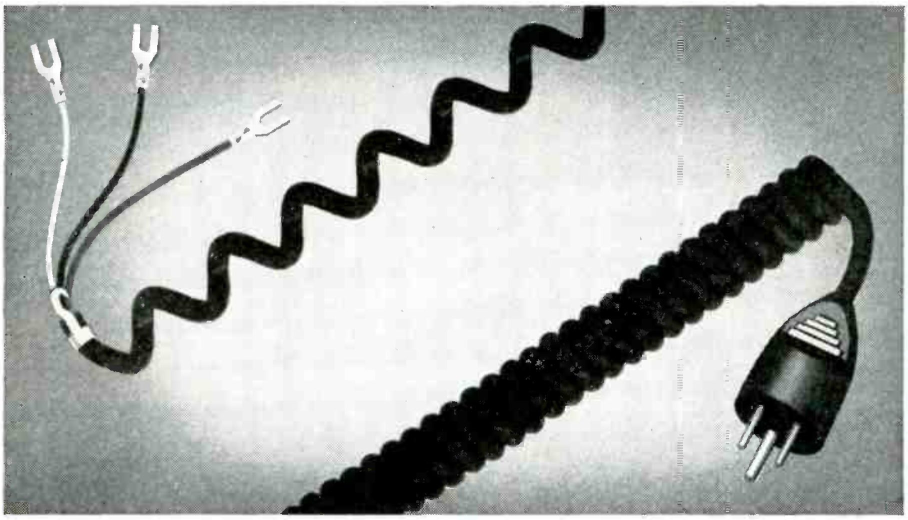
...add important convenience and safety features to your equipment!



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Coiled Cords, first choice in the communications industry, find numerous important applications in other fields! In addition to user convenience, Cords Ltd. Coiled Cords provide a safety factor preventing costly industrial accidents. Maintenance-wise, Coiled Cords give much longer service than straight cords by eliminating common abuses that shorten serviceability.

Product Data: A leader in the development of Coiled Cords, Cords Limited is a major supplier of this product to the telephone and communication industries. Coiled Cords are engineered for specific applications. Special oil, acid and moisture resistant properties of the jackets protect the product under unusual conditions. The most modern molding facilities for plug and conductor termination are available at Cords Limited to serve your needs quickly and economically!

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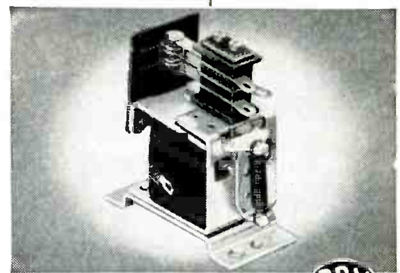

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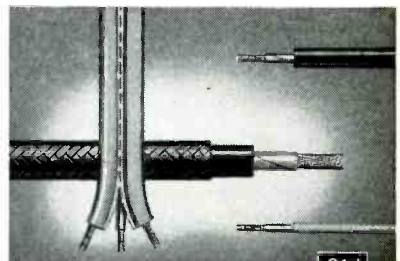

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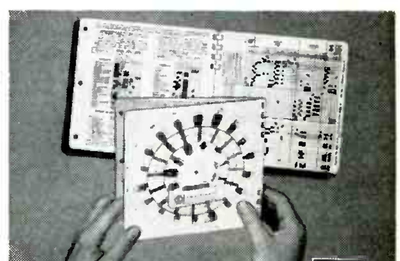

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The CORDINATOR®, a time-saving engineering tool, features simplified charts showing approved wire by product types. Dial side permits visual fabrication of cord sets and power supply cords. All components standard approved . . . minimizing cost . . . assuring scheduled delivery. Write for your free CORDINATOR.

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Now!

New low cost oscillator covers entire audio band in one sweep of the dial

-hp- 207A Audio Sweep Oscillator—continuous output 20 cps to 20 KC—flat response, low distortion—may be motor driven or coupled to recording device

SPECIFICATIONS

Frequency Range:
20 cps to 20 KC, covered in one range.

Accuracy:
±4% including changes due to warm-up, aging components, tubes, etc.

Dial:
Six-inch diameter dial calibrated over 300° of arc.

Frequency Response:
±1 db entire frequency range.

External Frequency Control:
¼-inch shaft, extending from rear of instrument, rotation approximately 150° for full frequency coverage.

Output:
10 volts into 600 ohm rated load, balanced or 1 terminal at ground.

Output Control:
Decreases level continuously by more than 40 db.

Distortion:
Less than 1% over entire frequency range.

Hum Voltage:
Less than 0.1% of rated output. Decreases as output is attenuated.

Power:
115/230 volts, ±10%, 75 watts.

Dimensions:
Cabinet Mount: 7½" wide, 11½" high, 15¼" deep. Rack Mount: 19" wide, 7" high, 12½" deep.

Weight:
Approximately 25 lbs.

Price:
$275.00

Data subject to change without notice

Here at last is a low cost, high quality oscillator providing the time-saving convenience of continuous single-sweep frequency coverage from 20 cps to 20 KC. The instrument has high waveform purity, constant output, high stability and dial calibration which is essentially logarithmic. Band switching and resulting transients are eliminated. A flexible 10 volt output can be used balanced or with one side grounded.

Model 207A may be swept by hand, motor driven, tuned remotely or coupled to a recording device by means of a shaft extended through the rear of the cabinet.

Priced at just $275.00, this new *-hp-* oscillator is an outstanding value and particularly convenient for such audio tests as speaker frequency response and amplifier flatness, measuring characteristics of filter networks, complex coupled systems and industrial transducers, or automatic response measurements where response is recorded or viewed on an oscilloscope.

650A — highly stable, wide band; 10 cps to 10 MC. For audio, supersonic, video, rf measurements. Output 15 mw/3 volts. Frequency response flat ±1 db. $490.00.

200AB — for audio tests, 20 cps to 40 KC. Output 1 watt/24.5 volts. Simple to use, compact, rugged. $130.00.

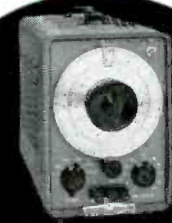
233A — carrier test oscillator covering frequencies 50 cps to 500 KC. Output 3 watts/500 ohms. $475.00.

200CD — popular precision instrument for audio and ultrasonic tests. 5 cps to 600 KC; output 160 mw/10 volts; 20 volts open circuit. $160.00.

11 additional -*hp*- quality oscillators

- outstanding value
- complete coverage 0.008 cps to 10 MC
- stable RC circuit pioneered by -*hp*-
- each instrument designed to do a specific job best

206A — very low distortion; for high quality, high accuracy audio tests. Covers 20 cps to 20 KC; output +15 dbm. $565.00.



200J — extreme accuracy for interpolation and frequency measurements. Covers 6 cps to 6 KC, output 160 mw/10 volts; 20 volts open circuit. $275.00.

205AG — time-tested convenience for high power tests, gain measurements. 20 cps to 20 KC. 5 watts output. $440.00.

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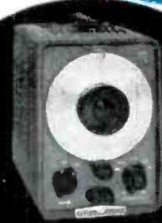
202C — replaces famous 202B for low frequency measurements 1 cps to 100 KC. Output 160 mw/10 volts; 20 volts open circuit. $300.00.

202A — for servo, vibration, medical and other very low frequency measurements. 0.008 to 1,200 cps. Output 20 mw/10 volts. $465.00.



201C — specifically designed for high quality audio tests. Covers 20 cps to 20 KC. Output 3 watts/42.5 volts. $225.00.

4170

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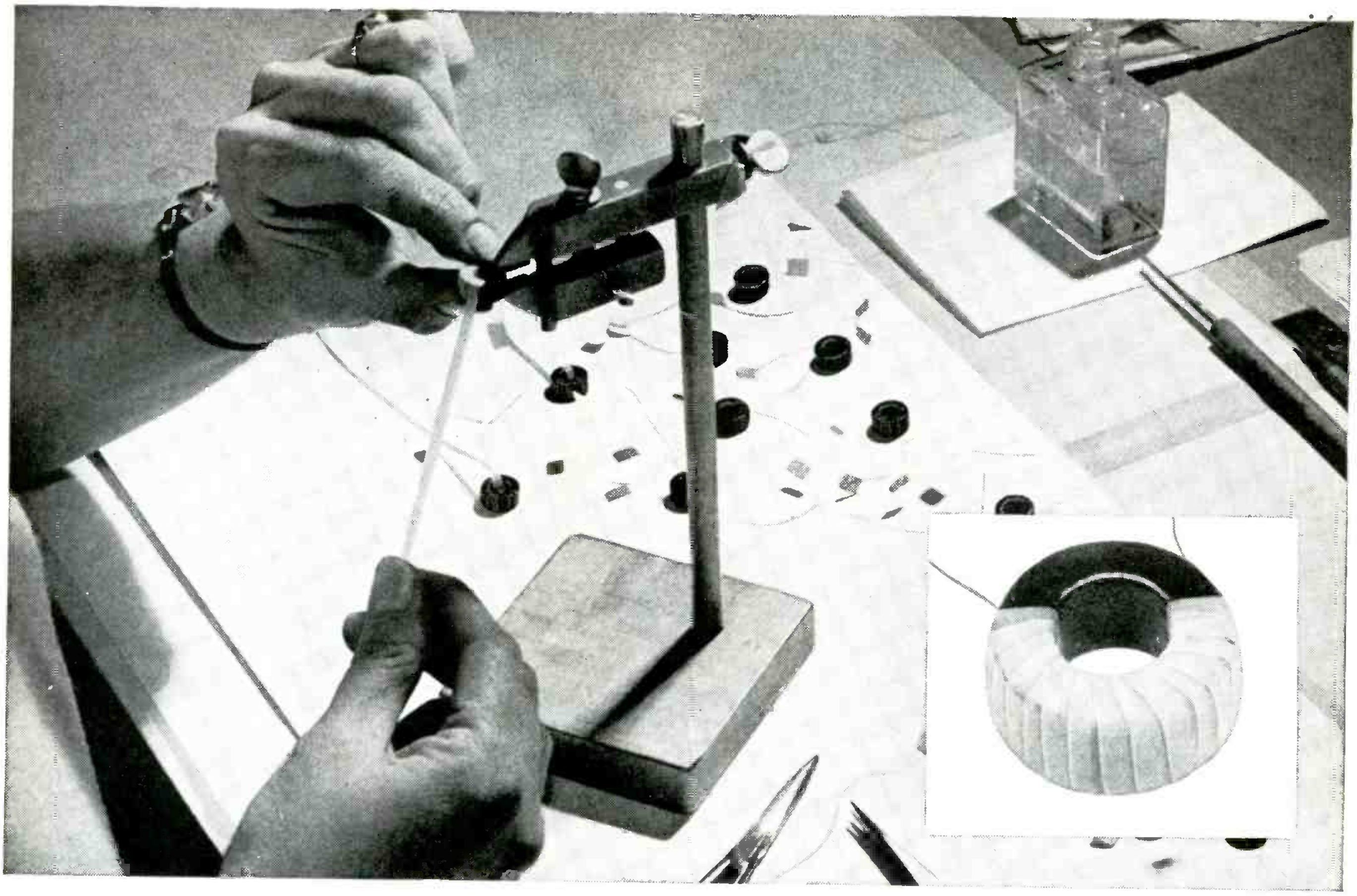

How R/M "Teflon"* Tape improves electronic component design

Has high dielectric strength • conforms to intricate shapes

Certain coils in a modern electronic computer required a special kind of insulator. Problem: to design an insulator of the high dielectric strength required—even in thin sections—and conforming to the contours of the small circular coils.

R/M "Teflon" Tape provided the ideal solution to the problem. "Teflon" has unusually high dielectric strength. It is completely unaffected by the many adverse conditions to which electronic components are frequently subjected—corrosive elements (including ozone) in atmospheres, high temperatures, and the like. R/M "Teflon" Tape is relatively easy to apply—even on intricate shapes, such as the ferrite coil shown above.

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

1. **Power factor** — less than 0.0003 over entire spectrum from 60 cycles to 30,000 megacycles.
2. **Volume resistivity** — greater than 10^{15} ohm-cm, even after prolonged soaking in water.
3. **Surface resistivity** — 3.6 x 10^{12} ohms, even at 100% humidity.
4. **Good arc-resistance** — on exposure to an arc, the material vaporizes, leaving no carbonized path.
5. **High short-time dielectric strength**—values range from 1000 to 2000 volts per mil, depending upon thickness.
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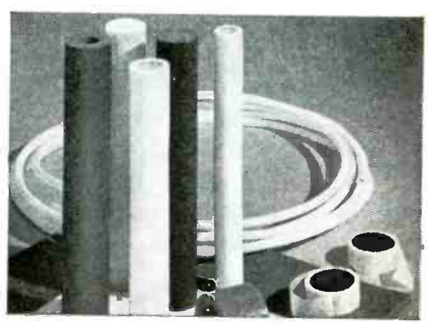
Raybestos-Manhattan has extensive experience in developing R/M "Teflon" products for use in the electrical and electronics industries. Let us fabricate R/M "Teflon" products to your specifications or supply the material in rods, sheets, tubes and tape. Write for your free copy of our bulletin "R/M Teflon Products."



*A Du Pont trademark

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Rods, slabs, strip and tube. All formulations.

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Sheets, rods, sleeving. Plasticized and unplasticized.

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All grades, sheets, rods, tubes, including copper clad in stock.

PLEXIGLAS
Clear and Colors, Military and "R" grades.

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Crystal clear sheets to 1" thick. All sizes rods and tubes.

POLYETHYLENE
Rolls (all gauges) Pipe, tubes, rigid and layflat, bags, sheets rods and billets to 36" diameter.

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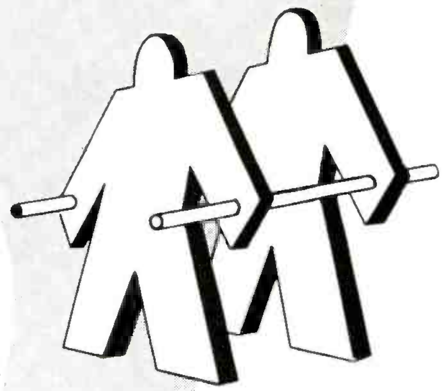
Rods, sheets, rolls.

VINYLITE
Rigid and flexible sheeting, hi-dielectric tubing, layflat and heavy wall pipe.

Custom Fabrication Of All Material

Immediate Delivery

A warehouse completely stocked with sheets, rods and tubes for all your needs



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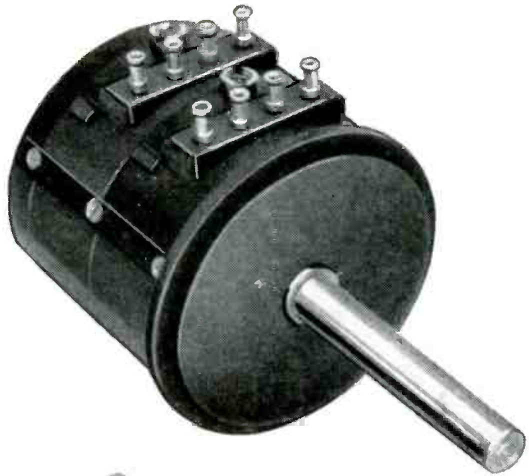

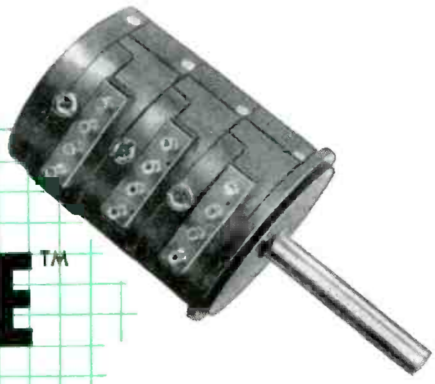

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Single-turn, variable-phasing precision potentiometers meeting A.I.A. electrical and mechanical specifications. Five sizes in wide range of resistance values and output functions—7/8", 1 1/16", 1 5/8", 2" and 3" diameters. Available as single or gang assemblies. Various mountings and bearings available.

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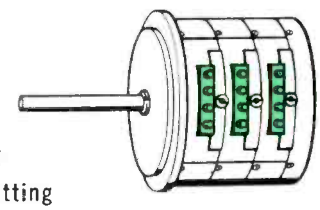
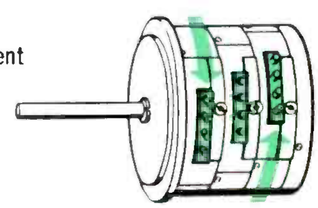
Independent external phasing, before or after mounting:

Phasing may be done before or after mounting and wiring, permitting readjustment to compensate for circuitry-component tolerance.





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Monitor radiated signal frequencies 100 times faster!

with accuracy of ± 1 cps...over range of 0.54-30.5 megacycles

Beckman/Berkeley Model 7700 Microsensitive Frequency Measuring System

Featuring

Exclusive direct digital readout—7-place numerical display for speed, accuracy and convenience.

Broad utility—measures AM, ICW, frequency shift keyed and multiplexed signals.

Extreme sensitivity—detects and measures signals of 1 microvolt strength.

Advanced engineering design—exceeds FCC specifications, is suitable for compliance with Part 15, FCC Rules and Regulations.

Wide range and bandwidth selectivity—30 1-mc frequency bands; bandwidth of 100 cps-6 kc for interference rejection.

Price: $3500.00 F. O. B. factory

DESIGN AND PERFORMANCE SUPERIORITY

Comprising a unique combination of a quality communications receiver and a high-speed electronic counter, Beckman/Berkeley Model 7700 provides 100,000 times the customary counter sensitivity, and 100 times the frequency measurement speed of other equipment. Its extreme sensitivity and accuracy permit quick, precise measurement of virtually all types of radiated signals in the 0.54 to 30.5 megacycle range, with maximum error of 1 in 10^7.

Simple and easy to use, the Model 7700 makes possible the measurement and monitoring of broadcast or other frequencies by non-technical personnel with a minimum of training. The system consists of three basic units: a broad range communications receiver, a translator with oscilloscope comparator, and a time-gated electronic counter. An audio system is incorporated for aural monitoring where desired.

Complete technical information on the Beckman/Berkeley Model 7700 Microsensitive Frequency Measuring System is available on request. Write to Dept. G11

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HOW TO ADD TO THE Saleability OF MANY ELECTRICAL PRODUCTS

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TO ENGINEERS, Stackpole Slide Switches in more than a dozen inexpensive types offer many interesting design possibilities for improving product performance.

TO BUYERS of today's instruments and appliances, the convenience of unique and attractive modern switching arrangements exerts strong sales appeal that far exceeds the modest cost involved.

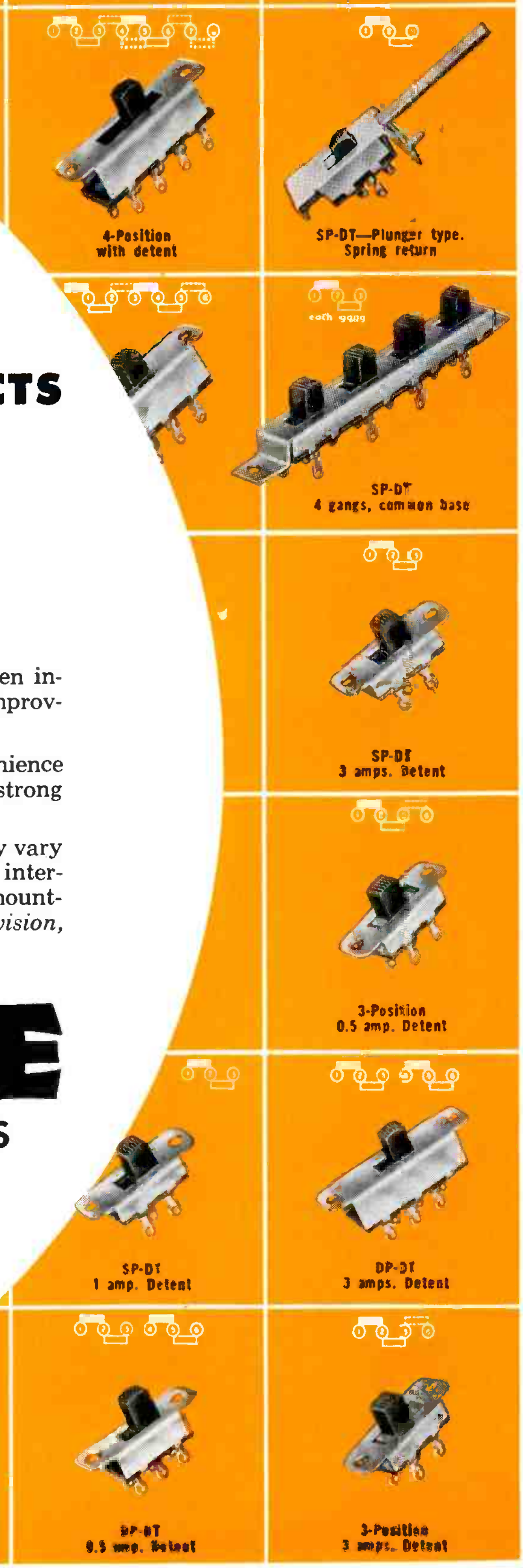
Stackpole Slide Switches cover the ½ to 3 ampere range. They vary from simple ON-OFF units to types that provide complicated inter-circuit switching in minimum space—often with less costly mountings than conventional switches. *Electronic Components Division,* STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

STACKPOLE

S-L-I-D-E SWITCHES

***New* SLIDE SWITCH DATA**

Stackpole Bulletin RC-10D — just out — gives complete ratings, dimensions, modifications, and other specifications for all standard Stackpole Slide Switches. Write for your copy or see your local Stackpole representative



KEY TO CONTACT ARRANGEMENTS

POSITION 1
POSITION 2
POSITION 3
POSITION 4

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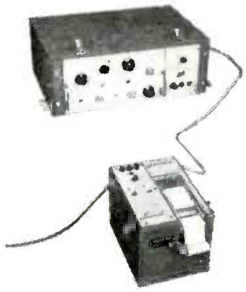
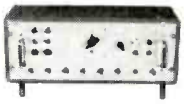
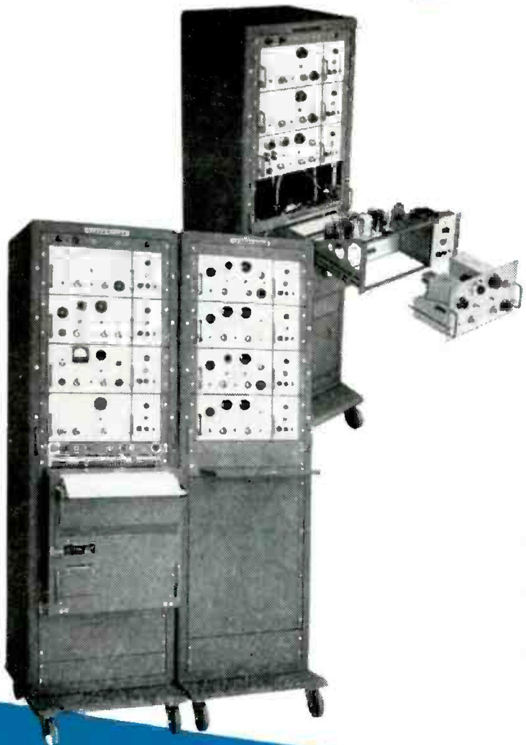




"B"

"A"

SYSTEMS 1



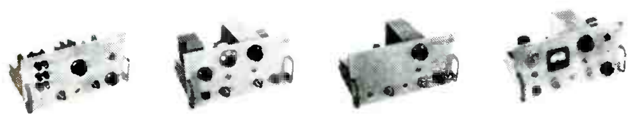
BASIC "150" assemblies housed in either vertical mobile cabinets or separate portable cases are available in 1-, 2-, 4-, 6- and 8-channel models. Each is equipped with driver amplifiers of current feedback design and regulated power supplies for *each* channel, and a recorder featuring *nine* extremely accurate paper speeds on 2- to 8-channel models, five on single channel units. Appropriate plug-in preamplifiers quickly and efficiently equip a basic assembly for recording virtually any 0-100 cps phenomena.

new 6- and 8-channel analog readout systems

In addition, complete Sanborn systems from 2- to 8-channels are available for recording analog computer outputs. These are equipped with dual-channel DC amplifiers, for single-ended or push-pull signals — input impedance 5 megohms each input lead to ground — drift less than 0.5 mm/hr. — frequency response down 2 db at 60 cycles for all amplitudes to 4 cm peak to peak. Newest of the computer readout recorders are the 6- and 8-channel console systems (8-channel illustrated — "A" at left). The Model 183 Programmer in a Model 184 case ("B" at left) is optional for use with the 6- and 8-channel consoles. The Programmer automatically turns on chart drive, feeds calibrated signals to all channels, reads computer DC levels, determines the length of record, and shuts off the paper drive.

SANBORN

oscillographic recording equipment



2 PREAMPLIFIERS

A choice of *twelve* "150 Series" plug-in preamplifiers is now available, to equip systems for any of numerous recording problems. Improved control of input signals results from attenuator ratios of 1, 2, 5, etc., and calibrated zero suppression on AC-DC, Carrier, and Low Level DC Coupling, Frequency Meter, and Chopper Stabilized DC models. Other "150" preamplifiers include: Servo Monitor, Log-Audio, AC Wattmeter, RMS Volt/Ammeter, 400 cycle Frequency Deviation, and Triplexer.

3 UNIT INSTRUMENTS

All Sanborn Preamplifiers and Recorders, as well as various other units, are available separately for specialized applications or use as "original equipment" in other apparatus. Instruments include the Model 150-300/700 Wide Band Driver Amplifier and Power Supply, for use with low power galvanometer elements, a 'scope and/or panel meter. When equipped with suitable "150" preamplifier, this amplifier provides a portable indicator for strain, force, pressure, temperature, AC watts, audio level, etc. Other units include the Model 150-1900 Master Oscillator Power Amplifier: Model 150-3100 Triplexer; Model 601 and 602 galvanometers; Model 150-2900 Dual-Channel DC Amplifier.

Added to these three aspects of Sanborn Oscillographic Recording Equipment are the basic advantages of inkless recording in true rectangular coordinates, to provide accurate, easily interpreted records; high torque galvanometer (10 ma develops 200,000 dyne cm.); one percent linearity resulting from current feedback driver amplifiers and high torque galvanometers (maximum error is 1/4 mm in middle 4 cm of chart, 1/2 mm across entire chart); controls for timing, manual and remote coding.

Take advantage of the scope and flexibility of Sanborn equipment to answer your recording requirements. Sanborn engineers will be glad to provide further information and application assistance whenever you wish. Contact your local representative or write to the main office below.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 WYMAN ST. WALTHAM 54, MASS.

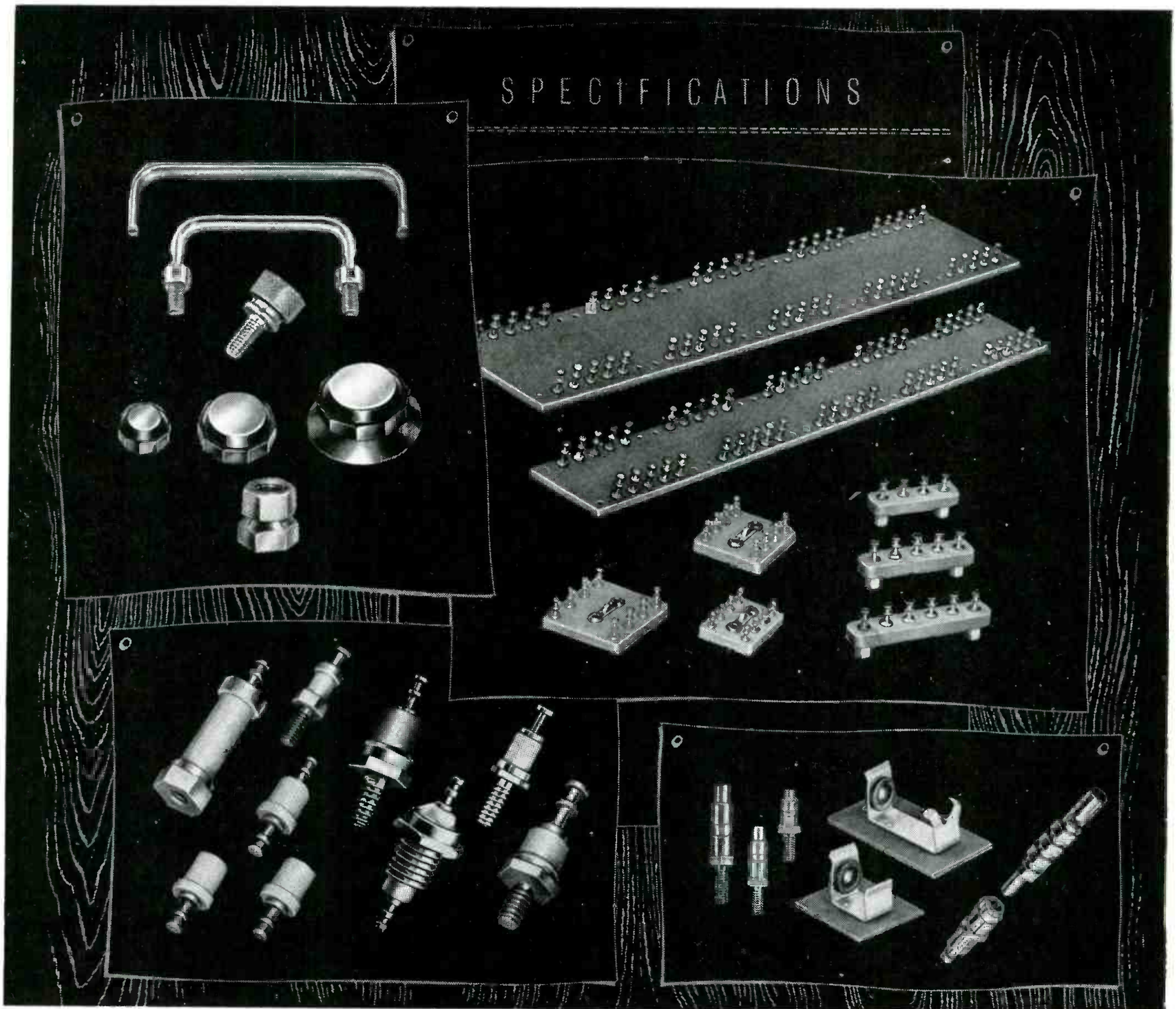


Photo shows wide variety of CTC components. Upper left, hardware, knobs, panel screws. Upper right, standard terminal boards, phenolic and ceramic. Bottom row, insulated terminals in ceramic and teflon, diode clips, battery clips, plugs and jacks. Common denominator — CTC reliability.

If specifications call for durability specify CTC hardware

Durability is not just a term at CTC — it's practically a manufacturing process! Take the above line of CTC hardware for example. CTC guarantees it and every one of its components unconditionally — in any quantity! That's high quality control — quality control that meets or betters all applicable military and government specifications. CTC quality controls the raw material, each step of production and the finished product — the result — *exceptional durability.*

Best of all you get this durability economically. In fact — you couldn't make such hardware items cheaper yourself! Our large selection of standard panel and chassis hardware fills most needs. If you require custom design, contact us direct.

Send for CTC's Catalog 600 — it has all the details of CTC's complete hardware line. Write to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass. On the West Coast contact E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, and 1560 Laurel St., San Carlos, Calif.

CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components
custom or standard

Concerned with microwave test equipment?

Only NARDA offers you these exclusive features!

TURRET ATTENUATORS

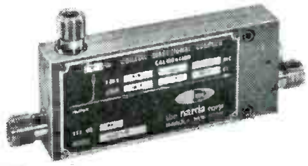
Only Narda offers you a UHF-only attenuator. This represents a considerable savings in cost for applications in this frequency range. Each of three models offers the Designer or Development Engineer 12 steps of attenuation from d.c. to 1,500 mc with a VSWR of 1.25. Designed for bench use or mounting into test equipment packages.

One unit can give a maximum of 30 db attenuation; two units can be used in series to provide a wide range of control in small steps.

Model 705—0, 3, 6, 9, 12, 15, 20, 25, 30 db
Model 706—0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20 db
Model 707—0, 3, 6, 9, 12, 15, 18, 21 INF db

ALL MODELS . . . **$275** each

COAXIAL DIRECTIONAL COUPLERS



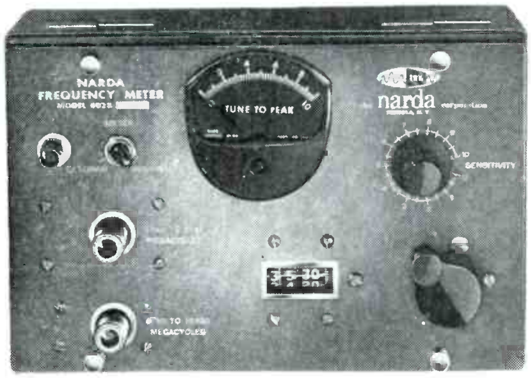
10, 20 and 30 DB . . . 225 to 4,000 mc.

Only Narda offers coaxial directional couplers in 10 and 30 db values, as well as 20 db. In addition, all models offer such advantages as these:

1. Flat Coupling—values with 1 db of nominal over a full octave frequency range, with calibration provided to ± 0.2 db accuracy.
2. Machined from solid blocks of aluminum—hence, more rugged.
3. Directivity exceeding 20 db.
4. Frequency Ranges: 225-460, 460-950, 950-2000, 2000-4000 mc.

Write for complete specifications.

$100 to $225



S to X BAND FREQUENCY METER

Narda offers the only single instrument covering this complete band of frequencies—2,350 to 10,500 mc. In addition, no combination of other meters can cover these frequencies at a comparable price!

An easy to read nomograph type calibration chart, mounted in the lid, converts digital counter readings to frequency in megacycles—to the rated accuracy of 0.2%. No calculations or interpolations are needed.

The unit is completely self contained, with built-in detector and indicating meter. A sensitivity control allows use with strong signals; for signals below 5 mw., the external meter jack may be connected to an amplifier or oscilloscope.

Model 802B . . . **$785**

UHF FREQUENCY METER DETECTORS . . . Direct Reading

The only direct reading frequency meter detectors available for the UHF range—and they're from Narda, of course! Absorption type meters, with 0.2 db insertion loss, each includes a resonant cavity, coaxial switch, crystal detector, current meter, sensitivity control and type N terminals.

SPECIFICATIONS

Frequency (mc)	Accuracy	Loaded Q	VSWR	Sensitivity for full scale deflection	NARDA Model	Price
200-500	0.5 mc	500	1.15	0.2 mw	804	$375
500-1500	1 mc	700	1.15	0.2 mw	805	375
1500-2400	2 mc	500	1.25	0.5 mw	806	375

Complete Coaxial and Waveguide Instrumentation for Microwaves and UHF — including:

DIRECTIONAL COUPLERS	TUNERS	ATTENUATORS
TERMINATIONS	ECHO BOXES	STANDARD REFLECTIONS
FREQUENCY METERS	SLOTTED LINES	BOLOMETERS
HORNS	BENDS	THERMISTORS

the narda microwave corporation

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The Narda Microwave Corporation
160 Herricks Road
Mineola, N. Y.
Dept. E-2.

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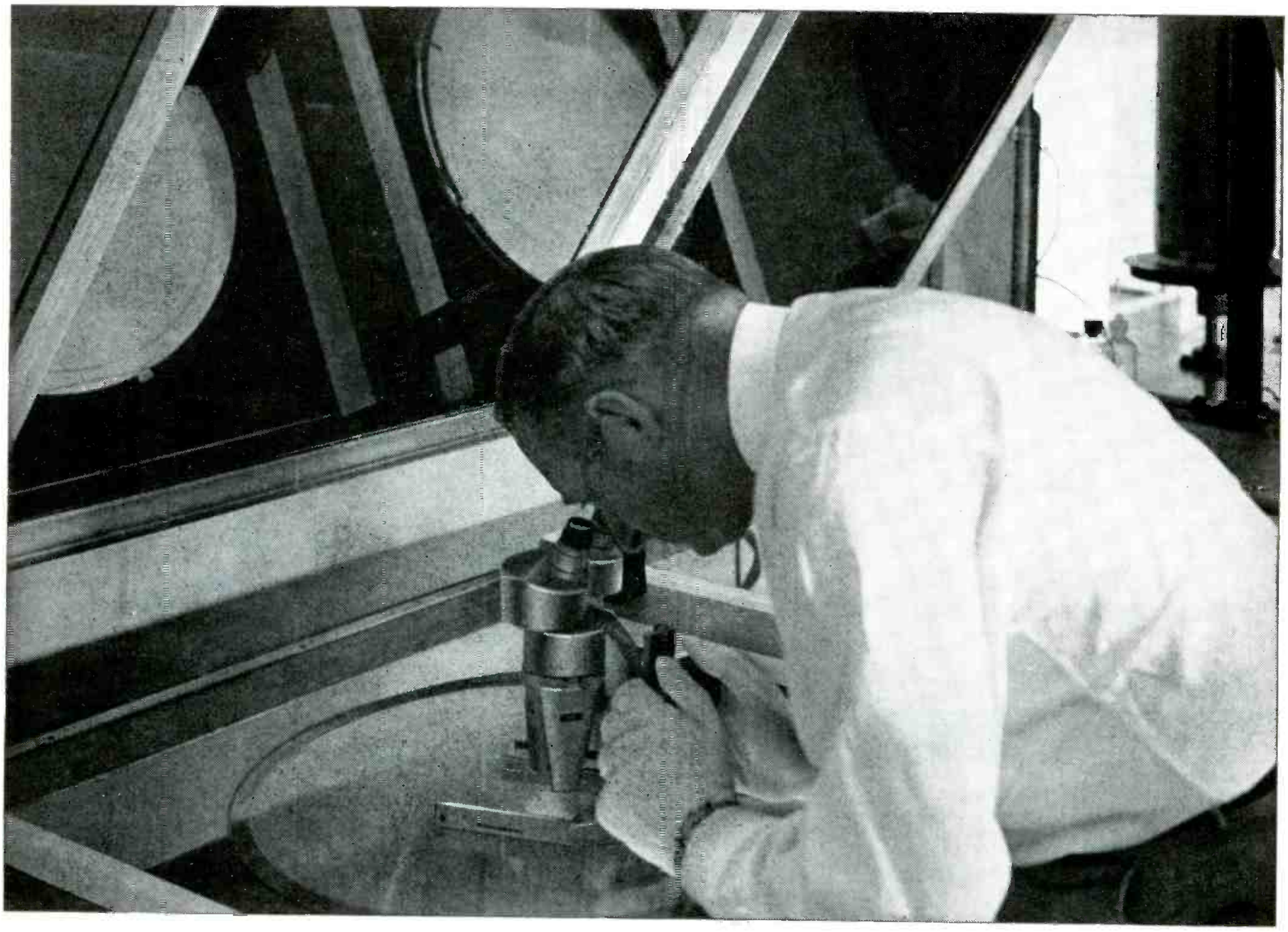
COMPANY__________

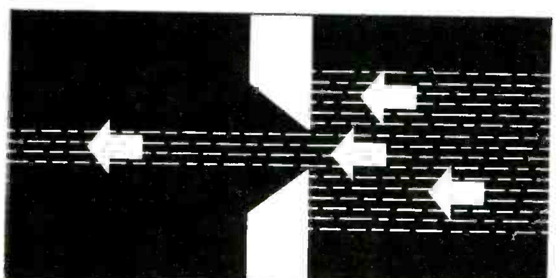
ADDRESS__________

CITY______ ZONE____ STATE____

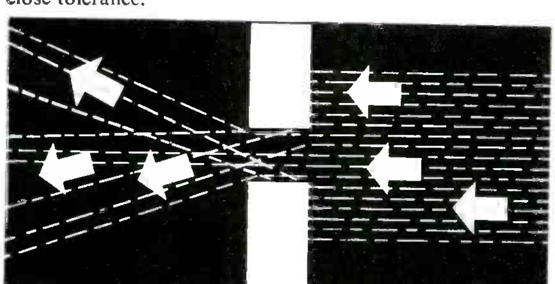


Get Sharper, Truer Color TV Pictures

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



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



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

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

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

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

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

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

Superior Tube

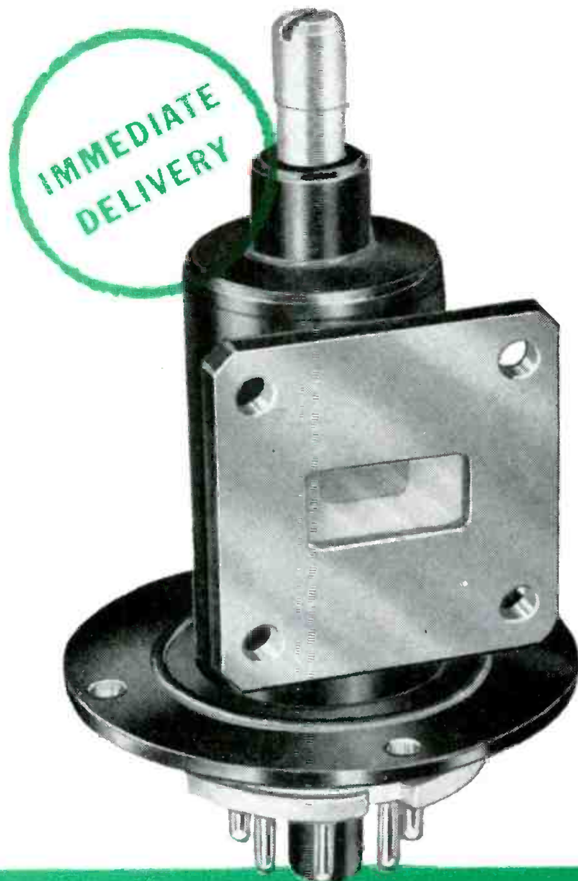
The big name in small tubing

NORRISTOWN, PA.

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

SRU-55 Series Klystrons give high power at low voltage

Small reflex oscillator klystrons for 14.5-17.0 kmc and 15.7-17.0 kmc



SRU-55 OPERATING SPECIFICATIONS		SRU-55A OPERATING SPECIFICATIONS
14.5 to 17.0 kmc	Frequency	15.7 to 17.0 kmc
300 v	Beam Voltage	300 v
45 to 75 mw	Output Power (optimum load)	40 to 45 mw
20 mw	Minimum Output Power	20 mw

Ready for immediate delivery are two Sperry K Band Klystrons. The SRU-55 and SRU-55A satisfy a multiplicity of requirements yet are manufactured with the economies of a single tube type.

The SRU-55 was developed primarily as a local oscillator in radar systems. Only 3 13/32" high and 1 5/16" in diameter, it couples rugged construction with superior vibration characteristics to withstand the severe environment of airborne applications for thousands of hours. The SRU-55 exhibits high frequency stability under abrupt changes in line voltage. Objectionable leakage has been controlled to eliminate need for external shielding. Other features include low voltage operation and ease of tuning over an extremely broad range with no appreciable hysteresis.

The SRU-55A was designed especially as a signal source for test sets like the AN/UPM-28-29. Other applications: local oscillator in microwave receivers and spectrum analyzers; low-power transmitting tube. Important features include minimum leakage and excellent test modes. Dimensions and operating features are similar to those of SRU-55. Write or phone your nearest Sperry district office for more details.

ELECTRONIC TUBE DIVISION

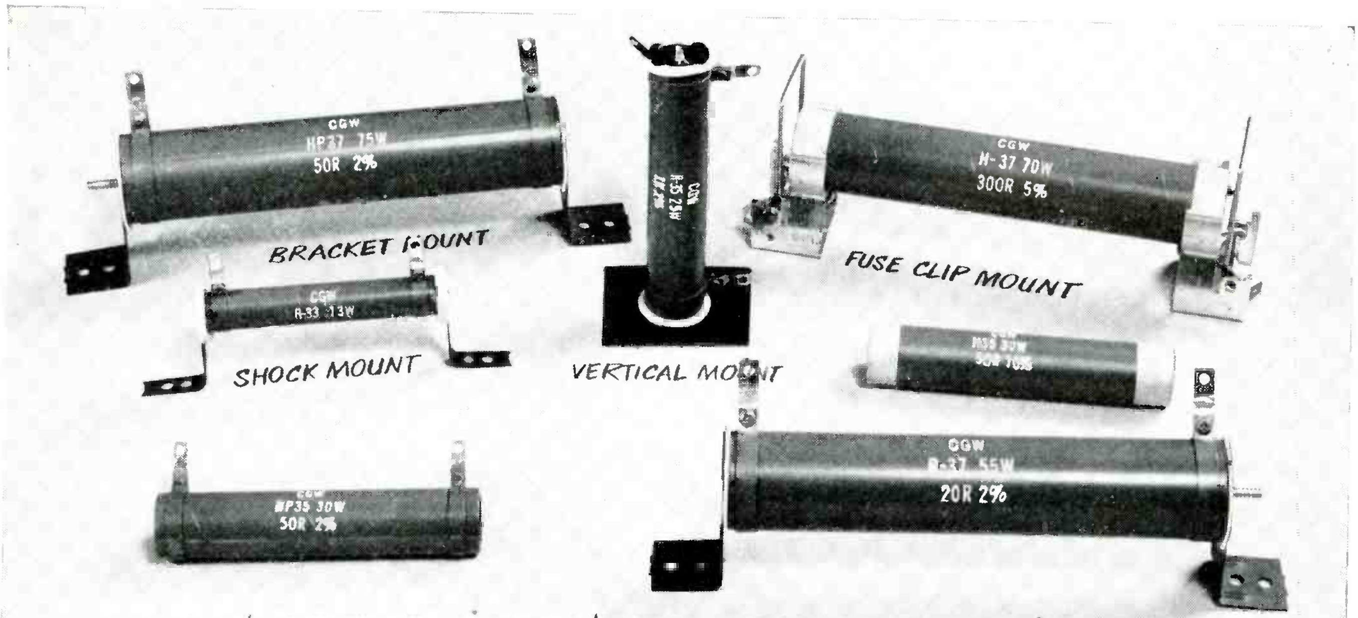
SPERRY GYROSCOPE COMPANY

Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION

BROOKLYN • CLEVELAND • NEW ORLEANS • LOS ANGELES • SAN FRANCISCO • SEATTLE. IN CANADA: SPERRY GYROSCOPE COMPANY OF CANADA, LTD., MONTREAL, QUEBEC

Circle 50 Readers Service Card



TYPE	RES. RANGE MIN.	MAX.	POWER RATING		LENGTH
R	10 Ω	1,000 K	7-115 W	DC	1½" to 12"
H	10 Ω	1,000 K	7-140 W	AC	1½" to 12"
HP	10 Ω	500 K	17-150 W	DC	3" to 12"

Why Corning High-Power, High-Frequency Resistors meet your most exacting circuit requirements

You'll find Corning High-Power and High-Frequency Resistors designed for stable, long-life service—even under the most difficult operating conditions.

With Corning Resistors you get the highest resistance range for a given physical size compared to wire-wound resistors.

Their thin-film construction makes them inherently non-inductive. The noise level of these resistors is so low it's difficult to measure. The resistive film is a metallic oxide, fused to the PYREX® glass core at red heat to form a permanent bond. This special glass insures highest core resistivity even at elevated temperatures, great resistance to chemical attack and to mechanical and thermal shock.

These Corning Resistors are remarkably stable regardless of moisture and humidity.

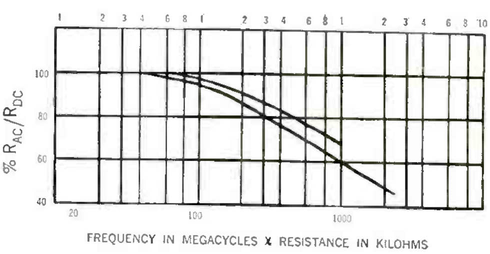
They meet all characteristics of MIL-R11804B.

The chart in the next column gives you a quick idea of their exceptional frequency characteristics.

The ranges and ratings shown in the illustration are for our standard lines, but we can design and build resistors to match your own requirements for all usable frequencies. We have made specials with ratings up to 150 kw. and we can go higher.

Within the standard range of these resistors, we can give you wide variations in mounting hardware. You can get hardware for vertical or horizontal mountings and mountings to absorb mechanical shock and severe vibration. Ferrule-type terminals are available for use with standard fuse clips.

For more complete details, write for catalog sheets.



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

**Distributed by Erie Resistor Corporation*

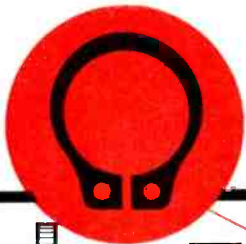
Corning means research in Glass

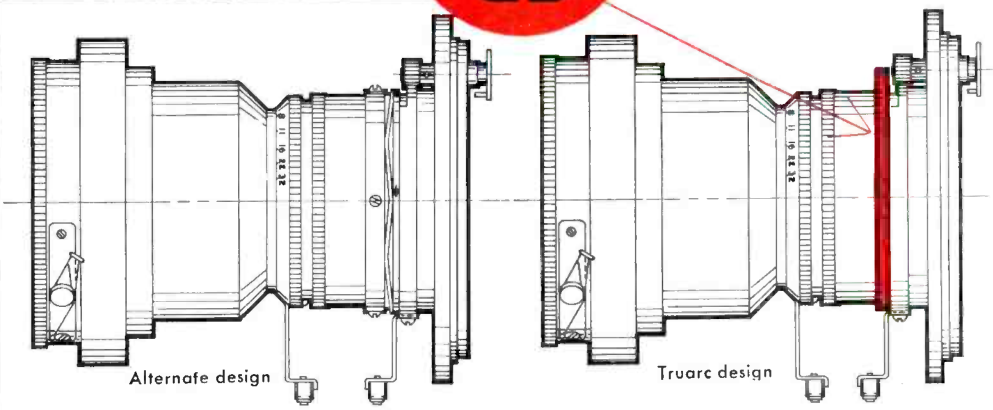
CORNING GLASS WORKS, 94-11 Crystal Street, Corning, N. Y.
Electronic Components Sales Department

Waldes Truarc Retaining Ring eliminates 7 parts, saves $8.88 in sub-assembly of aerial reconnaissance camera

Gordon Enterprises, No. Hollywood, California, saved the Navy almost 1½ million dollars on 500 cameras. Gordon rebuilt new, efficient "CA" series out of Navy-owned obsolete models. Critical parts are now held together by Waldes Truarc Retaining Rings.

Truarc Rings are trouble-free, will not change position during operation. Accuracy is limited only by groove and ring dimension tolerances. And standardized Truarc Rings are quickly interchangeable in overhaul which now takes only 11 minutes, can be handled by unskilled technicians.





Weight Saving: 7.25 oz.

Assembly Time Saving: . . . . . 6½ min.

DOLLAR SAVINGS:

Material	**$ .93**
Fabrication	**6.88**
Inspection	**1.07**
Total	**$8.88**

Truarc 5100-287 ring retains shutter speed adjustment mechanism on the Lens Adapter Plate Assembly which mounts and locks the lens and shutter assemblies accurately to camera body. Alternate design required retaining washer, spring, collar and 4 locking screws.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

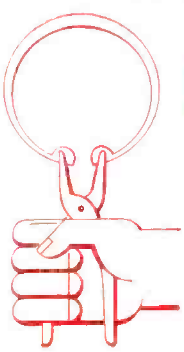
Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Controlled Quality from engineering and raw materials through to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool!



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Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications. *(Please print)*

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E119

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

glass-base laminates?

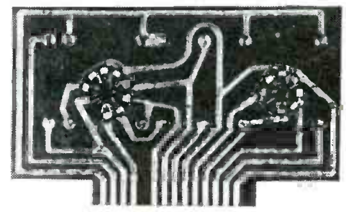
C-D-F DILECTO®
is the answer!

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

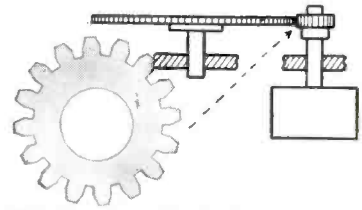
You can improve design, speed production, and save money by specifying one of the many C-D-F Dilecto grades. Whatever your application for these laminates — with fine- or medium-weave glass-cloth base — you'll find a better answer to your problem at C-D-F. (Melamine can also be made with glass-mat base.)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

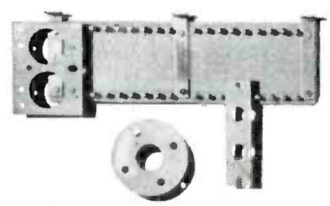
*DUPONT TRADEMARK FOR TETRAFLUOROETHYLENE RESIN



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-10	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.

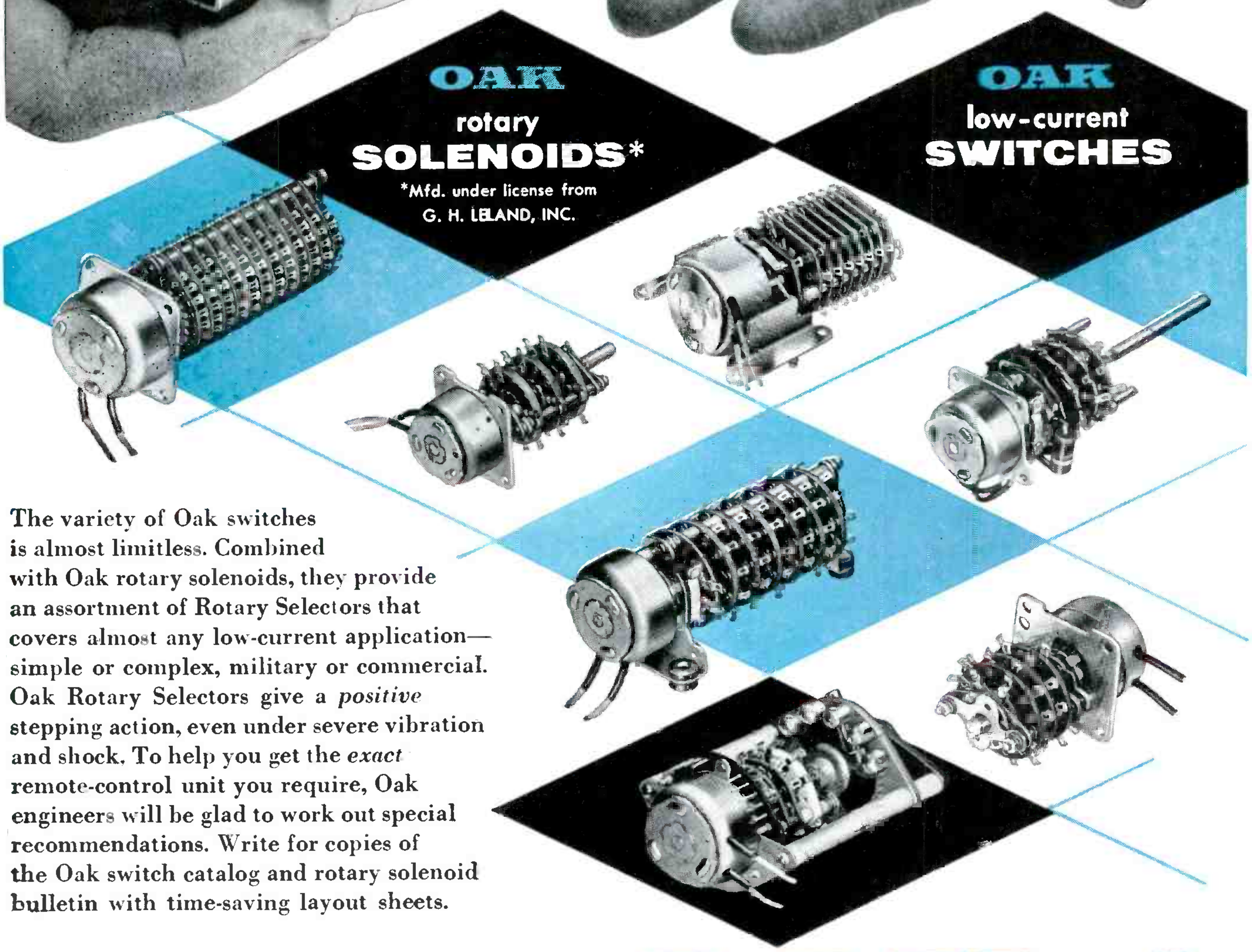
CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE Budd COMPANY • NEWARK 16, DELAWARE

Circle 53 Readers Service Card

thousands of combinations for

REMOTE CONTROL SWITCHING



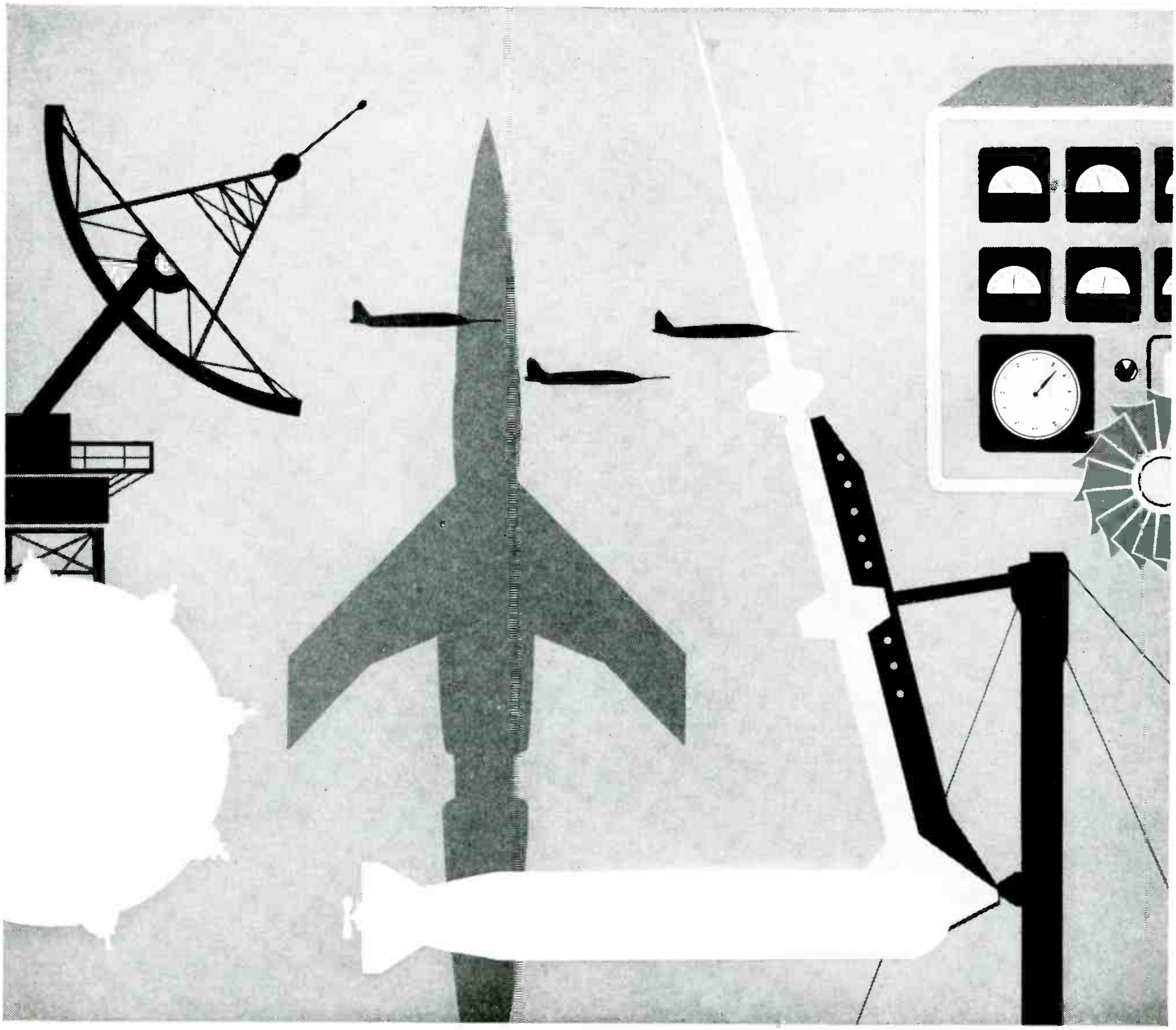
The variety of Oak switches is almost limitless. Combined with Oak rotary solenoids, they provide an assortment of Rotary Selectors that covers almost any low-current application—simple or complex, military or commercial. Oak Rotary Selectors give a *positive* stepping action, even under severe vibration and shock. To help you get the *exact* remote-control unit you require, Oak engineers will be glad to work out special recommendations. Write for copies of the Oak switch catalog and rotary solenoid bulletin with time-saving layout sheets.

SWITCHES • ROTARY SOLENOIDS • CHOPPERS • SPECIAL ASSEMBLIES • VIBRATORS • TUNERS

OAK MFG. CO.

1260 Clybourn Avenue, Dept. G, Chicago 10, Illinois
Phone: MOhawk 4-2222

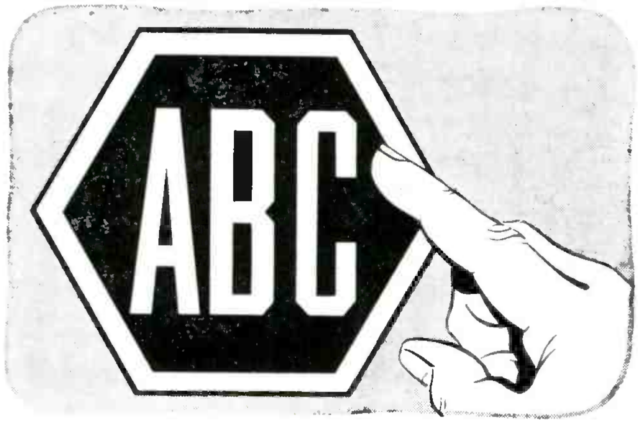
Circle 54 Readers Service Card



Who's Minding The Store?

. . . *in the magazine publishing business, it's*

The Audit Bureau of Circulations (ABC) is a cooperative organization that sets standards of good business conduct for its publisher members. Twice each year ABC auditors carefully scrutinize the entire circulation structure and operation of every member magazine. In a very real sense, therefore, they are "minding the store" — making sure that no false or misleading claims are made regarding the size or composition of a magazine's audience.



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You, the subscriber, win when you buy business magazines that hold membership in the Audit Bureau of Circulations. The ABC symbol signifies that the publication to which you subscribe makes every effort to provide you with the type of informatin you need to do a better, more effective job. It also indicates that the publisher maintains the highest standards of business ethics.

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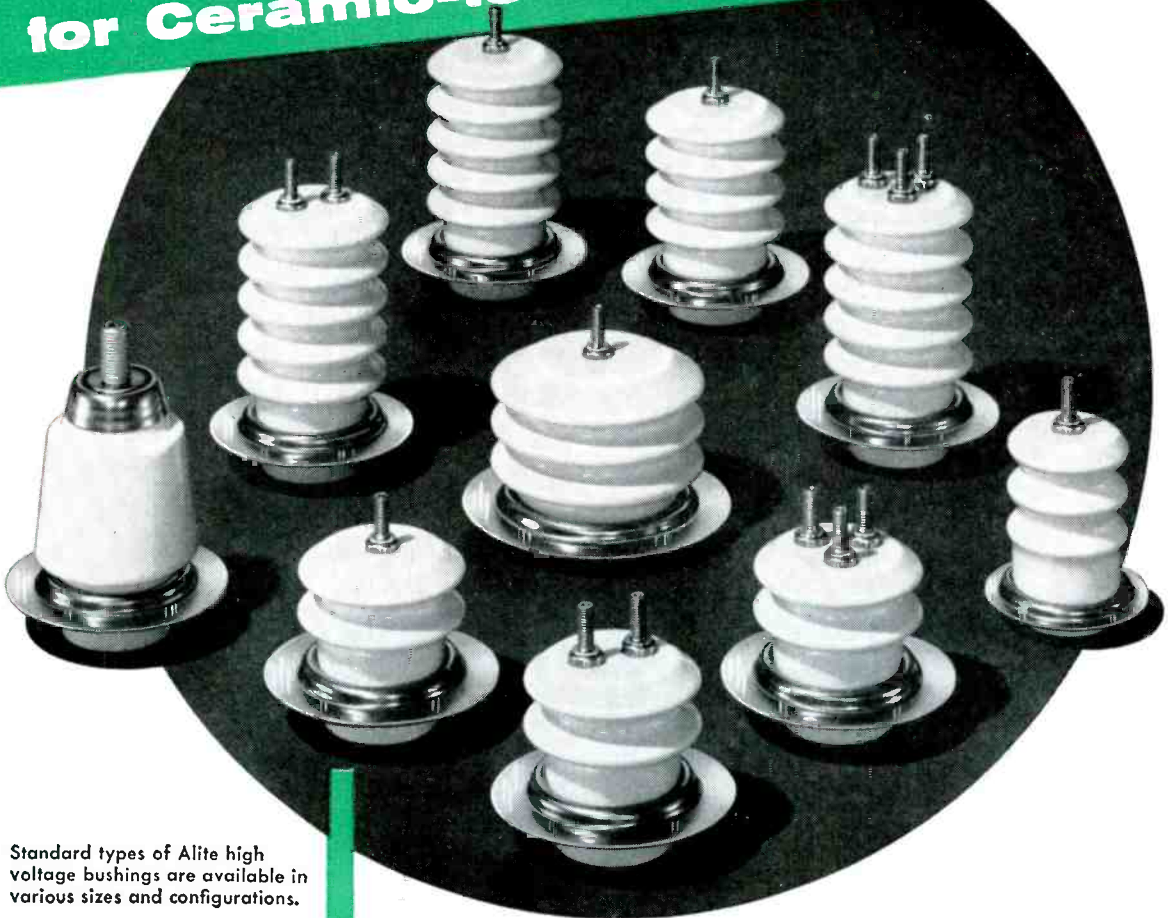

Standard types of Alite high voltage bushings are available in various sizes and configurations.

In *all* phases of planning for ceramic-to-metal seals—from design to finished assembly—you can rely on ALITE for the know-how and "*do*-how" required to produce highest quality ceramic-metal components for critical applications.

High alumina Alite is the ideal material for making rugged, high performance hermetic seals and bushings. It has superior mechanical strength, high temperature and thermal shock resistance, plus reliable electrical characteristics. Our complete high temperature metalizing and bonding facilities assure delivery of the finest seals available—mass-spectrometer tested for vacuum-tightness.

Please contact us for valuable performance data and information regarding ceramic-to-metal applications . . . no obligation.

INSIDE LOOK AT ALITE—

Fact-packed, illustrated Bulletins A-20 and A-7R just off the press. Give vital technical data and product information. Write today.

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Fenwal THERMOSWITCH Temperature Controls are enclosed in a tamper-proof assembly that's built to take grueling punishment — and stay highly accurate, uniformly sensitive throughout the operating range — *and its range is three to five times that of an ordinary thermostat!*

That means you can run your machine at greater speeds . . . your machine will require less maintenance! It means greater flexibility for your machine — greater sales for you — *and all at a low first cost.*

Even the assembly of a Fenwal THERMOSWITCH unit is easier and cheaper! The application of Fenwal THERMOSWITCH units are limitless — they're being used in planes . . . factories . . . ships . . . hospitals . . . homes . . . laboratories — *used almost any place where temperature is a factor and accuracy is a must!*

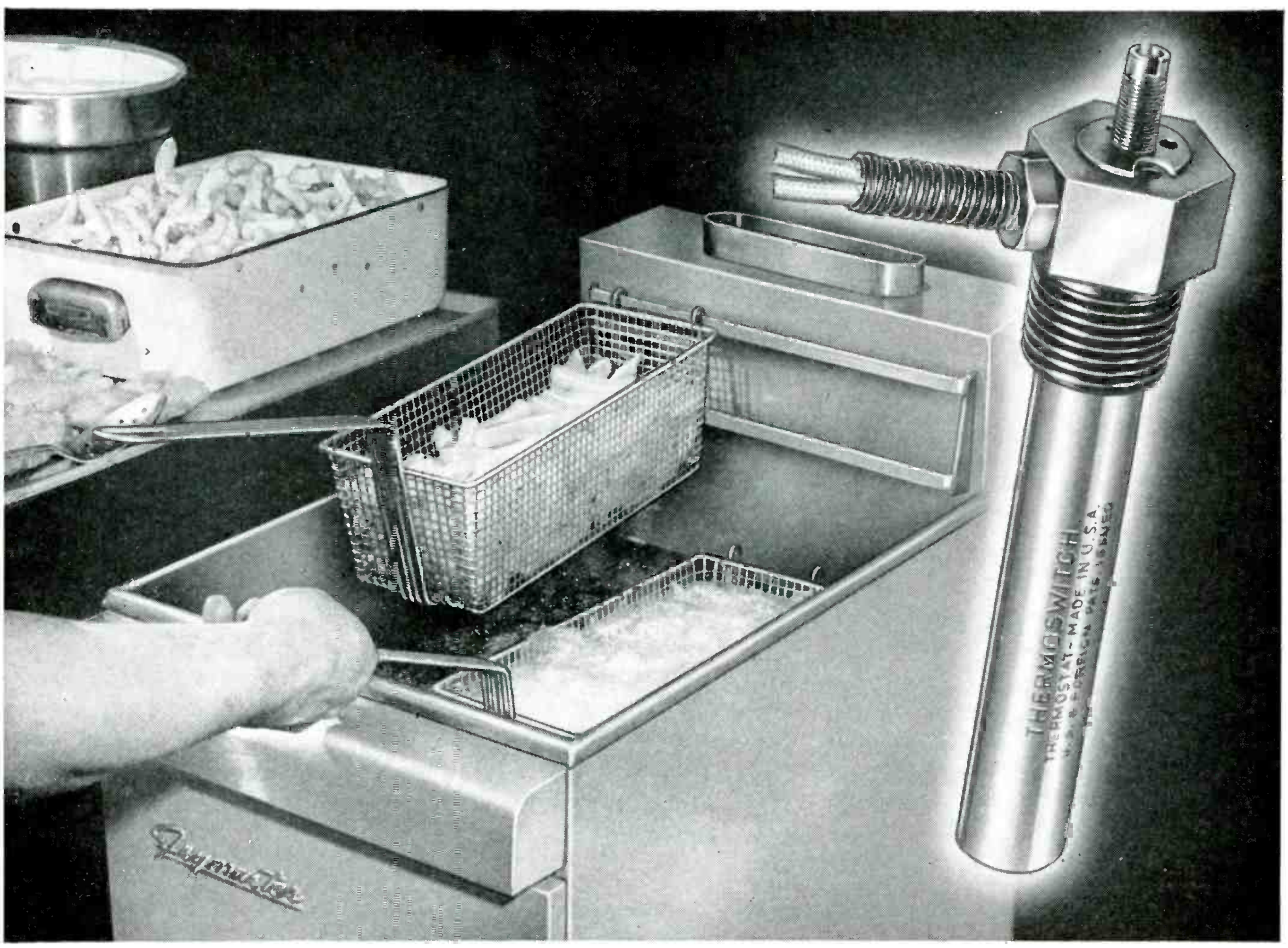
Drop us a line at Fenwal Incorporated, 2011 Pleasant Street, Ashland, Mass. and we'll send you our catalog MC-135 or our sales engineer, whichever you want.

It's a tough life

but the sensitive

Fenwal THERMOSWITCH® unit takes it in its stride

This is our 17000 series (we've got 25,000 other variations with the operating ranges from –100°F to 600°F) in use in Master Jet Frymaster. The Fenwal control gives the machine rapid, precise response; greater reliability — even makes it more economical by conserving cooking fat and gas!



Fenwal CONTROLS TEMPERATURE . . . PRECISELY

having your ups and downs?

if they involve EQUIPMENT KNOBS

DALOHM has the answer!

Precision-made Dalohm knobs, incorporating an exclusive collet-fitting design, permit positive locking on the shaft without any of the damaging effects found in other knob securing methods—even when used on soft metal.

You can depend on DALOHM Ω ®

TYPE K INDUSTRIAL KNOBS

for hard use at high/low temperatures

- Precision cast of thermo-setting plastic in easy grip shapes
- Knobs fit concentrically on shaft and can be positioned easily and accurately
- Pleasing appearance to match modern styling of apparatus
- Five sizes—⅝", 1-1/16", 1¾", 2¼", 3"
- Collets interchangeable for shafts ⅛" to ⅜"
- Highest quality at lowest price
- Standard escutcheons, pointers and indicators available

Write for Bulletin K-29

TYPE MS MILITARY STYLE KNOBS

in accordance with MIL-K-25049

The incorporation of collet-fitting design into military style knobs offers the ultimate in airborne and other military knob applications.

- Maximum locking pressure on shaft eliminates any slippage from vibration or torque
- Precision made of tough, durable thermoplastic material which is fungus proof.
- All metal parts are corrosion resistant
- Designed for flatted shafts
- Complete selection of skirts available as required by
- MIL Specs. Marking of skirts can be to your specific requirements

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TYPE MS KNOBS SHOWN ACTUAL SIZE

JUST ASK US!

Write for the complete Dalohm catalog of knobs, precision resistors, and potentiometers.

If none of our standard line fills your need, our staff of able engineers and skilled craftsmen, equipped with the most modern facilities, is ready to help you solve your problem in the realm of development, engineering, design and production.

Just outline your specific situation.

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Export Dept:
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New York 1, N.Y.

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2 New Ultra·Stable frequency sources

- Stabilities of better than 1 part in 10^8 per day
- Priced at a fraction of comparable instruments

MANSON MODULAR HIGH STABILITY OSCILLATOR

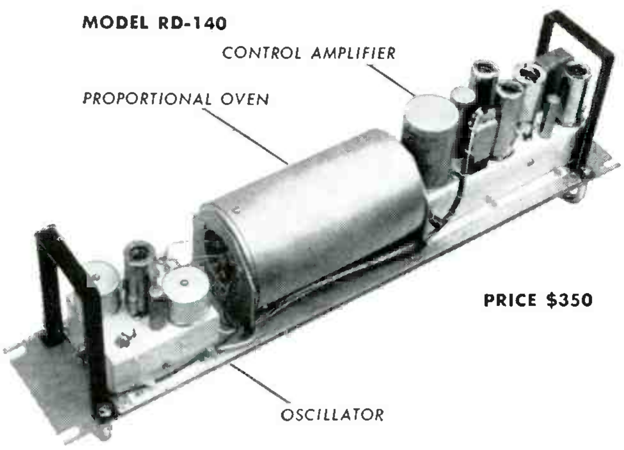
An exceptionally compact, stable and low-cost crystal-controlled oscillator suitable as a one-megacycle reference source or as a master oscillator in frequency control systems. Its panel-mounted sub-assembly construction meets MIL specifications for construction and environmental temperature range.

SPECIFICATIONS

FREQ. STABILITY: Better than 1 part in 10^8 per day.
FREQUENCY: 1 megacycle, adjustable 10 cycles to compensate for crystal aging and to allow periodic resetting of frequency.
OUTPUT: Sine wave, 1 volt RMS across 50 ohms.
MOUNTING: Standard 19" relay-rack panel, 3½" high, with handles.

Available, less oscillator assembly, as Manson Model RD-130 PROPORTIONALLY-CONTROLLED OVEN SYSTEM for temperature controlling crystals, oscillator circuits, thermocouples and other temperature-sensitive components. This non-cycling system holds oven temperature to within 1/1000 of ambient changes. Oven can be set at any point from 10°C to 100°C above ambient, with vernier adjustments available.

MODEL RD-140



PRICE $350

Write today for full information

1-MC. HARMONIC REFERENCE OSCILLATOR

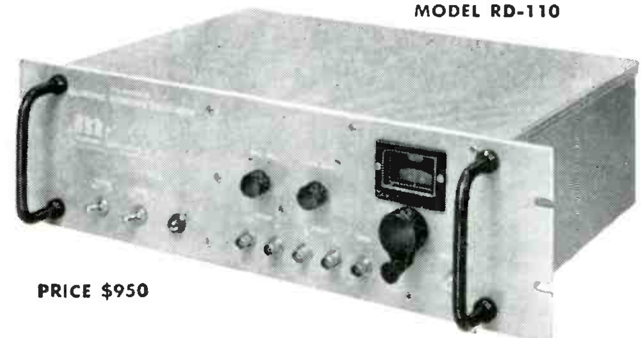
a laboratory-level frequency standard
plus
a jitter-free milli-microsecond pulse source for harmonic measurements

A complete, self-contained system for frequency measurement or monitoring. Built-in balanced mixer enables the direct determination of unknown frequencies up to 1000 mc. Unique circuit provides extra wide-range tunability. Non-microphonic design and proportionally-controlled thermo-oven insure exceptional insensitivity to both vibration and temperature. Regulated power supply incorporated.

SPECIFICATIONS

FREQ. STABILITY: Better than 1 part in 10^8 per day.
FREQUENCY: 1 megacycle tunable ±25 cycles.
TUNING ACCURACY: To 0.1 cps with ultra-linear dial. Direct readout frequency counter assures substantially zero-error readability and resettability.
OUTPUTS: Pulse: Jitter-free, balanced, 40 volts peak across 250 ohms; rise time better than 20 milli-microseconds.
Sine wave: 3 volts RMS across 50 ohms.
HARMONICS: Usable harmonics extend to the kilomegacycle region.
SIZE: 5¼" H x 19" W x 11¾" D for rack or bench.

MODEL RD-110



PRICE $950

100-KC HARMONIC REFERENCE GENERATOR

Model RD-120 available as accessory, providing additional fundamental frequency with jitter-free pulse and sine-wave outputs. Incorporates own mixer and beat-frequency amplifier. Also usable as an independent 100-kc oscillator.

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at SEA
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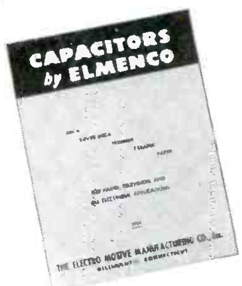
El-Menco

Dur-Mica CAPACITORS do the job BETTER!

MIGHTY MICAS
Do the Work
of GIANTS

Now, Stronger Than Ever . . . give up to 18 years of sure, rugged service!

Put through a series of rough tests, these tiny, tireless workhorses of the electronics industry came up with a record-smashing performance. El-Menco engineers found that El-Menco DM-15, smallest mica capacitor in the world, DM-20 and DM-30 Dur-Mica Capacitors beat all others for long life and tried reliability. Under accelerated conditions of 1½ times rated voltage at 125° C ambient temperature, El-Menco Dur-Micas kept on going strong even after 12,000 hours . . . equal to 18 years or more of service under normal operating conditions.



Write for FREE samples and catalog on your firm's letterhead.

El-Menco Dur-Mica DM-15, DM-20, DM-30, DM-40 and DM-42 Capacitors outlive, outperform, outshine . . .

Longer life . . . tremendous power . . . tiny size . . . terrific stability — silvered mica . . . perfect performance. Test them for yourself and see . . .

DM-15 — tiniest mica capacitor in the world . . . ideal for extreme miniaturization . . . up to 820 mmf at 300 VDCW . . . up to 400 mmf at 500 VDCW.

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With newly-designed crimped leads . . . Parallel leads simplify use in TV, electronic brains, miniature printed circuits, guided missiles, and countless other applications. El-Menco Dur-Mica Capacitors meet all humidity, temperature and electronic requirements, including military specs.

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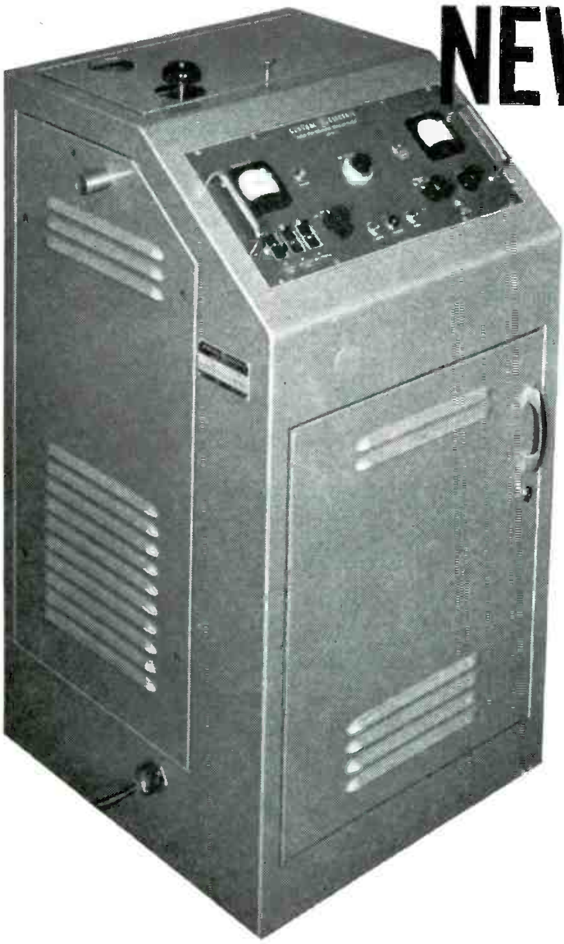
Circle 61 Readers Service Card



NEW General Electric M-2 Leak Detector Offers You

UNSURPASSED LEAK SENSITIVITY

Expensive rejects of sealed electronic products can be reduced by leak testing housings before assembly with the new General Electric mass spectrometer leak detector. It offers:

EXTREME SENSITIVITY—detects leaks of 1 X 10^{-10} standard cubic centimeters of air per second (9 X 10^{-6} micron cubic feet per hour).

FAST RESPONSE—as low as 2 seconds for small, hermetically sealed electronic components.

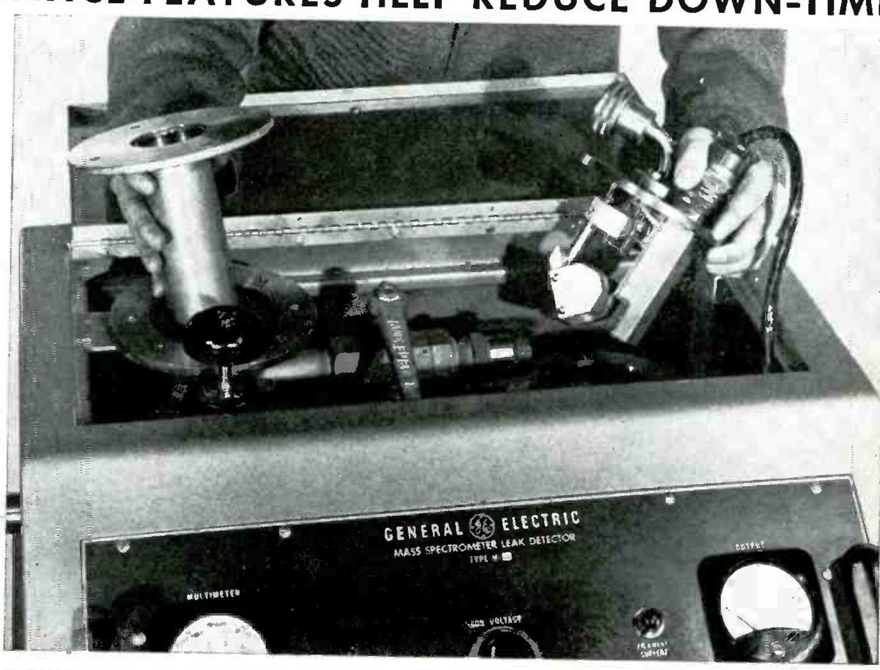
HIGH RESOLUTION which helps eliminate the possibility of response to elements other than the tracer gas.

THESE EASY MAINTENANCE FEATURES HELP REDUCE DOWN-TIME

SIMPLIFIED DESIGN of the vacuum system and use of plug-in components gives excellent accessibility and saves maintenance time. The easily removed spectrometer tube greatly reduces down-time when the tube needs cleaning or filament replacement.

NO SPECIAL TRAINING is needed to operate the General Electric M-2 leak detector. After starting, the M-2 is operated simply by opening and closing one valve. The leak will show up on the leak rate indicator of the operator's panel. An audible alarm is also available.

FOR FURTHER INFORMATION, contact your nearest General Electric Apparatus Sales Office or write for descriptive bulletin, GEC-336, to Section 585-63, General Electric Co., Schenectady 5, N. Y.



DOWN-TIME IS REDUCED through easy access and removal of the spectrometer tube (right) and by a simplified vacuum system design.

GENERAL ELECTRIC

Circle 62 Readers Service Card

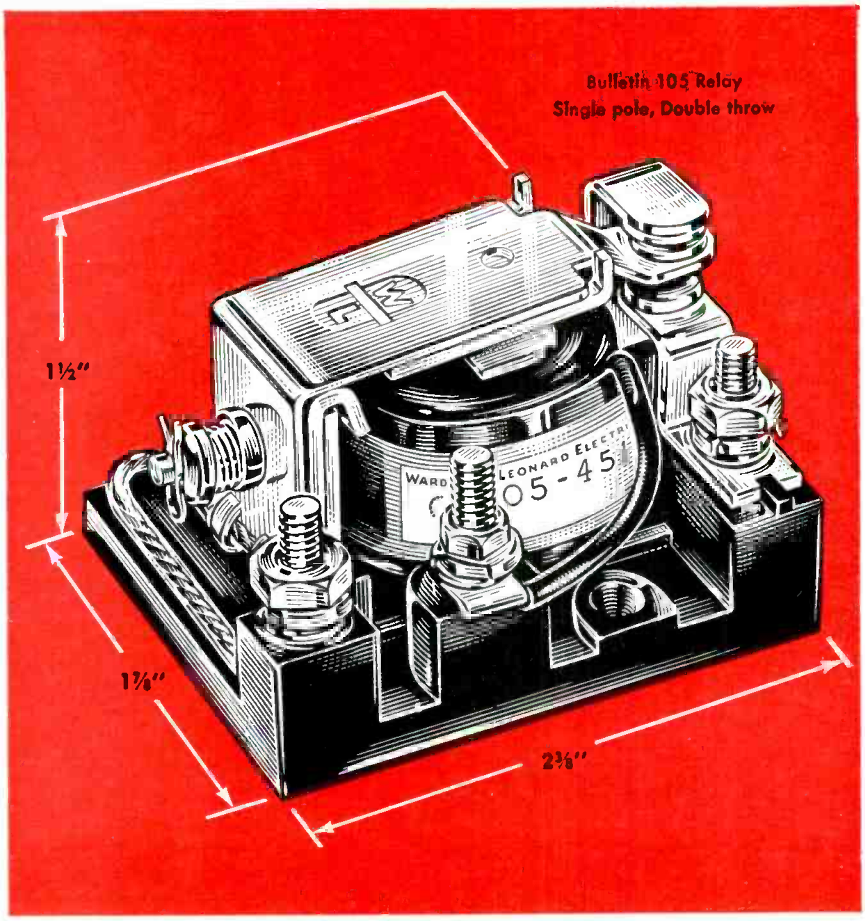
Compact power relay—high contact ratings

More relay for your money—that's the big thing you get when you specify Ward Leonard's Bulletin 105 for light power switching jobs.

No delicate, misapplied telephone- or instrument-type relay, the 105. From rigid phenolic base to ample silver-to-silver, self-cleaning contacts, the 105 is built to deal with *power* . . . just like the larger Ward Leonard relays and contactors. And yet it's extremely compact and low in cost.

You'll find the Bulletin 105 relay—in SPST, SPDT, DPST, and DPDT types—ideal for controlling power to electric heaters, signals, pumps, radio and TV transmitters and public address systems.

Check your catalog file today for Bulletin 105. If it's missing write to: Ward Leonard Electric Co., 30 South Street, Mount Vernon, N. Y. (In Canada: Ward Leonard of Canada Ltd., Toronto.) 7.1



ENGINEERING DATA

SINGLE POLE BULLETIN 105 RELAY

Contact Ratings

Volts	D.C. Amps.* N.O.	D.C. Amps.* N.C.	A.C. Amps.* N.O.	A.C. Amps.* N.C.
0-24	20	15	20	15
25-125	½	½	20	15
126-250	—	—	15	10

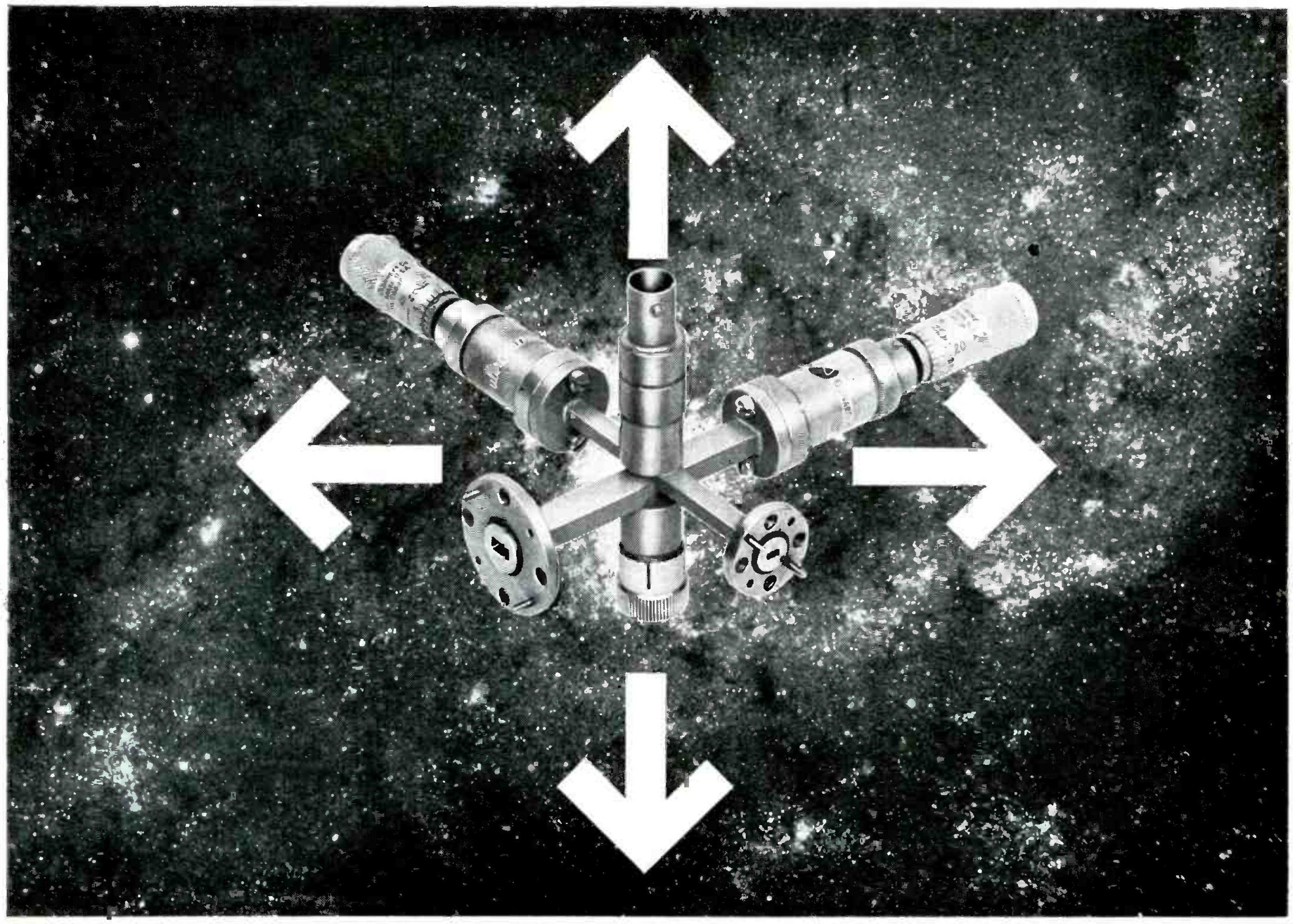
*Ratings are non-inductive.

COIL VOLTS: 6, 8, 10, 12, 24, 32, 48, 115, 230
AVG. COIL WATTS: 2 D.C., 3.75 A.C.
PICK-UP: 85% or less of rated voltage
WEIGHT: 5 ounces
TERMINALS: Stud type

LIVE BETTER...*Electrically*

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892



MICROWAVE RESEARCH EXTENDED TO 140,000 MC!

now you can enter Ultramicrowave research with this complete new line of* **D-B** *test instruments*

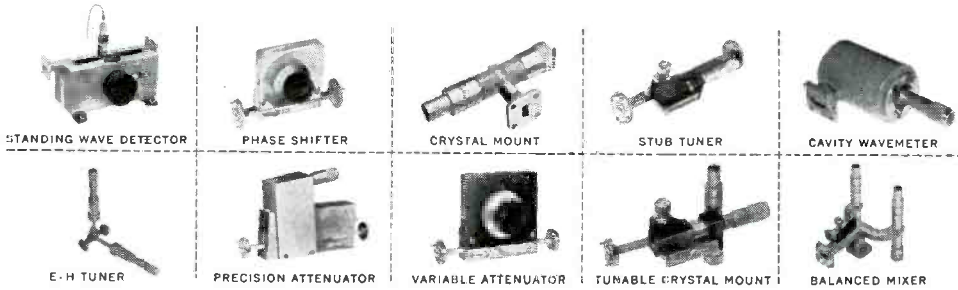
Now microwave engineers can plunge into new research territory. With this 140 KMC Crystal Multiplier (harmonic generator) to provide higher frequencies, and eleven other instrument sizes available for testing, researchers can experiment with 50% more latitude.

For example, you can build working models only 1/10 actual size. You can get better resolution with these higher frequencies – better by 10 to 1.

Here are crystal mounts, precision attenuators, variable stub tuners, standing wave detectors, phase shifters, frequency meters – every type of instrument used from 2.6 KMC to 90 KMC. All are now available in continuous coverage to 140 KMC!

No matter what your research field, it will pay you to consider the application of ultramicrowaves to your problems. De Mornay-Bonardi will help your staff plan special systems, and set up test equipment. You'll be receiving experienced assistance, too – 14 years of leadership in microwave instruments.

WRITE FOR FURTHER INFORMATION



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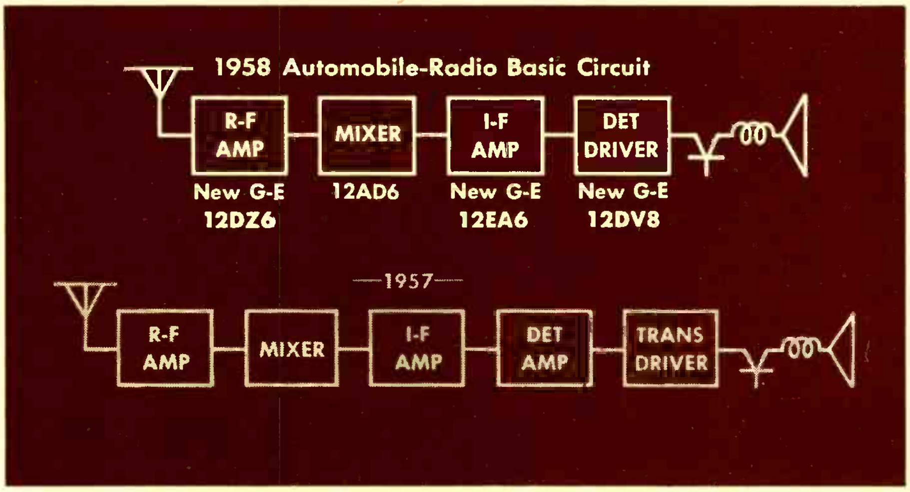
GENERAL ELECTRIC

TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY

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



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

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

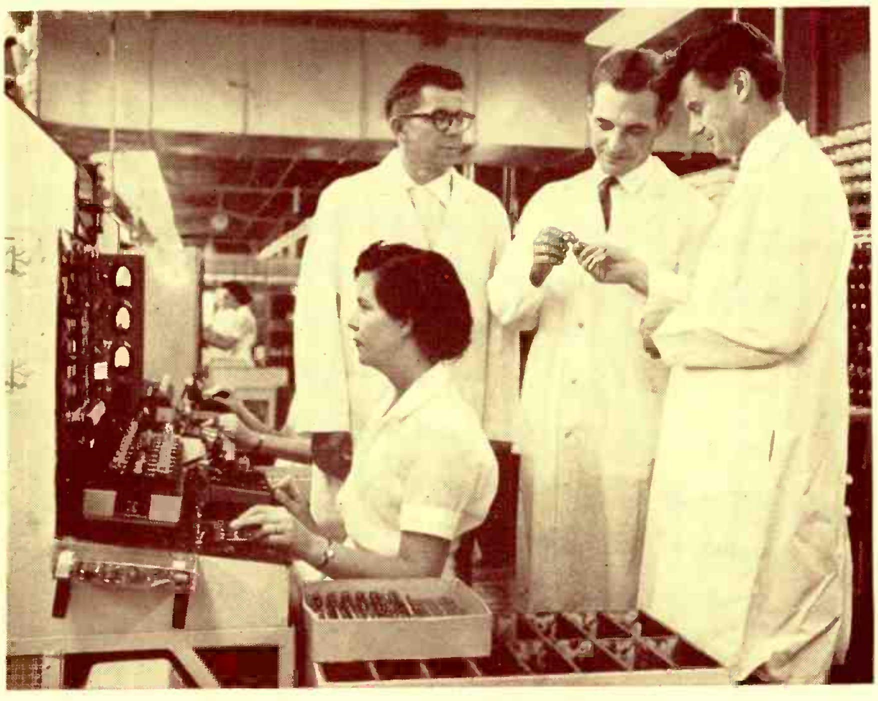
Now . . . a year later . . . General Electric promotes still higher standards of car-radio performance with Types 12DZ6, 12EA6, and 12DV8. Phone any G-E tube office on the next page for full information.

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

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

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

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



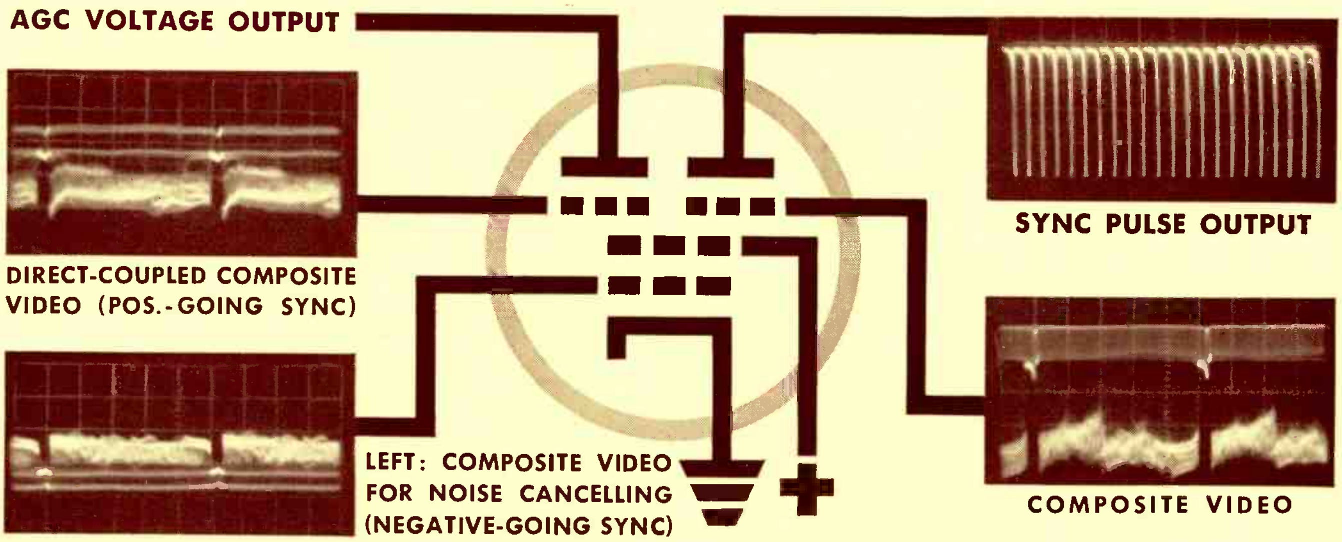
RIGHT: R. M. Duncan, manager of General Electric's Owensboro, Ky., tube plant (second from right), and two of his staff inspect the 35,000,000th 5-Star high-reliability tube, a 5670, which has just passed its initial electrical-characteristics tests. Record high total for these tubes proves their wide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

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

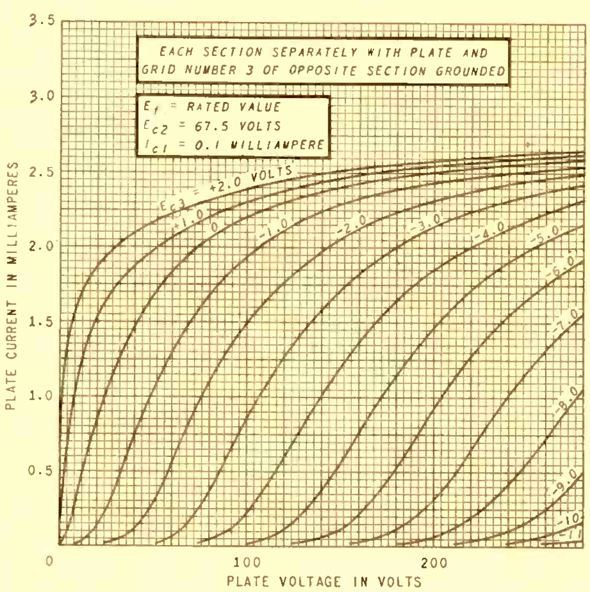
Developed and designed by G.E., Types 3BU8 and 6BU8 are twin pentodes that provide outstanding low-noise performance, with economy. The two tubes are identical except for heater ratings (3.15 v, 6.3 v). Also, the 3BU8 has controlled heater warm-up for service in 600-ma series-string circuits.

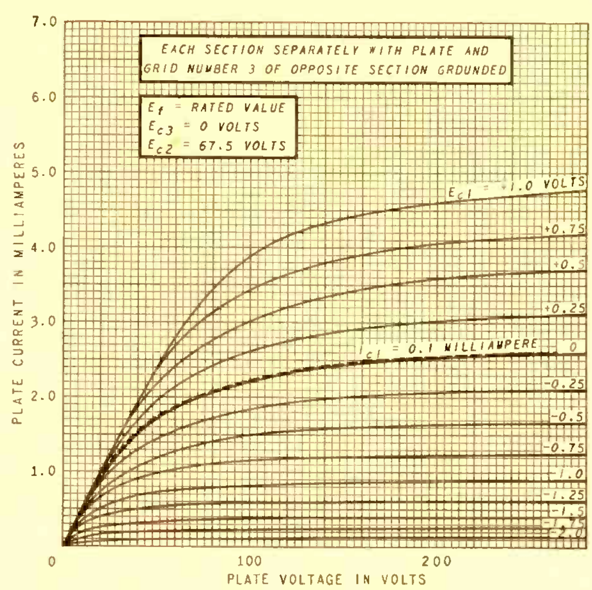
Cathode, Grid No. 1, and screen grid are common for both sections of the 3BU8 and 6BU8. Use of a common No. 1 grid makes possible the rejection of noise pulses from both tube sections. The recommended application for these G-E twin pentodes is: one section, AGC keyer or amplifier . . . the other section,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

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



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





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

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

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

WESTERN REGION
11840 West Olympic Boulevard
Los Angeles 64, California
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162-1C7

RECEIVING TUBE DEPARTMENT, GENERAL ELECTRIC COMPANY, OWENSBORO, KENTUCKY

NEW HIGHER TORQUE MULTI-FUNCTION SYNCHROS SURPASS MIL ACCURACIES

Higher Torque • Higher Accuracy • Multi-function Versatility

Systems engineers can now gain *simplicity and better performance in torque synchro systems* by using new synchros developed by Norden-Ketay for the Bureau of Ordnance. The unique design reduces error by approximately one-half while increasing torque 2 to 3 times in comparison with standard Mil synchros. By performing interchangeably as Torque Transmitters and Receivers, these synchros offer the further advantage of systems simplification. This new development by Norden-Ketay *extends the capabilities of the systems designer to advance beyond previous limits of performance.*

- *Higher Torque Gradient* —
  2 to 3 times previous mil spec values.
- *Higher Electrical Accuracy* —
  Size 15: ±6′ compared with ±12′ (Mil)
  Size 18: ±5′ compared with ±8′ (Mil)
- *Multi-function Versatility* —
  Torque and Accuracy values excel Mil torque transmitters and receivers. These synchros can be used interchangeably in both functions with improved system performance.
- *Greater Dynamic Accuracy* —
  Higher torque provides receiver error of ± 1.0° max. throughout the life of the unit.

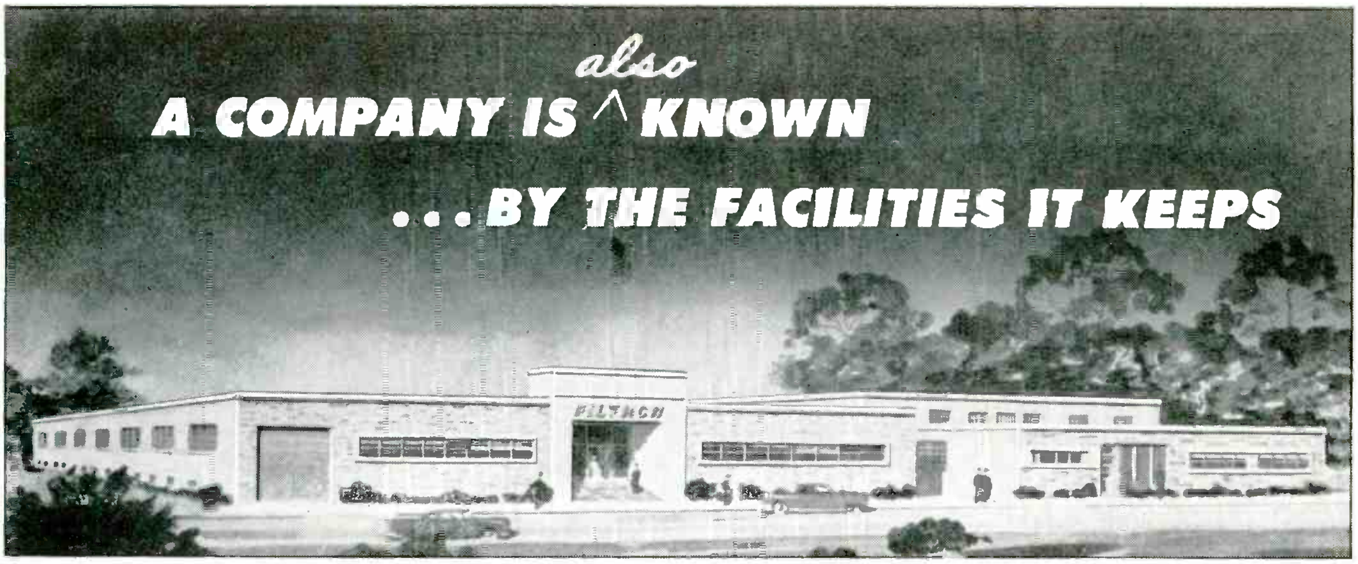
extending man's capabilities
NORDEN KETAY

Sales Offices: STAMFORD, CONN.
CHICAGO, ILL. • LOS ANGELES, CAL.
WASHINGTON, D.C. • DAYTON, OHIO

For full data and application engineering on these new multi-function synchros, write to Norden-Ketay Corporation, Precision Components Division, Commack, Long Island, N.Y.

FUNCTION	UNITS	NEW MULTI-FUNCTION SYNCHROS	STANDARD MIL SYNCHRO	NEW MULTI-FUNCTION SYNCHROS	STANDARD MIL SYNCHRO
NORDEN-KETAY TYPE		105C2E1	105C2A3	108C2C2	108C2B1
SIZE		15	15	18	18
Number of Phases { STATOR / ROTOR		3 / 1	3 / 1	3 / 1	3 / 1
EXCITATION PHASE		Rotor	Rotor	Rotor	Rotor
FREQUENCY	cps	400*	400	400*	400
VOLTAGE RATING	volts	115/90	115/90	115/90	115/90
Maximum Input { CURRENT / POWER	amps / watts	0.20 / 3.0	0.176 / 3.1	0.50 / 5.5	0.275 / 4.1
INPUT IMPEDANCE	ohms	680/83°	715/81°	235/84°	460/83°
FRICTION TORQUE AT 20°C MAX.	oz. in.	0.05	—	0.05	—
ELECTRICAL ERROR, MAXIMUM	minutes	±6	±12	±5	±8
RECEIVER ERROR, MAXIMUM	degrees	±1.0	±1.0	±1.0	±1.0
TORQUE GRADIENT, MINIMUM	oz-in/deg	0.026	0.013	0.10	0.036
DAMPING TIME, MAX. (179°)	seconds	2.0	2.5	2.0	2.0
OPERATING TEMP. RANGE	°C	−55° to +55°C (Available on special order to 125°C and 200°C)			
WEIGHT	oz.	7.2	6.4	10.0	9.0
MIL DESIGNATION		15TR4b	15TR4a	18TR4b	18TR4a

*Although these synchros are rated at 400 cps, they are available to your order to operate at any frequency from 400 cps to 10,000 cps.
Data at extremes of temperature available upon request.



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East to West...Flushing, New York, to Culver City, California

On Filtron's Staff: Engineering specialists in component design, development and production. . . . **In Filtron's Plants:** The most modern and completely equipped laboratories for research and testing, to MIL specifications; high speed quality manufacturing and assembly. . . . **In the Field:** Competently staffed mobile engineering laboratories to solve problems on-the-job at complex electronic installations.

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- RF FIELD ENGINEERING SERVICE
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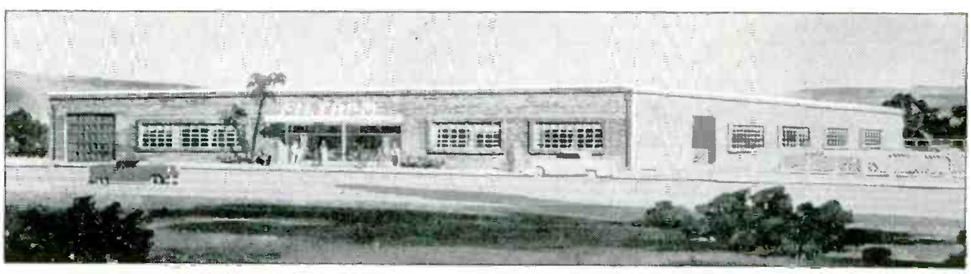
FLUSHING, N. Y., PLANT NO. 3

CULVER CITY, CAL., PLANT NO. 1



CULVER CITY, CAL., PLANT NO. 2

FILTRON IS KNOWN FOR ITS PRODUCTS...THE FACILITIES WE KEEP EXPLAIN WHY

REPRESENTED IN CANADA BY: AIRCRAFT APPLIANCES & EQUIPMENT LTD.
585 Dixon Side Road, Toronto

FILTRON COMPANY, INC.
FLUSHING, LONG ISLAND, NEW YORK
PLANTS IN FLUSHING, NEW YORK, AND CULVER CITY, CALIFORNIA

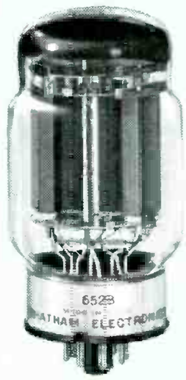
TWO OF FILTRON'S COMPLETELY EQUIPPED MOBILE LABORATORIES

RECTIFIERS—Both vacuum and gas filled tubes with peak inverse voltage ratings from 200 to 15,000 volts. Included are tubes with special features such as fast warm-up, cold cathodes, clipper service ratings and rugged construction.

TELEPHONE TYPES — A highly specialized line of vacuum and gas filled types in both the 300 and 400 series.

THYRATRONS—An extensive line of thyratrons for use as grid control rectifiers, relays and noise generators. Inverse voltage ranges from 100 to 5,000 volts. Sizes from subminiatures to ST 16 bulbs. Filamentary as well as hot and cold cathode types are available.

VOLTAGE REGULATOR AND REFERENCE TUBES—Gas filled tubes designed to specific voltages for regulating small currents. Also used to make available stable reference voltages for high current supplies. Sizes from subminiatures to bantams, including many reliable, ruggedized types.

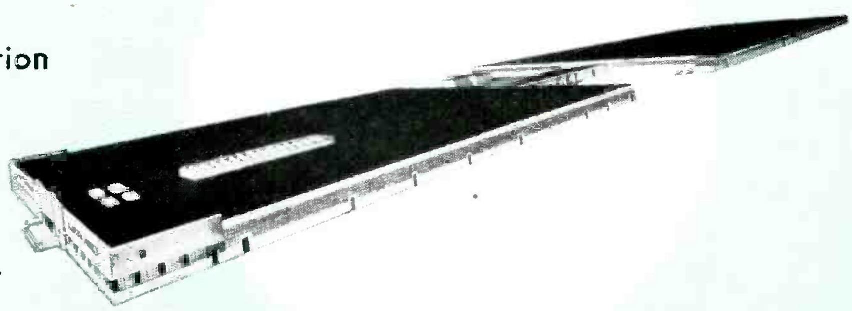


TWIN POWER TRIODES—The most complete line of high current twin power triodes developed especially for regulated power supply usage. Current and power ranges up to 800 milliamperes and 60 watts respectively. Included are rugged types in both low and medium mu construction.

HYDROGEN THYRATRONS—Used primarily as switching tubes in line type radar modulators, these tubes permit accurate control of high energy pulses. Sizes from miniatures to the VC 1257. Peak pulse power ranges from 10 kilowatts to 33 megawatts.

EXPANDS TO MEET INCREASED SPECIAL PURPOSE TUBE DEMANDS

100,000 Square-Foot Addition *Doubles* Existing Facilities

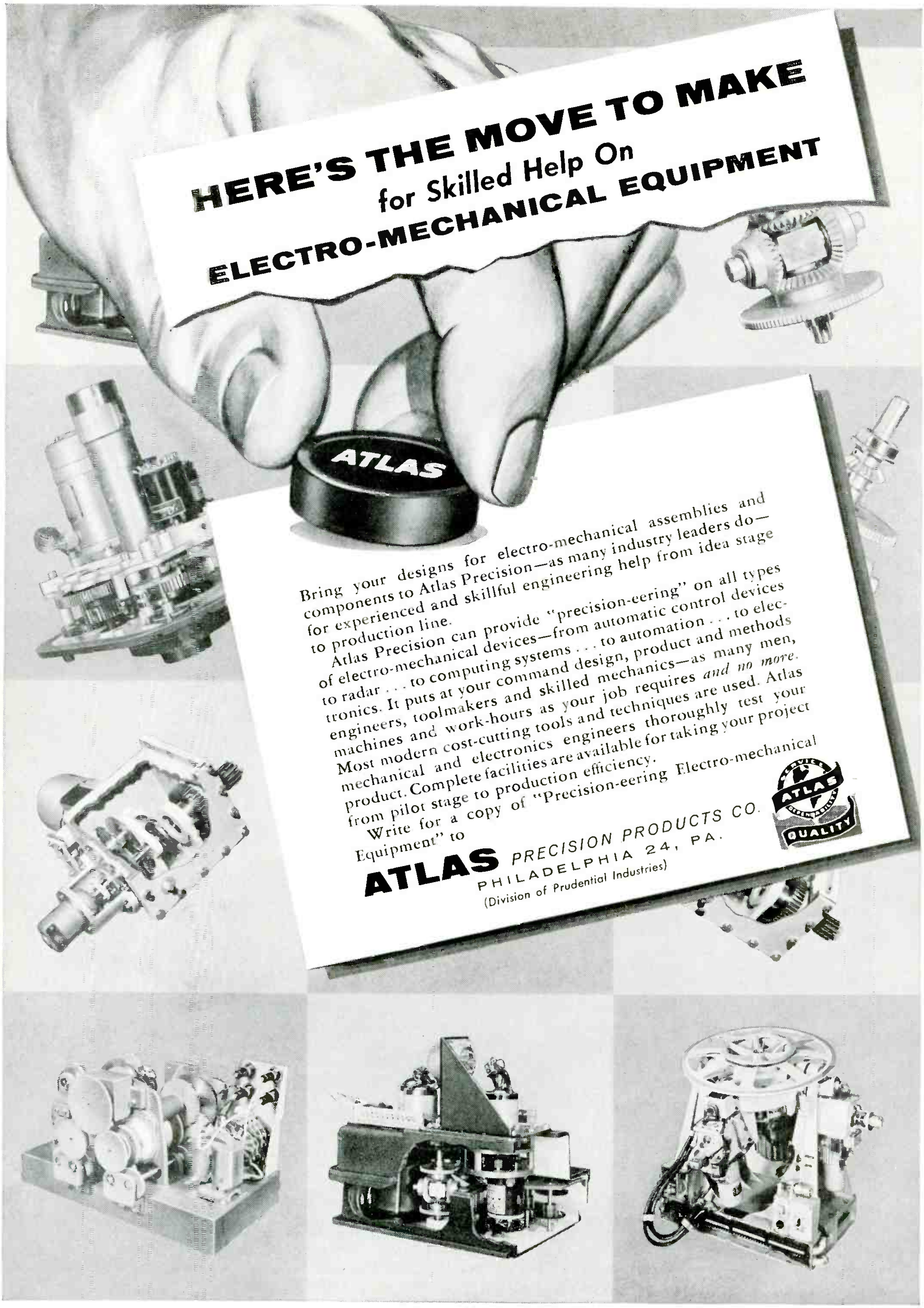


The creative engineering that has been responsible for many Chatham "originals", now has larger and improved facilities to help you solve your special purpose tube problems.

CHATHAM ELECTRONICS Division of **TUNG-SOL ELECTRIC INC.**

General Office and Plant: Livingston, New Jersey

SALES OFFICES: CHICAGO, DALLAS, LIVINGSTON, LOS ANGELES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for Skilled Help On
ELECTRO-MECHANICAL EQUIPMENT
ATLAS
Bring your designs for electro-mechanical assemblies and components to Atlas Precision—as many industry leaders do—for experienced and skillful engineering help from idea stage to production line.
Atlas Precision can provide "precision-eering" on all types of electro-mechanical devices—from automatic control devices to radar . . . to computing systems . . . to automation . . . to electronics. It puts at your command design, product and methods engineers, toolmakers and skilled mechanics—as many men, machines and work-hours as your job requires *and no more*. Most modern cost-cutting tools and techniques are used. Atlas mechanical and electronics engineers thoroughly test your product. Complete facilities are available for taking your project from pilot stage to production efficiency.
Write for a copy of "Precision-eering Electro-mechanical Equipment" to
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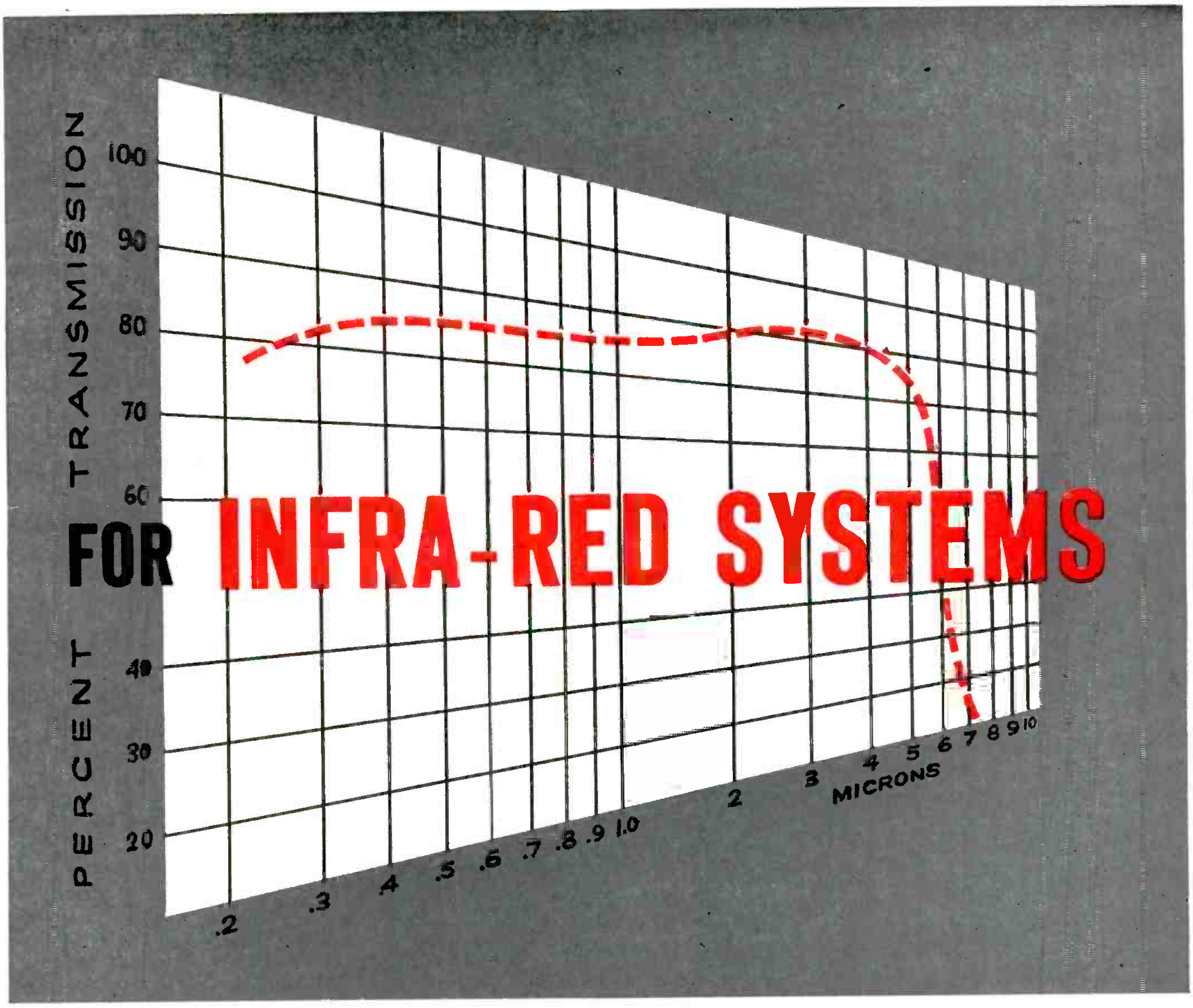
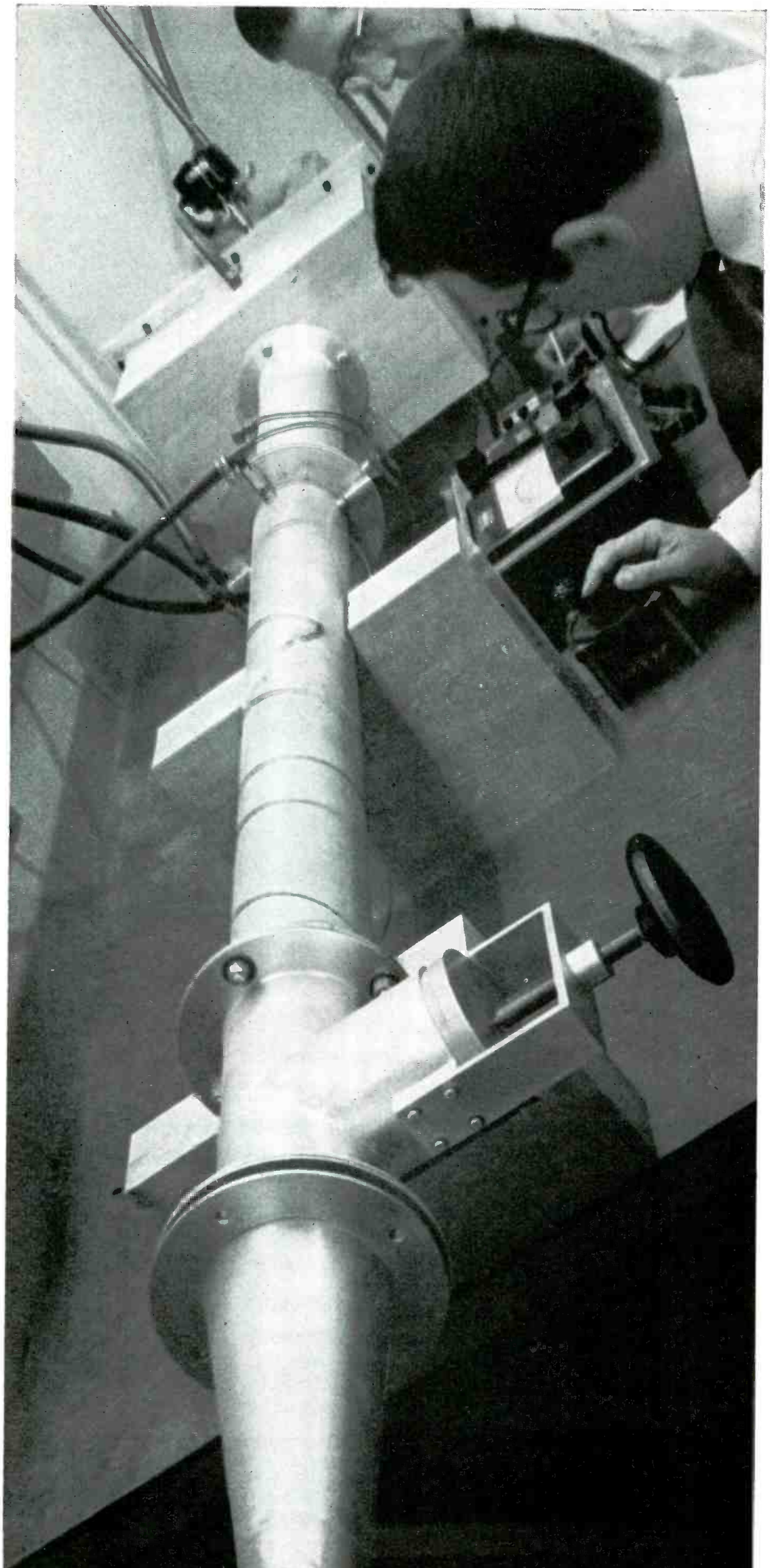
ATLAS
QUALITY



Circle 150 Readers Service Card



Subminiature Hughes silicon power rectifiers pictured with some of the standard vacuum tubes they replace.

Body diameter: 0.105-inch max.
Body length: 0.265-inch max.

NEW, AT HUGHES LOW-POWER RECTIFIERS WITH HIGH-VOLTAGE CAPABILITIES

Once again, Hughes has supplemented its line of silicon rectifiers—this time, with units rated up to 600 volts yet using the famous Hughes subminiature glass package. Like other Hughes rectifiers, these have the advantages of low forward voltage drop and low back leakage enabling them to handle power values that are large for the size of the rectifier. Features of this kind, combined with exceptional efficiency, make them ideal for electronic power supply applications where they can be used in place of many vacuum tube rectifiers.

Descriptive literature for the entire rectifier series is available upon request. Please write: SEMICONDUCTOR DIVISION • HUGHES PRODUCTS
International Airport Station, Los Angeles 45, California

SPECIFICATIONS

HR10311			
Peak Reverse Voltage (E_b) @ $-2\mu A$	$\geqq$	500V	@ 25°C
Reverse Current (I_b) @ −450 Vdc	$\leqq$	$35\mu A$	@ 150°C
Max. Ave. Inverse Current (I_{bo}) @ $315V_{rms}$@ 200mA	$\leqq$	$20\mu A$	@ 25°C
Max. Ave. Rectified Current (I_o)	$\geqq$	200mA	@ 25°C
HR10312			
Peak Reverse Voltage (E_b) @ $-2\mu A$	$\geqq$	600V	@ 25°C
Reverse Current (I_b) @ −550 Vdc	$\leqq$	$35\mu A$	@ 150°C
Max. Ave. Inverse Current (I_{bo}) @ $385V_{rms}$@ 200mA	$\leqq$	$20\mu A$	@ 25°C
Max. Ave. Rectified Current (I_o)	$\geqq$	200mA	@ 25°C

Maximum operating and storage temperature −65°C to +150°C
Derate average rectified current 1.5mA/°C above 25°C

The HR10311 and HR10312 have the famous glass package developed years ago at Hughes. This package, still the finest available, is tiny, but sturdy, thereby fulfilling all of the requirements for miniaturization while providing reliable operation under severe conditions of shock and vibration.

Creating a new world with ELECTRONICS

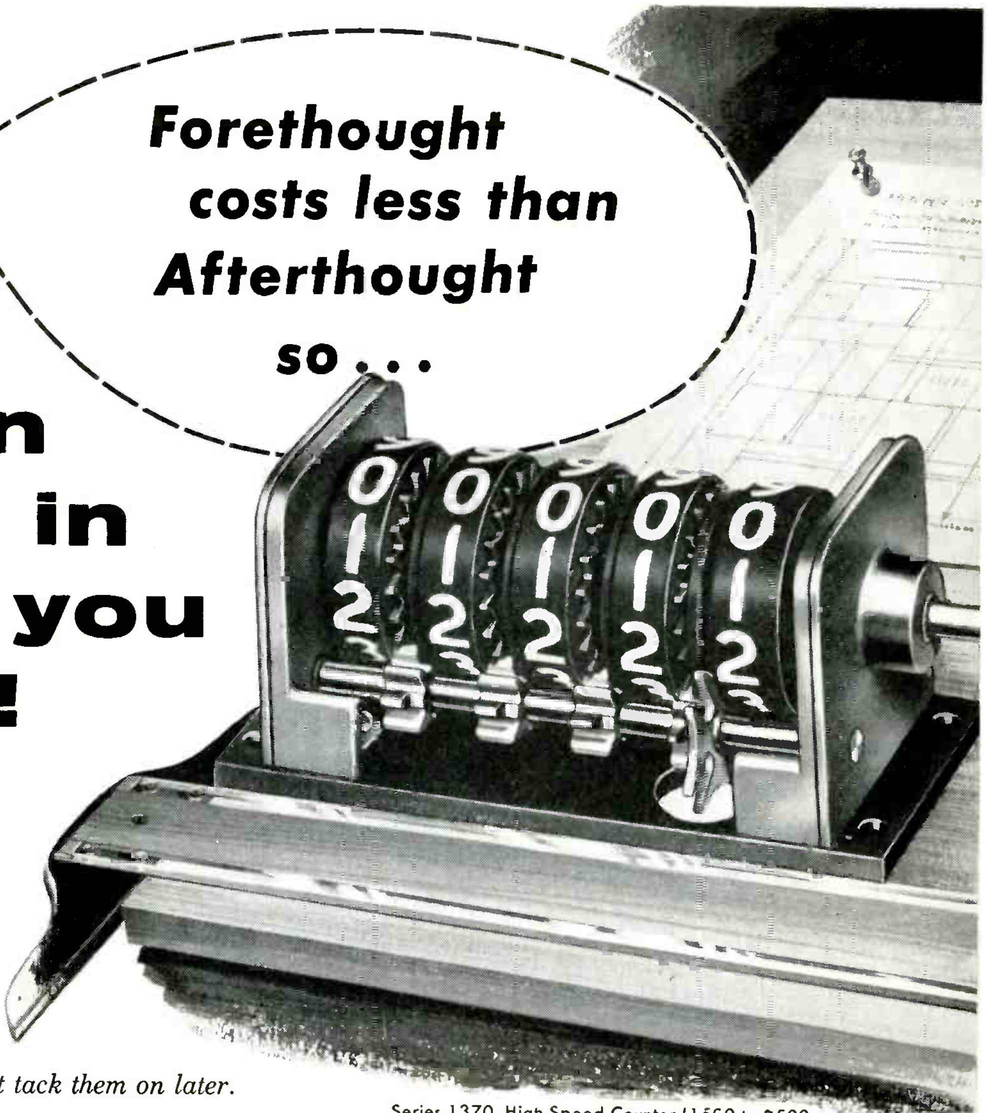
HUGHES PRODUCTS

HUGHES SEMICONDUCTORS

Circle 151 Readers Service Card

Forethought
costs less than
Afterthought
so . . .

Design These in When you Begin!



If you need mechanical or electrical counters in any of your new products, here's a word to the cost-wise designer: *Design them in, when you begin . . . don't tack them on later.*

Series 1370 High Speed Counter (1500 to 2500 rpm) built into a wide variety of equipment.

For if you'll give us a chance to work with you, right from the beginning, chances are we can save you time and money by adapting or modifying a *standard* Veeder-Root Counter to your needs . . where you might get into a costly special job if you went about it alone. What's more, you save time in your engineering, purchasing and assembly departments.

Count on Veeder-Root to help you in every way . . . from design to delivery. Write:

Everyone... Can Count on

Veeder-Root
INCORPORATED
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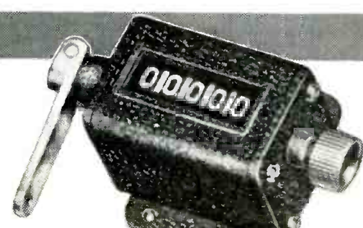
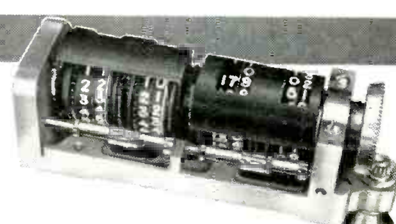
New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities

Series 1205 Reset Magnetic Counter with panel mount and lock and key.



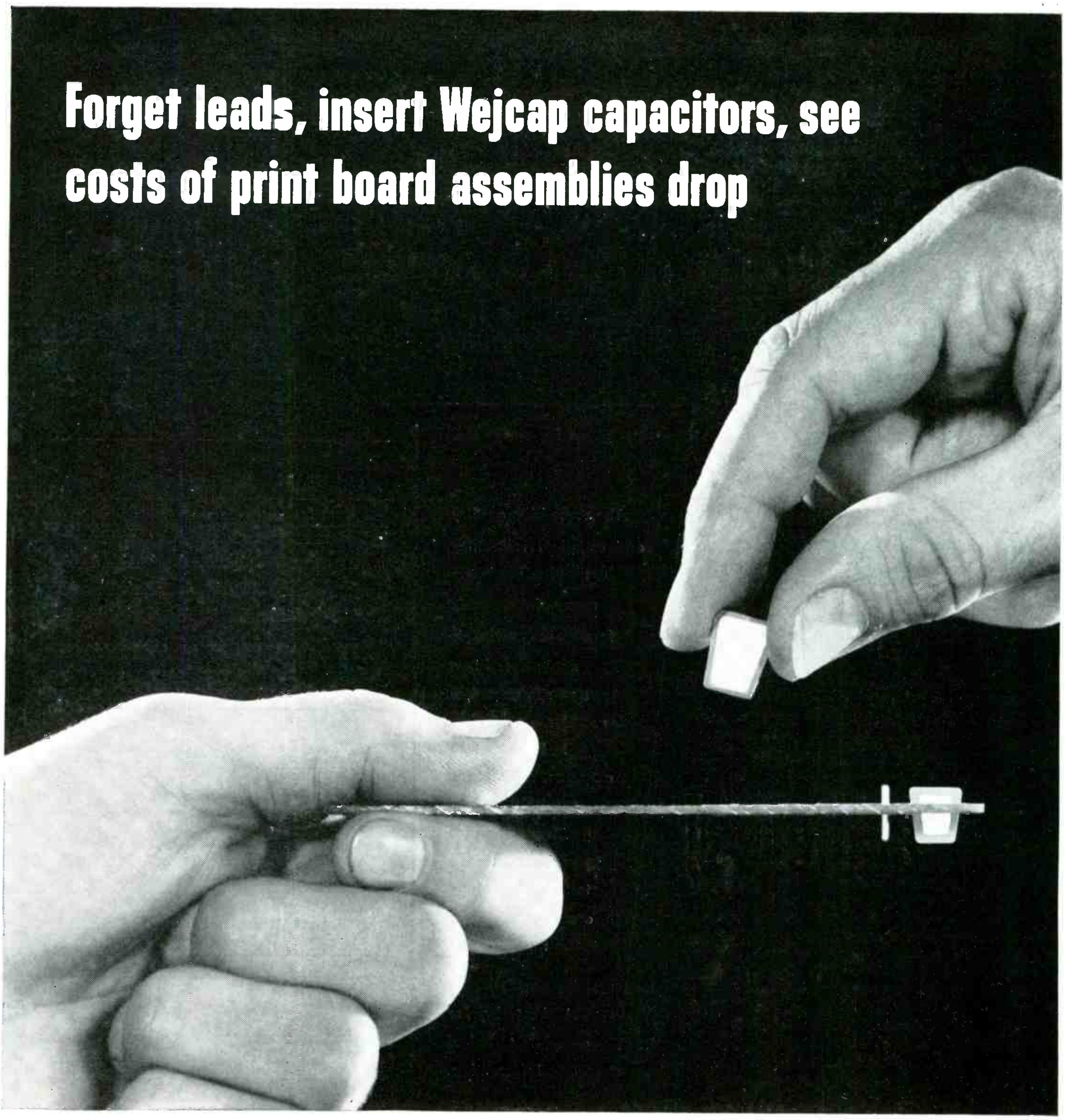
Series 1122 Small Reset Ratchet Counter.

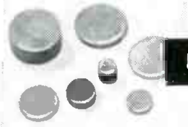


Special Longitude Counter, one of many made for aircraft navigational equipment.

Circle 167 Readers Service Card

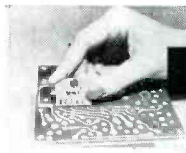
Circle 168 Readers Service Card →





Lead Metaniobate

A piezoelectric material recently developed by General Electric, Lead Metaniobate remains remarkably stable over the temperature range from —54°C to 265°C, an important fact in high-temperature instrumentation devices. It displays superior aging characteristics compared with other ceramic piezoelectric bodies. The high Curie temperature (570°C) allows repeated heat cycling with no effect on electrical output.



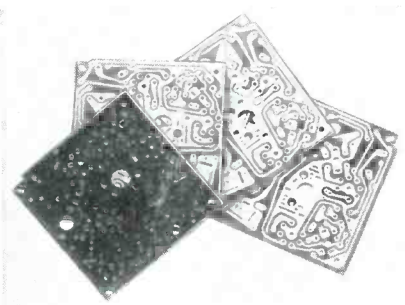
Encapsulated RC Networks

A new series of encapsulated RC networks is now available from General Electric that replaces a host of individual resistors and capacitors. The price saving can be ten percent or better. The assembly saving in print wire boards—inserting one unit instead of five or ten—averages about 67 percent. Furthermore, this small RC network results in a smaller overall assembly, cutting board costs.

New stabilized types or general purpose types cost up to 35% less, resist breakage and moisture.

Wejcap capacitors were specially developed to let you realize more fully the economy and design advantages of printed boards. They are a product of General Electric research into the high density, high strength properties of improved barium titanate. They have no leads to bend or break, or that require extra time to crimp and align. Extensive production use proves Wejcap capacitors are practically unbreakable and resist moisture absorption. They are available in general purpose types, or in the new stabilized types that maintain their value at room temperature to within ± 20% of the nominal value.

How much can you save? Wejcap capacitors cost up to 35% less than other capacitors. Production runs show that four Wejcap capacitors can be inserted in the time it takes to put in three ordinary capacitors. The total cost and assembly savings will be appreciable, even if you apply only three Wejcap capacitors to your production chassis.



Thru-Con* print wire boards. Now you can design a compact wiring pattern on both sides of the board without the cost of further processing to connect them. The "Thru-Con®" additive technique plates through the holes at the same time it plates the wiring pattern. This permits high-speed dip soldering remarkably free from rejects. No special eyelets or pre-cleaning are required. Assembly weight is reduced and inventory is simplified.

Sample Wejcap capacitors and other General Electric components—plus technical data—are yours for the asking. Just fill in the coupon below. *Specialty Electronic Components Dept., General Electric Company, West Genesee Street, Auburn, New York.*

**Registered trademark of the General Electric Company.*

Manager of Sales, Specialty Electronic Components Dept.,
General Electric Company, West Genesse St., Auburn, New York

Please send me complete technical information on

☐ **RC Networks** ☐ **Lead Metaniobate**
☐ **Ferrites** ☐ **Wejcap Capacitors**
☐ **Thru-Con® Print Wire Boards**

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E1157

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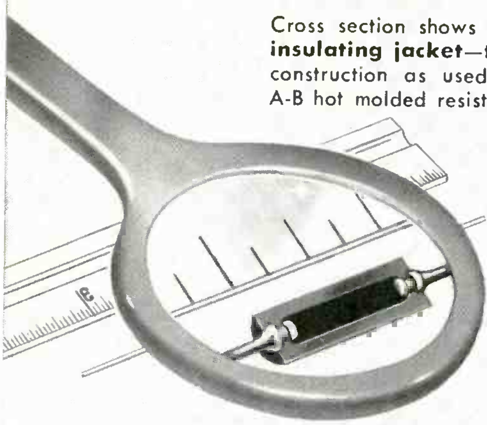
NEW!

1/4-WATT insulated hot molded composition resistor only 1/4" long!



Cross section shows **molded insulating jacket**—the same construction as used for all A-B hot molded resistors.

Here's a new ¼-watt, *insulated* composition resistor in a truly *small* size . . . ONLY ONE QUARTER OF AN INCH LONG . . . that provides the same superlative performance, reliability, and uniformity which have made the Allen-Bradley hot molded resistor preferred the world over.

Although exceptionally small, Allen-Bradley Type CB hot molded resistors are rated for "continuous operation" at 70°C ambient temperatures. The hot molded construction of this Type CB resistor makes impregnation unnecessary . . . it also provides the most reliable protection against extended periods of high humidity, as encountered in practical applications. Available in all RETMA resistance values from 47 ohms to 22 megohms. Tolerances: 5%, 10%, and 20%.

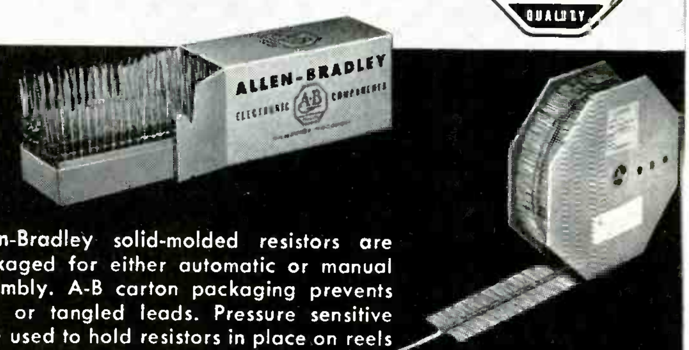
Where space is at a premium . . . and where failures would be disastrous . . . you owe it to yourself to investigate this new addition to the Allen-Bradley *quality* line. Please write today for complete specifications. Samples available for your tests.

Allen-Bradley Co.
1315 S. First St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

A-B
QUALITY

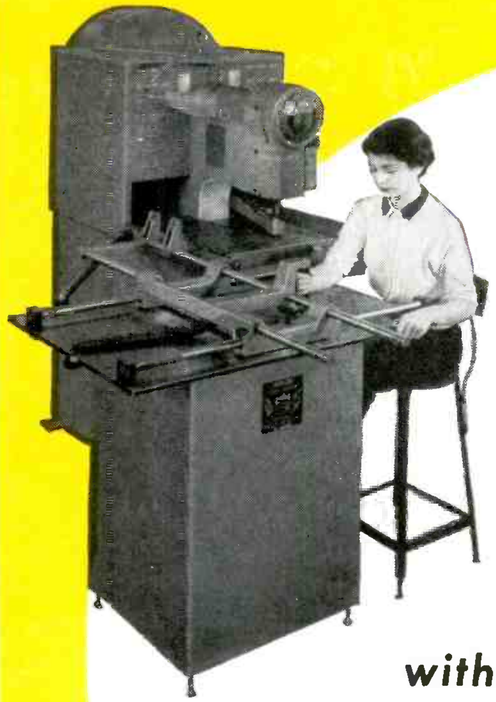
OTHER HOT MOLDED RESISTORS IN THE A-B FAMILY

Allen-Bradley fixed, molded resistors rated at 70°C ambient are available in standard RETMA values from 2.7 ohms to 22 megohms in ½ and 1-watt sizes . . . and from 10 ohms in the 2-watt size. In 5%, 10%, and 20% tolerances.



Allen-Bradley solid-molded resistors are packaged for either automatic or manual assembly. A-B carton packaging prevents bent or tangled leads. Pressure sensitive tape used to hold resistors in place on reels—for most economical assembly.

ALLEN-BRADLEY
HOT-MOLDED COMPOSITION RESISTORS
QUALITY



Punch
PRINTED CIRCUITS
Cold...
with WALES Fabricator - Duplicator

The WALES **Fabricator** combined with WALES positive **Duplicator** is the modern, low cost answer to printed circuit hole punching. You get holes with sharp definition, clean walls and minimum bell mouth. This equipment is perfect for short runs from one piece to thousands. Change dies for hole sizes in seconds with a range up to 3½" dia. Accuracy is automatic and positive. Make your own templates, too, on the Fabricator. No need for drilling machines or jig-borers. The WALES Fabricator-Duplicator is a complete punching shop in itself.

SEND FOR BULLETIN NO. 13K

Complete specifications and capacities are yours for the asking.

WALES Strippit COMPANY

A UNIT OF HOUDAILLE INDUSTRIES, INC.

AKRON, NEW YORK

WALES-STRIPPIT OF CALIF., SOUTH GATE, CALIF.
WALES-STRIPPIT OF CANADA LTD., HAMILTON, ONT.

"...the Wales-Way is the PLUS-PROFIT way"

PROOF THAT NEW SAVBIT ALLOY BY MULTICORE MAKES COPPER SOLDERING TIPS LAST UP TO 10 TIMES LONGER!

These photos illustrate the greatest solder

UNRETOUCHED PHOTOS: The three soldering iron tips illustrated above were taken from identical irons

Although this tip has been constantly rebuilt, it is now at the end of its useful life, having made only 1,500 soldered joints using a standard tin/lead alloy.

This tip has been used for making 1,000 soldered joints, using a standard tin/lead alloy.

This tip has been used for making more than 10,000 soldered joints with Ersin Multicore SAVBIT ALLOY. Note that it shows virtually no wear!

CONSIDER WHAT THIS CAN MEAN TO YOUR MAINTENANCE AND PRODUCTION COSTS!

advancement in 25 years

Now ready!

SAVBIT® Multicore

A SPECIAL ALLOY AVAILABLE ONLY IN ERSIN

FIVE-CORE SOLDER

Simplified Explanation:

	Before Soldering	During Soldering	After Soldering
In soldering with straight tin/lead alloys . . .	Tin/Lead Solder — Copper Tip **Solder contacted by copper tip...**	Molten Tin/Lead/Copper — Copper Tip **absorbs tip metal to saturation...**	Tin/Lead/Copper Joint — Copper Tip **and wears out tip rapidly!**
Whereas... In soldering with new SAVBIT ALLOY...	Tin/Lead/Copper Solder — Copper Tip **Copper-saturated SAVBIT solder...**	Molten Tin/Lead/Copper — Copper Tip **cannot borrow copper from the iron...**	Tin/Lead/Copper Joint — Copper Tip **which receives hardly any wear.**

THIS EXPLAINS HOW SAVBIT ALLOY STOPS THE WEARING OUT OF COPPER TIPS

Two years ago, Multicore introduced a special alloy for soldering silver-plated ceramics, containing a 2% silver content, so that it would not absorb silver from the ceramic. The same patented principle has now been applied to prevent the copper of soldering iron tips being absorbed into solder alloys! Until now, incorporation of copper in a solder alloy to more than 0.3% of the tin content was discouraged, since it was believed that copper might slow the flow of solder in making seams. An extensive investigation under actual working conditions on television assembly lines has now proven that a copper-loaded alloy does *not* effect the speed of soldering, when making the joints which form 98% of the soldering processes in the assembly and manufacture of all electronic equipment.

WEAR OF COPPER TIPS

Most engineers have presumed that the wear of copper soldering iron tips used on assembly lines was caused by (1) oxidation of the copper due to heat, (2) attack of the flux on the copper bit, and (3) absorption of the copper from the tip into the tin of the solder alloy. However, these investigations have proven conclusively that reasons (1) and (2) are not the explanation.

On the other hand, comparative tests between Ersin Multicore Solder with the new SAVBIT copper-loaded alloy, and solders containing pure tin/lead alloys have indicated that a reduction of about 9/10 in tip wear can be achieved by the use of SAVBIT ALLOY! It is a fact that the tip of an iron which needs resurfacing after 1,000 joints with normal tin/lead alloys can last for 10,000 or more similar joints before requiring resurfacing, using Ersin Multicore SAVBIT ALLOY. (See illustration.) Therefore, it is hardly necessary to emphasize the great economies that can be effected in soldering iron maintenance by using this new alloy. Equally important, a higher standard of soldering is guaranteed throughout the life of the iron, because it stays in first class condition much longer!

CHARACTERISTICS AND SPECIFICATIONS

SAVBIT ALLOY is now available in Ersin Multicore 5-core solder, containing non-corrosive extra-fast Ersin Flux, in 14, 16 and 18 gauge.

MELTING POINT: Virtually the same as standard tin/lead alloys.

ELECTRICAL CONDUCTIVITY, TENSILE AND SHEAR STRENGTH: No appreciable difference bewteen SAVBIT and normal tin/lead alloys. Strength of SAVBIT slightly greater.

IMPORTANT

SAVBIT is one of a number of alloys developed for the Industry by Multicore. In addition to SAVBIT, Ersin Multicore, the world's finest cored solder, is also available in all the standard tin/lead alloys and diameters, in 1 lb. cartons and 7 lb. reels. Multicore contains 5 cores of exclusive, high speed, non-corrosive Ersin Flux. This great solder, so widely-imitated, has never been equalled for speed of operation, effective prevention of rejects and, in the long run, lowest cost for superior results.

SAVBIT ALLOY has been impressively proven on the assembly lines of England's greatest manufacturers. We will be pleased to furnish testimonials.

Address U. S. A. inquiries on company letterhead to Dept. MS167

MULTICORE SALES CORPORATION
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Canadian inquiries:
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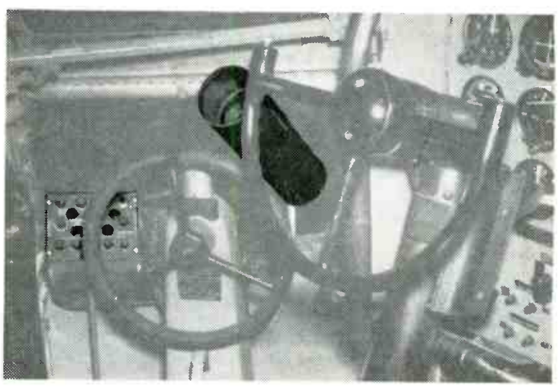
PAN AMERICAN

WORLD'S MOST EXPERIENCED AIRLINE

SELECTS

EDO LORAN

Pan American World Airways has ordered Edo Loran units for installation in its fleet of Boeing and Douglas jet transports. Selection of the new Edo long-range navigation equipment followed testing in both Atlantic and Pacific service. Edo Loran drew praise from pilots and technical personnel alike for its simplicity of operation, accuracy and reliability. Edo's lightweight (29 pounds), compact design for cockpit installation, simple operation and directly-read data for pilot use, combined with the accuracy and proven reliability of the Loran system, were factors in Pan Am's choice of Edo Loran as the basic long-range navigation system for its upcoming fleet of jet aircraft.



Installation of Edo Loran in Pan American Boeing Stratocruiser shows compact design and convenient mounting for pilot operation. ¾ ATR receiver unit is remotely installed.

Brochure available on request.

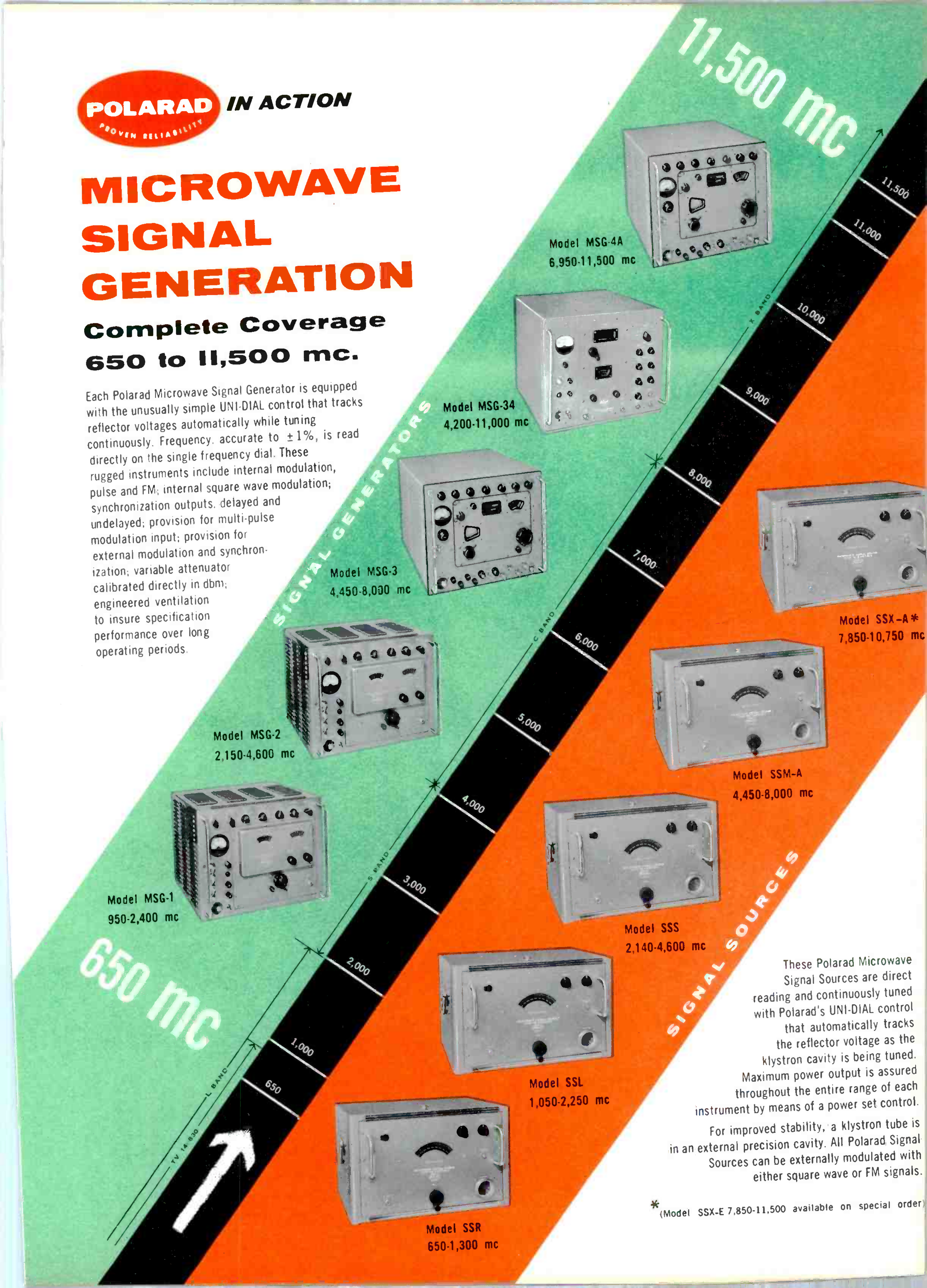
Edo **Corporation**

College Point, Long Island, New York

Manufacturers of a Trusted Line of Marine and Airborne Electronic Equipment

Circle 171 Readers Service Card

Circle 172 Readers Service Card →


POLARAD
PROVEN RELIABILITY
IN ACTION
MICROWAVE SIGNAL GENERATION
Complete Coverage 650 to 11,500 mc.
Each Polarad Microwave Signal Generator is equipped with the unusually simple UNI-DIAL control that tracks reflector voltages automatically while tuning continuously. Frequency, accurate to ±1%, is read directly on the single frequency dial. These rugged instruments include internal modulation, pulse and FM; internal square wave modulation; synchronization outputs, delayed and undelayed; provision for multi-pulse modulation input; provision for external modulation and synchronization; variable attenuator calibrated directly in dbm; engineered ventilation to insure specification performance over long operating periods.
SIGNAL GENERATORS
Model MSG-4A
6,950-11,500 mc
Model MSG-34
4,200-11,000 mc
Model MSG-3
4,450-8,000 mc
Model MSG-2
2,150-4,600 mc
Model MSG-1
950-2,400 mc
11,500 mc
650 mc
11,500
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
650
X BAND
C BAND
S BAND
L BAND
TV 14-830
Model SSX-A*
7,850-10,750 mc
Model SSM-A
4,450-8,000 mc
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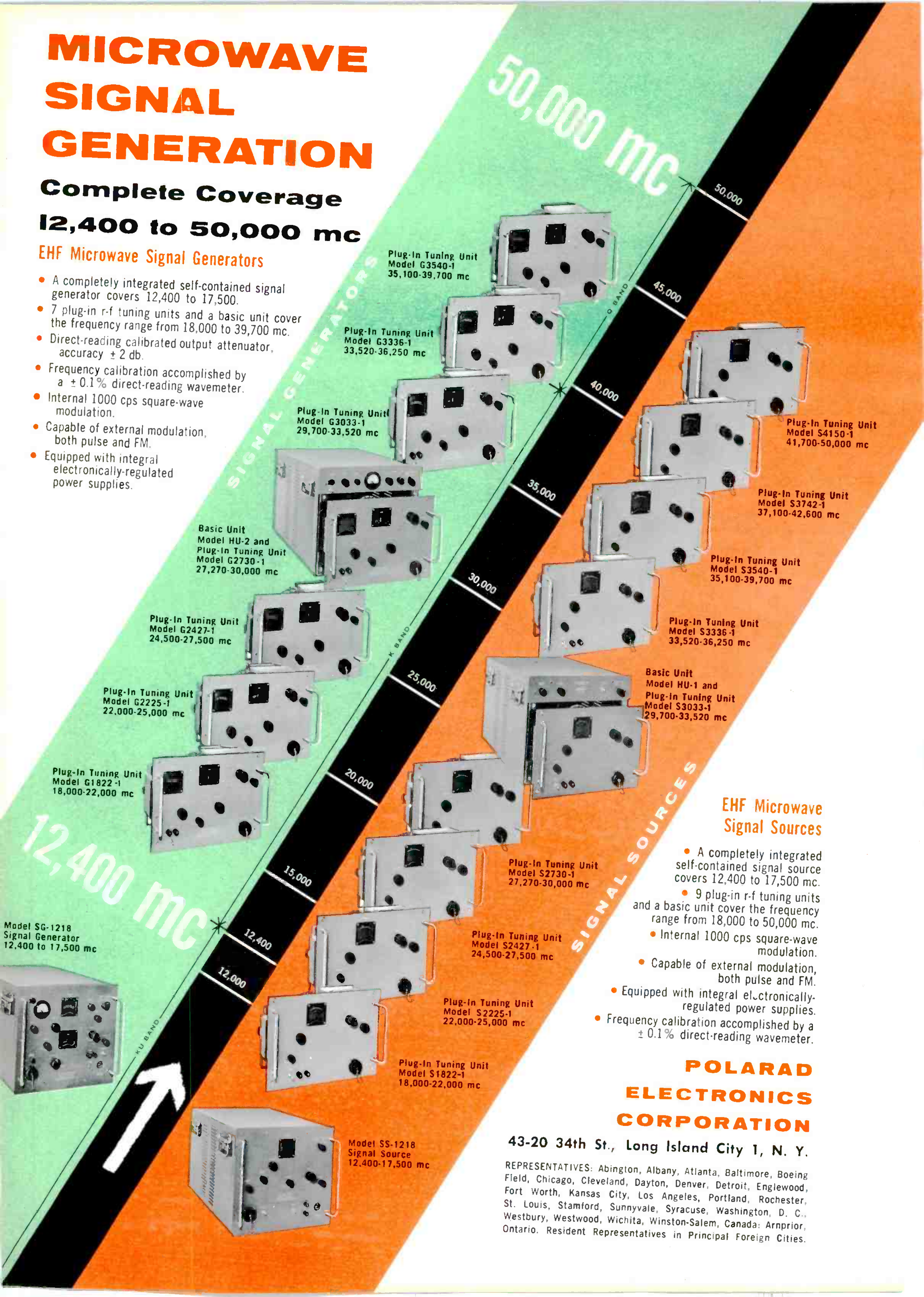
650-1,300 mc
SIGNAL SOURCES
These Polarad Microwave Signal Sources are direct reading and continuously tuned with Polarad's UNI-DIAL control that automatically tracks the reflector voltage as the klystron cavity is being tuned. Maximum power output is assured throughout the entire range of each instrument by means of a power set control.
For improved stability, a klystron tube is in an external precision cavity. All Polarad Signal Sources can be externally modulated with either square wave or FM signals.
*(Model SSX-E 7,850-11,500 available on special order)



MICROWAVE SIGNAL GENERATION
Complete Coverage
12,400 to 50,000 mc
EHF Microwave Signal Generators
• A completely integrated self-contained signal generator covers 12,400 to 17,500.
• 7 plug-in r-f tuning units and a basic unit cover the frequency range from 18,000 to 39,700 mc.
• Direct-reading calibrated output attenuator, accuracy ± 2 db.
• Frequency calibration accomplished by a ± 0.1% direct-reading wavemeter.
• Internal 1000 cps square-wave modulation.
• Capable of external modulation, both pulse and FM.
• Equipped with integral electronically-regulated power supplies.
50,000 mc
12,400 mc
SIGNAL GENERATORS
SIGNAL SOURCES
Q BAND
K BAND
KU BAND
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
12,400
12,000
Plug-In Tuning Unit Model G3540-1 35,100-39,700 mc
Plug-In Tuning Unit Model G3336-1 33,520-36,250 mc
Plug-In Tuning Unit Model G3033-1 29,700-33,520 mc
Basic Unit Model HU-2 and Plug-In Tuning Unit Model G2730-1 27,270-30,000 mc
Plug-In Tuning Unit Model G2427-1 24,500-27,500 mc
Plug-In Tuning Unit Model G2225-1 22,000-25,000 mc
Plug-In Tuning Unit Model G1822-1 18,000-22,000 mc
Model SG-1218 Signal Generator 12,400 to 17,500 mc
Plug-In Tuning Unit Model S4150-1 41,700-50,000 mc
Plug-In Tuning Unit Model S3742-1 37,100-42,600 mc
Plug-In Tuning Unit Model S3540-1 35,100-39,700 mc
Plug-In Tuning Unit Model S3336-1 33,520-36,250 mc
Basic Unit Model HU-1 and Plug-In Tuning Unit Model S3033-1 29,700-33,520 mc
Plug-In Tuning Unit Model S2730-1 27,270-30,000 mc
Plug-In Tuning Unit Model S2427-1 24,500-27,500 mc
Plug-In Tuning Unit Model S2225-1 22,000-25,000 mc
Plug-In Tuning Unit Model S1822-1 18,000-22,000 mc
Model SS-1218 Signal Source 12,400-17,500 mc
EHF Microwave Signal Sources
• A completely integrated self-contained signal source covers 12,400 to 17,500 mc.
• 9 plug-in r-f tuning units and a basic unit cover the frequency range from 18,000 to 50,000 mc.
• Internal 1000 cps square-wave modulation.
• Capable of external modulation, both pulse and FM.
• Equipped with integral electronically-regulated power supplies.
• Frequency calibration accomplished by a ± 0.1% direct-reading wavemeter.
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How to Save Man Days in Research and Testing Involving Transients — **No. 3** *of a series*

PROBLEM: Wave-form photography

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

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

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

HUGHES PRODUCTS

MEMO-SCOPE Oscilloscope

International Airport Station, Los Angeles 45, California

HUGHES MEMO-SCOPE OSCILLOSCOPE

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

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

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

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HUGHES PRODUCTS

Circle 155 Readers Service Card

Hermetically-sealed
Self-contained

POWER SUPPLIES

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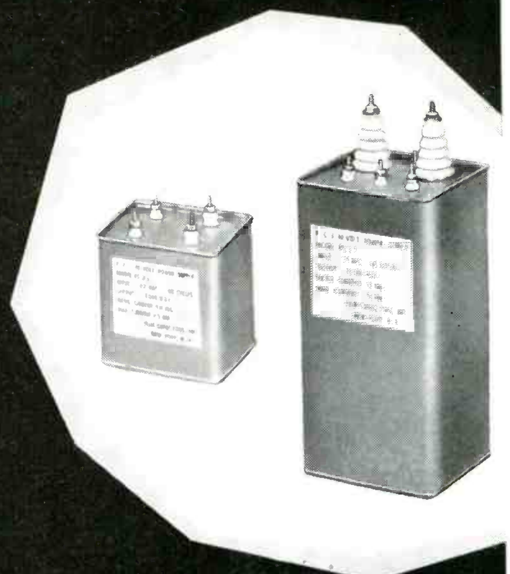
fci

Designed for

HIGH VOLTAGE

Low Current DC Applications

- Oil filled construction and special miniaturized components make for a compact, light weight, reliable unit.
- All models are designed with a full wave doubler circuit.
- Safety-rated components assure long trouble-free life.
- Neutral case may be positive, negative, or left floating.
- Specially constructed F.C.I. plastic dielectric capacitors assure low ripple, compactness, and reliability.
- Housed in CP70 cases, which makes for easy mounting and attractive appearance.
- Solder sealed terminals are used exclusively to prevent oil leakage.
- Voltages on all models can be varied from zero to maximum.
- Designed to operate at temperatures up to 65C.
- The 2 and 5 KV units utilize selenium rectifiers; the 12 and 15 KV units utilize ruggedized 1B3 tubes.
- Voltages of 30 and 50 KV are available upon request, as well as 400 cycle supplies in all voltages.



ELECTRICAL CHARACTERISTICS

PART NO.	OUTPUT VOLTAGE	% RIPPLE AT RATED CURRENT	RATED CURRENT OUTPUT	MAX. CURRENT OUTPUT
PS — 2 S	2 KVDC	1%	5 MA	7.5 MA
PS — 5 S	5 KVDC	1%	5 MA	7.5 MA
PS — 12 T	12 KVDC	1.5%	1 MA	1.75 MA
PS — 15 T	15 KVDC	1.5%	1 MA	1.75 MA

For Varied Applications

1. Radiation counters
2. Spectographic analyzers
3. Dust and electrostatic precipatators
4. Oscilloscopes
5. Display tubes
6. Projection television sets
7. Many types of air-borne equipment
8. Fire control equipment
9. Xerographic process printers
10. Cable and Insulation Testers

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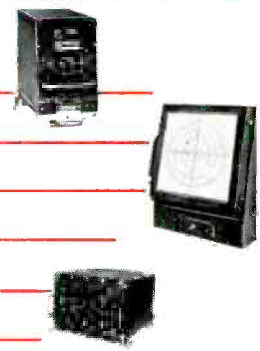
CYpress 2-5180

In the field of RECONNAISSANCE LORAL has developed *Important New Concepts* in:



- ASW and AEW DISPLAY SYSTEMS
- AIRBORNE NAVIGATIONAL COMPUTERS
- MILITARY PLOTTERS
- ELECTRONIC COUNTERMEASURES
- GUIDANCE SYSTEMS

and has competently served the ARMED FORCES directly, and their PRIME CONTRACTORS.

LORAL ELECTRONICS CORPORATION
NEW YORK 72, NEW YORK

Circle 174 Readers Service Card

A Dip here does so much

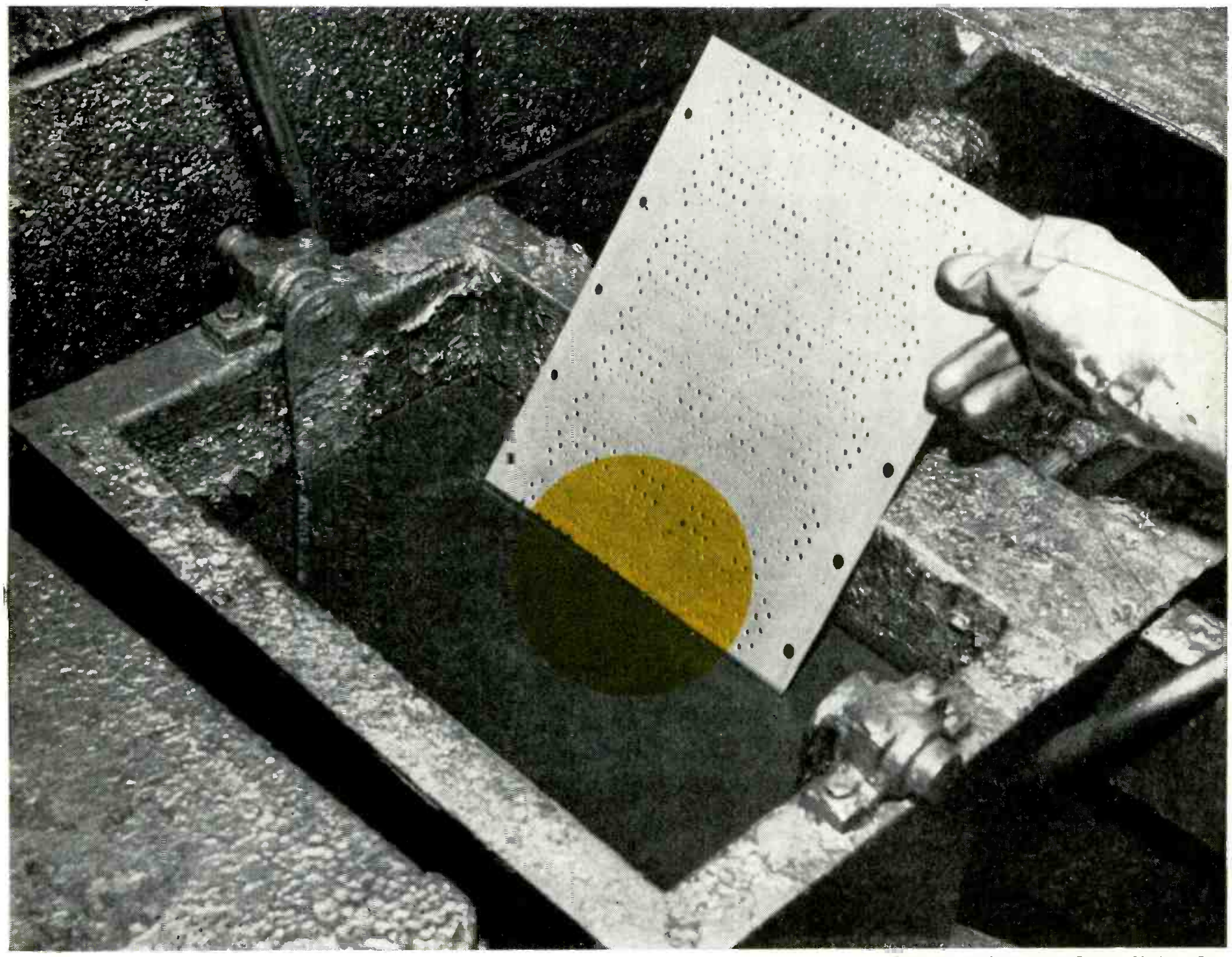


Photo courtesy International Business Machines Corp.

How 'dag'® can spell the difference between possible and impossible!

Take the case of International Business Machines Corporation, for example. At the company's Kingston, New York plant, a dip in a 'dag' dispersion makes it possible to plate a conductor through holes in copper clad phenolic sheets.

Used in the production of printed circuit cards, the pierced sheets are dipped in a solution of 'dag' dispersion #154 and alcohol. The sheets then pass through rubber rollers which remove excess solution from the surface and are then conveyed through an oven to dry. Following this, an automatic sanding machine removes excess graphite from the surface, leaving a graphite coating on the walls of the holes in the sheet.

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This is only one of many practical benefits of 'dag' colloidal graphite dispersions. An Acheson Service Engineer will be glad to consult with you on any problem you may have, where a graphite coating can help you. Bulletin 433 will provide additional valuable information; for your copy, address Dept. E-11.

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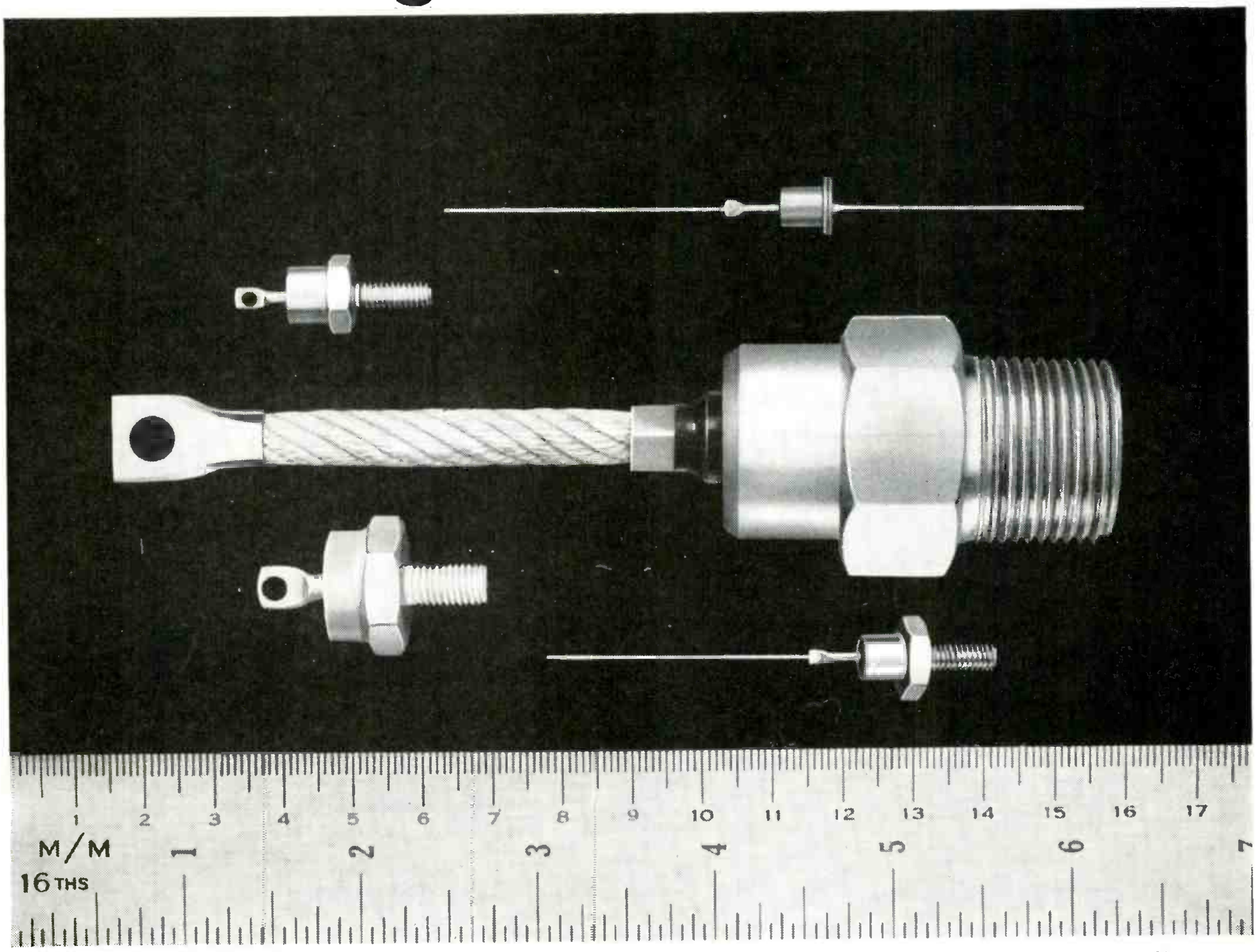
Boost DC power efficiency, cut costs with Westinghouse Silicon Rectifiers!



Whether you *use* or *manufacture* DC power equipment for low or high-power applications, Westinghouse Silicon Rectifiers offer you a way to step up power output efficiency yet save space, weight—*and costs!*

Manufacturing economies through tremendous volume and engineering know-how permit Westinghouse to bring you a product that is unsurpassed for quality at the lowest prices in the industry. All Westinghouse Silicon Rectifiers meet Military Environmental Tests and are ruggedly designed to withstand a wide range of operating conditions.

Westinghouse Silicon Rectifiers are ready for immediate delivery. Why not find out how they can cut DC power costs for you? Call your local Westinghouse Representative or mail the coupon now.

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WESTINGHOUSE SILICON RECTIFIERS

Number	PIV (Max.)	Peak Reverse Current (Max.)	Maximum Current at 150°C Case	Thermal Drop Junction to Case
HIGH & MEDIUM POWER				
302	50-600 V	20 Ma	35 Amps.	1°C Per Watt
303	50-600 V	10 Ma	18 Amps.	1.5°C Per Watt
304	50-600 V	10 Ma	12 Amps.	2°C Per Watt
322	50-500 V	40 Ma	110 Amps.	.3°C Per Watt
LOW POWER				
305	50-800 V	1.5 Ma	1.6 Amps.	5°C Per Watt
320	50-800 V	1.5 Ma	1.6 Amps.	5°C Per Watt

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Lavoie

From the broad experience of our years — from a great aggregation of Oscilloscope skills —

This Important Engineering Achievement

NEW MODEL LA-259D OSCILLOSCOPE

WITH FIVE INCH CR TUBE

Here's down-to-earth practicality in a scope of functional simplicity, dependable performance and highest accuracy. Embodying refinements of all the best features of the Lavoie LA-239C (USM-50)—workhorse and standard of accuracy for the military and missiles systems — the LA-259D provides greater CRT viewing area with brighter images for pulses of high speed. Amplitude measuring is speeded up by a direct reading amplitude scale. The highly visible scale changes with each range . . . prevents confusion, eliminates multiplication errors. Completely ruggedized for field use as portable bench unit, or installed in relay rack, the Lavoie LA-259D Oscilloscope meets all military requirements. Send for brochure and complete specifications.

SPECIFICATIONS

VERTICAL AMPLIFIER

Deflection Sensitivity: 10 mv/cm ac or dc

Transient Response: better than 0.02 microseconds

Frequency Response: dc to 15 mc, 2 cps to 15 mc, ac
Sensitivity approx. 50 mv/cm at 25 mcs.

Compensated Attenuator: calibrated from 0.01 v/cm to 25 v/cm
Calibration continuous with vernier cursor.
Direct reading indication.

Signal Delay: 0.2 usec delay network

TIME BASE

Sweep Range: 0.07 usec/cm to 0.1 sec/cm in 6 steps.
Facilities for external capacitor.

Sweep Expansion: 10 times

Triggering: internal trigger generator, external, signal and high frequency sync.

Horizontal Amplifier; frequency response 10 cycles to 750 kc. Can be used as external amplifier—source of sawtooth voltage.

OTHER CHARACTERISTICS

Square Wave Voltage Calibrator: Internally generated 1 kc square wave—0.01 v to 50 v in 11 steps.

Z Axis Timing Markers: available at 0.2, 1, 5, 20, 100, 500 and 2000 usec intervals synchronized with sweep.

Flat Face CRT: Dumont K1443 P2 (P1, P7, P11 optional)

Accelerating Potential: 10,000 volts

Electronically-Regulated Power Supplies

Power: 115/230 v—50 to 1000cps, 325 watts.

Lavoie Laboratories, Inc.

MATAWAN 1, NEW JERSEY

ALBANY, J. A. Reagan Co., Albany 8-5155 · BALTIMORE, Thomas L. Taylor, Belmont 5-9126 · BOEING FIELD, Testco, Mohawk 4895 · CHICAGO, R. Edward Stemm, Estebrook 9-2700 · DENVER, Allen I. Williams Co., Main 3-0343 · EUCLID, O., Electro Sales Associates. Redwood 2-7444 · FORT WORTH, Mitchell Speairs Co., WA 6-4444 · HARTFORD, Michael S. Coldwell, Jackson 2-5832 · LOS ANGELES, Kittleson Co., Webster 3-7371 · SAN CARLOS, Cal., R. L. Pflieger Co., Lytell 1-0396 · ST. LOUIS, Edwin L. Murty, Jefferson 1-2075 · WEST ORANGE, N. J., Louis A. Garten & Associates, Redwood 1-1800. · CANADA, Instronics Limited, Stittsville, Ont. EXPORT, Frazar & Hansen, Ltd., New York City.

Circle 159 Readers Service Card

Circle 345 Readers Service Card

Everything you need!

fast, easy

- **Immediate delivery. See your *-hp-* rep now!**
- **Direct reading, extreme accuracy**
- **Color-coded controls; simplest to use**
- **Highest performance, highest quality**
- **Universal automatic triggering**

SPECIFICATIONS

130A

Input Amplifiers: (Similar Vert. and Horiz. Amps.). Sensitivity 1 mv/cm to 50 v/cm; 14 calibrated ranges, 1-2-5-10 sequence plus continuous vernier. Pass band dc to 300 KC; ac or dc coupling. Balanced input on 1, 2, 5, 10 and 20 mv/cm ranges.

Sweep Range: 1 μsec/cm to 12 sec/cm. 21 sweeps: 1-2-5-10 sequence, 5% accuracy.

Triggering: Internal, line voltage or external 0.5 v or more. Pos. or neg. slope, +30 to −30 v trigger range.

Preset Trigger: Optimum setting for automatic stable triggering.

Amplitude Calibration: 1 KC square wave, 5% accuracy.

Price: $650.00.

SPECIFICATIONS

150A, 150AR

Sweep Range: 0.02 μsec/cm to 15 sec/cm.

Calibration: 24 sweeps: 1-2-5-10 sequence, 0.1 μsec/cm to 5 sec/cm. 3% accuracy.

Triggering: Internal, line voltage or external 0.5 v or more. Pos. or neg. slope, +30 to −30 v trigger range.

Preset Trigger: Optimum setting for automatic stable triggering.

Horizontal Amplifier: Sweep magnification 5, 10, 50, 100 times. Vernier position control selects any 10 cm part of sweep. External input pass band dc to over 500 KC. Sensitivity 200 mv/cm to 15 v/cm.

Vertical Amplifier: Pass band dc to 10 MC. Optimum transient response and rise time less than 0.035 μsec. Signal delay of 0.25 μsec permits leading edge of triggering signal to be viewed.

Amplitude Calibration: 18 calib. voltages, 1-2-5-10 sequence, 0.2 mv to 100 v peak-to-peak. Accuracy 3%. Approx. 1 KC square wave, rise and decay approx. 1.0 μsec.

Prices: *-hp-* 150A High Frequency Oscilloscope, $1,100.00.

-hp- 150AR Rack Mount Oscilloscope, $1,200.

-hp- 151A High Gain Amplifier, $200.00.

-hp- 152A Dual Channel Amplifier, $250.00.

Low Frequency Cabinet Oscilloscope, Model 130A. Covers dc to 300 KC. Similar horizontal and vertical amplifiers. Input circuits balanced on 5 most sensitive ranges. Single ended input may be dc or ac coupled. Direct reading, linear sweep times. With most transducers, needs no preamplification to produce brilliant, high resolution trace. Universal automatic triggering; one preset condition provides optimum triggering for almost all inputs. $650.00.

Low Frequency Rack Mount Oscilloscope, Model 130BR. Similar to *-hp-* 130A except for rack mount and includes x5 magnifier usable on all ranges and expanding fastest sweep to 0.2 μsec/cm. Parallel input terminals front and rear. $650.00.

HEWLETT-PACKARD COMPANY

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CABLE "HEWPACK" • DAvenport 5-4451

Field engineers in all principal areas

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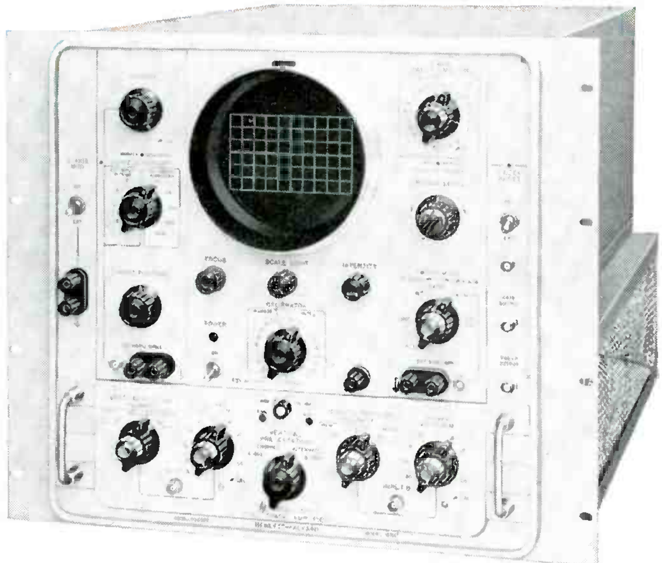
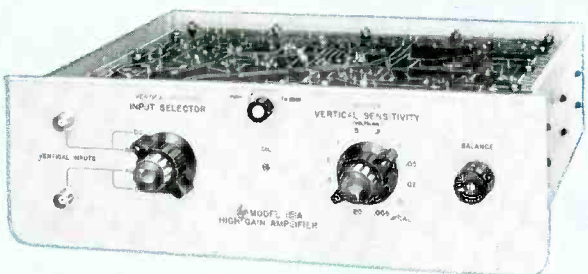
to use, quality

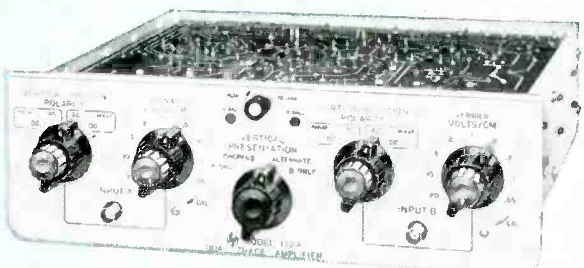
OSCILLOSCOPES



High Frequency Cabinet Oscilloscope, Model 150A. Covers dc to 10 MC with new reliability and convenience. Two plug-in preamplifiers for high gain or dual channel measurement (see below). 24 direct-reading sweep times; sweeps 0.02 μsec/cm to 15 sec/cm. Universal automatic triggering; one preset condition insures optimum triggering. $1,100.00.

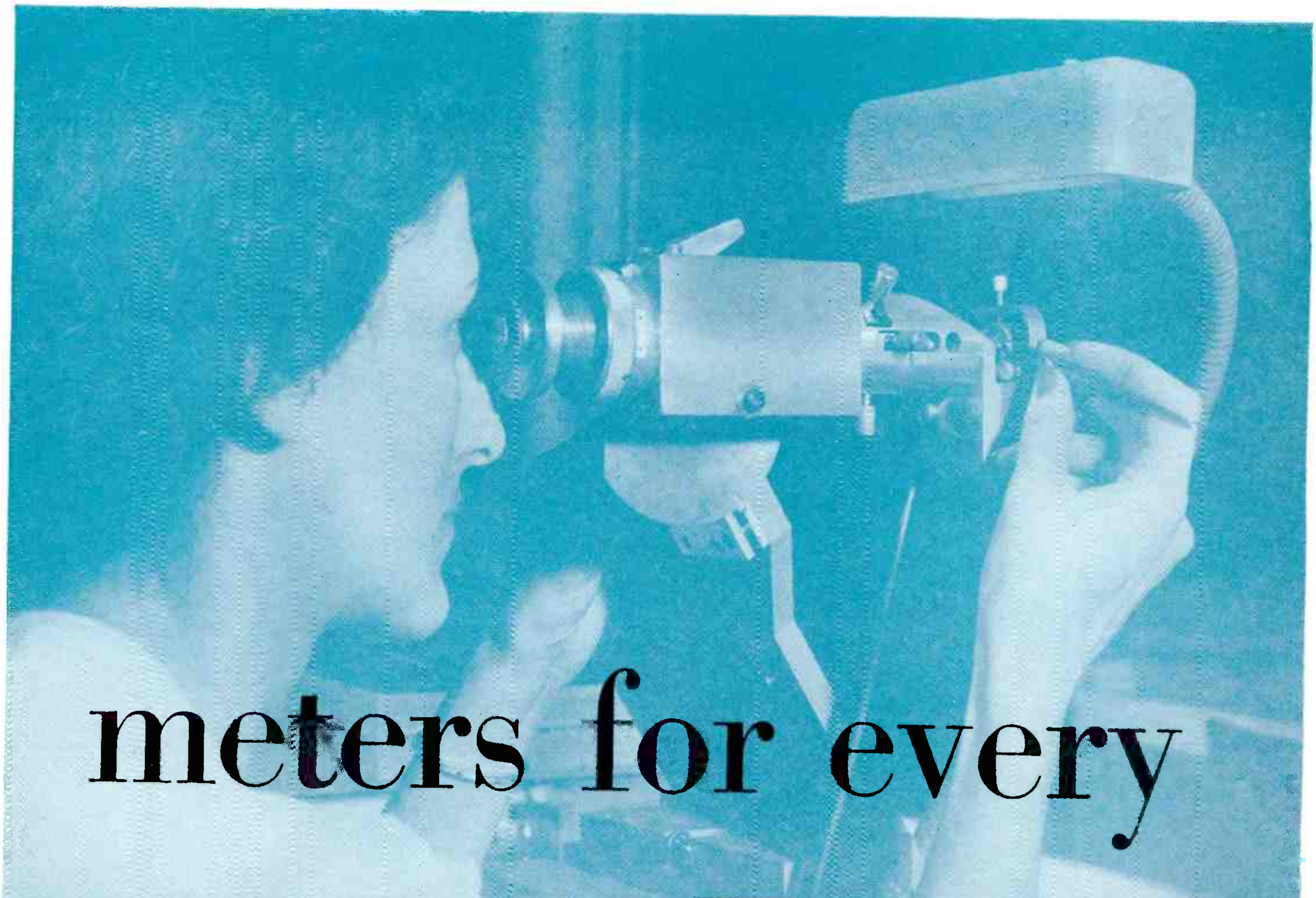
High Frequency Rack Mount Oscilloscope, Model 150AR. Same as *-hp-* 150A except for mounting in standard relay rack. Fitted with "pull-out" slides for maximum servicing accessibility. $1,200.00.



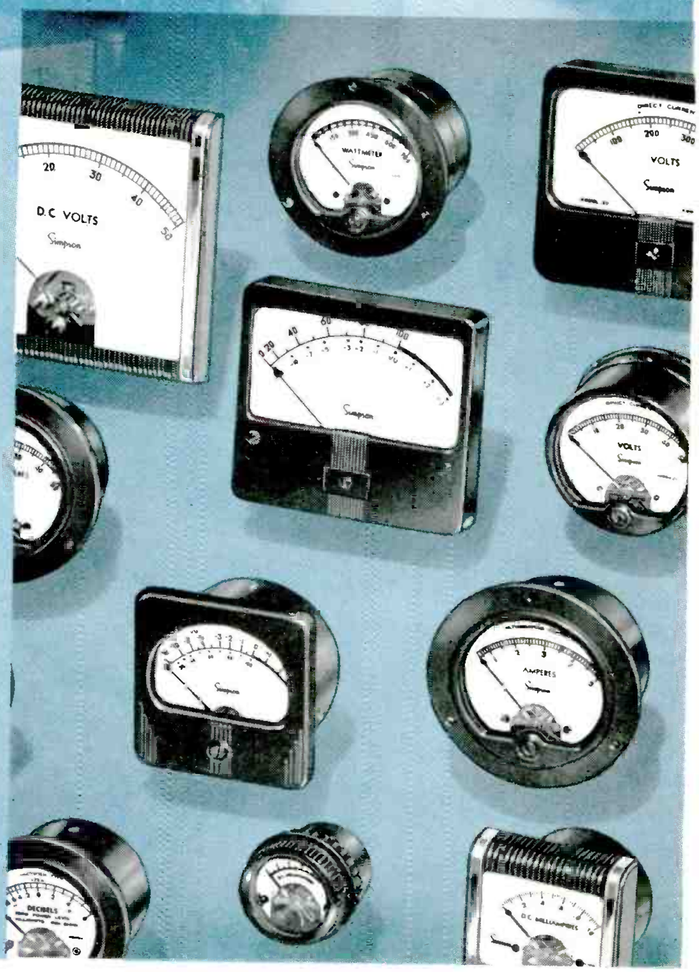


High Gain Amplifier, Model 151A. Designed for plug-in use with *-hp-* 150A or 150AR Oscilloscopes. High gain unit with 5.0 mv per cm sensitivity and frequency response dc to 10 MC. 12 calibrated ranges in 0.5, 1, 2, 5 sequence. 1 megohm input impedance with 25 μμf shunt. Pass band rise time 0.035 μsec. Equipped with two BNC input terminals. $200.00.

Dual Channel Amplifier, Model 152A. Designed for plug-in use with *-hp-* 150A or 150AR Oscilloscopes. Permits two phenomena to be presented on CRT simultaneously. Either amplifier usable separately. For dual presentation, electronic switch applies outputs to alternate traces, or switches outputs at a 100 KC rate. 50 mv/cm sensitivity, 9 ranges, 1, 2, 5, 10 sequence. $250.00.



meters for every



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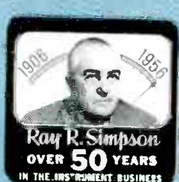
Simpson Offers a Complete Line

To meet your special requirements, Simpson can build electrical panel meters in many combinations of size, range, type, and style. For meters in small quantities, you can select from 60,000 stock units (over 900 sizes and types) available for *immediate delivery* through your Electronic Distributor. Many stock models now have the *self shielded* Core Magnet Meter Movement.

These fine panel instruments are known throughout industry for their ruggedness and long-lived accuracy. Write today for Technical Manual No. 17.



SIMPSON ELECTRIC COMPANY
5200 W. Kinzie St., Chicago 44, Ill.
Phone: EStebrook 9-1121
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instruments that stay accurate

Today more than yesterday . . . tomorrow more than today

A dependable source of stable voltage

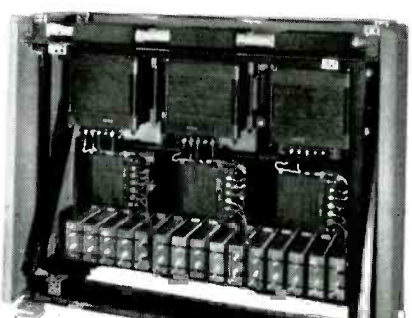
Today more than yesterday—and tomorrow more than today—circuit reliability and simplification is a vital responsibility of the electronic and electrical design engineer. Where the problem is voltage control, utmost simplicity and reliability is provided by the Sola Constant Voltage Transformer.

STANDARD-TYPE DESIGN *for the 250-1000 va ratings range of Sola Constant Voltage Transformers shows compactness and simplicity of this static-magnetic regulator.*

Along with its simplicity, the static-magnetic Sola regulator offers many important advantages over other voltage stabilizers, some of which depend upon saturation of core materials for their regulating action; or other types employing tubes. The performance characteristics of Sola Constant Voltage Transformers have led to their widespread use in applications for which other types of regulators are unsatisfactory. Included are:

1. *Completely automatic, continuous regulation of output within ±1% with primary voltage variations as great as ±15%.*
2. *Response time of 1.5 cycles or less.*
3. *No moving or expendable parts or manual adjustments.*
4. *Self-protecting against short circuits or heavy overloads on output or load circuit.*
5. *Current-limiting characteristic protects load equipment from excessive fault currents.*
6. *Availability of transformation ratio for step-up, step down, plate and/or filament supply permits substitution in place of conventional non-regulating transformers.*
7. *Provides isolation between input and output circuits, often eliminating the need for "static shields."*
8. *Relatively compact compared to other equipment for comparable ac voltage regulation.*

The basic-design Sola regulator—referred to as the Standard-Type Constant Voltage Transformer — is available from stock in capacities from 15 va to 10 kva in a variety of ratings. Many of these standard models can also be supplied for 25 and 50 cycle service, or with other input and output voltages, on a "build-to-order" basis.



SPECIAL DESIGN *above exemplifies adaptability of the basic Sola Constant Voltage Principle to special electrical or mechanical needs. This unit, rated at 9 kva — either single, or three-phase — delivers ±1% voltage regulation with negligible harmonic distortion.*

Special adaptations of the basic design have resulted in six additional types of Sola regulators that meet a variety of voltage stabilization problems. Included are types that provide low harmonics in the output wave, regulation of electronic plate and filament voltage supplies, and lower-cost regulation for household appliance service.

LATEST ADDITION *are these filament-voltage regulators in capacities up to 25a at 6.3v. Capacitor, at right, is wired separately from transformer for most compact mounting of the assembly as component in manufacturers' product.*

Your letterhead request for "The Sola Constant Voltage Transformer —Theory of Design and Operation" will bring answers to your technical questions about the operation of the Sola regulator. This monograph includes a discussion of special adaptations of the basic-design voltage regulator. Specific information about transformer availabilities for your particular "component" or "end use" applications may be obtained promptly from your nearest district sales engineer. He's listed below.

SOLA *Constant Voltage* **TRANSFORMERS**

CONSTANT VOLTAGE TRANSFORMERS • LIGHTING TRANSFORMERS • CONSTANT VOLTAGE DC POWER SUPPLIES
SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414 • BRANCH OFFICES: Boston, Mass.; Cleveland, Ohio; Kansas City, Mo.; Los Angeles, Calif.; New York, N. Y.; Philadelphia, Pa.; San Francisco, Calif.; Wallingford, Conn. • *Representatives in Other Principal Cities*
Sola Electric (Canada) Ltd., Toronto 17, Ontario: 102 Laird Drive, Mayfair 4554

THERE'S A GENERAL ELECTRIC IGNITRON FOR EVERY DESIGN NEED

Wide choice of Welding and Power Rectifier Tubes for the design engineer

STANDARD IGNITRONS

For Welding Service—KVA demand ratings from 300 through 2400 amps; or maximum average anode current from 22.4 through 355 amps.

For Power Rectifier Service—Continuous average amps 10 through 675; peak amps 30 through 3500; voltage ratings up to 20,000, inverse and forward.

CONVERTIBLE IGNITRONS

Available in same ratings as standard welding ignitrons (except GL-5550). Standard ignitrons have built-in thermal contact plate. Therefore, they can easily be converted to demountable-thermostat ignitrons.

Thermostat with flying leads—Thermostat gives over-temperature protection or water regulation.

Terminal-block thermostat—Thermostat gives over-temperature protection or water regulation.

TEMPERATURE-CONTROLLED IGNITRONS

Available in all welding and power rectifier ratings (except GL-5550). Over-temperature control and water regulation integral with tube.

PLASTIC-COATED IGNITRONS

Safety feature available on welding types. Red plastic shields workers from hazardous voltages. "DANGER ... VOLTAGE" stamped on plastic.

FACTORY-TESTED AT FULL RATINGS. Exclusive with General Electric is special factory test equipment that operates G-E ignitrons at full ratings under actual service conditions. You buy tubes proved-in-advance for service in your equipment. Every General Electric ignitron, moreover, is checked at the factory for the possibility of vacuum or water-jacket leakage.

HIGHEST-QUALITY IGNITORS. G-E ignitors will outlast others by as much as 2 to 1. Examples of 4-years-and-over G-E ignitor life are common; also cases in which G-E ignitors have outlived the tube. Reasons are: carefully controlled materials; holding the ignitor resistance to close limits; precision grinding.

CONTROLLED-GRAPHITE ANODES. By using a specially-developed electronic grade of graphite, with both density and size of particles controlled to tight limits, General Electric is able to build ignitron anodes that stand up under extremely long and hard usage, give maximum life in heavy-duty service and under high-temperature conditions.

TRIPLE-DISTILLED-MERCURY POOLS. Mercury in G-E ignitron cathode pools is distilled to a point where impurity content is only 1 in 100,000 or less. Organic impurities, which can bring about gas formation, and inorganic materials, which can cause the ignitor to plate over, are held to a virtually irreducible minimum.

STABILIZED STAINLESS-STEEL JACKETS. General Electric uses stabilized stainless-steel for both inner and outer ignitron water-jackets. Characteristics of this material—its expansion and contraction, strength, chemical content—do not change with time or use. G-E ignitrons retain their full structural strength for life.

TURN THE PAGE FOR LIST OF G-E RECOMMENDED TYPES......

CONSULT THIS LIST OF G-E RECOMMENDED TYPES FOR YOUR IGNITRON NEEDS

WELDING-CONTROL TUBES

TYPE NUMBER (All types available with plastic coating)	SIZE	SUPPLY VOLTS	MAXIMUM RATINGS**			
			KVA DEMAND	CORRESPONDING AVERAGE ANODE CURRENT, AMP	MAXIMUM AVERAGE ANODE CURRENT, AMP	CORRESPONDING KVA DEMAND
GL-5550	(A)	250–600 rms	300	12.1	22.4	100
GL-5551-A*	(B)	250–600 rms	600	30.2	56	200
GL-5552-A*	(C)	250–600 rms	1200	75.6	140	400
GL-5553-B*	(D)	250–600 rms	2400	192.0	355	800
GL-6346 ⊙	(B)	250–600 rms	600	30.2	56	200
GL-6347 ⊙	(C)	250–600 rms	1200	75.6	140	400
GL-6348 ⊙	(D)	250–600 rms	2400	192.0	355	800

*Can be converted to demountable-thermostat ignitrons using these kits:

	Water Control	Over-temperature Protection
	N-15272AA (flexible lead)	N-15273AA (flexible lead)
	N-15286AA (terminal block)	N-15287AA (terminal block)

⊙ Built-in, temperature-controlled types. **Two tubes connected in inverse parallel.

FREQUENCY-CHANGER WELDING TUBES

TYPE NUMBER	MAXIMUM PEAK ANODE VOLTAGE		MAXIMUM ANODE CURRENT			
	INVERSE	FORWARD	PEAK	CORRESPONDING AVERAGE	AVERAGE	CORRESPONDING PEAK
GL-5551-A	1200	1200	600	5	22.5	135
	1500	1500	480	4	18	108
GL-5553-8	1200	1200	3000	40	140	840
	1500	1500	2400	32	112	672
GL-5822-A	1200	1200	1500	20	70	420
	1500	1500	1200	16	56	336
GL-6346 ⊙	1200	1200	600	5	22.5	135
	1500	1500	480	4	18	108
GL-6348 ⊙	1200	1200	3000	40	140	840
	1500	1500	2400	32	112	672
GL-6511 ⊙	1200	1200	1500	20	70	420
	1500	1500	1200	16	56	336

⊙ Built-in, temperature-controlled types.

POWER RECTIFIER TUBES

TYPE NUMBER	MAXIMUM ANODE RATINGS				
	PEAK VOLTS		PEAK AMP	CONTINUOUS AVERAGE AMP	AVERAGE AMP 1 MINUTE
	INVERSE	FORWARD			
GL-5779	350	350	30	10	—
GL-5554	900	900	900	100	200
	2100	2100	600	75	150
GL-5555	900	900	1800	200	400
	2100	2100	1200	150	300
GL-5564	900	900	3600	400	800
	2100	2100	2400	300	600
GL-5788 ■	900	900	1800	200	400
	2100	2100	1200	150	300
GL-6958	4000	4000	2000	300	600
GL-5630	20000	20000	200	50	50
GL-6228	20000	20000	900	150	300
GL-6512 ⊙	900	900	900	100	200
	2100	2100	600	75	150
GL-6513 ⊙	900	900	1800	200	400
	2100	2100	1200	150	300
GL-6514 ⊙ ■	900	900	1800	200	400
	2100	2100	1200	150	300
GL-6515 ⊙	900	900	3600	400	800
	2100	2100	2400	300	600

⊙ Built-in, temperature-controlled types.
■ Same ratings as GL-5555. These types will operate at higher water temperature and lower water pressure drop than type GL-5555.

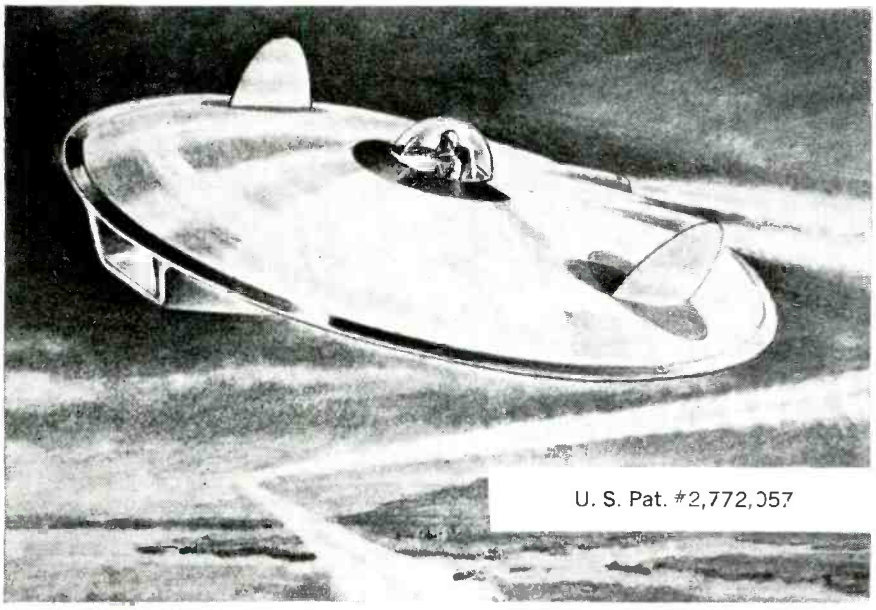
POWER TUBE DEPARTMENT

GENERAL ELECTRIC

9545-8481-5

SCHENECTADY, NEW YORK

MARS outstanding design **SERIES**



saucer secret?

Whose incredible design is the flying saucer?

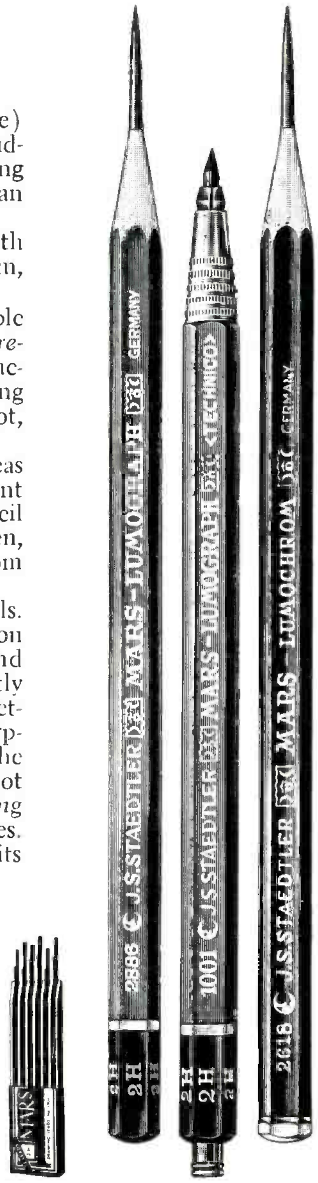
These flying objects (unidentified, of course) maneuver at high speed, with human-crushing suddenness. Their unearthly behavior poses a perplexing problem to imaginative designers: how might man survive in them?

John C. Fischer, Jr. approached the problem with this circular aircraft and its unique control system, U. S. Pat. #2,772,057.

This "saucer's secret" is a rotatably adjustable shell (upper) and a pilot's compartment which *pre-rotates* toward the direction to be flown. The functional design "humanizes" saucers because the rotating provisions distribute *g-forces* laterally on the pilot, minimizing blackouts.

No one can be sure which of today's new ideas will become reality tomorrow. But it will be important then, as it is now, to use the best of tools when pencil and paper translate an idea into a project. And then, as now, there will be no finer tool than Mars—from sketch to working drawing.

Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and—last but not least—the Mars-Lumochrom, the new colored *drafting* pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.



The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom colored *drafting* pencil, 24 colors.

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John C. Fischer, Jr., San Diego professional engineer, one of the winners in the 1957 MARS Contest. Mr. Fischer's project, "Saucer Secret?," is featured in the MARS presentation on this page.

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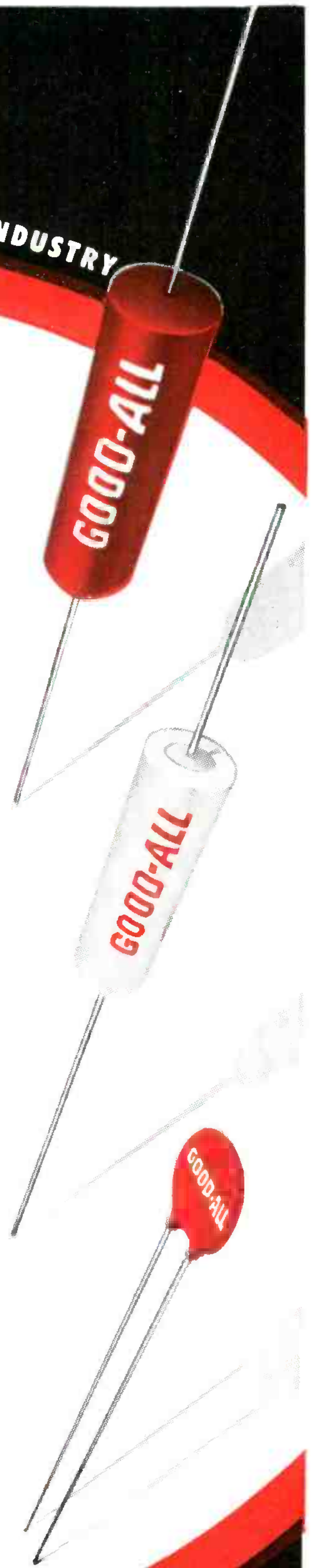

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Dielectric	Mylar Film	**Temp. Range**	−55 to +125°C
Case	Epoxy	**IR at 25°C**	100,000 Meg. x Mfd.
Voltage Range	100–1600	**Power Factor**	0.6% Max.

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Case	Hermetically Sealed	**D.C. Voltage Rating**	50, 100, 400 and 600
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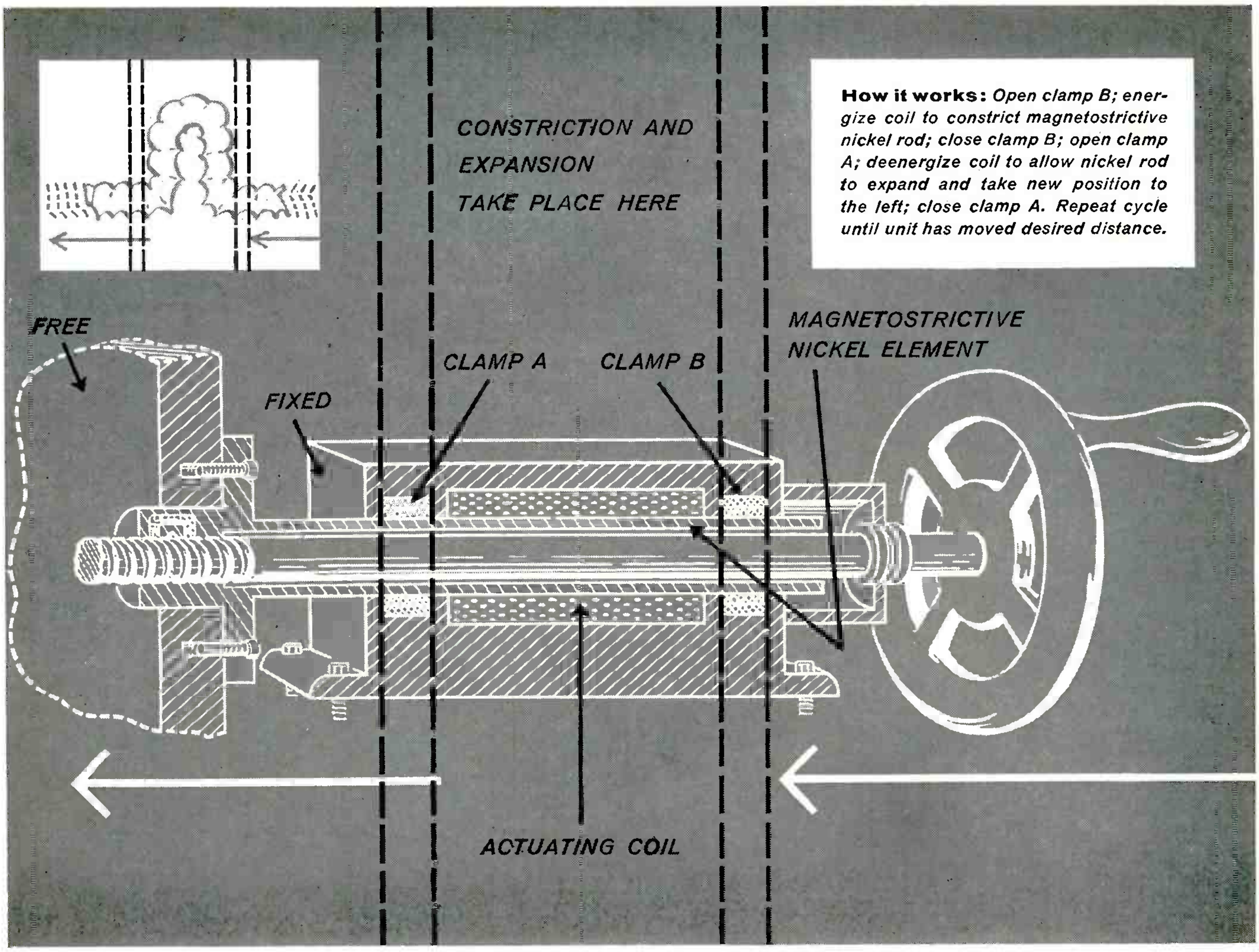

How it works: Open clamp B; energize coil to constrict magnetostrictive nickel rod; close clamp B; open clamp A; deenergize coil to allow nickel rod to expand and take new position to the left; close clamp A. Repeat cycle until unit has moved desired distance.
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Standard rectifier

RRco. Petti-Sel rectifier

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compare the size . . .

compare the specs . . .

STANDARD SELENIUM RECTIFIERS

NOMINAL CELL SIZE (INCHES)		RRco. CELL CODE	Continuous DC Amperes at 35° C Ambient					
			SINGLE PHASE			THREE PHASE		
Vert.	Horiz.		Half Wave	Center Tap	Bridge	Half Wave	Center Tap	Bridge
1.0	1.0	M	.11	.22	.22	.29	.40	.33
1 3/16	1 3/16	P	.23	.45	.45	.60	.81	.67
1.5	1.5	Q	.45	.90	.90	1.2	1.6	1.3
2	2	S	.70	1.4	1.4	1.8	2.5	2.1
3	3	U	1.6	3.2	3.2	4.2	5.8	4.8
3 3/8	3 3/8	V	2.0	4.0	4.0	5.3	7.2	6.0
4	4	W	3.0	6.0	6.0	8.0	10.8	9.0
4.5	5	G	3.75	7.5	7.5	10.0	13.5	11.2
4 1/4	6	T	4.2	8.5	8.5	11.0	15.0	12.5
5	6	H	5.0	10.0	10.0	13.3	18.0	15.0
6	7 1/4	L	7.5	15.0	15.0	20.0	27.0	22.5

RRco. PETTI-SEL SELENIUM RECTIFIERS

NOMINAL CELL SIZE (INCHES)		RRco. CELL CODE	Continuous DC Amperes at 35° C Ambient					
			SINGLE PHASE			THREE PHASE		
Vert.	Horiz.		Half Wave	Center Tap	Bridge	Half Wave	Center Tap	Bridge
1.0	1.0	6	0.2	0.4	0.4	0.6	1.0	0.6
1.3	1.3	11	0.5	1.0	1.0	1.5	2.5	1.5
1.6	1.6	16	0.75	1.5	1.5	2.25	3.75	2.25
2	2	25	1.25	2.5	2.5	3.75	6.25	3.75
2.6	2.6	44	2.25	4.5	4.5	6.75	11.25	6.75
4	4	100	4	8	8	12	20	12
4	8	200	8	16	16	24	40	24
4	12	300	12	24	24	36	60	36
8	8	402	16	32	32	48	80	48
8	12	600	22.5	45.0	45.0	67.5	112.5	67.5
8	16	800	30.0	60.0	60.0	90	150	90

In case you haven't noticed, the yellow and gray areas denote actual comparative sizes of the two rectifier types.

and compare the prices! HCD Petti-Sel rectifiers, developed in Western Germany by Siemens and now made in the U.S. by Radio Receptor, offer many important electrical advantages over standard types plus economic advantages.

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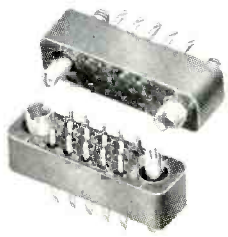
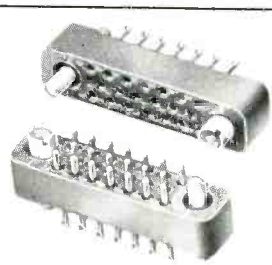
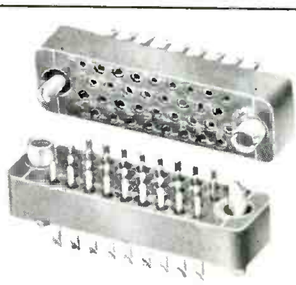
7 Contacts MM7-22



14 Contacts MM14-22



20 Contacts MM20-22



34 Contacts MM34-22

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Voltage Breakdown:	
At Sea Level	1800 Volts RMS
At 60.000 Ft.	450 Volts RMS
Current Rating	3 Amps.
Solder Cup (MM-22)	#22 AWG Wire
Minimum Creepage Path Between Contacts	1/8″
Minimum Air Space Between Contacts	3/64″
Contacts. Center-to-Center	3/32″
Pin Diameter (MM-22)	.030″

Technical data sheets on micro-miniature and other Continental Connectors are available on request. Specify your requirements to Electronic Sales Division, DeJUR-Amsco Corporation, 45-01 Northern Blvd., Long Island City 1, N. Y.

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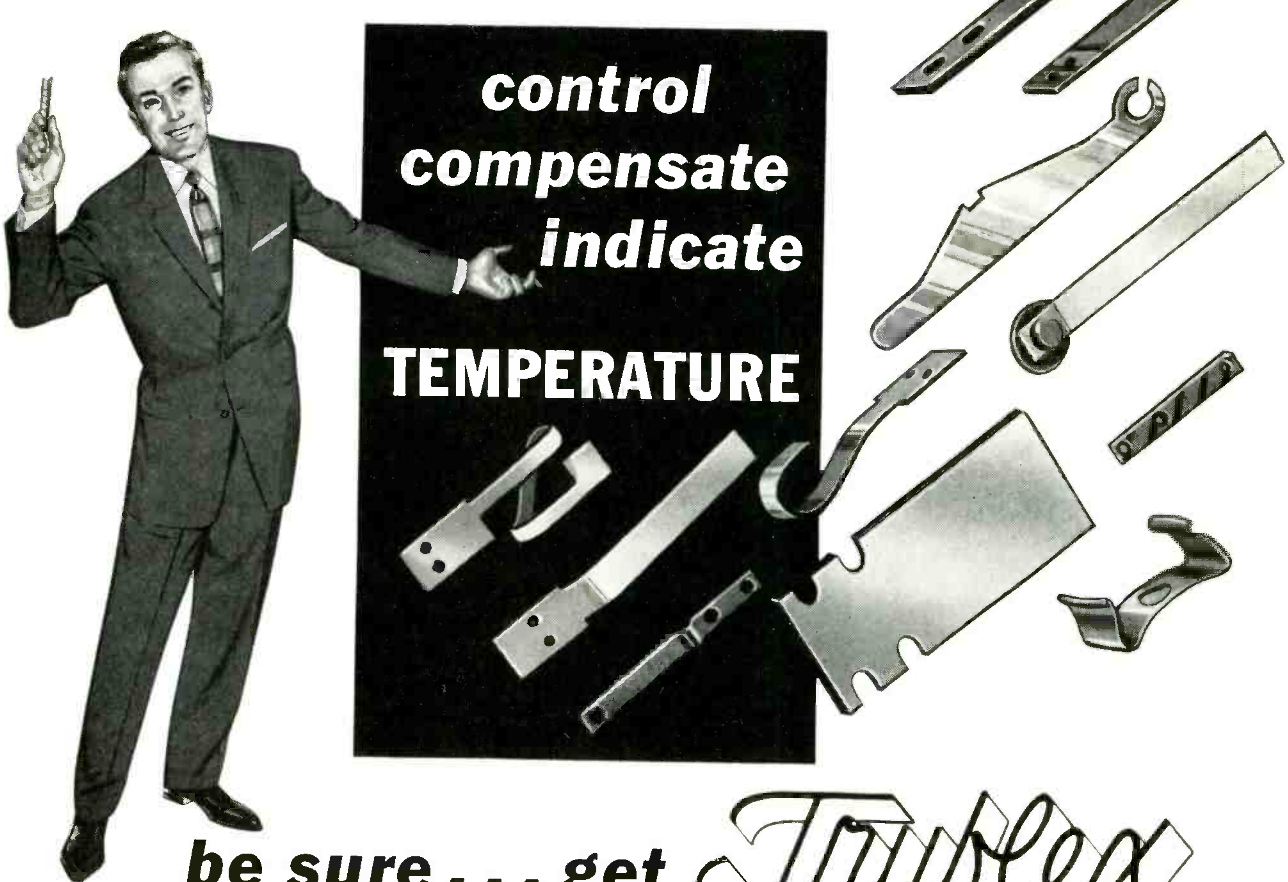

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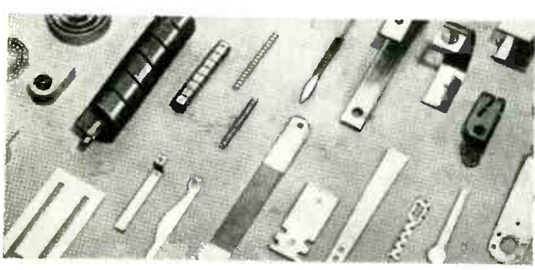

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Internal and external cavity type klystrons are used in PRD microwave oscillators. Both types belong to the reflex klystron group which is usually preferred because it provides easy tuning over a relatively wide frequency range and easy frequency or amplitude modulation.

The coaxial cavity is most often used for broadband oscillators since its principal mode is the TEM. This permits greater frequency coverage than either the TE or TM modes of rectangular waveguide sections.

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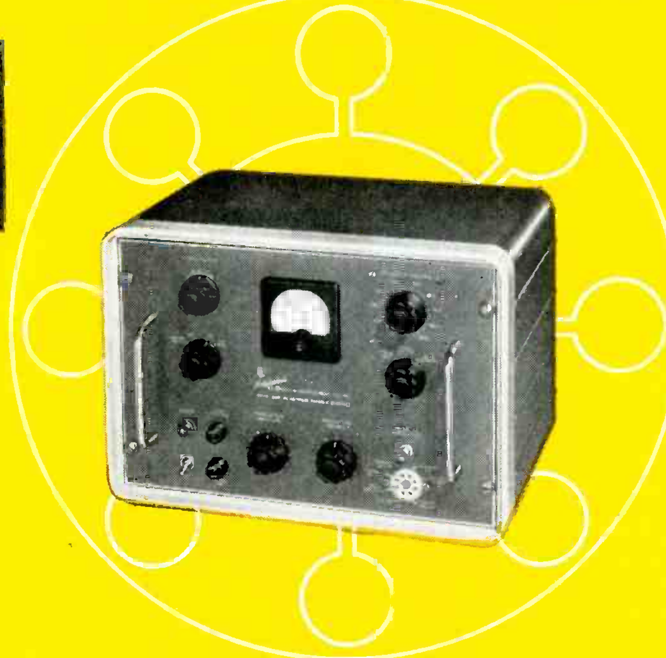
Data such as that contained in the foregoing paragraphs are available in our PRD Reports. Published periodically, these reports give practical information on virtually every aspect of microwave research and engineering. Mathematical derivations, graphs, and charts are always included. If you'd like to receive these reports (there's no charge of course), we'll be happy to add your name to our mailing list. Please address your request to: Reports Dept. 21.



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With good stability and regulation, and with square wave and saw tooth modulation plus provision for external modulation, Type 809 Klystron Power Supply is equally at home in the laboratory or on the production line.

SPECIFICATIONS

	Type	Voltage (volts)	Current (milliamperes)	Additional Specifications
Output	Beam	Continuously variable 250 to 600	0 to 65	Ripple: < 5mv RMS
	Reflector	Continuously variable 0 to −900	50 μa max.	Ripple: < 10mv RMS
	Filament	6.3	2 amperes	±3% center tapped

	Type	Frequency Range (cps)	Nominal Voltage (volts)	Rise Time (microseconds)	Decay Time (microseconds)	
Modulation	Square Wave	400 to 2000	0 to 90	<10	<10	Clamping circuit maintains top of square wave within 2 V of cw reflector voltage.
	Saw Tooth	60 (fixed)	0 to 125			

Price—$350 f. o. b. Brooklyn, N. Y.

For additional details on PRD 809 Klystron Power Supply, contact your local PRD Engineering Representative or write to Technical Information Group, Dept. 21.

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electronics
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NOVEMBER 1, 1957

Photoelectric Target for Missile Tests

SUMMARY — Rectangular coordinates of test missile can be determined at selected point along its trajectory by two banks of multiplier phototubes located at ground level. Each phototube in banks sees narrow segment of sky; missile passing through segment momentarily decreases light incident on phototube causing output pulse. Phototube banks, acting together, give coverage of flight area. Varying slit width changes area covered

By SAMUEL E. DORSEY
Ballistics Division
U. S. Naval Ordnance Test Station
China Lake, California

IN MISSILE TESTS, it has been customary to set up extensive as well as expensive targets of cardboard or other material, strung between poles placed at strategic points along the trajectory of the missile to obtain the rectangular coordinates. Break wires placed at certain locations establish a measurement of time.

This article discusses a proposed photoelectric target that uses electronic means to determine the rectangular coordinates of a test missile at a selected point along its trajectory. It also gives an indication of the time of passage through this point. The target is to be used in conjunction with tests where the trajectory of the missile lies close to the ground, as in cross-wind firing.

System Description

With the photoelectric target, a fairly accurate indication of these data can be obtained from equipment situated at ground level.

The five units comprising this system are two banks of phototubes in their light-restricting boxes, two cabinets of electronic apparatus for control and indication and a power supply cabinet as shown in Fig. 1.

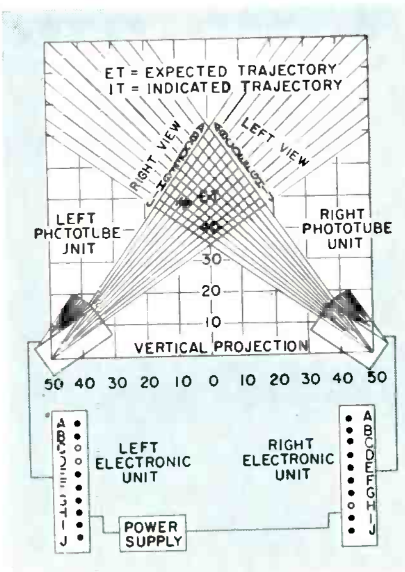

FIG. 1—Elements of target system. Upper half of diagram represents theoretical setup for expected trajectory of 50 ft and small dispersion

One bank of phototubes is placed on the ground to the left of the vertical projection of the expected trajectory, at a distance equal to its height. The other bank of phototubes is similarly placed to the right of the expected trajectory path.

Bank Construction

Each phototube bank consists of ten multiplier phototubes with each phototube mounted at the bottom of an elongated box constructed so light that impinges upon the phototube must pass through an adjustable slit in the top of the box as well as a small square hole in front of the phototube.

Each box is adjustable in direction and slit length so that each phototube sees a narrow segment of the atmosphere with sky in the

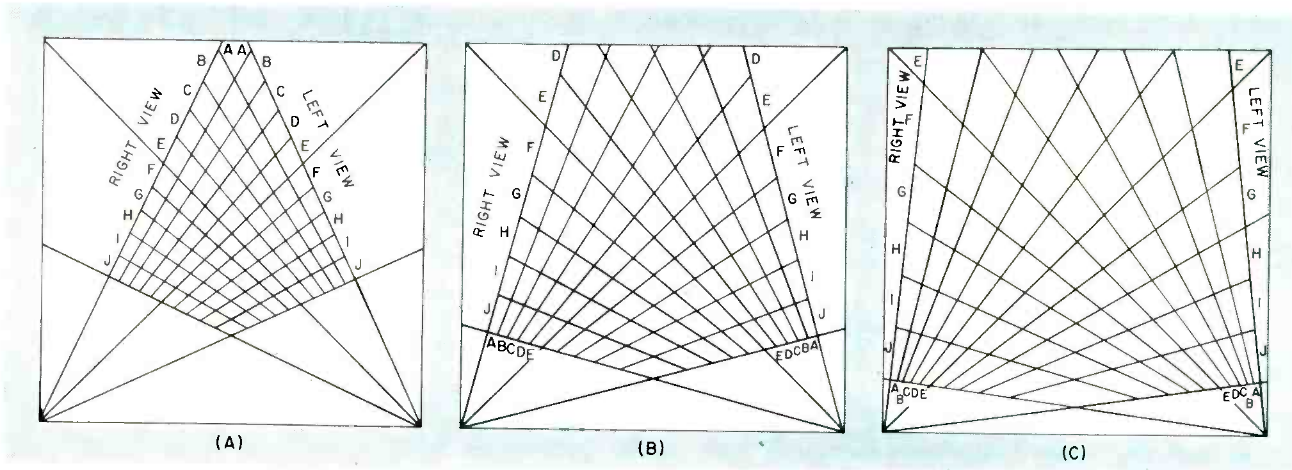

FIG. 2—Charts interpret meaning of lit indicator lamps for spacings and slit lengths of 4 (A), 6 (B) and 8 (C) degrees

background. If the missile passes through the segment, the momentary decrease of the light will be evidenced by a pulse of current in the phototube.

The ten phototubes when properly adjusted cover, fan-fashion, a thin slice of the range area extending above and below the expected trajectory to include the entire region of possible dispersion. The two phototube units, acting in different directions, give a sort of stereoscopic coverage of the flight area.

Readout

In each electronic unit, there are ten neon lamps, one for each phototube. These lamps are represented by the small circles in the lower half of Fig. 1.

When the missile cuts across some of the light received by any phototube, the corresponding circuitry in the electronic unit causes the phototube's neon lamp to light and remain lit. Simultaneously, the electronic unit lights the main pilot lamp and delivers a pulse into its timing output. The circuits between the nine other phototubes and their neon lamps are then quickly locked out. Therefore, about one millisecond after any one phototube within the unit has caused its corresponding neon lamp to light, no other neon lamp in that electronic unit can light.

Should the missile cut across the very edge of the field of view of one of the phototubes where there is slight overlap by the field of view of the adjacent phototube, both phototubes would light their neon lamps before the lockout action could take place.

Test Setup

The upper half of Fig. 1 represents a theoretical test setup where the expected trajectory is 50-ft high and the dispersion small. The phototube units are each set 50-ft from the expected trajectory path and adjusted for 2-degree operation (2-degree slit length and 2-degree separation).

The lighting of neon lamps *C* and *D* in the left electronic unit and lamp *H* in the right electronic unit, shows an indicated trajectory through a region 7 to 9 feet to the left of the expected trajectory and zero to 2 feet below it.

To interpret the meaning of the lamps, a series of charts, similar to that in Fig. 2, has been made for the phototube box spacing and slit lengths of 2, 4, 6 and 8 degrees.

Electronic System

A block diagram of the electronics of one side of the target system is shown in Fig. 3.

Ten multiplier phototubes, each with its separate regulator circuit, feed ten amplifier channels. Each channel in turn feeds a thyratron. Output circuits from all ten of the thyratrons are tied together to form a common signal bus which makes up the input of three other amplifiers: a lockout amplifier which renders inoperative all ten amplifier channels whenever one or more thyratrons are conducting; a pulse amplifier which generates the timing pulse and a relay amplifier which causes the pilot lamp to light.

This application of phototubes presents the problem of changes in average level of illumination on the cathodes of the phototubes. These changes are brought about by several factors: the manual changes in slit length at the top of the restrictive housing of each phototube in setting up the target for different

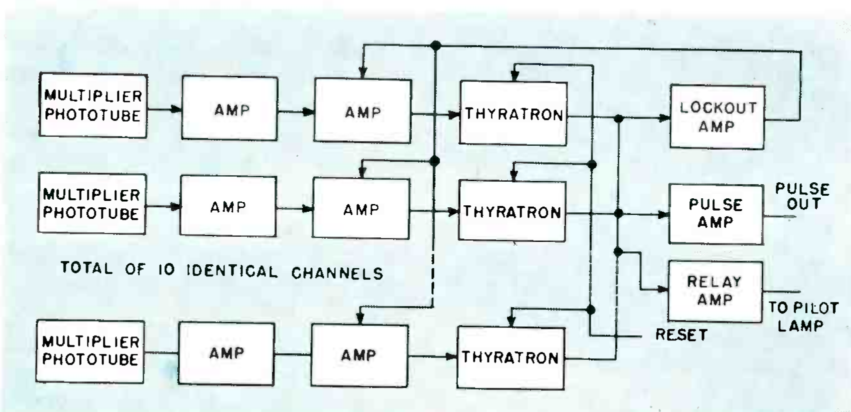

FIG. 3—Block representation of one side of electronic portion of target system

Inside view of one phototube box shows arrangement of slits

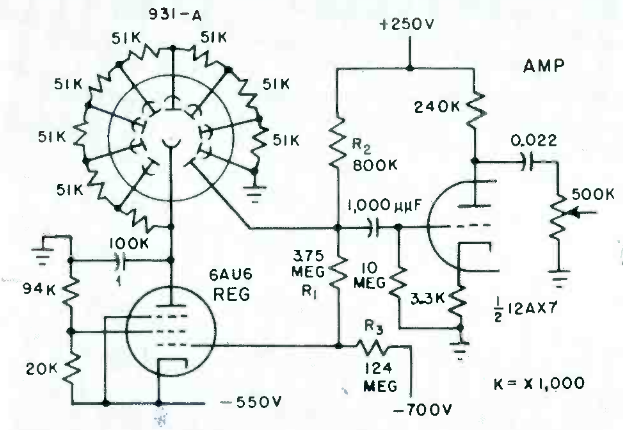

FIG. 4—Regulator compensates for illumination changes

angular sizes of target area; the angles from the horizon at which the field of view of each phototube is directed; the nearness to the sun at which each phototube is directed; the time of day and the weather. The first factor introduces a variation of 4:1. It can be estimated that the variations for the other factors are quite large.

Phototube Regulators

These changes in illumination are compensated for with a regulating circuit for each phototube, as shown in Fig. 4.

Resistors R_1 to R_3 form a voltage divider between the +250-v supply, the anode of the phototube, the control grid of the 6AU6 and the −700-v supply. When the anode voltage is about +60-v, the control grid of the pentode is held at about −5-v with respect to its cathode (−550-v with respect to ground). This range of control grid bias causes the 6AU6 to drop enough voltage from the phototube supply of −550-v to hold the anode voltage of the phototube at its +60-v value. If the anode of the phototube were nonconducting, the voltage divider would prevent its voltage from rising above +100-v. These conditions set the sensitivity of the phototube to a value which remains adequate.

Control Circuits

A simplified diagram of the circuitry remaining is given in Fig. 5. The second amplifier triodes are fed from the gain controls. The second amplifier plates are tied through coupling capacitors to the control grids of the thyratrons. The plate of each thyratron is fed through a parallel combination of load resistance and indicator neon lamp circuit to the reset bus, which is tied through the normally closed push-button reset switch to the positive plate supply.

The cathode and shield of each thyratron are tied through a filtering resistance to the common signal bus. The voltage on this bus, under conditions of reset, is approximately zero, rising to approximately 10-v when any one thyratron starts conducting. This voltage rise forms the input to the lockout, timing signal and relay amplifiers.

Lockout

The lockout amplifier amplifies and inverts the voltage rise and applies it through the cathode follower to the lockout bus, which furnishes plate supply for all the second amplifiers. The starting voltage of the bus is high enough so the second amplifiers can operate properly. After one of the thyratrons starts conducting and after a delay caused by the charging of capacitor C_1, the voltage of the lockout bus is reduced to a value so low that its associated second amplifier can no longer operate.

The timing signal amplifier is a two-stage amplifier with a cathode follower output.

The relay amplifier is cathode biased so it can draw enough plate current to actuate the relay only after the rise of voltage on the signal bus. The contact of this relay controls indicator lamp I_{11}.

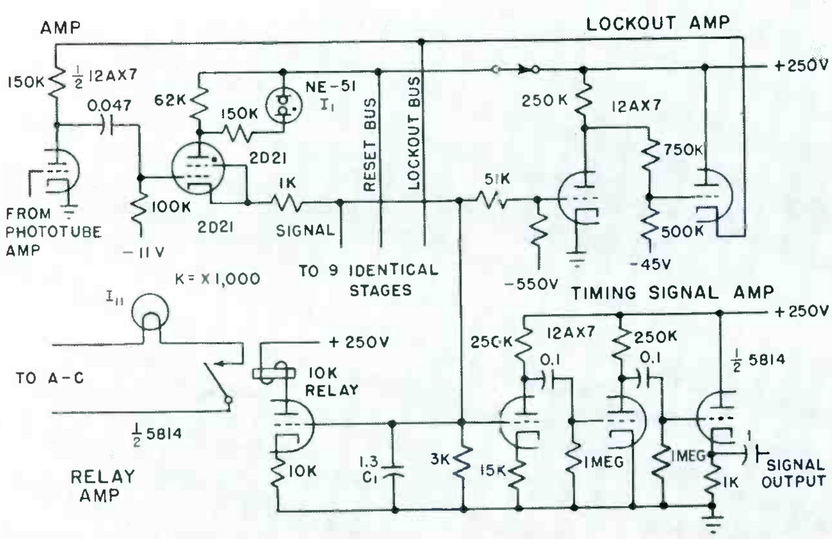

FIG. 5—Lockout, timing-signal and relay amplifiers are common to all ten signal channels

Semiconductor Compounds

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SUMMARY — Comprehensive survey of semiconducting compounds distinguishes these materials from conventional semiconductors and discusses their characteristics, unusual properties and applications, both present-day and future. Tables of intermetallic and dye semiconducting compounds show all important presently available facts on these materials

AN UNUSUALLY fertile field for further investigation and commercial exploitation is that of semiconducting compounds.

A semiconductor is a substance with a resistivity in the range between that of metals and insulators, roughly from 0.005 to 10^8 ohm-cm, and whose resistivity decreases with temperature in some temperature range. Some degree of photoconductivity and rectifier action are usually exhibited; however, not all exhibit transistor action to a useful degree.

Definitions

Compounds are composed of two or more constituent elements with properties different from those of the elements.

Metals exhibit hardness, good electrical and thermal conductivity and have a typical luster. These metals are usually, but not always, ductile malleable and may be base-forming.

The term intermetallic compound is often misused. Thus Mg_2Si, GaP and InAs are frequently found listed among the intermetallics, but are not intermetallic by definition.

Organic compounds have one constituent element as C and frequently also H. On this general basis, which is historic rather than scientifically desirable, an inorganic compound is one containing any other elements, but may contain C as well (SiC). Thus the distinction is not rigorous and the overlap between the organic and inorganic compounds is accepted.

A solution is a mixture of elements or compounds charcterized by complete homogeneity, an absence of settling or separation, and minute subdivision down to molecular magnitudes. When the result is a solid or the process of solution takes place while the constituents are in the solid state, it is called a solid solution.

Uses and Applications

Virtually all semiconductor transistors and diodes today use germanium or silicon. Diodes made of selenium or copper-oxide, fall into the category of the semiconductors. These materials have limits in the coming world of higher speeds, higher temperatures, higher frequencies and higher powers.

Since the energy to bring holes or electrons across the forbidden energy gap varies with kT, a higher energy and therefore temperature are required to increase the number of carriers significantly for a material with an energy gap of 3 ev compared to the temperature required for a material with an energy gap of 1.1 ev.

One may thus infer that in Table I, with other parameters constant, the permissible upper operating temperature increases going down from Si and decreases going up from Si. For instance, Ge devices will operate satisfactorily approximately up to 65 to 70 C, as compared to 125 C for Si.

Alpha cut-off frequency for transistors is given to a good approximation by

$$f_{\alpha co} = \frac{kT}{\pi e w}\,\mu_n \text{ for } n \text{ type material} \quad (1)$$

$$f_{\alpha co} = \frac{kT}{\pi e w}\,\mu_p \text{ for } p \text{ type material.} \quad (2)$$

Other parameters equal, the frequency response is directly proportional to the mobility (μ) to a good degree of approximation. On this basis, if a transistor could be made of InSb, for example, it would have a frequency response, for the same barrier width w, 57,000/1,400 or over 40 times the frequency response for one made of Si and over 15 times compared to Ge.

Compounds like InSb, InAs, MgTe, GaSb and HgSe could be superior to silicon for transistor applications in the matter of frequency response with all other parameters constant; while InP, GaAs and diamond could be superior to silicon in frequency response and upper temperature of operation.

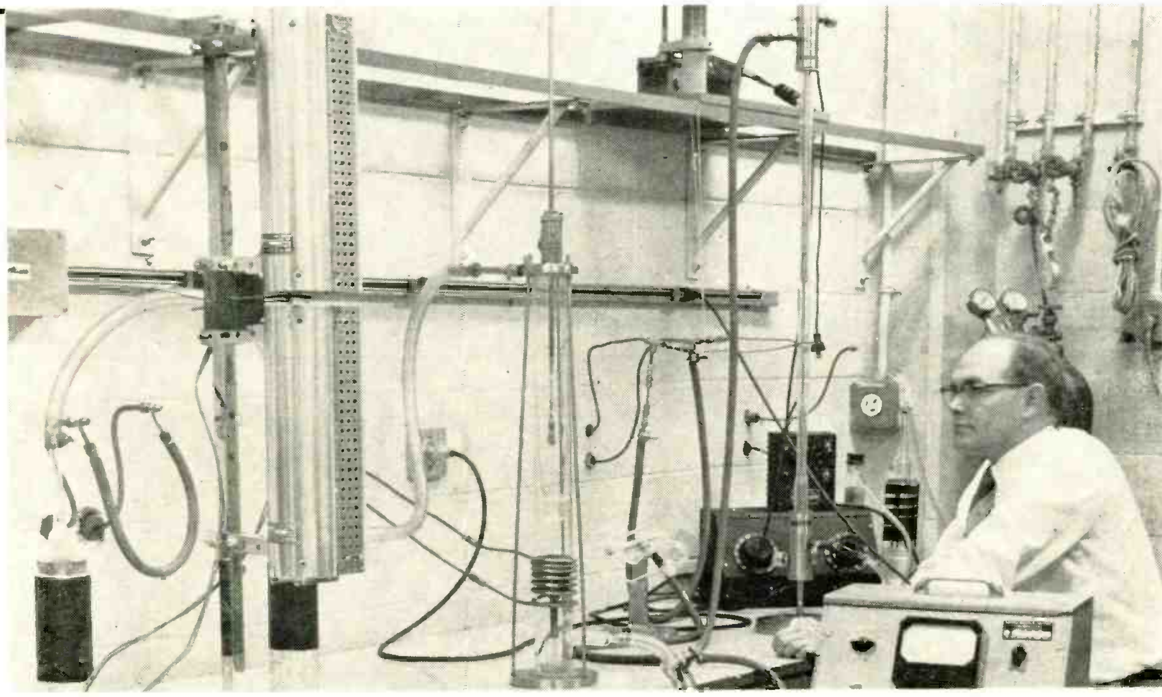
For high-power operation, one problem is to remove the I^2R heat

All compounds below silicon in the table might well outperform silicon for power applications.

Forbidden Band Width

An attractive variation of effective forbidden band width is afforded by solid solutions of some semiconduct or elements and compounds. Silicon and germanium form a series of solid solutions with a continuous distribution of

Open New Horizons



Floating-zone purifier (left) and single-crystal puller (center) are used for AlSb and InSb compounds

each element from 0 to 100 percent. The resulting alloy has a forbidden band width varying continuously from $E_g = 0.72$ ev for 100-percent Ge, to 1.09 ev for 100-percent Si.

A similar set of solid solutions is obtainable for S_e ($E_g = 2.05$) and Te, with the energy gap varying continuously from 0.34 ev to 2.05 ev. Similarly, compounds GaP and GaAs form a continuous series of solid solutions with a continuous variation of energy gap; so do also InAs and InP, and HgSe and HgTe. Other mixtures of this type have been reported. One thus sees the practicability of a custom-made forbidden energy gap.

The potential of semiconducting compounds stems in part from the wide range of controllable parameters to choose from, in part from the possibility of choice of semiconducting elements taken two, three ($CuFeS_2$) and even four at a time ($CuFeSnS_4$, Tl_2Se-As_2Te_2) and in part from combinations of these compounds in intermixtures.

Cooling

Current flowing through a junction of dissimilar metals can pump heat from one junction to another in a two-junction system called a couple; this is the Peltier effect. Its inverse, creation of current flow by application of heat is the Seebeck effect. The rate of change of the emf acting in such a couple with temperature is the thermoelectric power; this parameter, measured with respect to some specified material like Cu or Bi, is a useful figure of merit of the material in refrigerating device.

Other characteristics of materials which determine refrigeration efficiency are electrical and thermal conductivity, mobility and atomic weight. It has been found that Ge and Si are poor for this purpose compared to, for example, bismuth telluride for which 40 C cooling for a single couple has been reported.

Special Effects

Magneto resistence is the change of resistance in the presence of a magnetic field change. For InSb a field change of 10,000 oersteds will produce a resistance change of 20:1. Such marked changes of resistance with magnetic field strength are not possible with Ge or Si.

In piezoresistance, pressure causes changes in resistance and mobility. Here again, InSb or InAs is much superior to Si and Ge. Pressure meters have been made using this principle.

The galvanomagnetic or Hall effect can provide an output power of 1/200 microwatt for a 1-deg rotation of a suitable element of InSb in the earth's magnetic field. This is equivalent to an effective multiplication of the earth's magnetic field by a factor of about 1,000 and points the way to ultrasensitive magnetic compasses.

Using photoconductive effects, InSb exhibits a usable change in resistivity upon irradiation with infrared wavelengths up to 7.5 microns, considerably more than Ge. The wavelength up to which a substance will pass radiation impinging upon it, filtering out, or reflecting, all radiation of a higher wavelength, is frequently called an absorption edge. This factor is given by h_c/E_g in microns and when E_g is in ev, the absorbtion edge $= 1.24/E_g$ (3).

For Ge, with an energy gap of 0.72 ev, the absorption edge is at 1.73 microns, for InSb it is about 7.15 microns. For InSb, by adding

Te, this absorption can be varied continuously up to the maximum indicated providing with a tailer-made absorption edge in an infra-red filter.

Applications Wanted

A number of unusual effects have been reported which seem to plead for applications. At 80 K, mobilities in InSb of the order of 500,000 cm^2/v-sec and in lead salts (PbS, PbSe, PbTe), in the presence of a magnetic field at 4.2 K, of the order of 750,000 cm^2/v-sec have been reported.

Another interesting effect indicates the persistence of photocurrents in various semiconducting compounds for days at room temperature after removal of the radiation.

With regard to infrared sensitivity PbS cells are superior to thermocouples when used as the sensitive element. For longer wavelengths and approximately equal sensitivity, PbTe cells are used; PbSe cells extend further into the infrared toward radar frequencies, with a sensitivity somewhat less than that for PbTe, but still an improvement over any thermocouple.

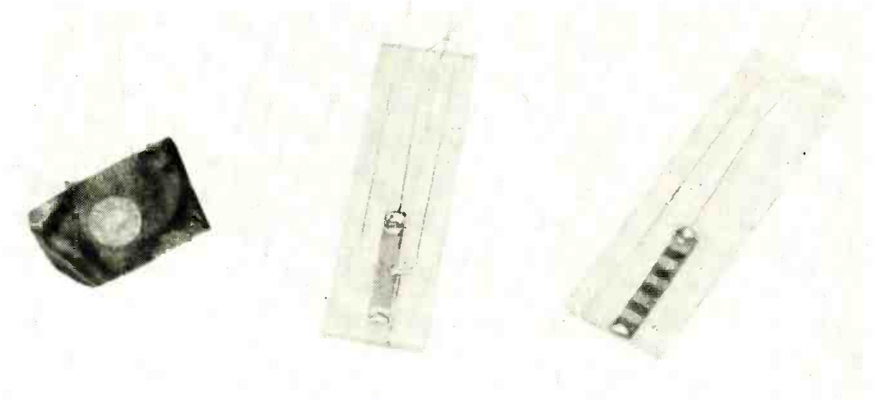
Luminescence

Luminescence is light emission not resulting from high heat or incandescence. When achieved with an almost complete absence of

Table 1—Characteristics of Inorganic Semiconducting Compounds (Mainly Intermetallics)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Symbol	Name	Str	E_g	β	ρ_i	μ_n	μ_p	τ	Dens	M.P.	K	a	Applications and Remarks
Bi_2Te_3 §	Tetradymite	Rh	0.15		0.03	800	400		7.7	573		4.38	Electric refrigeration material
InSb	Indium antimonide	Z	0.17	3.3	0.0045	57,000	780	3	5.77	523	16.8	6.48	Highest mob
Mg_2Sn	Magnesium stannide	F	0.20	3.4	0.6	250	200	250	3.59	778		6.76	Anomalous behavior
PbSe	Clausthalite	N	0.25	4	0.25	1,400	950	0.6	8.1	1,065		6.14	Type changes at 77K
PbTe	Altaite	N	0.28	4.5	0.01	2,100	840	310	8.16	911		6.45	Infra-red detector
Te §	Tellurium	H	0.34	1.8	0.6	1,300	600		6.25	452	10.8	4.45	Eolotropic
Bi_2Se_3 §	Castillite	H	0.35		0.06	600			6.82	710		4.14	Also called guanajuatite
InAs	Indium arsenide	Z	0.37	4	0.1	22,600	200			940p	11.6	6.04	Anomaly: μ_p higher at 400C
PbS	Galena	N	0.4	4.7	3.1	650	250	2,800	7.5	1,117		5.97	Photoresistor
HgTe	Coloradoite	Z	0.4			11,800	100		8.07	670		6.43	Ionic-bond semiconductor
$CuFeS_2$	Chalcopyrite	O	0.53						4.2	875		5.24	Point-contact rectifier
Mg_2Ge	Magnesium germanite	F	0.6			400	100		3.09	1,115		6.38	
HgSe	Tiemannite	Z	0.65			10,000			8	690		6.07	Semiconductor when liquid
GaSb	Gallium antimonide	Z	0.69	3.5	0.06	4,000	750			702	11.6	6.13	Type changes at 357 C
Mg_2Si	Magnesium silicide	F	0.7	6		400	70		1.88	1,102		6.34	Dope with silver to get *p*
Ge	Germanium	D	0.72	2.2	47	3,600	1,750	1,000	5.32	937	16.4	5.66	Element
InSe	Indium selenide	P	0.96		12,500		5			660			Sensitive in uv, i-r and near i-r
Si	Silicon	D	1.09	3.6	300,000	1,400	440	2,500	2.33	1,417	11.7	5.43	Element
InP	Indium phosphide	Z	1.25	4.7	10	3,500	650			1,060		5.86	Point-contact diodes
GaAs	Gallium arsenide	Z	1.35	5.2	5×10^7	4,000	450	20		1,260		6.63	Solar battery, X-ray dosimeter
CdTe	Cadmium telluride	Z	1.45	3.6	2×10^4	400	60		6.2	1,050	10.9	6.46	Type changes at 300 C
AlSb	Aluminum antimonide	Z	1.55	3.8	0.5	70	150		4.25	1,060	4.8	6.14	Point-contact diodes
Sb_2S_3	Stibnite	O	1.55		5×10^8				4.6	548	9.6	11.2	300-piv diodes
CdSe	Cadmium selenide	Z	1.77	4.6	0.05	900		10000		1350p		6.05	Photosensitive
ZnTe ¶	Zinc telluride	Z	2.1		10^{11}		50		5.6	1,239		6.09	Photosensitivity varies with intensity
GaP	Gallium phosphide	Z	2.29	5.5		1,000						5.44	Electroluminescent
In_2Te_3	Indium telluride	P	2.4		160				5.78	667		18.4	
CdS ¶	Greenockite	Z-W	2.4	5.2	10^{13}	250	20	1,000	4.82	1,850	11.6	5.82	Many applications in phosphors
ZnSe	Zinc selenide	Z	2.6	7.2		100			5.42	1,000		5.66	
AlP	Aluminum phosphide	Z	3.0							1,050		5.42	
ZnO	Zincite	W	3.2		5	200	180		5.68	1,975	12	3.24	Ionic bonding
SiC	Carborundum	Z	3.5			60	8		3.17	2,700		3.1	Several forms
ZnS	Sphalerite Wurtzite	Z W	3.7	3.6	4.5×10^9				4.09 4.10	1850p 1,020	16.6	5.42 3.84	Thermoluminescent; phosphors
TiO_2 ¶	Rutile	T	3.7						4.26	1,640		4.59	Rectifier at 250 C
C ¶	Diamond	D	6		10^{16}	1,800	1,400		3.51	3,800	16.5	3.56	Good point-contact rectifier

sensible heat, it is called phosphorescence, the glow of the lighting bug for example. When achieved in the presence of an electric field, or electric potential difference, it is called electroluminescence.



Photovoltaic cell at left is constructed of AlSb; InSb Hall-effect element is at center and InSb magnetoresistance element for chopper is shown at right

Phosphors

Materials known to exhibit these phenomena are collectively called phosphors. Among these are semiconducting compounds such as CdS, ZnS, ZnO or ZnSe which exhibit a luminescence under suitable conditions. Under d-c excitation, the phosphors show luminescence only upon application or removal of potential, much like the secondary voltage of a transformer; therefore pulse or sinusoidal voltages are used. When the luminescence is produced by radiation in some particular frequency range, it is called photoluminescence; the frequency or color of the reemitted radiation need not be the same as that of the incident radiation and can be controlled to some extent.

New photoconductive materials promise high response speeds, with applications to infrared and x-ray frequencies instead of the visible light spectrum. It is possible to use a solid-state screen as the target in an ordinary cathode-ray tube, where the electron beam acts as the source of illumination for the photoconductor.

Tables

Tables I and II represent a compilation of data from many sources; the figures can be considered current up to Feb. 1957. Complete lack of some data is indicative of the early state of the art.

Many of the compounds have been investigated only superficially (InSe, In_2Te_3). The many gaps in the tables also indicate the amount of research still necessary even in compounds that have been relatively well investigated.

The appearance of Table II shows that the study of the organic compounds has just begun; moreover, the data does not present the accuracy in such determinations that is usually desired. Standardization of procedures and definitions of terms in different laboratories and in different countries is in an infantile stage; in some cases different technicians from the same laboratory have reported differing values of parameters, using the same or different techniques. With these facts in mind, reference has been made to as many authorities as possible and averaging methods have been applied.

In column 1 of Table I, the symbol § next to a formula indicates that the compound or element exists in two physical forms and characteristics parallel and perpendicular to a major axis, usually the C axis, may be different. Items marked ¶ have a resistivity so high that they border on the domain of insulators; their claim to the semiconductor family resides principally in their negative temperature coefficient of resistivity.

In column 3, the structural abbreviation are: D, Diamond; F, Fluorite; H, Hexagonal; N, NaCl; O, Orthorhombic; P, Pyrite; R, Rhombohedral; T, Tetragonal; W, Wurtzite; Z, Zincblende.

Energy-Gap Determination

Column 4 shows values of forbidden band width in electron volts, at room temperature. The energy gap can be determined by optical methods as suggested by Eq. 3, from change of conductivity with temperature, from Hall-effect data, from radiation recombination measurements, from the photoconductivity excitation spectrum, luminescence excitation spectrum or luminsescence edge emission.

The number of the various methods, when combined with the different techniques of different investigators in different laboratories, indicate that the results will not be too consistent. The energy gap also appears to give different results depending on whether the material used is *p* or *n*. In some cases, Te and Bi_2Te_3 for example, the energy gap varies with the direction of current flow in the crystal, depending on the orientation in the crystal holders; in others, CdS and ZnS for instance, the gap varies with the crystal type. In all such cases, the higher value has been reported.

Temperature

Energy gaps have been converted to room temperature values from known data regarding β, the change of energy gap with temperature given in column 5. The value of $\beta = dE_g/dT$, must be multiplied by 10^{-4} to convert to ev per degree K. Some writers report this value in degrees C, others in degrees K.

Here again several methods are used, such as absorption spectrum data and photoconductivity data and results are not too consistent. A particular precaution to be observed here is that β is often a function of the temperature range under study, rather than being constant over the entire range over which the material exhibits semiconductor properties.

Intrinsic resistivity ρ_i is given in ohm-cm. Here also an averaging process is used. Resistivities parallel and perpendicular to the principal axis for tetradymite and tellurium are different and the larger value has been reported. In some cases, the figures do not necessarily represent intrinsic resistivity since the extent of present investigations is inadequate to verify that the figures quoted are indeed intrinsic resistivities. In such cases also, the highest resistivity reported has been used in the averages.

Mobility

The mobilities given in column 7, in cm/sec per volt/cm may be Hall, drift or conductivity mobilities, including or excluding scattering effects. Even for materials as relatively well investigated as Ge, Si or InSb, values of mobility differ significantly among the investigators and laboratories.

Mobility is a temperature dependent quantity, frequently varying inversely as the T^x power, where x may vary from about 1.2 to 2.5. Mobilities also are reported at room temperature where possible, but in some of the lesser investigated materials, the temperature dependence is not known and the figures are proportionately less reliable.

The mobility reported is the highest mobility measured, but need not necessarily represent the true upper limit. Note the anomaly in AlSb where hole mobility is greater than electron mobility. Table I gives the impression that the compounds with the higher energy gaps in general have lower mobilities, but theoretically there need not be a 1:1 correspondence between these two factors.

Lifetime τ in column 9 is in microseconds, also averaged. As the gaps in this column indicate, lifetime is least thoroughly investigated and understood among the principal parameters of semiconducting materials. Highest values obtained by any investigators consulted are reported.

Density in column 10 is in gm/cm^3. Some of these values were obtained by investigators 20 years ago, when purification techniques were less developed than they are today.

Melting points in column 11 are in degrees C; remarks similar to

Table II—Characteristics of Organic Semiconducting Compounds (Mainly Dyes)

Name	Formula	E_A	E_g	ρ_i	μ_n	M.P.	Remarks
Cynanthrone		0.1		1.2×10^7	10^{-8}		Also called indanthrene blue R, caledon blue R or durathrene blue
α—α-diphenyl—β-picryl hydrazil			0.26	1.6×10^6			
Indanthrene, black	$C_{28}H_{14}N_2O_4$	0.28				470p	Also called durathrene, caledon
Indanthrone	$C_{28}H_{14}N_2O_4$	0.32					Also called indanthrene blue
Indanthrazine		0.33			10^{-12}		
Flavanthrone		0.35			10^{-7}		Also called indanthrene yellow G
Isoviolanthrone	$C_{34}H_{16}O_2$	0.38			10^{-6}		Also called isodibenzanthrone (var.)
Violanthrone	$C_{34}H_{16}O_2$	0.39	0.8	2.9×10^3			Dibenzanthrone; repr of stable polycyclic hydrocarbons
Isoviolanthrene		0.41			10^{-9}		
Pyranthrone	$C_{30}H_{14}O_2$	0.53	1.08	3.7×10^6	10^{-9}		Also called indanthrene yellow-orange G
Pyranthrene		0.54					
Ovalene		0.56			10^{-8}		
m—Naphtodianthrene		0.60			10^{-11}		
m—Naphtodianthrone		0.65			10^{-9}		
Isodibenzanthrone		0.75	0.96	50	10^{-5}	142	Also called indanthrene violet R or caledon purple R
Anthracene—single crys	$C_{14}H_{10}$	0.82	1.65		10^{-2}	216	Strongly fluorescent; monoclinic
Anthracene—powder	$C_{14}H_{10}$	0.83			10^{-4}		
Anthracene—film	$C_{14}H_{10}$	0.96			10^{-4}		
Naphtacene—film		0.82			10^{-3}		
Anthanthrene		0.84			10^{-7}		
Anthanthrone		0.85	1.7		10^{-6}		
Pantacene—film		0.86	1.72		10^{-2}		
Methyline blue	$C_{16}H_{18}N_3SCl$-$3H_2O$	0.92					E_A = 1.6 ev when ZnCl is added
Perylene—film	$C_{20}H_{12}$	0.97	1.94		10^{-2}		
Coronene	$C_{24}H_{12}$	1.15	2.3		10^{-3}	438	Monoclinic
Phthalocyanine (metal free)	$C_{32}H_{18}N_8$	1.2	2.4		1		Monoclinic
Cu—phthalocyanine		1.3	2		10		Monoclinic
5, 6N-pyridino-1, 9 benzanthrone		1.6	3.2		10^2		
Hydroviolanthrone		1.7	3.4		10^2		
Naphthalene, single crystal	$C_{10}H_8$	1.85	3.7	10^{-13}	10^{11}	80	Values for resistivity and mobility are in question

those made about E_g apply here also. The suffix letter p indicates that the substance sublimes and melting points given are obtained at some pressure greater that atmospheric.

The dielectric constant K in column 12 is a dimensionless number in the esu system.

The a or side-of-cube dimension in column 13 is in Angstroms.

Organic Compounds

Table II lists organic semiconducting compounds on which data is available. As indicated by the blank spaces, these are not even as well investigated as the inorganic compounds and the data must be considered tentative in view of the limited number of research teams who have contributed. Note the remark for single crystal naphthalene.

The list is indicative of still another unexplored area of the semiconducting compounds from which fruitful results may be forthcoming; from the literature consulted, practical transistors or diodes have not been made from these, even on a laboratory basis.

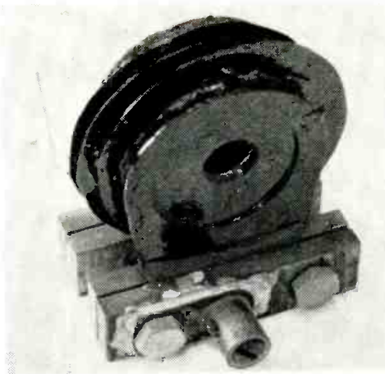
The activation energy in ev, given in the E_A column, is defined as the minimum energy for the interchange of two atoms of a substance; it may or may not be directly related to the energy gap in all substances. If the impurity atom is located at an energy level half way into the forbidden gap, then the energy gap will be numerically twice the activation energy.

General Comments

When a mixture of elements which results in a compound contains atomic proportions accurately represented by the formula, the compound is said to have stoichiometric proportions; when the proportions indicate an excess or deficiency in any constituent, the material is nonstoichiometric. A useful property of semiconducting compounds is that an excess of one of the elements may produce an n or p-type substance; for example

Substance	n if excess	p if excess
PbS	Pb	S
CdTe	Cd	Te

For Si and Ge, doping agents are taken from the third or fifth column of the periodic table; similarly, doping agents for the semiconducting compounds are taken from the appropriate columns of the periodic table. For instance, for CdTe elements from the third and seventh columns yield n-type material; from the first and fourth columns, p-type material. Now the doping agents come from four columns instead of two; when this is combined with the stoichiometric excess noted, it is evident that a truly inviting flexibility exists for the compounds.



Peltier effect cooling unit constructed of Bi_2Te_3 produces 40 C temperature difference with 13-w input

Though compounds of a form such as $A^{II}B^{IV}$ may result in semiconductor material, for example Mg_2Sn, Mg_2Si, Mg_2Ge, they need not produce semiconductors—Mg_3P_6 is a conductor. Thus the problem of producing semiconducting compounds must be approached on a one-by-one basis, with each product investigated over an extensive temperature range while examining for characteristics of the semiconductors.

Shortcomings

No commercial transistors or diodes are available made of semiconducting compounds. The known shortcomings of many of these compounds militate against their more general use. For example, many of the compounds exhibit a change in type, from n to p or vice versa, over a useful temperature range. At 90K, n-type InSb turns to p type; Te and TeSe alloys exhibit a double reversal in the range from 20C to 200C, Te will become n type at 20C and revert to p type at 200C. For CdTe, irreversible changes occur at about 150C and the material turns to n type; above 300C, the type changes irreversibly to p.

The changes in such cases are not necessarily abrupt, a gradual change of characteristics being noted as the temperatures are reached or passed. There are many such illustrations, the effect being due in many cases to separation or evaporation of one of the constituents at critical temperatures. This is particularly noticeable in the excess semiconductors when the excess element tends to sublime or, as in the case of Te just noted, changes type when it is the excess element.

In some materials transistor action is observed only at low temperatures; for PbSe this is in the neighborhood of 90K. Some of the compounds (AlSb, CdS, Mg_2Sn) are unstable in air, particularly if high in humidity; some (GaSb) are particularly difficult to purify. In many, the rectification effect is not good enough for commercial application. Either the ratio of reverse-to-forward resistance is too low or the piv too small; in still others, transistor action is almost entirely absent.

Desirable Characteristics

The specifications of characteristics for the materials to make good transistors and diodes are long and difficult to fulfill. Salient features are that the material should be easily and economically available, should be unconditionally stable in moist as well as dry air, have a reasonably high melting point, show a dielectric constant of at least 10 from bond strength considerations and temperature variation, have an energy gap in the range possibly from 1.5 to 4 ev, have principally covalent bonding without an ionic component so large that the accompanying dielectric constant is too small, show reasonable piv and rectification ratio and show good transistor action in regard to carrier injection problems over the useful temperature range.

The author thanks Battelle Memorial Institute, General Electric Co., Bell Telephone Laboratories, Clevite Corporation and Ohio Semiconductors, Inc. for their kind assistance in furnishing the photographs of the materials and apparatus.

Thyratrons Improve

By W. ORNSTEIN
Supervisory Engineer
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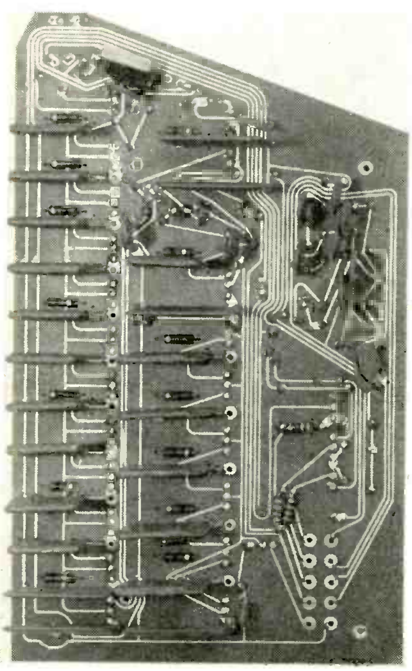
SUMMARY — Cold-cathode trigger tubes in sequential counter circuits supplant "watchmaker's nightmare" in vehicular radiotelephone system. Five-digit code of integers from 2 to 10 permits up to 59,049 subscriber phones on single channel. Interchange between two audio tones, 600 and 1,500 cps, occurs for each unit of digit dialed. Readout circuit energizes buzzer at receiver for 4 seconds, then lights indicator lamp if call is not answered. Unit is smaller and less expensive than electromechanical selector used for the same purpose

LAND MOBILE RADIO communication systems handle the bulk of their traffic between a fixed central station and a number of vehicular installations. In systems operated by common carriers a central-station transmission destined to a particular subscriber should operate only the handset receiver or loudspeaker in the vehicle of that subscriber.



Printed wiring on inner side of board

Most methods of selective calling use a signal of audio tones generated by a coder unit at the central station to modulate the carrier. A different code signal is employed for each subscriber in the system. When the selector unit in the mobile receiver responds to a given code, a readout circuit functions and the subscriber is given an aural or visual indication that he has been called.

Electronic Selector

The novel aspect of the present design lies in the functions previously performed by electromechanical devices which are here achieved by electronic circuitry. This results in a mobile selector of appreciably lower cost and smaller size than other current designs. A block diagram of the complete system including the coder is shown in Fig. 1.

The selective call is made by the central station operator as follows:

(a) Press the CALL button on the coder control unit and pause until the WAIT lamp lights in 0.6 sec.

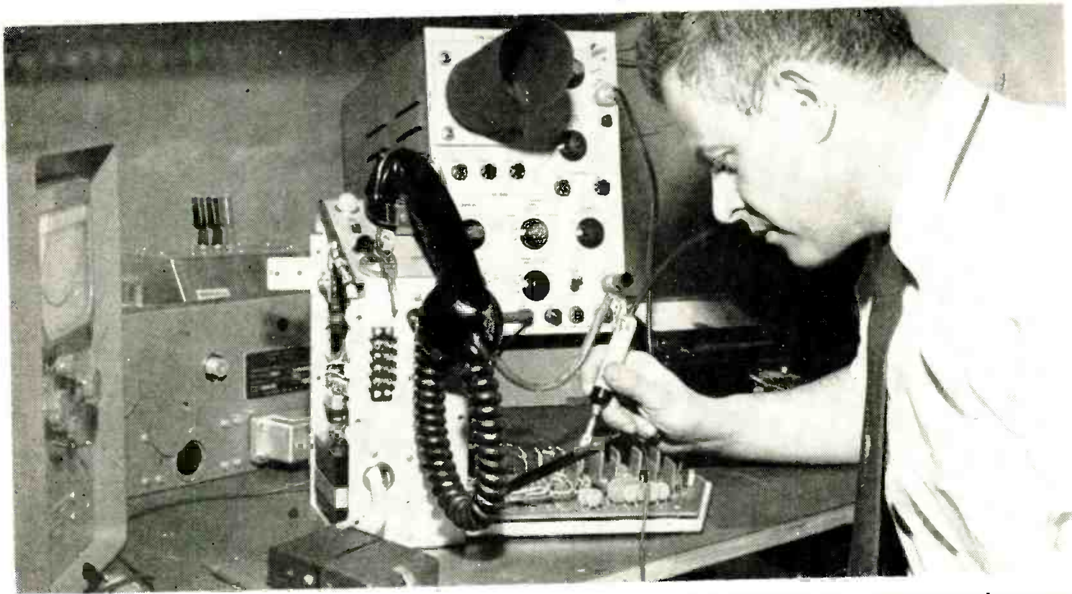
(b) Dial the five-digit code on the standard telephone dial associated with the coder control unit. Each digit has a value from 2 to 10 and their sum is normally 23 or 25. Digit 0 corresponds to 10 and digit 1 is used only as a clearing signal to restore all selectors to their rest positions.

The code signal comprises two audio tones, 600 and 1,500 cps. One of these tones is always present when a code is transmitted. The selector unit operates mainly as the result of a frequency interchange in the code signal received. The interchange would be either from 600 to 1,500 cps or from 1,500 to 600 cps. When the CALL button on the coder is operated, the carrier is turned on with 600-cps modulation. After 600 millisec the WAIT lamp goes on, indicating that the operator can proceed to dial, and a tone interchange to 1,500 cps occurs. The 600-cps interval and the initial tone interchange insure that all selectors in the system are restored to their rest position before the code is transmitted.

Final Interchange

The dialing of any digit causes a corresponding number of tone interchanges. Since the sum of the digits is odd, a final interchange always goes to 600 cps. This causes a bell to ring in the desired subscriber's installation. Four seconds after the completion of dialing there is a final interchange to 1,500 cps after which the tone

Mobile Phone Operation



Selector circuits are enclosed in unitary assembly of telephone. Drop-leaf construction permits ready access

modulation ceases and the carrier is turned off. The final interchange of tone silences the subscriber's bell if he has not yet answered and a lamp signal is substituted. Also all selectors in the system, including that of the subscriber just called, are reset to rest position.

Tone sequence for the code number 4-3 is shown in Fig. 2. This two-digit code has been used for simplicity of illustration, but a more typical code might be 3-3-10-2-5, a five-digit group adding up to 23. Although the dialing pulses for a given digit are shown as 100 millisec while the interval between digits is shown as 500 millisec, these are nominal values. For design purposes it is assumed that dialing pulses occur at a rate between 8 and 11 per sec while the interdigit interval is a minimum of 500 millisec. The number of digits can be anything from one to five and each digit can have any value from two to ten. The possible number of five-digit codes is therefore 9^5 or 59,049.

Thyratron Counters

The design of the selector is based on the use of cold-cathode thyratrons in sequential counter circuits. Like the hot-cathode thyratron, the cold-cathode variety is essentially an on-off device in which the trigger loses control as soon as the main discharge between anode and cathode has been established. Control is regained only when the glow discharge is extinguished by reducing the anode voltage below the maintaining value.

The Hivac XC18 tube employed in this design has the following characteristics:

(1) Control gap breakdown voltage 62 to 74 v.

(2) Main gap maintaining voltage 68 to 74 v.

(3) Minimum main gap breakdown voltage 200 v.

These figures are based on some ambient illumination of the tubes providing an initial ion source to initiate the discharge. In the selector this is provided by a miniature NE2 neon bulb mounted between each pair of trigger tubes.

The decade counter circuit of Fig. 3 consists of a zero tube and ten counter tubes. Readout terminals are connected to the cathodes of counters 2 to 10 inclusive. There is a common plate load for all tubes and a common counting pulse line for all but the zero tube. The trigger electrode of each counter tube is coupled capacitively to the common pulse line and resistively to the cathode resistor tap of the preceding stage. The trigger electrode of tube zero has a fixed positive bias of 45 v. The anode supply is regulated at 180 v which is 20 v below the 200-v minimum striking voltage but well above the 70-v maintaining voltage.

Counter Operation

Assume that all eleven tubes in the counter are initially extinguished. When plate voltage is applied to the selector a 4-v pulse is applied to the trigger of tube 0 by the reset circuit. This tube fires and its current develops a cathode voltage of 90 v. This applies 50 v to the trigger of tube 1, which is the normal initial condition for this counter.

When a digit is dialed at the coder unit the input of the selector generates a 2-millisec positive pulse with an amplitude of 50 v for each interchange of tones received. Thus dialing the digit 2 would generate two positive pulses, each of 2 millisec duration and spaced 100 millisec apart. These pulses appear on the trigger electrodes of tubes 1 to 10. In the case of all but tube 1 the pulse amplitude is insufficient to fire the tube to which it is applied. But tube 1, due to its 50-v priming voltage, will fire.

When this tube fires it reduces

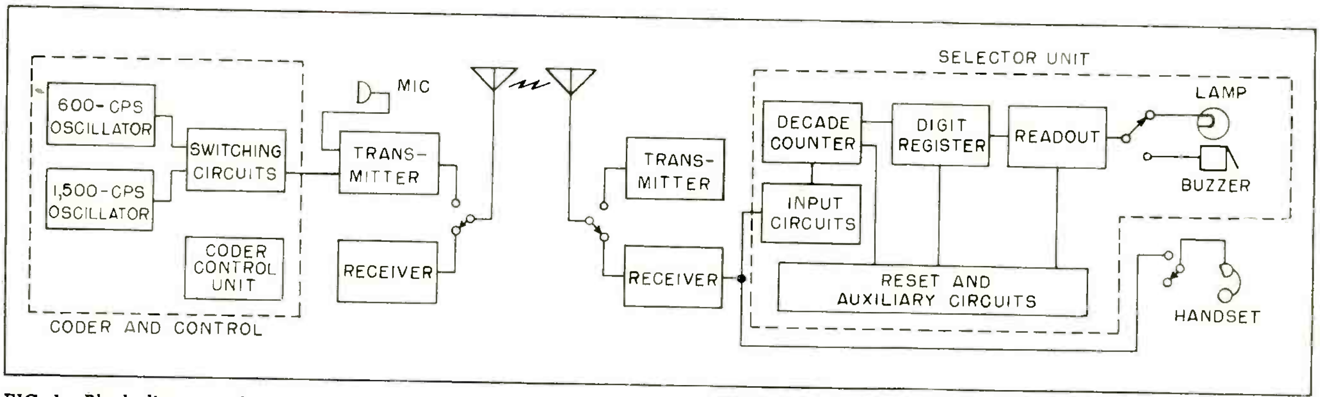


FIG. 1—Block diagram of two-way mobile telephone system. Central-station equipment is shown left, vehicle unit at right

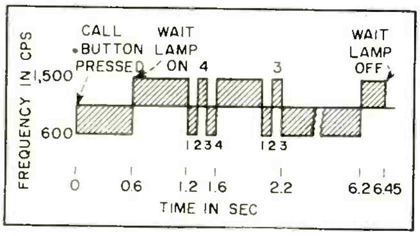


FIG. 2—Tone sequence for code signal 4-3

the voltage to ground from the common anode line to its own maintaining voltage of 70 v. This is because at the instant of firing there is no voltage across its cathode resistor due to the time required for a voltage rise across its cathode capacitor. Tube 0, however, will have 90 v from cathode to ground due to the charge on its cathode capacitor. Tube 0 is therefore extinguished since the voltage across it is less than the maintaining voltage and the discharge is transferred to tube 1. The cathode capacitor of tube 1 will charge up to nearly 90 v in considerably less time than the 100-millisec interval between pulses, thus restoring the anode line to its original value of 160 v and also priming the trigger of tube 2 with 50 v. When the second pulse arrives an identical sequence of events causes the discharge to transfer from tube 1 to tube 2.

To summarize, in the initial condition prior to dialing a digit tube 0 in the counter is on and all other tubes are off. On dialing a given digit the discharge transfers to the corresponding tube in the counter and a readout voltage appears on the cathode of that tube.

The circuit time constants are chosen so that the voltage rise at the anode line immediately after a tube is fired occurs slowly compared with the deionization of the tube just extinguished. But nearly full priming voltage to the next counter stage must exist before another pulse arrives. For the slow counting rate of ten pulses per sec required in this application time constant presents no problem, but the upper limit of the counting rate depends upon the deionization time of the particular tubes used.

The input circuit shown in Fig. 4 converts the sequence of tone interchanges received from the coder unit to a sequence of pulses having the desired polarity, amplitude and duration to operate the decade counter and auxiliary circuits of the selector. This circuit has high immunity against false triggering of the counter by noise, and output pulses whose amplitude is independent of the code signal level.

Selector Input

The input transformer matches source impedances of 3.2, 50 and 500 ohms. Shunted across the secondary are two series-tuned circuits with a loaded Q of 10. The first circuit is resonant at 600 cps, the second at 1,500 cps. Adjustment of the series capacitors compensates for errors up to ten percent in the code signal frequencies.

Across the inductance of each tuned circuit is a rectifier-filter comprising two voltage doublers and a clamping diode. A 45-v bias is obtained through a voltage divider from the 180-v line. All rectifier outputs are referred to this bias.

Voltage doublers connected to a given inductance produce a positive and a negative voltage respectively. The positive output of the 600-cps inductance connects to the negative output of the 1,500-cps inductance at the junction of the 5.6 and 2-meg resistors. This junction connects to the bias line through a clamping diode and to the trigger of the 600-cps input thyratron. This trigger can thus become more positive than 45 v but cannot go below this value due to the clamping diode. Similarly the trigger of the 1,500-cps thyratron receives positive voltage from the 1,500-cps inductance and negative voltage from the 600-cps inductance, and it is also clamped to a lower limit of 45 v.

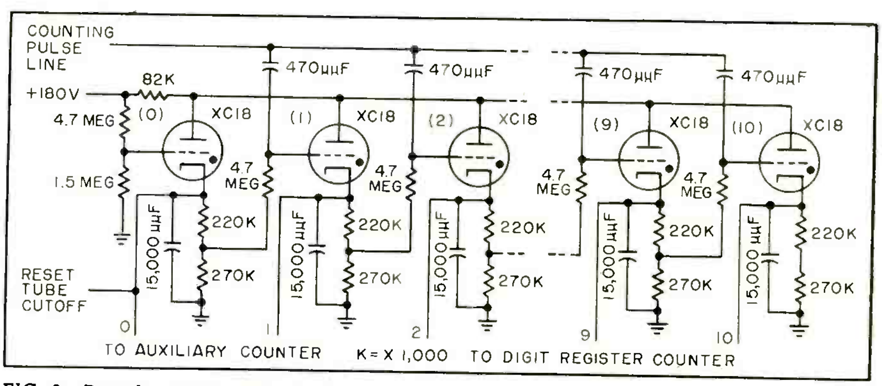


FIG. 3—Decade counter initially has tube 0 on and all other tubes off. Dialing transfers charge from tube 0 to corresponding counter stage

Consider the effect of a pure tone of 600 cps at an input level of at least 100 mw. Assume that both input tubes are initially in an off condition. A positive voltage will be produced at the trigger of the 600-cps tube sufficient to fire it. This results in an initial positive current pulse in the common cathode circuit due to the discharge of the capacitor at the plate of the fired tube. This pulse has a steep leading edge dying down exponentially nearly to the steady-state cathode potential of 10 v in 2 millisec. The shape and amplitude of this output pulse is independent of the amplitude of the triggering voltage which causes it.

If the 1,500-cps tube is already on, when the 600-cps tube is triggered, the cathode voltage of the 1,500-cps tube will also rise due to the common cathode connection. Its anode voltage is held at 80 v, however, due to the time required to charge its plate capacitor to an appreciably higher value. The voltage across the 1,500-cps tube therefore drops instantaneously below its maintaining value and the tube extinguishes. The voltage remains below the maintaining value longer than the deionization time and the tube remains extinguished. If the 600-cps tone is applied when the 600-cps tube is already on, there will of course be no output pulse from the common cathode circuit. The application of a 1,500-cps tone has identical results to those just mentioned if reference in the foregoing description is made to the 1,500-cps tube in place of the 600-cps tube.

Consider now the effect of a band of noise frequencies having both 600 and 1,500-cps components. This would result in a combination of positive and negative voltages at both input tube triggers. If the noise powers at the two frequencies were of about the same magnitude, as would be likely in practice, the resultant voltage would not be sufficient to trigger either input tube. The complexity of the code makes false triggering due to noise alone or even noise combined with another code signal practically impossible. The input circuit gives a pulse output for every tone interchange between 600 and 1,500 cps. There is one output across the full cathode resistor for the decade counter reset circuit, and another across a tap in the cathode resistor for the pulse counting line of the decade counter.

Counter Reset

The decade counter reset circuit shown in Fig. 5 resets this counter to tube 0 350 millisec after the completion of dialing each digit of the code Since the interval between digits is at least 500 millisec this insures that the counter will be reset prior to the dialing of each digit.

Assume that supply voltage has just been applied to the counter and all its tubes are initially extinguished. The reset diode will fire and charge the large capacitor connected to its anode. The resulting pulse at its cathode is superimposed on the steady priming bias to fire tube 0. This firing in turn results in a 0-tube cathode voltage of 90 v. Since the reset diode is returned to ground through the cathode of tube zero, the diode voltage falls below maintaining value and it consequently extinguishes.

If counting pulses are now applied to the decade counter, tube 0 is extinguished, its cathode voltage drops to zero and the disabling bias is removed from the cathode of the reset diode. The reset tube would immediately supply another triggering pulse to tube 0, resetting the counter as soon as it had counted one, if it were not for the reset inhibitor tube.

The reset inhibitor receives a triggering pulse every time a counting pulse is supplied to the decade counter. Since its plate resistor will not pass enough current to sustain its discharge, the inhibitor tube remains fired only as a result of the charge on its plate capacitor. This ceases when the potential at the tube end of the plate capacitor declines below the 70-v maintaining voltage of the inhibitor tube. The voltage across the capacitor is now 110 v and it proceeds to discharge through the plate load. Each time a new pulse is generated at the input, however, the reset inhibitor fires, the voltage across the capacitor again rises to 110 v and the discharging cycle begins anew. When the last pulse is generated for a given digit, 350 millisec later the reset diode plate capacitor discharges sufficiently to raise the diode potential to its ignition value, resulting in a triggering pulse to tube 0 which resets the decade counter.

Digit and Auxiliary Counters

In the rest condition of the selector, prior to receiving the five digits of a code signal, tube 0 of the digit register counter shown in Fig. 6 is fired and the other six

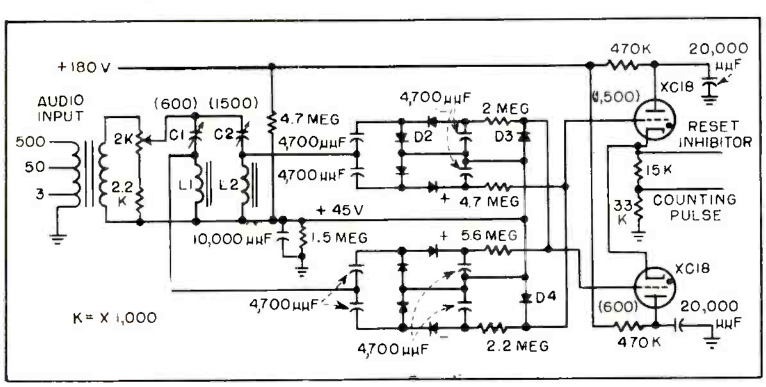


FIG. 4—Selector input circuit converts tone changes to pulse sequence to operate the decade counter and auxiliary circuits of the selector

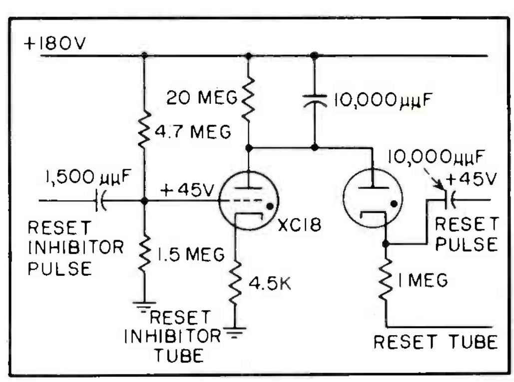


FIG. 5—Reset circuit restores decade counter to zero after end of dialing of each digit

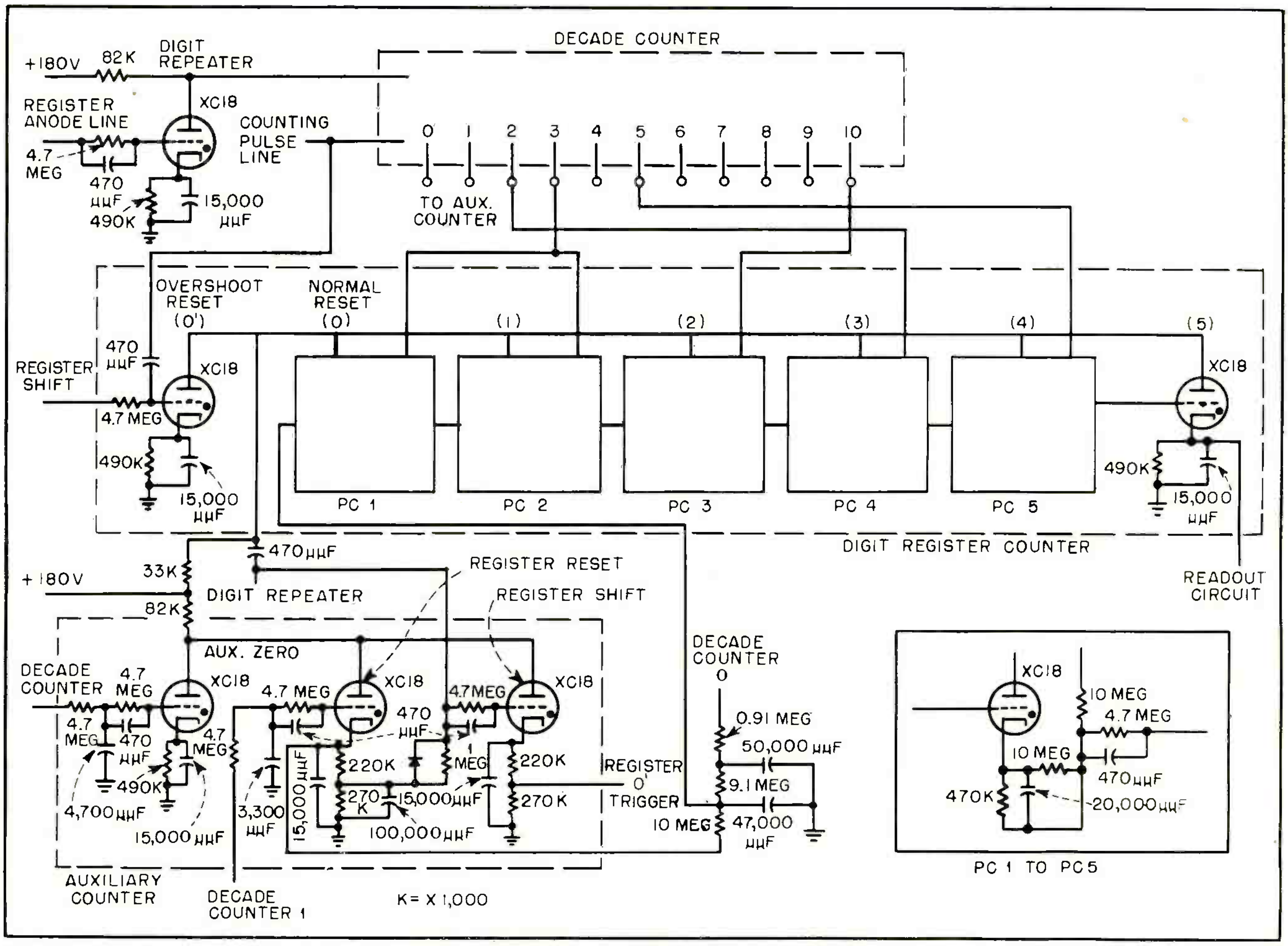


FIG. 6—Digit register tube inputs are connected to decade counter cathodes corresponding to desired code. Connection here is 3-3-10-2-5

tubes are extinguished. If the digit register were in any other condition it could always be reset to this rest condition by dialing 1 or by the single tone interchange which always precedes a code signal.

Time Constants

Except for the 0′ stage the tubes of the digit register and auxiliary counters have fairly large time constants in their trigger circuits. This is desirable because, unlike the tubes of the decade counter which are triggered by 2-millisec pulses, these tubes are triggered by voltages of 100 millisec or longer. Large time constants also insure against false triggering due to accidental transients.

Consider the selector 350 millisec or more after the receipt of its last dialing pulse. Decade counter tube 0 will have fired due to the action of the reset diode. Auxiliary tube 0 has its trigger connected through a 20-millisec R-C circuit to the cathode of decade counter tube 0, and auxiliary tube 0 will therefore fire about 20 millisec after the decade counter resets.

On dialing 1 the decade counter will step up one thereby removing voltage from the trigger of auxiliary tube 0. Voltage is applied to the trigger of the register reset tube which is connected via an R-C circuit to the cathode of tube 1 of the decade counter. The auxiliary counter will then step up one, extinguishing auxiliary tube 0 and firing the register reset tube.

The trigger of digit register tube 0 is connected to a coincidence circuit comprising two resistors, one terminating at the cathode of the register reset tube, the other at the cathode of decade counter tube 0. When both of these tubes are fired their cathodes are at 90 v, as is the trigger of digit register tube 0, which fires and resets the digit register. If only one of the tubes is fired the cathode of the other is at ground potential. Only 45 v then appears at the trigger of digit register tube 0 which is insufficient to fire it.

When 1 is dialed the register reset tube fires. When the decade counter resets its tube 0 fires. But for approximately 20 millisec the auxiliary counter has both decade counter tube 0 and the register reset tube on. Thus dialing 1 and allowing the decade counter to reset also resets the digit register.

The selector responds to a given code when trigger inputs of register tubes 1 to 5 are connected to the cathode terminals of the decade counter corresponding to the code digits. In Fig. 6 this set of connections has been made for a code of 3-3-10-2-5.

Digit Register

Assume that the digit register is in its zero reset condition and that some digit greater than one is dialed. There are three possibilities: the dialed digit is either less than, the same as, or greater than the first digit of the desired code. In the first case no triggering pulses are received by tube 1 of the digit register and its rest condition is not disturbed.

In the second case the first tube of the digit register is fired and tube 0 is extinguished in a manner similar to the counting sequence in the decade counter. Priming voltage is removed from the trigger of digit register tube 1 and applied to tube 2. Moreover when the decade counter resets the voltage derived from it and previously applied to the trigger of digit register tube 1 disappears.

When the digit register counts from zero to one a voltage pulse appears at its anode line. A capacitor coupled to the anode line differentiates the pulse and feeds it to the triggers of the register shift and digit repeater tubes.

The differentiated pulse consists of two narrow spikes, the first negative and the second positive. The negative pulse is bypassed to ground by the clamping diode while the positive pulse serves to trigger both the register shift and digit repeater tubes.

The transfer of the discharge in the auxiliary counter from the register reset to the register shift prevents the digit register from being reset by the coincidence circuit at the trigger of its tube 0 when a desired digit has been counted.

Double Counting

Consider the case where two consecutive tubes in the digit register are connected to the same readout point on the decade counter, when two consecutive digits of a code signal are the same. If the decade counter were not reset for 350 millisec after counting up to the first of the two identical consecutive digits, two stages of the digit register would be fired by the given digit instead of one.

But once the digit register has been stepped up by the desired digit, the pulse in its common anode line resets the decade counter to the digit repeater quickly enough to prevent the double count from occurring. This is due to the time constant in the trigger circuits of the digit register being much longer than the time constant in the trigger of the digit repeater. The firing of the digit repeater does not prevent the digit counter from resetting to its tube 0 in the normal way 350 millisec after the dialing of the last pulse of the particular digit just received.

Consider now the third case where the dialed digit is larger than the desired digit for which the first digit register tube has been set up. This is taken care of by tube 0′ in the digit register. When the register shift tube fires as a result of a count by the digit register it primes tube 0′. The trigger of this tube is connected by a capacitor to the counting pulse line of the decade counter. If any subsequent pulses are received by the decade counter tube 0′ will fire. This resets the digit register to the 0′ position and no permanent count can be recorded by it. Once tube 0′ has fired it is impossible to fire subsequently any other tubes in the digit register except tube 0.

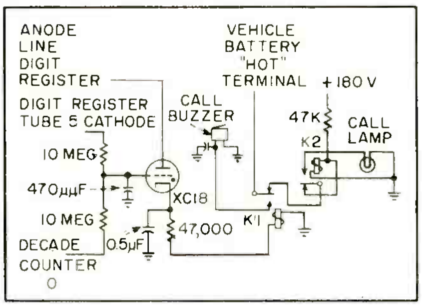


FIG. 7—Readout circuit energizes buzzer and then lamp to indicate incoming call

If a digit either equal to or greater than the desired digit is dialed and the register shift tube is therefore fired, the resetting of the decade counter to its zero position will also reset the auxiliary counter to zero thereby extinguishing the register shift tube.

Dialing a digit equal to that to which register tube 1 is set up will step up the register from 0 to 1. If a second digit is then dialed equal to that for which the second tube in the register is set up, the digit register will step up to 2. But if the digit dialed is either less than or greater than that for which tube 2 is set up, the effect will be the same as already described for dialing an incorrect digit. If the five digits of a received code signal are those for which the selector has been set up, then the counter tubes of the digit register will fire in sequence and 90 v will appear across the cathode resistor of tube 5 of the digit register.

Readout Circuit

The readout tube shown in Fig. 7 has its trigger connected to a coincidence circuit of two resistors which return respectively to the cathodes of digit register tube 5 and tube 0 of the decade counter. When the decade counter resets after counting the last digit of a code signal for which the selector has been set up 90 v appears at both of these cathodes. This voltage also appears at the trigger of the readout tube causing it to fire. This operates relay $K1$ which in turn actuates the CALL buzzer and energizes relay $K2$.

After the completion of a code signal a clearing pulse consisting of a single tone interchange is received 4 sec later by the selector. This resets the digit register and thereby extinguishes the readout tube. Relay $K1$ now opens to silence the call buzzer while a holding contact on relay $K2$ keeps it closed. This combination has the effect of lighting the CALL lamp which remains lit after the readout tube extinguishes.

The handset mounted on the front panel of the selector is held in a retainer which operates a hook switch. One set of contacts on this switch disconnects the audio from the handset while it is held in the retainer. Another set connects the high-voltage supply to the selector while the handset is in the retainer and disconnects the supply voltage when the handset is removed. Since the CALL lamp relay operates from the high-voltage supply, removing the handset immediately extinguishes the CALL lamp as well as any fired thyratrons.

The writer acknowledges the work of Mr. T. A. Watson who was responsible for basic development of both the coder and selector.

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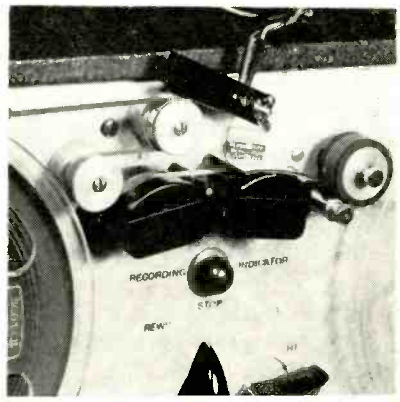
Recording unit handles microphone, phono and self-contained control-tone generators



Auxiliary switch stops machine on cue

SUMMARY —— Two-hundred selection changer for 45-rpm records plus a 3.75-ips tape system are the heart of an automatic programming arrangement. Complex sub-audible or modulated-carrier control signals are avoided by dual-track recording with announcements and control tones on separate tracks. During playback the changer is automatically energized by the control tone following an announcement, is tripped when music ends before entering the leadout spiral, then cues up next record

Jukebox and Tape

By JOHN K. BIRCH

Project Engineer
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AN AUTOMATIC BROADCASTING system must be able to take over the major part of the program activity while making the least demand on operating personnel and external equipment. If it can handle spot announcements, records and tapes in a flexible manner with minimum time consumed in the makeup process, its full potential for profitable use will be realized.

The system to be described, dubbed Auto-station, was conceived as a complete package requiring only a few external connections to fully automate broadcasting.

Flexibility is achieved by recording announcements and control tones on separate tracks. For operation of a record changer and two auxiliary circuits, such as portable tape machines, three control tones of 290, 700 and 1,300 cps are produced by highly stable phase-shift oscillators.

Makeup Process

The recording unit is self-contained and includes a control console and a solenoid-operated tape machine. The tape operates at 3¾ ips with reels up to 14 in. and is shock mounted in a totally-enclosed soundproof cubicle. By manipulating front panel controls an announcer can mix microphone and turntable inputs, start and stop the recorder and apply an automatically-timed tone at the end of each announcement. He also can check the tape audibly by means of the small panel-mounted loud speaker and two switches which run the tape machine forward or backward at normal-operating tape speed.

Operation of the unit may be understood by reference to the simplified schematic in Fig. 1. The mixing system is conventional, and uses the interstage volume control of the recording amplifier as a master control. The flexibility of the system is largely due to the 5-position RECORD-EDIT switch S_1. In the RECORD position the mixing bus is connected to the record amplifier input. The output of this amplifier is connected to the announce record head, the vu meter and the headphones. The tone oscillator bus is connected to the tone record head and the d-c circuit is completed to the coil of record relay K_1.

In the EDIT position the heads are tied in parallel and connected to the

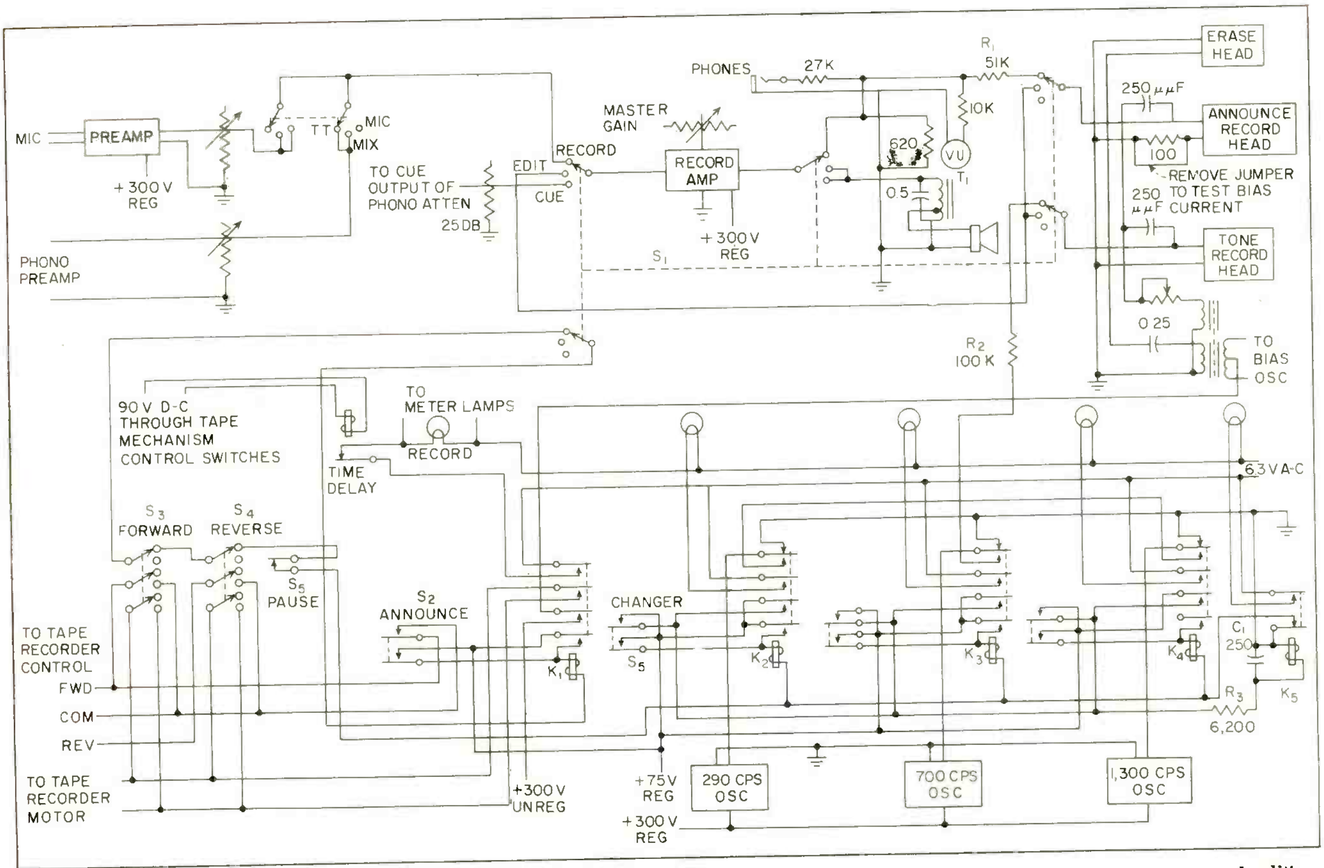


FIG. 1—Simplified schematic of audio and control circuits of Autostation recording unit includes playback for monitoring and editing

Automate Radio Shows

input of the record amplifier, whose output feeds the front panel loud speaker. The K_1 coil circuit is broken to prevent accidental recording when editing. In the CUE position, the cue output of the turntable attenuator is fed to the record amplifier input. Excessive highs due to amplifier equalization are rolled off by a capacitor across T_1.

The recording heads are of the high-impedance type, and a constant current source is provided by resistors R_1 and R_2. Since the erase head is low impedance two secondaries must be used on the bias oscillator transformer to obtain the correct currents.

Recorder Operation

When ANNOUNCE switch S_2 is depressed relay K_1 closes and energizes the tape recorder motor and solenoid, applies bias oscillator plate voltage, and illuminates the vu meter and record lamps. This last circuit is completed through a time-delay relay in the tape mechanism, which opens at the instant K_1 closes, but closes 0.5 sec later. The slight delay in lighting the panel lamps cautions the announcer to wait for the machine to stabilize before talking.

The ground return for the coil of K_1 is interlocked through the edit switches S_3 and S_4 and the mode selector switch S_1 to make it impossible to erase the tape accidentally while editing. It is also carried through PAUSE switch S_5 which provides a means of interrupting the recording when necessary.

The upper set of contacts on S_2 energizes the forward-direction contactor in the tape mechanism in the event that the machine has been left in the reverse-direction mode. The FORWARD and REVERSE edit switches S_3 and S_4 energize the respective direction contactor and the motor simultaneously.

Basic Oscillators

The three oscillators whose basic circuit is shown in Fig. 2 are running continuously, but have their outputs grounded to prevent crosstalk. They are selected by relays K_2, K_3 and K_4 when the associated pushbutton switches are depressed. When S_5 is depressed, for example, the lower set of contacts energizes K_2, which holds in when the button is released. The upper set of contacts of K_2 connects the oscillator to

Playback unit may be remotely operated from control console with other sources

Remote control unit for use at console

the record head. The second set illuminates a lamp adjacent to the switch. The third set applies voltage to relay K_5, which closes in about two seconds due to the action of R_3 and C_1.

When K_5 closes, it releases K_2 by breaking the ground return. Thus a 2-sec tone has been recorded on the tape. Since the ground return also serves K_1, this relay opens and shuts off the tape motor and bias oscillator. The upper set of contacts on S_5 prevents the continuous cycling of K_2 and K_5 in the event that the switch is held down longer than two seconds. Operation of the other two tone circuits is identical.

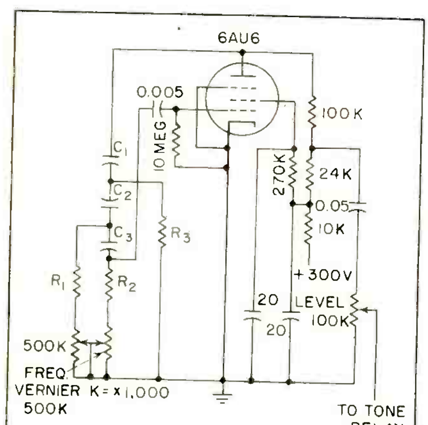
The playback tape machine is identical to the recording mechanism except for the absence of the bias oscillator and erase head. Mounted in the same cabinet are a 200-side jukebox-type record changer, an automatic-gain program amplifier and a monitor amplifier, along with two relay control chassis.

Changer Control

The changer mechanism is not modified but the preamplifier-control unit is replaced with a broadcast-type phonograph preamplifier and a separate relay control system.

The control system shown in Fig. 3 starts the changer when energized by the 290-cps tone, trips the changer when the music ends and causes the changer to cue up the next record and then stop.

The basic circuit for the selective amplifiers is shown in Fig. 4. The relays associated with these amplifiers are normally de-energized with no signal. When a 290-cps tone appears on the tape K_6 will close for the 2-sec duration of the



Freq in CPS	R_1, R_2	R_3	C_1, C_2, C_3 in μμF
290	750 K	750 K	200
530	750 K	750 K	100
700	500K	500K	100
1,000	750K	750K	50
1,300	500K	750 K	50
1,830	750 K	1 MEG	25

FIG. 2—Basic circuit of tone oscillators

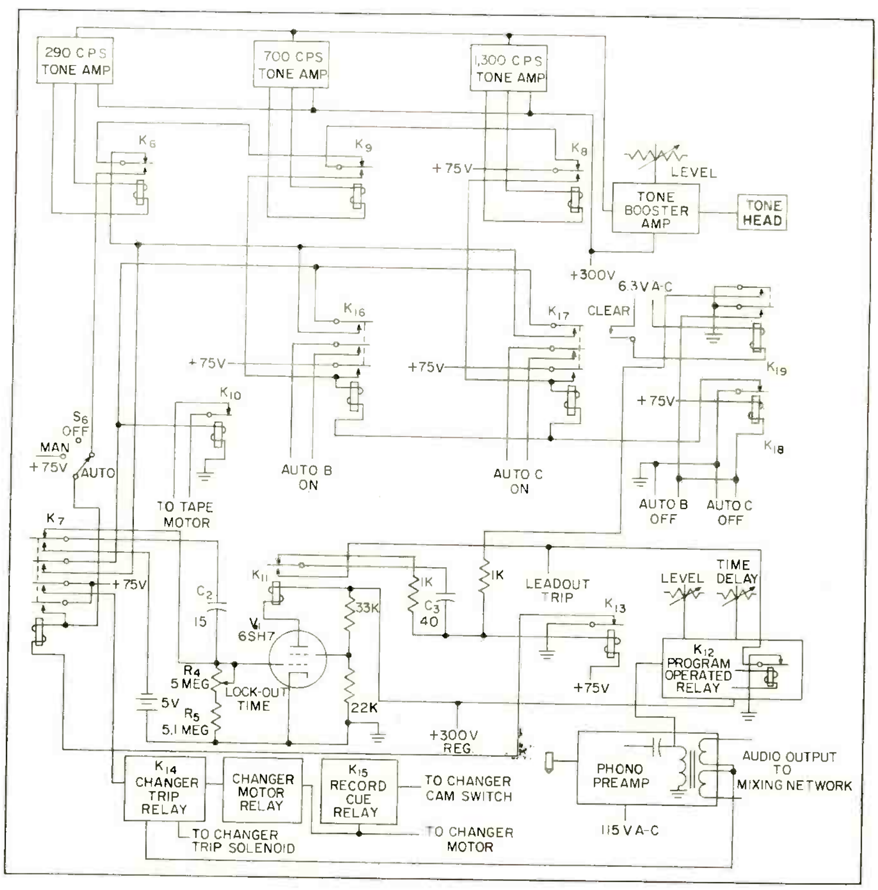
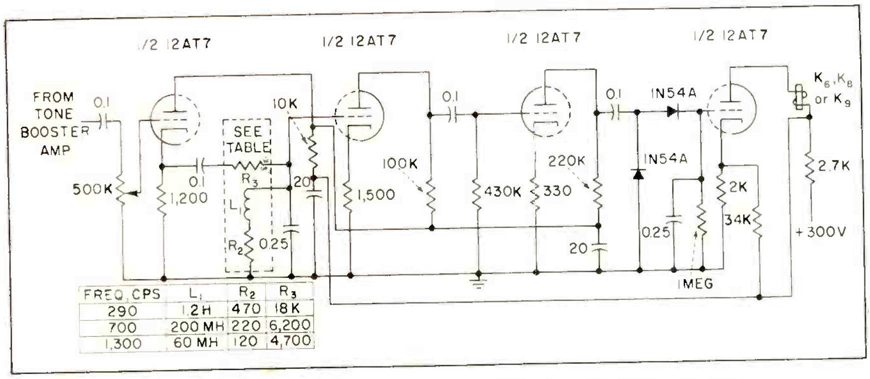


FIG. 3—Simplified schematic of audio and control circuits of playback unit



FREQ, CPS	L_1	R_2	R_3
290	12H	470	18K
700	200 MH	220	6,200
1,300	60 MH	120	4,700

FIG. 4—Basic schematic of the three selective control-tone amplifier circuits

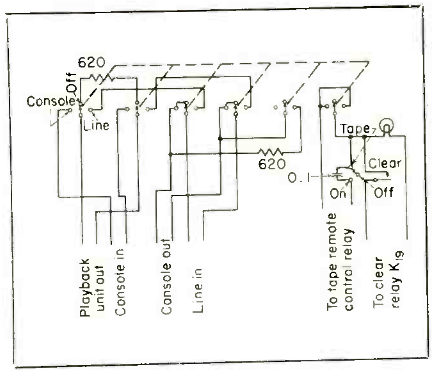


FIG. 5—Circuit of remote-control unit

tone. When it closes K_7 will close and lock in, starting the changer. At the end of the tone K_6 releases and its back contacts make a circuit from the 75-v d-c supply through the back contacts of K_8, K_9, through closed contacts of K_7 to the coil of K_{10}. At this point K_{10} closes and turns off the tape machine.

Program Trips Changer

It is not desirable to let the record leadout groove trip the changer due to the lengthy time required with some records. Consequently a program-operated relay K_{12} has been incorporated to trip after a predetermined length of time following the end of the music. As shown in Fig. 3, this circuit is fed from the output of the phonograph preamplifier, and with no signal the relay is closed.

Lock-out

To prevent the changer from triggering due to a long pause in the record, a lock-out circuit is included to disconnect the program-operated relay during a period of time while the record is playing. This is adjustable from 1½ to 3 min, a common setting is 1 min, 45 sec.

This lock-out circuit is set up by K_7. When it closes to start the changer, one set of contacts applies -5 v to the grid of a relay tube V_3, cutting it off and releasing K_{11}. As long as K_{11} is open, there is no circuit to program-operated relay K_{12}. However capacitor C_2 begins to charge through R_4 and R_5, and after a time determined by R_5 the grid voltage is reduced to a point where the tube conducts and K_{11} closes. Now when K_{12} closes after a pause of about 1.5 sec in the music, ground is applied through the contacts of K_{11} to K_{13}, which closes and releases relay K_7.

The purpose of C_3 is to provide a momentary pulse to K_{13}, since it must not remain energized. Both C_2 and C_3 discharge when their respective relays are released. When K_7 releases, K_{14} trips the changer mechanism, and K_{15} disconnects the changer motor after the arm drops on the next record. K_{14} also mutes the preamplifier during the change cycle. To insure that the changer trips in the event that K_{12} does not function (a situation which could result from a noisy record, for example) the leadout trip circuit of the changer mechanism is paralleled with K_{12}.

Control panel switch S_9, which is locking in the automatic position and non-locking in the manual position, allows manual operation of the changer for testing purposes.

The auxiliary functions, designated as AUTO B on-and-off and AUTO C on-and-off, are intended for the control of external tape playback machines. With the *on* terminals connected in series with the common a-c lead to the tape motor, a 700 or 1,300-cps tone on the control tape will energize K_{16} or K_{17} and start the auxiliary machine.

Machine Shutdown

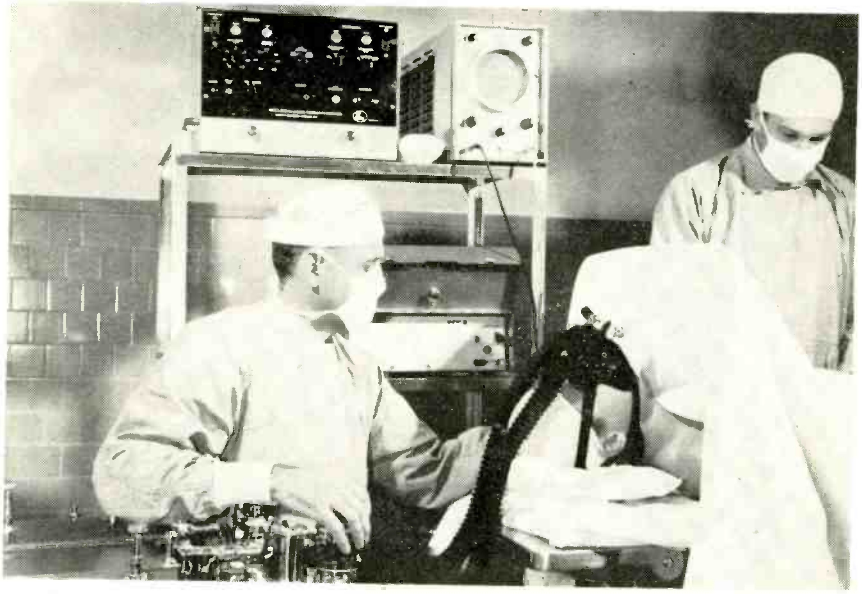
To stop the machine it is necessary to energize K_{18}. This is accomplished by attaching to the front panel of the auxiliary machine a cutoff switch block having two light spring-wire fingers which make contact with the back surface of the magnetic tape. A short piece of ¼-in. wide adhesive aluminum tape is attached to the tape backing at the end of the program segment and the short circuit thus provided applies a ground to K_{18}. This drops out K_{16} or K_{17} and shuts off the machine. Any number of spots or programs may be played on either machine in this manner.

The audio outputs from the auxiliary tapes, the phonograph preamplifier and the master tape playback amplifier are combined in a fixed mixing network the output of which feeds the automatic gain amplifier. This amplifier provides a nearly constant output with input signals which vary as much as ± 15 db from the average. This allows for the considerable level variation in records and recorded tapes of various manufacture.

Program Routine

To facilitate the integration of the Auto-station into the daily programming routine, a remote control box is provided which is used in conjunction with the playback unit. The schematic is shown in Fig. 5. Placed adjacent to the control console, it eliminates the necessity for contact with the playback unit once it has been set up. It contains an audio selector, a tape switch and a clear switch. The audio selector provides three modes of operation: playback unit output to console input with console feeding the line; playback unit output feeding the line with console terminated; or playback unit terminated and console feeding the line.

The first enables the operator to mix the Auto-station program with studio program sources. The second frees the console during long periods of automatic programming, and the last is the regular nonautomatic condition. The TAPE switch permits the master tape to be started or stopped from the remote point, and the CLEAR switch de-energizes all control relays, placing the machine in the master mode.



Cardiac instrumentation in use. On top the 5-ft high cart, an area free from the danger of explosion, are a Defibrillator-Pacemaker (single unit at left) and a dual-trace cro. Electrocardiophone mounts on lower shelf due to its explosion-proof construction

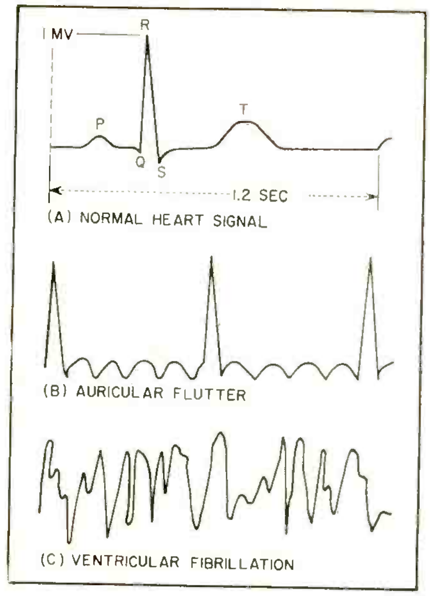


FIG. 1—Potential across shoulders caused by normal (A) and malfunctioning (B, C) heart. Differences must be detected

Tones Monitor Heart's

By ALBERT J. MORRIS and JOSEPH P. SWANSON

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SUMMARY —— Frequency of neon-tube oscillator is controlled by amplitude of heart's electrical signal. Resulting tone series gives surgical team a constant check on heart. Explosion-proofed circuitry includes low-distortion differential preamplifier which discriminates against hum

CONTINUOUS monitoring of the heart's electrical activity during surgery has long been recognized as necessary. The problem in such monitoring is not simply that of separating the heart's electrical activity from local interference and amplifying it, but one of presenting the information to the anesthestiologist in such a way that it will give him instantaneous warning when abnormalities occur, yet provide a minimum of distraction at all other times.

The monitor should be portable, explosion-proof, operate reliably in the presence of severe electrical disturbances and produce an undistorted signal for visual observation on an oscilloscope or an electrocardiographic recorder.

The instrument to be described derives its input from two leads typically connected to the patient's right and left shoulders. These leads pick up an electrical signal originating in the heart and connect to a differential preamplifier with 30 μv sensitivity and frequency range of 0.08 cps to 80 cps.

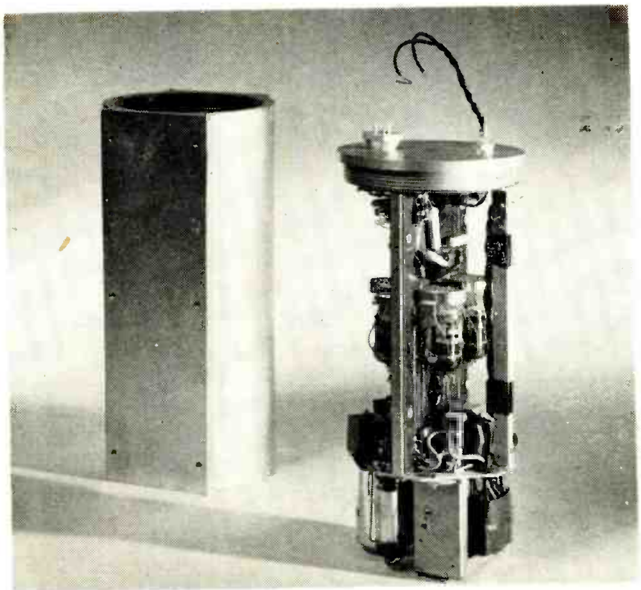
Heart Rhythm

The amplified signal is used to produce a frequency-modulated audio tone centered at 2,000 cps. The frequency deviation of this tone is roughly proportional to the amplitude and polarity of the input signal. Normal heart rhythm results in three short bursts of sound, each at a different frequency, and each corresponding to a particular mode of the heart's electrical activity, the *P*, *QRS*, and *T* modes. These sounds may be reproduced by a small loudspeaker built into the instrument or may be monitored by the anesthesiologist alone with headset.

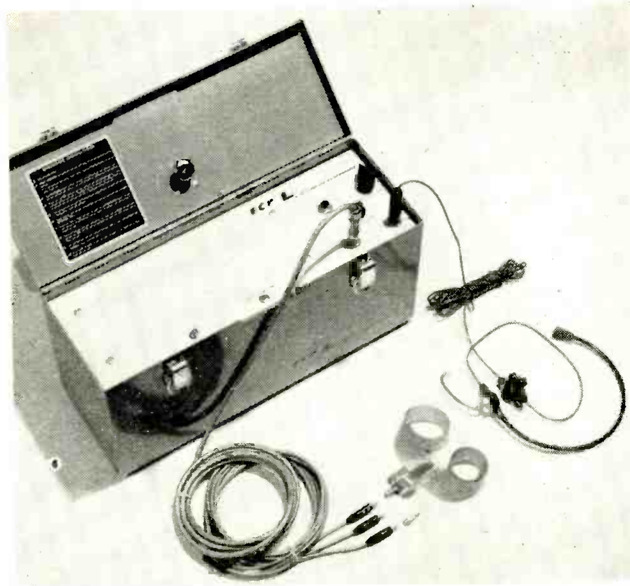
Under normal conditions, the heart rhythm is relatively constant and tends to be accepted as background noise. However, any significant change in this rhythm is forcefully brought to the anesthesiologist's attention.

Electrical Operation of the Heart

Muscular as well as nervous action is accompanied by an electric potential generated across the organ in question. Since a heart beat consists of synchronous action



Bulk of circuitry is mounted within aluminum cylinder able to contain any explosion. Power leads are brought through separate header from that used for input/output leads



Electrocardiophone carrying case has small loudspeaker mounted in rear. Unit is designed for continuous operation. The entire surface of the carrying case is used as a heat radiator

Electrical Action

of the muscles and nerves of the heart, each heartbeat is accompanied by the generation of a rather large rotating electric vector.

One way to measure this vector is to sample the potential it generates between various points on the body as a function of time. For monitoring purposes, the potential generated across one set of points, usually the patient's right and left shoulders is used. A normal heart signal, as measured between these two points, is shown in Fig. 1A. The signal has three distinct parts, the *P*, *QRS* and *T* modes. These components correspond to the contraction of the auricles, contraction of the ventricles, and refilling of the ventricles, respectively.

Figure 1B shows one type of abnormal heart signal which may be encountered. This particular signal represents auricular flutter. While this condition alone is not too dangerous to the patient, it often serves to warn the anesthesiologist of more serious complications to follow unless remedial action is taken. To provide this warning, the instrument must be able to distinguish clearly the heart's *P* mode activity.

Two conditions which may occur during surgery call for immediate action by the surgical team. The first of these is cardiac standstill, a complete cessation of ventricular activity and blood flow. The second is ventricular fibrillation which is distinguished by incoherent residual electrical activity and no flow of blood. Ventricular fibrillation gives rise to the electrical signal shown in Fig. 1C. A successful monitoring device must be able to detect these two conditions instantly and distinguish between them.

Preamplifier

The instrument, shown in Fig. 2, takes its input signal from the two patient leads marked RA and LA. A third patient lead marked LL is also included in the circuit. This lead is used to ground the patient when operating during severe electrical disturbances.

The useful input signal appearing across the RA and LA leads has a peak amplitude of approximately 1 millivolt. This signal is amplified by the two-stage differential amplifier, V_1 and V_2. The differential-mode gain of this amplifier is approximately 2,000, whereas the common-mode gain is on the order of 0.5. This high ratio of differential-mode to common-mode gain serves to increase the ratio between the signal of interest and the 60-cycle interference voltages always present on the body.

Two separate output signals are supplied by the preamplifier. The first of these is an undistorted replica of the input signal to drive an oscilloscope or electrocardiograph for diagnostic purposes. The second output is used to actuate the tone gate.

Modulation

The instrumet must be capable of clearly distinguishing all three

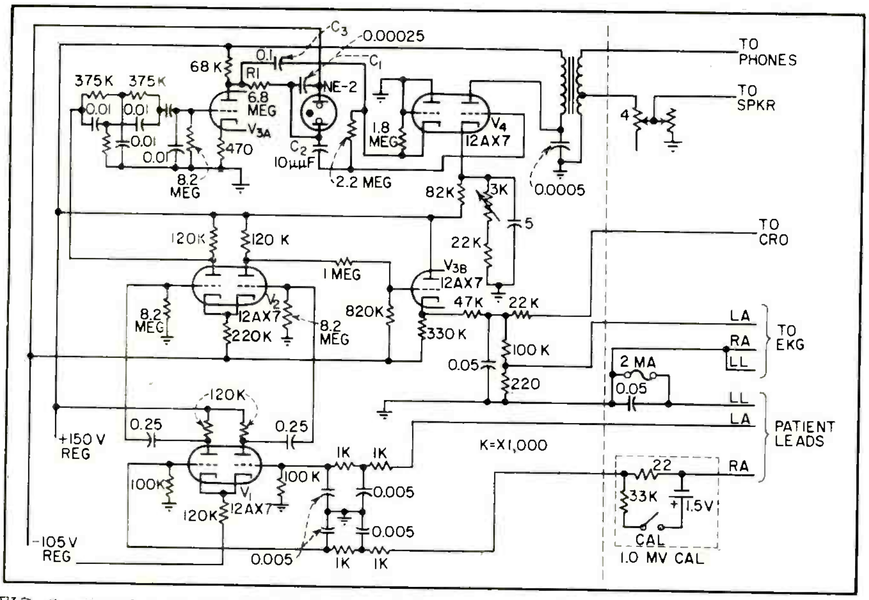


FIG. 2—Circuitry to the left of the dotted line is mounted in explosion-proof case. Low-distortion outputs for cro and ekg are provided

modes of the heart's electrical activity. An early model which amplitude modulated an audio carrier signal was not as successful in distinguishing between these three modes as the present f-m model.

With an a-m carrier, the ear must distinguish between two signals, the *P* and *QRS* modes, separated by a small number of milliseconds in time and by about 20 db in amplitude. The smaller of these two signals, the *P* mode, is almost completely masked by the larger signal which follows it, so that the two modes seem to be a single burst of sound.

With an f-m carrier signal a clearer definition of the three individual modes is obtained. The ear is required to distinguish three sequential signals, differing in frequency but of the same amplitude, a job for which it is much better suited. Tests with the f-m system established that the ear's resolution of the three modes seemed optimum at a center frequency of about 2,000 cycles per second. This resolution is further improved and the disturbing effect of the tone greatly reduced if the carrier is gated off at all times when the magnitude of the heart signal falls below some predetermined level.

Tone Gate

The output of the tone gate circuit may be diagramed as shown in Fig. 3. Only signals larger than the clipping level cause an audio tone to be passed by the tone gate. The frequency of the audio signal out of the gate is proportional to the amplitude of the actuating signal.

Input signal for the tone gate is derived from one output of the differential preamplifier. It is first passed through a twin-T 60-cps rejection filter and then to the grid of a third stage of amplification, V_{3A}, which raises the peak amplitude of the signal to approximately 40 volts.

This 40-volt signal performs two functions. First, it varies the voltage across a small neon bulb oscillator, consisting of R_1, C_1 and the bulb. The center frequency of this oscillator is 2,000 cps. A 40-v change at the plate of V_{3A} is sufficient to cause approximately one octave of frequency deviation. A small sample of this frequency-modulated signal is coupled to the grid of V_{4B} through C_2.

Second, the heart signal from the plate of V_{3A} is coupled to the grid of V_{4B} through C_3. Tube V_{4B} is biased about four volts below cutoff, however positive heart signals coupled to its grid drive it into the conducting region. When this happens, the f-m audio signal, also coupled to this grid, is amplified and appears at the loudspeaker and earphone output jacks. Thus, the desired audio output of Fig. 3 is obtained. The audio output is kept at constant amplitude because of grid limiting in V_{4B}.

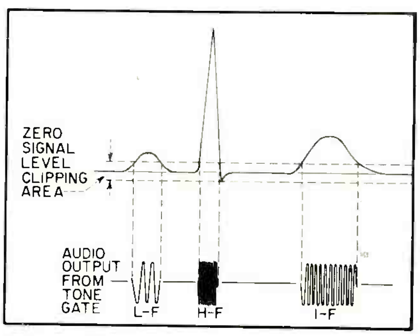


FIG. 3—Simplified tone gate output waveform. Tones are a few milliseconds apart, but may be distinguished by ear

Mechanical Construction

Circuit components are mounted on two phenolic center boards contained within an explosion-proof case. Components are, in most cases, connected by printed wiring. The lower deck mounts the power supply components.

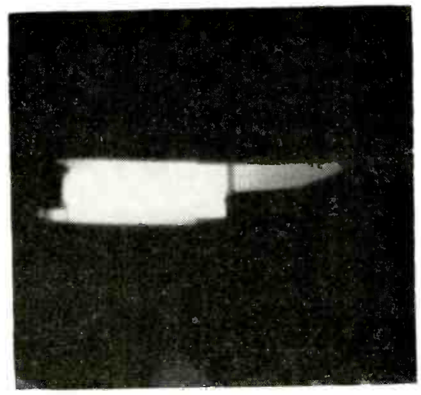
The entire assembly is rigidly attached to a ¾-in. thick aluminum end plate which screws into the explosion-proof aluminum cylinder. Input and output leads are brought through the header, also explosion-proof. Power is fed into the container through a separate header. Special precautions are taken to insure that these leads cannot become damaged in such a way as to cause sparks. The entire assembly is then packaged in an outer case. Input and output jacks and a volume control are brought to the front panel.

Packaging this circuitry in an explosion-proof container raised special thermal problems. Approximately 16 watts are used by the equipment. As much of this heat as possible is conducted to the container walls by metal elements. Since the explosion-proof container itself is well bonded to the outside carrying case, the entire surface area of the carrying case is utilized as a heat radiator. With this approach, the temperature inside the case has been kept close to 60 C with about 27 C ambient air.

We are grateful for the continuing cooperation, efforts and suggestions of Dr. John W. Pender at the Palo Alto Hospital and Dr. Milton S. Waldman and his associates at the Highland Hospital, Oakland.

Infrared photo taken in complete darkness has 600-line resolution at center

Infrared photo reproduced on screen of conventional tv receiver



Soldering iron heated to 400 C as seen through infrared viewer

R-F Power Supply for Infrared Viewers

By T. FUJII and H. KOJIMA

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SUMMARY — Substitution of r-f power supply for conventional vibrator power supply in sniperscopes or snooperscopes results in noise-free operation and avoids magnetic effects of low-frequency transformer flux leakage

VIBRATOR HIGH-VOLTAGE power supplies used in sniperscopes are heavy, bulky and tend to be unreliable in operation after many hours of service due to poor contact of the vibrator contact. Moreover, the noise produced by the vibrator and the magnetic leakage flux of the power transformer might cause blurred images.

These difficulties are minimized by the use of a r-f power supply.

Conventionally the primary winding of a r-f step-up transformer is used as a part of the oscillator tank circuit and the oscillator must be operated at or near the self-resonant frequency of the secondary winding. The reaction of the secondary circuit upon the primary results in a hysteresis phenomenon appearing in the high-voltage output when the oscillator tank circuit is tuned to resonance from two different directions. This results in instability of operation when the circuit is to be operated at its maximum output voltage.

These undesirable effects are avoided by operating the oscillator at a frequency slightly off the self-resonant frequency of the secondary circuit. Lower output voltage and higher power consumption are the result.

The circuit in Fig. 1 uses electron coupling to isolate the oscillator from the load, thus realizing both stability and high output voltage with minimum current drain and without detuning to avoid instability.

Night-vision equipments using the r-f power supply are free from audible noise, compact in size, light in weight and reliable in operation. Blurred image caused by ripple voltage and stray magnetic flux are avoided by providing a set of small-valued capacitors in the filter and bypass circuits.

The authors thank M. Kobayashi, Z. Kamayachi and O. Harashima.

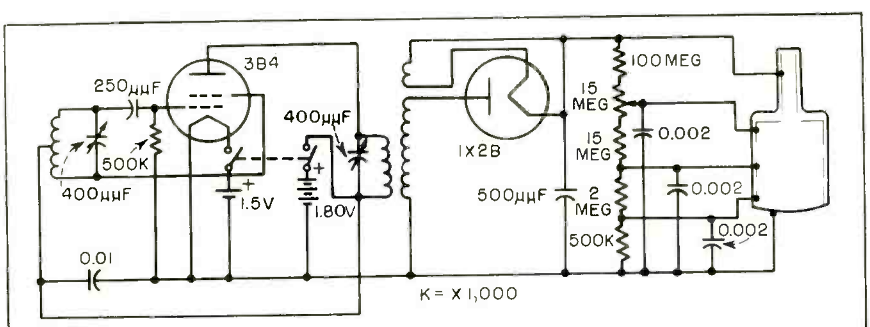
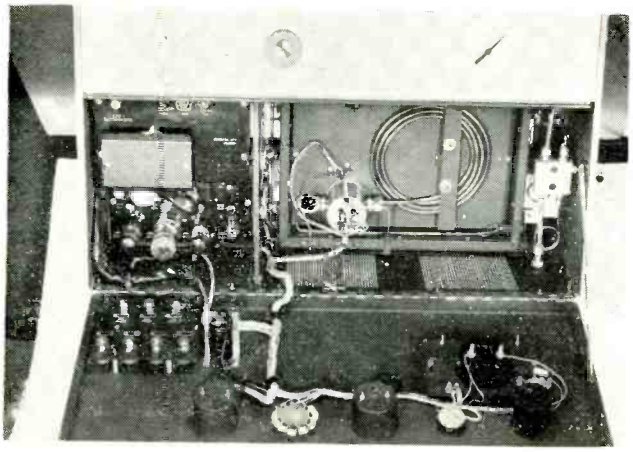


FIG. 1—Electron-coupled r-f oscillator provides noise-free portable high-voltage supply



Interior view of chromatograph shows column mounted directly against bottom plate that is heated by conduction.

Operator uses syringe for injecting sample gas through rubber serum cap. Strip recorder is at left

Electronics Controls Gas

SUMMARY — Heat-controlled instrumentation system, with thermistor as temperature sensing element, automatically maintains any preset temperature between 40 and 225 C within a thermal compartment. Precision voltage regulator supplies 2 to 4 volts at maximum of 400 ma with overall stability superior to a storage battery source.

STANDARD bimetal-thermostatic control of a gas chromatograph causes cyclic variations of the zero line of the recorder due to the high sensitivity of the thermal conductivity cell.

An electronic controlled system has been developed which automatically maintains any preset temperature between 40 and 225 C within a thermal box. It permits the operating temperature to vary over a wide range so optimum resolution can be obtained for a variety of components. This feature facilitates the analyzing of several types of mixtures daily.

Heat-Control System

To eliminate cyclic variations in temperature caused by an on-off system for heat input, the full-proportional heat-control system shown in Fig. 1 was designed.

A thermistor temperature sensing element is one leg of a resistance divider which is returned to a 3-v, low-impedance point. The voltage at the junction of the divider is compared with the cathode voltage of the input tube, which is derived from the same divider and returned to a regulated B+ supply.

Plate current of the input tube is a function of the thermistor divider voltage and the bias stability of the tube. Stability is maintained at 1 or 2 mv per day by the use of an electrometer tube as the input stage.

Its filament is supplied by regulated B+. Since plate voltage of electrometer V_1 thus varies with temperature, the change of plate voltage is amplified and applied as bias to regulator tube V_3.

The regulator tube drives transformer T_1 whose secondary is in series with the control heater in the thermal compartment; T_1 therefore acts as a variable impedance in series with the control heater. The dynamic range of the system is determined by the impedance ratio of transformer T_1. Heater power can be varied from 6 to 90 w as V_3 is varied from cutoff to saturation.

The a-c line produces the 0 to 150 ma plate current required in V_3, so that no current is required for this stage from the regulated supply. The output transformer center tap is tied directly to the cathode of the output tube and this point is referenced to B+ to maintain proper d-c operating potentials.

Differential amplifier V_2 maintains proper phase for the feedback loop. Any increase in thermal compartment temperature is offset by a decrease in the power supplied to the control heater. The operating temperature can be selected by varying the resistance value placed in series with the thermistor, since the circuit tries to retain the same bias voltage for the input tube. For example, if the series resistor is decreased the circuit will automatically heat the compartment until the thermistor value is also

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Gas Chromatography

. . . is a simple technique for rapidly and efficiently separating and analyzing materials. A chromatographic column containing an adsorbent material and possibly a high-boiling liquid partitioning agent is used. A vapor sample is injected at the column inlet and is swept by an inert carrier gas through the column.

The adsorbent material separates the sample into its components and the carrier gas removes individual sample components at different rates. Equilibrium among carrier gas, sample components and column material determines the time required for each component to pass through the column.

Gases flow from the column through the sensing side of a thermal conductivity cell exhausted to atmospheric pressure. Carrier gas flows through the reference side. The difference in thermal conductivity between the reference and sample sides produces a voltage differential which is indicated by a strip-chart recorder.

By measuring emergence or elution time from the column, a qualitative analysis is performed. By measuring the area under the resultant trace of the recorder a quantitative analysis is obtained

Chromatography

decreased proportionally to maintain the same voltage at the junction of the thermistor and the series resistor.

Equivalent Circuit

The equivalent circuit of the heater controller is a resistance in series with an impedance applied across voltage E as shown in Fig. 2. The power into the heater is $P_h = I^2R$ where $I = E/(R + Z)$, E is the applied voltage, Z is the impedance offered by the output transformer, I is the current through the heater and R is the heater resistance. Then $P_h = E^2R/(R + Z)^2$ and Z, the impedance required in series with the heater for a given heater resistance and heater power $= -R + E\ (R/P_h)^{\frac{1}{2}}$. This impedance is transformed to a tube load impedance by the square of the turns ratio of the output transformer. The actual heat dissipation required in the control tube depends on the ratio of reactance to the resistance offered by the output circuit.

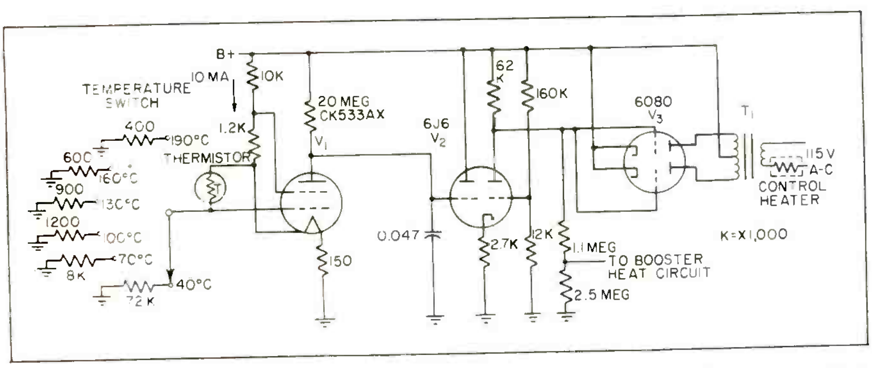


FIG. 1—Thermistor series resistors provide choice of system operating temperatures

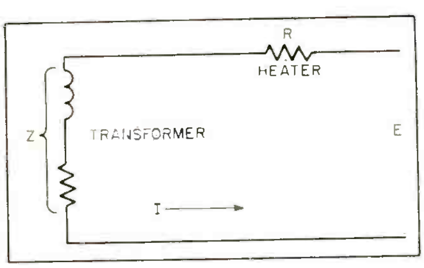


FIG. 2—Equivalent circuit of heater controller simplifies dissipation calculations

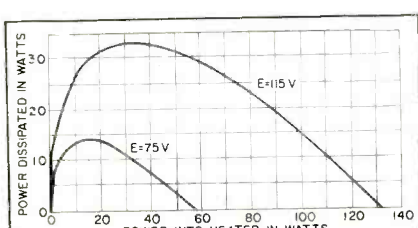


FIG. 3—Variation of dissipation with heater power for a resistor of 100 ohms

Power Dissipation

Power dissipation required in the output tube is $P_a = EP_h^{1/2}/R^{1/2} - P_h$. Power dissipated in the resistance of the transformer winding must be subtracted from total power dissipation.

A plot of power dissipation versus heater power is shown in Fig. 3 for two values of E. The point of maximum power dissipation shifts along the x axis as the heater resistance varies.

Since the output tube bias is a function of the power applied to the control heater, the bias voltage can be used to control additional power. Normal bias range of the output tube for any temperature setting will not trip the relay circuit. When a higher temperature is selected by the temperature step switch, the resultant decrease in bias trips the relay. The relay supplies a booster heater to the thermal compartment which automatically provides power for a large temperature change. As the thermal compartment approaches this new temperature, the bias on the output tube is increased

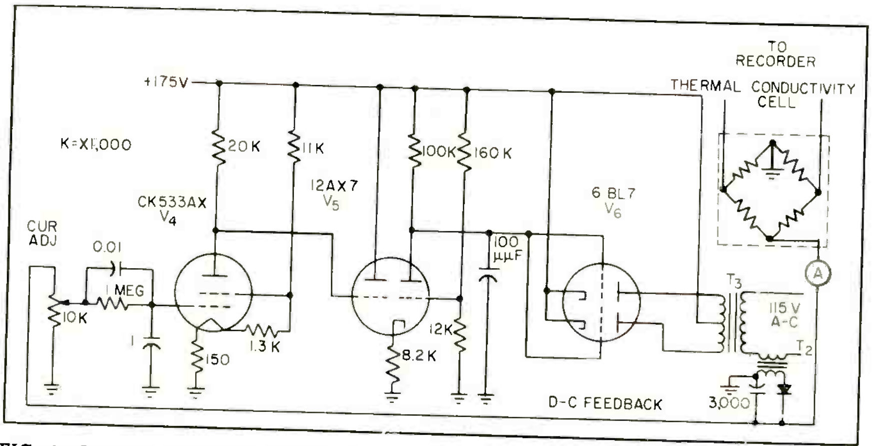


FIG. 4—Detector regulator provides improved zero stability

and the relay drops out. An adjustment provided for minimum temperature overshoot supplies a completely automatic temperature controlling system.

By adding a fixed amount of power in the higher temperature range the regulator will always operate in the center of its dynamic range. This is done by ganging a switch to the temperature-set switch; at the higher temperature positions it provides additional power to the booster heater. This arrangement still allows full proportional control, but a smaller percentage of the total power is controlled by the regulator.

The thermal conductivity cell requires 2 to 4 v over a range of current from 150 to 400 ma. The sensitivity of the cell increases about 10 times as the bridge current is changed over the current range. Therefore, the power supply for the cell must be extremely stable at any current setting. A maximum unbalance of 10 μv is permissable during a sample run, which may require up to 1 hour when handling high-temperature boiling liquids.

The thermal conductivity cell is composed of four tungsten filaments arranged in a wheatstone-bridge circuit. Four volts d-c with high stability is required across the bridge when maximum sensitivity of 400 ma is used.

Referring to Fig. 4, the output of T_2 is rectified and applied to the bridge and also to the input of the voltage regulator where it is amplified and applied as bias to control tube V_6. The amplifier tries to maintain a constant bias on input tube V_4.

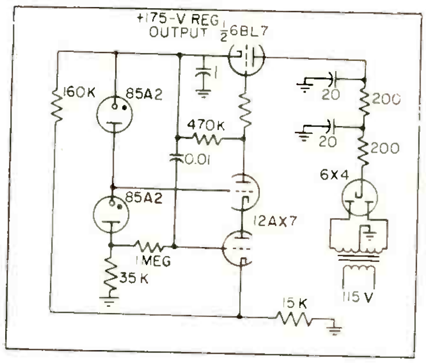


FIG. 5—Regulated +175-v power supply

Sufficient loop gain is supplied so the regulator can cancel normal variations in the a-c line. The regulation required depends upon the balance of the four tungsten filaments in the bridge. If all filaments were exactly balanced no regulation would be required. In practice, the filaments are measured and matched to approximately 2 percent.

Normal bridge unbalance with a battery source is about 20 μv per hour. With this electronic regulator zero stability can be maintained to 20 μv per day since it is directly dependent upon input-stage bias stability and not upon a continuously discharging battery. An electrometer tube is again used to maintain as high a bias stability as possible.

The regulator amplifier is direct coupled. The output tube is referred to B+ in order to maintain proper d-c operating potentials throughout the amplifier. The input-stage filament divider is composed of wire-wound resistors and supplied from regulated $B+$. The bias stability of this circuit is approximately 2 mv per day, corresponding to about 0.03-percent regulation.

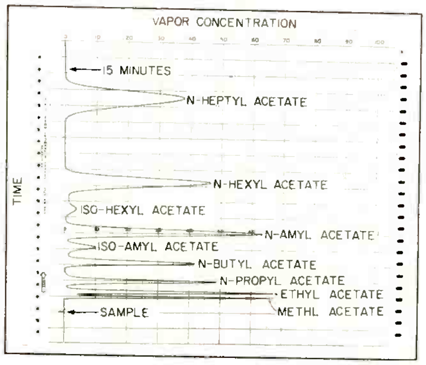


FIG. 6—Chromatograms of acetate esters produced by electronically controlled gas chromatograph. Each peak represents a pure component after complete separation

Power Supply

The power supply shown in Fig. 5 consists of a series amplifier using v-r tubes operating with constant current as reference. The series circuit allows high gain to be used with only one amplifier tube. Because of the high-gain regulator amplifier, minimum filtering is required after the rectifier.

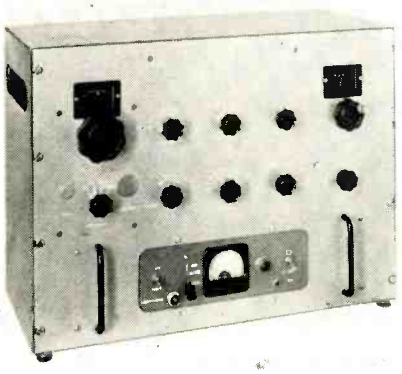
The carrier gas flow rate is affected by column temperature and carrier gas pressure at the column inlet. Stabilization is achieved with two pressure regulators and a capillary tube in series with the column. Since the drop across the capillary is approximately 15 psi, a low pressure drop can be reproducibly maintained across the column with the pressure regulators operating in their control range.

Sample Injection

To inject a sample into the column, two methods are provided. A sample valve may be used which injects a fixed volume of sample gas into the helium stream. An alternate method of sample injection utilizes a sample syringe. The syringe can be filled with the liquid or gas sample and the needle point then injected into the instrument through a rubber serum cap.

Column lengths required for analysis of hydrocarbons and other organic components will vary from 18 in. to 40 ft.

A strip recording of acetate esters taken at 160 C column temperature is shown in Fig. 6.



Transmitter with power supply is relay-rack size, yet delivers 100 w on phone

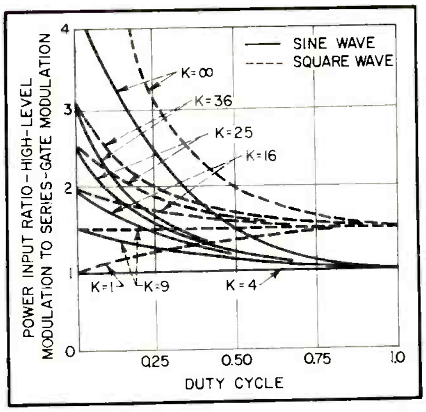


FIG. 1—Relative input powers of high-level and series-gate modulators

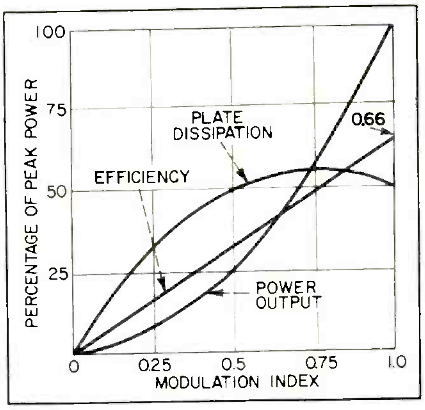


FIG. 2—Peak efficiency of sgm system is equal to that of high-level modulators

Transmitter Cost Trimmed by Series Gate Modulator

By RALPH H. BAER

Vice President
Transistron, Inc.
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SUMMARY —— Screen-grid modulator of low audio power approximates efficiency of comparable high-level modulators. Controllable clamping circuit holds residual power output to around one-fifth the no-modulation output of a high-level system. Splatter-free speech clipping is inherent, available simply by increasing modulation level

SAVING SPACE, weight and primary-power requirements is of first importance in airborne, mobile and portable communications equipment. Using the modulation method to be described, radio transmitters of voice or other intelligence for communication may be reduced by at least 50 percent in bulk and weight and 60 percent in primary power requirements, while still giving equal or better results than present a-m systems. The method, known as series-gate modulation, is particularly applicable for equipment whose price range or operational requirements do not justify the additional complexity of suppressed-carrier and sideband techniques.

In high-level modulation systems commonly employed in a-m transmitters, power for the generation.

Use of the series-gate modulation system reduces physical size of the units and also provides automatic splatterless speech-clipping if desired simply by increasing audio gain, protection against negative overmodulation and reduction of equipment cost by 50 percent.

Operating Principle

To obtain these results the sgm system depends on carrier level control and direct d-c coupled modulation circuitry. It is essentially a form of screen-grid modulation in which relatively low conversion efficiency and normal speech duty cycle are combined to produce high over-all efficiency. The residual carrier level without modulation is held to some fixed fraction of peak modulation level, usually around 1/4 to 1/6. Hence the residual power level is between 1/16 and 1/36 of peak modulation, or 17 to 20 percent of the no-modulation power in similar sidebands must be supplied by the modulator. Under normal conditions, the audio power delivered by the modulator is one-half the d-c plate input power to the modulated stage at 100 percent modulation. This necessitates large tubes and components in the modulator circuit, but the modulated tube operates at an efficiency of about 66 percent. By contrast the efficiency is only about 50 percent with conventional low-level modulation requiring only small audio power.

high-level modulated stage. Since this power level has only mathematical significance in the sgm system, it will be termed the effective no-modulation power output. A residual carrier level is required for ease in tuning the transmission at a receiving station.

As the audio signal increases in amplitude, the modulation of the residual carrier rises to approximately 95 percent. Further increases in audio level raise the average carrier correspondingly, but the negative modulation peaks never go below 3 to 5 percent of peak carrier level. Hence negative overmodulation is averted. Continued rise in audio level will produce similar increases in carrier level up to the point where the positive r-f peak excursions are equal to a new maximum level. This point is determined by the highest positive voltage to which the screen grid of the modulated tube is permitted to rise, and may be considerably in excess of that reached during c-w operation of the same stage. The level now attained corresponds to 100 percent modulation of the full carrier power. Further increases in audio level will result in both negative and positive peak-clipping.

Use of d-c coupling throughout the modulator up to the r-f power amplifier screen grid produces clean, high-level clipping without the transient distortion frequently associated with reactive clipping circuits. Higher-order a-f harmonics generated by the clipping action are suppressed by the screen grid bypass capacitor, while modulation linearity is maintained through the low-impedence cathode-follower drive of the screen grid.

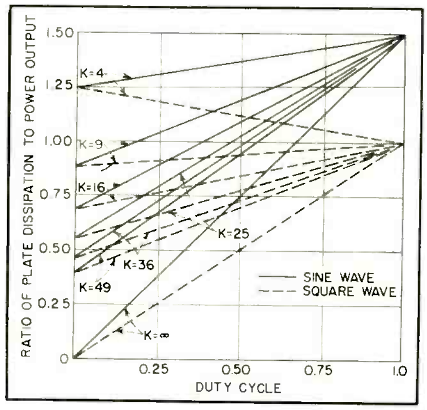


FIG. 3—Square-wave advantage shown is approximated by 10-15 db of clipping

To compare the overall efficiency of high-level modulation with that of sgm it is necessary to take into account the duty cycle of the information to be transmitted. For the high-level modulated stage, assuming a class-B modulator operating only during the duty cycle with an overall efficiency of 50 percent, the total d-c plate input power P_{in} with 100-percent sine-wave modulation is P_{out} $(1 + D/0.66)$, where P_{out} is the no-modulation carrier power and D is the duty cycle.

In the series-gate modulation system the efficiency of the modulated stage varies in direct proportion to the output level. Assuming a maximum efficiency of 66 percent on modulation peaks, and letting $k = (E_{peak}/2E_{residual})^2$, then $P_{in} = 3P_{out}$ $[1/\sqrt{y} + (1 - 1/\sqrt{k})\, D]$.

A plot of this equation in Fig. 2 indicates that the plate input power requirements of the sgm system are less than those of high-level modulation for identical fully modulated sine-wave carriers, providing k is greater than 4. This relation derives from the increase to 50 percent of the average efficiency of the linear sgm stage at 100 percent modulation, and from the absence of additional modulator power such as that required by the high-level modulated stage.

A further contributing factor is the relatively low overall efficiency —50 percent—with which the audio power for the high-level modulated stage is generated. Hence a decrease

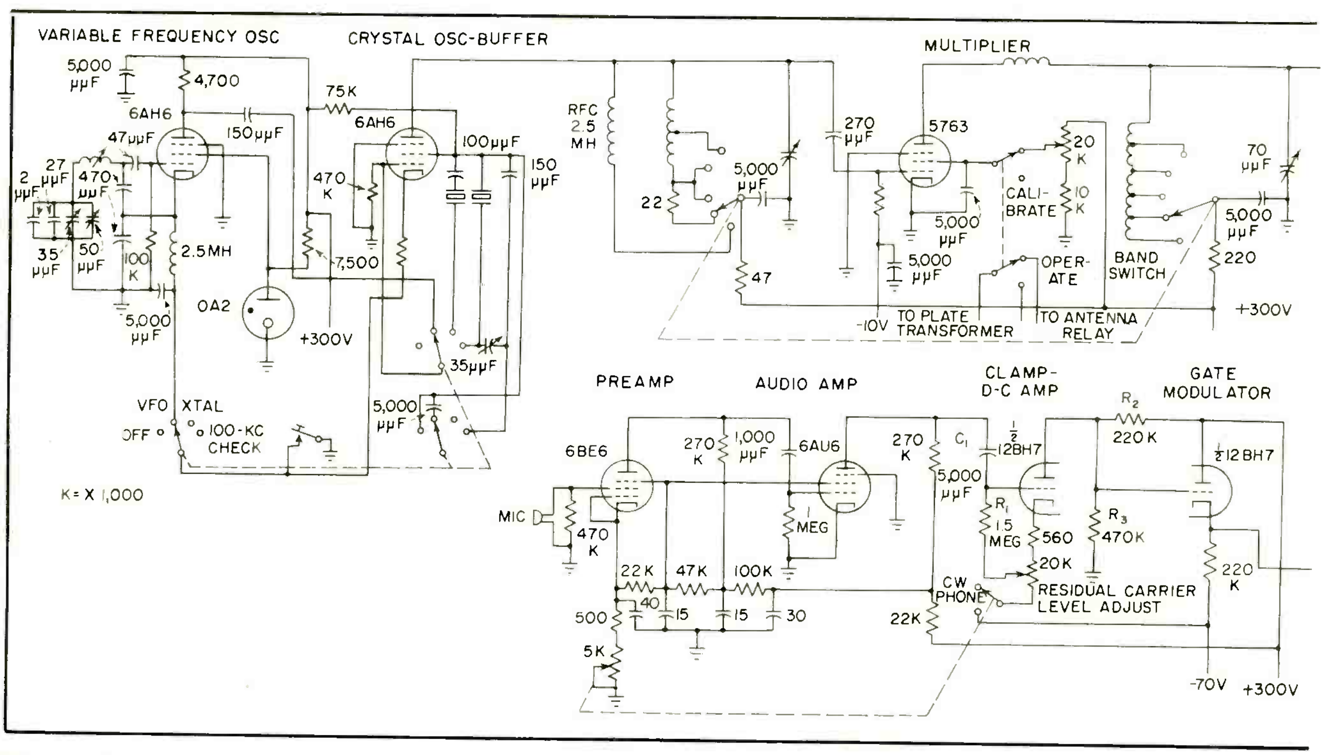


FIG. 4—Schematic of 100-watt prototype transmitter affording c-w operation and a-m phone using sgm system. Bend from 3 to 30

in the size of the sgm plate power supply is permissible.

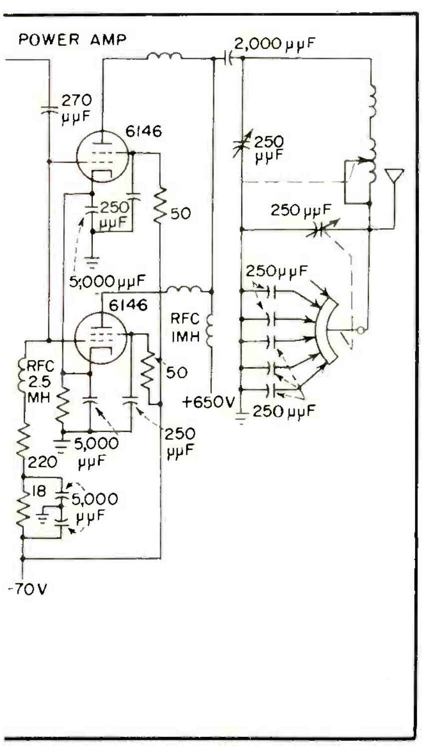
If symmetrical square-wave modulation is applied to the two systems, for high-level modulation $P_{in} = (P_{out}/0.66)\ (1 + 2D)$. For series-gate modulation $P_{in} = (m^2 P_{peak}/0.66\ m)\ (1 - D) + (2P_{out}/0.66)D$, where $m = 1/2\sqrt{k}$. Thus no increase in input power is required for sgm since the efficiency has risen to 66 percent.

Plotting these power ratios results in the dashed curves of Fig. 1. These show further possibilities of input power reduction in the sgm system for certain ranges of k and D. Normally a large amount of speech-clipping is feasible, which places the operating conditions in a region between the two sets of curves of Fig. 1.

A choice of average design center values for k and D in the system must also take into consideration the plate dissipation in the modulated stage, which is equal to $mP_{peak}\ (1.5 - m)$.

The plot of this equation in Fig. 2 shows the plate dissipation curve has a maximum at $m = 0.75$. When $P_{peak} = 4\ P_{out}$ the sgm plate dissipation for sine-wave modulation equals $P_{out}\ [1.5D + 2/\sqrt{k}\ (1.5 - 1/2\sqrt{k})\ (1 - D)]$. This equation is plotted in Fig. 3. For the high-level modulated stage the plate-dissipation equals $P_{out}\ (0.33 + 0.17D)$.

The operating conditions which will permit the use of identical tubes in either an sgm or high-level modulated stage will have equal plate dissipations and equal power outputs. Then $D = [0.33\ k + (1 - 3\sqrt{k})]/[1.33\ k + (1 - 3\sqrt{k})]$, provided $0 < D < +1$ and $70 < k < \infty$. $k = \infty$ (no residual carrier) $D = 0.25$ and identical tubes may be used for the same average and modulated peak power output. When $D = 0.125$, k must be approximately 200. Then residual power output $= 1/200\ P_{out}$, or practically zero, for equal plate dissipation. For square-wave modulation the sgm plate dissipation is $P_{out}\ [D + 2/\sqrt{k}\ (1.5 - 1/2\sqrt{k})\ (1 - D)]$. A plot of this equation in the dashed lines of Fig. 3 indicates the reduction in plate dissipation for square-wave modulation as compared with sine-wave modulation. When speech-clipping is employed the actual dissipation will be somewhere between the ranges of these two sets of curves.



mc is covered by vfo or selectable crystal

Speech Clipping

Peak-clipping of the speech waveform can aid materially in raising the average modulation level. Approximately 10 to 15 db of clipping is normally desirable, and this will increase the effectiveness of the transmission several hundred percent, while maintaining voice quality adequate for communications. The success of any speech-clipping system depends in part on its ability to suppress higher-order harmonics generated in the clipping process. If these were permitted to modulate the carrier considerable sideband radiation (splatter) would result.

Conventional speech clippers incorporate low-pass filters to reduce these audio harmonics to acceptable levels. But unless clipping is done at the point of modulation injection into the r-f stage, phase shifts in the audio amplifier stages following the clipper circuit will have the effect of tilting the flat-top waveforms developed by the clipper-filter combination.

In the sgm system these difficulties are avoided by obtaining clipping action in the grid and plate circuit of the voltage amplifier driving the cathode-follower modulator, to which it is d-c coupled. Attenuation of about 6 db per octave below approximately 400 cps is provided by the coupling networks of the microphone preamplifier. This aids in the reduction of the vowel bass content of normal speech which is largely responsible for the peak excursions of composite waveforms.

Practical Circuit

As shown in Fig. 4, the modulator is a 12BH7 twin triode. The first half is used as a voltage amplifier, the second half as the output cathode follower. A conventional r-c coupled amplifier precedes the modulator tube. Small coupling capacitors reduce the frequency response of the amplifier at a rate of 12 db per octave below 1,000 cps.

Capacitor C_1 and resistor R_1 provide a method of grid clamping. This results in a shift of average d-c potential at the junction of R_2 and R_3 which is proportional to the peak-to-peak amplitude of the incoming audio signal.

The junction of these two resistors is coupled directly to the grid of the cathode follower. This results in a shift of screen-grid potential of the r-f amplifier tubes. As a result both carrier level shift and audio modulation are simultaneously applied to the screens of the final tubes. The low output impedance of the cathode follower helps maintain good waveform, despite the varying load presented by the screen grids of the final.

In addition to this action speech-clipping is automatically obtained by increasing the input to the modulator so that the amplifier tube grid cuts off on negative peak swings. The maximum voltage to which the final screens can rise is determined by R_2 and R_3, and it is therefore completely controllable through a change of value of these two resistors. High-order harmonic products generated as a result of speech clipping are effectively reduced by the screen-grid bypass capacitors. Using this sytem, it is entirely feasible to operate a 250-watt transmitter from a six-volt car battery or a 10-watt unit from portable-radio type dry batteries.

Geiger-Muller tube is housed in external unit partially seen at lower right

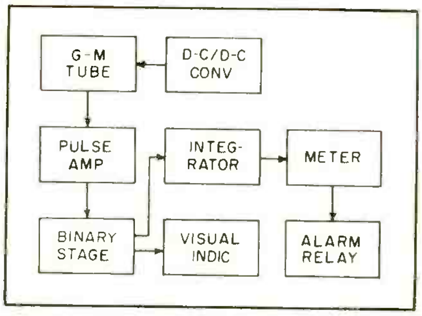


FIG. 1—Block representation of gamma-ray detector

SUMMARY —— Transistorized instrument detects gamma radiation over 1 to 1,000 milliroentgen per hour range with accuracy of ±40 percent. Alarm, which is adjustable from 10 to 900 mr per hr, indicates when radiation exceeds preset value. Reliability is achieved partially by simplicity of circuit design; all active circuits, except for power supply, are mutivibrators

Gamma-Ray Monitor

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ROBABILITY that a complex circuit will fail is usually a function of the number of components in the circuit. Hence, reasonable objectives for a reliable design are to use a minimum number of components and to make those that are used as individually reliable as possible.

On the basis of these considerations and in the light of component availability, it was decided to transistorize an entire gamma detector with the exception of the detecting element, a Geiger-Muller tube of a conventional and proven type.

System Description

A block diagram of the gamma-radiation monitor is given in Fig. 1 and the circuit diagram is shown in Fig. 2.

The detecting element followed by a pulse amplifier increases the energy level of the signal pulses and also performs a discrimination function to minimize noise effects. The amplified pulses are fed to a binary counter which converts the pulse train to a square wave of constant amplitude and of frequency equal to one-half the pulse repetition rate of the signal. One of the outputs from the binary stage is to a visual-count indicator circuit.

A second output from the binary stage is to an integrating circuit which converts the square wave to a d-c signal whose amplitude is proportional to the frequency of the square wave. A current-sensitive relay in series with the output meter actuates an alarm device when the radiation level exceeds some predetermined safe value.

The detecting tube is sensitive to gamma radiation but has almost no response to alpha, beta or neutron radiations. Its output consists of a train of pulses at a repetition rate proportional to the intensity of the gamma radiation field. An experimental curve of the response of the tube type used in this circuit is illustrated in Fig. 3. The output pulses tend to be uniformly large at low count rates, but as the rate increases a larger percentage of the pulses become smaller in amplitude.

Transistor Selection

Detailed consideration of the circuit specifications for the entire system led to the conclusion that, with a single exception in the power supply, one transistor type could be used throughout.

Transistors with an a_b cutoff frequency of 1 mc are more than adequate in this application.

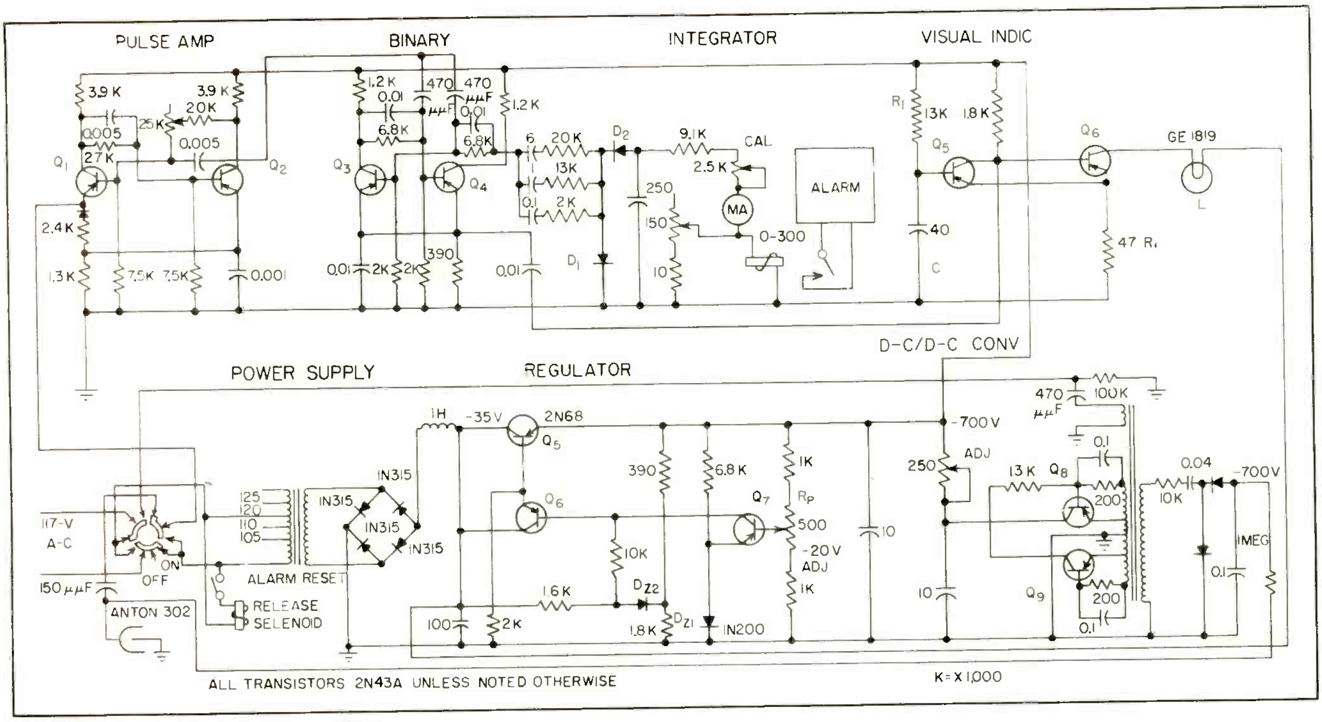


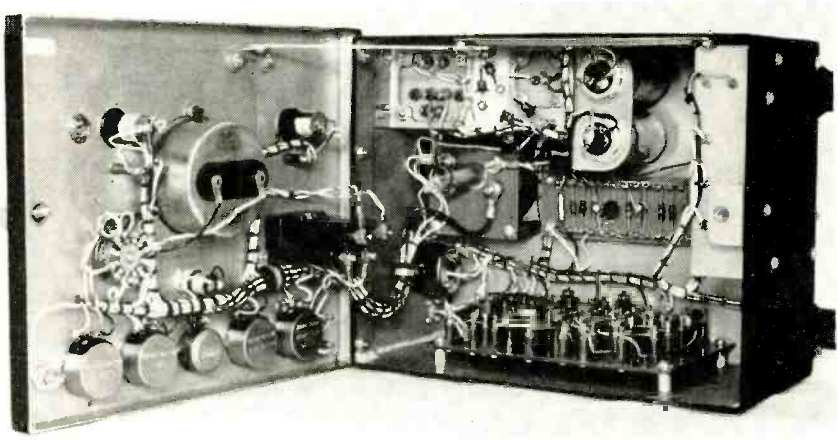
FIG. 2—Eleven-transistor unit uses type 2N43A in all circuits except for two 2N68's in regulator

Has High Reliability

Though current-amplification factors of 30 or greater are desirable, the designs were based on a lower figure to insure reliable operation despite aging effects. Reverse leakage current of less than 2 μa at room temperature were specified to insure adequate performance over the desired ambient temperature range.

An inverse collector-to-emitter voltage rating of at least 20 v was selected to facilitate the design of the power supply. Finally, a power dissipation rating of 100 to 150 mw at room temperature was specified to insure a proper margin for derating.

On the basis of these desired properties, the type 2N43A *pnp* alloy transistor was selected for all the circuits except the voltage regulator for which a 2N68 *pnp* alloy power transistor was selected.



Inside view of transistorized gamma-ray monitor shows component location

Pulse Handling

Pulses from the G-M tube feed a monostable multivibrator configuration of the type illustrated in Fig. 4.[1] Inclusion of R_e in the emitter lead of Q_1 unbalances the normally bistable circuit and makes it monostable. In the monostable mode, Q_1 is normally cut off and Q_2 is conducting; Q_2 is unsaturated in its conducting state for maximum circuit sensitivity.

Diode D provides a high-impedance triggering point for the G-M tube, thus eliminating the necessity for an additional buffer stage between the detector and amplifier. Since the cutoff potential developed across R_f divides between the back resistances of D and the emitter-base junction of Q_1, it is desirable to have the back resistance of

D of the same order of magnitude as the back resistance of the transistor emitter-base junction.

A positive pulse from the G-M tube triggers the multivibrator into an unstable state where Q_1 conducts and Q_2 is cut off. While in its unstable state, pulses from the G-M tube will have no effect on the circuit. The recovery time of the multivibrator may thus be used to discriminate against after-pulses from the detector by making the time constant of the circuit longer than the expected duration of the after-pulses. For the circuit of Fig. 4, the recovery time of the multivibrator is 50 μsec.

Triggering Requirement

The amount of charge required to trigger the monostable multivibrator is a function of the α-cutoff frequency of the transistors and the conducting level of Q_2.[2] An approximate equation for the charge requirement is

$$Q_T \cong \frac{I_{e2}}{\omega\alpha_b} \cong \frac{1}{\omega\alpha_b}\left(\frac{R_b}{R_b + R_k + R_1}\right)\left(\frac{E_{bb}}{Rf}\right) \qquad (1)$$

where Q_T is the trigger requirement in coulombs, I_{e2} is the collector current of the conducting transistor in amperes prior to triggering and ω_{ab} is the cutoff frequency of the transistors in radians per second. For the circuit of Fig. 4, Q_T is approximately 5 x 10^{-10} coulombs.

Discrimination against low-charge noise pulses is accomplished by adjusting the steady-state conduction current of Q_2 by varying R_f.

The charge available from the G-M tube during a primary discharge is approximately 10^{-9} coulombs, providing a trigger margin of at least 100 percent. The output of the multivibrator consists of a negative pulse 50-μsec wide and approximately 10 v in peak amplitude.

The binary stage can load the circuit appreciably without adversely affecting the operation of the monostable multivibrator during the regenerative cycle. An estimate of the peak pulse power gain of the amplifier circuit is 25 to 30 db.

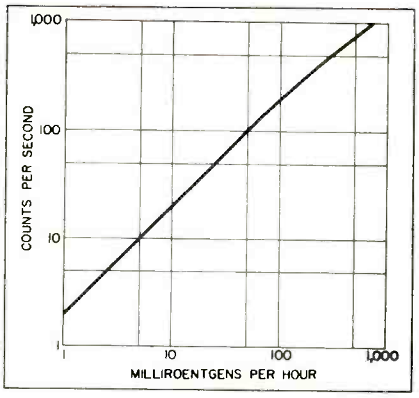


FIG. 3—Characteristic of Anton 302 Geiger-Muller tube

The binary stage is a conventional emitter-coupled flip-flop which is base-triggered by the negative pulses from the pulse amplifier stage. The coupling capacitors are selected so that its recovery time is less than one-half the period of the highest frequency anticipated.

Negative pulses from the pulse amplifier are applied simultaneously to the bases of both transistors in the flip-flop circuit. Since comparatively low pulse frequencies below 10 kc are anticipated, a diode routing gate in the trigger circuit is not required. For optimum trigger action the flip-flop is designed as a nonsaturating circuit.[1]

Logarithmic Integration

The collector swing of the binary transistors is 10 v and 10 ma. The collector of Q_4 is loaded by a logarithmic integrating circuit which delivers a d-c current to the output meter. Since the output meter must cover a range of three decades, 1 to 1,000 mr/hr corresponding to approximately 1 to 1,000 counts per second, the amplitude of the d-c output from the integrator is required to be proportional to the logarithm of frequency.

Logarithmic conversion is obtained by a simple R-C network attached to the collector of Q_4. When the collector of Q_4 swings negative, a quantity of charge is pumped into the 250-μf capacitor and the charge magnitude is determined by the R-C network time constants.

During the positive half of the square wave D_1 conducts and D_2 is blocked, isolating the capacitor from the binary and maintaining a flow of d-c into the output meter. As the frequency of the binary multivibrator increases, due to increased gamma activity, more charge is pumped thus increasing current to the output meter. By proper selection of the R-C time constants and by scaling the series resistance values of the R-C branches so that the current flow always tends to increase logarithmically with increasing frequency, a good approximation to a logarithmic response is obtained.

Statistical Smoothing

The capacitance value is large to provide a long time constant in the output circuit. For the circuit in Fig. 2, the integrating time constant is approximately 2.5 sec. Such a long integration period is required to smooth the statistical variations in the count rate.

The output meter is calibrated directly in milliroentgens per hour and hence provides a continuous indication of the average gamma radiation intensity. The current-sensitive relay in series with the meter provides a high-level alarm.

The setting of the alarm point, which may be varied from 10 to 900 mr/hr by a variable resistor shunting the relay coil, is complicated by the random nature of detected radiation. If the alarm is set too close to an ambient level, inadvertent alarm triggering may occur due to statistical variations in the count range. Setting the alarm point experimentally by use of a calibrated cobalt-60 source has proved to be the most satisfactory means for determining the proper alarm level.

Visual Count Indicator

The visual-count indicator causes a lamp to flash every time a gamma interaction occurs in the G-M tube. A circuit of this type is useful only in the low-count region since the resolution of the eye is limited to approximately 20 flashes per second. Nevertheless, it is of inestimable value as a psychological channel to indicate that the circuit is operating satisfactorily.

A direct-coupled monostable trigger circuit meets the requirements of the monitor. Transistor Q_5 is normally conducting and Q_6 is held cut off by the low collector potential of Q_5 and by the voltage drop across R_f. Capacitor C is therefore charged to a low potential which is approximately equal to the voltage drop across R_f. Since indicating lamp L is in the collector circuit of Q_6, the lamp is normally off.

Lamp Lighting

If a negative pulse is applied to the base of Q_6, the latter is momentarily pulsed into a conducting state. The flow of current in the emitter of Q_6 will increase the negative potential across R_f, but since the base of Q_5 is momentarily maintained at a constant potential by C, Q_5 is forced into a cutoff state. This action causes the negative potential at the collector of Q_5 to increase which in turn drives Q_6 into saturation, thus lighting L.

At the termination of the trigger action the capacitor begins to charge through resistor R_1. When the negative potential across C becomes equal to the potential drop across R_f, Q_5 begins to conduct causing its collector potential to drop, hence, Q_6 is driven back to a cutoff state. The lamp is then extinguished and remains so until another trigger pulse from the binary stage initiates the circuit action. The resolution of the indicator circuit is

$$f_r \leqq \left[R_1 C \ln \left(\frac{E_{bb} - E_1}{E_{bb} - E_2} \right) \right]^{-1} \qquad (2)$$

where E_{bb} is the supply voltage of Q_5, E_1 is the potential drop across R_f under quiescent conditions and E_2 is the potential drop across R_f when the lamp is lighted. For the circuit in Fig. 2, Eq. 2 indicates a maximum resolution of approximately 20 pps. Any higher frequency will result in a constant glow of the indicator lamp.

Reliable Triggering

Separate voltage supplies for Q_6 and Q_6 are used in the indicator circuit since a regulated voltage supply is required only for Q_5 to insure reliable trigger action. Consequently, the watt of power required to flash the lamp may be drawn from the unregulated supply and thus does not impose unnecessary power drain upon the regulator circuit.

The trigger source for the indicator is the common emitter resistance of the binary-stage flip-flop. A negative pulse occurs at this point each time the binary multivibrator is triggered from the pulse amplifier. In addition, the common-emitter terminal of the binary circuit is a low-impedance point and hence is not seriously loaded down by the visual-count circuit.

Power Supply

The power supply requires an accurate voltage regulator and high-voltage generator. Good voltage regulation is required for the G-M tube since a variation of ± 2 percent about 700 v may result in improper tube response. Close regulation is also required for the multivibrator circuits to insure constant output levels.

The regulator circuit maintains the voltage level against variations of load impedance as well as against input voltage fluctuations. The reference voltage, from which the difference feedback voltage to a series-regulating element is established, is obtained from zener diode D_{z1}.[3] The difference voltage is amplified by Q_8 and Q_9 and fed back to the base of power transistor Q_7 which is in series with the line and which constitutes the regulating element. A second zener diode reference, D_{z2}, stabilizes the base and collector supply voltages of feedback transistors Q_8 and Q_9 respectively, thus making the amplifier gain virtually independent of input voltage changes. Adjustment of the regulated output voltage may be made manually by variation of R_p.

The regulator circuit has an output resistance of approximately 0.2 ohm and regulates the 20-v supply within 1 percent over a temperature range from 0 to 50 C.

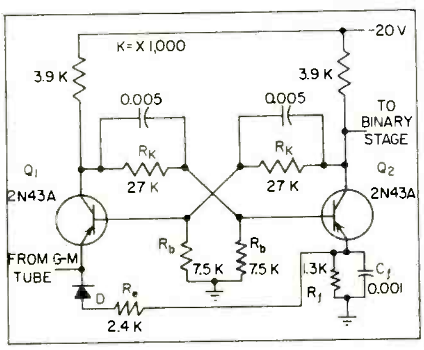


FIG. 4—Monostable multivibrator serves as pulse amplier

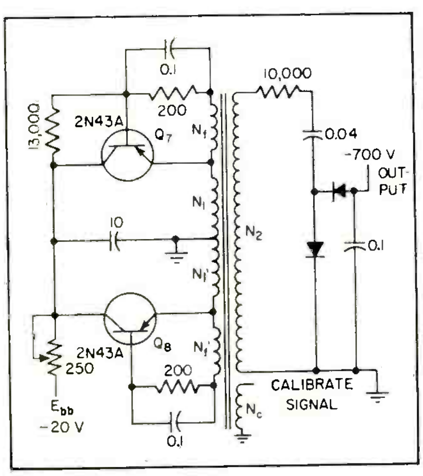


FIG. 5—Voltage-doubler d-c/dc converter supplies 700-v excitation for G-M tube

High-Voltage Generation

High voltage for the G-M tube is obtained from the d-c/d-c converter of the type illustrated in Figs. 4, 5. A square wave of alternating voltage is generated when the transistors alternately switch supply voltage E_{bb} across transformer windings N_1 and N_1'. Regenerative feedback is supplied by windings N_f and N_f'.

Frequency of operation is governed by the magnitude of the supply voltage and the saturation properties of the square-loop transformer material. If ϕ_s is the saturation flux in webers and if $N_1 = N_1'$, the frequency of oscillation is

$$f = E_{bb}/(4\, \phi_s N_1 \qquad (3)$$

Since E_{bb} is a regulated voltage and ϕ_s is fairly temperature insensitive over a wide range of temperature, the frequency of the converter is constant. This property may be used in calibration of the monitor equipment by employing the converter as an internal generator for testing the indicator circuits by taking the calibration signal off winding N_c.

The voltage across secondary N_2, is rectified and filtered in a voltage doubler configuration. The re-

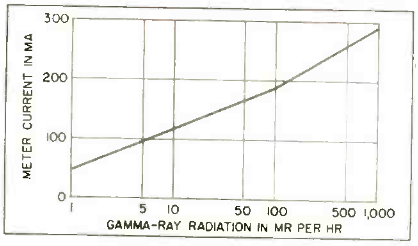


FIG. 6—Output characteristic of complete instrument

sistor in series with the secondary winding limits the maximum current flow in the secondary circuit. A fine adjustment of the d-c output voltage may be made by variation of the 250-ohm potentiometer, which adjusts the collector potential of the transistors within a small margin.

The converter operates at a frequency of 500 cps. The transformer turns ratio (N_2/N_1) is 17.5 and the core is a toroid fabricated from Orthonol square-loop material. Supply voltage E_{bb} is from the 20-volt regulated line.

System Performance

The output response characteristic of the circuit, showing d-c output current as a function of radiation intensity, is illustrated in Fig. 6.

The circuit is calibrated by switching the input of the pulse amplifier from the G-M tube to the differentiated output of the calibration-signal winding on the high-voltage transformer. The meter current under these conditions is known, since the frequency of the converter is constant; therefore, the meter-circuit resistance may be adjusted until a correct reference reading is obtained. Calibration by this means eliminates the effect of component variations which could cause minor differences in the output readings from unit to unit.

Count-rate calibration is not rigorously analogous to radiation calibration. However, the technique does meet the accuracy requirements of the system and provides a simple method for individual adjustments. For calibration in the lower two decades, the circuit depends upon the assumption that the G-M tubes exhibit approximately the same characteristics. Experience shows that this is a reasonably valid assumption and leads to only negligible errors.

Operational Accuracy

Once the system is calibrated, continued accuracy of the output indication depends upon the voltage stability of the regulating circuits. For example, if the output meter is rated as accurate to within 1 percent and has a full-scale deflection of 300 μa, the error anywhere on the scale may be as high as 3 μa.

Since the meter is marked in three logarithmic decades, an error of this magnitude corresponds to one thirty-third of a decade or approximately 7 percent in the indication. Consequently, a 2-percent change in the supply voltage, which leads to the same percentage change in the voltage output of the binary stage, could result in a maximum error of almost 15 percent in the meter indication.

This sensitivity can be reduced by the addition of an emitter-follower amplifier stage between the binary multivibrator and the logarithmic integrator circuit, providing a larger current for the output meter and permitting the use of a meter with a larger full-scale current rating. However, if the voltage regulator circuit is adequate for the required accuracy, as in the present design, the additional transistor stage is not necessary.

Drift

Operation of the monitor over an ambient temperature range of 0 to 50 C meets the given accuracy requirements since the drift in output indication for a single unit is no greater than ± 40 percent.

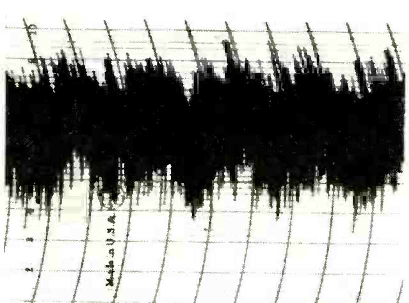


FIG. 7—Five-hour recording of output response to radium watch-dial source. Vertical divisions are 5 μa

The multivibrators in the indicating circuits are stabilized against temperature changes by the d-c bias network so that under the worst possible conditions the amplitude of the output pulse from the amplifier circuit does not vary more than ± 10 percent and the output amplitude from the binary stage does not vary more than ± 2 percent over the 50 C temperature range.

Frequency stability of the converter in the same temperature range is better than ± 2 percent. It is estimated that most of the observed drift is due to component variations in the logarithmic integrating circuit.

Radium Response

A 10-hour pen recording of the gamma monitor output current response to a radium watch-dial source is illustrated in Fig. 7. Each major division along the horizontal axis is a one-half-hour time unit and each major division along the vertical axis is a 5-μa unit. The cyclic variations of 1-hour periods are due to the motion of the minute hand. Added to the hourly variations is a 12-hour cycle due to the motion of the hour hand. Statistical variations from the average radiation level are as much as ± 50 percent.

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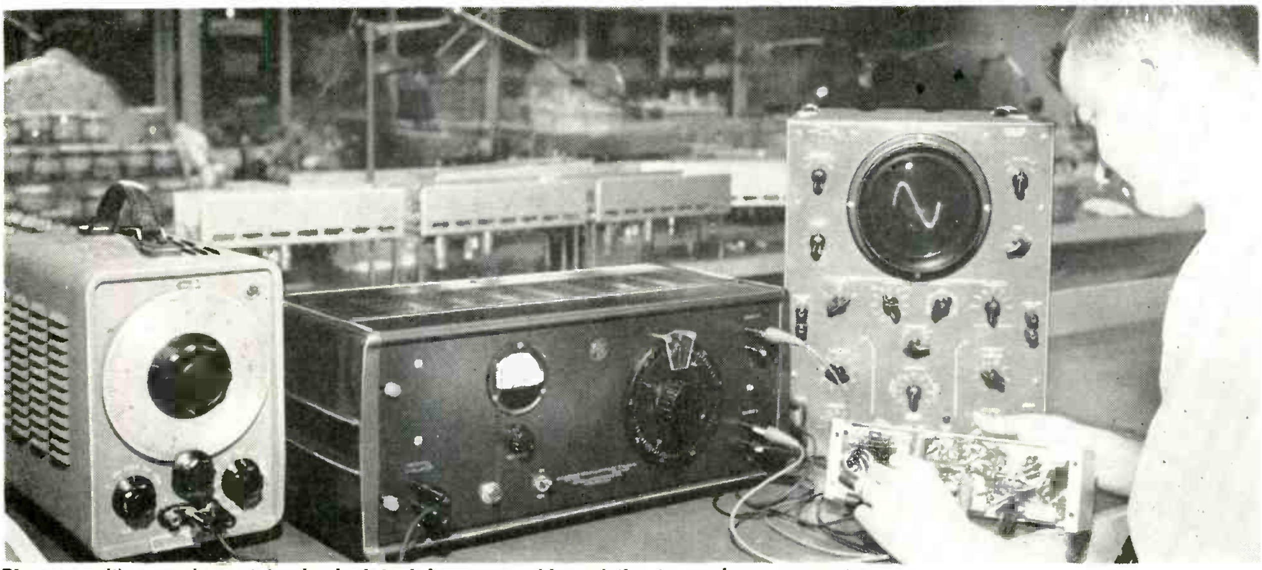
Phase-sensitive equipment is checked in laboratory with resistive-type phase generator

Phase Generator Has Resistive Shifter

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SUMMARY —— Pair of sinusoidal signals are supplied over range from 20 cps to 20 kc with accurately known phase relation that is continuously adjustable over 360 deg. Phase-shifting network with linear wire-wound potentiometer is excited by quadrature voltage derived from modified phase-difference network. Phase calibration is linear with respect to dial rotation

SIGNAL SOURCES capable of supplying pairs of voltages with controlled and accurately known phase relations are useful in the investigation of phase-sensitive equipment.

Phase Shifting

The phase generator to be described supplies a pair of sinusoidal output signals having an accurately known phase relation that is continuously adjustable over a 360-deg range. The critical phase shifter network of the generator, shown in Fig. 1 and 2, uses a resistive phase shifter which is operable over the frequency range from 20 cps to 20 kc. It is excited by quadrature voltages derived from a modified phase difference network.

A signal of the desired frequency is applied simultaneously to a pair of phase-shift networks, each consisting of a cascaded arrangement of phase inverters and all-pass half-lattice sections. Within the design frequency range of the networks, output voltages E_1 and E_2 will be separated by approximately 90 deg. Voltages E_1 and E_2 are nearly equal in magnitude since only all-pass networks and degenerative phase inverters are involved in the networks. Therefore it is possible to obtain another pair of voltages almost 90 deg out of phase by taking the sum and difference of E_1 and E_2, as shown in the vector diagram of Fig. 1. The sum and difference voltages E_3 and E_4 are different in amplitude by an amount dependent upon the departure of the original phase angle from 90 deg.

Quadrature Voltages

Voltages E_3 and E_4 may be passed through opposed attenuators to restore the amplitude equality and applied to phase inverter stages to

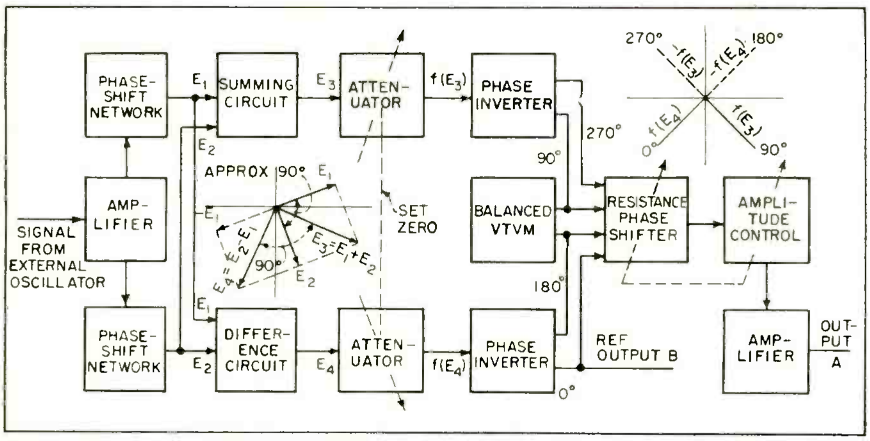

FIG. 1—Phase generator has resistive phase shifter excited by quadrature voltages. One output bears known phase relationship with one input

Table I—Resistive Phase Shifter Relationships

Mechanical Angle θ (deg)	Electrical Angle ϕ (deg)
0	0
5	4.96
10	9.96
15	14.97
20	19.99
25	25.01
30	30.01
35	35.02
40	40.01
45	45.00

produce a quadrature voltage system. A null detector or balanced vtvm provides for this adjustment. These quadrature voltages excite the phase shifter from which one output is derived bearing a known angle with respect to one of its input voltages.

A broad-band, resistive phase-shifter was developed for this system. It consists of a linear, 360 deg wire-wound potentiometer having taps brought out at precisely 90 deg intervals as shown in Fig. 3.

Disadvantages

When the potentiometer is fed with quadrature voltages, the output voltage can be varied in phase throughout the 360-deg range.

The nonlinear relation between electrical and mechanical phase angles and the change in amplitude of the output voltage as the control is rotated are disadvantages.

The first of these difficulties can be resolved by the method in-

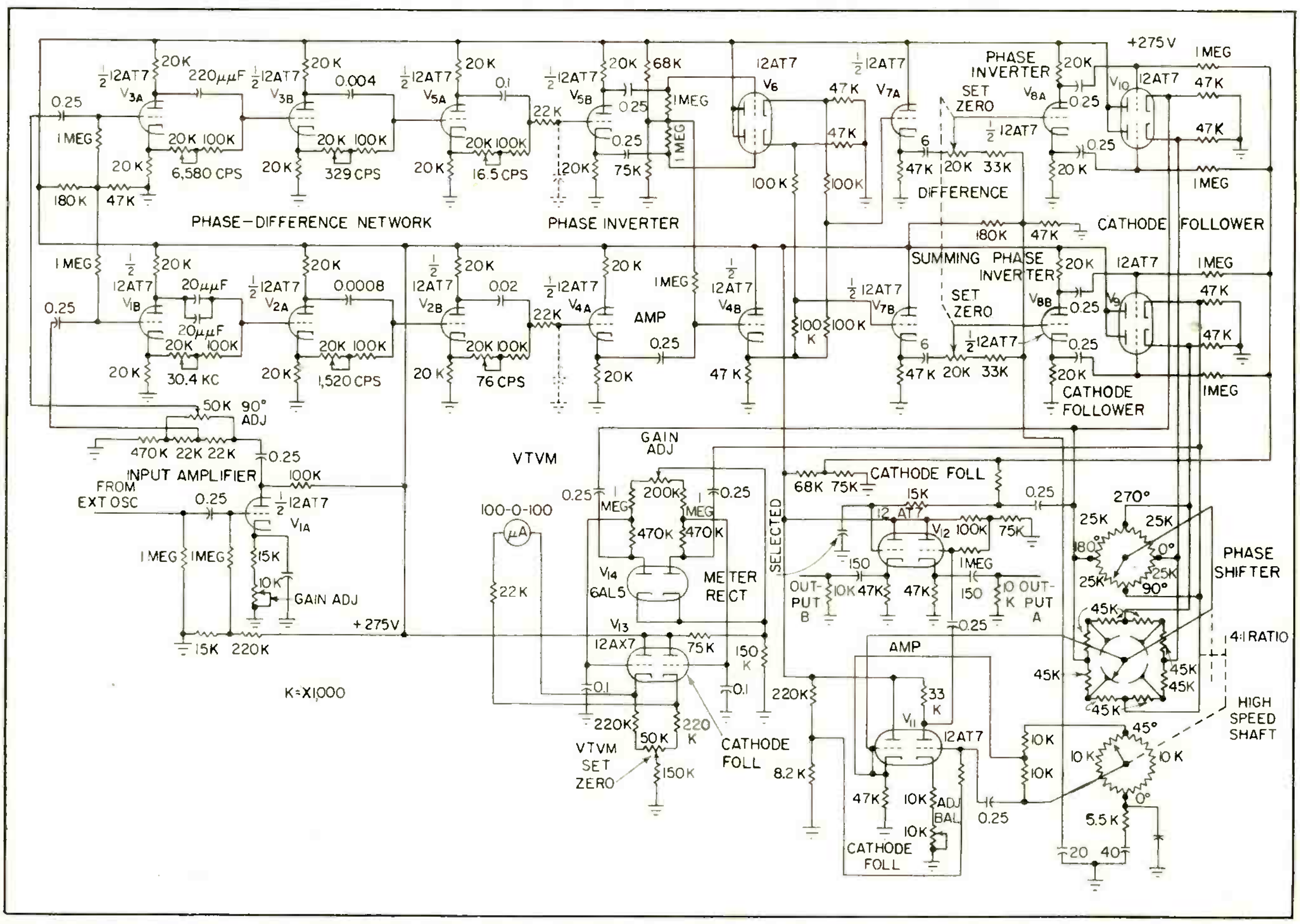

FIG. 2—Phase generator uses differential vtvm. Phase inverters for driving half-lattice phase-shift networks comprise the phase difference network

Table II—Amplitude Potentiometer Response

θ (deg)	$\frac{V_o}{V_o \max}$	$\left(\frac{V}{E}\right)\left(\frac{V_o}{V_o \max}\right)$
0	0.707	0.707
5	0.771	0.711
10	0.824	0.711
15	0.868	0.710
20	0.903	0.704
25	0.934	0.702
30	0.954	0.700
35	0.977	0.702
40	0.987	0.701
45	1.000	0.707

dicated in Fig. 4 for the first quadrant only.

Mechanical Nonlinearity

Resistor R_B is the phase-shifter winding resistance for the first quadrant and the two similar resistors R_A are connected between the ends of the winding and the rotor. Solution of the network for the relation between the mechanical angle θ and the electrical angle ϕ is

$$\phi = \tan^{-1}\left[\frac{R_B/R_A + 90°/(90° - \theta)}{R_B/R_A + 90°/\theta°}\right]$$

The value of R_B/R_A which allows the closest equalization of θ and ϕ values is 0.5523. Using this value, the computed relationship between ϕ and θ is shown in table I.

The relationship between ϕ and θ over the range from 45 to 90 deg is similar. For many purposes, the error in equality between θ and ϕ can be neglected.

Commutation

To provide a continuously variable phase shift over a 360-deg range, the R_A resistors must be reconnected to different quadrant taps as the potentiometer is rotated. Alternately, four pairs of resistors can be permanently connected to the 90-deg tap points and the wiper must be connected in sequence to the resistor taps as the shaft is rotated. The latter alternative is accomplished by incorporating a four-segment commutator carrying a wiper attached to the potentiometer shaft.

To keep the output voltage magnitude fixed with shaft rotation a second linear potentiometer is used in the network shown in Fig. 5.

One complete rotation of the potentiometer in this amplitude potentiometer network will correct the amplitude response of one quadrant of the phase-shift potentiometer. The amplitude potentiometer is therefore driven through a four-to-one gear ratio from the phase potentiometer shaft. The amplitude response, measured as the ratio of output voltage to maximum output voltage for a constant input versus shaft rotation of the phase-shift potentiometer, is shown together with the product of the two response functions in Table II. The product of the response functions indicates the flatness of the overall response.

Packaging

The phase-shifting and amplitude-correcting potentiometers together with the necessary commutator and gear train are enclosed in a single compact case. The phase-potentiometer shaft is brought out to the main dial calibrated directly in phase angle and the amplitude potentiometer shaft is brought out in concentric fashion to provide a vernier control.

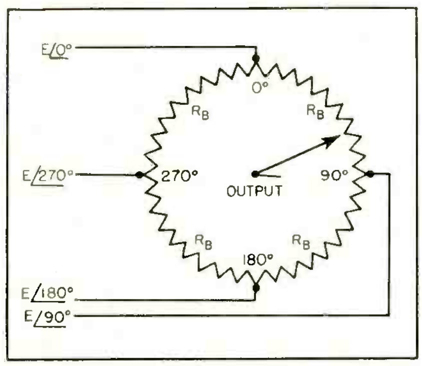

FIG. 3—Resistive phase-shifter is wire-wound potentiometer with taps at 90-deg intervals

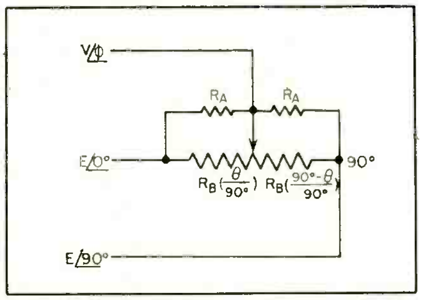

FIG. 4—Nonlinearity between electrical and mechanical angles is minimized by selecting proper R_B/R_A ratio

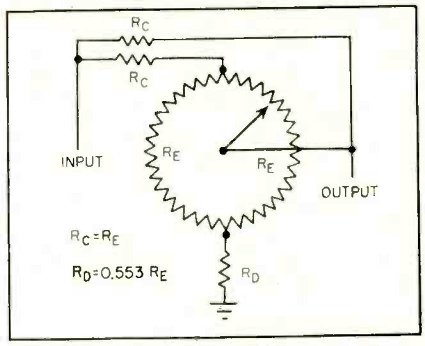

FIG. 5—Potentiometer corrects the amplitude response of one quadrant of phase-shift potentiometer

The overall voltage ratio between output voltage from the amplitude potentiometer and one of the quadrature voltages applied to the phase-shift potentiometer is 0.48. This ratio neglects the voltage loss in a conventional cathode follower used to couple the two potentiometers. The single-stage low-gain amplifier shown in Fig. 2 restores the output voltage level to that of the unshifted channel.

Use

A signal of the proper frequency derived from any convenient source is applied to the input terminals of the generator and the attenuator set for equal amplitudes as indicated by the balanced vtvm. A single dial allows adjustment of the phase angle difference between outputs.

The accuracy of the phase setting depends primarily upon the linearity of the wire-wound phase-shift potentiometer. Accuracies of the order of ±0.5 deg are feasible.

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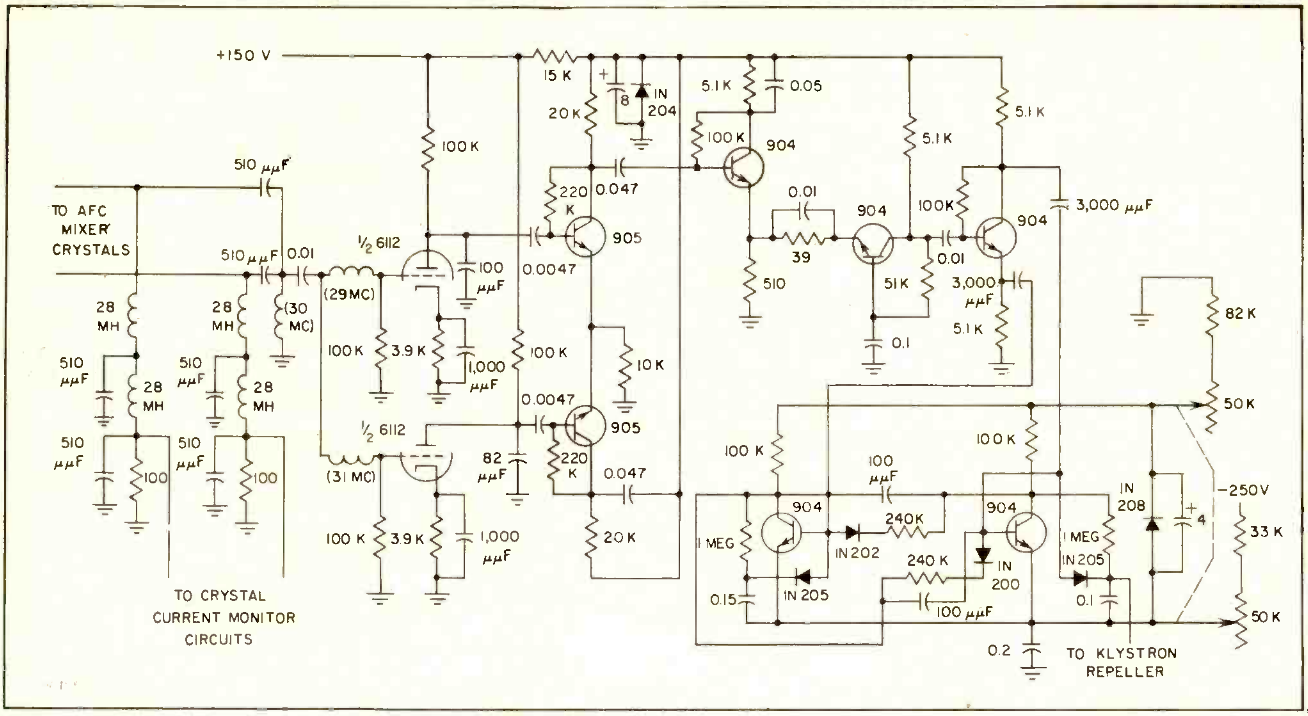


FIG. 1—Schematic of complete afc circuit. Unit has transistors and diodes throughout except for vacuum-tube discriminator stage

Transistorized AFC Uses

SUMMARY —— Miniaturized plug-in unit for radar uses transistor multivibrator with Zener diodes. Search sweep varies local oscillator klytron repeller voltage, holding 30-mc i-f to bandwidth of 200 kc. Vacuum-tube discriminator feeds three-stage video amplifier triggering sweep generator. Low-voltage, low-power components afford greater reliability at less than half the power consumption of conventional vacuum-tube sawtooth systems

RADARS require afc systems to hold the difference frequency between the local oscillator klystron and the magnetron to the frequency of the i-f amplifier. Magnetron frequency variation may be due to pulling effects of scanning, while both magnetron and klystron frequencies will shift with power supply and temperature variations. The receiver bandwidth must pass the signal even if the magnetron frequency shifts. But, since the receiver performance is lowered as the bandwidth increases, the afc must hold the local oscillator to close limits, usually about 200 kc for a 30-mc i-f.

In the typical afc system, a small portion of the magnetron output is combined with the local oscillator output in a crystal mixer. The difference frequency is detected by a discriminator circuit. The detected signal passes through a differential amplifier and triggers a monostable multivibrator, which in turn stops the search sweep and thereafter corrects the local oscillator frequency at the repetition rate. A conventional afc unit consumes 10 to 20 watts in these functions.

Afc With Transistors

The semi-transistorized afc of Fig. 1 employs vacuum-tube detection because the low alpha cutoff of present silicon transistors yields a detected signal too greatly attenuated for practical use. The outputs of the two detectors feed the base of an emitter-coupled differential amplifier using two silicon transistors.

Output is taken from one collector to invert the signal from one detector and produce an S-type discriminator curve. The signal is fed to a three-stage video amplifier, using silicon junction transistors, whose output triggers a sweep generator. A common-collector stage matches the high impedance of the differential amplifier collector cir-

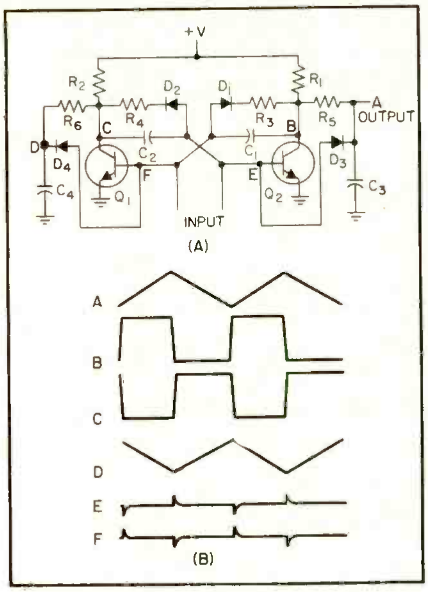
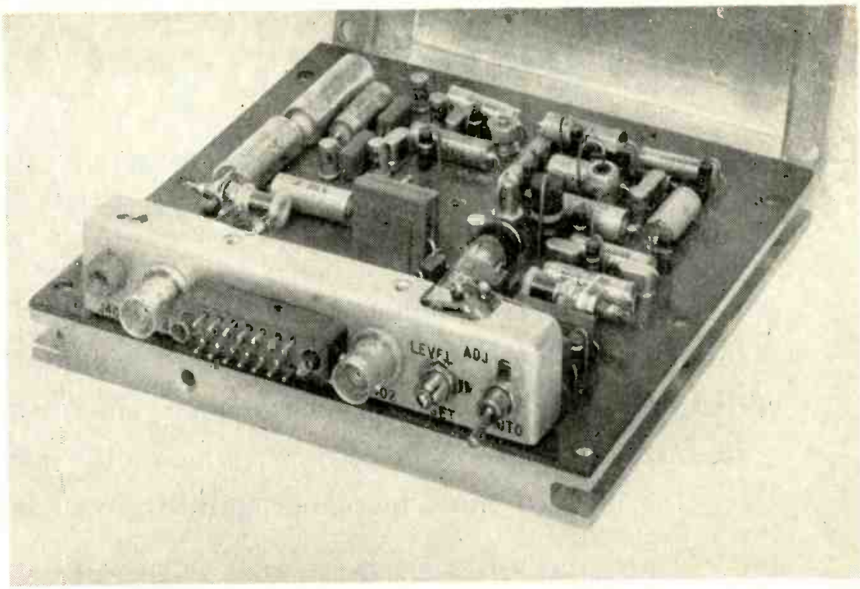


FIG. 2—Flip-flop circuit and waveforms



End-on mounting of some components is employed in plug-in unit

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Triangular Search Sweep

cuit to the low impedance of the second video stage which has a common-base connection.

The output of this stage couples to the sweep generator through a split-load phase inverter. Manual adjustment of the repeller voltage is by the dual potentiometer. A range of about 55 volts insures full coverage of the klystron power mode. The sweep circuit and divider network draw less than 2 ma.

Basic Sweep Circuit

The sweep circuit of Fig. 2A comprises two transistors and four silicon diodes operating in the Zener region. Diode D_1 has a lower Zener voltage than D_2 and the current through R_1, R_3 and D_1 saturates Q_1, making point C only a few volts above ground.

Transistor Q_2 remains cut off, while point B is at a high potential and C_3 charges through R_1 and R_5 until point A reaches the Zener voltage of D_3.

The current through D_3 then passes through the base of Q_2 to produce an amplified negative signal at point B. This signal is fed through C_1 and amplified by Q_1. The positive signal which appears at point C is then coupled back into Q_2. The signal regenerates until the potential at C reaches the Zener rating of D_2, thus locking the circuit with Q_2 saturated, point B a few volts above ground and Q_1 cut off.

Point C is now at high potential and C_4 charges through R_2 and R_6 until the Zener rating of D_4 is exceeded. Capacitor C_3 is simultaneously discharging through R_5 and Q_2 which is held in saturation. When the Zener rating of D_4 is exceeded the multivibrator will exchange status with C_4, discharging while C_3 recharges.

The resulting triangular waveform is applied to the repeller of the local oscillator until a change in discriminator output is effected. This change in polarity is fed to the video amplifier and then to the correct base to stop the search sweep. As the charge on C_3 leaks off, the repeller voltage changes and the resulting frequency shift is detected at the next pulse of the magnetron.

The sweep may be stopped at any point on the triangular search pattern. The range is set by the Zener diodes D_3 and D_4. The response of network R_5 and C_3 at the repetition rate is such that the voltage swing at C_3 represents about a 200-kc change of the klystron frequency. The search sweep is therefore disconnected and the klystron is shifted only enough to see-saw across the i-f. between repetition rate pulses. This results in a lock-on saw-tooth sweep of about 0.2 volt p-p, which is well within the bandwidth of the receiver.

The loop is degenerative and tight enough to prevent false triggering due to stray radiation. The entire system uses approximately six watts. Assembled unit is less than 6 in. square, 2.5 in. high. Greater reliability and subminiaturization are therefore achieved through the use of low-power components with semiconducting devices.

Designing Oscillators

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SUMMARY — Frequency stability of oscillator types that can be divided into an amplifier and a feedback network is improved by design procedure that permits selection of proper geometry and elements of frequency-controlling network. Examples of oscillator circuits using transistors and designed by this method show increased stability by as much as a factor of 25

PAST APPROACHES in the design of vacuum tube and transistor oscillators have had as the principal object improved frequency and amplitude stability and/or greater output amplitude. The purpose of this article is to show how the frequency stability of most oscillators can be improved after a general oscillator type has been chosen. This method also provides for minimum harmonic distortion in the oscillator output.

This design procedure is applicable only to oscillator types which can be divided into two sections, an amplifier and a feedback network.

Stability Factors

For an oscillator with low distortion, two primary factors affect the ultimate frequency stability. The first is the change in phase shift in the amplifier portion of the oscillator when external parameters such as voltage and temperature are changed. The second is the frequency change required for equal and opposite phase shift change in feedback loop. These factors are interrelated because the total oscillator loop phase shift must be zero.

The block diagram of a feedback oscillator is shown in Fig. 1A. The amplifier is considered as its equivalent Thevenin generator with voltage $K\epsilon \angle \theta$ in series with a resistance, r_o, where r_o is considered a part of the feedback network. The input impedance of the amplifier is infinite since any reactive component may be canceled at any one frequency and voltage. The resistive component may be included as a part of R. Phase angle θ is a function of all external parameters such as temperature and voltage. It is assumed that θ has been made zero for the normal static condition of the external parameters. Constant K is a real, positive constant so no distortion of the waveform occurs.

Amplitude Limiting

If the frequency-controlling network is linear, the oscillator output will be a pure sinusoidal waveform. In most actual oscillators some distortion must occur so that amplitude limiting will result. However, by careful selecting the gain k of the feedback network this distortion can be kept small so the assumption of no distortion will be substantially correct.

The primary factors affecting stability now becomes $\phi(f)$ and $\theta(s)$ where s is a general external parameter affecting the amplifier phase shift and $\phi(f)$ is the phase angle of the feedback network as a function of frequency. The objectives are to make $d\theta/ds$ as small and $d\theta/df$ as large as possible.

Several methods are well known for reducing $d\theta/ds$, thus, it is assumed that $d\theta/ds$ for the amplifier has already been made as small as possible.

Phase Angle

The factors influencing $\phi(f)$ are the geometry and element values of the frequency-controlling network. The choice of network geometry is limited only by practical values of K and r_o. For most amplifiers, r_o is much too large for use with practical feedback networks. Therefore, the use of transformers or coupling coils is usually necessary to obtain the desired impedances. If the values of K and r_o for the amplifier alone are compared with the values for the amplifier with the transformer, the quantity K^2/r_o will be found to remain constant. This is shown in Fig. 1B where K' and r_o' are the characteristics of the amplifier without the transformer. Either K or r_o may be selected for best performance with any particufor feedback network, however, K^2/r_o must be held constant.

For a practical transformer-cou-

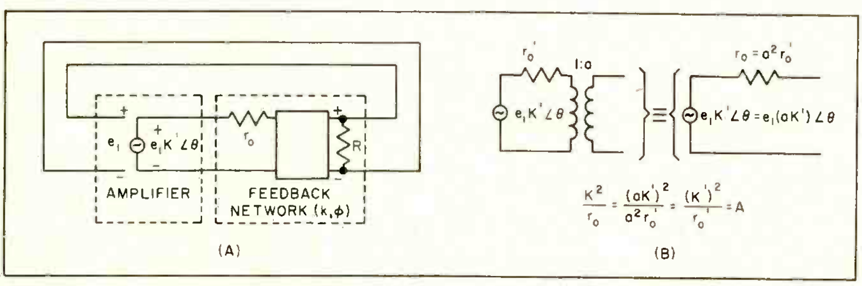

FIG. 1—Equivalennt Thevenin circuit of feedback oscillator (A) is modied in (B) to show that the quantity K^2/r_o remains constant

For Greater Stability

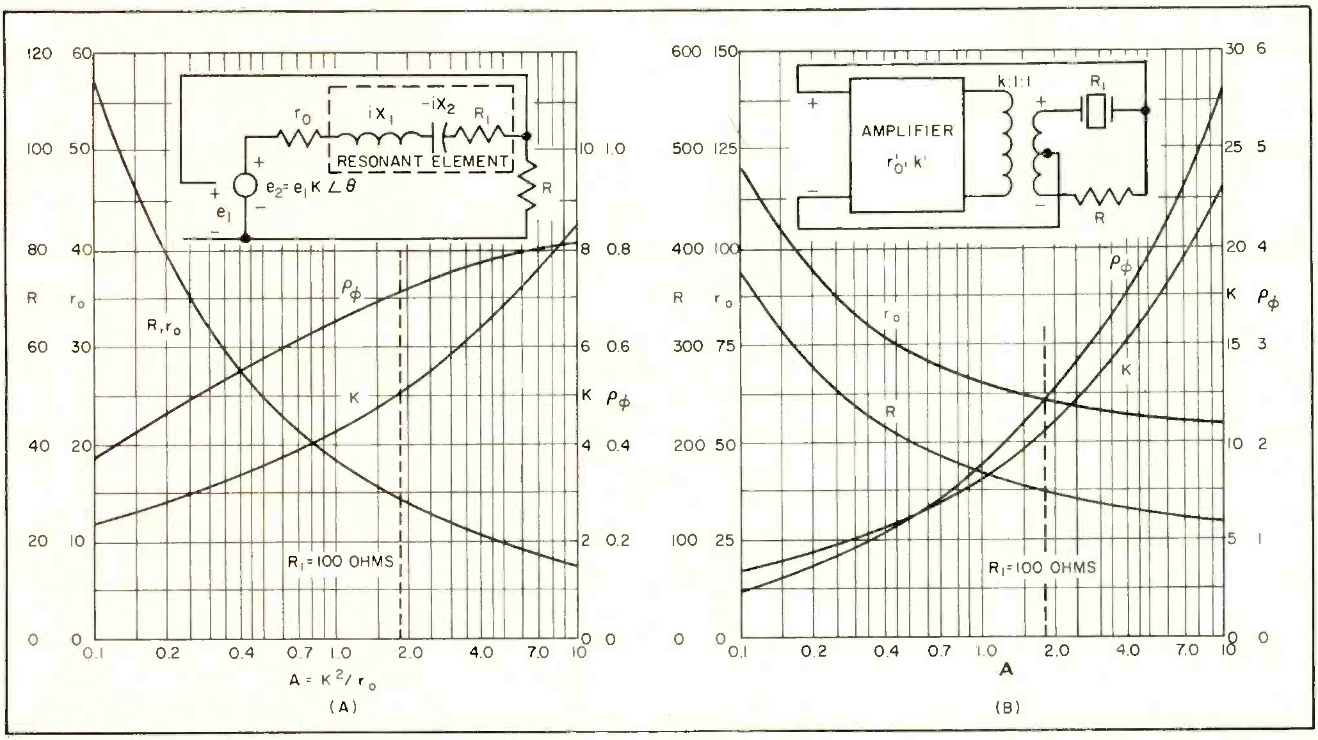

FIG. 2—Curves show the variation of circuit parameters for two different network configurations. Circuit and curves at right show what happens when the effective crystal Q is greater than its actual measured value

pled amplifier the transformer loss and phase shift should be included as part of the characteristics, $K \angle \theta$ and r_o. This is accomplished by measuring the amplifier characteristics with a representative transformer in use. The amplifier and transformer combination are then completely characterized in terms of $\theta(s)$ and $K^2/r_o = A$ = four times the available power output of the amplifier for one-volt input. Once A is known, the remaining problems are the selection of a frequency-controlling network configuration and the optimization of this network for best stability.

Network Selection

To optimize network values, consider the network shown in Fig. 2A. Here, the resonant element may be a series resonant L-C circuit or more appropriately, a quartz crystal. Any infinite amplifier input resistance may be considered as part of R. Amplifier parameters $K \angle \theta$ and r_o are both variable with the restriction that K^2/r_o is a constant.

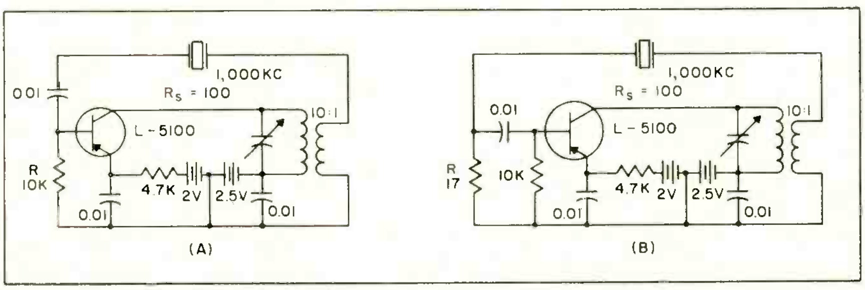

FIG. 3—Standard oscillator using surface-barrier transistor (A) has an instability of 100 parts in 10^9. Circuit in (B), designed for impedance match between input and output of transistor, has stability of 13 parts in 10^9.

For this network

$$jX = jX_1 - jX_2 \qquad (1)$$

Then,

$$e_1/e_2 = k \angle \theta = k \angle \tan^{-1} - X/(R + r_o + R_1) \qquad (2)$$

Equation 2 shows that near series resonance $d\phi/df$ increases as $(R + r_o)$ decreases. The object is to find the minimum value of $(R + r_o)$ that will permit oscillations thus making $d\theta/df$ as large as possible.

For $X = 0$,

$$R = (r_o + R_1)/(r_o^{1/2} A^{1/2} - 1) \qquad (3)$$

from which

$$R + r_o = [(r_o + R_1)/(r_o^{1/2} A^{1/2} - 1)] + r_o. \qquad (4)$$

The quantity r_o may be selected to make $(R + r_o)$ minimum by differentiating Eq. 4 with respect to r_o. Thus $(R + r_o)$ is minimum when

$$2r_o^{3/2} A^{1/2} - 3r_o - R_1 = 0. \qquad (5)$$

By substituting R_1 as determined from the resonant element chosen for the oscillator and A as determined by the amplifier into Eq. 5, r_o can be found. The curves of Fig. 2A show the variation of r_o with A as aparameter and with R_1 constant at 100 ohms. For each value of r_o and A constant K is determined from $K^2/r_o = A$. Resistance R is found from Eq. 3. The variations of K and R for R_1 = 100 ohms are also shown in Fig. 2A.

If r_o and R could both be made

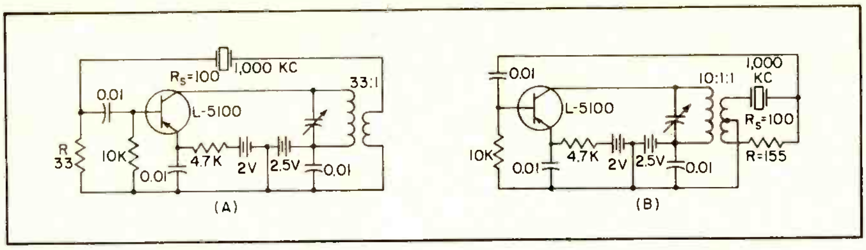

FIG. 4—Circuit in (A), designed from curves in Fig. 2A has instability of 8 parts in 10^9 while that in (B), designed from curves in Fig. 2B, has stability of 4 parts in 10^9

zero and still maintain oscillations, the change in frequency for a small amplifier phase shift, $\Delta\theta$, would be:

$$\Delta f = (\Delta\theta)\,(f_o)/2Q \qquad (6)$$

where Q is X_1/R_1 and f_o is $1/(2\pi\sqrt{LC})$ for the resonant element. For values of r_o and R other than zero, Eq. 6 must be modified by making Q equal to $X_1/(R_1 + R + r_o)$. The relative change in frequency for a practical circuit compared to the change for an unloaded resonant circuit for the same $\Delta\theta$ is

$$\rho_\phi = R_1/(R + r_o + R_1) \qquad (7)$$

Thus, ρ_ϕ is a figure of merit for the network. If the values of ρ_ϕ are compared for two different networks, then the relative stabilities, $(S_v)_1$ and $(S_v)_2$, of oscillators using the two networks can be determined since

$$(S_v)_1/(S_v)_2 = (\rho_\phi)_1/(\rho_\phi)_2 \qquad (8)$$

where the same amplifier and resonant element are used. Equation 7 expresses ρ_ϕ only for the network of Fig. 2A. For other networks, a similar expression for ρ_ϕ is needed.

Practical Circuit

To design a practical circuit to use the network of Fig. 2A, a suitable amplifier is first chosen. Parameter A is found experimentally. A suitable resonant element is chosen (crystal, series L-C circuit, or other). Resistor R_1 is determined from the resonant element. The correct value of r_o is then found from Eq. 5 and resistance R can then be found from Eq. 3. Reactance X as a function of frequency can be calculated for the resonant element. Then, ϕ as a function of frequency can be found from Eq. 2. If the amplifier phase shift θ is known as a function of voltage or temperature, then the frequency of oscillation as a function of voltage can be found by making ϕ equal to $-\theta$ for all voltages.

This method yields a theoretical stability which may be slightly better than can be obtained in a practical circuit since distortion has been neglected and R generally cannot be made as small as the value calculated in Eq. 3. If R is made exactly equal to the minimum value, when a phase shift occurs R may no longer be large enough to permit sustained oscillations.

Improvement in stability obtained by externally unloading the crystal R is found by first substituting the amplifier input resistance into Eq. 2 and calculating the stability then substituting R (minimum) into Eq. 2 and again calculating the stability. The ratio of the two stabilities is the improvement due to proper selection of R.

Network Configuration

This method is also valuable as a tool in choosing the constants for any particular feedback network.

It is possible with some networks for ρ_ϕ to be greater than unity, that is, the effective crystal Q is greater than its actual measured value. For example, the equations for the network shown in Fig. 2B are

$$K = 1 + \sqrt{1 + R_1A/2}, \qquad (9)$$

$$R = [4K^2 + R_1A(K+1)]/A(K-1) \qquad (10)$$

and

$$\rho_\phi = 200(R + 2r_o)/[(R - R_1)(R + R_1 + 4r_o) - 1] \qquad (11)$$

The curves of Fig. 2B show the variations of R, K, r_o and ρ_ϕ for values of A from 0.1 to 10. Resistance R_1 is again chosen as 100 ohms. In designing oscillators the curves of Fig. 2B are used in the same way as the curves of **Fig. 2A**.

The importance of R_1 is not directly indicated by the equations for either network described. However, it can be shown that when the inductance and capacitance of the resonator remain unchanged, the frequency stability is increased as R_1 is decreased. For example, using Eq. 9, 10 and 11 and a typical value for A of 2 results in values for $R_1 = 1000$ ohms, $\rho_\phi = 0.795$, for $R_1 = 100$ ohms, $\rho_\phi = 2.5$ and for $R_1 = 10$ ohms, $\rho_\phi = 7.1$.

When a quartz crystal is used as the resonator with the circuit of Fig. 2B an effective Q greater than that of the crystal alone can usually be expected. With the circuit of Fig. 2A, ρ_ϕ can never exceed unity, that is, no Q multiplcation can occur.

Figure 2B makes no provision for the inclusion of a finite input impedance to the amplifier. For this condition, equations 9, 10, and 11 must be modified. Thus it is possible that the network of Fig. 2A might yield greater stability for a given amplifier and resonator.

Examples

A total of four transistor oscillators were constructed to illustrate this design procedure. An L-5100 surface barrier transistor was chosen for the amplifier because of its low power requirements and relatively high alpha cutoff frequency. The oscillator shown in Fig. 3A received no special design considerations. The component values were selected empirically and the selections were then modified as necessary to obtain oscillation.

The circuit shown in Fig. 3B was designed on the basis of an impedance match between the output and input terminals of the transistor. The only change in Fig. 3A required for this design was to replace R with a 17-ohm resistor.

The circuit in Fig. 4A was designed from the curves of Fig. 2. This required a change in the transformer turns ratio and also in the crystal terminating resistor as shown. The circuit shown in Fig. 4B was patterned after the block diagram in Fig. 2 and was designed using the curves of that figure The instability characteristics of the oscillators were 100, 13, 8, and 4 parts in 10^9 frequency change for a one percent collector supply voltage change for the circuits of Fig. 3A, 3B, 4A and Fig. 4B respectively.

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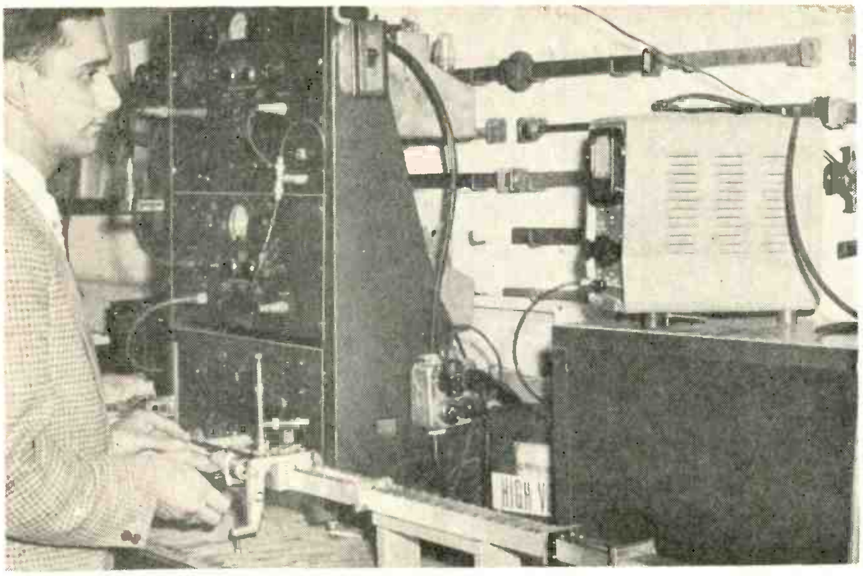
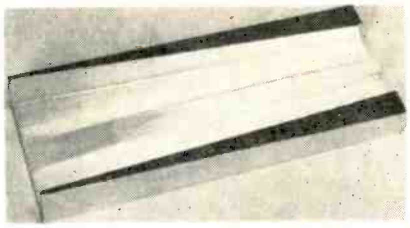
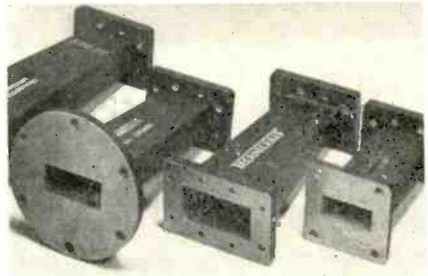


Setup at Technicraft Laboratories for proving transition performance



Internal machining of cutaway section



Typical graphically-designed transitions

Designing Tapered Waveguide Transitions

By BERNARD J. MIGLIARO*
Director of Engineering
Microtech Inc.
Hamden, Connecticut

SUMMARY — A procedure for designing well-matched transitions between different waveguides where the guide wavelength varies along the taper. Simple graphical method employs data presented here for double-ridge-to-rectangular transitions. Procedure may also be used for rectangular-to-rectangular or ridge-to-ridge tapered transitions with corresponding accuracy

MUCH HAS BEEN WRITTEN about tapered transitions between different types of transmission lines, but the common problem of designing a reasonably-matched tapered transition between waveguides in which the guide wavelength varies along the taper has not been extensively covered. This problem occurs in almost all types of tapered transitions between different waveguides. This article deals in particular with the design of transitions between various types of standard rectangular waveguides and double-ridge waveguides.[1, 2, 3, 4]

To provide a smooth transformation from one impedance to another various types of tapers are employed. Three of the most common are exponential,[5] gaussian[3, 5] and more recently a taper which is the limiting case of an infinite number of quarter-wave transformers.[6] All of these methods give reasonably-matched transitions provided the characteristic impedances of the transmission lines remain constant with frequency. But this is not true with waveguides except in the special case of a transition between rectangular units which have different narrow dimensions.

At any fixed frequency a taper can be designed using any desired variation of impedance along its length. If a taper is designed for optimum length and has a particular desired impedance variation along its length at the lowest operating frequency, as the frequency is moved toward the higher end of the operating band the originally-designed impedance condition will no longer exist.

At the same time, however, the

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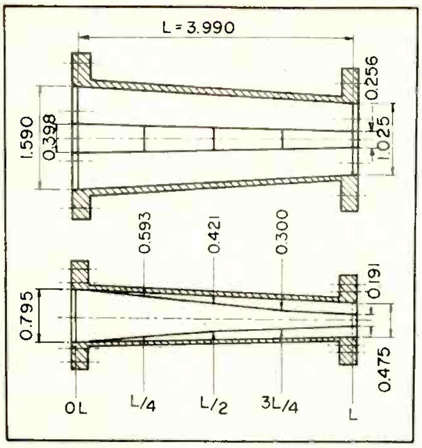

FIG. 1—Cross section of tapered transition from WR-159 rectangular to D-19 double-ridged guides

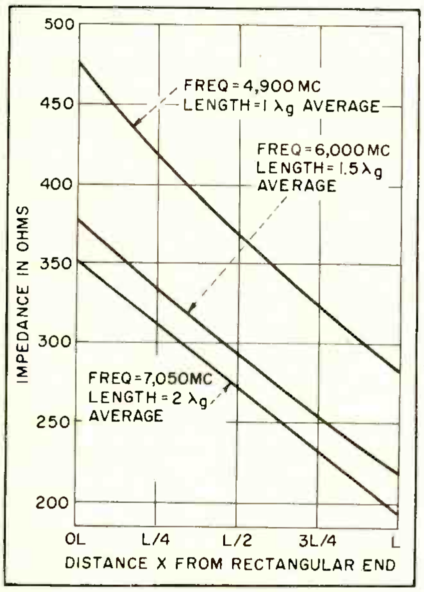

FIG. 2—Impedance characteristics of transition of Fig. 1, with exponential impedance taper at 4,900 mc

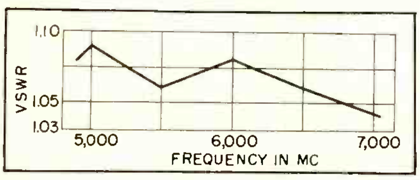

FIG. 3—The vswr characteristics of transsition of Fig. 1

electrical length of the transition grows increasingly longer, making an optimum impedance variation along the taper much less important. These two effects tend to cancel each other, resulting in a transition which is electrically good over a wide band of frequencies.

Double-ridge Transition

This is illustrated by Fig. 2 and 3 for a transition between rectangular and double-ridge waveguides

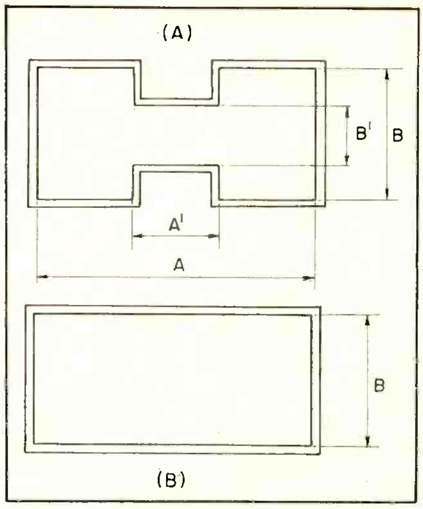

FIG. 4—Four double-ridge dimensions and two rectangular dimensions are employed in calculations

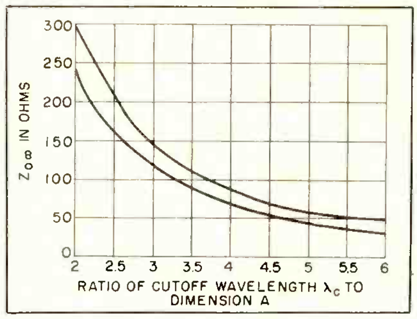

FIG. 5—Impedance variation of double-ridge guide with cutoff wavelength and dimension A for two values of B/A. In each case A'/A equals 0.25

shown in Fig. 1. Using this principle a procedure has been devised wherein transitions between double-ridge and rectangular waveguides can be designed quite simply with the aid of several graphs.

Characteristic Impedance

In the waveguide types shown in Fig. 4

$Z_o = Z_{o\,\text{infin}} (\lambda_G/\lambda_o)$ and $\lambda_G = \lambda_o/\sqrt{1 - (\lambda_o/\lambda_c)^2}$

wherein Z_o is the characteristic impedance at any frequency; $Z_{o\,\text{infin}}$ is the ratio of voltage across waveguide center to total longitudinal current on top face at infinite frequency; λ_G is the guide wavelength; λ_o, the free-space wavelength, and λ_c the cutoff wavelength.

The characteristic impedance of the double-ridge waveguide is a function of B/A, A'/A, B'/B and the operating frequency. The cutoff wavelength is a function of B/A, A'/A, B'/B as well as the A dimension. The characteristic impedance of the rectangular waveguide is only a function of B/A and the operating frequency, and of course the cutoff wavelength is equal to $2A$. The curves of Fig. 5, 6 and 7 are all for a double-ridge waveguide with A'/A equal to 0.25. The rectangular waveguide is considered to be a double-ridge waveguide with B'/B equal to one.

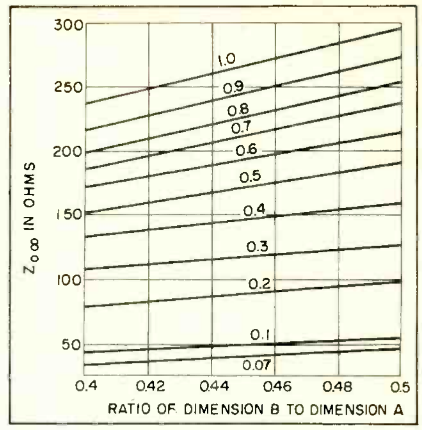

FIG. 6—Impedance variation of double-ridge guide with B/A. Figures on curves denote B'/B ratio

Design Procedure

In the following procedure an exponential impedance taper was chosen, but the same method can be employed as well with any other type. For mechanical simplicity all dimensions except B' are linearly tapered mechanically from one guide to the other and the B' dimension is adjusted to provide the exponential impedance taper. Using the formulas given and the curves of Fig. 5, 6 and 7, Z_o and λ_G are found for both the double-ridge and rectangular waveguides at the lowest operating frequency. In order to plot the correct mechanical taper for B' this dimension must be found for at least several points along the taper. Finding this dimension at L, $3L/4$, $L/2$, $L/4$ and $0L$ is usually sufficient, although a greater number of points can be used if desired.

In the case of an exponential taper

$\ln Z_{ox} = \ln Z_{o1} + x/L\,(\ln Z_{o2} - \ln Z_{o1})$

wherein $\ln Z_{ox}$ is the natural log of the impedance at any distance x from the rectangular end of the transition; Z_{o1} is the characteristic impedance of the rectangular waveguide; Z_{o2} is the characteristic impedance of the ridge waveguide and

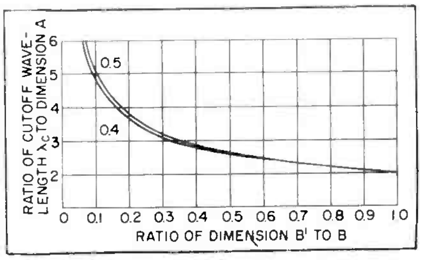

FIG. 7—Variation of cutoff-to-*A* ratio with *B'/B*. Figures on curves denote *B/A* when *A'/A* is 0.25

L is the overall length of the transition.

Using the values of Z_o obtained from this equation, $Z_{o\ \mathrm{infin}}$ is computed for various assumed values of λ_c/A for each of the chosen points along the length of the taper. $Z_{o\ \mathrm{infin}}$ is given by the formula

$$Z_{o\ \mathrm{infin}} = Z_o\ (\lambda_o/\lambda_g)$$

Curves are plotted of $Z_{o\ \mathrm{infin}}$ against λ_c/A for each of the chosen points using the same scales as used in Fig. 5 and the curves superimposed on Fig. 5. The points of intersection between these curves and the curve of $Z_{o\ \mathrm{infin}}$ against λ_c/A for the proper B/A ratio gives the correct values of λ_c/A and $Z_{o\ \mathrm{infin}}$ for each of the chosen points along the taper. Having found λ_c/A, λ_g for each point can be computed, and by using Fig. 7 the various values of B' can be found.

Mechanical Taper

Curves are then plotted of B' against x and λ_g against x. The first curve shows the mechanical taper for the B' dimension. In the actual machining this can be approximated by means of several straight lines. The curve of λ_g against x is graphically integrated and an average value of λ_g is obtained.

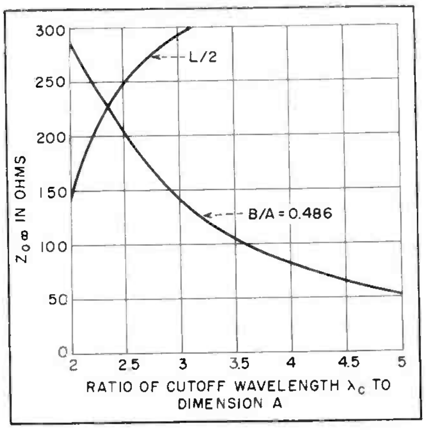

FIG. 9—Intersection of curve calculated for *L*/2 with that for *B/A* obtained from Fig. 2 shows 227 ohms impedance with cutoff-to-*A* ratio of 2.34

The length of the transition can be any integral number of half average wavelengths. A transition one average wavelength long is a reasonable compromise between convenient length and electrical performance.

WR-159 to D-19 Transition

Suppose it is desired to design a transition from WR-159 rectangular waveguide to D-19 double-ridge waveguide. The lowest operating frequency is 4,900 mc and the highest operating frequency is 7,050 mc. A table is constructed showing the parameters for various values of x as in Fig. 8. Figure 9 shows the manner in which the applicable values for $Z_{o\ \mathrm{infin}}$ and λ_c/A can be determined. It is a plot of $Z_{o\ \mathrm{infin}}$ for various assumed values of λ_c/A when $x = L/2$. The point of intersection with the λ_c/A against $Z_{o\ \mathrm{infin}}$ curve for $B/A = 0.486$ from Fig. 5 gives the correct values of λ_c/A and $Z_{o\ \mathrm{infin}}$ for $L/2$.

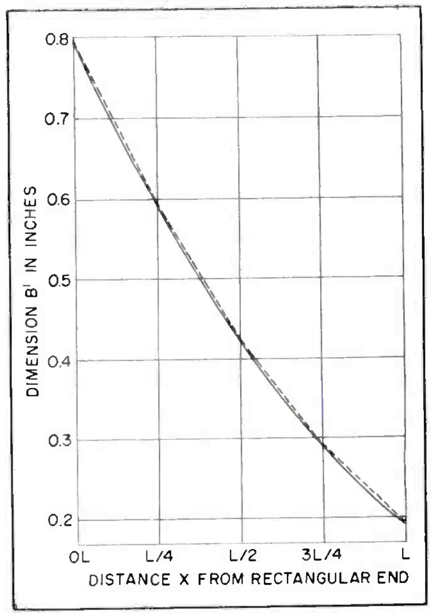

FIG. 10—Transition dimensions for exponential impedance taper at 4,900 mc. Curve is closely approximated by four broken straight lines shown

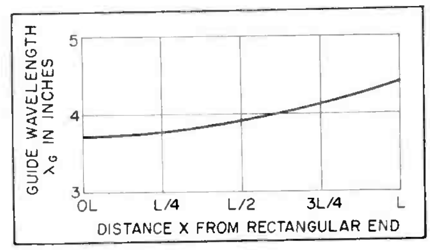

FIG. 11—Wavelength curve is graphically integrated and an average found, here 3.99 in. at 4,900 mc

Figure 10 is a plot of B' against x showing the approximation of the curve using four straight lines. Figure 11 is a plot of λ_g against x which is used for the graphical integration and gives an average λ_g of 3.99 in. at the lowest operating frequency. The actual length of the taper was made one average guide wavelength long.

		WR-159 END				D-19 END
		OL	L/4	L/2	3L/4	L
I	A IN. B IN. B/A A'/A	1.590 0.795 0.500 0.25	1.449 0.715 0.494 0.25	1.308 0.635 0.486 0.25	1.167 0.555 0.476 0.25	1.025 0.475 0.464 0.25
II	Z_o OHMS AT 4,900 MC ln Z_o	477 6.17	418 6.04	370 5.91	323 5.78	284 5.65
III	λ_c/A	2.00	2.20	2.34	2.54	2.72
IV	λ_c IN. λ_g IN.	3.180 3.70	3.140 3.76	3.060 3.92	2.960 4.16	2.780 4.40
V	$Z_{o\infty}$ OHMS	297	258	227	189	155
VI	B'/B	1	0.830	0.663	0.541	0.442
VII	B' IN.	0.795	0.593	0.421	0.300	0.191

FIG. 8—Typical table constructed for transition shown in Fig. 1. Data in group I is for a linear mechanical taper while that in group II is for an exponential impedance taper. Data in group III is derived from Fig. 5 and 7 and provides basis for computation of values in group IV. Values in group V are taken from Fig. 5 and those in group VI from Fig. 6. Group VII data is computed from groups I and VI

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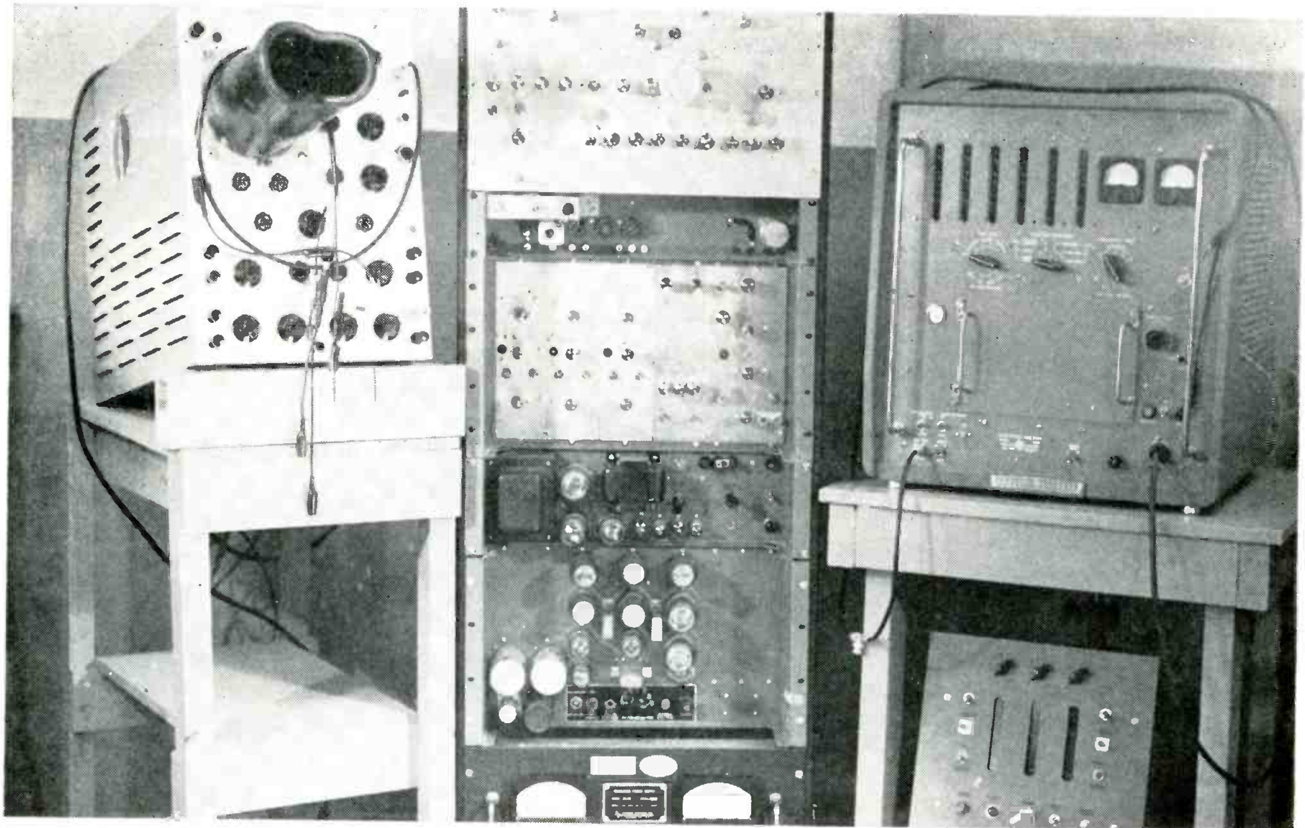

Setup used to test binary-decimal counter shown in rack at center. Ten-megacycle pulse-burst generator is at top of rack

Binary-Decimal Counter

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MANY DECADE COUNTERS employ direct feedback schemes but the use of *and* gates provides feedback with isolation as well. The binary-decimal counter to be described produces one output pulse for every ten input pulses.

Code

Any number of input pulses that is not a multiple of ten will be stored in the counter binaries until the binary is reset. This counter is different from many decade counters since it makes use of the binary decimal 8, 4, 2, 1 code which is convenient, simple, and most compatible with many readout devices currently used with digital machines.

The counter detects bursts of pulses of any pulse-burst width over a frequency range of 5 to 10 mc.

Logic

The block diagram of Fig. 1 shows that the counter would be similar to an ordinary binary counter with a scale of 16, except for the introduction of *and* gates *A* and *B* and a flip-flop in the last stage. The two *and* gates control the scheme of counting and effectively isolate the first binary from the second binary and flip-flop.

Before the arrival of any input pulses, the flip-flop is in the zero state; hence one input of *and* gate *A* is high and the other input from the first binary is low. After two pulses are fed into the first binary, it generates one pulse which can pass through *and* gate *A* to the second binary. As yet no pulses can pass through *and* gate *B*, since the one state of the flip-flop is low.

Three more pulses are passed by *and* gate *A*, indicating an input to the counter of eight pulses. The flip-flop is now set to the one state by a pulse from the third binary, enabling *and* gate *B* to pass signals, but blocking *and* gate *A*.

Output Signal

After two more input pulses, or at the count of ten, *and* gate *B* generates a pulse that is the output signal of the counter. This pulse

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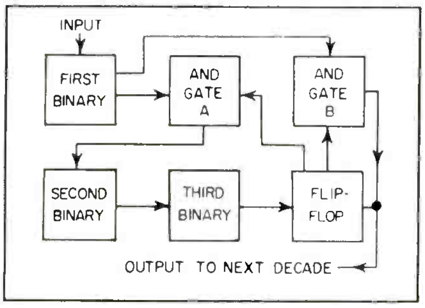
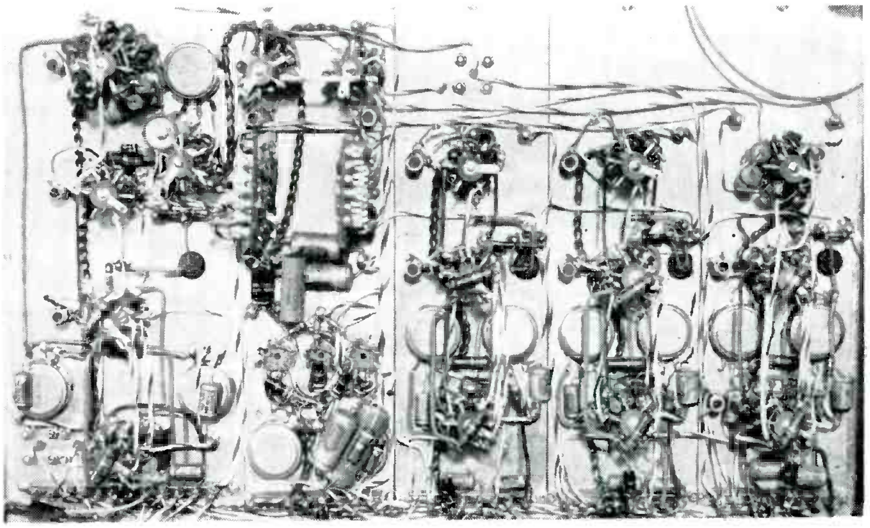


FIG. 1—Block diagram of counter. Use of *and* gates coupled with elimination of direct feedback makes high-frequency operation possible



Wiring side of counter shows, from left to right, first binary, *and* gates, second and third binaries and flip-flop

SUMMARY — Conversion from binary to binary-decimal form to facilitate application of computer output to readout device is made by counter using logical *and* gates in feedback loop. Design techniques, including use of isolation diodes, low plate voltage and grid-signal clamping, result in a rise time of 0.05 microsecond for the first binary circuit

Operates at 10 Mc

also resets the flip-flop to the zero state in readiness for the next cycle. Use of the *and* gates means that the resolution time of the rest of the counter is required to be only half as good as that of the first binary.[2] Also, the elimination of direct feedback and isolation by *and* gates permits operation at higher frequencies.

Counter Circuit

Figure 2 is the circuit diagram for the 10-mc binary decimal counter. The binaries and flip-flop of this counter use the basic Eccles-Jordan circuit with several refinements that contribute to better recovery time for the binary. It was desired to build a binary which would recover in 0.05 microsecond.

One refinement involves the use of a T-5 diode clamped to ground and a 68,000-ohm resistor returned to B + on each of the inputs to the binaries and flip-flop. This has the effect of giving the input signal much better rise time, since the signal attempts to rise from − 13 volts to B +, but is cut off at ground by the diode.

Diodes are connected to the grids of the binary and flip-flop tubes at the inputs to isolate them from external sources of transients. Grid-clamping diodes are also used to set the lower limit on input pulses at − 3 volts and to keep the grid bias at a steady value.

Further sharpness of output signals of the binaries is obtained by a 15-μH coil in series with the plate resistance in the right half of each binary. This provides shunt peaking to yield a sharp plate signal which is 0.05μsec wide. The diode across the coil eliminates negative overshoot. The voltage divider network of the binaries and flip-flop, consisting of 24,000-ohm and 30,000-ohm resistors connected from each plate to B minus, provides for zero volts on the grids when the tubes are conducting.

Frequency Compensation

The 10$\mu\mu$f speed-up capacitor in parallel with the 24,000-ohm resistor of the voltage divider is added for frequency compensation to allow rapid switching from one state to the other.

Figure 3 shows a burst of nega-

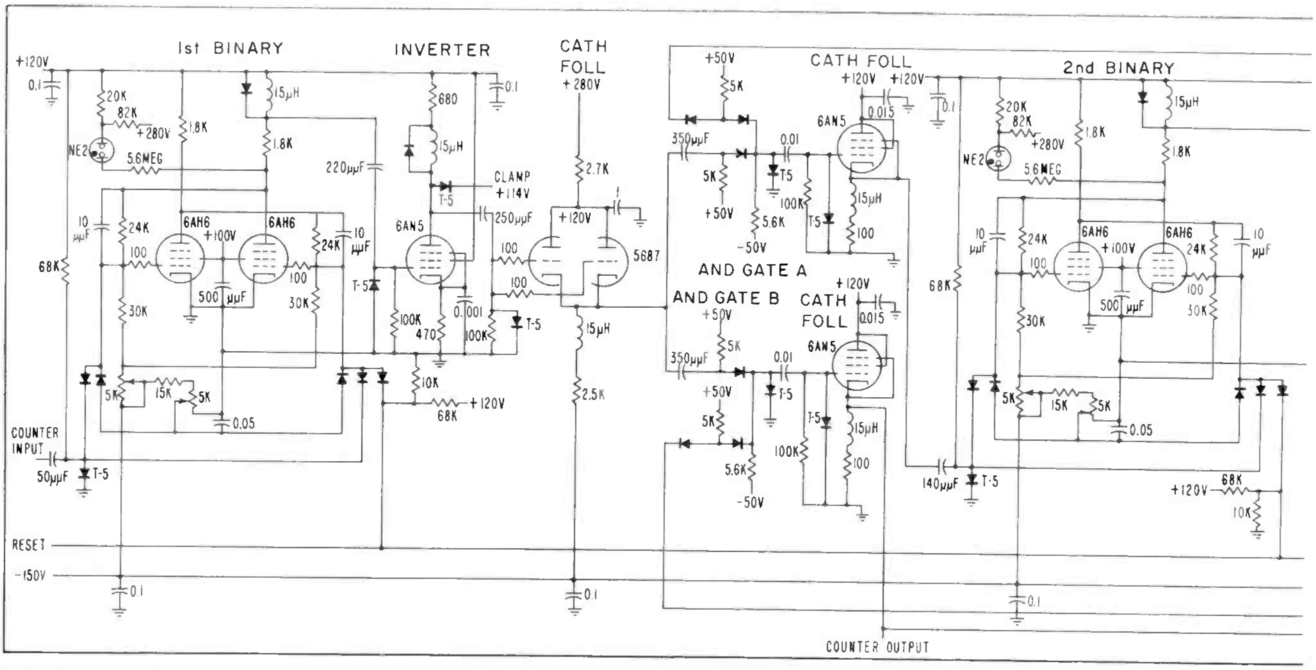


FIG. 2—Input pulses to the binary-decimal counter occur in bursts. Grid-signal clamping tends to eliminate bias change on the grids of

tive pulses typical of the counter input. Each pulse has an amplitude of 13 volts and is 0.05μsec wide. The width of such a pulse burst may vary anywhere from one or two pulses to a steady string of pulses over a frequency range of 5 to 10 megacycles.

Gating

The two *and* gates effectively isolate the first binary from the counter output, the flip-flop, and the second binary. The gating action is clearly shown for *and* gate *A* in Fig 4B. When the cathode follower of the zero-state flip-flop is on, as shown in Fig. 4A, *and* gate *A* gates four pulses from the first binary. The blank time of the waveform indicates that the zero-state flip-flop is off.

Figures 4C and 4D show the gating action of *and* gate *B*. When the one state flip-flop is on, as shown by the negative signal in Fig. 4C, a signal from the first binary in coincidence with it will result in the counter output pulse of Fig. 4D.

Cathode followers are used extensively in the counter to provide driving power, isolation, and low impedance sources. The inverters of each of the binaries provide shunt peaking and amplify the signals to give sharp rise times.

Design Procedure

The main considerations governing the design of the binary circuit include: frequency of operation, type of input signal (steady state or random pulse-burst) and the pulse recovery time of the binary.

The design of the binary circuit may be simplified into several steps.

Figure Of Merit

A tube is selected with a high figure of merit, which is g_m/C_T for R-C amplifiers. It is generally conceded this parameter is of greatest importance in obtaining the best recovery time.[3] The transconductance g_m should be as high as possible at the operating point and the total capacitance C_T due to the tube and stray capacitance should be as low as possible.

Each half of the binary is designed as a separate R-C amplifier operating class C. A low plate supply voltage permits a small load re-

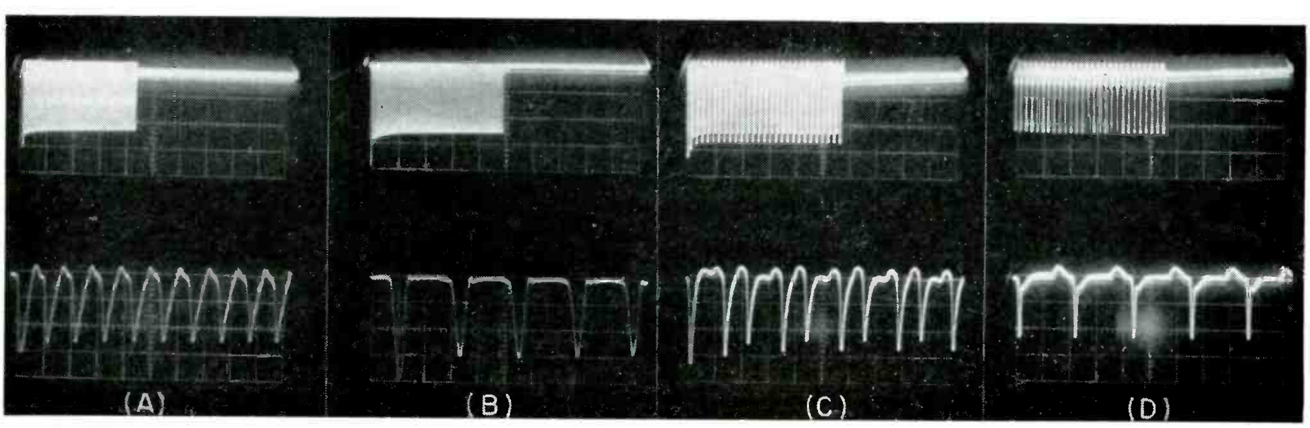
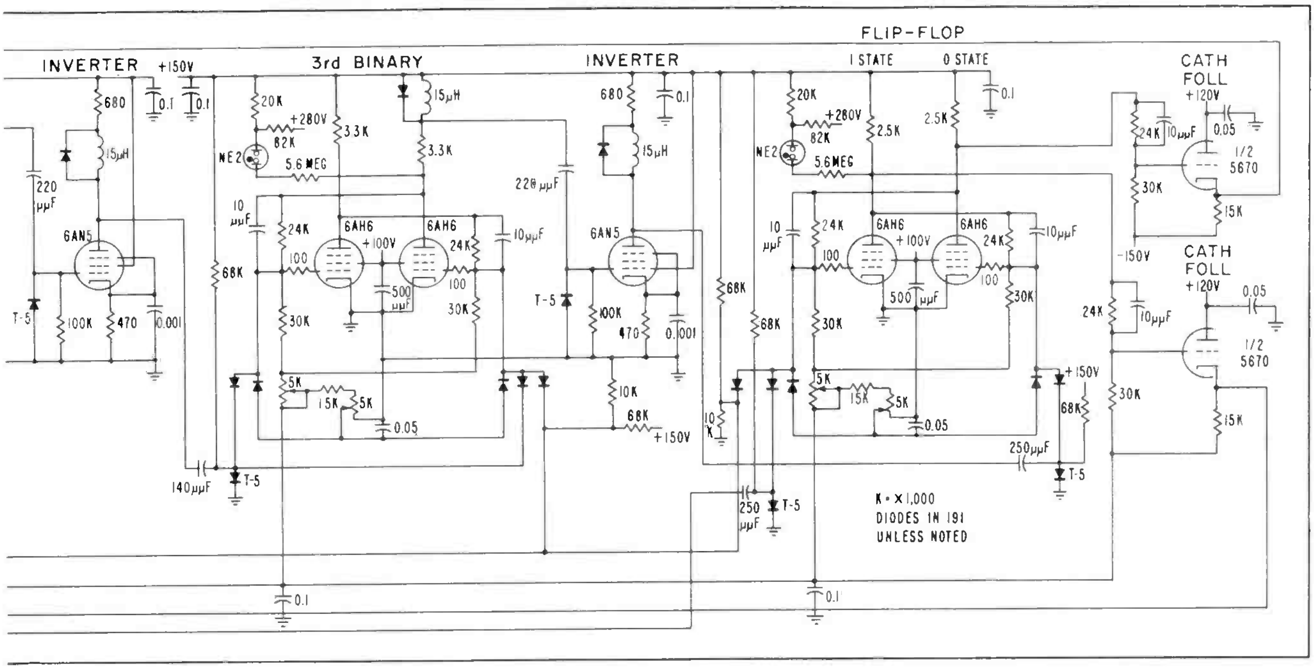


FIG. 3—Waveshapes show input pulse-burst to counter (A), output of first binary cathode follower (B), second binary inverter output (C) and third binary inverter output (D). Upper traces are displayed to a scale of 5 μsec/cm while lower traces are at 0.1 μsec/cm for (A) and (B) and 0.5 μsec/cm for (C) and (D)



the counter tubes as a result of discontinuous characteristics of the input signal. Isolation diodes eliminate effects of external transients

sistance which is important for sharp rise time of the plate signal and high-frequency response of the amplifier.

Shunt Peaking

A coil is chosen to be placed in series with the right half load resistance for shunt peaking. The value of the coil inductance is determined by the formula[4]

$$L_b = mR_L^2C_T$$

where m is the peaking parameter and R_L is the plate load resistance.

The resistance values of the voltage divider connecting the plate of the opposite tube to the grid to B − are computed.

Frequency compensation for the upper resistance of the voltage divider is provided because of tube input and stray capacitance. The compensation capacitance can be calculated by the formula derived from the transfer function of the voltage divider network

$$C_x = R_2C_i/R_1$$

where C_x is the capacitance across the upper resistance, C_i is the tube and stray capacitance across the lower resistance, R_1 is the upper resistance of the voltage divider and R_2 is the lower resistance of the voltage divider.

Isolation

The basic binary is designed by following the preceding steps and the final important step is to isolate it from external influences by using germanium diodes. These are chosen for their low capacitance, high back resistance, low forward resistance, pulse recovery time and small size.

The author thanks C. Johnk of the University of Colorado and D. Dubbert of the Denver Research Institute. This work was sponsored by funds made available by the Denver Research Institute.

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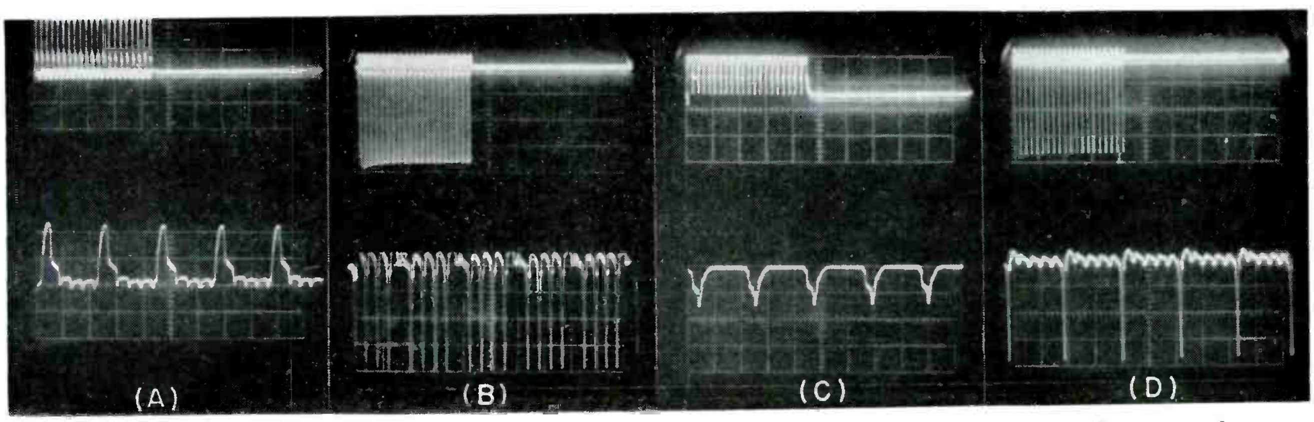

FIG. 4—Zero state of flip-flop is shown at (A) while (B) shows output of *and* gate *A*. One state of flip-flop (C) shows further count down. Output of *and* gate *B* (D) is also counter output. Upper traces are displayed to a scale of 5 μsec/cm while lower traces are at 0.5 μsec/cm. A signal from the first binary in coincidence with the one state flip-flop results in an output pulse

Coaxial Line Impedance Chart

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SUMMARY — Characteristic impedances of coaxial lines are related graphically to dielectric constants and the ratios of outer to inner conductor diameters. Dielectric constants of common materials are also tabulated

THIS CHART simplifies the solution for the characteristic impedance of a single coaxial line.

Example

If a characteristic impedance of 50 ohms is desired and the insulating material is air then from the chart the D/d ratio is 2.3. If metal tubing with an inside diameter $D = 0.250$ in. is chosen for the outer conductor, the outside diameter of the metal inner conductor is 0.109 in.

If a ceramic such as Alumina 95% with $K = 9$ were introduced as the dielectric and the Z_o of 50 ohms were still desired, then from the chart $D/d = 12.3$. If the D of 0.250 were also still desired, then $d = 0.020$ in.

The chart shows that if in this example d were not changed when the ceramic material replaced air, then Z_o would drop from 50 to 16.5 ohms.

Table I—Dielectric constant K from 1 to 10,000 mc at 25C

CERAMICS		PLASTICS	
Alumina 85%	8.3–8.0	Bakelite BM 120	3.7
Alumina 95%	8.9–9.3	Epoxy Resin	3.1
Alumina 97%	9.0–9.6	Formica XX	3.6
Aluminum Silicate	5.5–5.2	Kel-F	2.3
Fosterite	6.2–6.0	Micarta 254	3.4
Magnesium Silicate	5.9–5.3	Nylon 610	2.8
Steatite	6.5–5.3	Plexiglass	2.6
Porcelain, standard electrical	5.5	Polystyrene	2.6
Porcelain, zircon	9.2	Styrofoam 103.7	1.03
		Teflon	2.1
		Tenite II	2.9
		Vinylite VG 5901	2.9

GLASSES		MISCELLANEOUS	
Corning 7052	5.1	Air	1
7070	4.0	Butyl Rubber	2.4
7720 Nonex	4.7	Mica	5.4
7740 Pyrex	4.6	Neoprene 38% GN	4.0
7900 Vycor (96% Silica)	3.8	Silastic 120	5.7
8871 (Lead Potash)	8.4	Silastic 152	2.9
9010 (Lead Free)	6.5		
Quartz, Fused	3.78		
Sapphire, Synthetic	8.6–10.6		

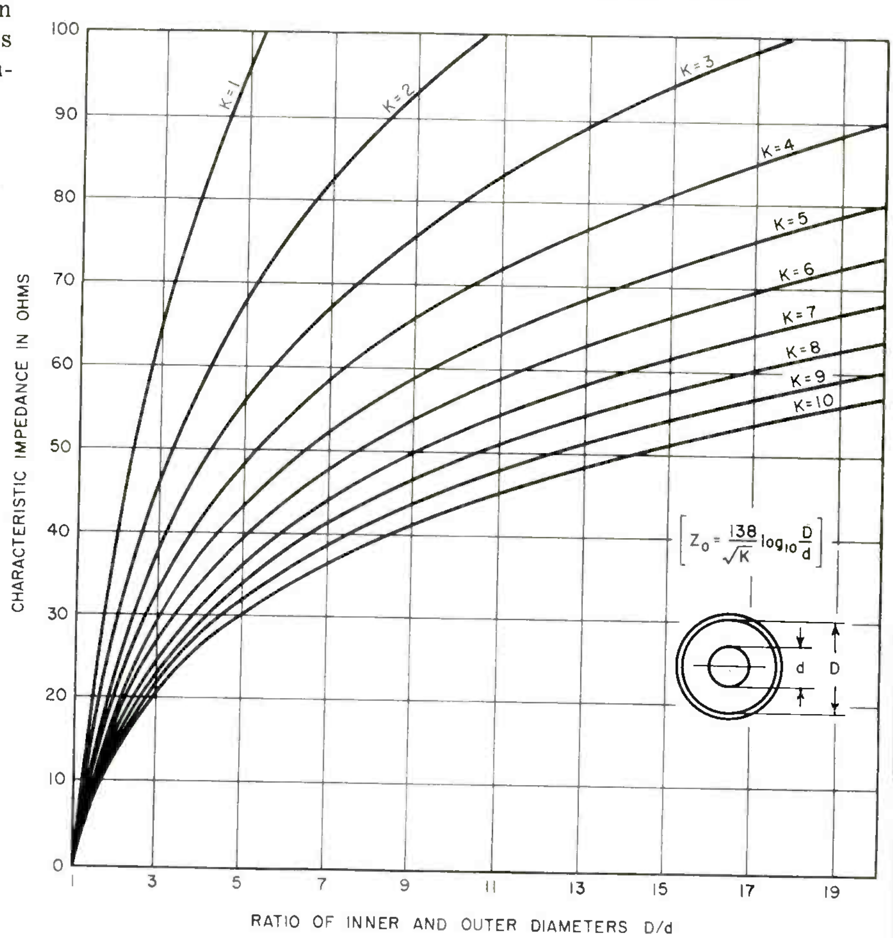

FIG. 1—Characteristic impedance of coaxial lines with various dielectrics

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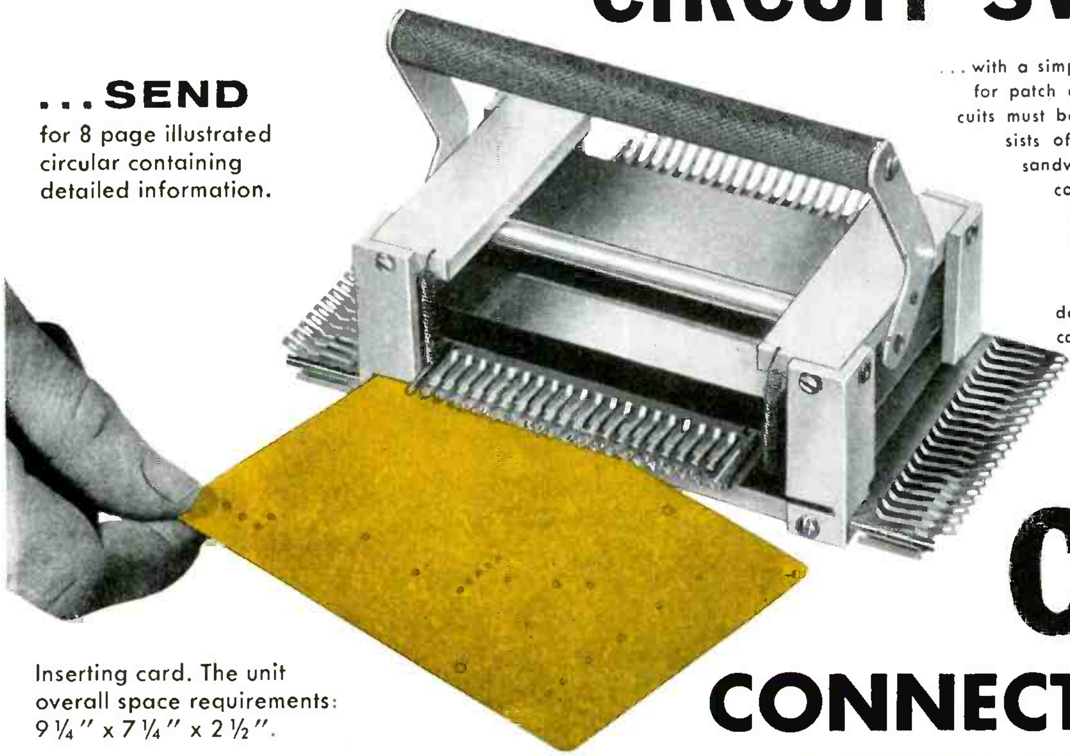
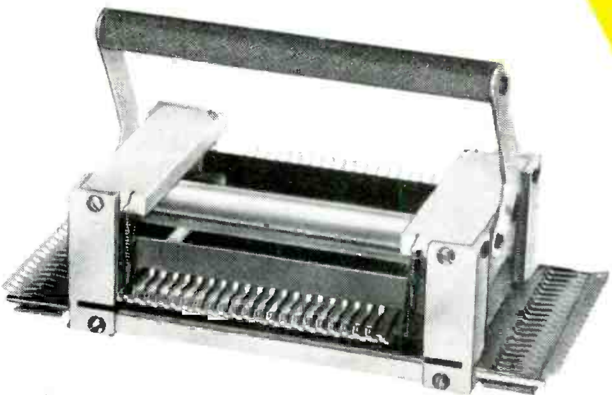
. . . with a simplified circuit switching device that substitutes for patch cord panel systems in applications where circuits must be changed at random intervals. The unit consists of a molded block with 400 floating contacts sandwiched between two printed circuit boards. The contacts make connections between groups of strip conductors on the two printed circuit boards except where the punched card interposes an insulation. Perforations in the card permit connections to be made where desired and later changed by inserting a new card. Ordinary 3" x 5" cards are used, containing the 400 perforations in a 20 by 20 array. The contact blocks can be mounted in multiples for more complex circuits on larger printed circuit boards.

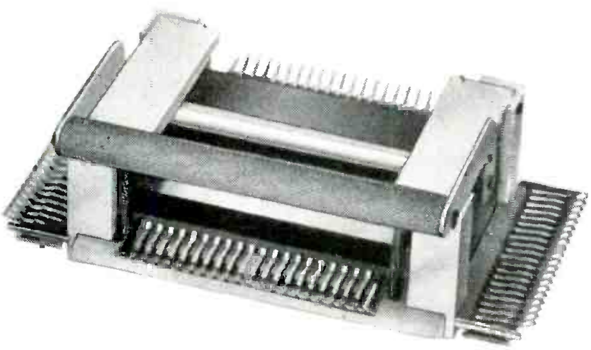


Inserting card. The unit overall space requirements: 9 1/4" x 7 1/4" x 2 1/2".

CINCH
CONNECT-O-MATIC

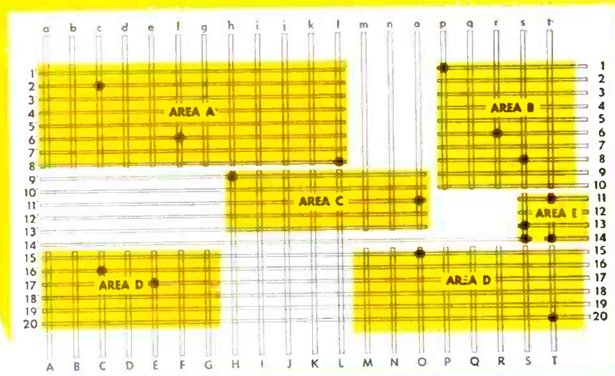


Open position. Lever is disengaged and the card slot is open



Closed position. The card has been inserted (Top illustration) and the lever engaged to close the unit, thus making the desired connections.

Typical Switching Arrangement Possible with Cinch Connect-O-Matic.
The diagram represents vertical and horizontal backing plates realistically superimposed on one another. The gaps in the printed conductors are to electrically isolate different areas of the backing plates.
In this arrangement any of 8 leads in area A can be selectively connected to 12 other leads in this area; any of 10 leads in area B can be selectively connected to 5 other leads in this area; any of 5 leads in area C can be selectively connected to 8 other leads in this area; any of 6 leads in area D can be selectively connected to 15 other leads in this area; any of 2 leads in area E can be selectively connected to 5 other leads in this area; The dots shown represent a hole position in a typical punched card used with this arrangement.



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Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

Parallel-T Nomograph

By DONALD F. CARTER

Chief Electrical Engineer
Harkins and Hershfield
Phoenix, Arizona

SUMMARY — Values of five parameters for parallel-T network are obtained directly with one setting of straightedge, for frequencies in audio and ultrasonic ranges, to expedite design of network used directly in amplifier chain to eliminate a single frequency. Same network can be used in negative feedback path to enhance a single frequency

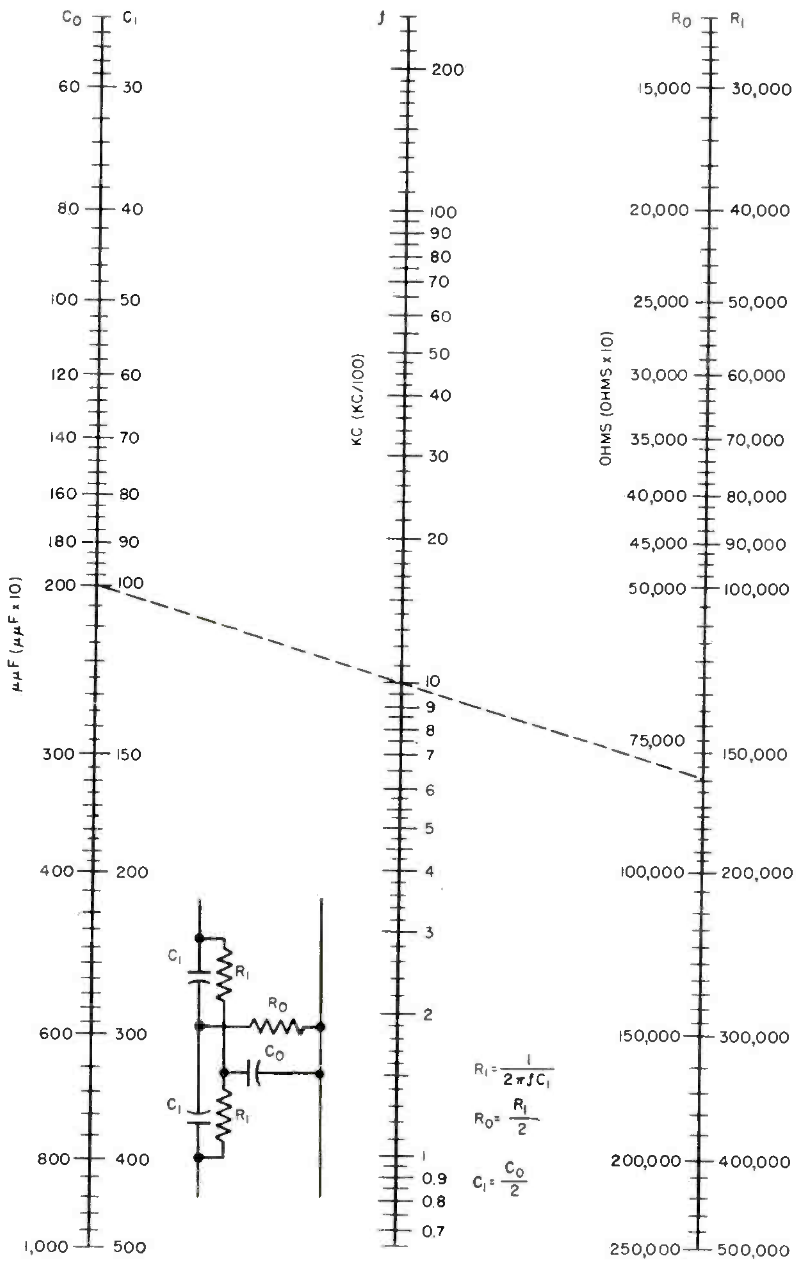
THIS nomograph facilitates calculating parallel-T networks for experimental work in multiplex f-m equipment design. The subcarrier frequencies used are in the range from about 20 to 75 kc. With one setting of a straightedge, all parameters of the parallel-T network needed to eliminate the undesired frequency f may be obtained to three significant figures.

Example. If a specific frequency f of 10 kc is to be eliminated and C_1 is selected by the designer to be 100 $\mu\mu$f, run a straight-edge from 100 $\mu\mu$f on the C_1 scale through 10 kc on the f scale. All other values can now be read directly from the nomograph. Thus, R_1 is 159,000 ohms, R_0 is 79,500 ohms and C_0 is 200 $\mu\mu$f.

Any two of the five parameters may be selected as the initial starting point of design. The other three can then be found with one setting of the straight-edge.

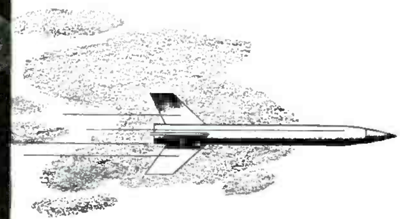
If the f scale is divided by 100, the C and R scales must be multiplied by 10. This changes the range of the nomograph to cover from 7 cps at the low end to about 2,000 cps at the high end.

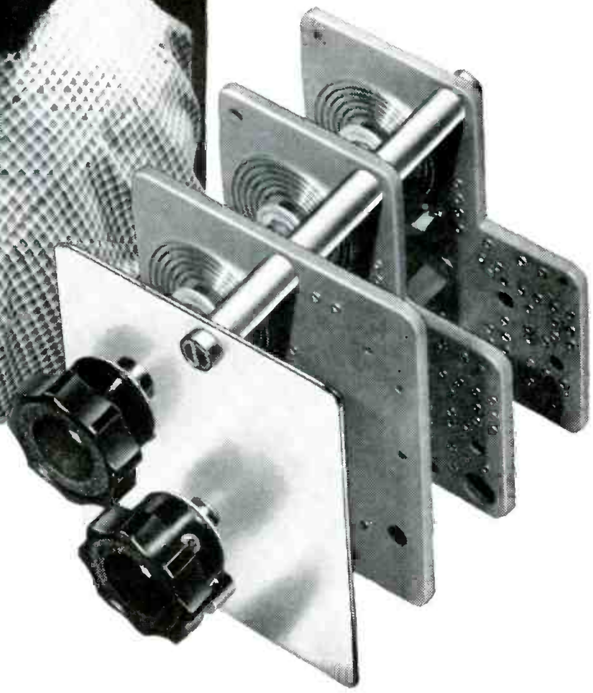
For a 100-cps elimination network and a value of 1,000 $\mu\mu$f for C_1, these scale multiplying factors must be used. The other parameters are then R_1=1.59 megohms, R_0=795,000 ohms and C_0=2,000 $\mu\mu$f.



Center scale gives frequency attenuated by parallel-T network

ELECTRONICS REFERENCE SHEET





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Electrons At Work

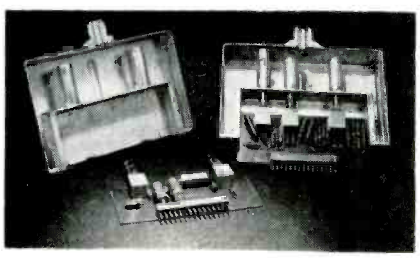
Edited by DAVID A. FINDLAY

Electronic Equipment Water-Cooling

A cooling system developed by Martin Aviation for aircraft electronic equipment uses a shaped container to hold water in close contact with the tubes and transformers as shown in Fig. 1. The water is permitted to evaporate to control operating temperature.

Using this technique, tests have been conducted to determine cooling efficiency. Component temperatures have been held essentially constant at ambient temperatures from 150 C to 400 C.

Previous practice in cooling systems for electronics in high speed aircraft has been to duct either ram air or refrigerated air over the electronic equipment. Both of these methods involve power and apparatus since ram air must be cooled at higher speeds. Martin claims effective cooling at speeds as high as Mach 5 for the water cooling system as compared to a Mach 2.5 limitation on the other techniques. Volume saving obtained by the water cooling system are estimated at 64 cu ft for manned aircraft and about 1½ to 3 cu ft for missiles.



Water cooled electronic assembly used in tests

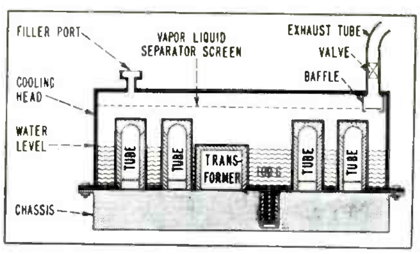
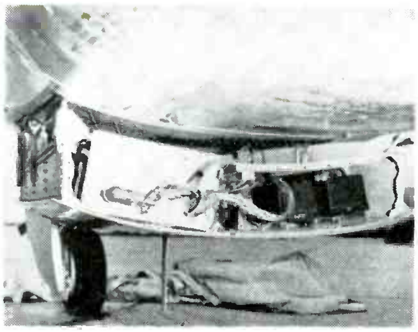
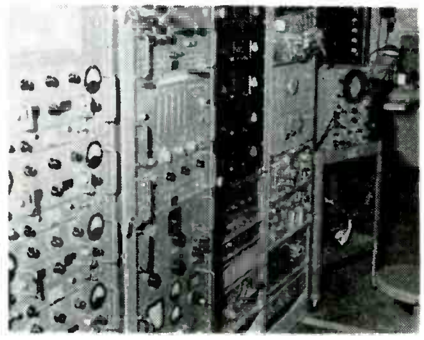


FIG. 1—Cross-section of chassis showing arrangement of cooling water chamber



Airborne end of telemetering system for ground display of airborne radar



Ground installation permits instructor to observe student's tactics

Radar Telemetering Trains Pilots

TELEMETERING equipment developed by the Air Research and Development Command is now being used to allow ground personnel to observe the radar display of an airborne jet interceptor during a training mission.

The new equipment will be used in training pilots for all-weather interceptor duty. Using the telemetering equipment, the instructor on the ground will be able to give voice instructions to the student pilot and then observe his performance in a mock attack by observing the ground reproduction of the pilot's radar display.

▶ **Equipment**—The airborne and ground telemetering equipment is shown in the photographs. A modified oscilloscope is used as the ground display unit. Airborne equipment mounted in a bay under the plane body can be lowered for servicing.

Indicator Simplifies Color TV Tuning

By A. A. Goldberg
CBS Laboratories, Inc.
New York, N. Y.

To sell color tv to the public, easy use of all viewer operated controls is essential. At present, this has not been achieved, particularly with regard to the fine tuning adjustment. A solution to this problem is the easily controlled, non-critical tuning indicator circuit discussed here.

▶ **Problem**—Although color receivers employ an intercarrier sound system similar to monochrome sets, the tuning is more critical because of the chroma subcarrier which is 3.58-mc away from the video carrier and 920-kc away from the sound carrier.

A typical color set has a main i-f amplifier frequency response of sufficient width to pass the video, chroma and sound carriers as shown in Fig. 1. Before reaching the video detector, the sound carrier is shunted off to its own detector. The balance of the i-f signal passes through a sound trap that brings the overall sound rejection to 50 db at the video detector. This heavy rejection is required to prevent a 920-kc interference pattern from appearing on the picture as a result of the chroma and sound carriers mixing in the nonlinear detector.

Sound rejection exists only when

it's *first in Performance Reliability and Quality* **Kepco**

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1.5 Amp. KR SERIES

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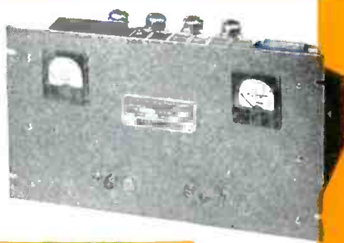
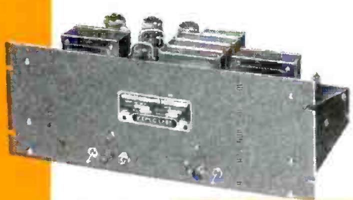
100-200	has two	KR17	19"	12¼"	17"	$625
195-325	15 Amp.	KR18	19"	12¼"	17"	$695
295-450	outputs	KR19	19"	12¼"	17"	$695

600 ma. KR SERIES



MODEL KR-8M

OUTPUT VOLTS DC	6.3V AC	Model	Rack Mount W	H	D	Price
0-150	Each supply	KR 8	19"	10½"	13"	$330
100-200	has two	KR 5	19"	10½"	13"	$240
195-325	10 Amp.	KR 6	19"	10½"	13"	$240
295-450	outputs	KR 7	19"	10½"	13"	$250



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300 ma. KR SERIES

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0-150	Each supply	KR 12	19"	7"	11"	$270
100-200	has two	KR 3	19"	7"	11"	$180
195-325	5 Amp.	KR 4	19"	7"	11"	$180
295-450	outputs	KR 10	19"	7"	11"	$190

125 ma. KR SERIES

MODEL KR-1C

OUTPUT VOLTS DC	6.3V AC	Model	Rack Mount W	H	D	Price
0-150	Each supply	KR 11	19"	7"	11"	$180
100-200	has one	KR 1	19"	7"	7½"	$ 90
195-325	3 Amp.	KR 2	19"	7"	7½"	$ 90
295-450	output	KR 9	19"	7"	7½"	$ 97

To Include 3" Current and Voltage Meters, Add M to Model number (e.g. KR 16-M) and Add $30.00 to the Price.
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RIPPLE: Less than 3 mv. rms.
STABILITY: The output voltage variation is less than the regulation specification for a period of 8 hours.

RECOVERY TIME. Less than 50 microseconds. The excursion in the output voltage during the recovery period is less than the regulation specification.

OUTPUT IMPEDANCE. Less than 0.1 ohms from 20 cycles to 100KC. Less than 0.5 ohms from DC to 20 cycles. Many units have very much lower output impedance.

featuring

- Fast recovery time, suitable for square wave pulsed loading.
- Voltage range continuously variable without switching.
- Either positive or negative may be grounded.
- Advanced vacuum tube regulator circuitry.
- Power requirements 105-125 volts, 50-65 cycles.
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- Oil filled condensers.
- Color Grey Hammertone.
- Guarantee one year.

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131-38 SANFORD AVENUE • FLUSHING 55, N.Y. • INDEPENDENCE 1-7000 the sound carrier is positioned correctly in the sharp trap notch. Any misadjustment of the fine tuning control prevents rejection and results in a degradation of the picture. The average person finds it difficult to locate this critical point of noninterference.

▶ **Solution** — Simplification of the fine tuning adjustment is effected by use of a tuning indicator which permits correct positioning of the sound carrier in the sound trap notch and which is insensitive to other phenomena. This is accomplished by measuring the sound carrier energy at the point between the 41.25-mc sound trap and the video detector and then tuning the receiver for a minimum indication.

A schematic diagram of the tuning indicator and the affected portion of a conventional color tv is shown in Fig. 2. In operation, the 1N58 crystal detector is tuned to a frequency lower than 41.25 mc. by the variable inductance. When this occurs, the i-f response through the detector, shown in Fig. 3, becomes symmetrical to the sound notch causing a symmetrical indication to appear on the 6E5 tuning eye. The sensitivity control in the cathode circuit of the 6E5 is preset for best indicator operation. The receiver is correctly tuned when the shadow angle of the tuning eye is minimum. Since the shadow angle is a nonlinear function of the d-c control voltage, the greatest angular change with voltage occurs when the shadow approaches its maximum angle. Therefore, the sensitivity of the 6E5 is decreased as the sound carrier enters the notch and the indicator operation becomes less critical at small shadow angles.

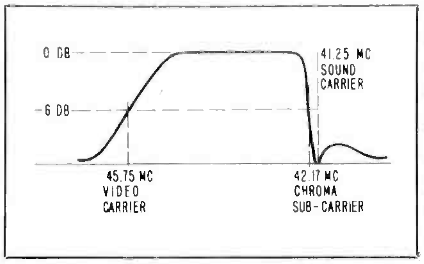


FIG. 1—Response curve for i-f section of typical color tv circuit

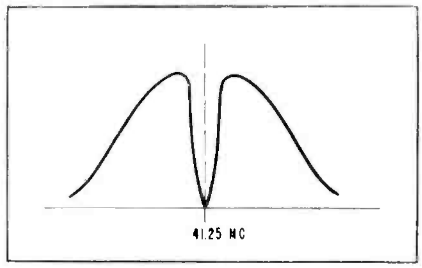
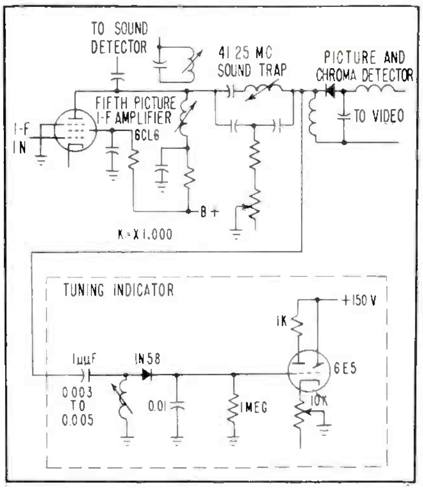


FIG. 3—I-F response curve for detector in tuning indicator



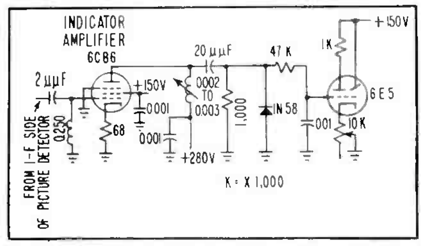


FIG. 4—Tuning indicator circuit with added amplification stage has increased sensitivity capable of operating at signal levels as low as 10 μv at the antenna

FIG. 2—Tuning indicator circuit and a portion of associated color tv circuit showing method of connection to i-f section

Better operation is possible with the circuit shown in Fig. 4. A stage of amplification is employed which improves the indicator operation on weak signals. Excellent results are obtainable with signal inputs between 10 μv and 0.5 volt at the antenna terminals.

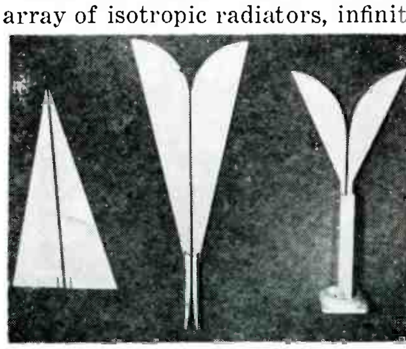
Coinventor of the tuning indicator is James Duggen, CBS Television.

Ridge Vane Antenna Provides Constant Beamwidth

By William A. Scanga
Aircraft Armaments, Inc.
Cockeysville, Maryland

UNIQUE characteristics of new form of antenna permit its use in applications requiring constant beam width over a wide range of frequencies. A pair of vanes, extending from the open end of a ridge waveguide, acts as an end-fire antenna that violates the conventional relationship between beam width and frequency. Representative model tested had a one-half power beam width of 41 deg at 8.2 kmc and 43 deg at 11.0 kmc. An end-fire antenna operating under similar conditions has a beam width of 40 deg at 8.2 kmc, and 34.5 deg at 11.0 kmc.

▶ **End-Fire Array**—Given a linear array of isotropic radiators, infinite in number, over a finite length and assuming that the individual radiators are uniformly excited, but that the phasing is in accord with the phase velocity of a transmission line, the radiation pattern is



End-fire antenna configurations. Circularly-tapered fin is in center and exponentially-tapered form is at right

$$\gamma = \left| \frac{\sin[\pi(\rho \cos \theta - \beta)]}{[\pi(\rho \cos \theta - \beta)]} \right|$$

where γ = relative field strength

θ = angle with respect to the array axis

ρ = length of array in free space wavelength

$2\pi\beta$ = phase shift in radians in the feed line from one end of the array to the other end

The pattern described by this for-

CHOPPER APPLICATIONS

Servo Comparator

Where the difference between two voltages is required, a mechanical chopper develops such a signal. With a BBM chopper, the two voltage sources are isolated from each other. The error signal is modulated, the phase showing which voltage is the greater.

Type 313 for operation from −65 C to +125 C with NO derating

DC Amplifier

The mechanical chopper, because it has long-term stability, especially under fluctuating ambients, provides a simple and dependable means for modulating and demodulating DC signals for amplification in either vacuum-tube or transistor amplifiers.

Type 176 drive coil leads out top for minimum noise

Operational Amplifier

Wide-band DC signals, such as in analog computers and proportional controls, are readily amplified in a directly coupled vacuum-tube or transistor amplifier whose zero is stabilized by a mechanical modulator.

Type 800 double-pole double-throw for full isolation

Guidance System

For guided missiles and other equipments subject to shock and vibration, the balanced-armature chopper is used. This chopper has the electrical stability of other mechanical modulators, plus unusual resistance to external disturbances.

Type 351 operates normally during 15 G vibration at 10 to 2500 CPS

Analog-to-Digital Converter

In such applications as production test equipment where digital indications are desirable, a mechanical chopper samples the analog input. The equipment retains its calibration, there being no drift in the chopper.

Type 175 standard plug-in 60-CPS unit

DC VTVM

Because of its stability, the mechanical modulator is used in vacuum-tube voltmeters. In such applications the chopper extends the DC sensitivity into the microvolt region, an order of magnitude beyond that usually possible.

Type 300 standard miniature 400-CPS SPDT unit

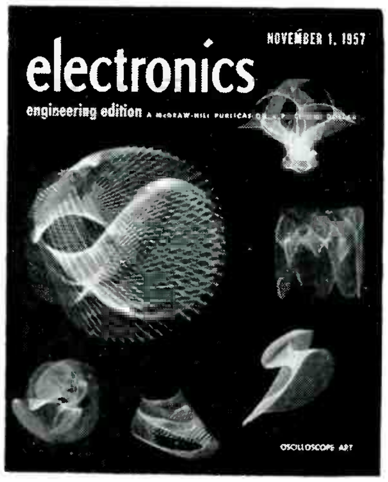
AIRPAX

DESIGNERS ENGINEERS

AIRPAX PRODUCTS CO., CAMBRIDGE DIVISION, JACKTOWN ROAD, CAMBRIDGE, MARYLAND

Circle 79 Readers Service Card

The Front Cover



The group of geometric patterns on the cover suggesting some kinds of abstract design are made with two oscillators and an oscilloscope by Ben F. Laposky.

The oscillators are set to put out sine waves of around 11,000 cps, at 8 volts, for one input, and at 900 cps at 2 volts for the other input.

Interconnected phase-splitting networks produce circular or elliptical patterns when used individually. When operated together, the results are rosettes, or circles with loops. These patterns may be varied by slight changes in the frequencies or voltages of the oscillators, or other settings of the circuit controls.

Color is added to the trace by means of a rotating filter wheel in front of the cathode ray tube of the oscilloscope. The wheel is of lucite plastic, 17″ in diameter, with six cellophane color segments, each 60 degrees, by about 6″ radially. There are two red, two green and two blue segments. The wheel is driven by a four-pole changer motor at about 900 rpm.

For the specific frequencies given, as well as the other settings, running the wheel at full speed produces good color effects, showing the three primary colors of red, blue and green in the loops, and some mixed colors, as yellow, purple and white.

mula is always symmetrical about the array axis, though not necessarily maximum along the axis. For β equal to ρ, the phase velocity along the feed line is equal to free space velocity, and the resulting pattern is end-fire. For β slightly greater than ρ the pattern remains end-fire. As β is further increased, the pattern deteriorates into a forward conical beam. For β less than ρ the pattern is again a forward conical.

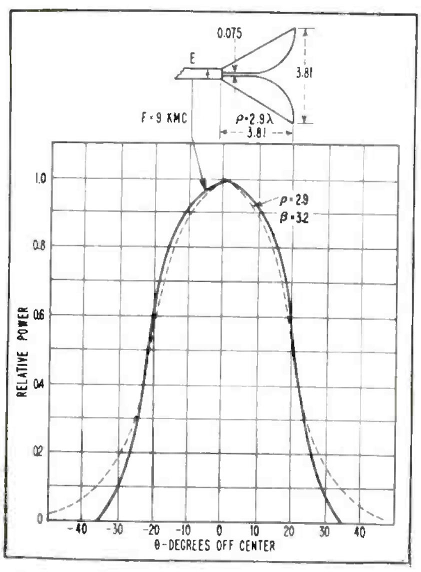


FIG. 1—Pattern of exponentially tapered antenna with theoretical pattern

► **Experimental Results** — Experimental data have been obtained at 8.2, 9.0, and 11.0 kmc. All of the antennas were fed from a symmetrically-tapered ridge, mounted in RG-52/U waveguide. All patterns given are E-plan patterns. While H-plane patterns were taken for most of the antennas, no attempt was made at analysis. For ridge widths of the order of 0.25 in. or less the H-plane pattern was essentially that of an open end of RG-52/U waveguide. For ridge widths greater than 0.25 in. the H-plane pattern deteriorates into a forward conical beam.

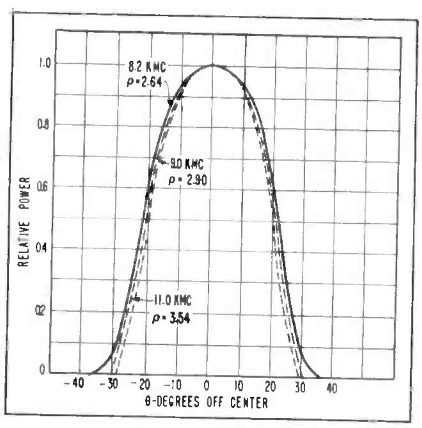


FIG. 2—Patterns of exponentially-tapered antenna taken at 8.2, 9.0 and 11 kmc.

Antenna shown in Fig. 1 consists of two plates cut from 0.25 in. brass plate. An 0.075 in. gap between plates, extends from the open end of the waveguide a distance of 1.0 inch. From this point, the gap is exponentially increased until the gap equals the length (3.81 inches). The measured pattern at 9 kmc is indicated by the solid line in Fig. 1. The β was determined (by substitution into the radiation pattern equation that gives a power pattern that most nearly fits the measured pattern of the antenna. This pattern, for $\beta = 3.2$, is indicated by the dotted curve in Fig. 1. Since equation assumes uniform illumination and the actual antenna is probably not uniformly excited exact overlap of the two patterns was not achieved.

In addition to patterns at 9 kmc, both antennas described above were checked at 8.2 kmc and 11.0 kmc with the resultant pattern as shown in Fig. 2. As indicated, the pattern shape and width change very little with frequency.

Mobile Radar Uses Balloon Antenna

A TRANSPORTABLE radar installation uses a lightweight sectionalized housing and an inflatable aluminum coated reflector for the radar antenna. The system designed for the Air Force by Westinghouse can be deflated and packed into shipping containers. Packing in special airlift cases makes it possible to airdrop the entire installation.

The inflatable antenna is made from a vinyl-coated fiberglass fabric. For the assembled antenna two 30-ft diameter paraboloids are

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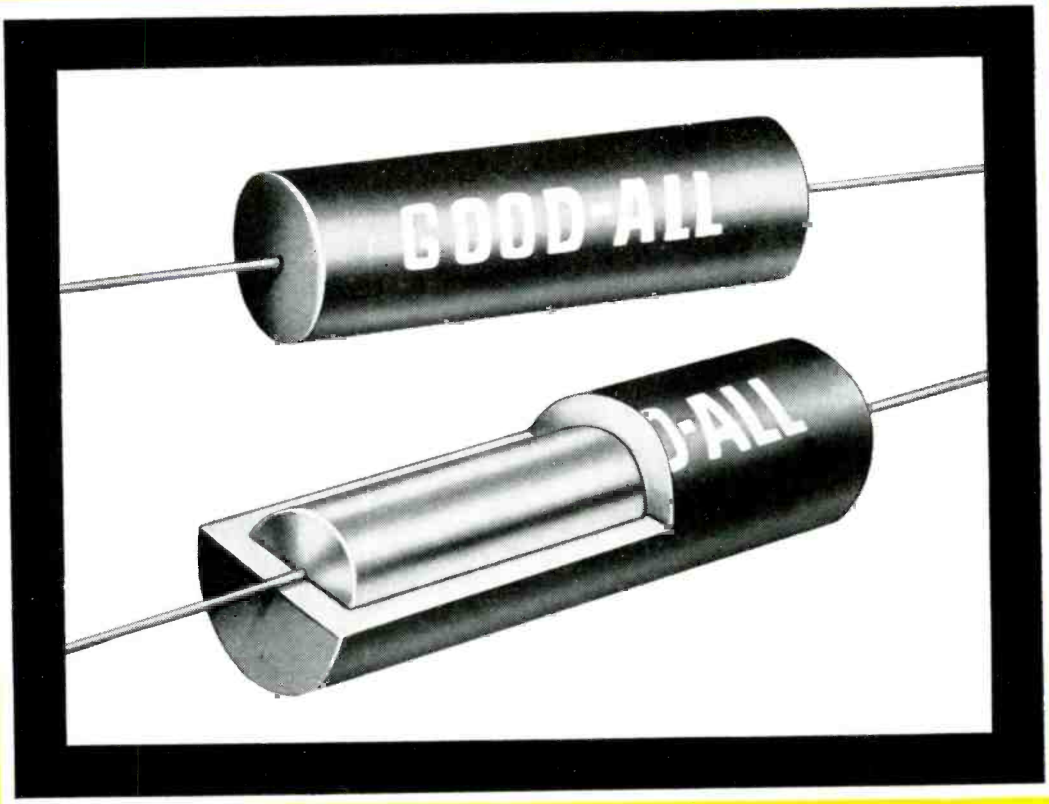

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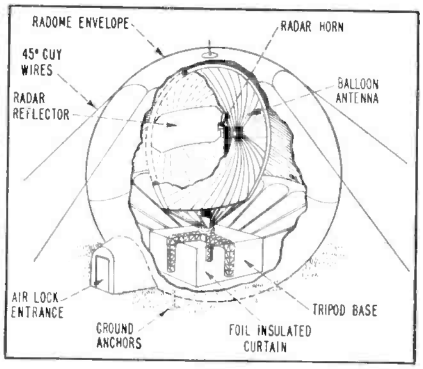

FIG. 1—Structure of radome and inflatable antenna for transportable radar station designed for military use

joined at their rims and inflated to less than 0.02 psi. This structure is then joined to a 16 in. diameter tubing that attaches to the rim of the two paraboloids. The tubing, inflated to 10 psi, acts as a stabilizer for the structure. The entire antenna system weighs 1,690 lb.

A sheet of Mylar, coated with aluminum by vapor deposition, is attached to the inside surface of one of the paraboloids. This is used as the reflector. The fiberglass fabric passes r-f energy with little attenuation.

▶ **Radome**—The protective housing for the radar antenna and electronic equipment is supported by air at a pressure of 0.17 psi. It is sectionalized into five side panels and one crown piece for transportation and erection. The complete radome assembly weighs about 1,400 pounds.

Both the radome and antenna are kept above surrounding air-pressure level by blowers. Capacity of the blowers is such that more than fifty 20-mm projectiles can pierce both anntenna and radome without affecting normal operation.

Deflated antenna and supporting structure ready for packing

Partially inflated antenna being checked as blowers are started

Dielectric Recorder Uses Simple Pickups

IN dielectric recording, information is stored as a surface charge on a rotating dielectric-coated drum. For some applications this technique has advantages over magnetic recording.

As shown in Fig. 1, the audio signal is stored as a space-varying surface charge on the drum. The charge is transferred to the drum through a conducting path of ionized air produced by a stable r-f corona discharge. As the drum passes through the discharge region, it is charged to the average potential of the region which is the instantaneous value of the audio signal.

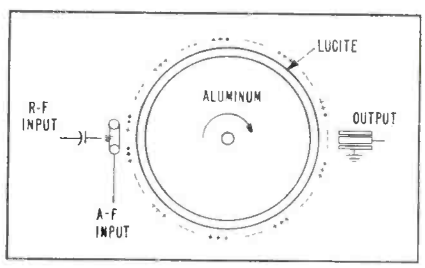

FIG. 1—Dielectric recording system

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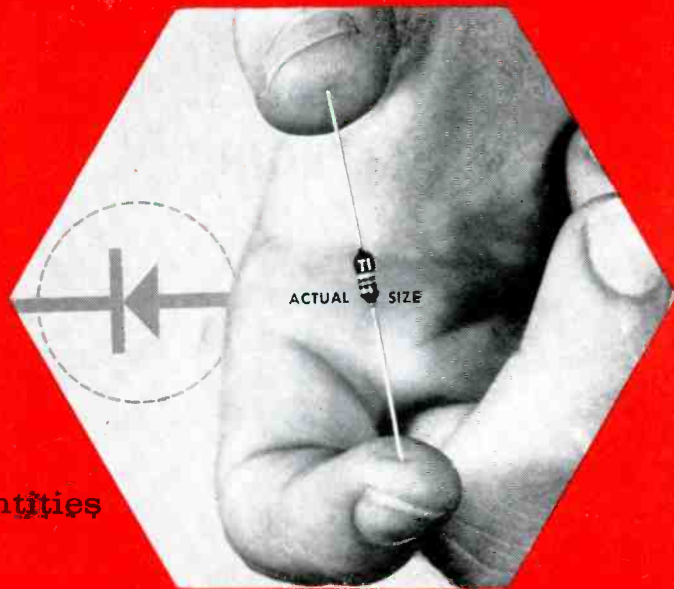

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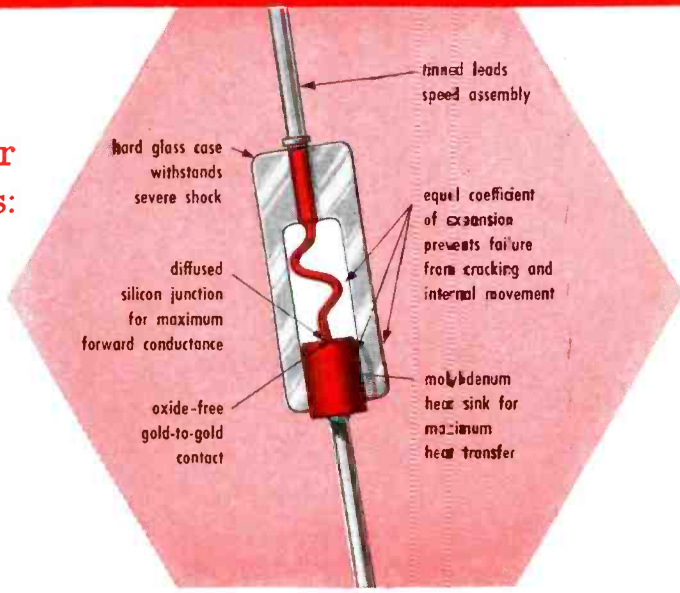

maximum ratings

	1N645	1N646	1N647	1N648	1N649	
Peak Inverse Voltage at −65 to +150°C	225	300	400	500	600	V
Average Rectified Forward Current at +25°C	400	400	400	400	400	mA
Average Rectified Forward Current at +150°C	150	150	150	150	150	mA
Recurrent Peak Forward Current at +25°C	1.25	1.25	1.25	1.25	1.25	amp
Surge Current, 1 Second DC at +25 to +150°C	3	3	3	3	3	Amp
Power Dissipation at +25°C	600	600	600	600	600	mW

specifications

	1N645	1N646	1N647	1N648	1N649	
Minimum Breakdown Voltage at +100°C	275	360	480	600	720	V
Maximum Reverse Current at PIV at +25°C	0.2	0.2	0.2	0.2	0.2	μA
Maximum Reverse Current at PIV at +100°C	15	15	20	20	25	μA
Maximum Voltage Drop at I_0 = 400 mA; at +25°C	1.0	1.0	1.0	1.0	1.0	V

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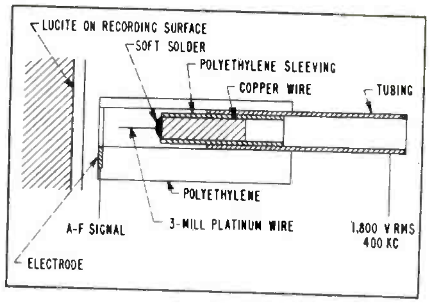


FIG. 2—Recorder uses high voltage carrier

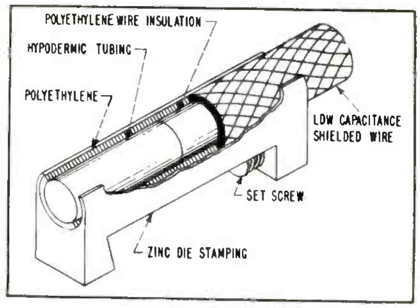


FIG. 3—Dielectric recorder playback head

medium can cause change of signal level. This is a relatively slow process. For playback of the signal a simple capacitative probe can be held near the surface of the drum.

▶ **Dielectric**—The dielectric material is selected for the decay time of a surface charge stored upon it. Methyl methacrylate, (Lucite) polystyrene, polyethylene and Teflon have decay time constants ranging from 80 hours for Lucite to over 3,000 hours for polyethylene. Because of its machinability and the availability of large thin wall extruded tubing, Lucite was used in the construction of the recorder.

The recorder as shown in Fig. 2 consists of a conductor placed near the dielectric and insulated from the surface by a thin layer of air. A 400-kc signal applied to the platinum center wire breaks down the air insulation to permit recording. The playback head is shown in Figure 3. Since the characteristic impedance of the playback head is capacitive, it is relatively simple to use a number of pickup heads in parallel.

A comparison of dielectric and magnetic recording is given in Table I. The dielectric recorder offers an inherently high dynamic range. Upper recording voltage limit is determined by breakdown along the surface of the dielectric.

This information has been abstracted from an article "Dielectric Recorder" by V. C. Anderson, *Rev Sci Inst.*, July 1957.

Table I. Characteristics of Dielectric and Magnetic Drum Recording.

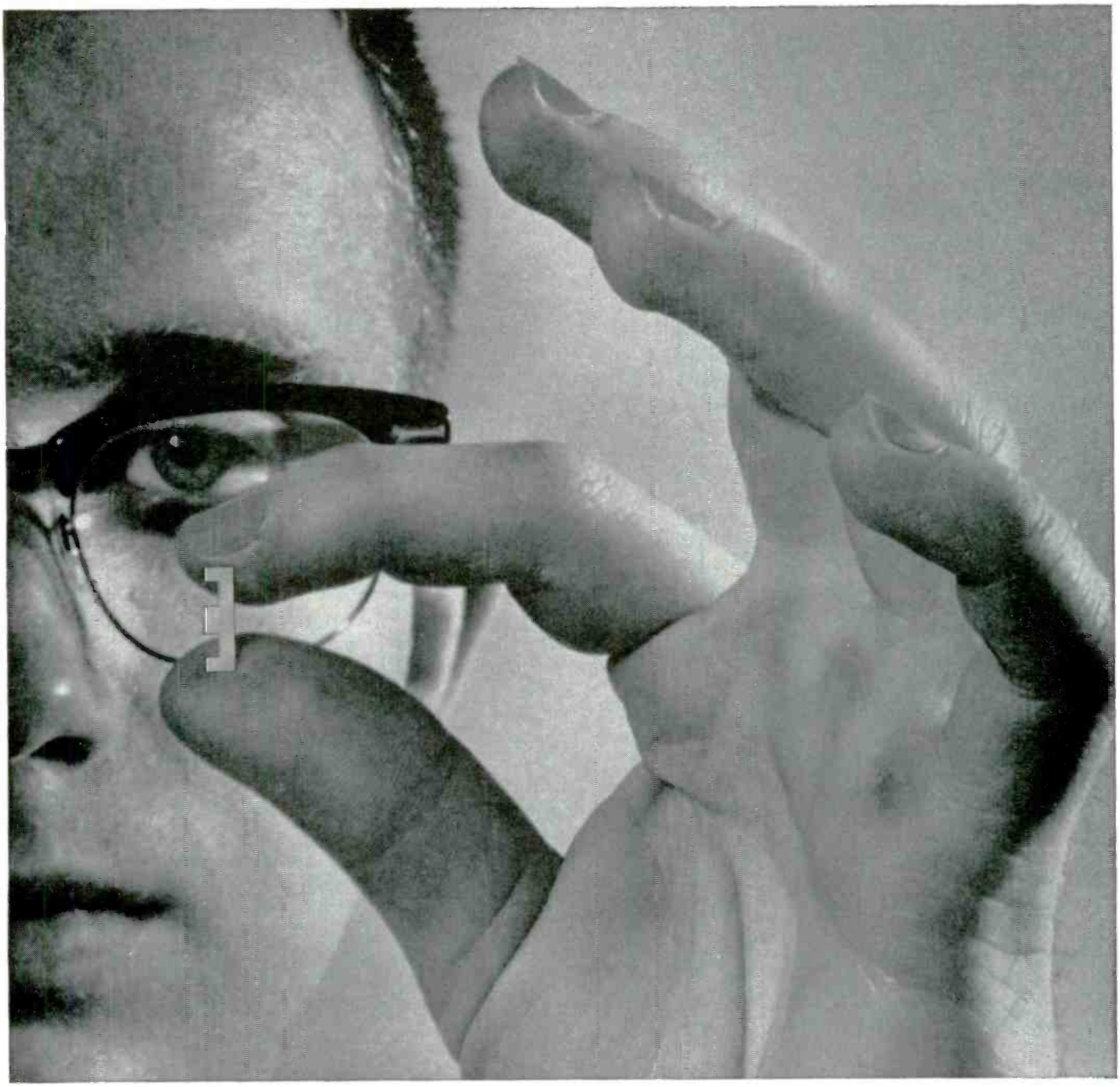
	Dielectric drum	Magnetic drum
Surface speed	20 in./sec	100 in./sec
Head-to-drum spacing	5 mils	0.5 mil
Amplitude sensitivity of head spacing	0.5 db/mil	5–10 db/mil
Upper frequency response	400 cps	10 kcps
Low-frequency cutoff	<1 cps	100 cps
Min recorded wavelength	50 mils	10 mils
Dynamic range	60 db	50 db

Back Window Cathode-Ray Tube

By M. B. Diegert
Airborne Computer Laboratories
International Business Machines Corp.
Owego, N. Y.

In the back-window crt, electronic and pictorial data on a 35-mm film strip, is projected optically through a back window in the tube and superimposed onto the phosphor viewing screen for comparison with the electronic display. This back-window design eliminates the ghost-reflection problem of using mirrors in front of the tube for superimposition.

▶ **Features**—The ten-in. tube incorporates magnetic deflection and electrostatic focusing. Cylindrical tube shape minimizes size of the back window. Windows are located as close as possible to the electronic axis of the tube to minimize optical



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complexity. The main body of the tube consists of a conventional faceplate, a central cylinder and a backplate. The neck is attached to the tube by means of a flared protrusion on the backplate.

The bulb backplate is pressed from standard crt bulb glass in the conventional manner. However, during the pressing operation, raised portions or bosses are included at selected positions around the flared protrusion. These bosses, after grinding and polishing, become the flat, parallel-sided windows that permit the formation of high quality optical images on the screen.

▶ **Optics**—The optical system, shown in Fig. 1, departs from conventional projection optics to ensure full screen coverage. This is obtained by locating the short-focal-length, wide-angle projection lens close to the back window of the crt. Image forming lenses are oriented with their axes parallel to the tube axis to prevent keystone distortion. Due to the displaced position of the projection lens, a field lens is used to collect the image-forming rays to give uniform screen illumination.

▶ **Use**—The back-window cathode-ray tube can be used in radar-guidance systems, both military and commercial, where route maps, airport traffic patterns or other optical information superimposed on the electronic display will aid the operator in interpreting the radar image.

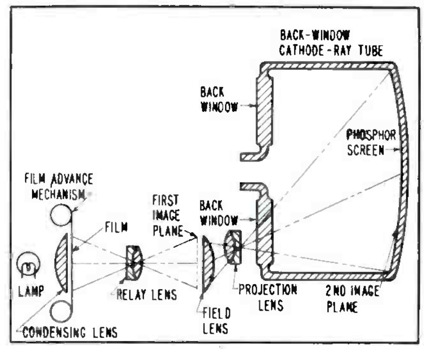

FIG. 1—Optical projection system for displaying pictorial data on phosphor screen of back-window cathode-ray tube. Additional back windows permit photographing combined pictorial and electronic display by means of an optical system similar to that used for projection of pictorial data onto the screen

This type of crt can be used also to photograph an electronic display through the back window. With more than one window provided, a combined electronic and optical display can be recorded. Photography through the rear of the crt can be accomplished with an optical system similar to the one used for projection of pictorial data. Rear screen recording provides an advantage in brightness and resolution over front-screen photography.

Low-Voltage Gun Gives Good Color Image

POST ACCELERATION color tubes require a compact assemblage of small diameter low voltage guns. Despite size and voltage restrictions, these display devices must produce images that have a high degree of color purity, good depth of focus and small spot size. The tricolor gun assembly discussed here was specifically designed to fulfill this need.

▶ **Gun Assembly Characteristics**—The assembly consists of three guns arranged in a plane perpendicular to the phosphor stripes on the color tube screen. Although this configuration requires a smaller barrel diameter than triangular positioning, the problem of beam convergence is greatly simplified. Various convergence schemes can be used; however, the three guns in this assembly were mechanically preconveregd.

Anode potentials required for the individual guns are between 5,000 and 7,000 volts as compared to the 20,000 to 30,000 volts required by other color tube display devices. The inside diameter of each gun is 0.358 in.; the center to center distance between neighboring guns at their exits is 0.427 in.

▶ **Functional Considerations**—The physical and electrical design limi-

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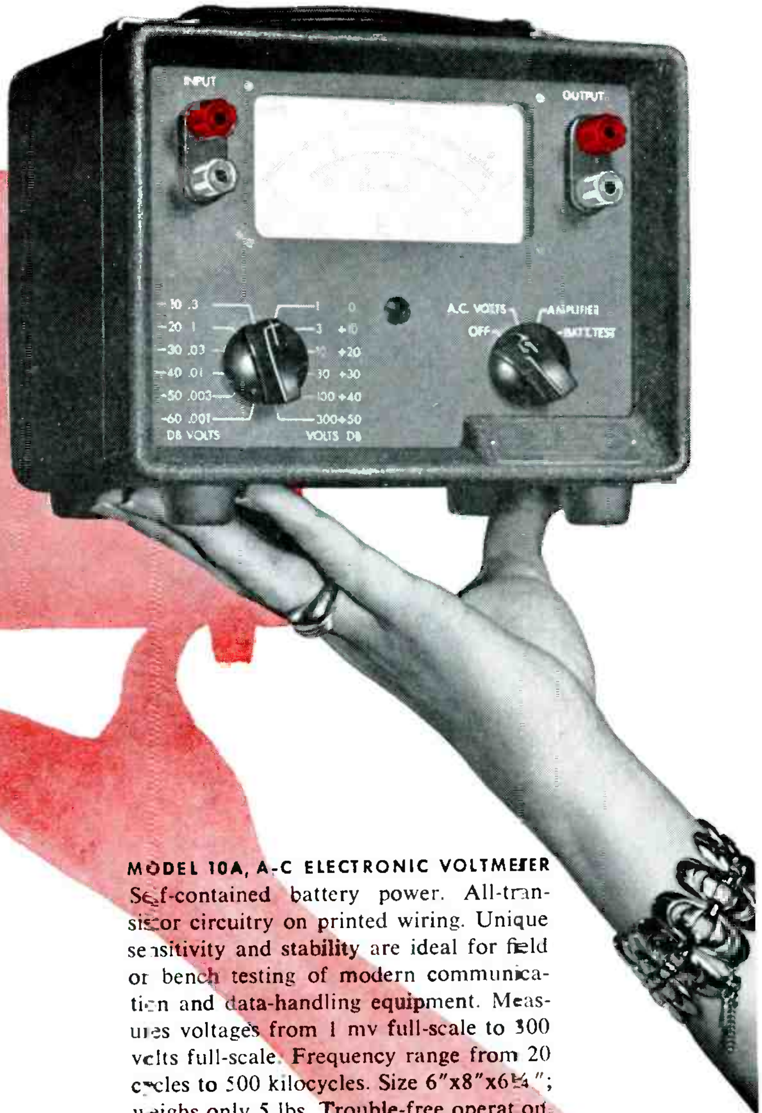

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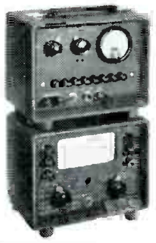

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1 mv to 300 v full-scale

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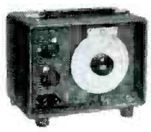

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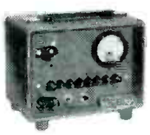

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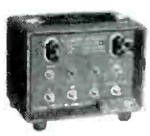

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OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD tations presented two problems: small electrode diameters require the beam to utilize a large cross section of the lenses resulting in excessive aberration, and low anode voltages cause the spot size to become unacceptably large.

Excessive abberation is avoided by keeping the beam narrow as it enters the focusing lenses and by minimizing beam deviation from the axis. This was accomplished by using closely spaced focusing lenses which tend to return the beam to the axis when deviations occur.

Large spot size is circumvented by designing the first lens (the immersion lens) in such a manner that

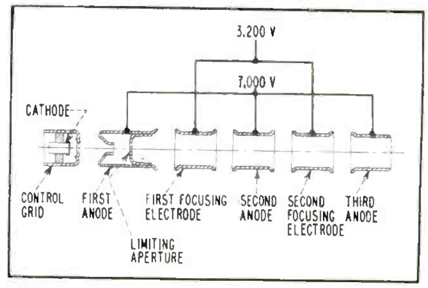

FIG. 1—Basic design of periodic focusing triode color-tube gun

its strength is maintained while the voltage ratio, and consequentially the focal length, of the focusing lenses are kept the same as in high voltage guns. This is accomplished by shifting the principle planes of the lens system toward the phosphorus screen by using two saddle field lenses on each gun.

▶ **Design Considerations**—Both triode and tetrode guns were built and tested. Although tetrodes exhibited smaller beam angle deflections, triodes were preferred since they can be more easily assembled—a feature which gives better overall performance. The basic design of the triode is shown in Fig. 1.

Cylindrical electrodes are used because the spacing between focusing electrodes and anodes can be made small enough to keep penetration by external fields at a negligible level. Each electrode is approximately one diameter long with the exception of the first anode which is two diameters long. These lengths developed from a compromise between the necessity for shifting the principle planes farther forward to assure acceptable spot size

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TM105	1000	400	.5
TM84	800	1000	.5
TM85	800	400	.5

AXIAL LEADS . . . RATINGS AT 100°C AMBIENT

Type	Maximum Inverse Operating Voltage (volts)	Maximum Average Forward Current (ma)	Maximum Average nverse Current (full load) (ma)
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1N560	800	250	.3

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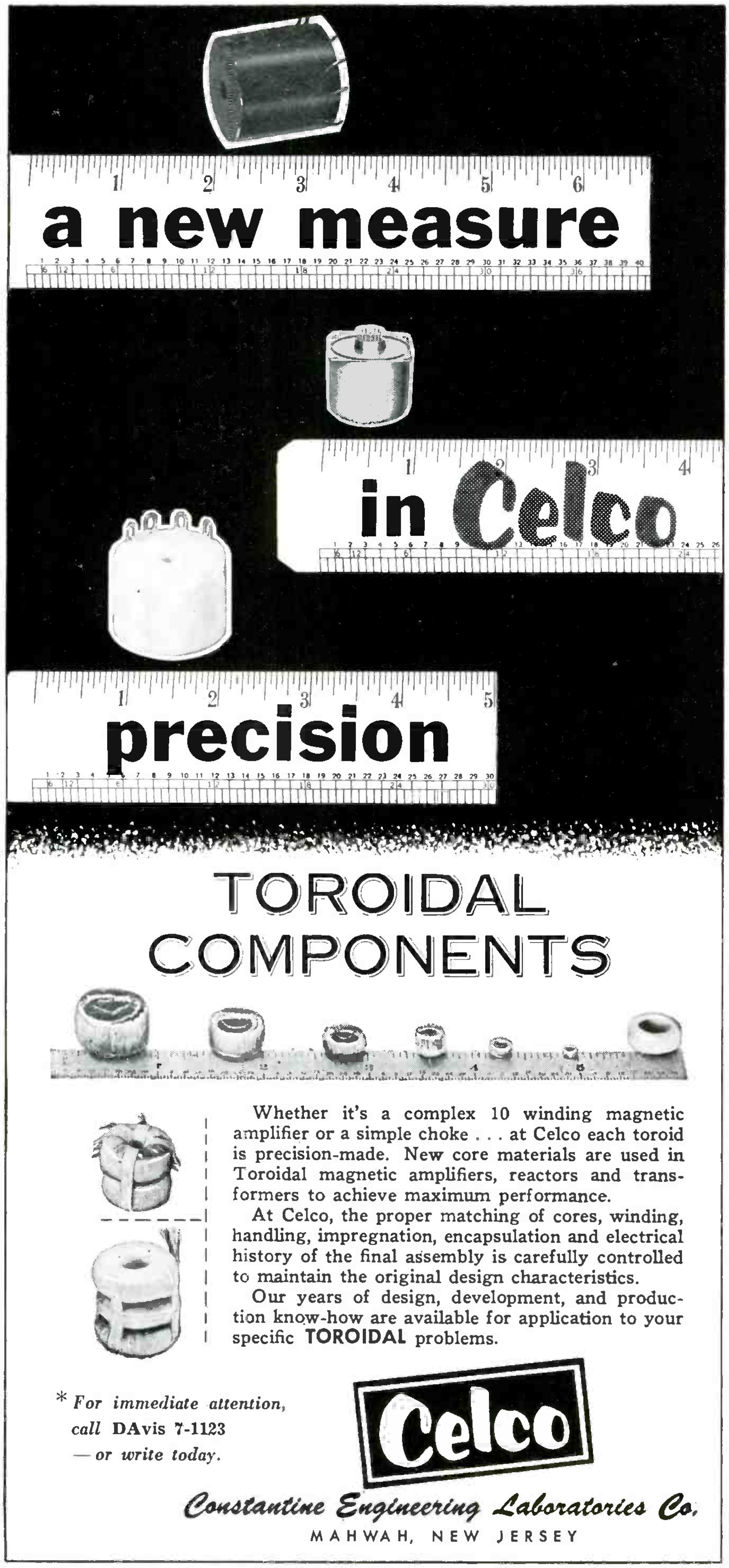


and necessity for establishing short distances between focusing lenses to prevent excessive aberration.

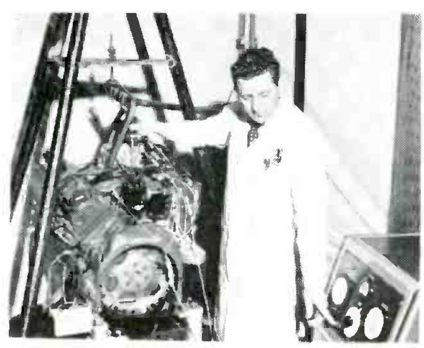
Periodic electrostatic focusing is used because it provides the simplest construction consistent with high performance.

▶ **Gun Construction**—The area around the control grid aperture is coined. This configuration causes the crossover to form in a region where the equipotential planes between the control grid and first anode are parallel. Under these circumstances, minimum aberrations are introduced by the field in the vicinity of crossover and the beam can be kept narrow without using a prefocusing lens.

A limiting aperture is placed in the first anode to limit the beam diameter before it enters the first focusing lens. Since the limiting aperture is close to the crossover point, good alignment of the aperture and the beam can be achieved. Secondary electrons emitted at the edge of the aperture are retarded by the decelerating field produced by the first focusing electrode. To maintain a constant voltage ratio regardless of voltage fluctuations, the focusing potential should be obtained from the anode voltage supply by means of a voltage divider.

▶ **Gun Performance** — Measurements of spot size, beam diameter,

Balancing Automobile Engines



Balancing system developed by General Motors for detecting dynamic unbalance in production line testing of engines provides faster and simpler quality control. Magnetic pickups placed at each end of the engine are used to detect unbalance. Synchronizing pulses from the engine ignition are employed to determine location of unbalance. The unbalance is then eliminated by weighting the fanbelt pulley or flywheel

and resolution were made with the gun assembly mounted in a monochrome tube. The exit end of the guns were placed 15¾ inches from the screen of the monochrome picture tube.

Spot size was determined by measuring the width, at half amplitude, of the distribution curve for spot brightness. At a screen current of 300 microamperes the spot size was 0.038 in. The size of the beam was measured from edge to edge using a wire mesh at the gun exit. This dimension was 0.130 in. at a screen current of 300 microamperes.

Assuming there is Gaussian current distribution, the beam diameter calculated at the half amplitude point of the current distribution curve, was estimated to be less than 0.075 in. at the gun exit and less than 0.060 in. in the plane of deflection. Therefore, the depth of focus is satisfactory.

Resolution, measured with an Indian head pattern chart, is over 500 X 500 lines at 200 microamperes screen current and about 480 X 480 lines at 300 microamperes screen current.

This article has been abstracted from a paper "Low Voltage Color Tube Gun Assembly with Periodic Focusing" by P. H. Gleichauf and H. Hsu of the Thermionics Section, General Electric Research Laboratories.

Pen Recorder Resolution Increase

By N. D. Diamantides
Goodyear Aircraft Corp.
Akron, Ohio

Usefulness of any multichannel direct-writing recorder can be extended by a relatively simple circuit in applications where recording resolution higher than ordinarily available in a single channel of the particular apparatus is necessary.

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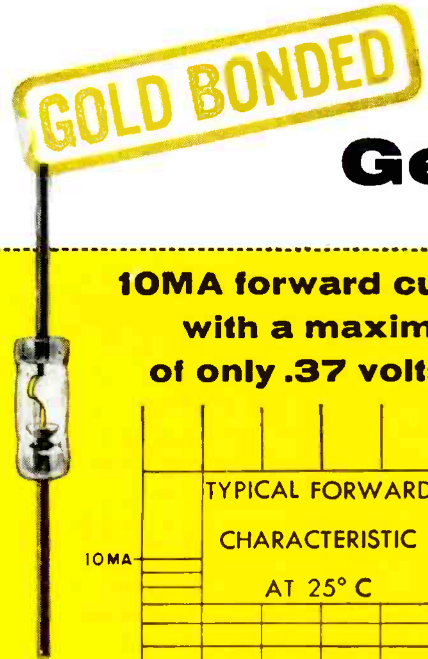

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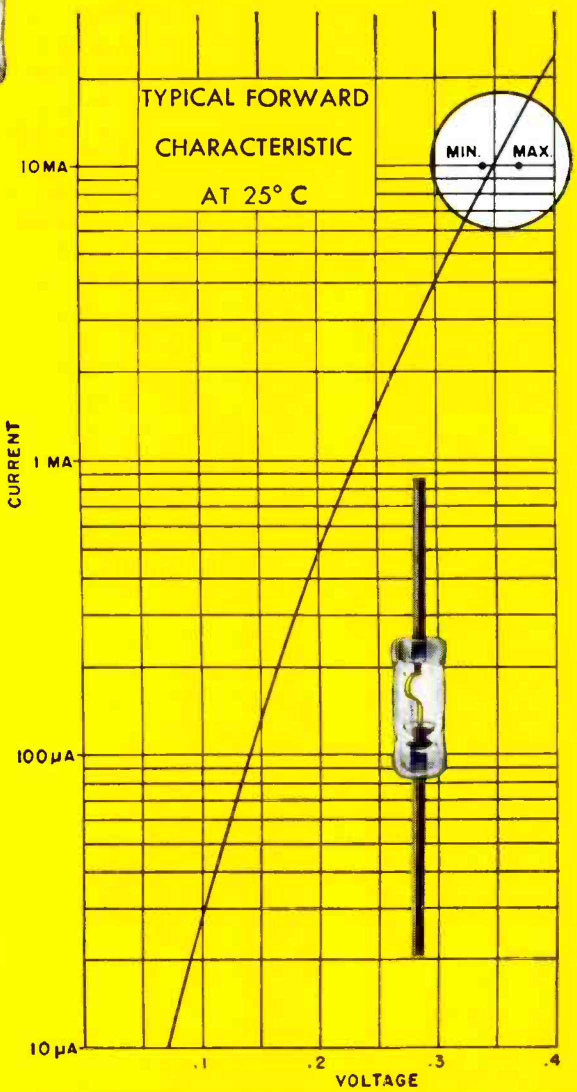

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Maximum	0.37V	0.37V	0.37V
Maximum reverse current at −10V	10UA	10UA	10UA
Peak inverse voltage	60V	40V	30V

Maximum ratings at 25° C

	DR 385	DR 434	DR 435
Maximum inverse operating voltage	50V	30V	20V
Continuous DC forward current	100MA	100MA	100MA
Surge current for 1 second	500MA	500MA	500MA
Average power dissipation	80MW	80MW	80MW
Derating above 25° C	10MW/10°C	10MW/10°C	10MW/10°C

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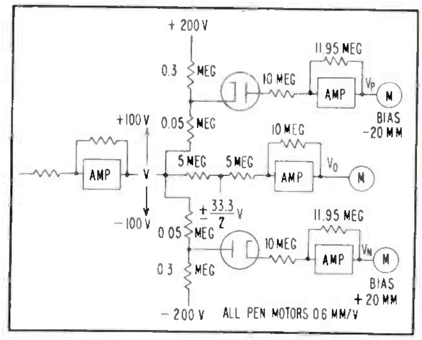


FIG. 1—Series-limited and two threshold-biased amplifiers

of millimeters per volt and sufficient channel width measured in mm on the recording paper. Increasing recorder sensitivity to a satisfactory level is not usually a problem provided care is exercised to avoid stray pickups.

Trying to accommodate a relatively widely varying quantity within the ±20 mm of the paper channel (as in certain standard six-channel recorders) renders useless any advantage that the increased sensitivity affords. The following arrangement aims at the alleviation of the difficulty. Suppose that voltage V to be recorded varies in the range ±100 v and that the paper channel width is A = ±20 mm while the maximum sensitivity available is $s = 0.2$ mm per volt.

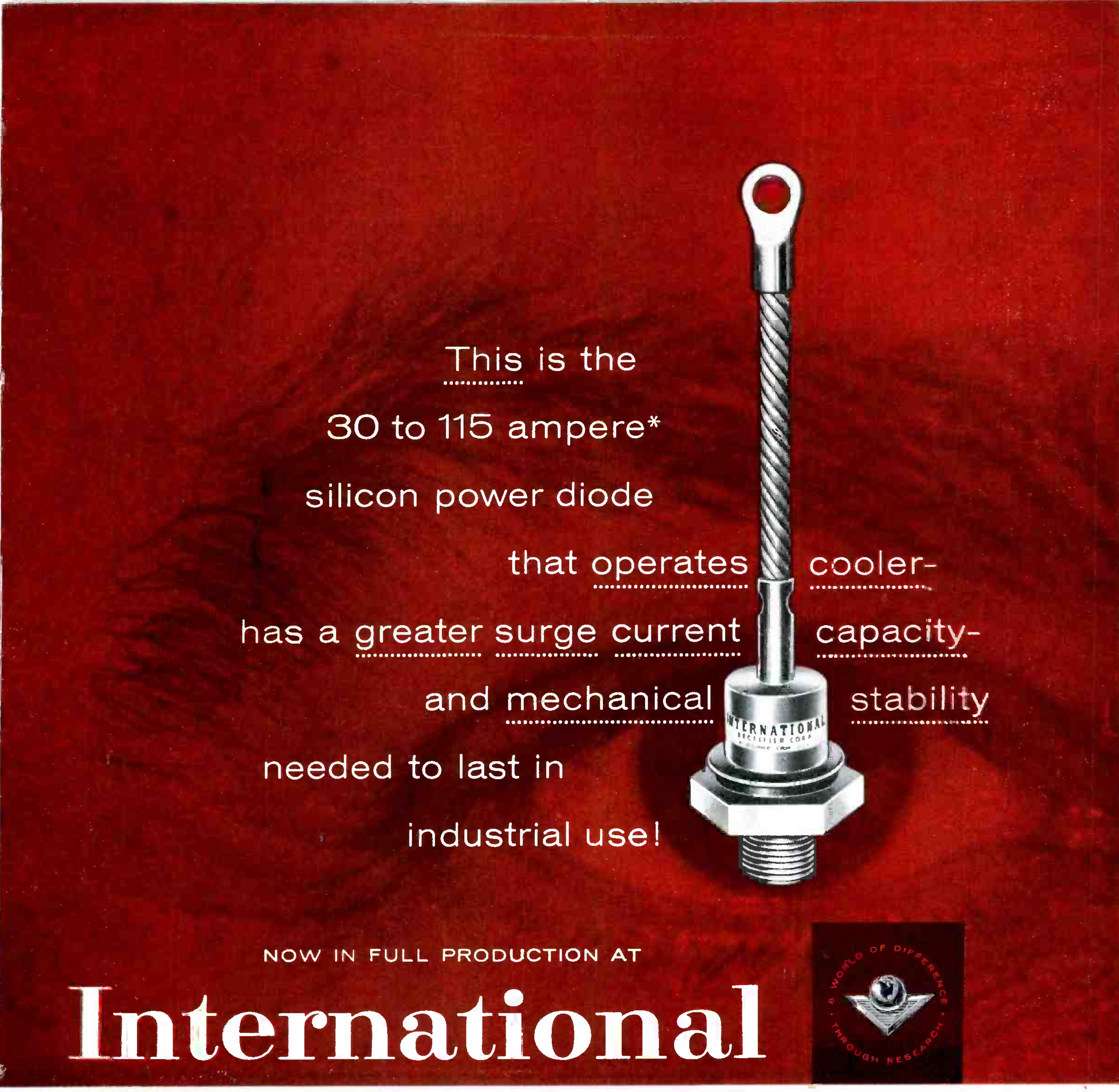
This satisfies the necessary condition $A = V_s$. It is also possible to split the range of V in $n = 3$ equal parts.

$$-100 \text{ v} \lesseqgtr V_n \lesseqgtr -33.3 \text{ v}$$
$$-33.3 \text{ v} \lesseqgtr V_o \lesseqgtr +33.3 \text{ v}$$
$$+33.3 \text{ v} \lesseqgtr V_p \lesseqgtr +100 \text{ v}$$

This can be done easily using one series-limited and two threshold-biased amplifiers as shown in Fig. 1.

Channel sensitivity can be increased by a factor n since now the range V volts can be accommodated in a paper width $A_n = An$. The only drawback is slicing the recording into three separate graphs. Figure 2 represents an actual recording of a random wave blown up threefold.

► **Accuracy**—In the meter-movement type assumed here there exists a pen-motor-accuracy figure ϵ (say ±2 percent of full travel) which is generally different at dif-



*Half wave circuit

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ferent portions of the range. This pen-motor accuracy effect is reduced to ϵ/n.

Reading-accuracy, which is at the most ± 0.25 mm and which therefore represents $\pm 0.25\ V/A$ volt is also improved to $\pm 0.25\ V/An$ volt. Influence of the limitors remains to be examined.

For the threshold condition point A is at zero voltage, which means that $e_i/R_1 = +B/R_2$ and since $e_i = V/n$ it follows that $R_2/R_1 = nB/V$.

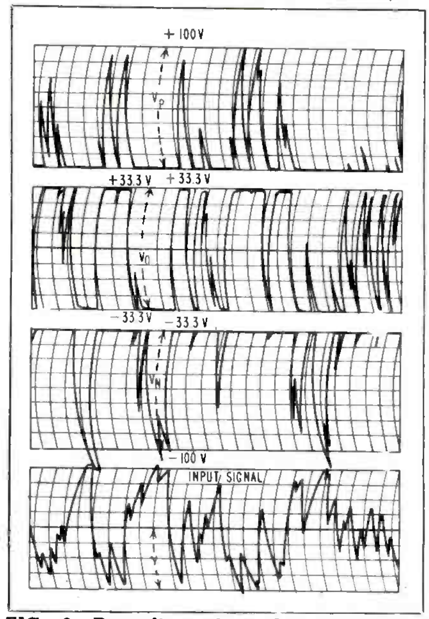


FIG. 2—Recording of random wave is split into various range values

Thus $R_1 = 0.05$ meg, $R_2 = 0.3$ meg.

Beyond the threshold condition the effective zero on the resistor MN (Fig. 3) moves to a distance β so that the loading effect of the resistor R + r has to be taken into account. For a 6AL5 diode the effective plate resistance is 300 ohms $< r <$ 700 ohms, which becomes negligible if R is chosen large, for instance $R = 10$ meg. Then

$$\frac{e_i}{R_1 + \dfrac{\beta R_2 R}{\beta R_2 + R}} = \frac{B}{R_2 (1 - \beta)}$$

Substitution of the parameter values mentioned previously and assuming $B = 200$ volts will result in $\beta = 0.222$ and $e_A = 56.98$. Since the output e_o has to be 66.66 volts the feedback resistor becomes

$$R_f = R\frac{e_o}{e_a} = 10\,\frac{66.66}{56.98} = 11.7 \text{ meg}$$

The above resistance values re-

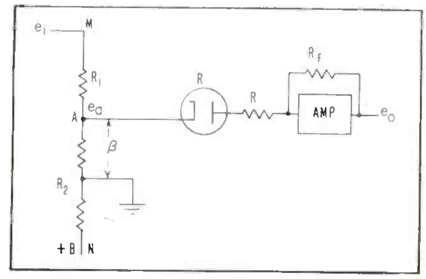


FIG. 3—Threshold circuit

sult in an error of -4 percent at the low end of range V_n where $e_i = 33.33$ volts. Increase of the feedback resistance to $R_f = 11.95$ meg results in a $+2.1$-percent error at the high end ($e_i = -100\ n$) and -2.1 percent at the low end ($e_i = -33.33\ n$) of range V_n.

► **Limiter Circuit**—The inaccuracy introduced by the limiter circuit is of less importance than that of the threshold. Once the limit value is reached the part of the recording beyond it is of no significance. At the limiting condition and for the shunt input-limiter employed, the nodal equations at the amplifier input (Fig. 4) and at both sides of the diode are

$$\frac{e_B - e_A}{R_1} + \frac{e_B - e_o}{R} = 0$$

$$\frac{e_A - e_i}{R_1} + \frac{e_A - e_B}{R_1} + \frac{e_A - e_C}{r} = 0$$

$$\frac{e_C - B}{(1-\beta) R_o} + \frac{e_C - 0}{\beta R_o} + \frac{e_C - e_A}{r} = 0$$

Simplifying this system and taking into account that $e_B \cong 0$ it is found

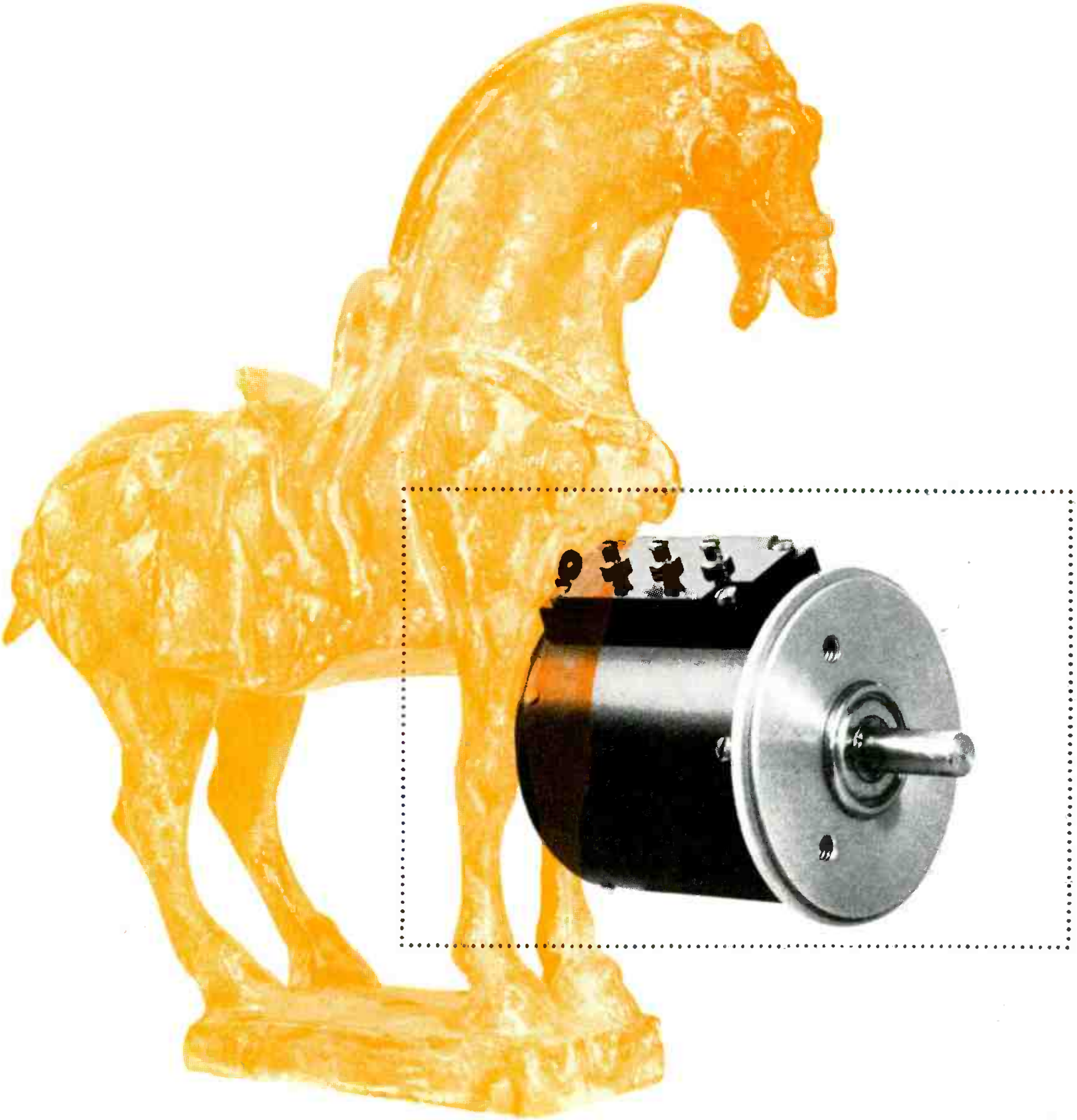
$$e_o = \frac{\dfrac{R e_i}{R_1}}{1 + \dfrac{R_1}{2\beta (1 - \beta) R_o}} - \frac{\beta R}{R_1} \; \frac{B}{1 + \dfrac{2 \beta (1 - \beta) R_o}{R_1}}$$

If $R_o << R_1$ this equation gives

$$e_o = - \frac{R}{R_1} B$$

Since the maximum value of the factor $2\beta\ (1 - \beta) = 1/2$ occurs at $\beta = \frac{1}{2}$ the maximum error introduced by the first term in the expression for e_o will be

$$\Delta e_o = - \frac{R}{2 R_1} \; \frac{\theta}{1 + \dfrac{2 R_1}{R_o}} e_i$$



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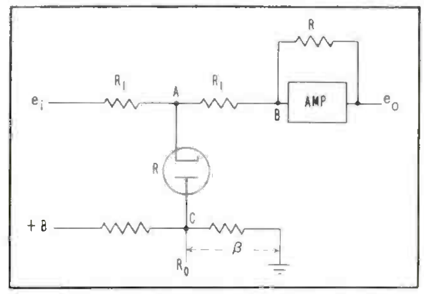


FIG. 4—Nodal equations are based on this circuit

which for $e_i = 100$ volts and $R_o/R_1 = 0.01$, $R/R_1 = 2$, $\Delta e_o = 0.5$ volts or 0.5 percent.

Ordinary analog computer applications do not tax the frequency response capabilities of recorders heavily. For recordings with higher frequency content the extended resolution will be bought at the expense of definite attenuation. Since the pen tip is forced into displacement n times larger than under ordinary recorder operation, reactive forces owing to friction increase by a constant proportional to n while forces resulting from acceleration increase by a factor proportional to n^2. This is equivalent to saying that the dynamic range of the recorder is reduced accordingly.

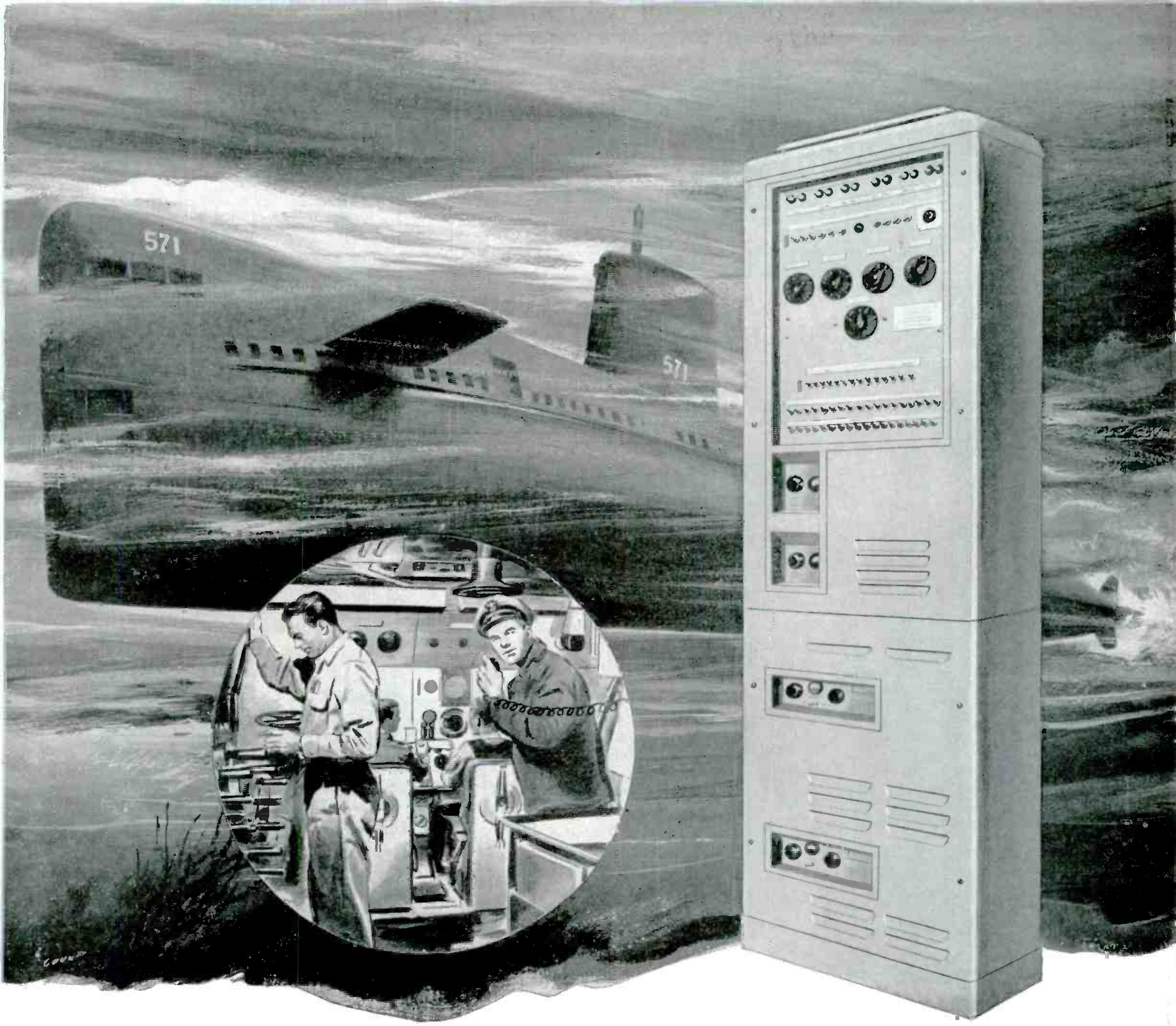
Avoiding Blown Fuses With Capacitative Loads

By Sergio Bernstein
General Precision Laboratory Inc.
Pleasantville, N. Y.

Fuse blow-outs that occur in regulated power supplies when switching large capacitive loads are annoying to laboratory engineers but intolerable to the broadcast engineer.

The most economical way of operating a large installation of electronic equipment, as in a broadcast studio, is to have the equipment necessary left on stand-by operation. Only filament power is applied continuously and the equipment is instantly operative when B+ power is switched on.

In such large installations it is also economical to have a single large rectifier supplying unregu-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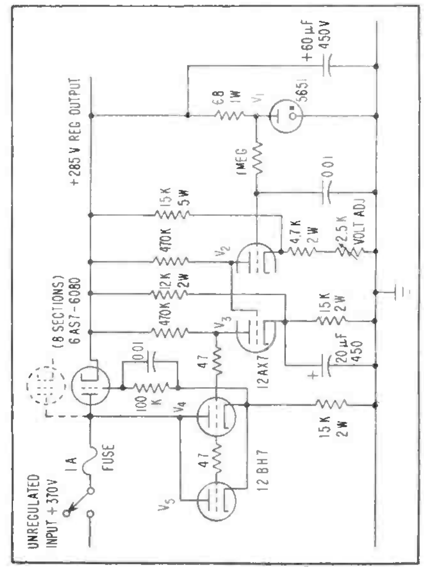

FIG 1—Circuit of typical electronic regulator

lated d-c power. Electronic equipment is then used to supply regulated B+ power to individual equipments.

A typical regulator such as that in Fig. 1 is designed for 1-ampere capacity. The input voltage is 370 volts and the output voltage is 285 volts. Each regulator includes a high-gain d-c amplifier and four type 6AS7 (6080) series regulator tubes.

Depending on the B+ power requirements of the equipment, one or more such regulators is used to furnish plate power.

With either input or output switching, the regulators are forced to deliver not only the normal steady-state B+ current, but also a very high momentary peak current required to charge all the bypass capacitors in the equipment. In large equipments, it is not inconceivable that the total capacitance appearing on the B+ bus is in the order of 200μf.

Thus, if the steady-state current for a particular equipment is 1 ampere at 285 volts, the transient load as seen by the regulator will be a resistor of 285 ohms shunted by a capacitor of 200μf.

Immediately after switching, because voltage is prevented from rising abruptly, the cathodes and grids of the series regulator tubes are at ground potential and the plates are at 370 volts.

Extrapolation of tube characteristics for a 6AS7, shows a surge

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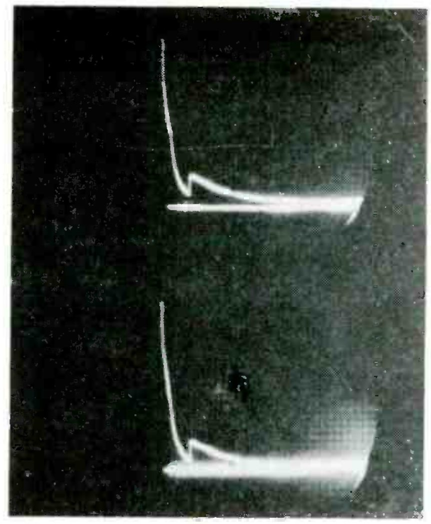


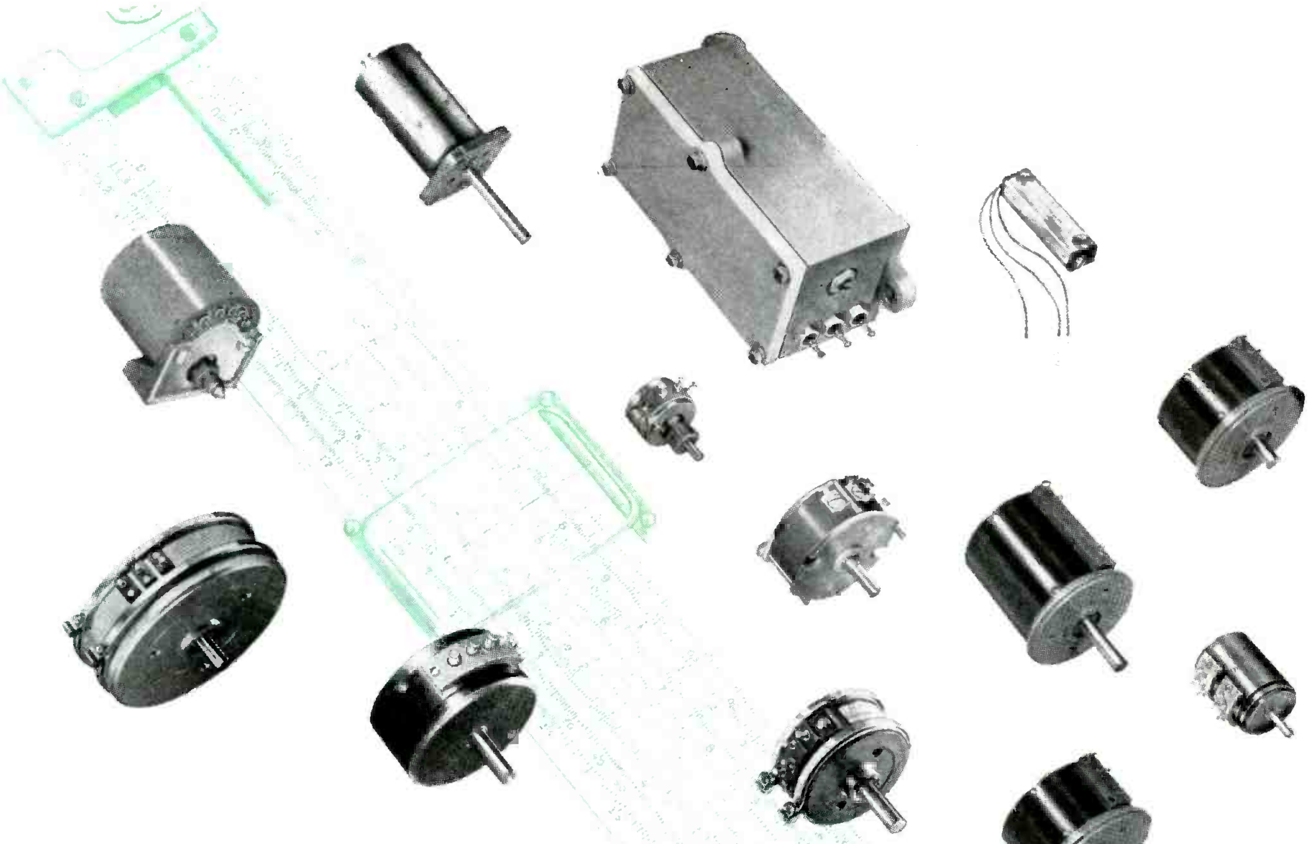
FIG. 2—Input switching transient (above) with 285-ohm and 200 μf load. Output switching transient (below) under same conditions

current of approximately 1,400 ma. a section; for a 1-ampere regulator, which uses a total of 8 sections, a total surge current of 11 amperes is to be expected. By actual measurements the peak current was found to be 18 amperes or approximately 2.25 amperes a section.

Figure 2 (above) delineates the actual switching current transient. It takes about 70 milliseconds for the regulator to recover from the switching transient and deliver only its normal current of 1 ampere.

When the load is applied to the output side of the regulator, the output is momentarily short-circuited by the capacitive component of the load and the regulator circuit decreases the grid bias on the series regulator tubes to deliver the large current demanded. (Figure 2 (below) is a photograph of the output-switching current transient. It is similar to the input-switching transient shown in Fig. 2 (above).

Several possible remedies for preventing fuse blowouts are unsatisfactory. Fuses of the slow-blow variety have been tried and have also failed, although less frequently than regular fuses. An inductor in the unregulated supply lead capable of carrying a current of 1 ampere continuously and having the inductance required, would be large in size, weight and cost. A series current-limiting resistor and shorting switch is not a practical



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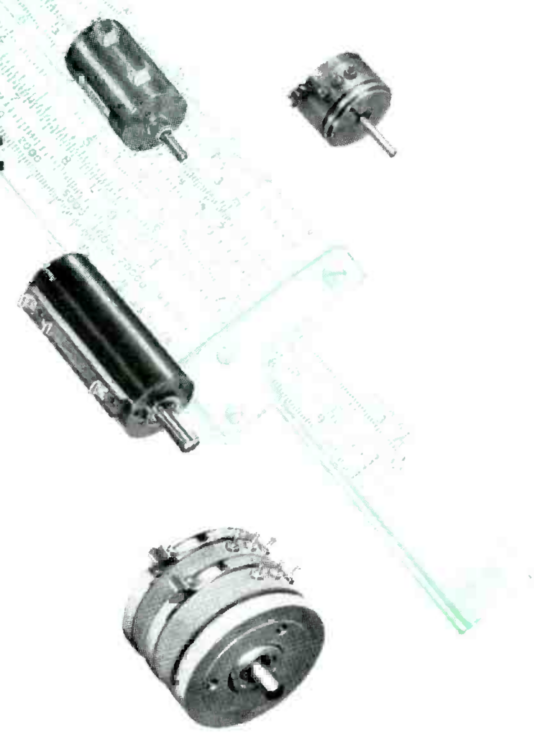

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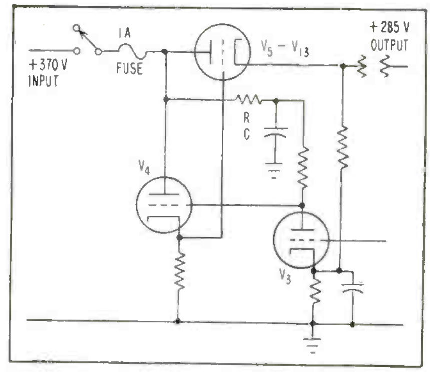

FIG. 3—Addition of R-C network to reduce input-switching transient

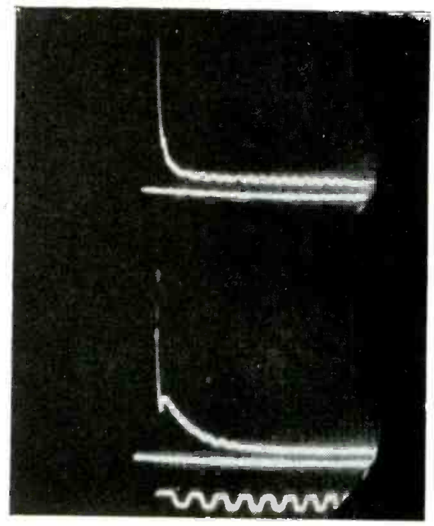

FIG. 4—Output transient using diode circuit (above) and without diode (below)

solution.

If the grids of the series regulator tubes are kept at ground potential when the unregulated voltage is turned on, any voltage appearing on the output side of the regulator will produce a negative bias on the series regulator tubes. The current in the load, therefore, will be limited by the bias voltage that is developed.

If the grid voltage on the series regulator tubes is allowed to rise slowly, the current in the load cannot increase faster than this rise in grid voltage. The capacitors loading the regulator will be charged slowly.

A transient occurs because initially the cathodes as well as the grids of the series regulator tubes are at ground potential. Until some bias is developed across the load, the 6AS7's conduct at zero bias. This transient lasts only about 15 milliseconds and a 1 ampere fuse can carry this short overload.

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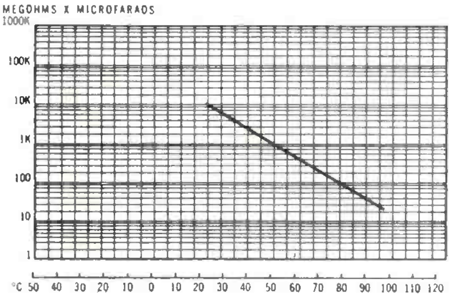

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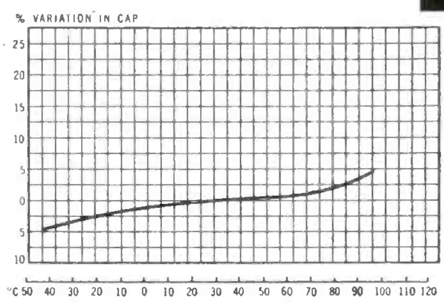

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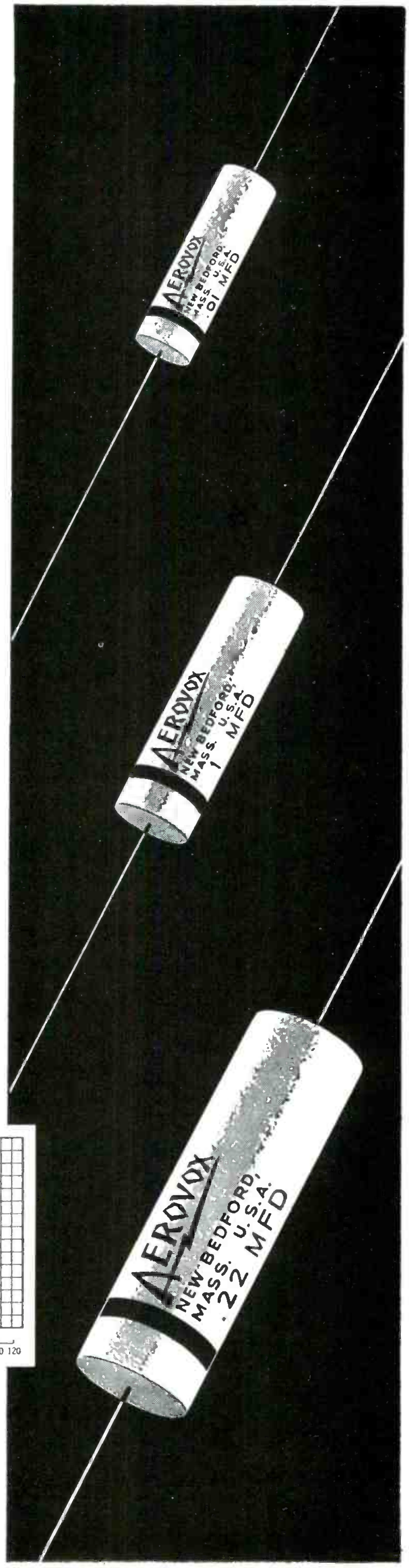

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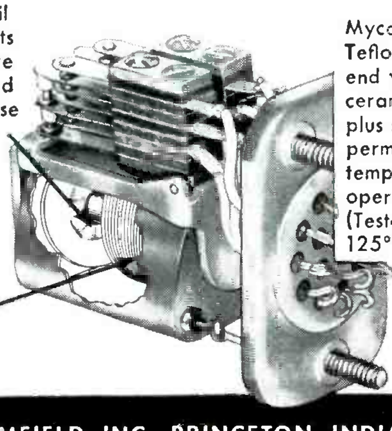

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of Fig. 1 was modified by the addition of resistor R and capacitor C to obtain the desired slow rise of grid voltage. The value of R is chosen such that the available plate supply voltage for V_3 is equal to or larger than it was previously. If R is made too large, the plate supply voltage for V_3 is lowered and the grid bias on the series regulator tubes will not be reduced enough

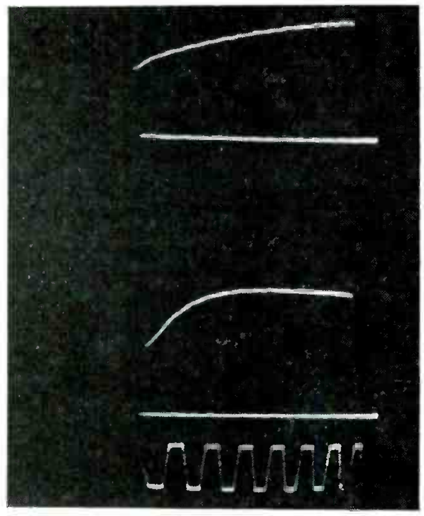

FIG. 5—Output voltage transient due to output switching with R-C network and diode (above). Transient without network or diode (below)

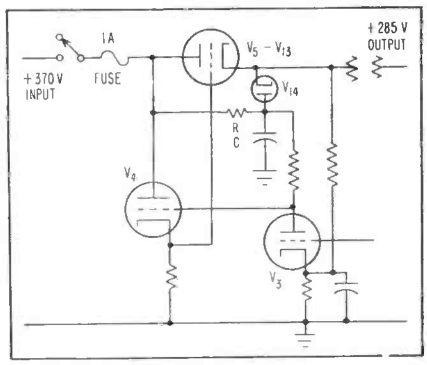

FIG. 6—Addition of diode V_{14} to reduce output switching transients

when the regulator is required to deliver large currents.

Any value between 220,000 and 560,000 ohms was found to be adequate. The value of C is chosen such that the product of RC is greater than the duration of the switching transient. It was found that by using a capacitor of 0.25 μf and a resistor of 390,000 ohms the transient due to input switching was reduced as shown in Fig. 4. After the initial high surge, the current drops gradually to its steady-state current of 1 ampere, instead of rising again to about 4 amperes as in Fig. 2. A regular 1-ampere fuse withstands the reduced transient repeatedly without blowing-out.

Output voltage rises rapidly after the switching transient in Fig. 5. If a diode is connected as shown in Fig. 6 it will not affect operation of the regulator circuit. If R is chosen such that the plate supply voltage of V_3 is equal to or greater than the voltage output of the regulator and the voltage on C tends to rise above the output voltage of the regulator, the diode will conduct. This effectively restores the circuit to that of Fig. 1.

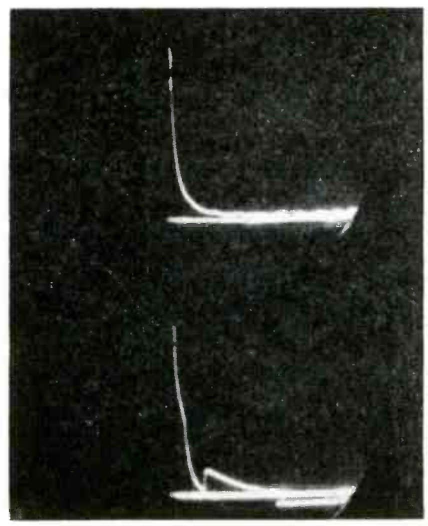

FIG. 7—Input switching transient using R-C circuit (above) and without (below)

When load is suddenly applied to the output of the regulator, the diode is automatically disconnected from the circuit while C recharges through R. The diode cathode voltage is higher than its plate voltage by an amount equal to the bias on the 6AS7 regulator tubes.

A delayed rise in output voltage is thus automatically obtained as shown in Fig. 5 and the current transient is reduced as shown in Fig. 7. A regular 1 ampere fuse can now be used when either method of switching is used.

A neon lamp such as a type NE-2 can be used in place of the diode. However the C will not be discharged as much with the neon lamp circuit as with the diode circuit, because the neon lamp has a voltage drop in the neighborhood

of 50 volts and a higher internal resistance than the diode. The transient due to output switching when using a neon lamp is greater than the transient obtained when using a diode. Although ordinary fuses blow when a neon lamp is used, slow-blowing fuses withstand repeated switching transients.

The work described was done while the author was with Tel Instrument Co., Inc., Carlstadt, N. J.

Magic Tee Techniques Refine Load Matching

Alan C. Macpherson
Solid State Electronics Branch
U. S. Naval Research Laboratory
Washington, D. C.

An ideal magic tee, as shown in Fig. 1, will give no output power from arm 3 when arms 1 and 2 are loaded equally and power is fed into arm 4. This characteristic is usually used to match a variable load A to an arbitrary fixed load B. It is apparent that unsymmetrical tees used in the same manner will not give the desired results. This difficulty can be eliminated by utilizing another variable load C and performing a two-step matching procedure.

Initially, loads C and B are placed on arms 1 and 2 respectively and load C adjusted until minimum power output is measured at arm 3. When this is accomplished, load B is replaced by load A and the latter adjusted until the output is nulled once again.

Since power input and detector sensitivity are finite, the reflection coefficients of the loads may not be identical. The limits of this error can be evaluated by various methods (ELECTRONICS, Sept. 1950, p 190). Although small defects in the tee cause a slight decrease in sensitivity while adjusting load A, the output is not significantly affected.

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TYPE	VOLTAGE (volts)	CURRENT (milliamperes)	INTERNAL IMPEDENCE (ohms)	ADDITIONAL SPECIFICATIONS
Beam	200 to 2000 1800 to 3600	0 to 125 0 to 100 to 2500V 250 W to 3600V	0.5 max. from 0 to 10,000 cps	Voltage Dial Accuracy: ± 1% Resolution: 0.5 volts Regulation: 0.03% from 105 to 125 volts Ripple: 3 mv rms, max.
Reflector	Negative 0 to 1000		1,000,000 min.	
Control Grid	Positive 0 to 150 Negative 0 to 300	0 to 5	0 to 30,000	Regulation: 0.03% from 105 to 125 volts Ripple: 3 mv rms, max.
Filament	6.3	3 amperes		Unregulated

MODULATION

TYPE	FREQUENCY RANGE (cps)	NOMINAL VOLTAGE (volts)	RISE TIME (microseconds, max.)	FALL TIME (microseconds, max.)
Square Wave	250 to 2500	0 to 200	1.0	1.0
Pulsed Wave	1 to 10 microseconds pulse width	0 to 200	1.0	1.0
Sine Wave	line frequency	0 to 200		
Saw Tooth Wave	40 to 120	0 to 200	Variable	30

DIMENSIONS (inches)	Width: 21¾ Height: 15¾ Depth: 18
OVERLOAD PROTECTION	AC Line: Fuse, 8 amperes, (both sides of line) HV Line: Fuse, 4 amperes DC HV Line: Variable overload relay 25, 65, & 125 ma or as desired by user
POWER	105 to 125 volts, 50-60 cps, 300 to 800 watts

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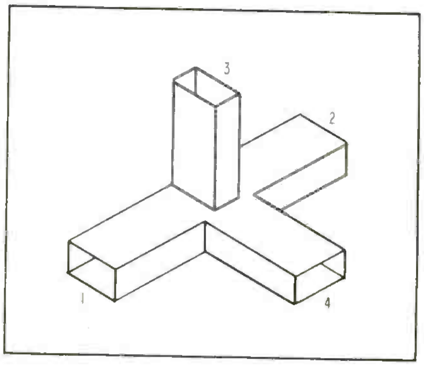


FIG. 1—Magic-tee network used to match variable load to an arbitrary fixed load

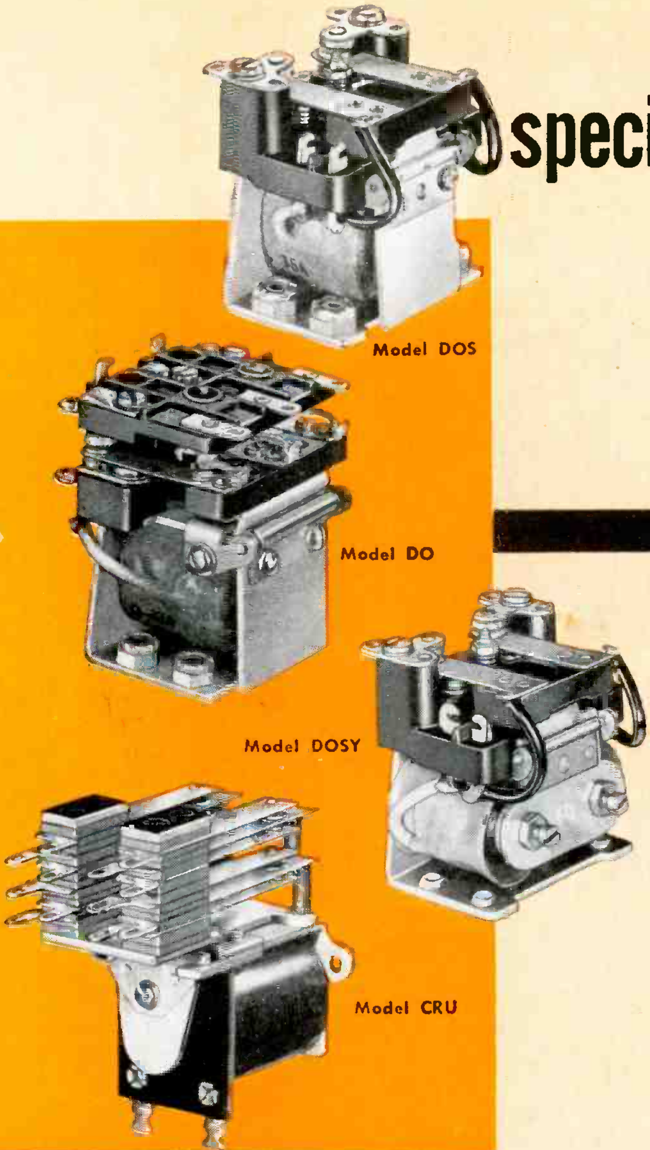
the load permitting it to slide back and forth without producing a discernible indication at the detector. When set up in this manner, the termination is reflectionless within the sensitivity range of the detector.

The ideal magic tee provides a sensitive means for making adustments simultaneously on two sliding loads. The preliminary setup consists of placing sliding loads X and Y in arms 1 and 2 respectively, mounting a sensitive matched detector in arm 3 and applying power to arm 4. When this is accomplished load X is slid back and forth changing the phase angle of the reflection coefficient which, in turn, varies the power output at arm 3 as indicated by

$$P_3 = \frac{P_4}{4}\left[|S_X|^2 + |S_Y|^2 - 2|S_X||S_Y|\cos(\theta_X - \theta_Y)\right]$$

where P_3 is the power output at arm 3, P_4 is the net input power at arm 4, S_X is the reflected coefficient of sliding load $X = S_X\exp(j\theta_X)$, S_Y is the reflected coefficient of sliding load $Y = S_Y\exp(j\theta_Y)$, θ_X is the phase angle of S_X and θ_Y is the phase angle of S_Y.

Maintaining zero power output at arm 3 while positioning X and Y terminators requires careful adjustment of the loads. However, since tees have defects, it is practical to adjust the loads until some power is delivered to the detector. This power remains constant while loads X and Y are positioned. Although S_X and S_Y are small, this adjustment is sensitive because a small variation of θ_X or θ_Y produces a large change in P_3.



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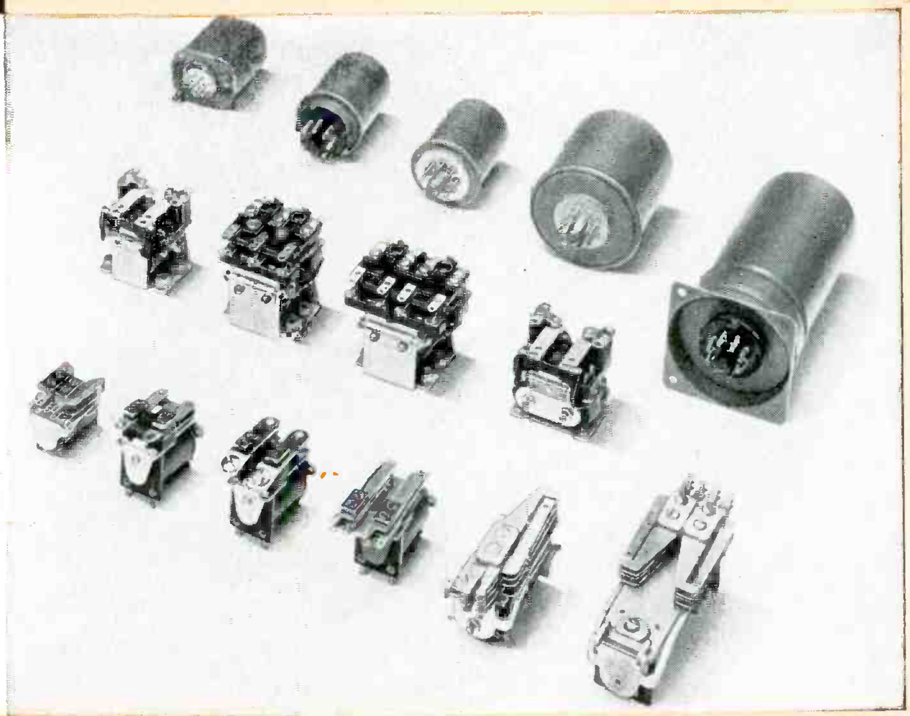

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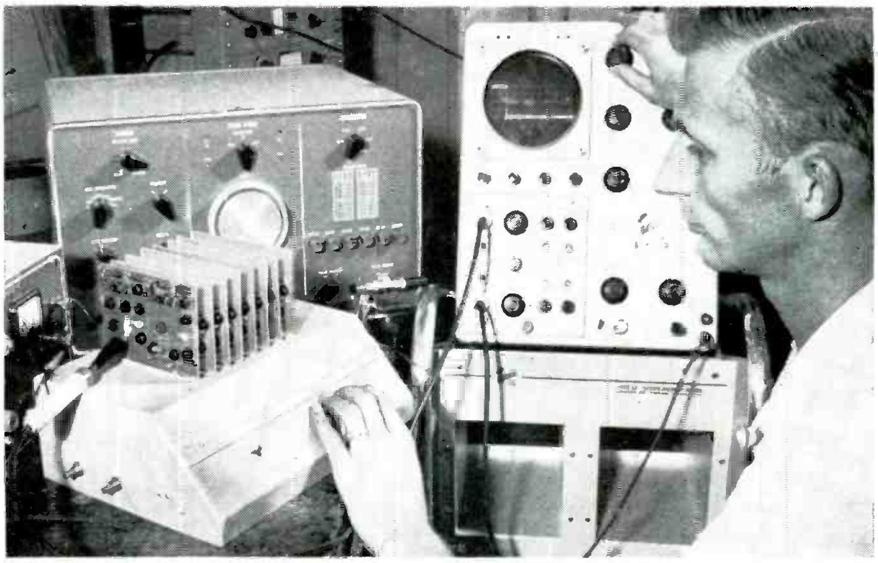
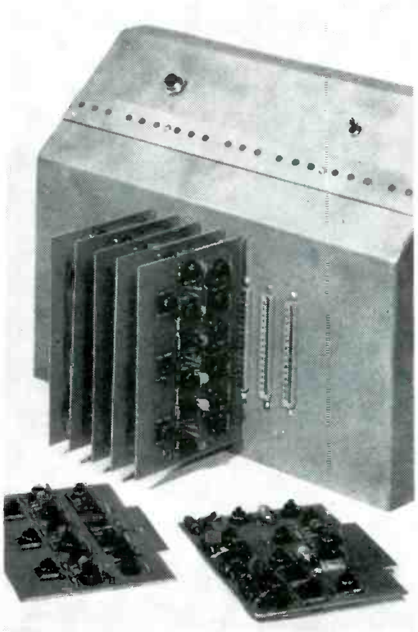


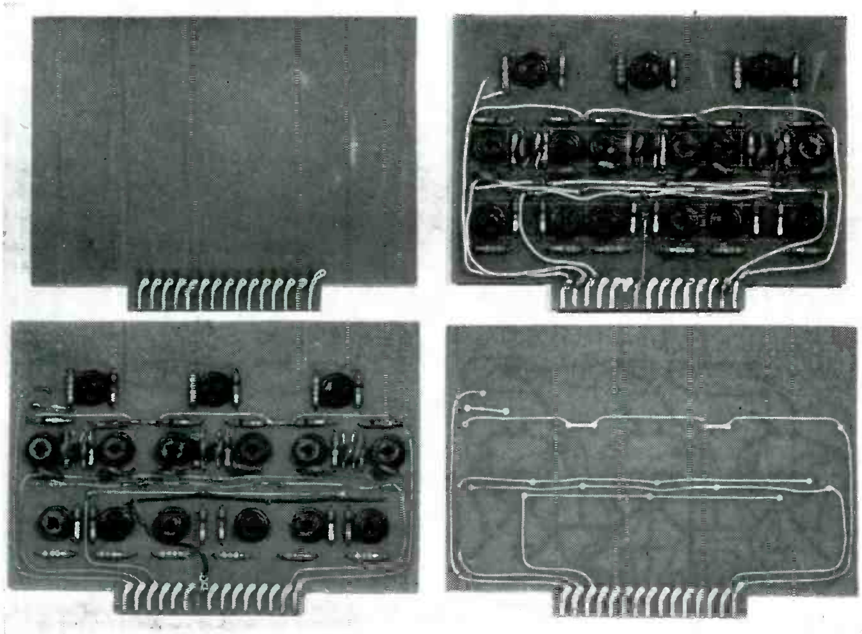
Testing broadboards put together on cards having same printed connector tabs as will go on final printed circuits for digital computer

Simulated cards may be used as models by a layout draftsman who is inexperienced in layout and unfamiliar with components used, since all parts and wires are already essentially in final positions. The model provides a fast check reference for detecting errors in drafting layout.

For small quantities, the bread-



Simulated printed circuit cards can be plugged directly into standard printed circuit connectors to make up prototype model of output display register for digital computer



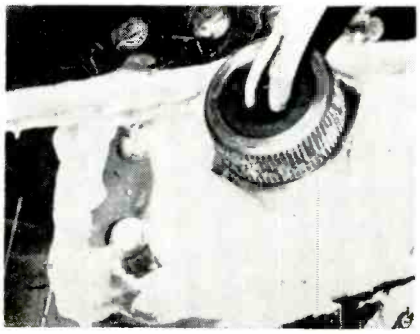
Four steps in designing and producing printed circuit card. Upper left—blank card with etched connector tabs. Upper right—simulated printed circuit card, on which parts have been mounted by hand in final positions and insulated wires run along routes of final etched wiring. Lower right—final card with etched wiring on both sides. Lower left—final card with components installed, ready for use

boards may be used in lieu of printed circuits. A complete simulated board model of average complexity can be turned out in 2 days and converted to printed circuitry in about 2 weeks, whereas conventional transition from diagram to printed circuitry required almost twice that time and much greater expense.

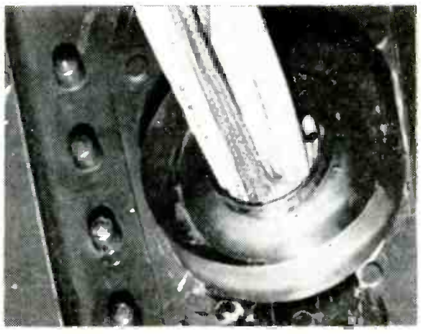
Molding Pressure Seals for Wire Bundles at Bulkheads

SEALS FOR ELECTRICAL wiring passing through bulkheads that must withstand critical pressure and temperature differentials are now molded in place at Douglas Aircraft Co. by a new method based on Thiokol liquid polymers.

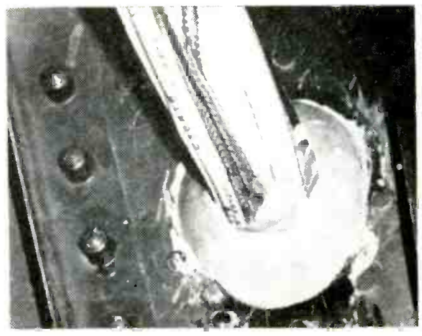
This method has been adopted for the Douglas F4D Skyray be-



Former method of using connectors

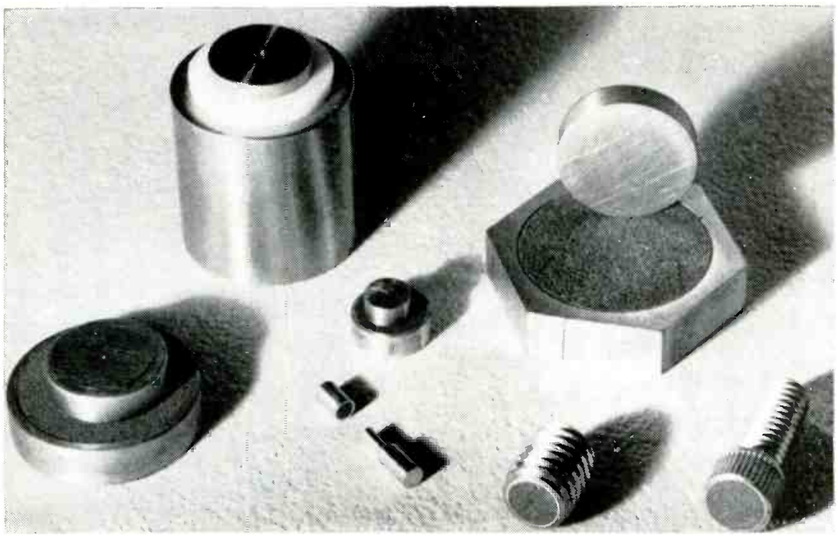


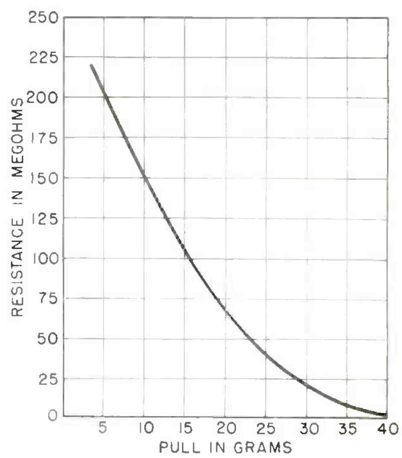
Plastic mold in place, ready for pouring



Completed hemispherical rubber seal

Design of the Month: RARE-EARTH STRAIN CELLS



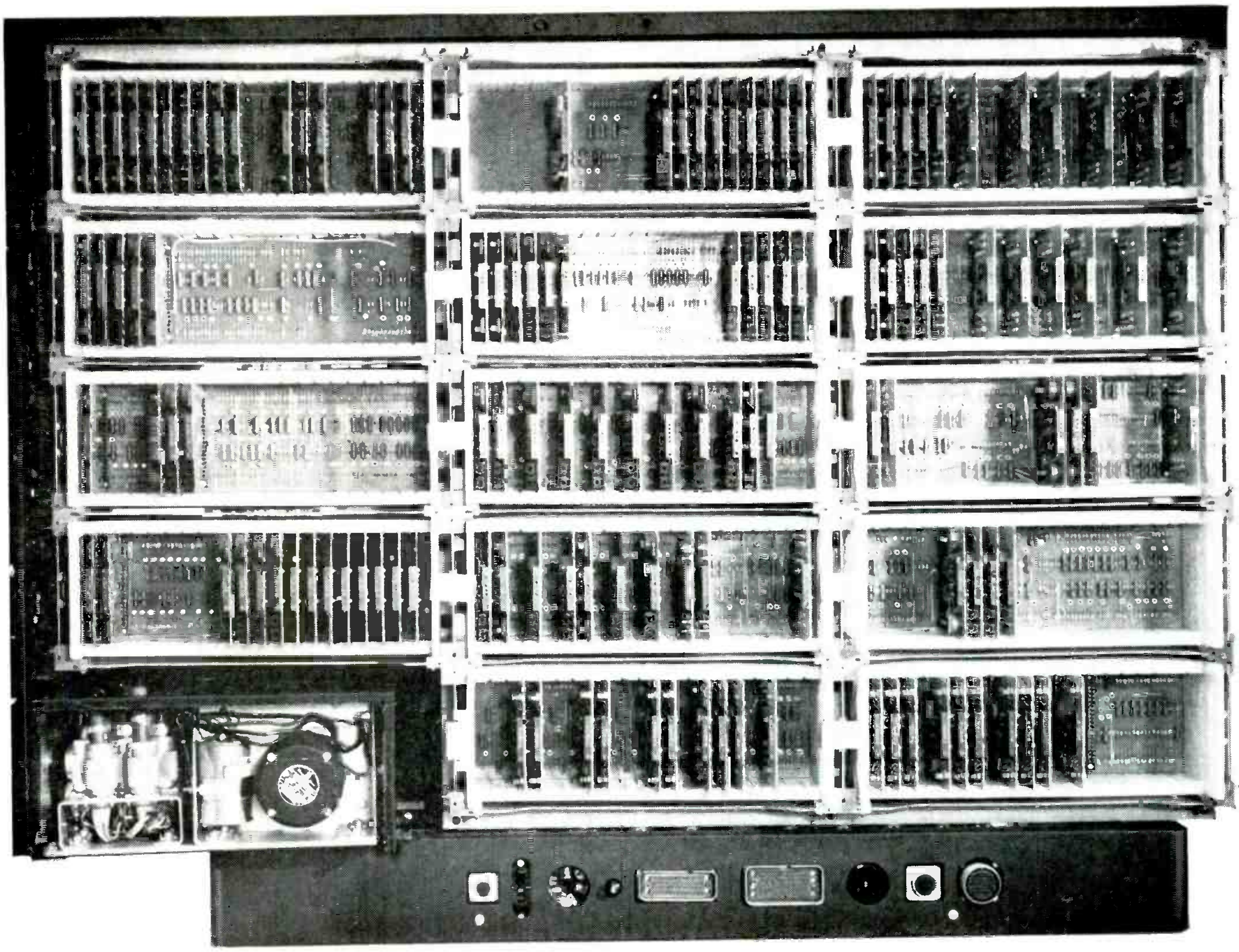


New chemical material sensitive enough to detect footsteps of a fly, made by processing intermetallic resins and rare earths with zirconium tetrachloride, is basis of Celab line of pressure transducers announced by Clark Electronic Laboratories, Palm Springs, Calif. Over 30 different compositions already available give no-load resistance values ranging from a few ohms to hundreds of megohms, each dropping almost linearly as pressure is applied

PRESSURE CELLS—Brass cup holding powder-like crystalline material serves as one electrode, while brass disk centered over material serves as other electrode and as means of applying pressure. In typical small unit, force of 1 lb gives resistance change of 500,000 ohms; for largest unit in stock, 15,000 psi gives 25-ohm change. Resistance is independent of temperature up to 300 F. Stock cells may be operated continuously at 500 F, specials up to 1,100 F. Metal shell will melt before cell material is damaged; upon cooling from red heat, original rating of cell is restored

IDEAS FOR USE—For explosion gaging, cells have been made with shock rating of 250,000 psi. Smallest versions have been used as cardiac catheter for measuring blood pressure inside heart. High-sensitivity cells, changing from practically zero ohms on no load to near infinity at full pressure, can serve as nonmechanical relays. All sizes can be adapted for measuring gas and liquid pressures. Standard units respond up to 60 cps, specials up to 400 cps, for vibration pickups. Pressure-sensitive powder is also available in bulk

STRAIN CELLS—Sensitivities up to 1 megohm per gram of tension are achieved with same basic composition. Construction is ultimate in simplicity; powdered material with binder is used like tape to separate stripped ends of stranded insulated hookup wire, positioned as for lap splice so that pull on wire is transmitted to material between ends to cause change in resistance. One model, shown above, drops from 220 megohms to about 3 megohms for only 40-gram pull. Applications include wrapping around wrist for sensing pulse action



The Role of
PRODUCT ENGINEERING
in Systems Work

It has become characteristic of modern weapons systems that they are required to operate under severe environmental conditions, as well as to meet stringent weight and space limitations. Moreover, the complexity of many of these systems poses additional difficult reliability problems, while at the same time the increasingly critical consequences that depend on the proper functioning of the typical system logically call for a *higher* degree of reliability than previously achieved. The same is true of certain electronic systems for industrial applications, such as the Ramo-Wooldridge digital control computer, some of whose design features are shown above.

Meeting all of these requirements is in large part the responsibility of product engineering. Generally speaking, product engineering starts with a system or subsystem at the breadboard stage and transforms it into the final product, which in addition to meeting all of the requirements previously stated, must be practical to manufacture and to maintain. Such creative productizing requires the development of ingenious mechanical design features, a thorough knowledge of circuit design and component reliability, and a broad familiarity with materials and manufacturing processes.

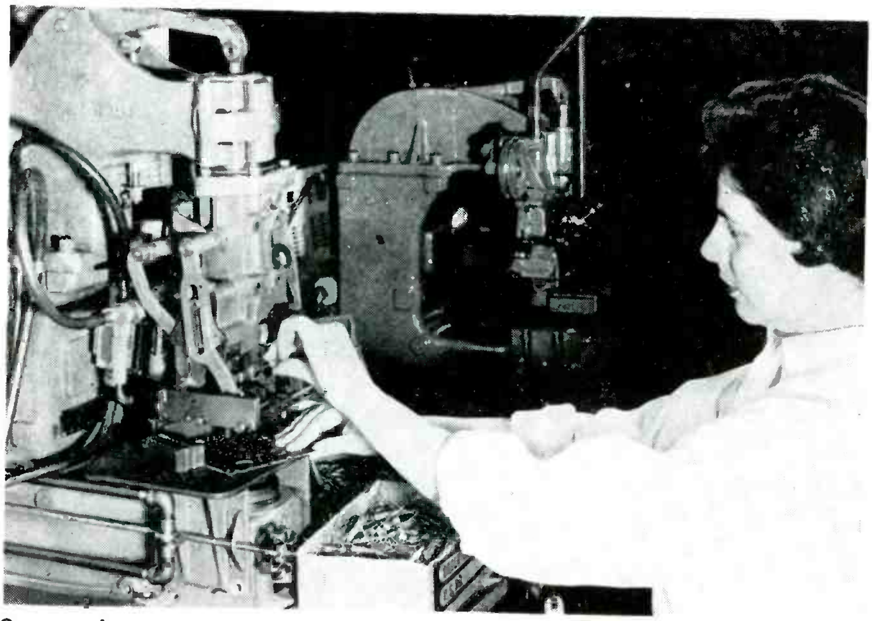
At Ramo-Wooldridge, the product engineer is an essential member of the research and development team which has the full responsibility for creating new systems, from the initial theoretical studies on into the manufacturing stage. Engineers experienced in product engineering are invited to explore the variety of openings which exist at Ramo-Wooldridge in such fields as airborne electronic and control systems, communications and navigation systems, digital computers and control systems, and electronic instrumentation and test equipment.

The Ramo-Wooldridge Corporation

5730 ARBOR VITAE STREET • LOS ANGELES 45, CALIFORNIA cause of difficulties involved in using standard aluminum plug-in receptacles. The technique consists of passing wires through the opening of the bulkhead and then injecting the Thiokol liquid polymer-based compound into hemispherical plastic molds around the wires to form the seals. This compound converts entirely to a rubber at room temperature without shrinkage, and has excellent adhesion to glass, metals and plastics. It will withstand temperature cycling from −65 F to approximately 300 F.

Hermetic sealing of wire through bulkheads can be applied at any time during plane assembly or in the field. Weight per seal is reduced from 18 ounces to 1⅜ ounces, and cost is only 1/70th of that with previous methods.

Machine Inserts Components In Boards



Operator drops in component with left hand while positioning board against magnetic stops on table of semiautomatic machine with right hand

ABILITY TO HANDLE axial-lead components ranging from small diodes to large tubular capacitors without precutting of leads is one feature of a new single-station component inserter developed by United Shoe Machinery Corp. of Boston. The operator simply moves a printed wiring board up to stops with her right hand, drops in a component with her left hand and presses the treadle switch with her foot. Under pneumatic power, the component is transferred from the loading station to a mechanism which straightens and corrects them for eccentricity. The leads are then automatically cut to the proper length, bent into a shape of a staple, inserted into the correct prepunched hole in the wiring board, then clinched underneath.

This new approach to semiautomatic component assembly for short-run production eliminates the need for special packaging or preliminary preparation of components. Rectangular components or irregularly shaped small coils can be handled without difficulty. With hand feed, an operator can insert up to 700 components per hour.

Wrappable Magnetic Foil Shields Relays

NEW DEAD-SOFT magnetic shielding foils can be cut to any required size or shape with ordinary scissors and wrapped tightly around a relay, vacuum tube or other component, to provide low-level shielding

Electronic Cooling Package...by AiResearch

SPECIFICATIONS OF TYPICAL AIRESEARCH COOLING PACKAGE

Air Flow	60 CFM
Fan Air Inlet Pressure	18 PSIA
Fan Pressure Rise	1.2 inches water
Heat Exchanger Pressure Drop	1.0 inches water
Liquid	Water Methanol (70% Methanol)
Liquid Flow	0.4 GPM
Heat Rejection*	300 Watts
Fan Power	30 Watts, 110 V., single phase, 400 cycle
Package envelope dimensions	7 x 6 x 3 inches
Package wet weight	2.5 lbs.

*Assumes Class A (85°C.) electronic components, liquid inlet temperature to heat exchanger, 55°C. Includes heat from fan motor.

This high performance AiResearch package cools sealed and pressurized electronic equipment. The fan circulates air through the liquid cooled heat exchanger and over electronic components in a hermetically sealed module. Air cooled units are also available. Fan and heat exchanger are designed, built and packaged by AiResearch for matched performance. Package size is tailored to your individual cooling requirements.

The Garrett Corporation, through its AiResearch Manufacturing divisions, is an industry leader in components and cooling systems for aircraft, missiles and nuclear applications. This wide experience is now being offered to the electronics industry to provide a cooling package to meet any cooling requirement. Send us details of your problem or contact the nearest Airsupply or Aero Engineering office for further information.

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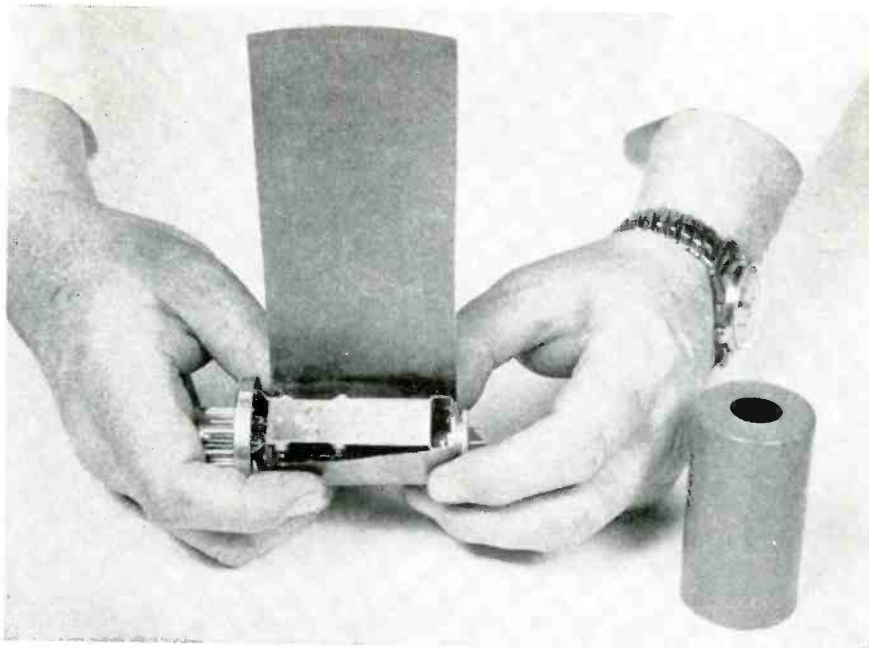


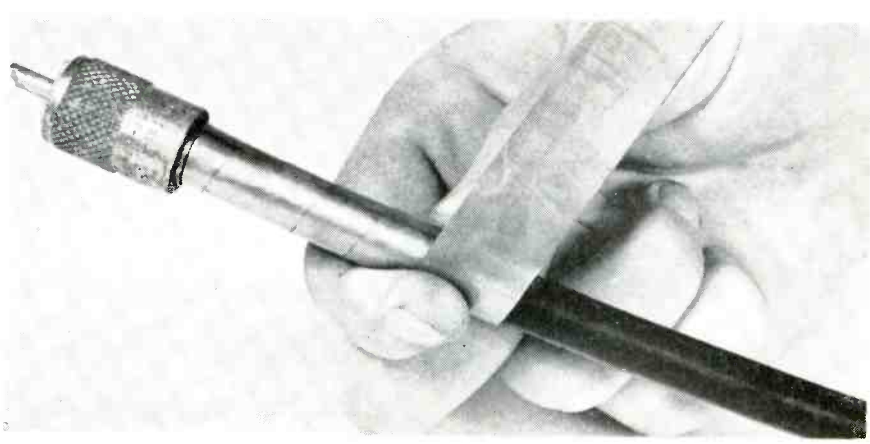
Wrapping relay with flexible magnetic shielding foil, thin enough to fit inside regular housing of relay

over a wide frequency range. Two wrappings provide ample shielding without leakage at joints.

Miniaturization is facilitated because the thin foil does not appreciably increase the bulk of the component. A tube wrapped in the foil will still fit in its standard shield even with the 0.007-in. foil, which is the thickest now made. The other standard thickness is 0.004 in. The material is available from the Magnetic Shield Division of Perfection Mica Co. as Netic and Co-Netic foils in rolls of various widths and lengths. It wraps tightly like a tape and does not spring back because annealing leaves it soft. Attenuation ranges from 8 to 1 at 60 cps to 1,200 to 1 1 at 250 mc.

▶ **Applications**—The foils can be advantageously used in a host of laboratory, electronic, electrical, airborne and shielded room applications. These include all types of experimental shielding for laboratory testing, transformer chokes, cable wrapping, lining the inside of vibrator and relay cans, vacuum-tube shielding, and lining the inside of wood or aluminum cabinets for ham or hi-fi uses.

An unusual application is using the foil as wallpaper to shield an entire room. The material can be applied by any carpenter, paper



Wrapping cable spirally with foil. Sufficient overlap to give two layers of foil is recommended to prevent hum pickup

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as low as 0.1% tolerances in most values!

Leading engineers know that S. E. C. pioneered the current polystyrene capacitors in Guided Missiles and Analog Computers. S. E. C. test data and engineering experience is based on years of research and constant improvement of product.

S. E. C. products have proved the answer to many tough engineering problems by such leading *analog computer manufacturers as;* Electronic Associates, Reeves Instrument, Beckman Instrument, Mid-Century Instrumatic, Goodyear Aircraft, Donner Scientific, Boeing Airplane Company and such *military contractors* as Northrop Aircraft, Gilfillan Brothers, North American Aviation, Convair, Motorola, Farnsworth Electronics, Bendix Aviation, Federal Tele-Communications and many others.

R. & D. establishments as M.I.T., Jet Propulsion Labs, Cornell Aeronautical Labs, Battele Memorial Inst., Sandia Corp., and many others have chosen S. E. C. engineered components for their prototypes.

Check these outstanding features for yourself:

- Tolerances as close as 0.1%
- Insulation Resistance as HIGH as 1×10^{12}
- Dielectric Absorption as LOW as .0001
- Dissipation Factor as LOW as .0002
- Temperature Coefficient...100 PPM per °C.
- Stability as close as .05% drift in 1 yr.
- Voltage derating . . . none to 170°F.
- *Hermetically sealed for enduring accuracy!*

Tubular .1 MFD—200V

.1 MFD—200V

10 MFD ± 1% 200V
4-7/16 x 3-1/16 x 2-1/8

1 MFD—200V

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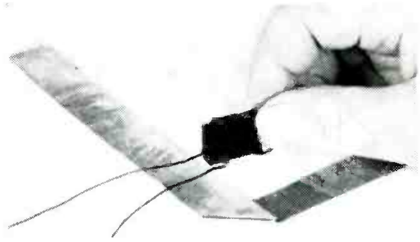
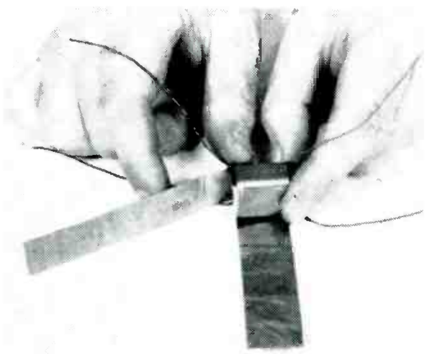
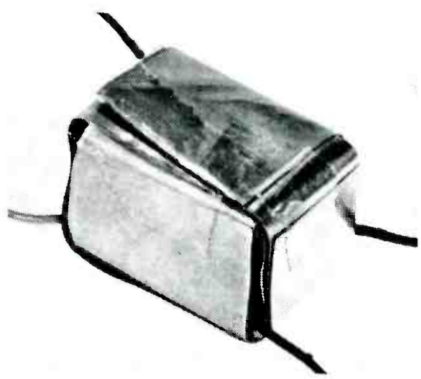
PIONEERS IN CUSTOM PRECISION CAPACITOR ENGINEERING



First step in shielding miniature audio transformer. Strip of foil is cut from sheet with ordinary scissors and folded at angle as shown



Wrapping with single strip of foil in manner shown, to get two layers on each side, leaves no gaps for flux leakage



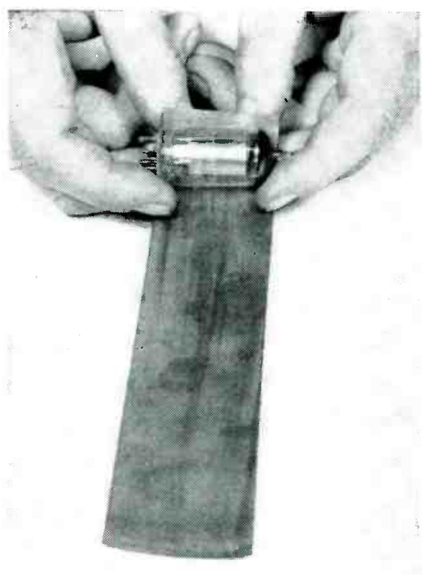
End of wrapping can be anchored with small piece of Scotch tape. Shield can be grounded conventionally, but this is usually not necessary

hanger or electronic technician in a matter of hours, using only scissors, hammer and small nails. With wide overlap construction, no welding, soldering or brazing is required. If desired, a pleasing finish may be added by painting. The foil wallpaper eliminates the expense and problems of bringing an unwieldy conventional shielded room into a hospital, laboratory or other location where space and access are limited.

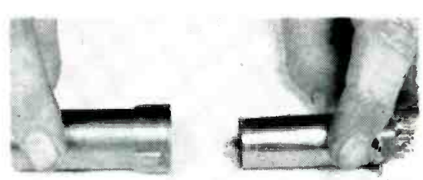
▶ **Medical Uses**—Hospital bed enclosure shields as well as electroencephalographic rooms may be constructed by first placing foil layers between flooring materials or directly beneath the entire bed. The rest of the shield should be fabricated with a hinged end or side so it can be slid around the bed when needed. Shielding is not affected by the outer or inner materials. The inner material should then be padded for soundproofing or patient protection and the outer layer finished in a material that harmonizes with the appearance of other hospital equipment. Air conditioning or air replacement may be provided if the enclosure is to be used for long periods of time.

▶ **Airborne Uses** — The light weight makes the foils particularly suitable for airborne applications. These include band wrappers for magnetic valves, cable wrapping, power supply shielding, servo motor wraps and insert liners for vibrator and relay cans.

▶ **Audio Uses**—The flexibility is a



Method of wrapping vacuum tube in Co-Netic foil to prevent hum pickup



Wrapped tube slips easily into standard aluminum shield can, since foil is thin and dead-soft

these four applications are improved with

DAPON® resin

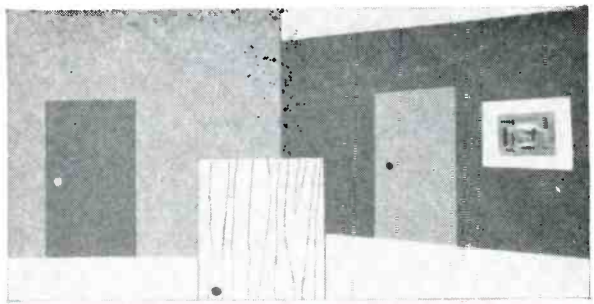
APPLIANCE HANDLES to match any color décor of the modern kitchen are now possible. The exceptional heat stability of DAPON resin molding compounds (producible in a wide range of colors) permits the finished article to withstand high temperature exposure for prolonged periods of time with substantially no loss or change in color. Moldability of DAPON resin compounds is excellent. Added advantages of good impact strength, high detergent resistance, unmatched resistance to food and beverage staining make DAPON the number one resin for appliance handles.

DAPON resin is a solid prepolymer of diallyl phthalate; making available the outstanding properties of this material in a form readily usable in all types of thermosetting resin operations.

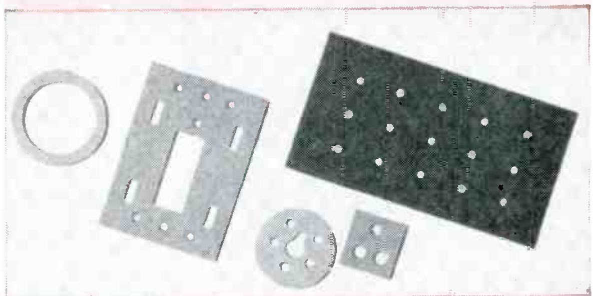
In selected applications these properties are unmatched by existing resins. DAPON resin should be evaluated for use as the base resin in any thermosetting application requiring chemical resistance, heat and humidity resistance, superior electrical properties, good moldability, or dimensional stability.

Extensive testing programs have been completed to point up those uses and applications in which DAPON resin has distinct merit and produces decidedly better properties. Molding compounds with various fillers, reinforcing fibers and colors are now available. Government approval under a number of military specifications has been obtained.

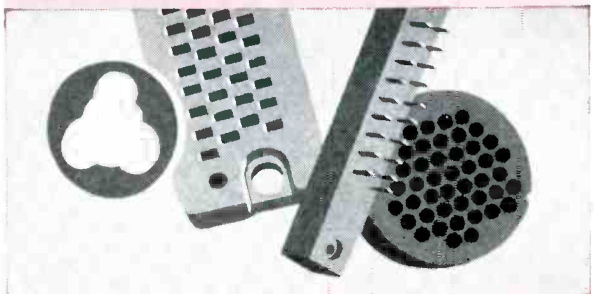
Let us know the application you have in mind for DAPON resin . . . write now for literature and technical data.



DECORATIVE LAMINATES made with DAPON resin do not require the usual "facing" steps. The printed paper can be laminated directly to the backing material in a single operation. For applications requiring soft backing materials excellent flows can be effected at pressures as low as 50 psi. With either high or low pressures, laminates of DAPON resin exhibit exceptional resistance to abrasion, chemicals and heat.



INDUSTRIAL LAMINATES made with DAPON resin have a number of outstanding properties: Superior electrical properties e.g., high insulation resistance retained under conditions of high humidity; heat resistance without degradation even under sustained vibrational stress. Other advantages exist in end uses requiring a high degree of chemical and moisture resistance, good dimensional stability, mechanical strength and ease of machinability. Formulated with or without volatile solvents DAPON resin is suitable for use in the full range of pressure curing conditions.



MOLDED ELECTRICAL PARTS containing DAPON resin exhibit highest resistance to humidity changes. Maximum retention and rapid recovery of electrical properties are insured by the unmatched stability of DAPON resin and the absence of deleterious products of degradation under long term use conditions. Properties of dielectric strength, dielectric loss, volume resistivity and arc resistance are particularly outstanding. Very low molding and post molding shrinkage allow close tolerances and the use of closely spaced inserts. Moldability and resistance to heat and chemicals are excellent.

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Circle 118 Readers Service Card

valuable factor in providing greater hi-fi fidelity. Applications here include lining high impedance input transformer cans, spiral wrapping around input lead from pickup head to preamplifier, wrapping pickup arm and head liner, use as disk between friction plate and turntable, use as subpanel under turntable between amplifier and pickup head, use as tube wrappers inside normal tube shields at input stages, and separating tuners, amplifiers and preamplifiers when these units are placed on top of each other.

3-D Packaging for Transistorized Circuits

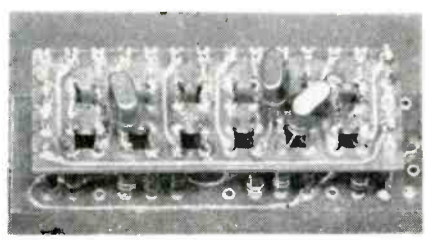
By JOHN A. WEREB, JR.
Staff Member, Lincoln Laboratory
Massachusetts Institute of Technology
Lexington, Mass.

PARALLEL MOUNTING of axial-lead components in a three-dimensional package has been applied to transistorized logic circuitry to reduce size and weight, improve ventilation potentialities, insure adequate mechanical strength and speed construction.

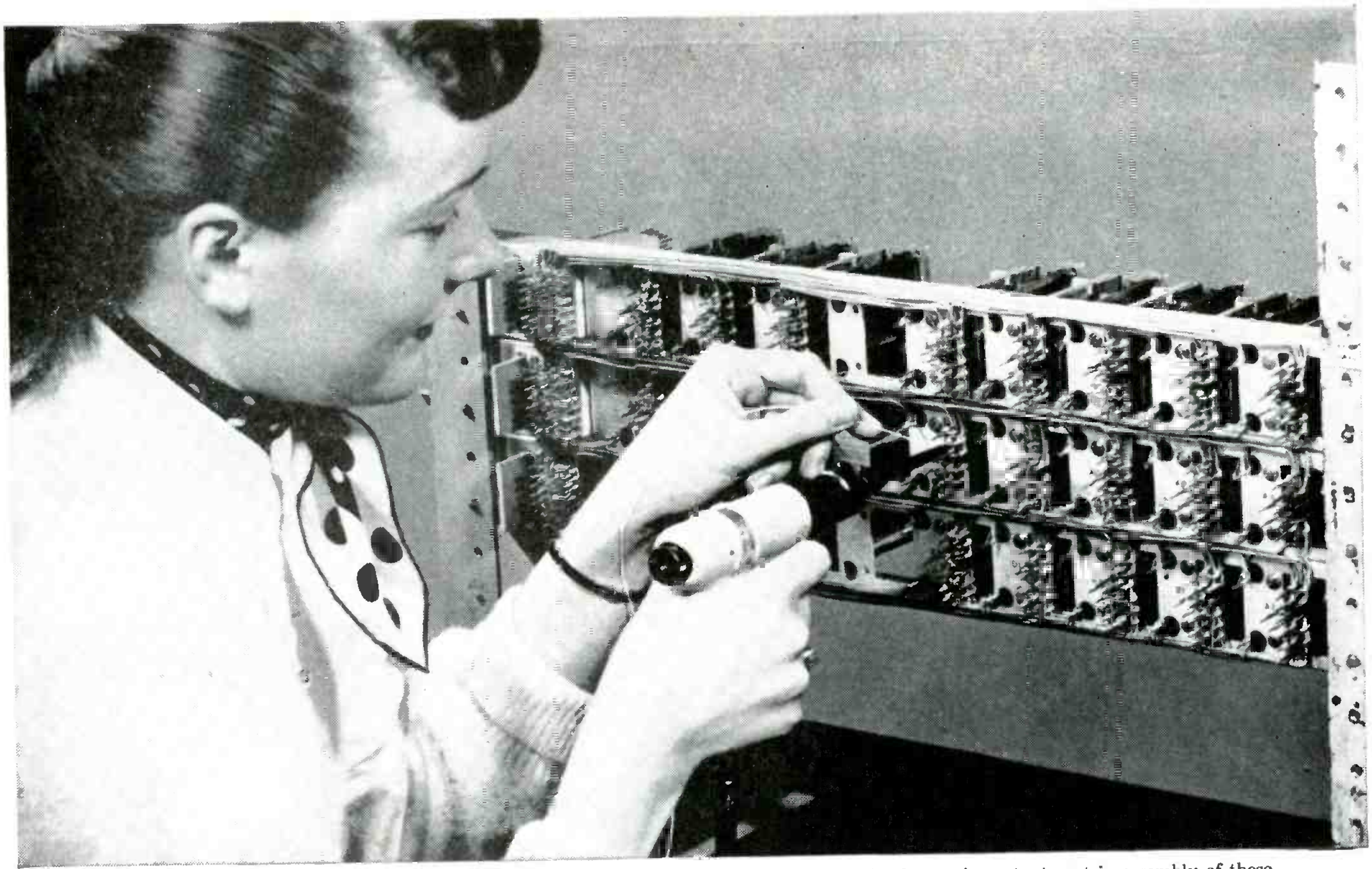
One method of using this construction employs discardable solder-in modules, while the other permits replacement of any part. Conventional axial-lead components which meet military specifications are used throughout both methods.

The solder-in module is constructed so it can be discarded in case of failure of resistors or capacitors. Semiconductors, which are more costly, are mounted near the perimeter of the module for easy replacement or salvage. This method avoids plug and connector failure; however, the modules are more difficult to remove and require a modified element in the soldering iron.

The second method makes use of



Cross-shaped holes in etched wiring boards permit replacing any of four components through each large hole



Keller "Wire-Wrap" tools play an important part in assembly of these well-known products: TV sets, computers, electric motors, radios.

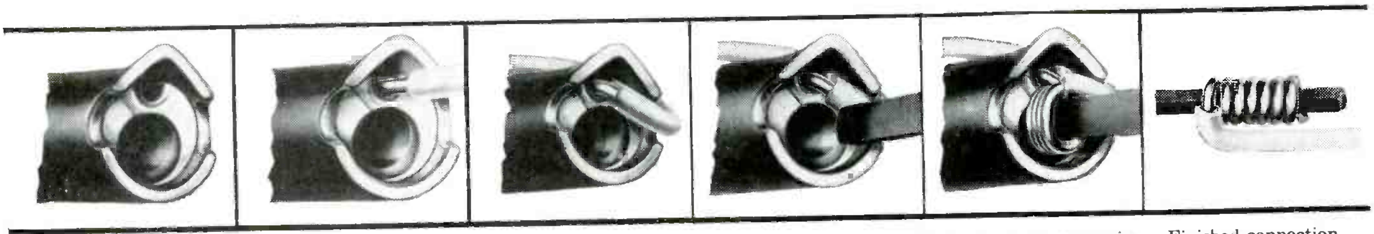
Why solderless connections with Keller "Wire-Wrap"® Tools are fast . . . reliable

Keller "Wire-Wrap" tool is fast operating—only seconds per connection. It automatically wraps wire around terminals to make solderless, permanent connections. No additional operations required. Tool weighs just one pound . . . no operator fatigue to slow down production schedules.

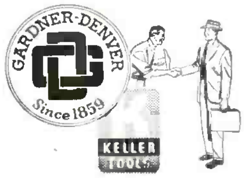
There are no faulty connections requiring expensive hand repair work. To date, well over 700 million connections have been made with "Wire-Wrap" tools without a reject. The exclusive controlled-tension compresses wire into terminal to assure permanent metal-to-metal contact. Either air or electric models.

Possibly you can step up production with "Wire-Wrap" tools while reducing assembly costs. Consult with your Gardner-Denver Industrial Specialist.

2.7 to 3 seconds to make a connection



Empty "Wire-Wrap" tool spindle	Insert wire in top opening	Anchor wire in side notch	Insert terminal in bottom opening	Apply power to wrap wire around terminal	Finished connection is permanent

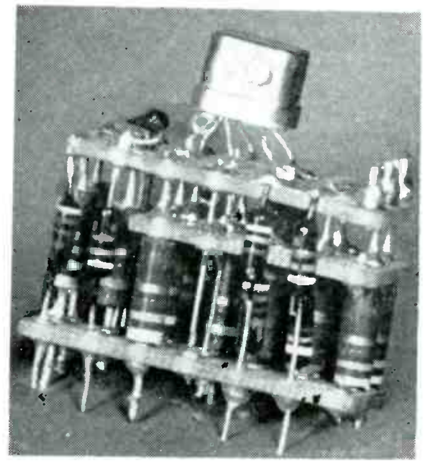


ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

Circle 120 Readers Service Card



Module built up from three wafers to give three-dimensional packaging

cross-shaped holes in the mounting board to permit removal of small internal components. Any of four components can be replaced through each hole. Both techniques have been employed in the repackaging of a transistorized airborne transducer.

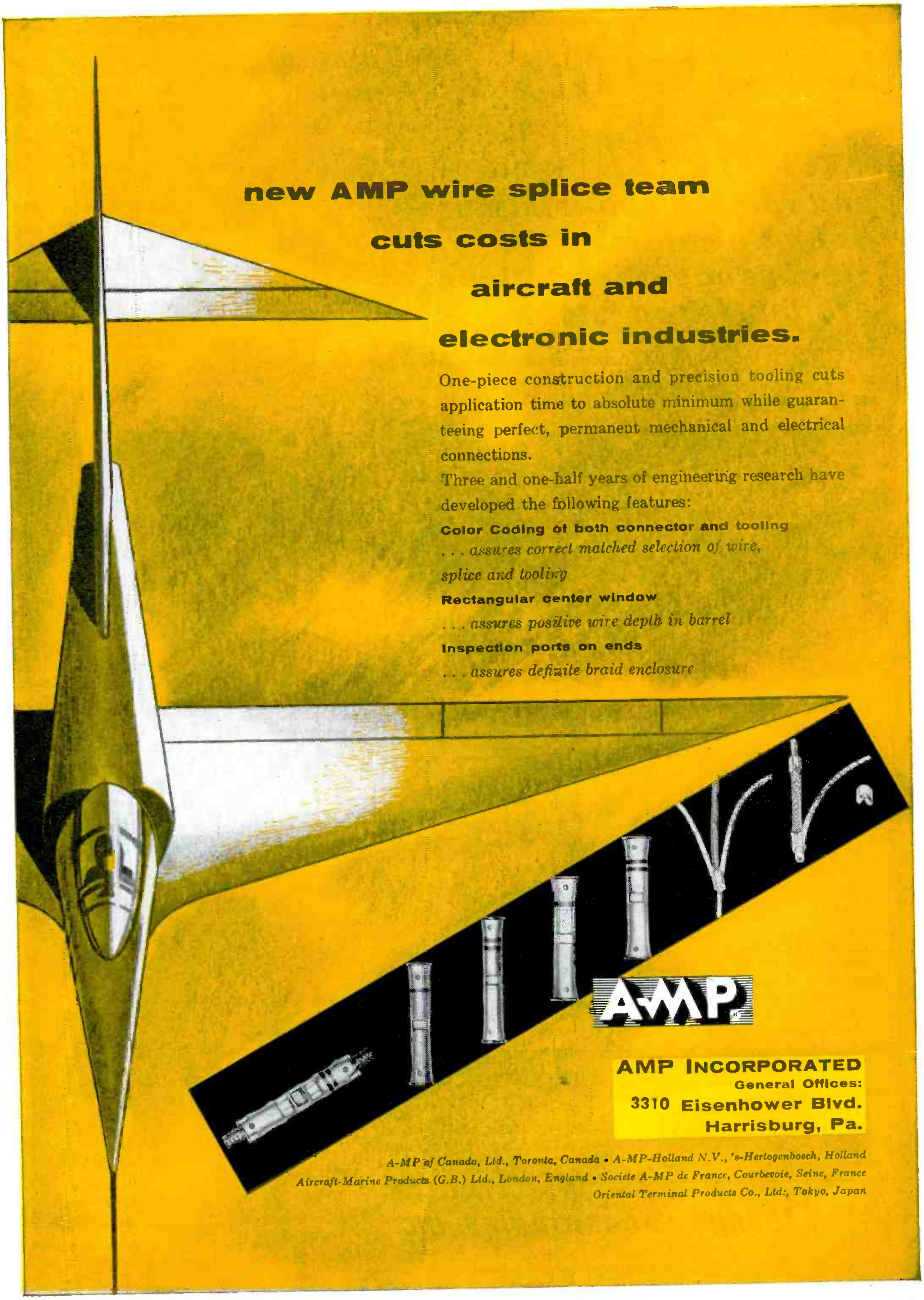
▶ **Construction** — Printed circuit boards are prepared by standard methods using hand construction for small quantities. Eyelets are used throughout and double-sided wiring is used as necessary.

Individual component leads are precut and cleaned for reliable soldering. No bent leads are used. A printed board is then selected and an aluminum comb is put in place, followed by an aluminum nest. The components are dropped into the nest and soldered in place. The comb adjusts the spacing of components from the board and helps conduct heat from the unit during construction.

After the first soldering operation, the nest and comb are removed and the comb is placed on the other end. The second board is then soldered and the comb is removed.

For those units with a third board the last operation is repeated. Little trouble has been encountered with remelting of the connections when the third board is being soldered since the soldering time is short and the comb removes some heat.

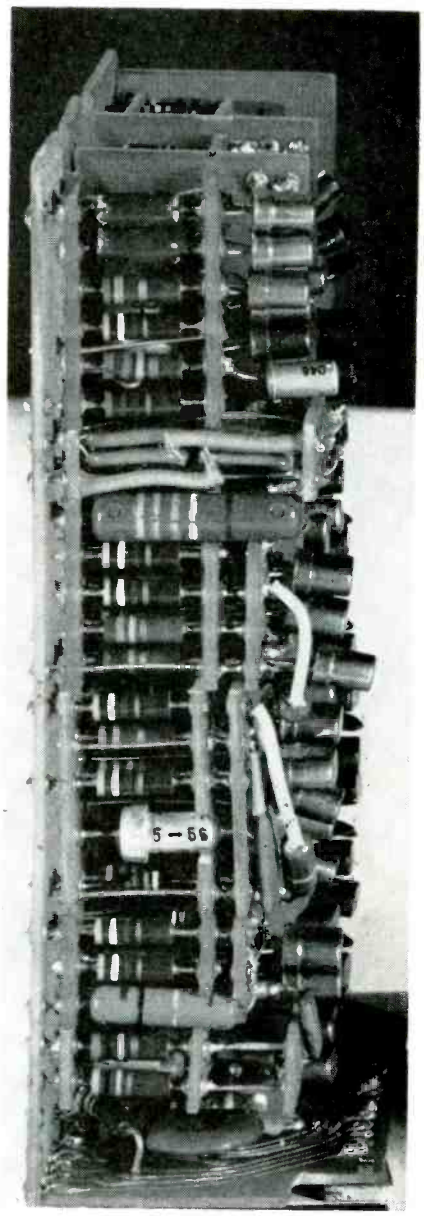
The modules are soldered into an interconnecting base board which contains power and interconnecting leads. In this particular experi-



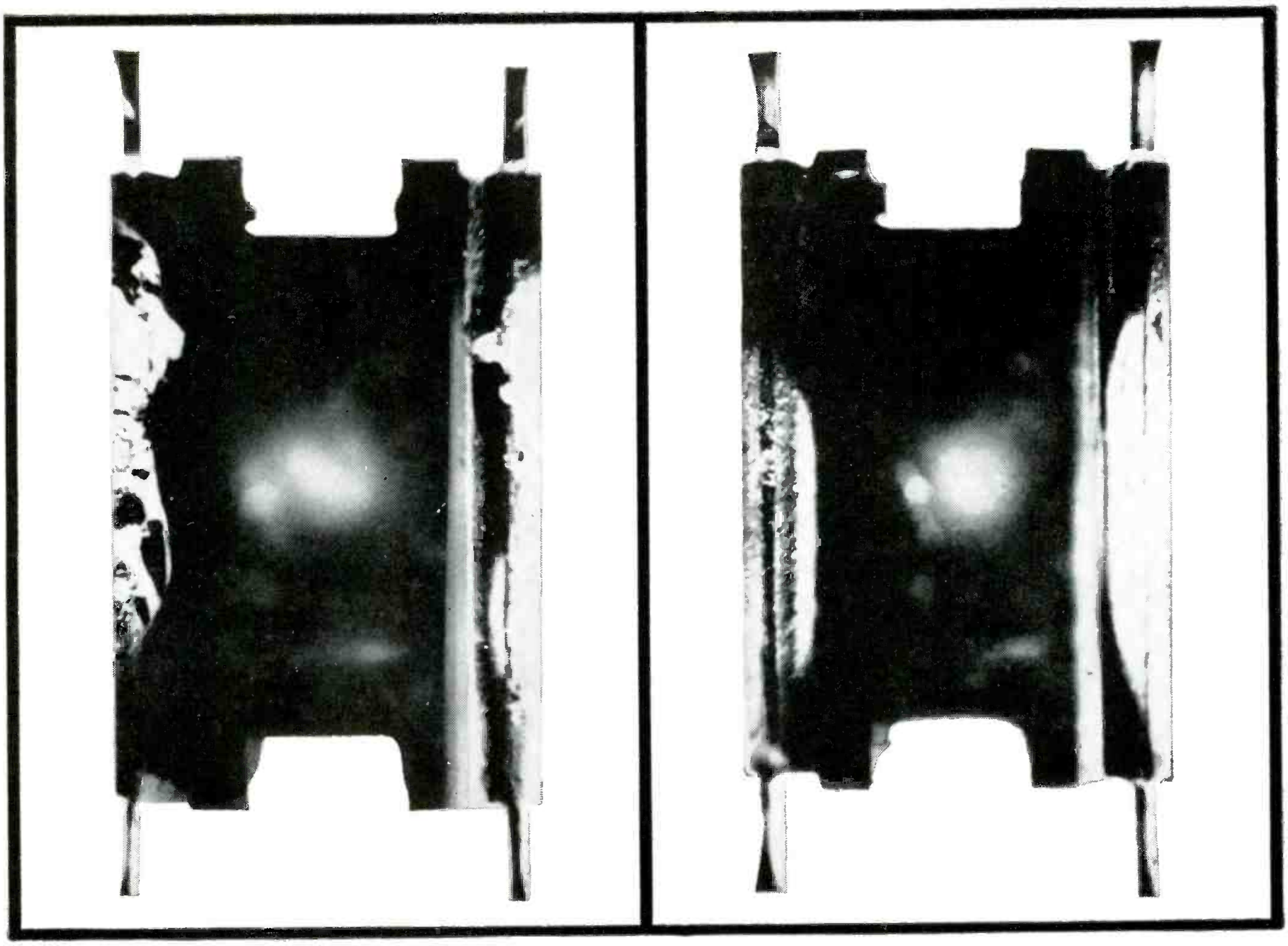
Circle 144 Readers Service Card

mental unit some coupling capacitors were not of the axial type and were conveniently mounted on the outside of the modules.

▶ **Troubleshooting**—Sufficient voltage points are externally accessible to instrument probes so that a defective component can be located. The module is then removed from the baseboard with the modified iron and a new one inserted. The defective module can either be repaired or discarded. If a transistor fails it can be replaced without re-



New computer logic package occupies one-fourth the volume of former conventional design yet contains practically all the parts that were in old unit



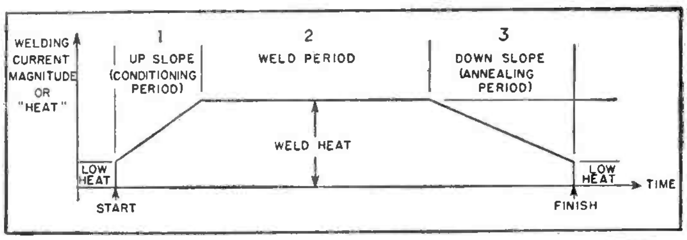
Now you can make perfect welds in coated, greasy, carbonized, oxidized or highly conductive metals!

Surface-contaminated metals do *not* have to be cleaned before welding! Raytheon's Heat Program Timer gives you strong, consistent, high-quality welds regardless of the surface condition of the metals to be joined. Highly conductive metals can also be perfectly welded with ease.

A typical application is the carbonized tube anode shown above. The left-hand photo illustrates how conventional welding causes splashes and a weak joint. The strong, clean weld (right) is produced with the Heat Program Timer. Because perfect welds such as this can be made without pre-cleaning of parts, savings in time and money result.

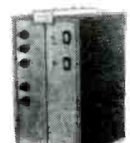
Greater freedom of design, material selection, coating and structure, and high-speed, low-cost production welding are assured with this unit.

Raytheon manufactures a complete line of precision welding systems. To learn how this equipment can solve your small parts metal-joining problems, or to have your samples processed in Raytheon's Welding Application Laboratory, please write Dept. 6120.



PROGRAMMED WELDING CYCLE

1. Heat build-up "conditions" the metal surfaces by burning through the coating—eliminates splatter.
2. Precisely controlled constant heat welds the metals.
3. Decreasing heat anneals the weld—reduces brittleness. Each period is independently adjustable from 2 to 10 cycles. Weld heat can be varied from 20%-100% of maximum; low heat, 0-80% of weld heat.



Heat Program Timer

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MICRO-BEARING ABSTRACTS

by A. N. DANIELS, *President*
New Hampshire Ball Bearings, Inc.

MEASUREMENT OF RADIAL RUNOUT

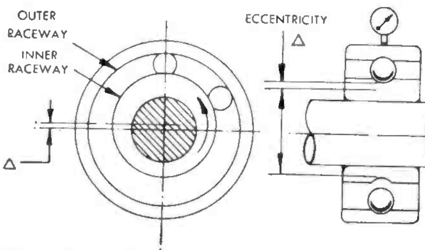

Fig. 1 — ***Measuring eccentricity of bore with respect to inner raceway.***

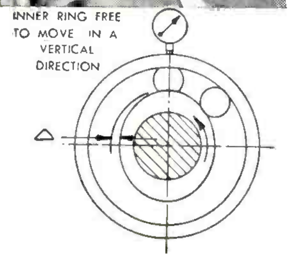

Fig. 2 — ***Inner raceway is out-of-round, although concentric with bore.***

Occasionally questions are raised about the methods of measuring "radial runout" and "out-of-round". In order to define "radial runout" properly, a discussion of "eccentricity" and "out-of-round" is necessary.

The amount of out-of-round, or lack of roundness of a given part (inner or outer ring or ball) is the difference between the maximum and the minimum diameter of the part in question.

Eccentricity refers to the distance between the centers of two circles. Concentricity refers to the exact coincidence of the centers of two or more circles. In high grade instrument bearings there is a very small tolerance on the permissible eccentricity between the bore and the inner ring raceway, and likewise between the outside diameter and the outer ring raceway.

Inner raceway out-of-round is measured by forcing the ring between the rounded edges of two discs, one of which is fixed and the other of which is mounted on the indicating mechanism. The difference between the maximum and minimum readings reveals the amount of out-of-round. Out-of-round of the outer ring raceway is measured by placing the ring over two rounded points which engage the raceway. One point is fixed and the other actuates an indicating mechanism. As the ring is rotated, the difference between the maximum and minimum readings indicates the degree of out-of-round.

The true amount of eccentricity between the bore and the inner ring raceway can be measured, providing these circles are not out-of-round, by mounting the assembled bearing on a slightly tapered arbor, applying a calibrated indicator on the center of the stationary outer ring, and then slowly rotating the arbor. The eccentricity is the difference between the minimum and maximum gage reading as the arbor is rotated through one revolution. Similarly, the eccentricity of the outer ring is measured by the difference in the dial readings with the arbor and inner ring held stationary while the outer ring is rotated one revolution. *Fig. 1* shows the set-up with an inner raceway which is eccentric with respect to the bore.

In the case above it has been stipulated that the bore and inner raceway must not be out-of-round, for only under these conditions is the true eccentricity measured.

If the raceway is out-of-round, while being either eccentric or concentric with respect to the bore, the out-of-round will be transmitted to the indicator, thereby influencing the reading. A condition in which the inner raceway is out-of-round although concentric is shown in *Fig. 2*.

In view of the fact that the majority of bearing rings will unavoidably be somewhat out-of-round and eccentric, however slightly, it is obvious that the measurement described above indicates neither true eccentricity nor true out-of-round but a summation of the two quantities. Hence, the measurement is more correctly termed radial runout.

DESIGN HANDBOOK OFFERED *FREE*

If you work with miniature bearings, you'll find this new, 70-page authoritative publication contains a further discussion of radial runout and is a great help in solving problems in designing instruments or small electro-mechanical assemblies.

It will be sent free to engineers, draftsmen and purchasing agents. **Write to: New Hampshire Ball Bearings, Inc., Peterborough 1, N.H.**

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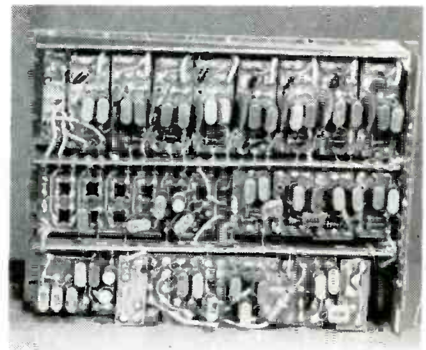
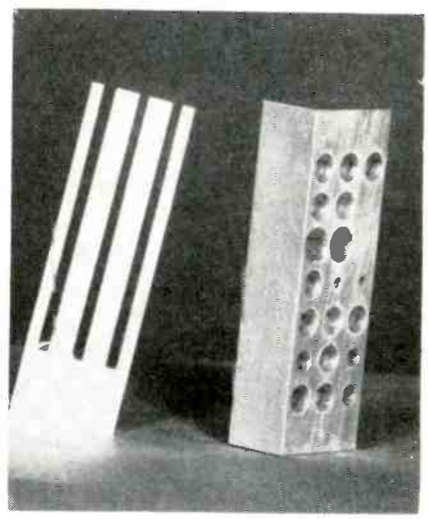
moving the module since it is mounted externally.

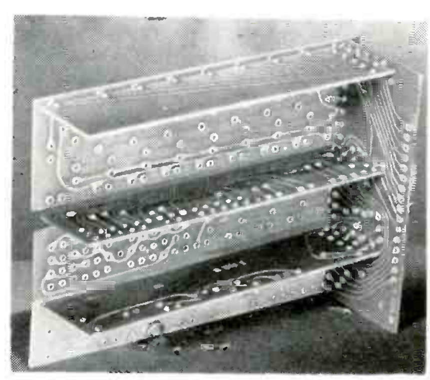
▶ **Applications**—This technique has been used in an experimental unit in which the ability to replace components was important. The model



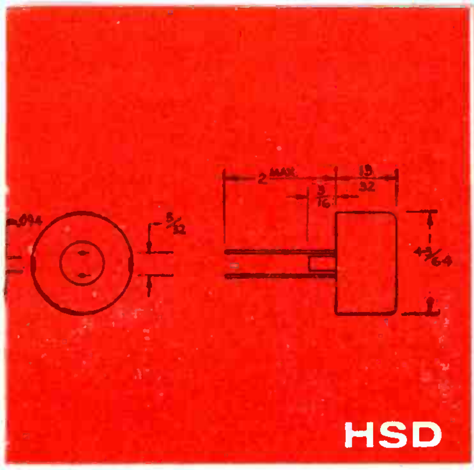
Top view of new three-dimensional package, showing how wiring boards at right angles provide interconnections for modules

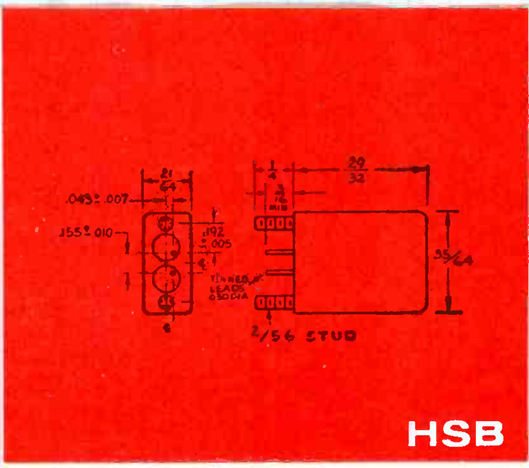


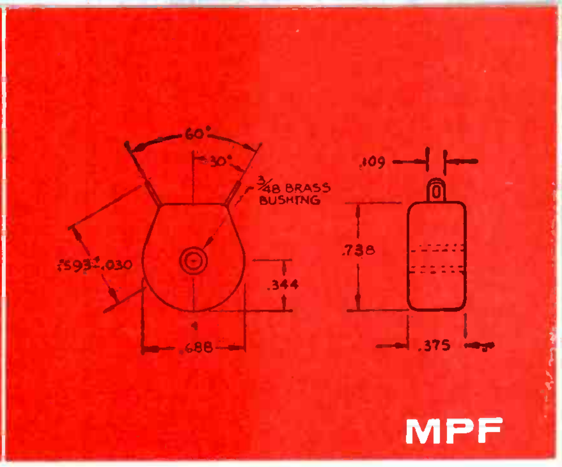
Aluminum comb and nest used in assembling modules



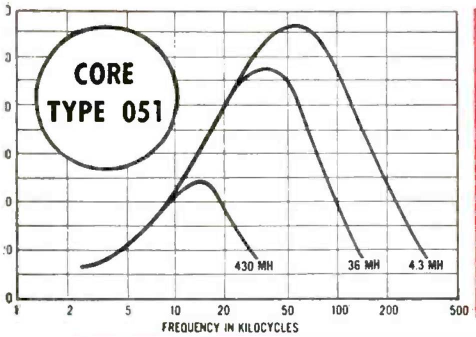
Method of providing interconnections between boards and modules. Power and logic inputs are on vertical row of eyelets at right

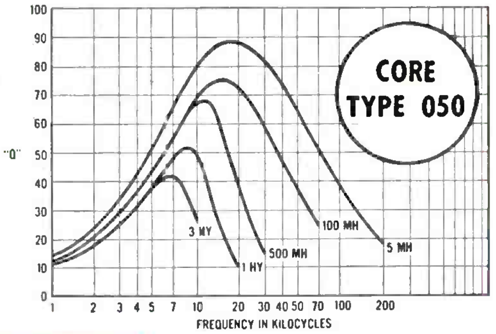


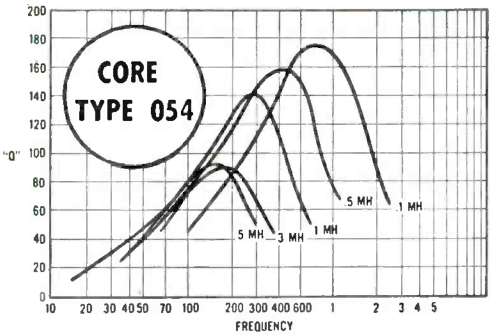




THREE STANDARD PACKAGES AVAILABLE IN THREE CORE TYPES







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STANDARD INDUCTANCE VALUES:

Dash No.	050	051	054
–1	5.0 MH	1.0 MH	.05 MH
–2	6.0	1.2	.06
–3	7.2	1.5	.072
–4	8.6	1.75	.086
–5	10.0	2.0	.100
–6	12.0	2.4	.120
–7	15.0	3.0	.150
–8	17.5	3.6	.175
–9	20.0	4.3	.200
–10	24.0	5.0	.240
–11	30.	6.0	.300
–12	36	7.2	.360
–13	43	8.6	.430
–14	50	10.0	.500
–15	60	12.0	.600
–16	72	15.0	.720
–17	86	17.5	.860
–18	100	20.0	1.0
–19	120	24.0	1.2
–20	150	30.0	1.5
–21	175	36.0	1.75
–22	200	43.0	2.0
–23	240	50.0	2.4
–24	300	60.0	3.0
–25	360	72.0	3.6
–26	430	86.0	4.3
–27	500	100	5.0
–28	600	120	6.0
–29	720	150	7.20
–30	860	175	8.6
–31	1.0 HY	200	10.0
–32	1.2	240	
–33	1.5	300	
–34	1.75	360	
–35	2.0	430	
–36	2.4	500	
–37	3.0		

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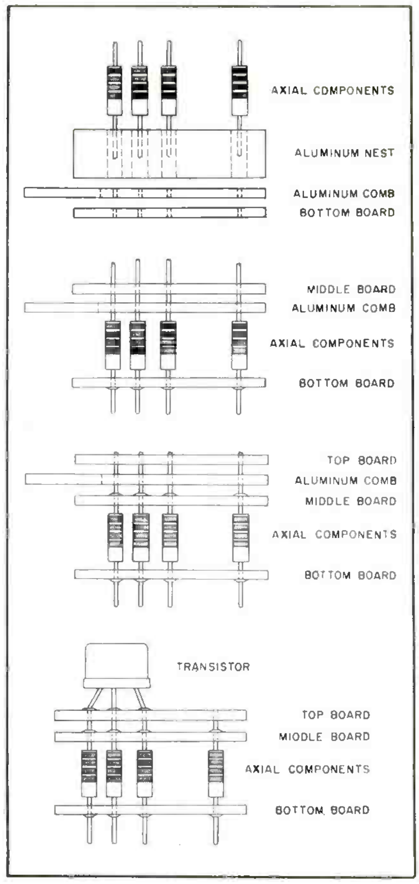
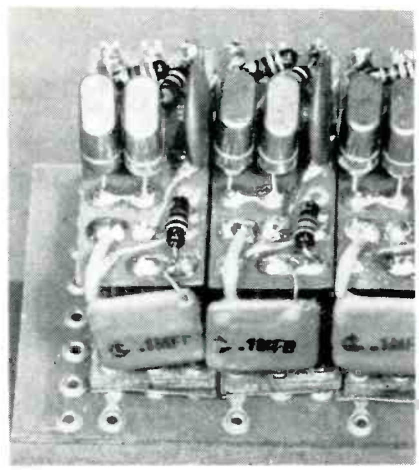


Steps in assembling module



External mounting of capacitors

has been flown in interceptor aircraft for 20 hours without failure, although not subjected to military test specifications. It has also been used successfully in ground mock-ups for better than 20 hours.

The technique should prove useful for units having low power dissipation and therefore permitting high-density packaging, providing there are no periodically replaced

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without pre-amplification!

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The Type 403 is the most sensitive oscilloscope commercially available. It permits direct measurements from low output transducers such as strain gages, pressure pickups, accelerometers, and others that normally require pre-amplifiers.

When used as a direct reading voltmeter, the Type 403 offers stability of better than 1 millivolt per hour for all ranges from 500 volts all the way down to 1 millivolt full scale. A super sensitive range is available of 1 millivolt full scale (100 microvolts per scale division) for short term measurements.

This outstanding performance is wrapped in the nicest package in the industry. The 403 features "human engineering" resulting in easier operation, complete accessibility and unsurpassed reliability backed by a 5-year guarantee.

F E A T U R I N G

AMPLIFIERS: Direct coupled amplifiers with single-ended or balanced input.
EXTREME SENSITIVITY: 5 millivolt to 500 volts full scale, continuously variable. Additional sensitivity for short term measurements, with resolution down to 20 microvolts.
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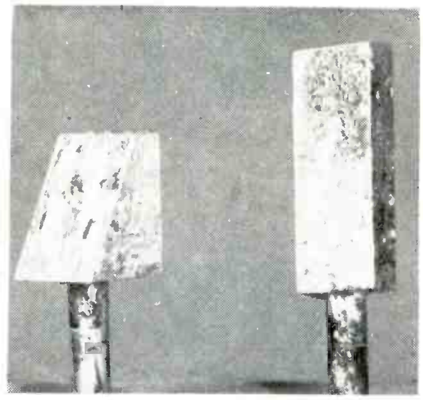
Circle 126 Readers Service Card



Two types of soldering iron heads used for removing defective module from baseboard. Both plug into standard 130-watt iron taking ¼-inch round shaft

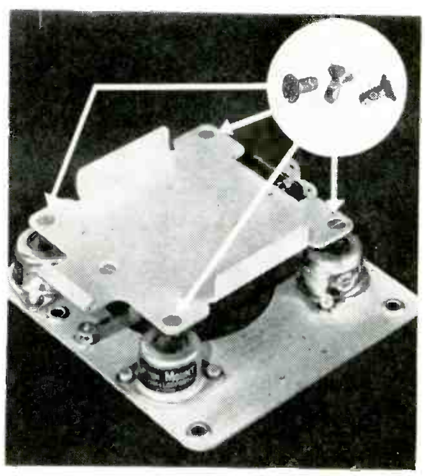
parts such as vacuum tubes, relays or other special short-life components in the circuits.

The research on this packaging technique was supported jointly by the Army, Navy and Air Force under contract with the Massachusetts Institute of Technology.

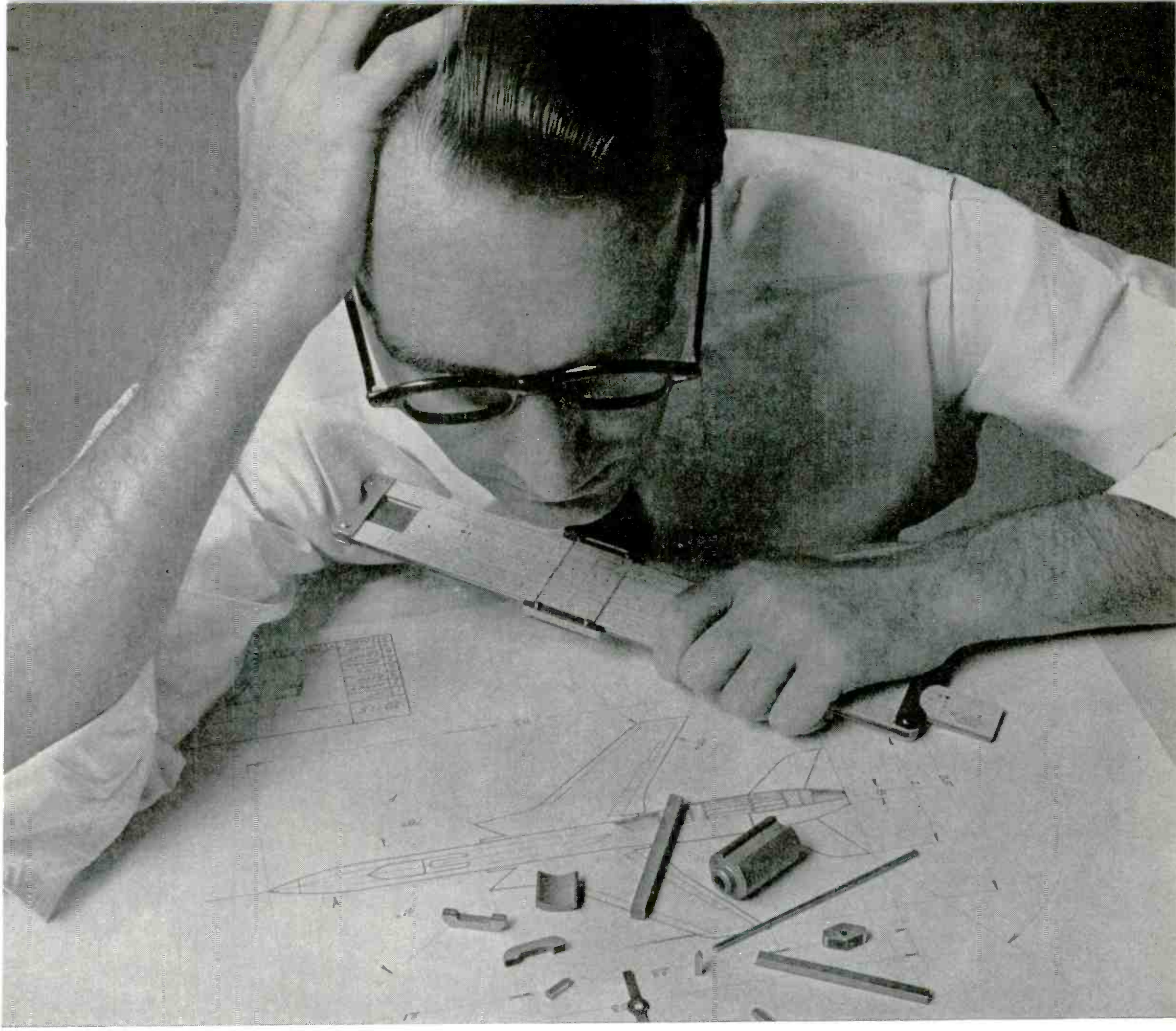
Nylon-Insert Screws Replace Locking Cement

SWITCHING TO nylon-insert self-locking screws and nuts eliminated a messy job and saved assembly time on mounting bases for airborne electronic equipment at the Hawthorne, N. J. plant of T. R. Finn & Co. The base protects a delicate electronic anti-skid device in the nose-wheel well of jet fighters.

Because flush-mounting pro-



Arrows point to locations of new self-locking screws which fasten platform to studs of vibration mounts. Similar Nylok nuts secure bonding straps



hibits the use of lockwashers, plain countersunk-head screws previously used had to be hand-dipped in a plastic locking cement to lock them in the mounting stud. The operation was time-consuming and costly, almost always a messy job and often marred the finish. The changeover to self-locking screws and nuts made by The Nylok Corp., 611 Industrial Ave., Paramus, N. J., has resulted in faster and neater assembly with better protection to the mount and the electronic equipment it was designed to hold.

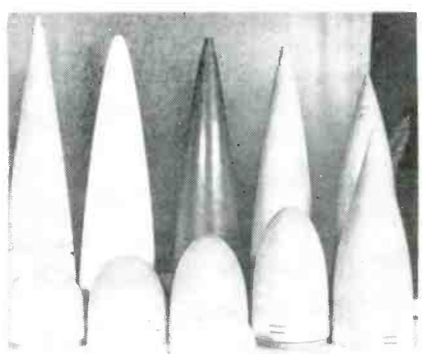
The Nylok self-locking screw holds its exact position and provides a positive lock because a nylon pellet inserted into the threads of the screw shank bears against the threads in the mount stud. This produces a tight metal-to-metal fit between mating threads and prevents the screw from loosening or changing position.

Because nylon is an elastic material it tends to regain its original shape. The screws and nuts can thus be reused many times without losing their self-locking ability.

Choosing Materials for Heat-Resistant Radomes

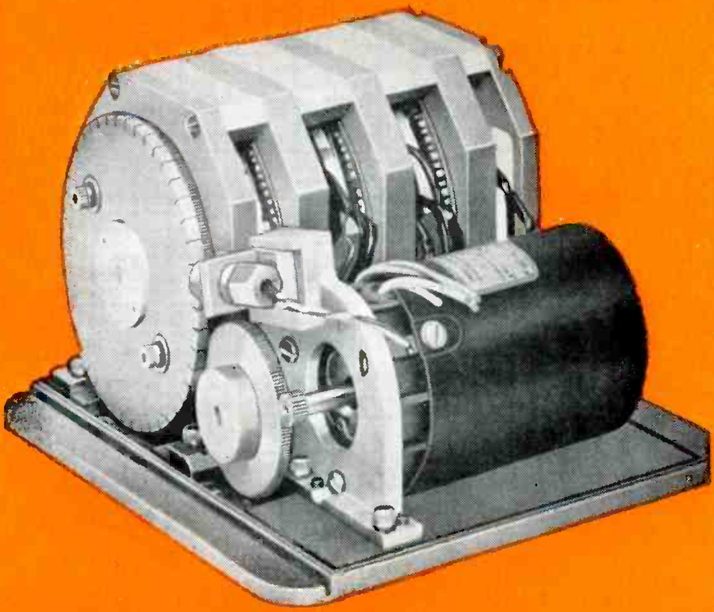
By Hugh O. Pierson
Canopy and Laminate Dept.
Goodyear Aircraft Corp.
Akron, Ohio

Heat resistance is a major factor in the choice of materials for both solid-wall and sandwich radomes of supersonic aircraft and missiles. Structurally, solid-wall radomes are more homogeneous and have better strength at high temperatures, but the weight penalty



Examples of missile radomes

DESIGN ACHIEVEMENTS WITH **SUPRAMICA*** ceramoplastics



MYCALEX TM Commutation Switch for Telemetering, Using Precision-molded SUPRAMICA* 555 ceramoplastic Commutator Plates.
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Under Exclusive License of MYCALEX CORPORATION OF AMERICA

Precision-molded SUPRAMICA* 555 ceramoplastic Commutator Plate, CP-346, with 360 Contacts and 2 Slip Rings. Other Standard Plates are Available.

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MYCALEX* TM commutation switches set new standards of reliability for aircraft and missile telementry

$25,000 a minute is costly time — but that is the estimated value of the final "count-down" for a major missile test.

Telemetered information will record the vital history of the flight and point the way to new developments and advancements. To achieve complete control, absolute dependability and long life, precision equipment is essential, both during flight and during the "count-down" when a complete check-out is demanded. Cleaning and adjusting commutators during the final hours or minutes of "count-down" is expensive — and wasteful.

MYCALEX* TM commutation switches with precision molded commutator plates of SUPRAMICA 555 ceramoplastic introduce new standards of reliability to this important operation. Hundreds of hours of completely unserviced life with dependable, low-noise-level signals is definitely attainable. Customer evaluation tests have shown satisfactory operation of MYCALEX TM switches for over 1000 hours at 1200 RPM with only brush cleaning and routine maintenance.

These exceptional performance standards are possible because of painstaking precision assembly and testing, and the use of SUPRAMICA ceramoplastic commutator plates, which have total, permanent dimensional stability and will withstand temperatures as high as 500 degrees C. without distortion or contact loosening.

MYCALEX TM commutation switches and SUPRAMICA ceramoplastics are making significant contributions to the reliability and durability of electronic equipment for military and civilian applications.

Write for detailed information.

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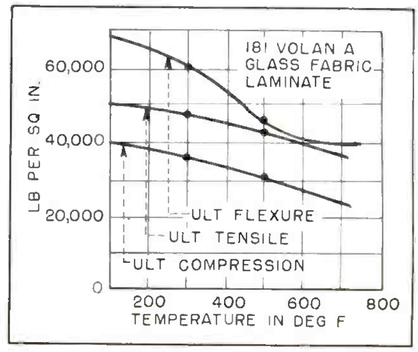
WORLD'S LARGEST MANUFACTURER OF GLASS-BONDED MICA AND CERAMOPLASTIC PRODUCTS of solid-wall radomes is so great that sandwich structures are considered wherever possible. Sandwich radomes, on the other hand, introduce such problems as different expansion rate and bond between the skins and core.

Solid-wall structures formerly showed better transmission and boresight deflection, but recent developments with loaded-core radomes permit the manufacture of sandwich structures which are electrically uniform at high temperatures while still giving the strength-weight advantages of sandwiches.



Strength of phenolic laminate

Designers of missile radomes may take advantage of the inherent poor heat resistance of organic laminates. Surface decomposition of the radome provides an insulating barrier to slow down the progression of heat through the rest of the laminates. Thus, materials which are far from attaining the heat resistance theoretically needed may still be used if this principle of controlled destruction is followed.

Each radome presents a specific material problem related to its specific function. Choice of the optimum material requires a thorough knowledge of available materials, including their behavior at elevated temperatures and their structural and electrical characteristics. To aid in making this selection, the eligible types of materials are here compared from a standpoint of usefulness for supersonic radome construction.

The thermosetting resins used in laminates, being organic, are built around a carbon element. Such a

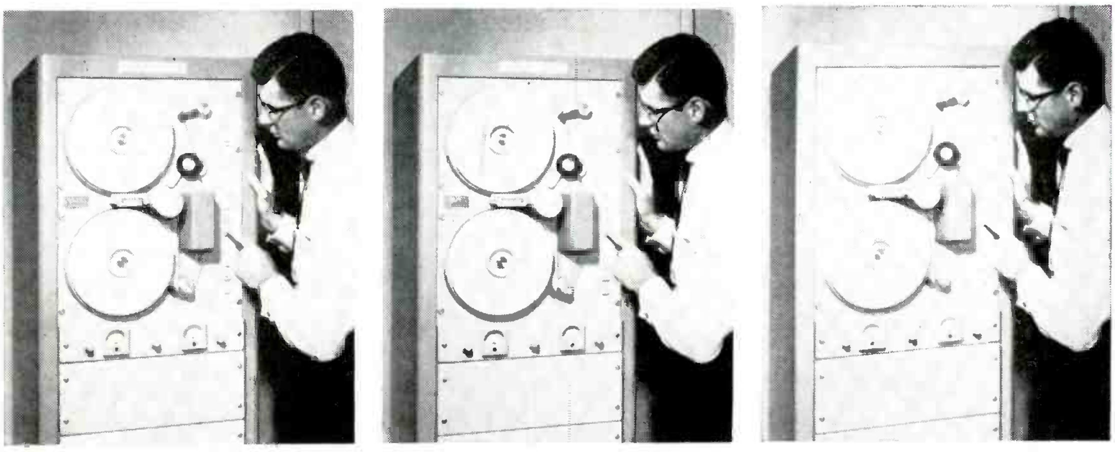
Circle 132 Readers Service Card—>

How the Queen's picture would keep its charm

Introducing "FAXTAPE"— facsimile on magnetic tape

We were entirely in accord with the British and Canadian points of view. Her Majesty's plans to visit Canada deserved special effort . . . which meant, from us, an earlier-than-planned unveiling of magnetic-tape facsimile recording.

In anticipation of phone-line news photos of the occasion, Ampex delivered FAXTAPE number one to Canadian Overseas Telecommunication Corporation's Vancouver office. By recording pictures off the wire onto tape, C.O.T.C. can retransmit to overseas with no visible loss of quality—desirable for any subject — most fitting preparation for the Queen.



FAXTAPE records its own photograph and provides a revealing comparison. Left photo was printed directly off the facsimile wire. Center is the photo after being received on tape and retransmitted. Right is the same photograph after being retransmitted the conventional way off a facsimile print.

A SLOW-SCAN COUSIN OF VIDEOTAPE

Ampex's FAXTAPE is to facsimile as Videotape is to television. It records the electrical signals used in picture transmission. Tape playback reproduces identical voltage patterns, retransmitting the picture and/or feeding a transceiver to make a negative or print.

FAXTAPE is a versatile adaptation of an Ampex FR-1100 instrumentation tape recorder. FM-carrier electronics provide faithful amplitude reproduction for accurate grey-scale with a tape speed of 7½ in/sec. matching phone-line frequency response of 2500 cycles/sec. A real technical achievement in the system is a tough, reliable time standard so precise that the drift is only one second per week. This keeps picture skew down to imperceptible levels.

PICTURE TRICKS AND PRACTICAL ANSWERS

For news photos, weather maps, documents and military data, picture quality no longer demands simultaneous transmission to all receiving points. From tape a second-generation facsimile is as good as the original. Even a third or fourth tape generation is entirely acceptable.

For unattended receiving, FAXTAPE provides one whole hour of recording time per reel. Unlike a facsimile transceiver, magnetic tape does not require makeready on each picture — and incidentally eliminates chance of wrong scanning speed or photo development errors. Voice instructions, coding and scale are recorded on the tape together with the picture itself.

Lines and radio links can be used more effectively and economically with FAXTAPE. Facsimile can be collected on tape and held for available line time or clear broadcast conditions. Also, when wider frequency bands are available, the tape can be speeded up many fold reducing transmission time accordingly.

Tricks? FAXTAPE plays back an electronic picture. You can stretch it, shrink it, speed it up, slow it down, invert the grey scale, juggle the values, or feed it all to a computer — subject only to the limits of human ingenuity. Any ideas?

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Series 800 Mobile and Airborne

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Series FL-100 Loop Recorders

Series FR-1100

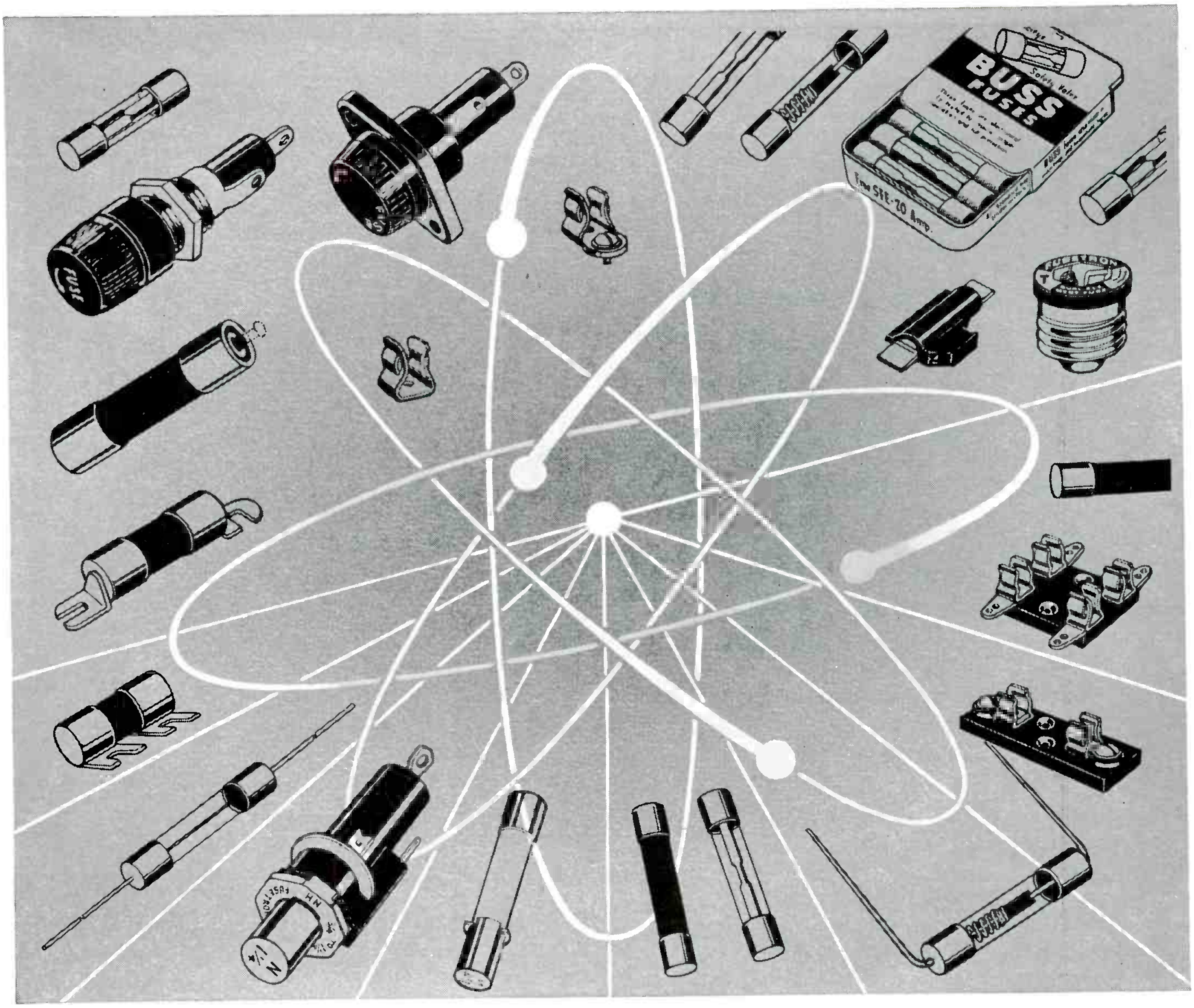
carbon element means relatively poor heat resistance, although chemists may rearrange the molecules to reach 1,000F or slightly more for limited periods. Above that temperature, organics must be abandoned at present in favor of the jungle of inorganics.

▶ **Modified Polyesters**—The heat resistance of modified polyesters is sufficient for most aircraft now in service. With proper post-cure, they retain good structural properties up to 360F. Electrically they are very good. Fabrication is easy. Bag molding can readily be used particularly for producing large shapes and prototypes of any size.

Above 360F the strength of modified polyesters drops off rapidly and they are of little value above 400F.

▶ **Triallyl Cyanurate**—The TAC resins possess excellent strength retention up to 500F. Electrical properties also are relatively good (dielectric constant 4.3, loss tangent 0.019 for 181 cloth laminates at 9,360 mc). The major disadvantage is a violent polymerization reaction, accompanied by much shrinkage and crazing. Blistering is difficult to avoid and fabrication tricky. Other disadvantages are lengthy post-cure and poor interlaminar strength. Wet-layup bag molding techniques may be successfully employed with careful processing. Keeping these limitations in mind, satisfactory radomes can be made. Several large programs have been completed using a considerable volume of TAC resins.

▶ **Epoxies**—One large airframe manufacturer uses epoxies almost exclusively in producing radomes. Their heat resistance, a notoriously weak point, has been substantially improved with the appearance of new curing agents such as het-anhydride or dicyandiamide. Excellent strength retention is shown with a recently developed epoxy even after 200 hours at 500F. These new developments, however, are still in the experimental stage. Because of their exceptionally high strength and outstanding interlaminar strength, epoxies should



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

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

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

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

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

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

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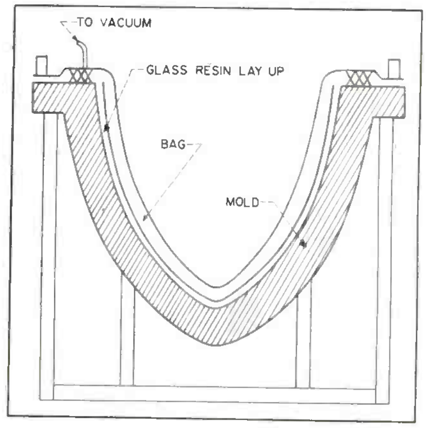
1157

not be overlooked in the search for high temperature resistance.

▶ **Phenolics**—Although barely out of the development stage, some of the newer low-pressure phenolics bear all the marks of a promising radome material. One drawback is poor thermal shock resistance, important in missiles where surface heating is extremely rapid. Press-molded phenolic laminates blister



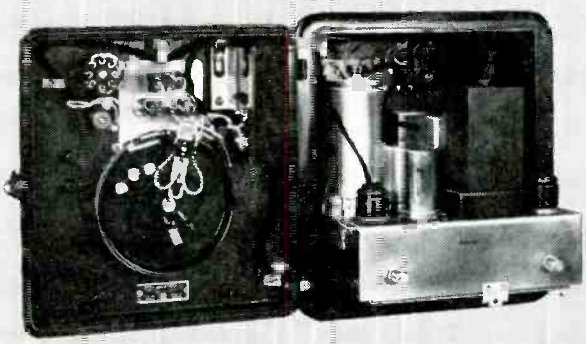
Vacuum bag molding technique for organic radome material

in the 500-600F range, due to entrapped gas within the laminate expanding with heat. Bag molding, using vacuum pressure and a bleeder material, provides an effective method of removing these gases. Bag molding, however, results in a porous laminate which is much more susceptible to oxidation; this in turn means much lower heat resistance.

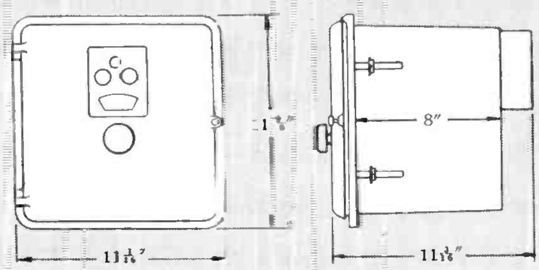
Recent work in low-pressure phenolics lamination has led to a modification of the curing cycle. This new cycle consists of a press cure at low temperature which advances the resin to a stage in between B stage and full cure. The structure of the material at this point is such that when being post-cured, entrapped gases can still escape by osmosis or vapor transmission. When processed in this manner, phenolics yield laminates with good thermal shock resistance. Equally good results are obtained in bag-molded parts when autoclave pressure (about 100 psi) is used; very little porosity is then noted.

Excellent strength properties are retained up to 750F and even

NEW



Design simplicity minimizes maintenance; sturdy components resist normal shock and vibration. Precisely calibrated slidewire and circuit resistors hold stability. For easy servicing, amplifier slides out of case; standard vacuum tubes are used . . . their replacement requires no special selection.



Compact Electromax controller mounts flush in panel. Leads are brought to terminal board located on back of case. Net weight about 27 pounds.

Thermocouple Electromax® Controller for temperatures up to 3200 F

- ***0.3% LIMIT OF ERROR***
- ***10 μV* CONTROL DEAD BAND***
- ***CONTINUOUS STANDARDIZATION***
- ***4-WEEK DELIVERY***

**0.5 F for base metal thermocouples; approximately 1.5 F for platinum thermocouples.*

Combining all the accuracy and reliability of a modified d-c potentiometer with a drift-free amplifier detector, this new Electromax signalling controller provides low-cost electronic two-position control where a record or continuous indication is not required. It's ideal for many electric and fuel-fired furnaces, ovens, plastic extruding machines, and some types of chemical processing units. Other uses include zone control on continuous ovens and kilns, and excess (overheat) temperature cutout control.

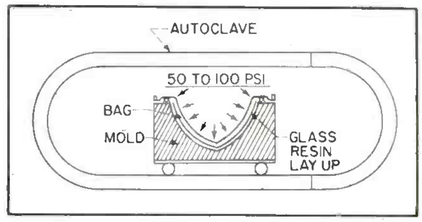
This compact signalling controller has only two moving parts—a plug-in relay and converter (chopper). These, together with simple circuitry and liberal use of plug-in components (including a plug-in amplifier), minimize maintenance and reduce initial cost. To speed start up of your process, Electromax is delivered four weeks after receipt of your order.

Other standard features include both thermocouple and amplifier fail-safe, and automatic reference junction compensation. Amber and red signal lights indicate whether process temperature is above or below set point.

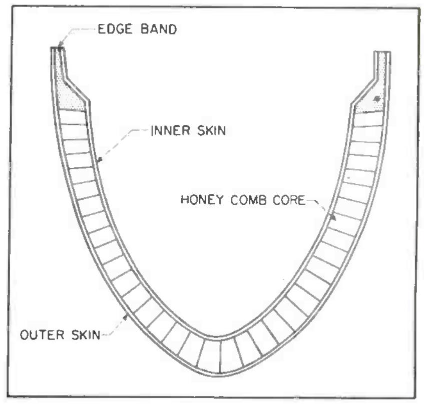
For additional information on the thermocouple Electromax, call your nearest L&N office or write 4979 Stenton Ave., Philadelphia 44, Pa. Ask for Preliminary Data Sheet ND47-33(1).

LEEDS NORTHRUP
Instruments Automatic Controls • Furnaces

Circle 136 Readers Service Card



Autoclave molding technique



Typical cross-section of honeycomb radome for missile

higher for short periods of time. Phenolics still do not have good electrical properties (dielectric constant 4.6, loss tangent 0.03 at 9,360 mc for 181 fabric laminates), yet they may be considered acceptable for radomes. From a heat resistance standpoint, they are difficult to match in the 500-1,000F range, especially where superior strength is a factor. The modulus of elasticity is well above the modulus of other resins.

▶ **Silicones**—Silicone resins have good properties in the 750-1,000F range and have been held at 2,000F flame exposure for 15 minutes without fire or burn-through. They appear immune to thermal shock blistering. Electrically, they are satisfactory (dielectric constant 3.7, loss tangent 0.02 at 9,360 mc for asbestos-felt laminates). Room-temperature strength properties and especially interlaminar strength are low.

Like phenolics, silicones are used in preimpregnated form. They may be bag-molded relatively easily. Autoclave molding appears to be a promising fabrication method.

▶ **Foams and Honeycombs**—Isocyanate foams, which make the bulk of foam radomes, barely reach 250F. Higher temperatures are in

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DESIGN
INSTRUMENTS

The M-3 SIGNAL GENERATOR

- 1 cps—120,000 cps
- Sine and Square Waves
- Less than 0.01% Drift per Hour after Warmup
- Less than 0.1% Distortion in Audio Range
- Frequency Calibration (1% + 0.1 cps)
- Calibrated Attenuator and Output Meter
- A necessity in a fully equipped electronics facility.

The new ADI instruments from SIE are based on an appreciation of the essential requirements for successful design and research instrumentation . . . Accuracy, Versatility, and Reliability. For example: the M-3 Signal Generator — first of the new ADI instruments — is designed to provide the research and design engineer with a highly accurate frequency source for applications ranging from amplifier design to telemetering measurements . . . and to meet these aims in a design which provides maximum "in use" convenience.

There will be new SIE instruments in the ADI Group available in the near future. Watch for their announcement, and, in the meantime, let your SIE representative demonstrate the M-3 in your lab. Check the accurate dial calibration and extremely low drift rate. You'll find a new standard of performance which really deserves the description . . . an **A**dvanced **D**esign **I**nstrument.

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Industrial Instrumentation for Industrial Progress

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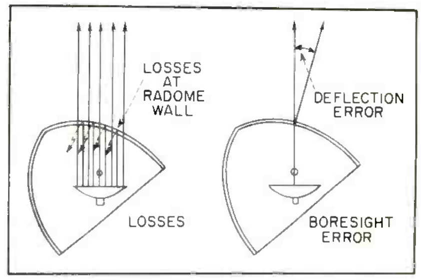
sight in some of the newer foams, but these are still in the development stage. High-temperature phenolic honeycomb, on the other hand, retains excellent strength at 500F. Recent tests showed that in certain cases, with special care, boresight error of honeycomb structures may be of the same order as similar isocyanate foam structures. Thus, honeycomb may replace foam in many cases where high heat resistance is required.

▶ **Reinforcements**—Radome laminates combine inorganic reinforcements such as fibrous glass with



Transmission through typical radome wall, and deflection of beam passing through typical radome wall

organic thermosetting resins. Each of these components has a different coefficient of expansion and a different rate of expansion. It is therefore of utmost importance to provide a good bond between them if good performance is to be achieved over a wide temperature range.

Several finishes for fibrous glass have recently been developed for specific resins, as follows: Polyesters—Volan A, 136, Garan; TAC—OC 301; epoxies—Volan A; phenolics—NOL 24; silicones—112.

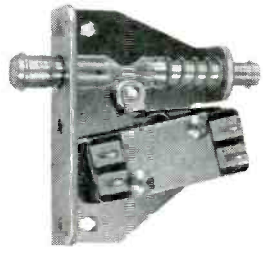
Glass begins to soften at 1,200F and is of little value above that temperature. Asbestos fibers retain their properties at higher temperatures. Asbestos laminates and particularly asbestos-phenolic laminates show improved thermal shock resistance over similar glass laminates. While a large amount of design data is now available on fiberglas laminates, information on asbestos laminates is still scanty.

▶ **Inorganics**—New supersonic missiles call for an entirely new concept of radome design and manufacture based on inorganic

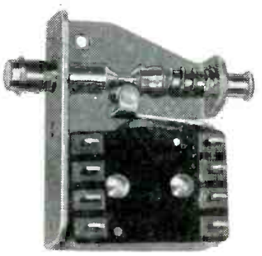
TYPICAL ELECTRO-SNAP INTERLOCKS

Push to operate;
returns automatically.

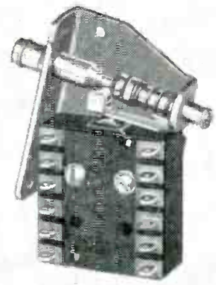
Pull to operate;
remains in operating position until reset for automatic return by next full-stroke push operation.



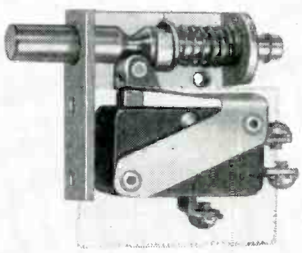
MODEL C2-4 S.P.D.T. 2 ckts. **Elec. rating:** 125/250 V.A.C., 30 V.D.C. —10 amps. 125 V.D.C., ½ amp. 250 V.D.C., ¼ amp. **Oper. force:** 2 lbs. ± 12 oz. **Weight:** 2 oz. **Dimensions:** 1-13/16" x 1-31/32" x 9/16"



MODEL C2-9 D.P.D.T. **Elec. rating:** 15 amp. 125/250 V.A.C. 60 cycle. **Oper. force:** 4¾ lbs. ± 12 oz. **Amb. temp:** —100° to + 275° F. **Elec. & Mech. Life:** 150,000 ops. **Weight:** 2 oz. approx. **Dimensions:** 1-29/32" x 1-31/32" x 9/16"

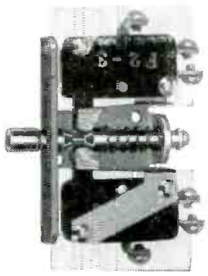


MODEL C2-14 T.P.D.T., 6 ckt. **Pre-travel:** 5/32" min. **Overtravel:** ¼" approx. **Mov. Diff.** .028" ± .007" **Elec. rating:** 15 amp. 125/250 V.-A.C.—15 amp. 30 V.D.C., res.—10 amp. 30 V.D.C., ind. **Life**—500,000 ops. min. **Dimensions:** 2-5/16" x 1-31/32" x 9/16"



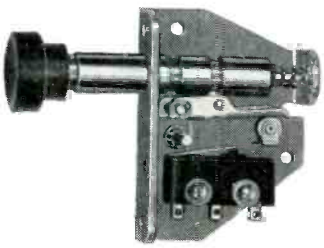
MODEL C2-5 Solid shaft. S.P.D.T. **Elec. rating:** 10 amps. @ 125/250 V.A.C., 60 cycles. **Oper. force:** 2 lbs. ± 12 oz. **Amb. temp.:** —100° to + 275° F. **Elec. & Mech. life:** 150,000 ops. **Weight:** 2 oz. **Dimensions:** 1-13/16" x 1⅞" x ½"

MODEL C2-10 same as C2-5, except has threaded shaft.

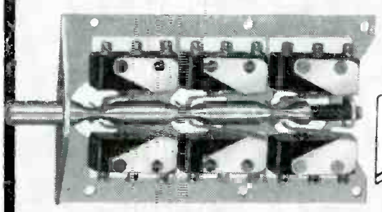


MODEL C2-7 Solid shaft. D.P.D.T. **Pre-travel:** 3/16" max. **Elec. rating:** 10 amp. 125/250 V.A.C. 60 cycle. **Amb. temp.:** —100° to + 275° F. **Elec. & Mech. Life:** 150,000 ops. **Dimensions:** 2-3/32" x 1⅞" x 33/64"

MODEL C2-6 same as C2-7, except has threaded shaft.



MODEL C2-15—Subminiature interlock. S.P.D.T.; **Elec. & Mech. Life and Rating:** 150,000 ops. @ 2.5 Amps., 125/250 V.A.C.; 100,000 ops. @ 5 amps, 125/250 V.A.C. **Dimensions:** 1-13/16" x 1¼" x 9/16". Various colored buttons available.
(Also available in momentary contact, one-way impulse action.)



GANGED INTERLOCKS—2 or more switches may be ganged for multiple control with single actuation.

how to cut control costs

with no sacrifice in switch reliability!

These proved-in-use interlock switches are now standard production items at ELECTRO-SNAP

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materials. Although very good electrically, these are deficient strengthwise. Among the most promising inorganics is aluminum oxide, which possesses physical properties not much lower than those of organic resins.

Inorganic coatings such as sodium silicate coatings over an organic laminate base may provide some of the answers. All of these materials are still very much in the earlier development stage and face many hurdles. Interesting results have been attained with laminates using inorganic binders with glass and asbestos fiber reinforcements. Up to the temperatures used so far in testing, 750F, these materials showed little loss in strength.

▶ **Conclusions**—Materials are now available that will perform satisfactorily up to the 750-1,000F range. Radomes can be designed and built to operate within these limits. Above these, a breakthrough in designs and materials is vitally needed. The imagination should perhaps strive toward new concepts such as heat sinks, refrigeration devices or evaporation cooling systems. Such breakthroughs, however, would provide the answer for only a few more steps into the thermal thicket. The Air Force recently reported speeds in excess of 18,000 mph in shock tubes. This means up to 15,000F skin temperature. Such staggering requirements may face us in the not too distant future.

Plastic Envelope Protects Work Orders

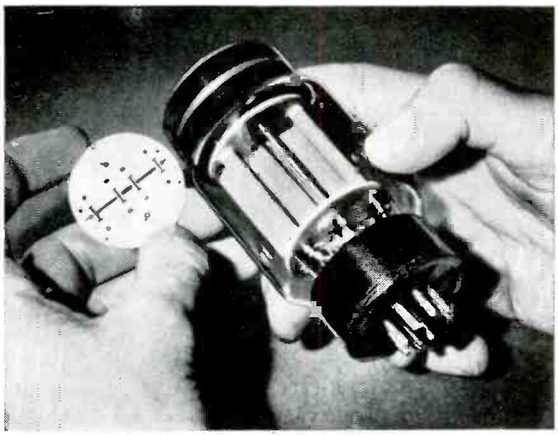
TRANSPARENT FILM ENVELOPES made of Bakelite polyethylene protect work orders as they are routed through plants and offices. Orders can be read easily without removing the papers.

A simple polyethylene pressure closure manufactured by Flexigrip, Inc., 504 E. 74th St., New York, N. Y. permits papers to be taken out and replaced easily and quickly if the work order needs notation. The pressure closure consists of two small interlocking ridges that give a complete seal. To open the envelope, it is merly necessary to

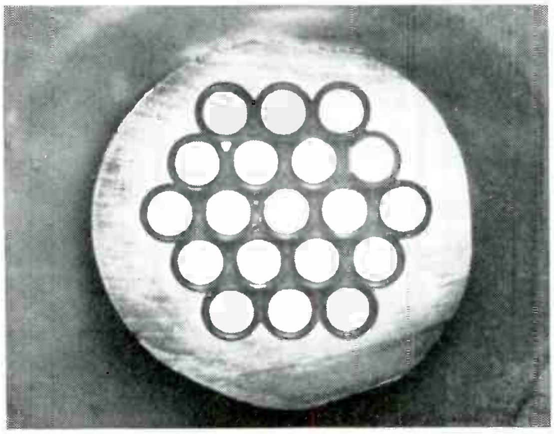
NEW LOW-COST RAYTHEON IMPACT GRINDER—$2790*

Ultrasonic machine cuts, slices, drills, shapes germanium, silicon, ferrites, ceramics with speed and precision

New low-cost Raytheon Impact Grinder uses ultrasonic power to drive abrasive particles at 25,000 cps between the tool and the work. An exact counterpart of the tool is reproduced with speed and precision.



Holes and slots for this ceramic tube spacer are easily cut with the Raytheon Impact Grinder. Use of ceramic, rather than mica, for this tube more than doubles its life. (Photo courtesy C-Mar Corp., Manasquan, N. J.)



Simultaneous cutting of circular pieces from germanium wafer. Any shape can be cut with speed and precision in hard or brittle materials such as germanium, silicon or ferrite. (Photo twice actual size)

Low-cost version of $7100 machine cuts limitless variety of shapes in hard or brittle materials. Design engineers welcome new freedom of design it makes possible. Great variety of production and cost problems solved by this versatile new machine.

FREEDOM OF DESIGN

In impact grinding an exact counterpart of the tool is reproduced in the work piece, tool pressure is extremely low and no heat or stress is involved. A limitless variety of shapes can be produced in virtually all hard and brittle materials. To the design engineer, this means that new substances can be used, or that familiar materials can be produced in shapes that formerly were impossible.

For example, the use of a ceramic rather than a mica spacer in the tube shown at left permits much higher tube operating temperatures, better degassing, reduced noise and doubles tube life. Without impact grinding, it is impossible to produce the ceramic spacer with slots and holes sized and positioned with sufficient accuracy.

Square holes can be accurately cut in ferrites. Too brittle to be readily processed by any other means, ferrites are easily drilled or cut with the Raytheon Impact Grinder without disturbing the crystalline structure.

Semiconductors are diced with great ease and can be produced in entirely new shapes. Round, square, delta, oval—any shape that can be fabricated in a soft metal tool can be exactly reproduced in semiconductors.

LOW-COST PRODUCTION

From the production engineer's standpoint, the Raytheon Impact Grinder offers decided cost and time saving advantages. In many instances it vastly simplifies jobs which would otherwise be extremely difficult, time-consuming and costly. In some cases it will even do work formerly considered "impossible". The machine lends itself to economical manufacture of prototypes or full production runs. This compact unit is built to the most exacting electrical and mechanical standards and can be operated by semi-skilled personnel.

APPLICATION ENGINEERING SERVICE

Find out how Raytheon's Impact Grinder can help solve your design and production problems. A Raytheon representative will be happy to demonstrate the machine *in your plant on your own material,* without cost or obligation. For free catalog or to arrange for demonstration, please write Dept. 6120F.

RAYTHEON

Excellence in Electronics

**Price subject to change without notice.*

A-2101

RAYTHEON MANUFACTURING COMPANY
Commercial Equipment Division, Waltham 54, Mass.

Example of envelope in use

lift one flange to disengage the lock. With the pressure closure sealed, the work order is protected against dirt, chemicals, moisture and finger smudges.

The envelopes are made in four standard sizes by Polyfab Co., 3511 Eagle Rock Boulevard, Los Angeles 65, Calif. An added feature is a slot at the top which can be used to hold identification of the originating department or supervisor.

Making Capacitors by Vacuum Evaporation

HIGH-TEMPERATURE equivalents of conventional paper capacitors have been made experimentally by Servomechanisms, Inc., El Segundo, Calif. by vacuum evaporation.

A small alumina cylinder is placed in a vertical position on a motor-driven pedestal in the center of the vacuum chamber. Located around the periphery of the vacuum chamber at 90-degree intervals are four vapor sources two of dielectric material and two of metal conductors, alternately spaced. Between these sources and the alumina core is a cylindrical mask having four vertical slits, one in front of each vapor source.

When the chamber is pumped down, the pedestal motor is started so the alumina core rotates. Now when the four sources are brought up to vaporization temperatures, streams of vapor pass through the four slits and deposit alternate metal and dielectric films on the core, to build up the familiar wound capacitor construction. Each metal film starts at one of the two terminal strips initially deposited on the core with special masks.

New Products

Edited by WILLIAM P. O'BRIEN

84 New Products and 9 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

TV UV MICROSCOPE
and microspectrophotometer

NEUTRONICS RESEARCH Co., 165 Lake St., Waltham, Mass., has developed a color translating tv ultraviolet microscope.

Basically, the microscope operates as follows: Three ultraviolet-monochromators supply the three preselectable ultraviolet or visible wavelengths. A substage rotating mirror system brings these sequentially into a 2,000A or 7,000A apochromatized microscope system. An identical post-ocular rotating mirror separates in space the three UV absorption images of specimen onto three UV-Vidicon cameras, respectively.

Microspectrophotometry is performed by selecting any one of the horizontal scan lines and displaying its density variation across the specimen on a line-analyzer oscilloscope. The microscope is essentially electronic as opposed to the mechanical-optical design of previous models. Price is $37,500. **Circle 401 on Reader Service Card.**

MINIATURE MICROPHONE
is precision-built

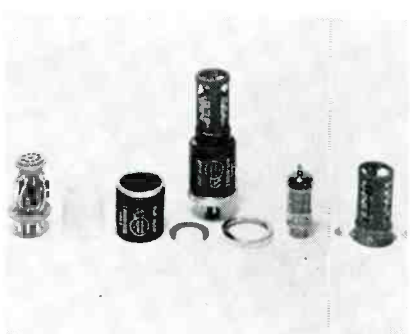
SHURE BROTHERS, INC., Evanston, Ill., announce the new rugged MC30 controlled magnetic microphone designed for use by manufacturers of hearing aids, communication equipment, tape recorders and dictating equipment. The half-in. square microphone is precision produced and features quality performance, uniformity and dependability.

Size is $\frac{1}{2}$ in. by $\frac{1}{2}$ in. by $\frac{17}{64}$ in. and weight 3.7 grams. Output is—76 db at 1,000 cps; response, 400 to 4,200 cps; impedance, 1,850 ohms at 1 kc. **Circle 402 on Reader Service Card.**

RUGGEDIZED PLUG-INS
meet MIL-E-5272A tests

ENGINEERED ELECTRONICS Co., 506 East First St., Santa Ana, Calif., has available a complete series of ruggedized plug-ins for designing and building automation systems. This line of rugged systems building blocks speeds the design of timing systems, automatic control systems, data handling, computing and automation systems.

The new group of EECO ruggedized plug-ins includes: cathode followers, pulse gates, squaring circuits, gate amplifiers, d-c amplifiers, reset generators, one-shots, flip-flops, gates, crystal oscillators, multivibrators, pentagrids, amplifiers, phantastrons, voltage regulators, blocking oscillators, thyratron ring counters and thyratron pulse generators. **Circle 403 on Reader Service Card.**



PULSE GENERATOR
useful to computer field

AMERICAN ELECTRONIC LABORATORIES, INC., 121 North 7th St., Philadelphia, Pa., announces the 138 pulse generator. This instrument produces pulses over the range of one microsecond to one second—singly, recurrently, single pairs, recurrent pairs, single trains

Leadership is hard to achieve and even harder to maintain. A stroke of genius or a lucky break may put you on top, but it takes stability of organization and persistent *product dependability* to keep you there. More C-D capacitors are sold because C-D capacitors are made better—not just in one big order, but in every order every year. Our leadership is added insurance for yours, because it is based on the high quality of every CORNELL-DUBILIER capacitor since 1910.

Write for catalog to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

Two of Thousands of C-D's Mica Types:

CERAMIC-CASED HIGH-POWER MICAS: Built to handle efficiently and economically the high kva requirements of transmitters, induction heaters, Loren circuits and a variety of other high-current equipment for military, communications and industrial applications.

"SUPER MICADONS*": An entirely new concept in quality midget mica capacitor construction. Greatly increased capacitance over that of conventional units of the same case size.

CONSISTENT HI-DEPENDABILITY
CORNELL-DUBILIER CAPACITORS

*®

SOUTH PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER & CAMBRIDGE, MASS.; PROVIDENCE & HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD, FUQUAY SPRINGS & VARINA, N. C.; VENICE, CALIF.; & SUB.: THE RADIART CORP., CLEVELAND, OHIO; CORNELL-DUBILIER ELECTRIC INTERNATIONAL, N. Y.

Circle 142 Readers Service Card

and recurrent trains. The output is reversible and supplies 35 v into 50 ohms.

The instrument should be useful to those engaged in the fields of sonar, digital computers, acoustics, countermeasures, geophysics, analog computers and radar.

Repetition frequencies from less than 1 cps to 250 kc are available internally. The instrument will follow external sync anywhere in this range aperiodically or periodically. **Circle 404 on Reader Service Card.**

DYNOGRAPH RECORDER
features up to 19 channels

Offner Electronics Inc., 5320 North Kedzie Ave., Chicago 25, Ill., has in production a new Dynograph direct-writing oscillograph recorder, the type 503. The new unit, a mobile console assembly is designed for applications requiring more than 8 channels of information on one recording chart. Up to 19 recording channels are available in the type 503 Dynograph, using either ink or electric curvilinear recording. The manufacturer supplies 24½ in. printed paper, either in roll or folded form, and 500 ft unprinted rolls as desired.

Pen spacing of 2 in. is normally provided with assemblies of 12 channels or less, and pen spacing of 1¼ in. with assemblies of 13 through 19 channels. Other pen spacing can be supplied if desired. The paper is driven by a synchronous motor and eight speed gear box, providing instant selection of speeds of 1, 2.5, 5, 10, 25, 50, 100, and 250 mm per sec, accurate to 1 percent. Paper is driven from both edges.

The new type 503 Dynograph recorder features fast response, high sensitivity, and absolutely drift-free recording through the use of the patented chopper amplifier developed by Offner. **Circle 405 on Reader Service Card.**

MYLAR CAPACITOR
is metallized component

Astron Corp., E. Newark, N. J., announces a new Mylar metallized capacitor, type RQL. This miniature unit in a hermetically sealed case is extremely reliable at temperatures up to 125 C without derating.

Type RQL is available in a wide range of case styles and constructional variations similar to those from type CPO4 through CPO11 in Mil-C-25A. Electrical specifications of MIL-C-18312, the military specification recently issued by the U. S. Navy for metallized capacitors, are met. **Circle 406 on Reader Service Card.**

BEAM SWITCHING TUBE
with high input impedance

Burroughs Corp., Electronic Tube Division, Plainfield, N. J., has available a full line of magnetron beam switching tubes. Featuring high input impedance and ten individual constant current outputs, these beam switching tubes may perform the functions of 20 or more tubes or transistors. It is compatible with tubes, transistors, cores, thyratrons, relays, Nixie numerical indicators and other devices.

This high vacuum electronic distributor has an estimated life span of 50,000 hours. Characteristics of the tube line include shock, 375 g; temperature range of −60 to +150 C; vibration, 20 g; and a speed up to 20 mc.

Type 6700 operates between 75 to 300 v with a switching rate above 2 mc and type 6701 from 12 to 25 v with a switching rate above 1 mc. Type MO-10R is the same as 6700 except that it has ten internally mounted space load vacuum resistors to permit operation at higher frequencies and with a reduced number of external stem leads.

Versatile, the beam switching tube is now in use in instruments, industrial control computers, tele-

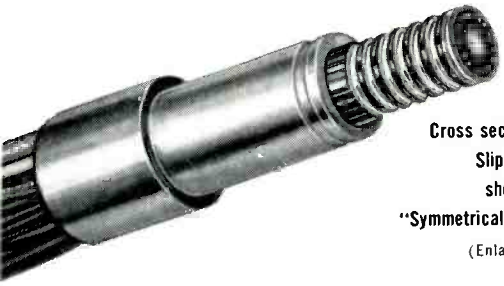
You hear that statement often these days, as engineers and production men shift their thinking to meet the dawning missile age.

For the past 10 years "ultra-reliability" has been the byword at Electro Tec Corporation.

We have achieved it by developing unique designs and methods that now place us in a leading position to meet the even greater emphasis placed upon reliability by the stringent requirements of missile control and guidance systems.

It costs no more to have the assurance of Electro Tec's "ultra-reliability" — and it is rooted in demonstrable scientific facts.

Take our slip ring assemblies, for example:



Cross section of 34-ring Slip Ring Assembly showing exclusive "Symmetrical Construction."
(Enlarged 1 ½ times)

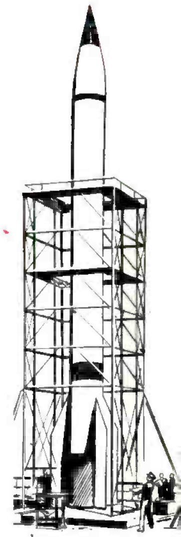
"*Ultra-reliability*" for the missile age.

* U. S. Pat. 2,696,570. Other patents pending.

1. **Mechanical stability under high temperatures, shock and vibration,** and greater strength are the result of **symmetrical construction** throughout, and the use of a hardened center wire. (See illustration at left.)

2. **Ultra-reliable electrical performance,** lowest noise levels, more uniform wear because the exclusive* Electro Tec processes permit the use of pure **24K gold** and fine silver instead of alloys.

3. **Molecular bond*** of ring to wire assures positive, permanent connections under high temperature, shock and vibration.



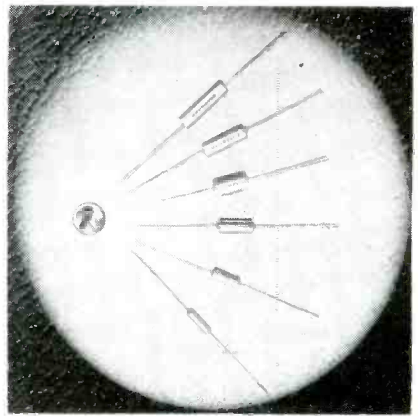
These are the points of Electro Tec superiority that add up to "ultra-reliability" in the air and on the shelf — now . . . *or three years from now!* Electro Tec Sales Engineers are available in all parts of the country. Write to:

ELECTRO TEC CORP.

South Hackensack, N. J.

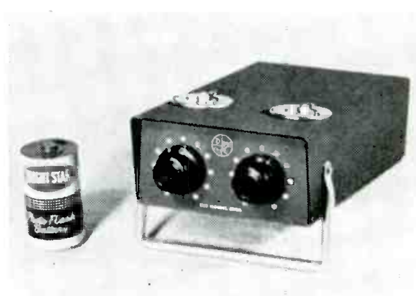
Products of Precision Craftsmanship

metering, radar and many other military applications as well as the Burroughs decade counter with a Nixie readout. Applications for frequency dividing, timing and multiposition distributing are limitless. **Circle 407 on Reader Service Card.**



ELECTROLYTICS
miniature aluminum type

THE MAGNAVOX CO., Fort Wayne 4, Ind. Miniature aluminum electrolytic capacitors, having only a few μa of electrical leakage, have been developed. Ratings range from 1 to 125 μf and 4 to 150 v d-c. Permissible operating temperature range is -20 C to $+85$ C. Lengths range from $\frac{3}{8}$ in. to $1\frac{1}{4}$ in. and diameters from $\frac{3}{16}$ in. to $\frac{5}{16}$ in. Centered axial leads permit automatic insertion in printed circuit boards. The case is electrically insulated and is effectively sealed with epoxy casting resin. **Circle 408 on Reader Service Card.**



AUDIO EQUIPMENT
is transistorized

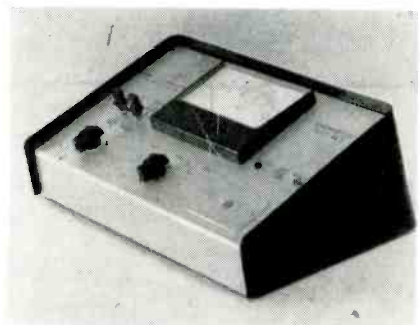
DUNLAP ELECTRONICS INC., 764 Ninth St., Des Moines, Iowa. The TM series of audio equipment has been designed with the maximum

Circle 324 Readers Service Card

of reliability and portability. The units use an etched circuit combined with transistors to obtain long and trouble-free life. Total interaction of the mixer stages does not exceed 1 db at any setting of the gain controls. The battery life exceeds 60 hours for an approximate operating cost of 2 cents per hr.

The mixer units have been designed to fit in the film storage compartment of the Auricon "Sound on Film" camera and have been used to give much better recording characteristics with the Auricon camera.

The TM-2 uses 3 transistors and the TM-4 uses 5 transistors in low noise temperature stabilized circuitry. Literature available gives options and ordering combinations and prices. **Circle 409 on Reader Service Card.**



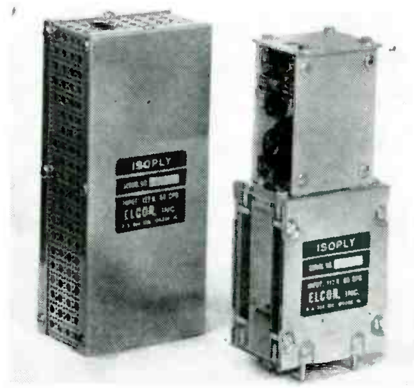
TRANSISTOR TESTER
determines basic parameters

ARMOUR ELECTRONICS, INC., 10800 Ventura Blvd., Studio City, Calif. An accurate system has been designed into this instrument to determine the basic parameters of a transistor. Beta and I_{co} are determined as well as figure of merit, I_{bco}. This I_{bco} can well be relied upon to denote the quality factor for it involves collector current leakage, emitter current leakage, transistor gain, base and emitter resistances.

The test set accurately measures Beta, I_{co}, and I_{bco} of both *pnp* and *npn* type transistors at any desired operating level assuring the flexibility required for circuit design. Component matching accuracy of approximately 2 percent is provided. Simplicity of the control panel and testing procedure makes the tester compatible with the requirements

of high rate quality control testing.

Modern circuit techniques are used throughout the unit which weighs only 4¼ lb and is enclosed in a cabinet 5 in. high, 11 in. wide, and 9 in. deep. All electrical power is derived from four mercury cells. The test set is priced at $96. **Circle 410 on Reader Service Card.**



STRAIN-GAGE SUPPLY
transistor regulated

ELCOR INC., P.O. Box 354, McLean, Va., has available a new line of low-voltage transistor-regulated Isoplys designed especially for strain-gage bridges, and other applications requiring an ungrounded low-noise power supply. Models A8/10-100A and A11/13-100A employ the same low-capacitance transformer construction used in other Isoplys. The low value of shunt capacitance (40 $\mu\mu$f with ventilated metal cover) and the special transformer shielding make the supply suitable for such applications as: (1) bridge circuits requiring an off-ground low-noise supply; (2) high-speed direct-coupled circuits requiring an ungrounded supply; and (3) special circuits requiring a floating supply for bootstrapping. This supply is well suited to conventional use, especially transistor circuits where either + or − terminal is grounded.

These models feature adjustable regulated outputs of 8-10 v d-c or 11-13 v d-c conservatively rated at 100 ma. Regulation with respect to load is 0.4 percent no load to full load. With respect to line voltage change the regulation is better than 0.2 percent for a 10 percent change in line voltage. Change in output voltage with re-

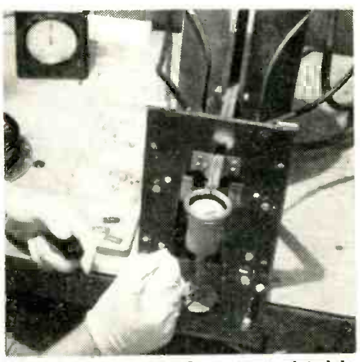
Waveguide Pressure Windows

...new techniques result in increased reliability

Does your problem involve reliable, low loss hermetic sealing at microwave frequencies? If so, Microwave Associates' large selection of over 50 different waveguide pressure windows is the answer.

Our windows include 20 flange mounted and 29 solderable types ranging in frequency from 2800 to 70,000 mc/s. Designed and produced by personnel combining years of experience in both microwave and glass-to-metal sealing techniques, these windows are indispensable for sealing both high and low power microwave devices such as ferrite isolators, antenna, duplexer and filter assemblies and many types of test equipment.

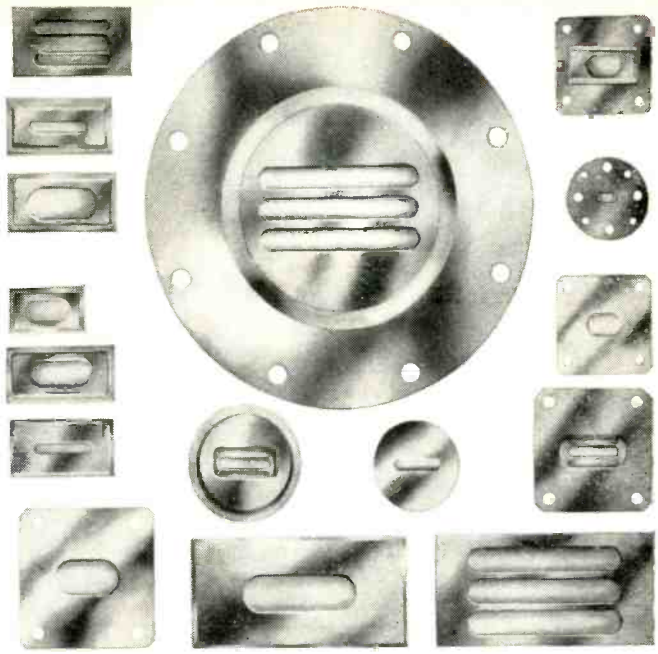
These windows are exclusively fabricated by melting glass into one or more slots of pre-oxidized kovar. The resulting structure is vacuum tight, broadband, low loss and especially resistant to wide varieties of thermal and mechanical environments. Kovar-glass windows can be repeatedly cycled over wide pressure differentials without danger of fracturing, a defect often encountered with windows fabricated from other materials. Microwave Associates' windows are silver plated and designed for convenient installation.



Glass-kovar sealing a highly critical operation, has been perfected at Microwave Associates, Inc. to produce pressure windows of exceptional quality.

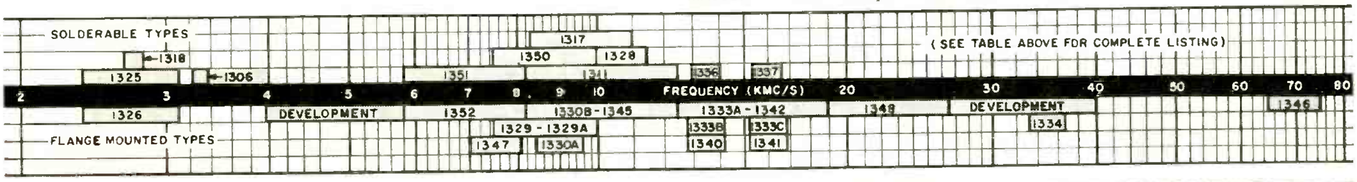
SEND FOR DATA

Write for catalog CP11-1, a 4 page brochure filled with design and application data.



FLANGE MOUNTED TYPES

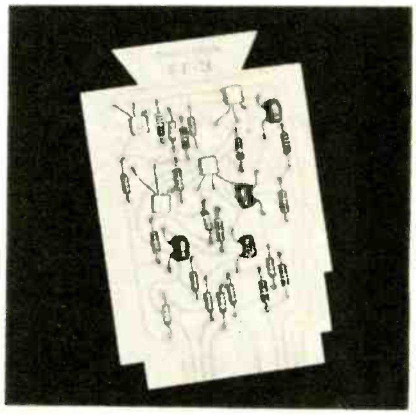
Model	Band	Center Frequency (MC)	Frequency Range (KMC)	Max. VSWR Band Edges	Peak Power (KW)	Waveguide Size RG—	Max. Pressure (PSI)
MA1326	S	2800	2.45-3.15	1.25	1200	48/U	45/30
MA1352	C	6800	5.85-8.2	1.25	500	50/U	45/30
MA1347	C	7540	7.0- 8.1	1.10	750	50/U	45/30
MA1329	X_L	9000	7.5-10.0	1.15	500	51/U	45/20
MA1329A	X_L	9000	7.5-10.0	1.15	320	51/U	60/30
MA1330A	X	9000	8.4- 9.6	1.15	200	52/U	60/30
MA1344	X	9000	8.5- 9.6	1.08	300	52/U	45/30
MA1349	X	9600	9.3- 9.9	1.10	20	.2X.9ID	45/30
MA1330B	X	9800	8.2-12.4	1.20	200	52/U	60/30
MA1345	X	9800	8.2-12.4	1.20	300	52/U	45/30
MA1339	X	9800	9.5-10.1	1.10	20	.2X.9ID	45/30
MA1333B	Ke	13500	12.8-14.2	1.10	125	91/U	45/30
MA1340	Ke	13500	12.8-14.2	1.10	125	91/U	45/30
MA1333A	Ku	15000	12.4-18.0	1.20	125	91/U	45/30
MA1342	Ku	15000	12.4-18.0	1.20	125	91/U	45/30
MA1333C	Ku	16000	15.2-16.8	1.10	125	91/U	45/30
MA1341	Ku	16000	15.2-16.8	1.10	125	91/U	45/30
MA1348	K	24000	18.0-26.5	1.15	70	53/U	45/30
MA1334	Ka	34860	33.25-36.5	1.10	40	96/U	45/30
MA1346	V	70000	65 -75	1.10	12	98/U	45/30
SOLDERABLE TYPES							
MA1318	S	2800	2.75-2.85	1.25	170	48/U	60/45
MA1325	S	2800	2.45-3.15	1.25	1200	48/U	45/30
MA1306	S	3300	3.25-3.35	1.25	170	48/U	60/45
MA1351	C	6800	5.85-8.2	1.25	500	50/U	45/30
MA1321	X	8800	8.5 -9.1	1.25	100	52/U	60/45
MA1301	X	9000	8.8 -9.2	1.25	20	52/U	60/45
MA1310	X	9000	8.8 -9.2	1.25	20	52/U	45/30
MA1320	Y	9000	8.7 -9.3	1.25	100	52/U	60/45
MA1327	X	9000	8.4 -9.6	1.25	150	52/U	45/30
MA1338	X	9000	8.4 -9.6	1.08	200	52/U	60/30
MA1350	X_L	9000	7.5-10.0	1.15	320	51/U	60/30
MA1302	X	9200	8.9 -9.5	1.25	100	52/U	60/45
MA1312	X	9310	9.0 -9.6	1.25	100	52/U	60/30
MA1353	X	9310	9.1 -9.7	1.25	100	52/U	60/45
MA1319	X	9375	9.1 -9.7	1.25	100	52/U	60/45
MA1317	X	9600	8.35-11.0	1.25	200	52/U	60/30
MA1322	X	9600	9.3 -9.9	1.25	100	52/U	60/45
MA1303	X	9800	9.5-10.2	1.25	150	52/U	45/30
MA1324	X	9800	9.6-10.0	1.25	20	52/U	45/30
MA1331	X	9800	9.6-10.2	1.10	150	52/U	45/30
MA1350A	X_L	9800	8.6-10.6	1.15	320	51/U	60/30
MA1311	X	9900	8.2-12.4	1.25	200	52/U	60/30
MA1323	X	9900	9.6-10.2	1.25	100	52/U	60/45
MA1354	X	10125	9.8-10.4	1.25	100	52/U	60/45
MA1314	X	10150	9.8-10.55	1.25	150	52/U	45/30
MA1328	X	10700	10.0-11.4	1.25	150	52/U	45/30
MA1336	Ke	13500	13.0-14.0	1.25	40	91/U	45/30
MA1337	Ku	16000	15.4-16.6	1.25	40	91/U	45/30



MICROWAVE ASSOCIATES INC.

Burlington, Mass.
BUrlington 7-2711

spect to temperature is less than 0.02 percent per deg F. A leakage resistance in excess of 50,000 megohms and voltage breakdown exceeding 2,000 v are features which make the Isoply useful in special applications. Dimensions of the supply are 1⅝ in. by 2½ in. by 5¾ in. **Circle 411 on Reader Service Card.**



PLUG-IN CARD
for digital systems

COMPTRON CORP., Belmont, Mass. The first of a new series of transistorized, printed circuit digital systems elements has been announced. Designated the FF-3, the unit is a flip-flop register which, with associated diode circuits, will gate clock triggers to a maximum of 10 similar flip-flop units without intervening power amplification. It is designed to operate from 0 to 200 kc (although operation up to 1 mc may be obtained on request) at temperatures up to 55 C. Input diode gates are included on this card to make the unit a more flexible computer element and simplify the external wiring. **Circle 412 on Reader Service Card.**

CERAMIC TETRODE
for single sideband

EITEL-MCCULLOUGH, INC., San Bruno, Calif., has announced a new high-current, low-voltage radial beam tetrode having high power gain and a plate dissipation of 1,000 watts.

Designated the 4CX1000A, this new tube type incorporates all the advantages of Eimac ceramic-metal construction and high-tem-

6 cps to 100,000 cps at

1,000 WATTS CONTINUOUS DUTY

...with the new Genisco-Savage high-output amplifiers!

Seven models—rugged enough for production line testing; versatile enough for almost all laboratory needs.

Here's the new line of quality, high-output amplifiers you've been waiting for! All seven models feature high power output, low distortion, exceptionally high reliability and stability, and excellent output voltage waveform.

The Model KLF, shown at left, is particularly useful as an exciter for vibration testing equipment and as a variable frequency power supply for a multitude of production and laboratory needs. It will operate *continuously* with an output of 1,000 watts from 6 to 2,000 cps.

Components of all Genisco-Savage Amplifiers are mounted on 19″ vertical panels to facilitate easy inspection and maintenance. Quick-release grill covers make all tubes readily accessible from the front. Numerous built-in safety features protect the equipment from operator errors.

Two New Shake Tables Available The new Model V1000 Genisco-Savage Shaker features a very light moving coil assembly, high thrust-to-weight ratio, automatic impedance matching, and an excellent output waveform. A continuous alternating thrust of ±600 lbs. is produced at 1,000 watts control power. Thrust can be increased to ±750 lbs. peak by use of a blower (Model V1000B). Both models have been stress-tested to withstand continuous operation at accelerations of 100 G's.

The Genisco-Savage Model V1000 Shaker

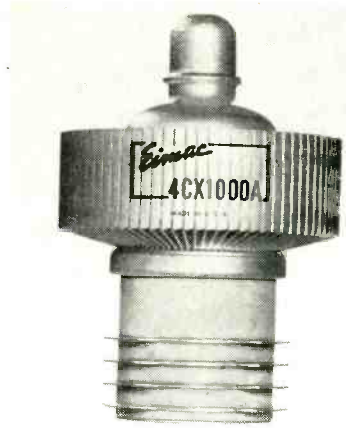
BRIEF SPECIFICATIONS	MODELS						
	BM2	DM2	KM2	10K	KM2S	KLF	KRF
Output	250 w at 50 or 100 v	500 w at 50 or 100 v	1000 w at 50 or 100 v	10,000 w maximum	1000 w at 50 or 100 v	1000 w at 50, 100, or 200 v	1000 w at 25, 50 or 100 v
Frequency Range	50 to 10,000 cps at 250 w	50 to 10,000 cps at 500 w	50 to 10,000 cps at 1000 w	40 to 10,000 cps at 10,000 w	50 to 10,000 cps at 1000 w	6 to 2000 cps at 1000 w	5 to 100 kc at 1000 w
Sensitivity	0.036 v at 600 ohms	0.04 v at 600 ohms	0.1 v at 600 ohms	0.16 v rms at 600 ohms for 10,000 w output	0.1 v at 600 ohms	0.05 v at 600 ohms	0.5 v at 600 ohms
Distortion	1% at 250 w, 1000 cps	0.75% at 500 w, 1000 cps	Less than 0.75% at 1 kw, 1000 cps	Less than 3% at 10 kw, 1000 cps	Less than 0.75% at 1 kw, 1000 cps	Less than 5% at 1 kw, 10 to 1000 cps	

Price and delivery of both amplifiers and shakers are exceptionally good. For complete specifications and prices send for the new four-page illustrated brochure.

Genisco Savage

Genisco, Incorporated
2233 Federal Avenue
Los Angeles 64, California

Circle 196 Readers Service Card



perature processing. Specifically designed for ssb operation, the 4CX1000A is a low-voltage, high-current Class AB, r-f or a-f linear amplifier tube, exhibiting high power gain and exceptionally low distortion characteristics. The 4CX1000A achieves its maximum rated output power with zero grid drive, thus minimizing driver stage design problems and eliminating one source of distortion. **Circle 413 on Reader Service Card.**

PLUG-IN MODULE
for strain gage balance

North Atlantic Industries, Inc., 603 Main St., Westbury, L. I., N. Y. A miniature, plug-in module, no larger than a lipstick case but containing complete circuitry for strain gage balance is now in production. It is the first of a series of repairable or expendable units which will provide space and weight-saving benefits to aircraft and missile electronic systems.

The strain gage balance module achieves precise calibration and adjustment through use of microminiature resistors and a miniature pot. The new circuit packaging concept permits shrinking both standard and special circuitry for other applications, incorporation

Introducing...

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

INDUSTRIAL TRIODE

...the new

Amperex® 7092

(Approx. ¾ actual size)

2 KW CONTINUOUS, 3 KW INTERMITTENT

INTO INDUSTRIAL LOADS – CLASS C – WITHOUT WATER COOLING

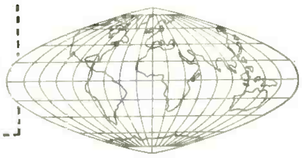
INDUSTRIAL OSCILLATOR, CLASS C
CONTINUOUS DUTY
SINGLE PHASE, RECTIFIED,
UNFILTERED PLATE SUPPLY

Typical Operation (Per Tube)

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

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

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



ask ***Amperex***

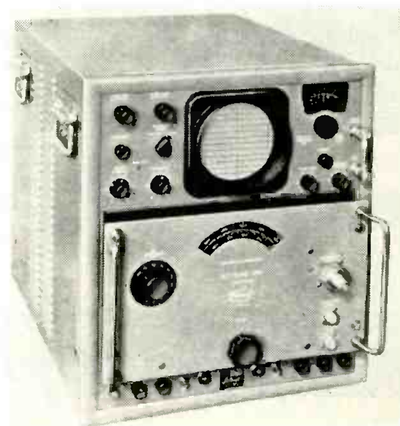
...about new tubes for high-power industrial applications

Further details available from Industrial Tube Division
AMPEREX ELECTRONIC CORP., 230 DUFFY AVENUE, HICKSVILLE, L.I., N.Y.
In Canada: Rogers Electronic Tubes & Components, 11-19 Brentcliffe Road, Leaside, Toronto 17.

of miniature amplifiers, cathode followers, pulse circuits and others employing transistors or subminiature vacuum tubes.

Modules of the P-500 series are available in a range of sizes, with light but rigid metal cases which can be color-coded. Equipped with male or female miniature connectors in one or both ends, they can be inserted directly in the line or used in tandem in appropriate combinations.

Current modules were designed for operation at ambient temperatures up to 125 C, altitudes up to 60,000 ft. Units are produced in ruggedized commercial form and to military specifications. **Circle 414 on Reader Service Card.**



SPECTRUM ANALYZER
wide-dispersion type

POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N. Y., announces the model TSA-W spectrum analyzer. This unit was developed to provide even greater frequency dispersion than that provided by the model TSA spectrum analyzer for the analysis of narrow and wide pulsed signals. The maximum dispersion of this new spectrum analyzer has been widened so that it now covers 100 kc (with a 7-kc resolution) to 70 mc (with a 50-kc resolution). A new marker has been provided with a range of 80 mc and employs a vernier control for measurements of small frequency differences.

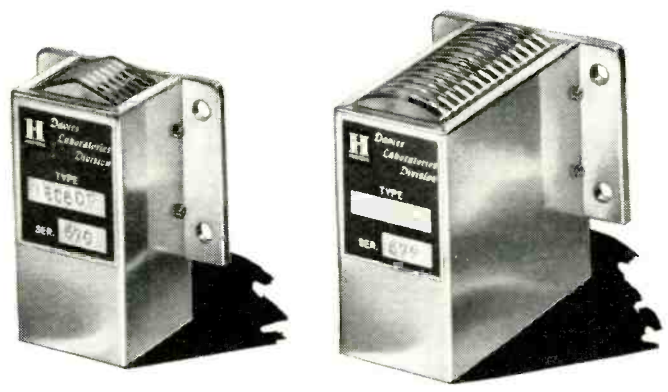
A pulse width scale calibrated in μsec has been added to the marker. Another new feature is a logarithmic display in addition to

Multi-track magnetic recording reproducing heads . . .

Laboratory-designed, precision-built by Davies

Series	Track Data		Crosstalk (db)	Number of Tracks for Various Tape Widths							
	Width (Mils)	Spacing C to C (Mils)		¼	½	¾	1	1¼	1½	1¾	2
700	50	140	–60*	2	4	5	7	9	11	13	14
800	40	125	–60*	2	4	6	8	10	12	14	16
1000	40	100	–55*	3	5	8	10	13	15	18	20
1200	32	85	–50*	3	6	9	12	15	18	21	24
1300	26	78	–40**	3	6	10	13	16	19	23	26
1400	40	72	–40**	3	7	10	14	17	21	24	28
S1400	32	70	–40**	3	7	10	14	17	21	24	28
1600	32	62	–35**	4	8	12	16	20	24	28	32
2000	20	50	–35**	5	10	15	20	25	30	35	40

*For Direct Recording, 1000cps
**For Digital Pulse Recording



MODEL 1206 DP   MODEL 814 A

Davies multi-track recording and reproducing heads for magnetic tape data recording are offered in a wide selection of designs for every practical tape service.

Davies single-stack heads are precisely aligned for those applications requiring coincidence of time and phase among tracks. Gap alignment is held to within ± 0.1 mil per inch of tape width.

For services requiring a large number of tracks, but where time and phase displacement can be tolerated, Davies 700, 800 and 1000 Series Heads can be interleaved to provide 14, 16, or 20 tracks on 1″ tape.

All-metal tape contact area on Models with the "P" designation (1206 DP above) essentially eliminate oxide build-up at high tape speeds.

In all types, plastic encapsulation protects and preserves the characteristics, even under adverse environmental conditions such as shock, vibration and extremes of temperature and humidity.

Select the appropriate recording/reproducing head from the condensed chart. Complete technical and application information may be obtained by writing Minneapolis-Honeywell Regulator Co., Davies Laboratories Division, 10721 Hanna Street, Beltsville, Md.

Honeywell

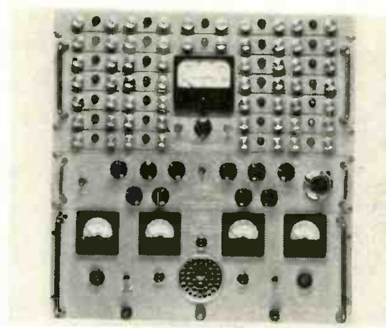
H HONEYWELL DAVIES LABORATORIES DIVISION

Circle 200 Readers Service Card

the linear display. This effectively increases the dynamic range of the instrument and permits detailed examination of minor lobes.

The broad frequency range of the TSA-W spectrum analyzer is the same as the other spectrum analyzers in the Polarad line and utilizes interchangeable plug-in heads to cover the frequency range of 10 mc to 44 kmc.

A specification sheet is available for further detailed technical information. **Circle 415 on Reader Service Card.**



DECOMMUTATOR

27-channel system

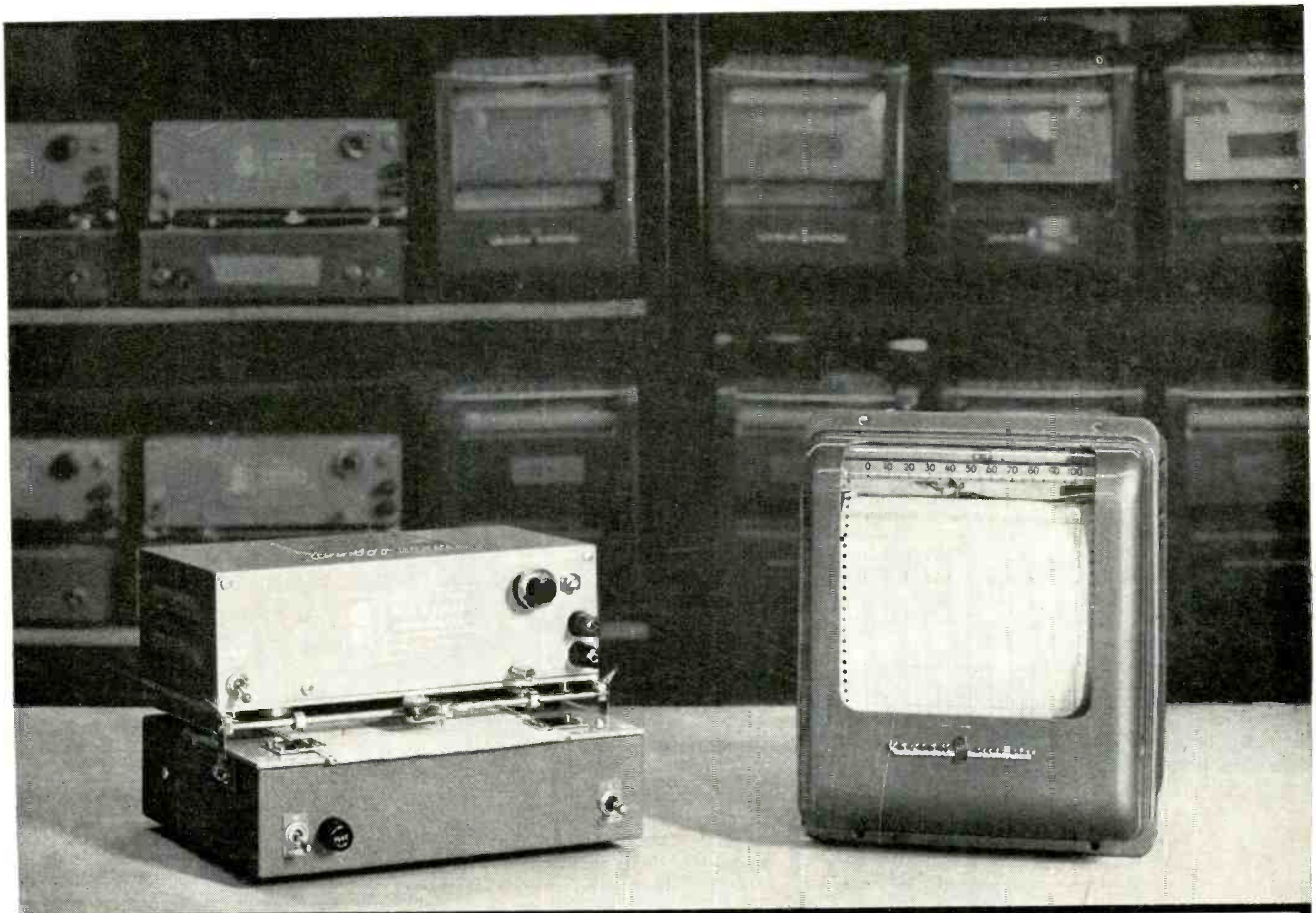
ARNOUX CORP., 11924 West Washington Blvd., Los Angeles 66, Calif. Designed for use in airborne or trailer installed telemeter receiving stations and in portable ground checkout equipment, this new 27-channel decommutation system occupies only 19½ in. of panel height in a standard relay rack. Overall depth is 13 in.

Model TDS30-1 decommutation system is completely self-contained within three chassis assemblies consisting of: gating unit (top), pulse selector (middle) and regulated power supply (bottom). Modular plug-in gating units allow quick replacement of faulty channels. Miniaturization is made possible through a unique design requiring only 76 vacuum tubes, as opposed to hundreds in comparable systems of conventional design. The system accepts all standard RDB inputs, either PAM or PDM, at any repetition rate from 2½ to 40 rps.

Either single ended or push pull input signals are accepted. Outputs may be operated single or double ended. Overall linearity is

Varian Strip Chart Recorders

POTENTIOMETER PERFORMANCE* AT MODERATE COST



Varian G-10 — Portable for laboratory or bench use where chart accessibility is of prime importance. Base price $340.

Varian G-11 — For panel, rack or portable use; designed for OEM, lab or field for long-term monitoring. Base price $450.

* The servo-balance potentiometer method has long been used in expensive recorders to achieve superior stability, sensitivity, ruggedness and high input impedance. Use of servo balancing systems assures full realization of these inherent advantages by providing ample power independent of the source being measured. Now Varian offers you recorders of moderate cost using this time-proven principle.

VARIAN SPECIFICATIONS:

- Spans as low as 10 mv
- Limit of error 1 %
- Maximum source resistance 50K ohms or higher
- Balancing times: 1 second or 2.5 seconds on G-10; 1 second on G-11

WRITE TODAY FOR COMPLETE SPECIFICATIONS

Varian recorders are sold and serviced throughout the free world by representatives in principal cities.

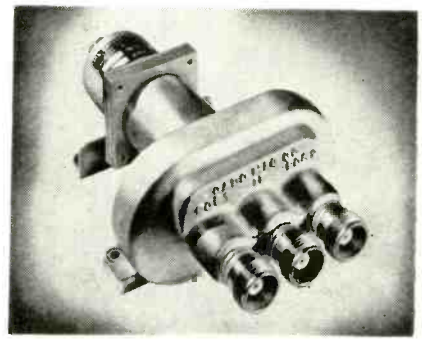
VARIAN associates
INSTRUMENT DIVISION

PALO ALTO 4, CALIFORNIA

Varian Associates manufactures Klystrons, Traveling Wave Tubes, Backward Wave Oscillators, Linear Accelerators, Microwave System Components, R. F. Spectrometers, Magnets, Magnetometers, Stalos, Power Amplifiers and Graphic Recorders and offers research and development services.

Circle 202 Readers Service Card

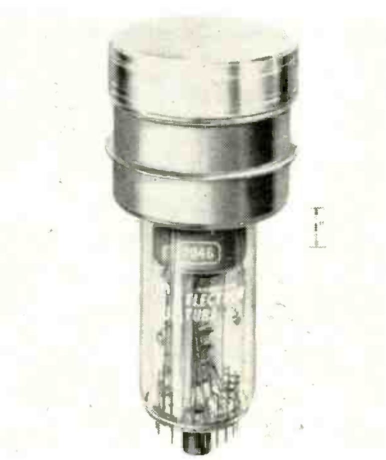
within $\pm\frac{1}{2}$ percent at maximum signal level. Long term level drift is within ± 2 percent and gain drift is negligible. **Circle 416 on Reader Service Card.**



LOBING SWITCH

small, lightweight

CADO MFG. CO., 1646 18th St., Santa Monica, Calif., has developed a small, lightweight lobing switch for lobing frequencies from 20 to 100 cps. Weighing less than 30 oz. and standing 3 in. high by 5 in. long, the new lober was developed to fill a long-standing need for a small switch to meet the requirements of MIL-E-5272-A. It maintains a vswr of less than 1.3 to 1 to 1,300 mc, while operating with a minimum crosstalk reading of 40 db and 1,000 hours life. **Circle 417 on Reader Service Card.**



PHOTOTUBE

with electron multiplier

RADIO CORP. OF AMERICA, Harrison, N. J. The 7046 is a 14-stage, head-on, multiplier phototube having a $4\frac{7}{16}$ in. diameter photocathode *for applications demanding* **DEPENDABLE INSULATIONS**

Specify...

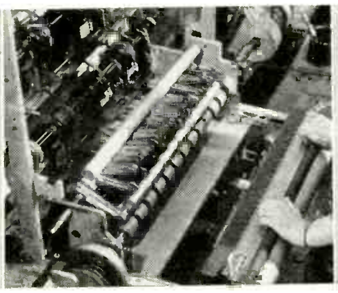
ESSEX
EXTRA TEST® MAGNET WIRE

Quality controlled by tests exceeding accepted standards

Consistently trouble-free performance characterizes the use of Essex Extra Test Magnet Wire. It stems from close quality control maintained at every step in fabrication. Illustrated above is one example... the continuity test used for measuring breaks in insulation. By this, and similar controls, does Essex produce Magnet Wire to the industry's most severe specifications. Essex only makes one quality ... and that's Extra Test. It costs no more to *be sure* by using SX.

APPLICATION...

Essex Extra Test Magnet Wire will save downtime... speed operations in your winding department. It has superior windability... maximum dielectric strength... and uniformity of size from spool-to-spool. Winds compactly at high speeds and around sharp radii.



PACKAGING...

Essex Extra Test Magnet Wire is available in Metal or Fiber containers (MAGNA-PAK®) or in commercial reel or spool put ups. Distinctive labeling assures fast, accurate identification. MAGNA-PAK containers are palletized for shipment; simplifying storage.

SX WIRE PRODUCTS

ESSEX *EXTRA TEST®* MAGNET WIRE

DIVISION ESSEX WIRE CORPORATION, Fort Wayne 6, Indiana

MANUFACTURING PLANTS — Birmingham, Alabama; Anaheim, California; Fort Wayne, Indiana; Detroit, Michigan.

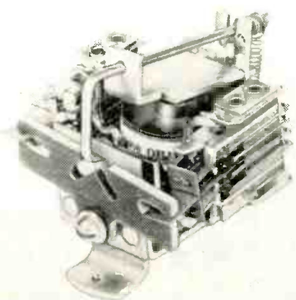
SALES OFFICES AND WAREHOUSES*

*Birmingham, Ala.
*Chicago, Illinois
Cleveland, Ohio
Dallas, Texas
Dayton, Ohio
Detroit, Michigan
Fort Wayne, Indiana
Fort Worth, Texas
Hartford, Conn.
Indianapolis, Ind.
Kansas City, Mo.
*Los Angeles, Calif.
Milwaukee, Wisc.
*Newark, N. J.
*Portland, Oregon
Rochester, New York
*Saint Louis, Mo.
*San Francisco, Calif.
Upper Darby (Philadelphia), Pa.

Distributed nationally to the repair and maintenance industry through Insulation and Wires, Incorporated and featuring very good electron-collection efficiency, very small spread in electron-transit time, very short time-resolution capability, relative freedom from after-pulses and high current gain. These features make the 7046 especially useful in nuclear radiation measurements.

Utilizing a semitransparent photocathode on the curved inner surface of an ultraviolet-transmitting-glass faceplate, the 7046 has a spectral response covering the range from about 2,500 to 6,500 angstroms. Maximum response occurs in the blue region at approximately 4,200 angstroms.

The faceplate has a flat external surface which facilitates mounting of flat phosphor crystals in direct contact with the surface. **Circle 418 on Reader Service Card.**

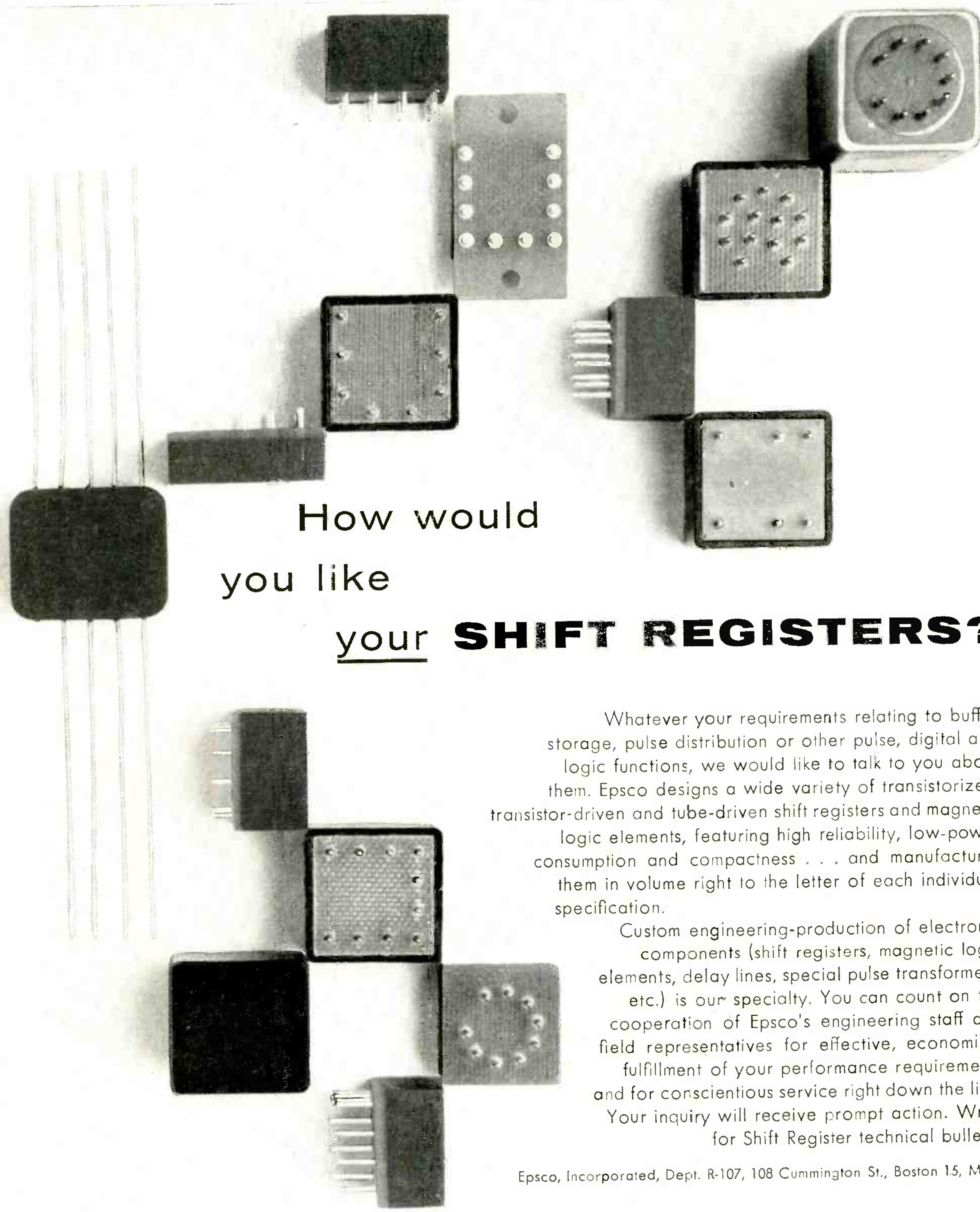


LATCHING RELAY
alternate pulse type

Potter & Brumfield, Inc., Princeton, Ind. A new single coil latching relay that selects alternate circuits or alternate circuit modes on successive impulses has been announced. Designated the PC, the relay employs an armature driven rocker type actuator to transfer one, two, three or four dpdt snap switches.

Gold flashed silver cadmium oxide contacts are rated at 10 amperes, 115 v a-c resistive. The relay can be operated from a-c or d-c sources and provides positive transfer on a single 30 millisecond impulse. The spring action of the contact arms effectively latches the relay in the transferred position when coil power is removed.

The PC was designed primarily for on-off and reversing features. It is used for remote tv controls, garage door openers, flow control



How would you like your SHIFT REGISTERS?

Whatever your requirements relating to buffer storage, pulse distribution or other pulse, digital and logic functions, we would like to talk to you about them. Epsco designs a wide variety of transistorized, transistor-driven and tube-driven shift registers and magnetic logic elements, featuring high reliability, low-power consumption and compactness . . . and manufactures them in volume right to the letter of each individual specification.

Custom engineering-production of electronic components (shift registers, magnetic logic elements, delay lines, special pulse transformers, etc.) is our specialty. You can count on the cooperation of Epsco's engineering staff and field representatives for effective, economical fulfillment of your performance requirements and for conscientious service right down the line. Your inquiry will receive prompt action. Write for Shift Register technical bulletin.

Epsco, Incorporated, Dept. R-107, 108 Cummington St., Boston 15, Mass.

START-TO-FINISH cooperation . . . an Epsco guarantee

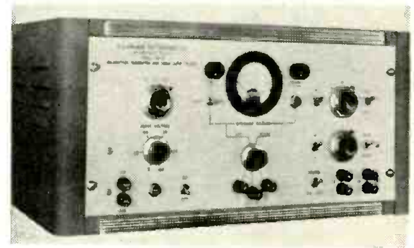
Epsco COMPONENTS

SALIENT FEATURES OF EPSCO SHIFT REGISTERS

- Standard packaging—9-pin miniature base, dip-solder terminals for printed circuits, and solder-lug panel with mounting ears; standard epoxy and hermetically sealed cases, or custom packaging to your specifications.
- Minimum size—below ¼ cu. in. per binary digit.
- Surpass applicable MIL specification.
- Extremely low power consumption—less than 0.25 watt peak power for 3kc rate; 0.6 watt peak power for 100 kc rate.
- Wide operating tolerances: dependable field performance.

Circle 206 Readers Service Card

motors and other applications requiring a low cost means for a transferring between alternate circuits at undefined periods. **Circle 419 on Reader Service Card.**



ANALYZER

for unijunction transistors

POLYPHASE INSTRUMENT CO., East Fourth St., Bridgeport, Montgomery Co., Pa. The TA-10 unijunction transistor and diode checker traces on an oscilloscope the negative resistance or emitter characteristic curves of the GE type ZJ14 unijunction transistor (double-based diode type). Interbase and emitter voltages are metered and adjustable by front panel controls.

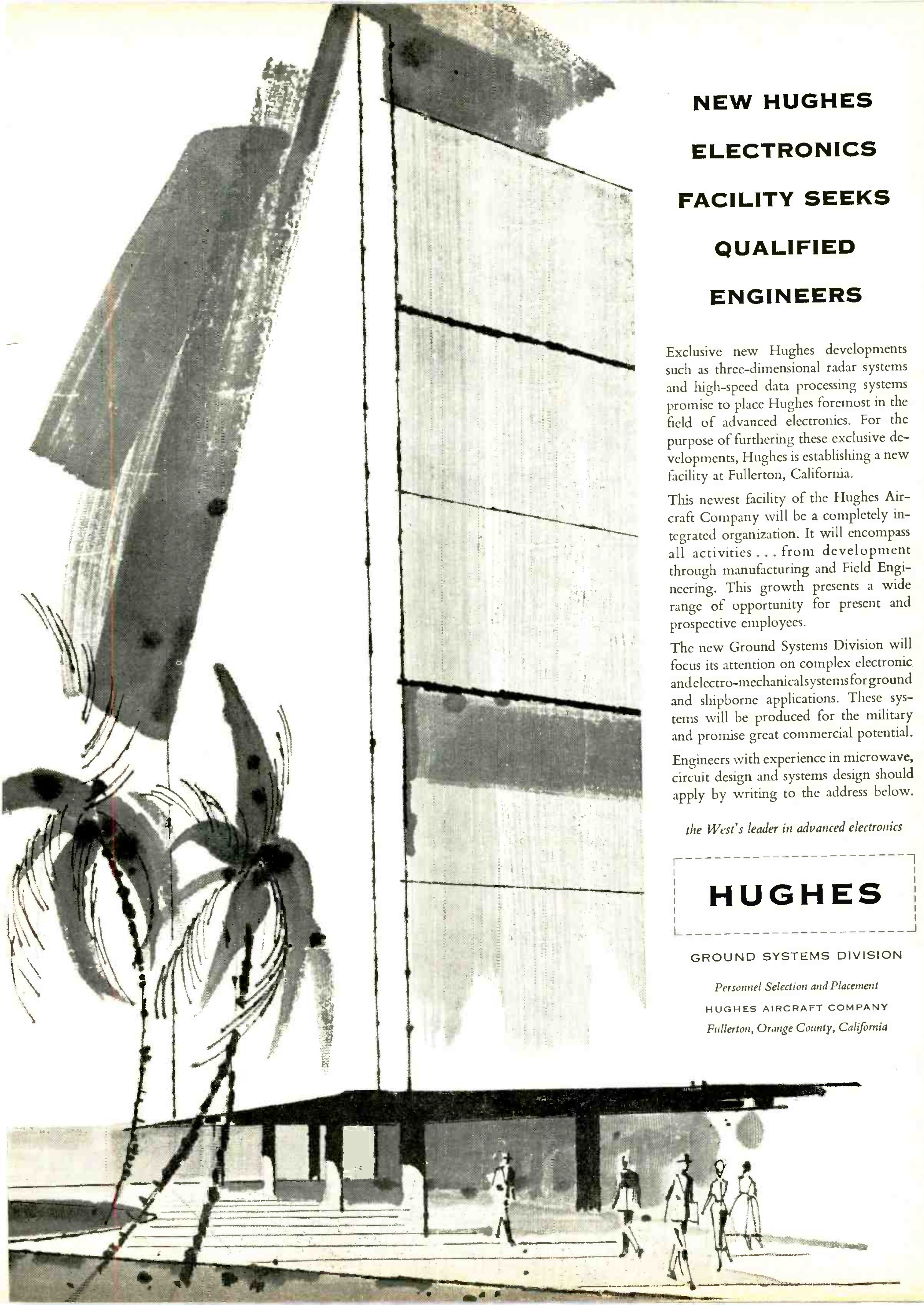
Semiconductor diode checking of all types of diodes is readily performed by oscilloscope display of forward and reverse current characteristic curves. Go, no-go type quality control and production checking procedures are easily set up.

A transistor circuit power supply is automatically provided because of the instrument's power supplies rated at 100 v, 100 ma. **Circle 420 on Reader Service Card.**

CERAMIC TUBE

for h-v switching

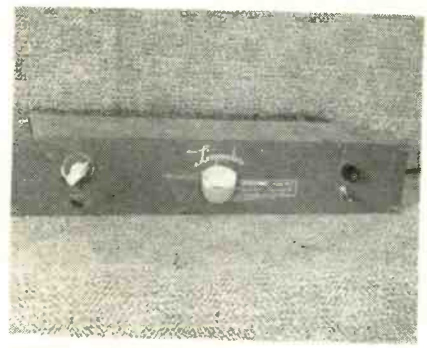
RESITRON LABORATORIES, INC., 2908 Nebraska, Santa Monica, Calif.,



has available the RL-C30 ceramic high voltage relay for use where extreme mechanical shock and vibration are encountered. It is designed for h-v switching applications as in pulse-forming networks, antenna systems and switching in explosive atmospheres.

The unit is constructed for partial oil immersion and will stand off 30 kv d-c at 500 amperes pulse current.

The ceramic envelope of the relay is highly evacuated making it unaffected by ambient atmospheric conditions. This unit is capable of withstanding a temperature excursion ranging from −70 deg C to −300 deg. C. **Circle 421 on Reader Service Card.**

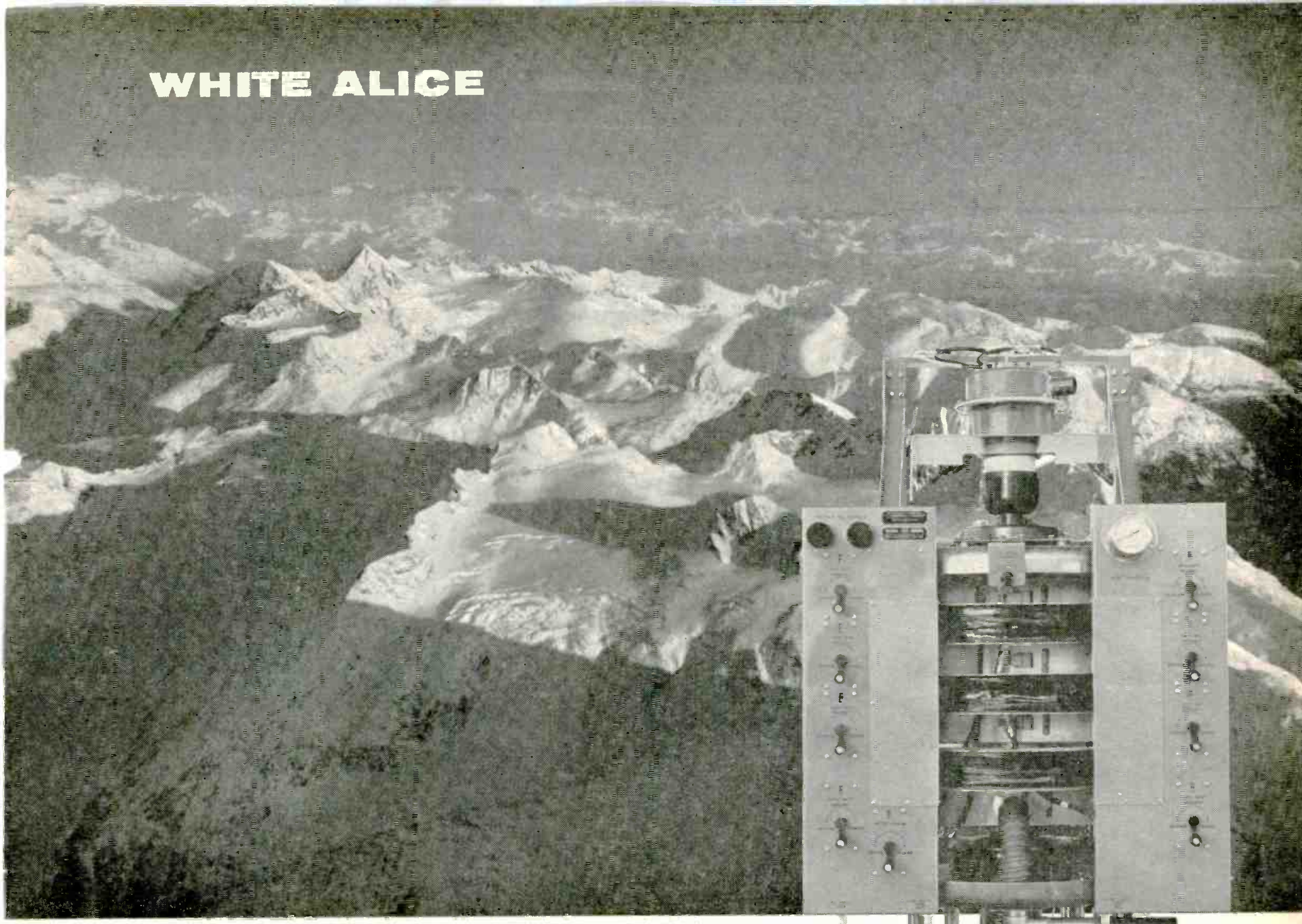


AGC AMPLIFIER
high-speed, nonfeedback

ELECTRONIC SYSTEMS ENGINEERING Co., 903 Cravens Building, Oklahoma City, Oklahoma. Model LE-3 Limpander (limiter-expander) is a new high-speed nonfeedback, automatic audio gain control amplifier with background noise squelching system. A low impedance input preamplifier provides sufficient gain to produce 30 db of low distortion limiting. High speed squelching operates between words without syllable clipping. Limiter attack time constant of 50 μsec and release time constant of 20 millisec produces consonant amplification for high intelligibility in recording and communication applications. It is a new tool for speech analysis and voice control communications systems.

The Limpander, Model LE-3 is especially designed to function as an agc system for tape recorders. It is particularly suited for re-

Circle 209 Readers Service Card →



Another in a series on the extensive use of Eimac Klystrons in tropospheric communication systems

Type 799WA 10 KW Klystron Amplifier Designed and Manufactured for Western Electric Co. by Radio Engineering Laboratories, Inc

Eimac one and ten kw klystrons power Alaska tropospheric communication system

In the minds of the engineers and construction men who fought Alaska's frozen terrain, "White Alice" was no lady. Linking 33 far-flung communities, "White Alice" will have 3000 miles of communications upon completion. Up to 132 channels are provided over this route thanks to a combination of point-to-point microwave and scatter communication systems.

For tubes to power the "White Alice" one and ten kw installations, engineers turned to Eimac klystrons. The success of Eimac tubes in the other tropo-scatter networks made it easy for the engineers to make such a decision. Today, Alaska speaks . . . a feat made possible by tropospheric communications powered by Eimac klystrons that "can take it."

Designers of electronic equipment are finding out more and more that Eimac has the answer to their tube problems regardless of what such problems involve. An inquiry to our Application Engineering Department will bring fast, informative information.

EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA

Eimac First **for klystrons for tropospheric communications**

Eimac

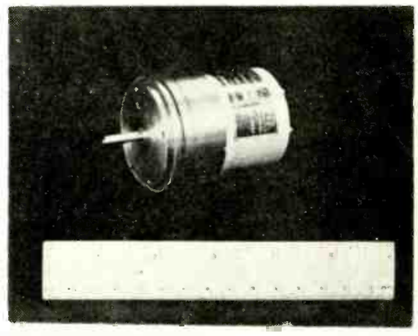
3K3000LQ

DC Beam Volts	8000	Power Output Watts	2000
DC Beam Amps	0.57	Collector Dissipation	3000
Driving Power Watts	4.0	Power Gain	25 db
Efficiency 45%			

4K50,000LQ

DC Beam Volts	16,000	Power Output Watts	11,000
DC Beam Amps	1.6	Collector Dissipation	50,000
Driving Power Watts	0.10	Power Gain	50 db
Efficiency 43%			

cording unrehearsed conversations and conferences where it is impractical to use conventional gain monitoring techniques. The 600 ohm output has sufficient power to drive a speaker directly. One Limpander can serve for limiting on recording, and limiting or expanding on playback. Noise suppression capabilities make 60 db of automatic audio control practical. **Circle 422 on Reader Service Card.**



TRANSFORMER
with low output impedance

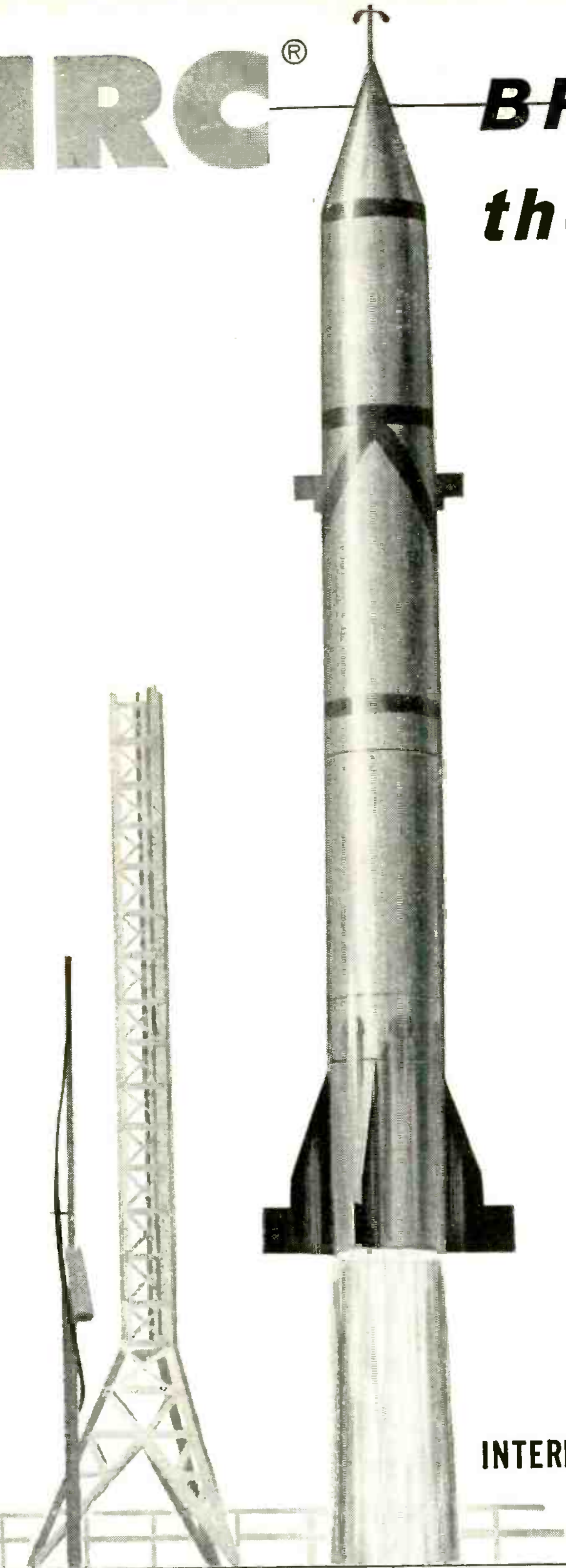
PERKIN-ELMER CORP., Norwalk, Conn. A new type of Vernistat variable ratio computing transformer with an open circuit linearity of ±0.1 percent has been developed. Model 20-C can provide a substantial power output—sufficient in many instances to eliminate power amplifiers. Applications of the new transformer include its use in analog computers where the product of a voltage and a shaft angle is required, in the control of two-phase servo motors, and in the supply of power to torque motors.

At an input of 115 v, 400 cps, the output voltage range of the model 20-C is ±80 v. Due to its low output impedance, a linearity of ±0.35 percent is obtained with a 1,000-ohm load. With a 2,000-ohm load, the linearity is ±0.18 percent. Under maximum load conditions, the quadrature component of output is approximately 5 mv per v of the primary excitation voltage. Basic resolution, resulting from 800 equivalent turns of wire, is 0.13 percent, and interpolation by a resistive brush permits the shaft to be adjusted to obtain any required value of output volt-

Circle 211 Readers Service Card →

IRC®

BREAKS THROUGH the reliability barrier



As jet planes and missiles leave old barriers behind, electronic components find ever-tougher barriers of reliability ahead of them. Those designed for yesterday are already obsolete, those designed for today will soon be. But IRC resistors are ready now to leap ahead of tomorrow's new barriers. Designed ahead of their time, they are also produced by "ahead of their time" processes and quality control techniques. This pattern of progress makes IRC reliability a standard unto itself—a standard that is yours on the widest range of electronic components in the industry.

There is nothing theoretical about the IRC standard of reliability. In most of the major avionic progress-projects, it is being proved out by rigorous field tests. It is also apparent in the way IRC resistors withstand extreme temperature, humidity, and mechanical conditions. It is evident, too, in resistance to shock and vibration . . . in improved shelf life . . . in the way IRC resistors consistently surpass MIL spec requirements.

IRC®

INTERNATIONAL RESISTANCE CO. Dept. 239, 401 N. Broad St., Phila. 8, Pa.

RESISTOR	IRC TYPE	MIL TYPE	MIL SPEC.	WRITE FOR IRC BULLETIN
Fixed Composition	BT	RC	MIL-R-11B	B-1
Fixed Wire Wound (Low power)	BW	RU	JAN-R-184	B-5
Fixed Wire Wound (High power)	PWW	RW	MIL-R-26C	C-1
Fixed Wire Wound (Precision)	516L 316A	RB 17 RB52	MIL-R-93A MIL-R-93A	PH
Meter Multiplier (Sealed precision)	MF	MF	JAN-R-29	D-2
Deposited Carbon	DC	RN	MIL-R-10509B	B-4
Deposited Carbon (Molded)	MD	RN	MIL-R-10509B	B-9
Boron Carbon	BC	RN	MIL-R-10509B	B-6
Boron Carbon (Molded)	MB	RN	MIL-R-10509B	B-8
High Frequency	MP HFR	RF RF50	MIL-R-10683A MIL-R-10683A	F-1

COMPUTER COMPONENTS — Pressure Transducers, Digital Logic Elements — Packaged Custom Networks, Differential Transformers — Integrators, Static Switches — Magnetic Amplifiers, Shift Registers age between these points.

Model 20-C Vernistat transformer is 2.5 in. long by 2 in. in diameter. **Circle 423 on Reader Service Card.**

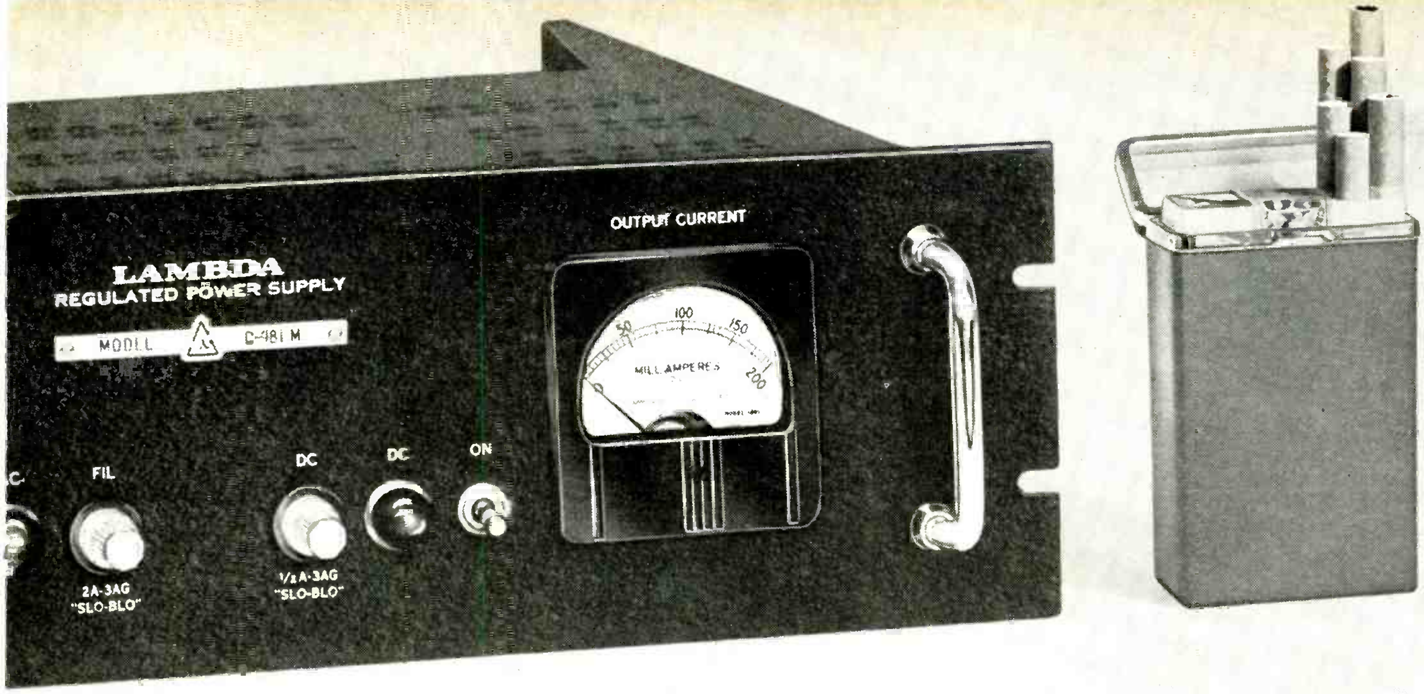
CONVERTER
sine-to-square wave

MANDREL INDUSTRIAL INSTRUMENTS, Division of Mandrel Industries, Inc., P. O. Box 13243, Houston, Texas, announces a sine-to-square wave converter little larger than a man's hand. Novel with this $25 plug-in gadget is its circuit which utilizes the signal from the driving oscillator to provide operating power for the transistor squaring circuit. Operating from 5 to 100,000 cps the unit is capable of 17 v peak-to-peak output upon being driven from almost any conventional oscillator. Rise time for the square wave produced is 0.5 percent of the period with a symmetry of 50 percent ±2 percent. Having no critical components or batteries to replace, the life of the unit should be unlimited. **Circle 424 on Reader Service Card.**

AM-PM MULTIPLIER
used in analog computers

CHADWICK-HELMUTH CO., 472 E. Duarte Road, Monrovia, Calif. A wide band, all-electronic analog computer multiplier designed for

Circle 212 Readers Service Card→



Not much taller than a pack of cigarettes...

See how much space you save with New Lambda COM-PAK® Power Supplies

THREE VOLTAGE RANGES: 0-200, 125-325, 325-525 VDC

Economically priced. 400 MA Lambda Com-Pak model (illustrated) needs only 5¼" of panel height, from $244.50 Other models include 200 MA (5¼") priced from $159.50, 800 MA (7") from $315, and 1.5 amperes (8¾") from $550.

FAST IN-RACK SERVICING

Wiring, tubes, and other components readily accessible. You can reach them easily, service them fast.

Quick rear access to tubes and controls.

Rear panel swings open for servicing.

C-200 series – 200 MA – need only 5¼" of panel height
C-400 series – 400 MA – need only 5¼" of panel height
C-800 series – 800 MA – need only 7" of panel height
C-1500 series – 1500 MA – need only 8¾" of panel height

Space-saving models available for all power supply needs up to 1.5 amperes

You get king-size performance as well as real space economy with Lambda's new Com-Pak regulated DC supplies. Completely new electrical and mechanical design. More functional – easier to combine with other components – designed for faster, handier maintenance and servicing.

400 MA and higher current range models have high-efficiency, long-life hermetically-sealed semi-conductor rectifiers. All Com-Pak models include hermetically-sealed transformers, chokes and capacitors.

LAMBDA Electronics Corp., Dept. E-1157
11-11 131st Street, College Point 56, New York

Send me literature listing complete specifications for all Lambda Power Supplies.

Name__________ Title__________

Company__________

Address__________

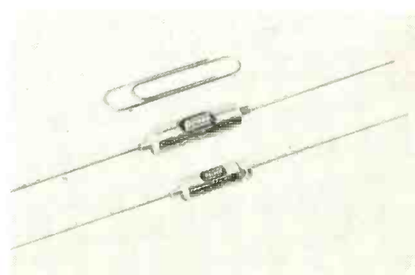
City__________ Zone___ State__________

LAMBDA Electronics Corp.
11-11 131 STREET • COLLEGE POINT 56, NEW YORK
INDEPENDENCE 1-8500
Cable Address: Lambdatron, New York

high accuracy and speed is announced. The unit generates a voltage proportional to the instantaneous product of two arbitrary input voltages from d-c to 5 kc, with less than 5 μsec delay. Accuracy is ± 0.1 percent of full scale over most of the band. After a short warmup, no adjustments are required for at least eight hours if accuracies of ± 0.25 percent are adequate. Built-in metering system facilitates calibration and performance testing while unit is in use.

Multiplication is accurate and dependable over long periods of time since every active element is within a linear feedback loop, and operation does not depend upon the nonlinear characteristics of vacuum tubes or diodes. With no moving parts in the small and moderately priced unit, multiplication is accomplished at high speeds and with precision.

Model 251 operates with a 450 kc carrier, which is phase-modulated and amplitude-modulated by the two inputs to produce an output proportional to the product of these two modulating voltages. Modulation and demodulation is performed in diode-ring balanced modulators of special design to yield the required linearity, stability and trouble-free operation.
Circle 425 on Reader Service Card.

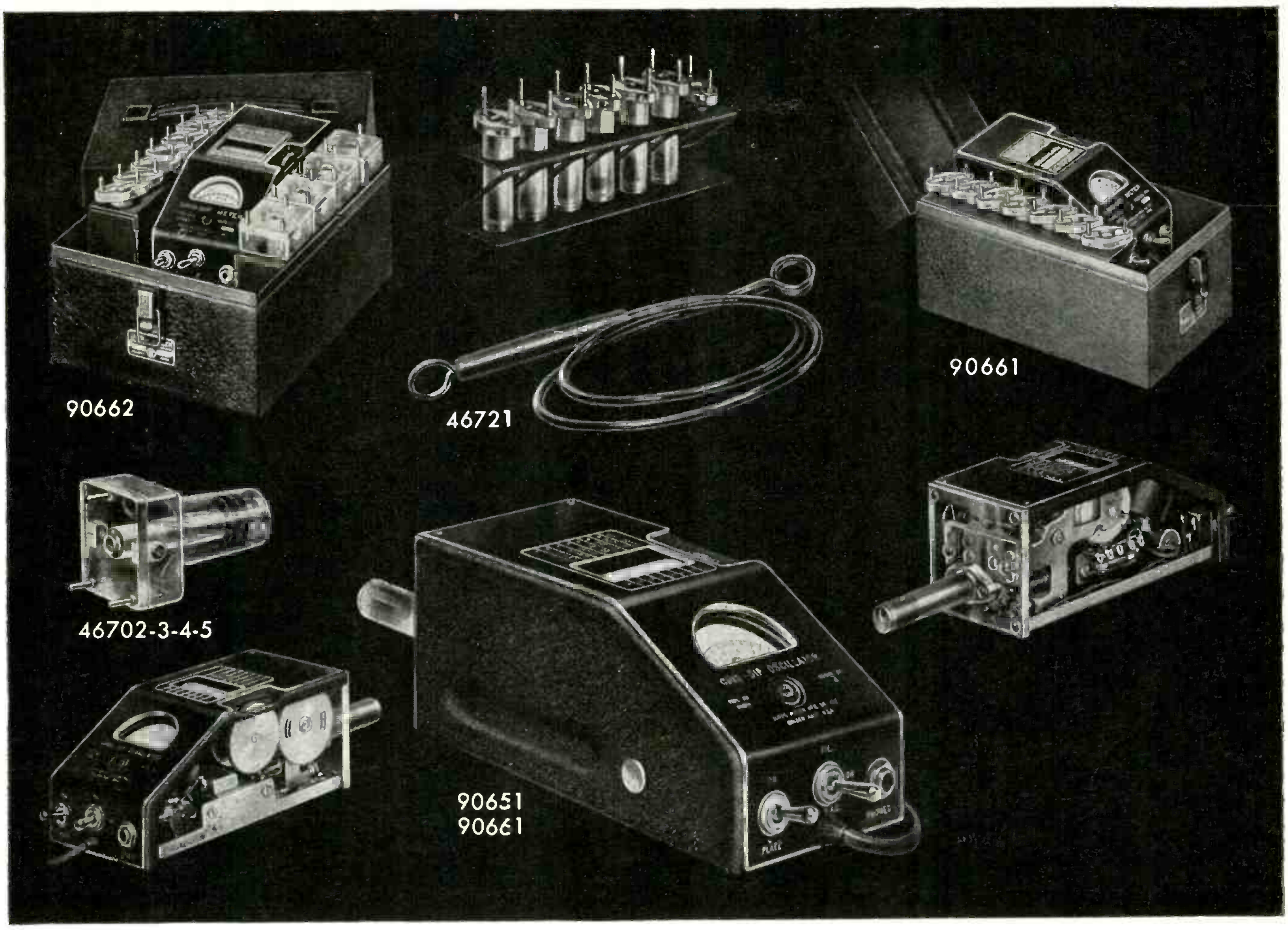


ELECTROLYTICS

feature subminiaturization

ASTRON CORP., 255 Grant Ave., East Newark, N. J. Types EE and EM subminiaturized electrolytic capacitors are announced.

The two subminiaturized units are especially designed for transistorized circuits and miniaturized low voltage d-c equipment. Featuring very low leakage characteristics for minimum battery



Designed for Application

Grid Dip Meters

Millen Grid Dip Meters are available to meet all various laboratory and servicing requirements.

The 90662 Industrial Grid Dip Meter completely calibrated for laboratory use with a range from 225 kc. to 300 mc. incorporates features desired for both industrial and laboratory application, including three wire grounding type power cord and suitable carrying case.

The 90661 Industrial Grid Dip Meter is similar to the 90662 except for a reduced range o 1.7 to 300 mc. It likewise incorporates the three wire grounding type cord and metal carrying case.

The 90651 Standard Grid Dip Meter is a somewhat less expensive version of the grid dip meter. The calibration while adequate for general usage is not as complete as in the case of the industrial model. It is supplied without grounding lead and without carrying case. The range is 1.7 to 300 mc. Extra inductors available extends range to 220 kc.

The Millen Grid Dip Meter is a calibrated stable RF oscillator unit with a meter to read grid current. The frequency determining coil is plugged into the unit so that it may be used as a probe.

These instruments are complete with a built-in transformer type A.C. power supply and internal terminal board to provide connections for battery operation where it is desirable to use the unit on antenna measurements and other usages where A.C. power is not available. Compactness has been achieved without loss of performance or convenience of usage. The incorporation of the power supply, oscillator and probe into a single unit provides a convenient device for checking all types of circuits. The indicating instrument is a standard 2 inch General Electric instrument with an easy to read scale. The calibrated dial is a large 205° drum dial which provides seven direct reading scales, plus an additional universal scale, all with the same length and readability. Each range has its individual plug-in probe completely enclosed in a contour fitting polystyrene case for assurance of permanence of calibration as well as to prevent any possibility of mechanical damage or of unintentional contact with the components of the circuit being tested.

The Gride Dip Meters may be used as:

1. A grid Dip Oscillator
2. An Oscillating Detector
3. A Signal Generator
4. An Indicating Absorption Wavemeter

The most common usage of the Grid Dip Meter is as an oscillating frequency meter to determine the resonant frequencies of de-energized tuned circuits.

Size of Grid Dip Meter only (less probe): 7 in. x $3\frac{5}{16}$ in. x $3\frac{3}{8}$ in.

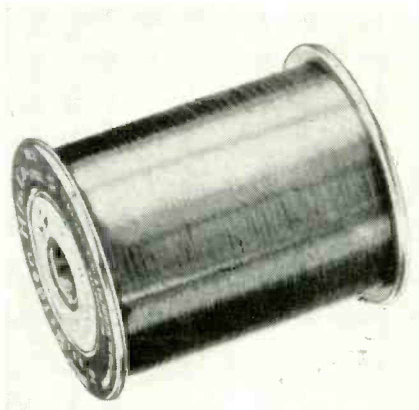
JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

MALDEN, MASSACHUSETTS, U. S. A.

drain, types EE (epoxy and fill) and EM (spun end with rubber bushing) are extremely small hermetically sealed electrolytics (from $\frac{3}{16}$ in. by $\frac{1}{2}$ in. to $\frac{1}{4}$ in. by $\frac{3}{4}$ in.). They have applications in hearing aids, transistorized pocket radios, miniaturized recorders and many other miniature units.

Available in voltages of 1, 3, 6, 8, 16, 26, and 50, the new units also feature long shelf and operating life. Circle 426 **on Reader Service Card.**



FILM-COATED WIRE

solders at 700-750 F

BELDEN MFG. Co., Chicago, Ill., has developed a new Polyurethane film-coated wire which solders consistently (without stripping) at 700-750 F. The new wire, called Beldsol, is rated AIEE Class A-105C, but comparative tests have shown that Beldsol's thermal stability exceeds that of previously available magnet wires of the oleo-resinous and the vinyl acetal types. Besides its solderable feature, Beldsol has excellent electrical properties, particularly in relation to insulation resistance in the presence of moisture. It combines low temperature solderability and a toughness of film coating comparable to Formvar, making a wire that is desirable for almost any winding where Formvar now is used satisfactorily. Thus Beldsol is especially well suited for h-f coils where high "Q" is required.

Other uses of Beldsol are practically unlimited. It can be wound into transformers, motor armature and field coils, radio and tv uni-

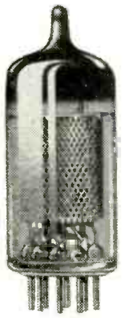
Circle 215 Readers Service Card

ELECTRONICS IN BRITAIN

Six *sound* investments...

The Mullard range of audio tubes has won universal acclaim among high fidelity sound experts: and it is easy to understand why. Every single tube in this range has been specially developed to meet the exacting needs of sound reproduction.

Read the specifications here; see for yourself what makes each tube such a sound investment.



EF86
6267

Exceptionally low hum, low microphony and low noise tube. Specially designed for input stages of high sensitivity in high quality equipment.

ECC83
12AX7

Double triode with especially good microphony performance and high gain. Used in equipments where utmost versatility is required.

EL84
6BQ5

Economical, high sensitivity output pentode. Of miniature all-glass construction on the noval base. Two tubes in push-pull can provide 17W output for only 20V drive (grid-to-grid).

EL34
6CA7

High sensitivity 25W pentode. Two tubes in ultralinear push-pull provide up to 40W output. For public address work, two tubes in push-pull can supply up to 100W o audio power.

Supplies available from:
in the U.S.A.
International Electronics Corporation,
Dept. E11,81, Spring Street, N.Y. 12,
New York, U.S.A.

in Canada
Rogers Majestic Electronics Limited,
Dept. IK, 11-19 Brentcliffe Road,
Toronto 17,
Ontario, Canada.

EZ81
6CA4

Compact full-wave rectifier of miniature all-glass construction on noval base. Provides up to about 350V output at 150mA with good regulation.

GZ34
5AR4

Modern full-wave rectifier supplying up to 600V at 160mA, or 450V at 250mA with good regulation. Recommended for the larger type of Hi-F. equipment.

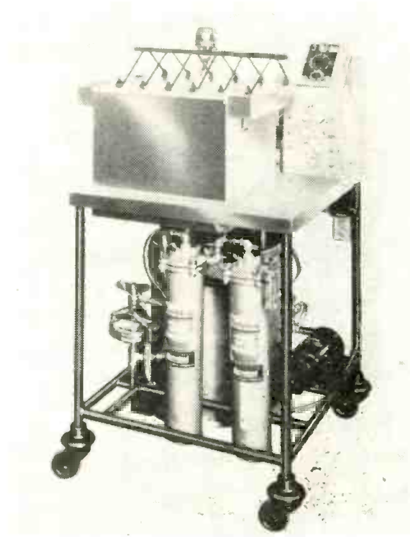
Mullard

ELECTRONIC TUBES
used throughout the world

Mullard

MULLARD OVERSEAS LTD., MULLARD HOUSE, TORRINGTON PLACE, LONDON, ENGLAND

versal coils, and many other random wound coils where solderability, coupled with excellent film abrasion resistance is required. It is available in sizes 14 through 40. **Circle 427 on Reader Service Card.**



TRANSISTOR WASHER

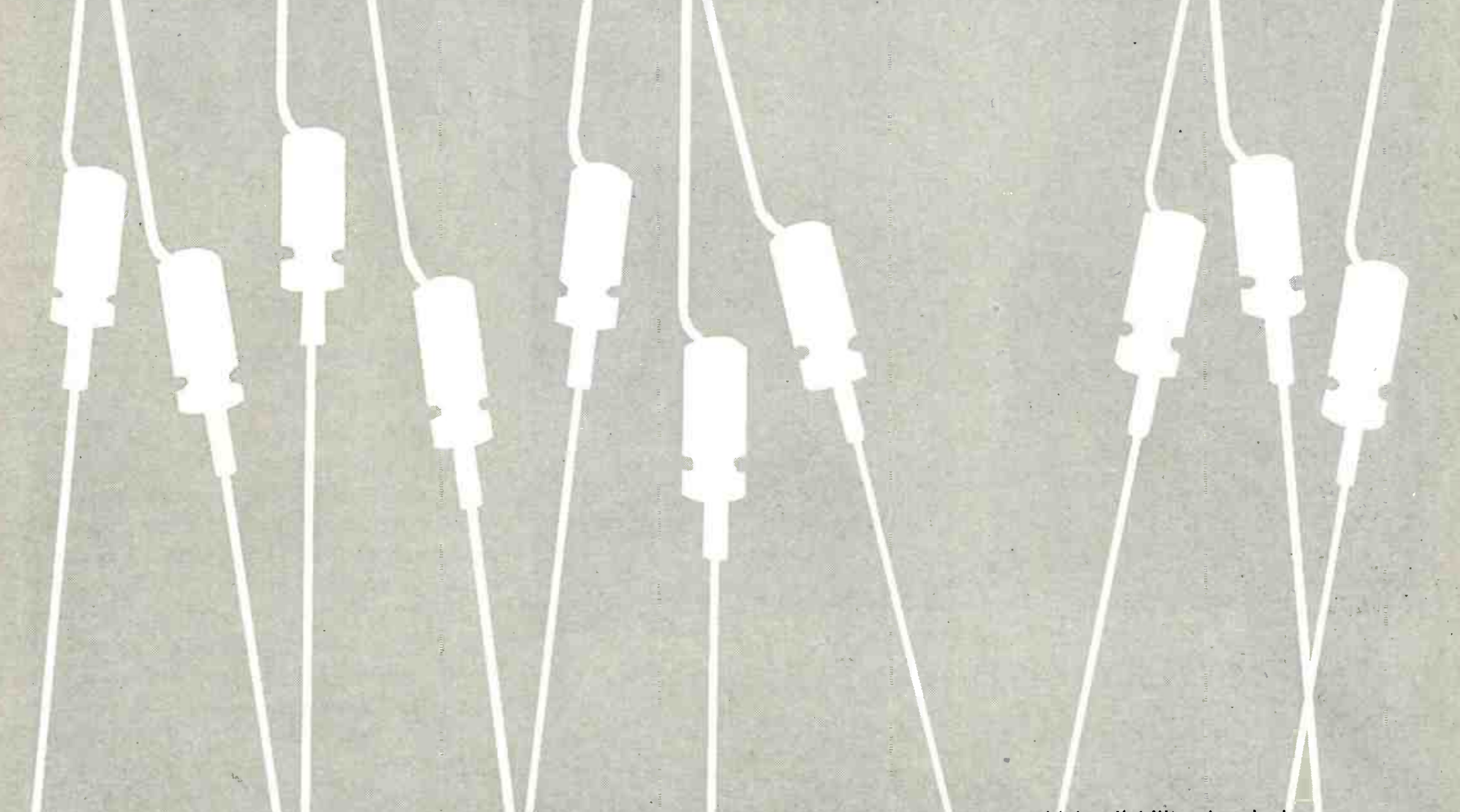
with rinse tank

BARNSTEAD STILL & STERILIZER CO., 2 Lanesville Terrace, Forest Hills, Boston 31, Mass., has developed a special apparatus for washing and rinsing transistors and other small electronic parts in hot distilled-demineralized water. It has been found that rinsing in such water improves quality and reduces rejects. This equipment incorporates continuous repurification of the rinse water by ion-exchange plus activated carbon filtration of submicroscopic particles to 0.45 micron. Washing and rinsing is accomplished in a five stage cascade type rinse tank. Rinse chambers are individually electrically heated and a regenerative heat-exchanger is employed in the circulating system to conserve electricity. Demineralizer and carbon filter are disposable cartridge type. Submicron filter employs replaceable membranes. The final rinse water is not only of high electrical resistance, 5,000,000 (18C) or more ohms, but is also free of organic impurities and submicroscopic particles which often contribute to substandard results.

The complete unit is mounted on

NEW
FROM
PYRAMID

DRY ELECTROLYTIC CAPACITOR FOR EXTREME TEMPERATURE RANGE REQUIREMENTS TYPE TR



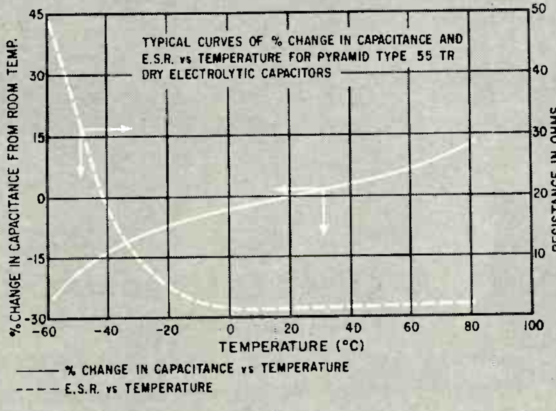
For applications previously reserved for Tantalum capacitors, Pyramid announces a new high reliability, dry electrolytic to be designated as Type TR. These are extended life capacitors using high purity aluminum foil, and can be supplied for any capacity requirements desired. Units are available in both polarized and non-polarized construction.

4 OPERATING TEMPERATURE RANGES: Type 20-85 TR −20°C to +85°C. Type 20-100 TR −20°C to +100°C. Type 40 TR −40°C to +85°C. Type 55 TR −55°C to +85°C.

CAPACITANCE TOLERANCES: Pyramid type TR units are made with commercial capacitance tolerances.

POWER FACTOR: TR units rated less than 15 working volts have a maximum power factor of 25% at 25°C and 120 cps. Type TR units rated 15 working volts and over have a maximum power factor of 15% at 25°C and 120 cps.

D.C. LEAKAGE: Leakage current limits for Pyramid type TR capacitors measured after the working voltage has been applied for 5 minutes may be determined from the following formulas: At 25°C; $I=0.04CV$, At 85°C; $I=0.35CV$, At 100°C; $I=0.63CV$. Where: I = leakage current in microampheres, C = capacitance in microfarads, V = rated working voltage.



——— % CHANGE IN CAPACITANCE vs TEMPERATURE
- - - - E.S.R. vs TEMPERATURE

WORKING VOLTAGE: Pyramid type 20-85 TR can be supplied up to 450 working volts. Pyramid types 20-100 TR, 40 TR and 55 TR can be supplied up to 150 working volts.

SURGE VOLTAGE: The surge voltage rating of Pyramid type TR capacitors at 85°C and 100°C is 115% of the rated working voltage.

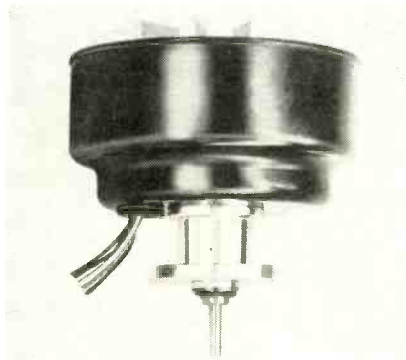
LIFE TEST: After 1000 hours at 85°C or 100°C, and working voltage applied, Pyramid type TR capacitors meet the following specifications at 25°C and 120 cps. The capacitance is within $^{+40\%}_{-20\%}$ of the capacitance measured before life test. The power factor is less than 150% of the power factor measured before the life test. The leakage current is within the limits specified above.

For circuit application information and a copy of TR Engineering Bulletin write to Industrial Division:

PYRAMID ELECTRIC COMPANY
1445 HUDSON BOULEVARD
NORTH BERGEN, NEW JERSEY

BURTON BROWNE/New York

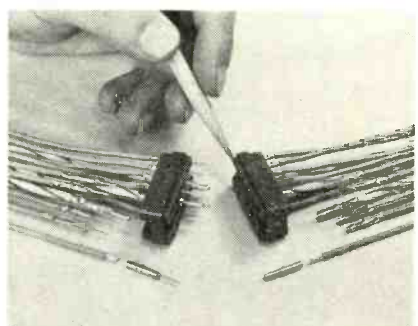
a mobile frame complete with circulating pump. **Circle 428 on Reader Service Card.**



HYSTERESIS MOTOR
three-speed type

TECHNICAL ELECTRONICS CORP., 4060 Ince Blvd., Culver City, Calif., has introduced a three-speed hysteresis motor which provides tape speeds of $3\frac{3}{4}$ in., $7\frac{1}{2}$ in., and 15 ips with a direct drive. Precision ground capstans are held to close concentric and diametrical tolerances and designed as an integral part of the rotor shaft to insure accurate velocities with minimum of flutter.

Quiet in operation, these motors are ideal as a precise drive for high fidelity recording and reproducing equipment such as tape recorders, computer storage drums and turntables. **Circle 429 on Reader Service Card.**



SOLDERLESS CONNECTOR
speeds electronic wiring

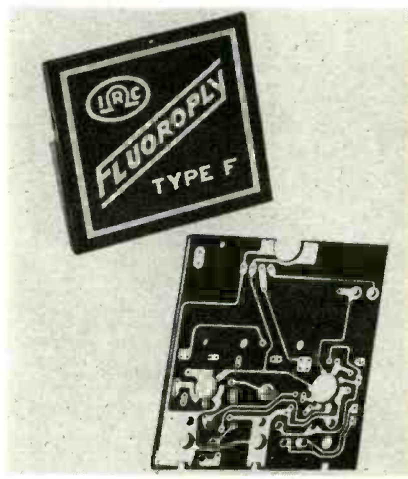
BURNDY CORP., Norwalk, Conn. A solderless multi-lead plug-and- receptacle connector designed to speed the wiring of electronic harnesses and achieve greater de-

pendability and versatility has been introduced.

Called the Hyfen, the connector has two mating units, a plug and a receptacle. Instead of being soldered, pins and sockets are crimped to wire ends by single-stroke manual or high-speed automatic tools.

Elimination of solder fluxes and dissimilar metals improves resistance to corrosion. A minimum number of contact points also reduces reliability problems.

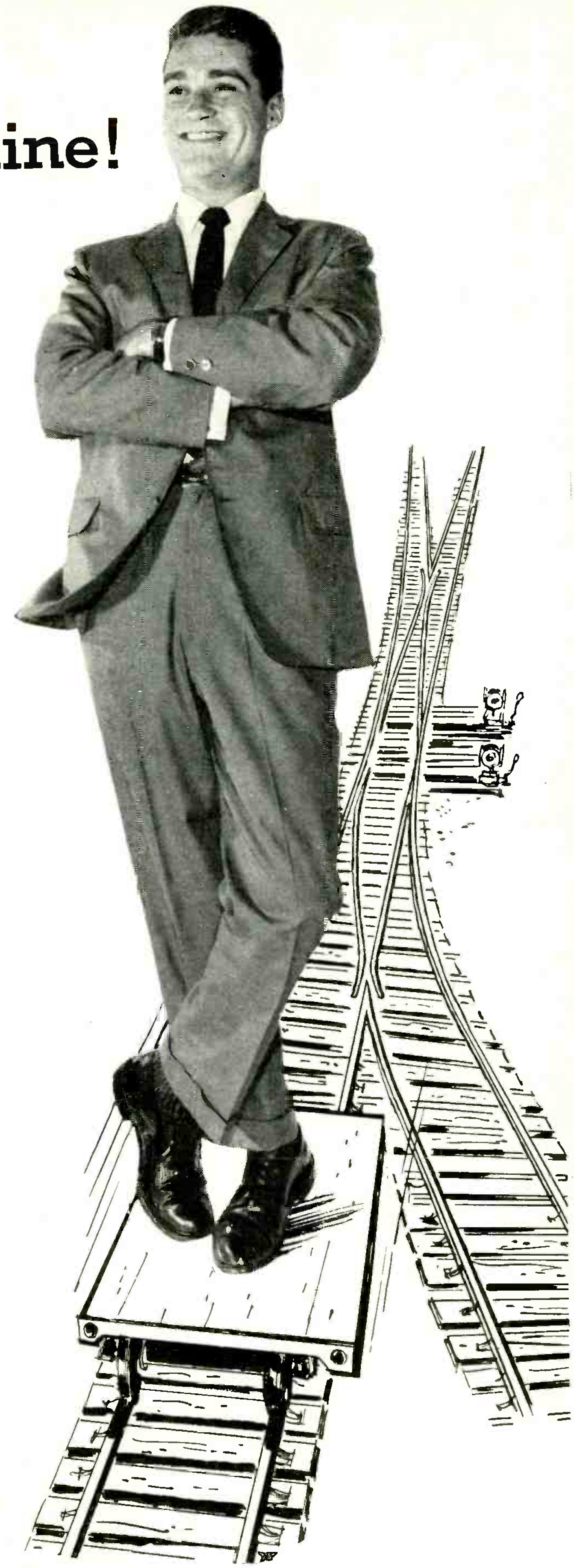
Crimping may be done before or after the harness is in place. Once wires are tipped with pins or sockets, they are snap-locked in the plug and receptacle, which may be mated as a gang connect or disconnect. Pins and sockets may also be pulled out separately to remove individual circuits. **Circle 430 on Reader Service Card.**



FLUOROPLY LAMINATE
for printed circuit uses

INTERNATIONAL RESISTANCE CO., 401 North Broad St., Philadelphia 8, Pa., has added Fluoroply-F lamnate for printed circuit applications to its product line. Fluoroply laminate type F provides high bond strengths of copper foil to plastic base without the use of adhesives. Fluoroply's special fluorocarbon plastic base eliminates the problems of water absorption and humidity surface leakage. Among the excellent electrical properties featured are high surface and volume resistivities, high dielectric strength, and good h-f characteristics. Arc re-

Get on the main line!



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The wide range of functions at Western Electric includes production, merchandising, purchasing, installation and other aspects of the overall job. Moreover, promotion from within is our policy. Today, fifty-five percent of the college graduates who have risen to the upper levels of Western Electric management have engineering degrees.

What would you do here? Well, maybe you'd help with our telephone job: making, distributing and installing the equipment needed for the nationwide Bell System network of 50 million telephones. Perhaps you'd have a hand in finding new – and better – ways of making telephones, central office switching systems, radio relay equipment; handle assignments involving miniaturization or automation.

In addition to our telephone work, there's a steady need for young engineers to help with our important government defense projects. The DEW Line of radar stations... the Nike guided missile system... White Alice – these are some of the important assignments the government has asked us to undertake.

The engineers who join us (mechanical, electrical, chemical, civil; physicists and mathematicians) will receive the security of a comprehensive retirement, benefit and insurance program . . . plus a chance to develop their professional skills through our Tuition Refund Plan and Graduate Engineering Training Program. Why not look into the career opportunities at Western Electric now. To apply, send resume of your education and experience to Engineering Personnel, Room 1066 Western Electric Company, 195 Broadway, New York 7, N. Y.

Western Electric

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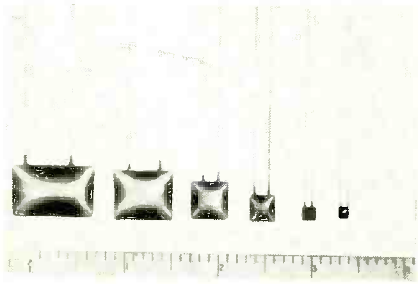
Manufacturing plants in Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; North Andover, Mass.; Lincoln and Omaha, Neb.; St. Paul and Duluth, Minn. Distributing Centers in 30 cities and Installation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

sistance of more than 360 sec makes Fluoroply-F superior in high voltage and high humidity applications.

Fluoroply can be readily cold-punched, drilled or machined. It is available in various sizes, thicknesses and colors. **Circle 431 on Reader Service Card.**



CERAMIC CAPACITOR
ultrasubminiature type

VALCO DIVISION, National-El Ray Corp., 11815 Vose St., North Hollywood, Calif., has announced a newly developed ceramic capacitor which maintains 90 percent of room temperature capacitance at critical temperatures up to 150 C and down to −55 C. The Val-Cap ultrasubminiature capacitor is offered through the full RETMA decade of capacitance ratings from 47 to 100,000 $\mu\mu f$.

The smallest Val-Cap (47 $\mu\mu f$) measures only 0.1 by 0.1 by 0.1. Rated voltage is 100 to 200 wvdc, with up to 1,000 wvdc available.

The capacitors described use an exclusive new high density ceramic material possessing a very high dielectric constant and stable temperature coefficient. **Circle 432 on Reader Service Card.**

TRANSISTOR CLIP
holds tiny components

GENERAL CEMENT MFG. CO., 400 South Wyman St., Rockford, Ill. Measuring 0.281 in. at its base, the new clip meets military requirements for retention of transistors and other rounded components used on printed circuit boards and conventional chasses.

Individual items such as diodes, relays, miniature capacitors, resistors and others that fall within

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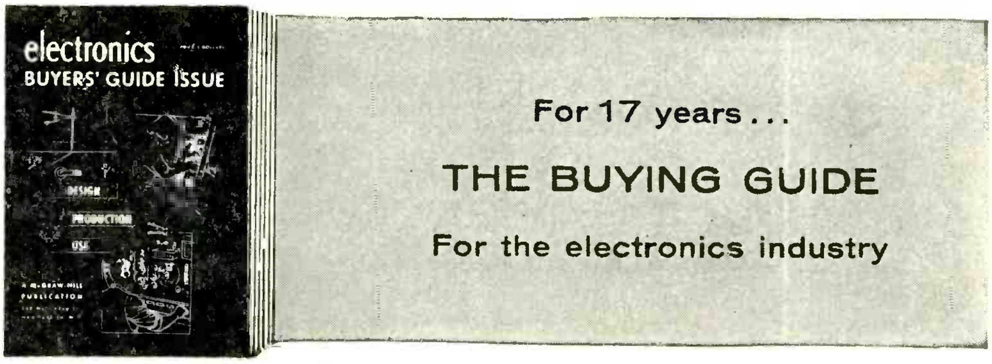

As easy to use as the telephone book, your all new 1957 electronics BUYERS' GUIDE features:

COMPLETENESS: 1070 pages of products, manufacturers, trade names, manufacturers' representatives, and professional services.

ACCURACY: The entire electronic industry is questionnaired from scratch each year. For the 1957 GUIDE, there were 181 changes, 586 deletions (of the deletions, many were due to mergers and name changes), and 872 additions. Total number of manufacturers increased to 4013 from 3727 in 1956. 87 new products were added in 1957 for a total of 1773.

USE: Whether you are concerned with the design, production, or use of electronic circuitry, turn to the listings of the **electronics** BUYERS' GUIDE. Here you will find the page numbers that refer you to catalog-type advertising, specially prepared to supplement the listings and give you the technical information you must have to specify and purchase electronic and allied products.

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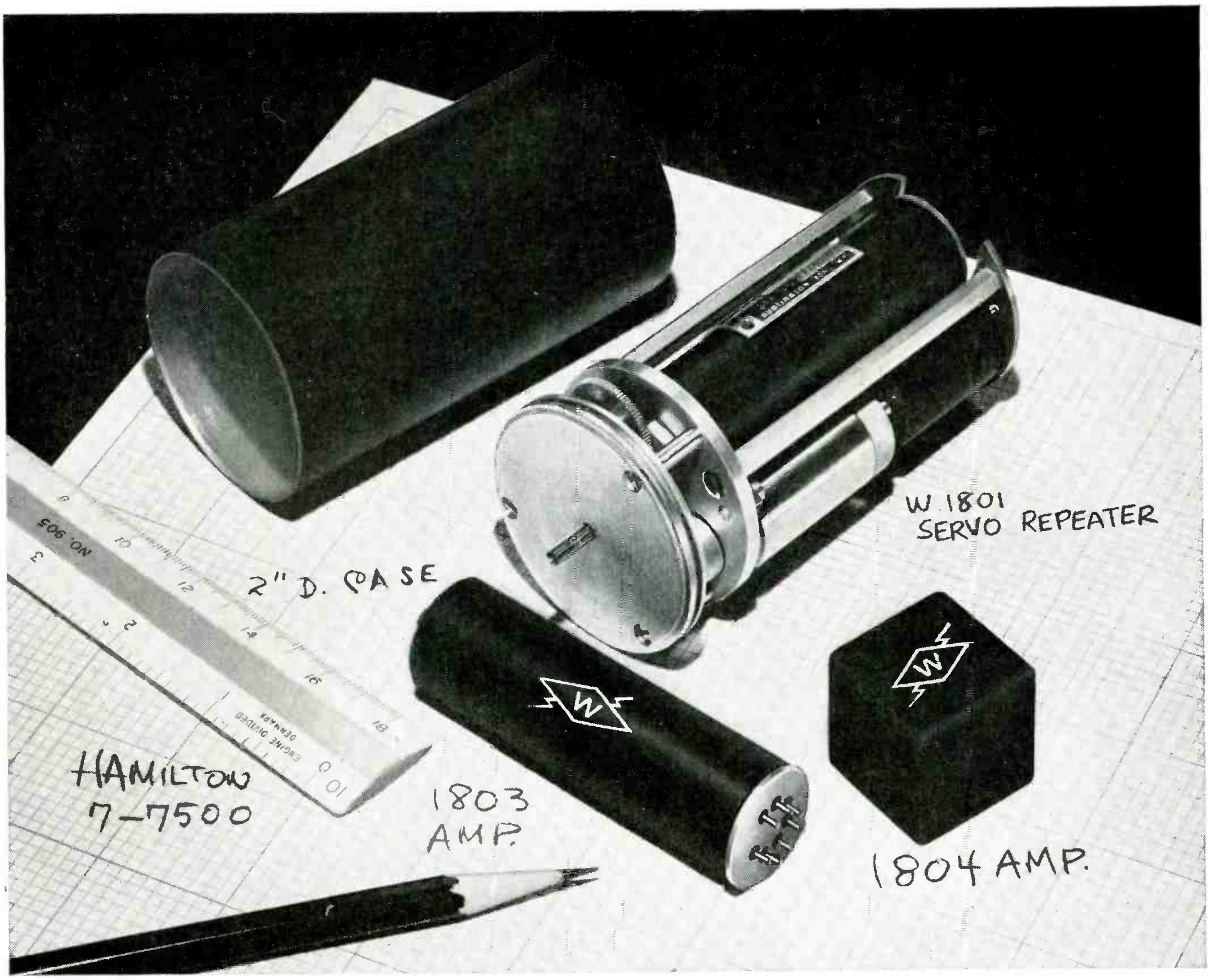

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MICROMATION—the logical result of Waldorf's unique talent for compressing more performance and reliability into less space.

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MICROMATION now makes available—

- Model W1801—Transistorized Servo Repeater System; size 2" Dia. x 4" long, weight 13 oz. including amplifier and power supply.
- Model W1803—Transistorized Servo Amplifier; size 13/16" Dia. x 2¾" long, weight 2 oz.
- Model W1804—Transistorized Servo Amplifier; size 1" x 1" x 1".

In the housing of the W1801 Servo Repeater System illustrated are all the electronic and electromechanical components to develop shaft position output with torque exceeding 20 oz.-in. Static accuracy is within 0.1° of input from synchro or transducer. Velocity constant is 60 sec.$^{-1}$. Requires only 115V, 400 cps supply. Other configurations are available to suit your requirements. Uses include control of positioning devices, valves or computer elements. May also be used as aircraft indicators. Meets military specifications.

Model W1803 Amplifier as used in the W1801 Servo Repeater is designed for minimum mounting surface—13/16" Dia.

Model W1804 Amplifier is identical electrically but packaged for minimum volume—1" x 1" x 1".

Both accept synchro, potentiometer, or other transducer data. Both drive size 8 or size 10 motors.

Interested?

If these product improvements—or the coming innovations in MICROMATION—integrators, differentiators, coordinate-converters, vector solvers and power supplies challenge your imagination, why not ask for further data?

Waldorf

INSTRUMENT COMPANY

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Circle 223 Readers Service Card

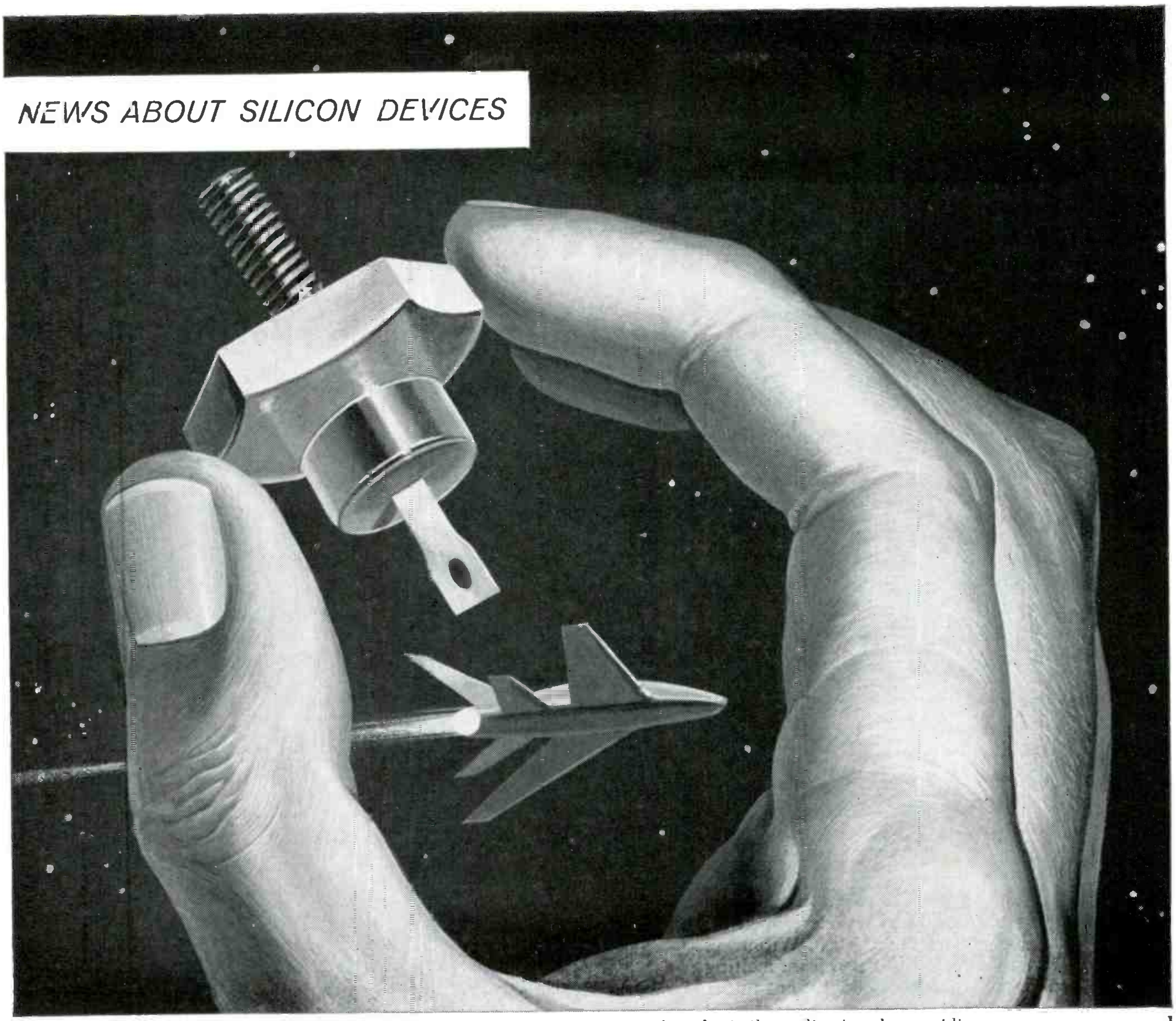
its size limits are gripped securely by the new clip even under extreme vibration or shock conditions. Only finger pressure is necessary for insertion or removal of the component. The stainless steel clip can be fastened in place by rivet, solder or dip-solder methods. **Circle 433 on Reader Service Card.**

DPDT SWITCH
features one-way action

ELECTRO SNAP SWITCH & MFG. CO., 4218 West Lake St., Chicago 24, Ill. A new Electro-Snap die-cast switch provides simultaneous, one-way action on two poles. Exclusive one-way action results in an electrical impulse on the inward stroke and does not operate the switch on return to its normal position. The snap-action of the four-circuit switch mechanism is totally independent of the speed of the plunger movement.

The dpdt basic switch is housed in an aluminum die-cast case with a splash-proof neoprene boot to protect its switching mechanism. The ES4-DM3 is designed to eliminate complicated one way dogs, extra switches, and costly relays. It is

NEWS ABOUT SILICON DEVICES



SILICON RECTIFIERS are finding increasing use at elevated temperatures in aircraft and missile applications by providing more power per pound.

Now... design improvements made possible with components of Du Pont Hyperpure Silicon

Today silicon rectifiers make possible a vast improvement in jet-age aircraft generators—the use of engine oil as a coolant instead of less-efficient ram air. Silicon rectifiers take the place of oil-sensitive brushes, commutator and slip rings . . . are completely unaffected by 150°C. engine oil. Result: a *brushless* generator of less weight and size than ordinary generators.

Silicon devices can similarly help you miniaturize—improve design and performance. Silicon rectifiers have excellent stability . . . can operate continuously at —65 to 200°C. They're up to 99% efficient—reverse leakages are only a fraction of those of other semiconductors. Both transistors and rectifiers of silicon can pack *more* capacity into *less* of your equipment space.

Note to device manufacturers: You can produce high-quality silicon transistors and rectifiers with Du Pont Hyperpure Silicon now available in three grades for maximum efficiency and ease of use . . . purity range of 3 to 11 atoms of boron per billion . . . available in 3 forms, needles, densified, cut-rod. Technical information is available on crystal growing from Du Pont . . . pioneer producer of semiconductor-grade silicon.

NEW BOOKLET ON DU PONT HYPERPURE SILICON

You'll find our new, illustrated booklet about Hyperpure Silicon helpful and interesting—it describes the manufacture, properties and uses of Du Pont Hyperpure Silicon. Just drop us a card for your copy. E. I. du Pont de Nemours & Co. (Inc.), Silicon N-2496-E-11, Wilmington 98, Delaware.

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claimed to be excellent for pulsing electrical control on both pneumatic and hydraulic valves and other similar installations requiring momentary one-way electrical impulses. The simultaneous break of two poles permits great flexibility in wiring variations. The switch is rated at 15 amperes 125/250 v a-c, 30 v d-c. **Circle 434 on Reader Service Card.**

MULTIMETER
for data link application

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y., announces availability of a multimeter for data link or analog application with a maximum of four simultaneous readouts. This unit is a 3-in. AN type meter, hermetically sealed and gas filled. It is completely ruggedized in a shielded, steel case. Maximum sensitivity is 200 μa for each display. Complete specifications are available. **Circle 435 on Reader Service Card.**

A-C ELECTROMETER
micromicroammeter type

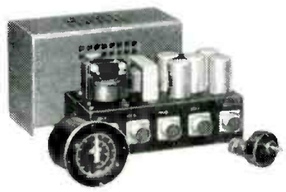
THE VICTOREEN INSTRUMENT CO., 5806 Hough Ave., Cleveland 3, Ohio. Model 565A micromicroammeter electrometer was designed for measuring low currents in ion

2-SPEED SERVO DRIVEN INDICATOR

Each input of this 5-channel servo system drives a synchro transmitter through a gear reduction of 5 to 1.

Indicator controlled by a size 9 motor operating off a 2-stage transistorized amplifier with a gain of 60 to 1.

Indicator synchro is geared at 1 to 1 for slow resolution, 36 to 1 for fast resolution. Error is ±5 minutes indicated.



servo problems stock units can't solve

This equipment "does the job right" because it was especially designed for a single application . . . by a company whose major function is solving individual servo control problems with complete, precisely engineered and manufactured servo assemblies.

Of course, if you just want servo *components*, Daystrom Transicoil can provide them to the highest order of precision and accuracy. But it is in the "package" engineering of unique assemblies that Daystrom Transicoil's experience and creative imagination offer the greatest value. And in most cases, these assemblies cost no more than the individual components would purchased separately.

Check out your next servo problem with Daystrom Transicoil first. Ask for the new gear-motor availability guide if you haven't yet received a copy.

DAYSTROM TRANSICOIL CORP.

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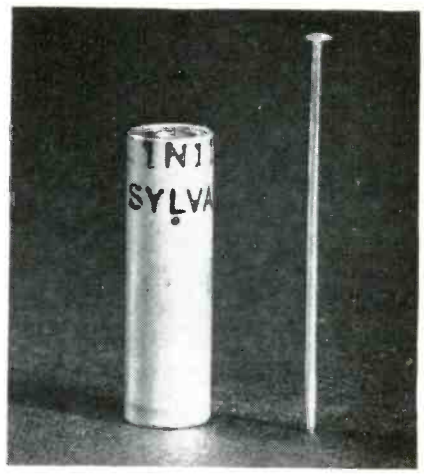
Circle 227 Readers Service Card

chambers and high-impedance networks. It conforms to ORNL Specification Q826B.

Accuracy of the system is better than 1 percent of full scale. Stability after the first hour of operation exceeds 1 percent per 24 hours. Linearity is ± 1 percent of full scale.

Extremely sensitive, the 565A can detect differences of current as small as 5X 10^{-15} amperes. With minimum capacity in the circuit, the RC time-constant is approximately 10 seconds. Each additional micromicrofarad of capacity increases the time-constant by 1 second.

The unit incorporates five ranges of from 2.5 × 10^{-9} to 2.5 × 10^{-13} amperes. Maximum full-scale current sensitivity is 2.5 × 10^{-13} amperes; maximum full-scale voltage sensitivity is 0.25 v. **Circle 436 on Reader Service Card.**

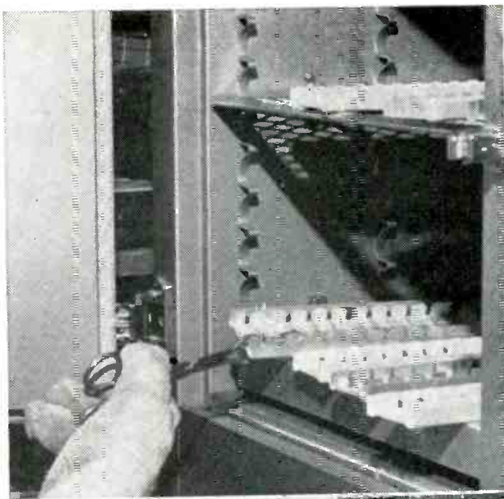


MIXER DIODE
for radar applications

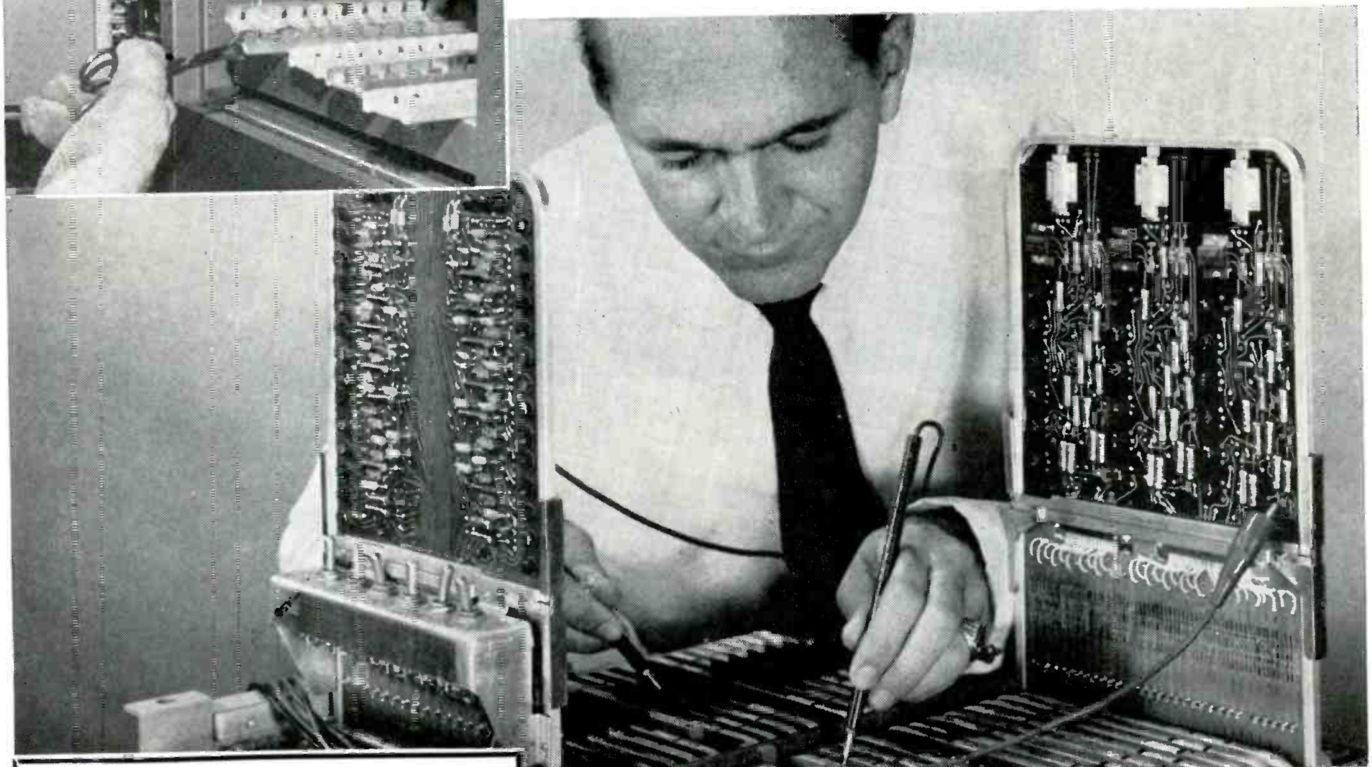
SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y. The 1N1132 broadband mixer diode is of tripolar construction and covers the frequency range from 3 kmc to 12.4 kmc in a single coaxial holder. Its characteristics contribute to a simplified, more compact system for radar applications.

Only ¾ in. long and about $\frac{3}{16}$ in. in diameter, the new broadband crystal diode is the mixer counterpart of Sylvania's low-level tripolar video detector.

Input of the 1N1132 covers any frequency from S through X-



Drift and aging problems solved with these new computer-type transistors



CHECK THE G-E TRANSISTOR DESIGNED SPECIFICALLY FOR YOUR COMPUTER SYSTEM

Computer system	G-E transistor type	Characteristics
DCTL logic	2N430 (silicon)	Low saturation resistance, controlled input characteristics.
NOR logic	2N430 (silicon)	Low saturation resistance, controlled input characteristics.
	2N396 (germanium)	Negligible aging, high speed, low saturation voltage.
DIODE logic	2N397 (germanium)	High peak power dissipation, high current gain at high collector currents, negligible aging.
Magnetic Drum Storage	4JD1B series (germanium)	Controlled current gain in either direction at 200 ma, one ampere peak currents, high dissipation, high voltage rating.
General Purpose	2N430 thru 2N434 (silicon)	Low I_{co}, narrow beta range, low saturation resistance.
	2N123 (germanium)	Proved in years of duty, high peak dissipation, 7 mc alpha cutoff.
	2N43 (germanium)	Low speed, high gain, 1 mc alpha cutoff, proved in years of duty.
Analog Computer Amplifiers	2N167 (germanium)	Low I_{co}, high output impedance, high current gain at low collector currents, high speed.

2N390 series added to General Electric's line of transistors for all computer systems

Characteristics of transistors have been known to change from the time when they've been subjected to manufacturer's heat tests until months later when they're finally at work in a computer. But not the new 2N390 series.

Each 2N390-series transistor exhibits parameters within a 10 per cent (plus or minus) drift area with time or under any storage conditions for which they are rated. You can depend on I_{co} and beta to remain stabilized.

Call your local General Electric representative for all the details on the new 2N390 series and other transistors. No matter what computer system you are working on, there are General Electric transistors specially designed for it. *Or write General Electric Company, Semiconductor Products Department, Section S25117, Electronics Park, Syracuse, N. Y.*

SPECIFICATIONS	2N397	2N396
Collector to Emitter (25°c)	—10 volts	—20 volts
Collector Current (25°c)	—250 ma	—200 ma
Power Dissipation (25°c)	150 mw	150 mw
Alpha Cutoff Frequency*	8 mc (min)	5 mc (min)
Collector Cutoff Current	—6 μ amp (max)	—6 μ amp (max)
Emitter Cutoff Current	—6 μ amp (max)	—6 μ amp (max)

*Common base—V_{cb} = —5 volts, I_e = 1 ma.

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GENERAL ELECTRIC

Circle 284 Readers Service Card

band, and it has a low noise figure over this range. With a built-in r-f bypass capacitor, the diode also has a separate output terminal for i-f which eliminates r-f chokes. Another feature is the simplified, low-cost mount design, used with the tripolar 1N1132.

At 25C, maximum overall noise figure is 9.5 db, i-f impedance is 100 to 200 ohms, and r-f impedance (vswr maximum) is 2.0. Ambient temperature is −40 C to +70 C. **Circle 437 on Reader Service Card.**

PULSE DELAY UNIT
features compactness

ELECTRICAL AND PHYSICAL INSTRUMENT CORP., 42-19 27th St., Long Island City 1, N. Y., has available a pulse delay unit which allows delays of 5, 10, 15, 25, 50 and 100 millimicroseconds and combinations of these delays. Standard coaxial cables of 53, 73 and 93 ohms are used for these delays in order to maintain a fast rise time and minimize pulse shape distortions. The rise time for a step function input is less than one millimicrosecond for pulse delays of 25 millimicroseconds or less and less than 5 millimicroseconds for a 100 millimicrosecond delay. BNC connectors are mounted on the front panel at the beginning and end of each delay. Adaptors from BNC to either uhf or type N are provided so that variation of the delay inserted in a cable with these connectors can be effected in a simple manner.

Dimensions of the pulse delay unit are 12 in. high by 7 in. wide

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At your finger tips, issue after issue, is one of your richest veins of job information – advertising. You might call it the "with what" type – which dovetails the "how" of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better – save your company money.

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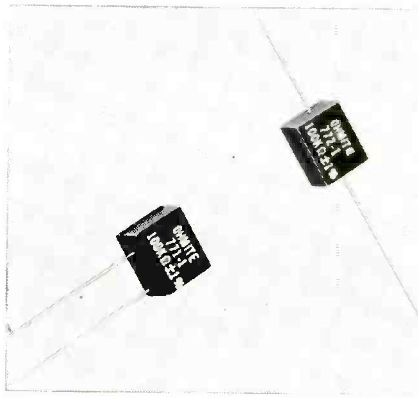
by 7 in. deep. **Circle 438 on Reader Service Card.**



PRECISION RESISTOR

metal film type

OHMITE MFG. CO., 3661 Howard St., Skokie, Ill. A new kind of precision resistor, the Riteohm Series 77 metal film resistor, is now available.

The advanced metal film resistors were developed to meet tough, new military and industrial demands. They represent a radical departure in construction from wire wound precision resistors. Bulletin 155 gives complete information. **Circle 439 on Reader Service Card.**

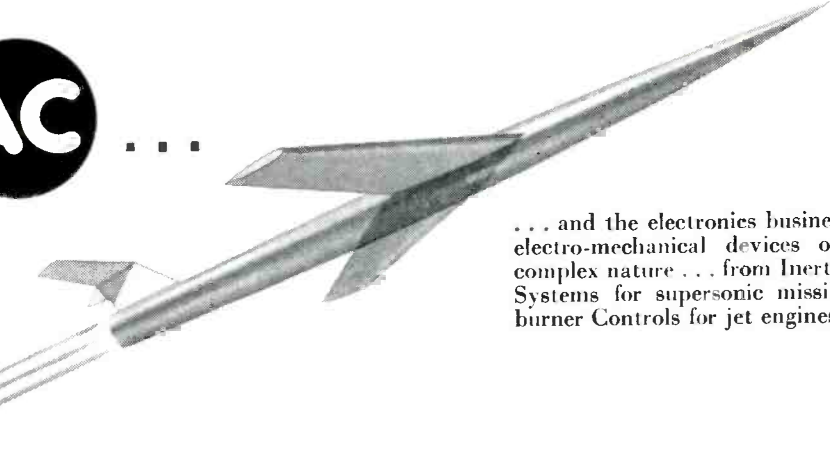
SOLDERING AIDS

for printed circuits

CBS-HYTRON, A Division of Columbia Broadcasting System, Inc., Danvers, Mass., has introduced two miniaturized soldering aids for printed circuits. The new tools—one with straight tip, the other with angled tip—are especially designed for servicing the compact and delicate printed boards of modern miniaturized equipment.

Both tools offer features of the

This is AC . . .

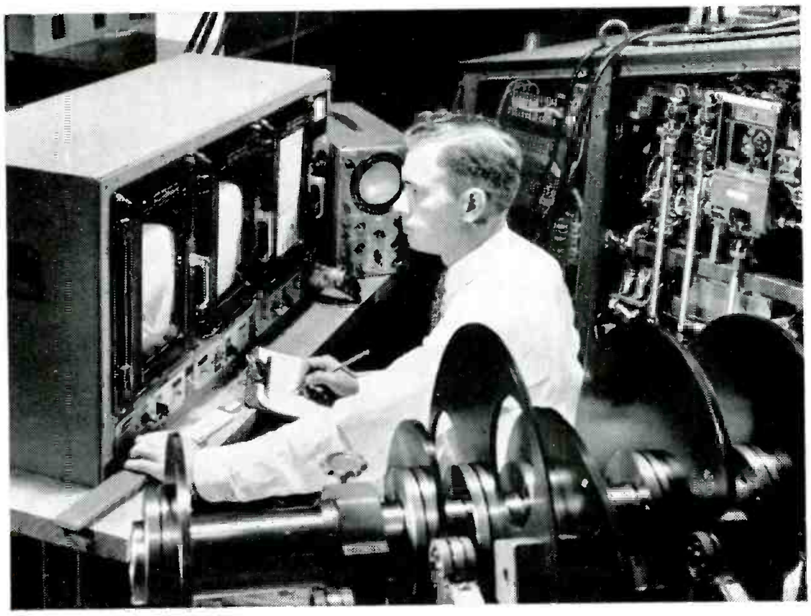


. . . and the electronics business, including electro-mechanical devices of the most complex nature . . . from Inertial Guidance Systems for supersonic missiles to Afterburner Controls for jet engines.

This is GENERAL MOTORS . . .

. . . and all that the name implies—a solid, sound company with a policy of decentralization that offers greater opportunities for the growth of individuals within the organization.

This may be for you . . .



If you are a graduate engineer with an electrical, mechanical or electronic background (and 3 to 10 years experience), there is a spot for you at AC.

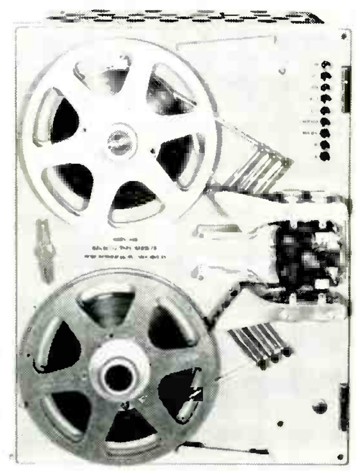
AC is now developing and producing Inertial Guidance Systems, Gyroscopes, Gyro-Accelerometers, Afterburner Fuel Controls, Speed Sensitive Switches, Speed Sensors, Three-way Selector Valves, Emergency Fuel Controls, Bombing Navigational Computers, Gun-Bomb-Rocket Sights, Manifold Air Pressure Regulators, and Torquemeters.

Opportunities now exist for you to work on any one of these projects, with some of the leading men in each of these fields.

If you feel AC may be the place for you, write or phone Mr. Cecil E. Sundeen, Supervisor of Technical Employment. AC . . . the Electronics Division of General Motors, 1925 E. Kenilworth, Milwaukee 1, Wisconsin.

AC THE ELECTRONICS DIVISION OF GENERAL MOTORS original CBS standard soldering aids. The fork end easily disconnects soldered joints. The spade end reams solder from lug hole. Many other uses are possible.

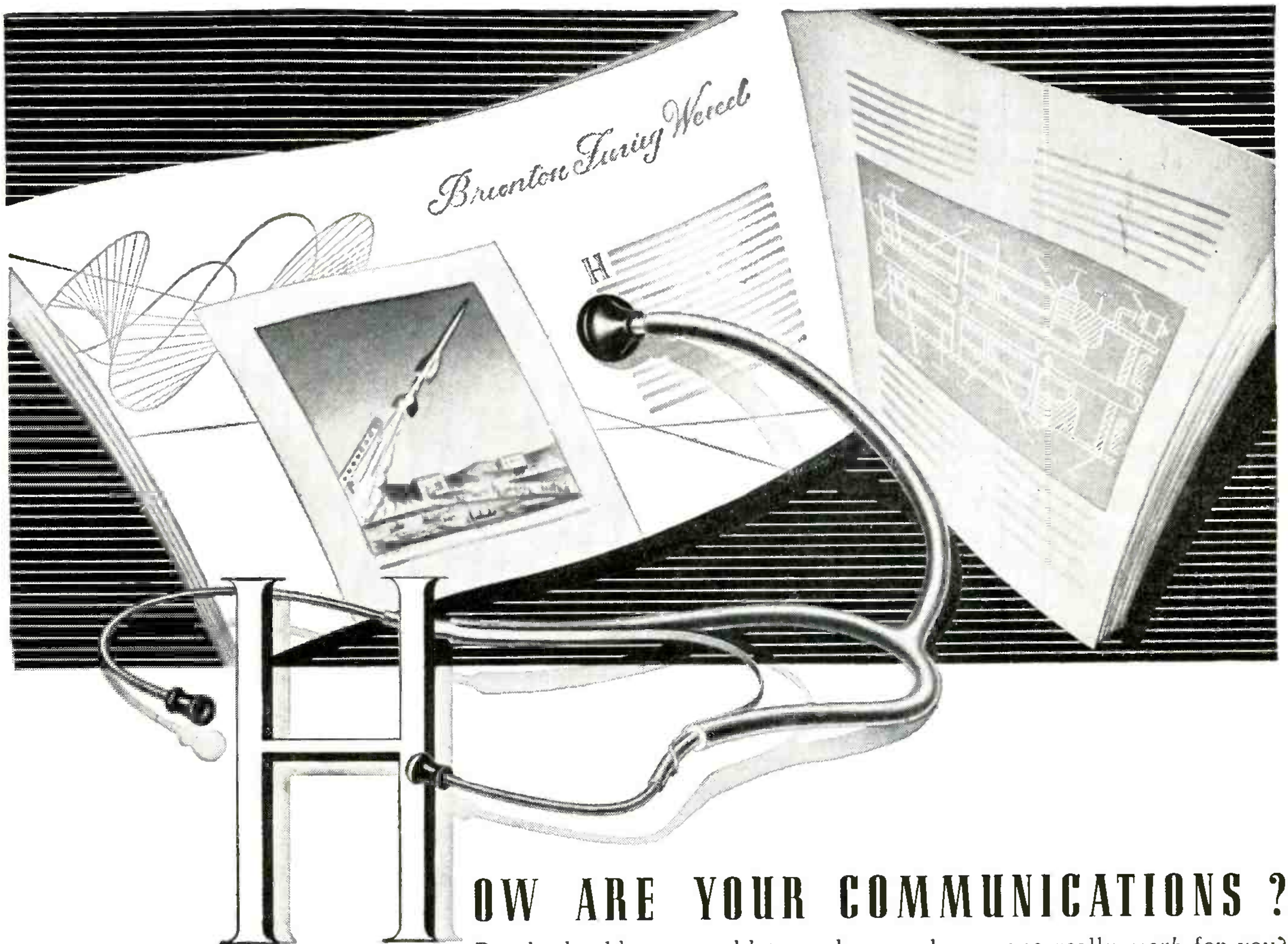
Tips are of tool steel tempered to withstand heat and hard-chrome plated to shed solder. **Circle 440 on Reader Service Card.**



TAPE HANDLERS
with speeds up to 75 ips

POTTER INSTRUMENT CO., Sunnyside Blvd., Plainview, N. Y. Features of the model 905 series of digital magnetic tape handlers include tape speeds up to 75 ips with 3 millisec starts and stops. Any tape width up to 1¼ in. may be used. Other new features include fast rewind in both forward and reverse directions, dual speeds in the ratio of four to one with high speeds up to 75 ips, transparent dust cover, quick threading, and rack mounting. The transport mechanism is mounted on a hinged panel which provides immediate access to all mechanical parts and tubes. A hinged rear door provides access to all wiring connections and the remote control terminal strip.

The model 905 is automatically stopped when the end of a reel of tape approaches, when line voltage fails or drops below a prescribed minimum, or in the event of a tape failure. All machine functions, including on, off, forward, stop, reverse, forward rewind, reverse rewind, high speed



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and low speed may be controlled by conveniently grouped front-panel pushbuttons or by remote contact closures or pulses. **Circle 441 on Reader Service Card.**

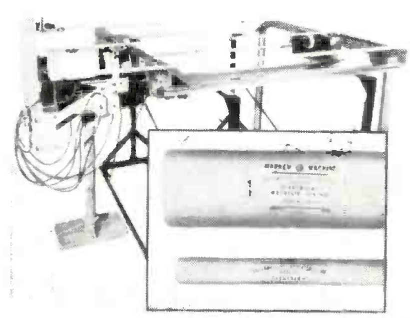
PULSE RESISTOR

views current waveforms

INTERNATIONAL RESISTANCE CO., 401 North Broad St., Philadelphia 8, Pa., has announced the addition of current pulse-viewing resistors to its extensive product line.

To observe or measure the magnitude and rise times of current pulses encountered in magnetrons and other devices, a means must be provided for applying the current pulse as a signal to the deflecting plates of a cathode-ray tube. IRC's pulse resistor views current waveforms with rise times from 0.01 to 0.5 μsec.

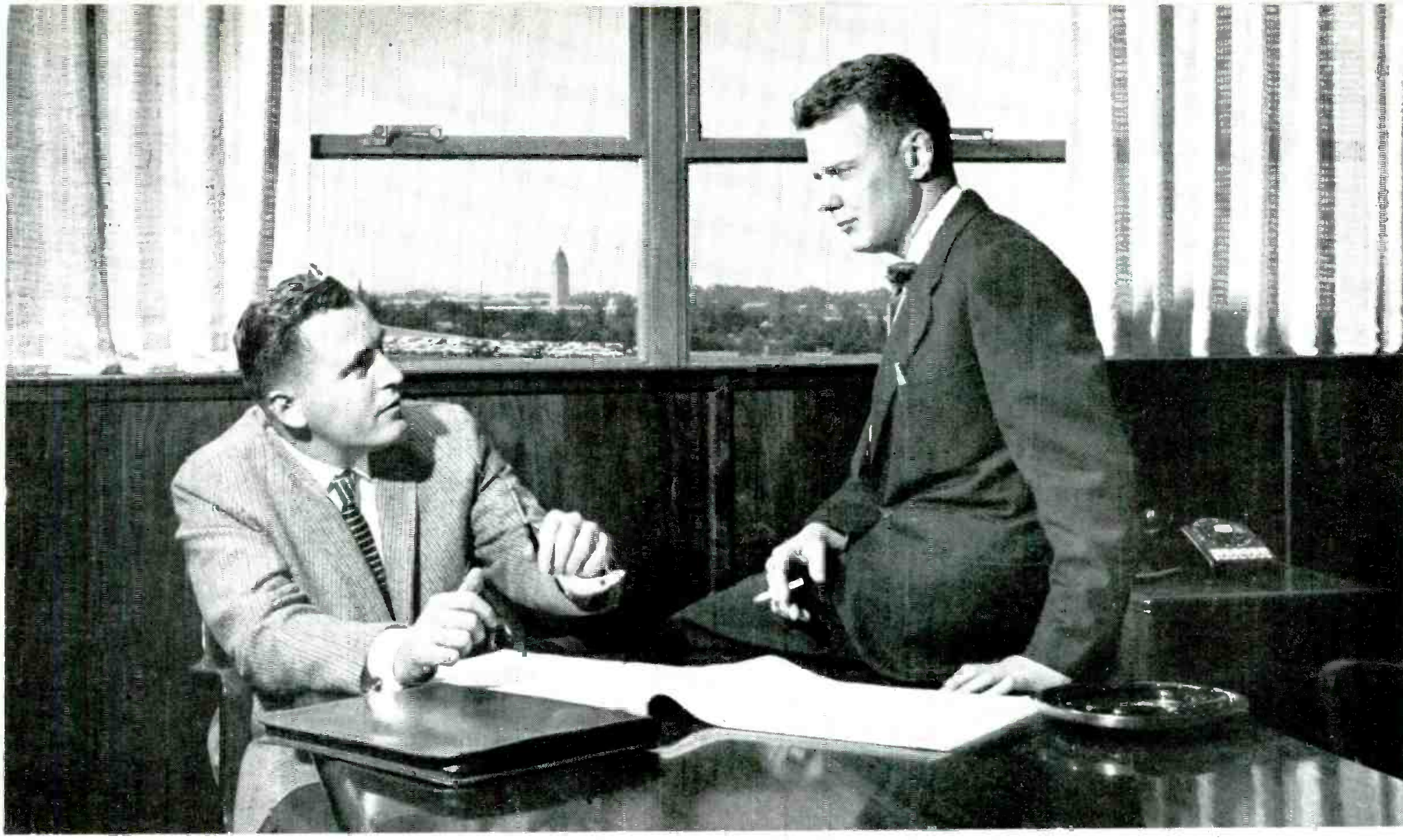
Noninductive resistive elements assure minimum distortion with sharp rise time presentation. The phone plug termination makes possible direct insertion into a live circuit. **Circle 442 on Reader Service Card.**



PRINTING MACHINE

marks tubular parts

MARKEM MACHINE CO., Keene 77, N. H. Rigid conduit, electrical metallic tubing and other long



Here E. V. Stearns (left), Inertial Guidance Department Manager, and G. D. Schott, Flight Controls Department Manager, discuss preliminary design of guidance and control systems.

Lockheed Missile Systems announces...

NEW POSITIONS IN INERTIAL GUIDANCE

Few areas of science or engineering equal inertial guidance in growth or the need for continuing advances.

It is a field of major effort at Lockheed Missile Systems. Weapon systems management programs include all phases of inertial guidance and navigation.

Continued expansion in these programs has created a number of new positions, involving:

Mechanical design of precision instruments such as gyros and accelerometers, giving extreme attention to size, weight, susceptibility to environment and related factors;

electronics circuit design, using miniaturized and solid state techniques;

design of precise computing systems for data handling within the guidance system;

theoretical analysis and study of guidance problems to relate the dynamics of a vehicle in a defined flight path or trajectory to a prescribed mission or objective of the larger weapon system;

theoretical analysis to determine performance of guidance systems and to optimize their design;

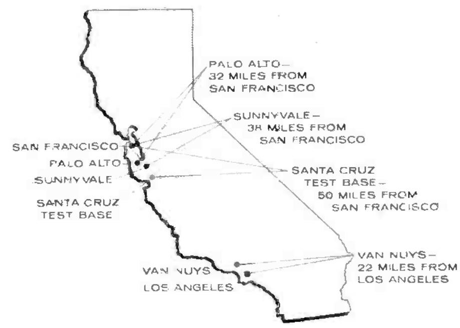
analysis and prediction of component performance through application of theory, study and laboratory testing;

design, development and construction of specialized testing equipment in which celestial and terrestrial motions form the basic reference for measurement;

manufacturing development of inertial components such as gyros and accelerometers.

Those possessing a high order of ability and experience are invited to write the Research and Development Staff, Palo Alto 18, California.

Engineers who lack experience in inertial guidance but wish to participate in its growth are invited to write.



Lockheed

MISSILE SYSTEMS

A DIVISION OF

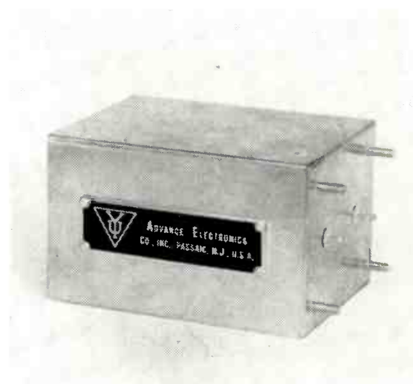
LOCKHEED AIRCRAFT CORPORATION

PALO ALTO • SUNNYVALE
VAN NUYS, CALIFORNIA

tubular parts and products can be marked rapidly with the new Model 86A printer. Specially designed for this type of work, the 86A accepts diameters from ½ in. to 4 in. in standard 10 ft lengths, either plain or coated, and prints up to 30 pieces per minute, depending on the conduit size.

Maximum imprint area is 1¾ in. from left to right along the axis of the tube, and 2 in. from top to bottom around the tube, dependent on tube area. Typical markings are the product name, trademark, grade or UL seal of approval.

Model 86A can be used as an automatic in-line unit or as a separate manually controlled machine. The machine is 36 in. long and 100 in. wide; height can be made to customer's order. **Circle 443 on Reader Service Card.**



DELAY LINES

feature small size

ADVANCE ELECTRONICS LAB., INC., 249-250 Terhune Ave., Passaic, N. J. A unit of type 4T series delay lines consists of 60 sections of m-derived networks. Each of these networks was especially designed to give linear phase response up to at least 70 percent of its cutoff frequency and less than 2 percent overshoot. These results are achieved by means of mutual coupling between two halves of a section, as well as mutual coupling between two adjacent sections. The amount of mutual coupling is carefully calculated and proved experimentally to be its optimum value for achieving minimum values of rise time, overshoot and ripples.

Cutoff frequency in mc equals

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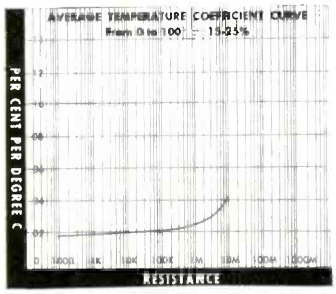
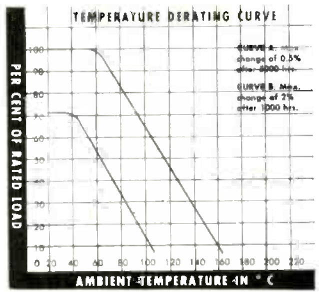
PRECISION CARBON DEPOSITED RESISTORS



Temperature coefficient characteristics for ALPT—1 watt resistor



Derating curve for ALPT—1 watt resistor

STANDARD RESISTORS ±1% TOLERANCE IN 10% RMA VALUES FROM 10 OHMS TO 2.7 MEGOHMS

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Circle 325 Readers Service Card

TRANSFORMERS FOR ELECTRONICALLY REGULATED POWER SUPPLIES

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Avoid delay in making your breadboards, no waiting for a special when a

STERLING 2K SERIES

transformer will meet your requirements exactly. Stock STERLING 2K units are available for supplies from 100 milliamperes at 100 volts to 400 milliamperes at 300 volts

Technical specifications on a typical unit of this family of transformers for use in a 300 volt 200 milliampere dc regulated power supply with 90 to 130 V AC input:

ST2010

Primary:
115 Volts AC, 50 to 1000 cps

Each 2K transformer provides:

	Secondaries:	
• PLATE VOLTAGE ALLOWANCE FOR PASS TUBE VOLTAGE DROP	570-0-570V	240 madc*
• RECTIFIER FILAMENT POWER	5.0V	3 A
• PASS TUBE FILAMENT POWER	6.3V	3 A
• REGULATOR CIRCUIT FILAMENT POWER	6.3V	1.2A
• AUXILIARY FILAMENT POWER FOR OTHER CIRCUIT REQUIREMENTS	6.3VCT	6 A
• REGULATOR CIRCUIT PLATE POWER	*Note 40 ma provided	
• APPLICATION BULLETIN WITH EACH UNIT		

Military versions of each of these units is also available. Technical data on the complete line is available on request.

Size: 5⅛ x 4⅝ x 5½ H
Mtg. Centers: 3½ x 3½
Weight 15 lbs.
Associated Choke: ST2009
4 Henries at 240 madc.

SAMPLES? SPECIALS? SHORT RUNS?

The 2K series is only one of the many types we make. We specialize in custom-built transformers to your specifications. Let our engineering staff help solve all your transformer problems.

Samples delivered in 1 to 3 weeks.

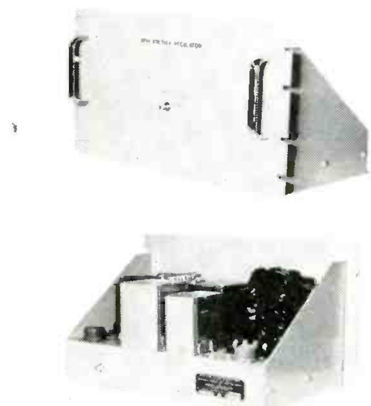
STERLING TRANSFORMER CORPORATION

299 North 7th St., Brooklyn 11, N. Y.
STagg 2-4200

Circle 326 Readers Service Card

19.2 divided by D, where D is the total time delay of the delay line in μsec. The rise time is less than 5 percent of the time delay. Accuracy of the time delay is ± 2 percent. Physical size is 3½ in. by 3 in. by 6 in.

There are more than 50 types available for this series. The total time delay can be made any value from 0.3 μsec to 60 μsec. The impedance can be made any value from 50 ohms to 2,000 ohms. **Circle 444 on Reader Service Card.**



VOLTAGE REGULATOR

all-magnetic, tubeless

MAGNETIC RESEARCH CORP., 3160 West El Segundo Blvd., Hawthorne, Calif. An all-magnetic, tubeless, 3 kva a-c line voltage regulator for use in 115-v, 400-cycle single-phase and 3-phase military ground support and laboratory equipment is now available.

Designated MRC part number 75-113-0, the unit maintains a constant 400-cycle a-c line voltage regardless of line or load variations. It insures proper operation of precision equipment where changes in a-c voltage could cause malfunctioning or loss of accuracy. Three of the single-phase units can be connected for three-phase operation, delivering a total of over 5 kva.

Regulation is held within ±0.5 percent against line changes between 100-130 v, load changes from 2.5-25 amperes, and frequency changes between 380 and 420 cps. Response time is less than 20 millisec. Output wave form distortion is 5 percent maximum. With out-

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YOU CAN STILL GET:

VERY LOW FREQUENCY, *June, 1957* — New research in the very low frequency band, below 30 kc., opens up greater portions of the radio spectrum for communication purposes. VLF has many new and important uses. A reference work you'll need for years.

SINGLE SIDEBAND, *December, 1956* — A round-up of recent technical discoveries as presented by the Joint Technical Advisory Committee through its sub committee on Single Sideband techniques. This special study for the FCC points up the many advantages of single sideband.

FERRITES, *October, 1956* — This new group of solid state materials outmodes the intermittent "pulse" system of World War II radar. The ferrites allow simultaneous sending and receiving on a single microwave antenna; as well as full-power transmission in microwave ranges with reduced power loss and interference.

SOLID STATE ELECTRONICS, *December, 1955* — This issue heralds the arrival of a new epoch in radio electronics — the solid state electronics era. Defined and named with the birth of the transistor, this concerns the control and utilization of the electric magnetic and photic properties of solids. There are now whole new classes of electronic devices due to discoveries in this field.

SCATTER PROPAGATION, *October, 1955* — Here's radio history in the making. This issue presents practical application of a new principle in the fields of broadcasting and electronics. Thirty-five papers lay the foundation of a new means of communicating over long distances.

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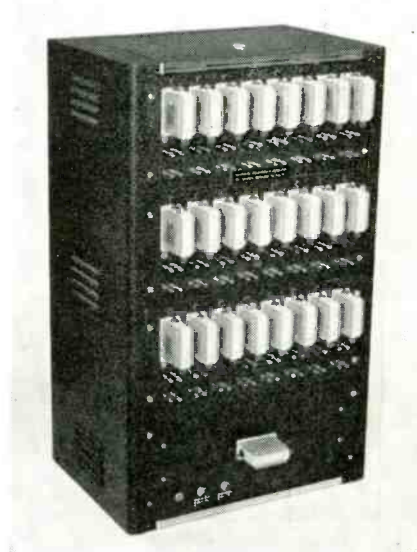
put voltage continuously adjustable between 110 and 120 v, the most desirable output of 115 v lies in the center of the adjustment range. The unit is particularly useful to provide independently regulated 400 cps power for individual laboratories which are fed from a common 400 cps supply.

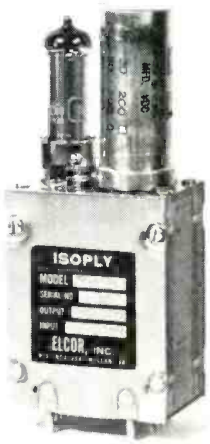
All magnetic components of the regulator are designed to meet MIL-T-27A specifications. Use of rugged, long-life magnetic amplifiers instead of tubes assures high reliability and long service in unattended locations. The unit is maintenance-free. It is short-circuit protected and cannot produce dangerous output overvoltages. **Circle 445 on Reader Service Card.**



DRY CIRCUIT TESTER
checks relays

FLEETWOOD LABORATORIES INC., 300 Victory Blvd., New Rochelle, New York, has available relay test sets that pass low-current, low-voltage signals through the contacts of relays to be used for grid switching applications while the relays are energized. Individual contacts can be monitored for research into the dry circuit phenomena or all contacts can be connected in series for production lots. Model R-3C passes 30 μa through the contacts with an open circuit voltage of 30 mv. Model R-4C passes 1 μa through the contacts with an open circuit voltage of 5 mv. Models with adjustable sensitivity, over a wide range of test conditions, are also available.

The test relay is energized once per second and a counter records the number of times a failure is encountered. Test sets of various sizes are available to test from 1 to 24 relays simultaneously. **Circle 446 on Reader Service Card.**

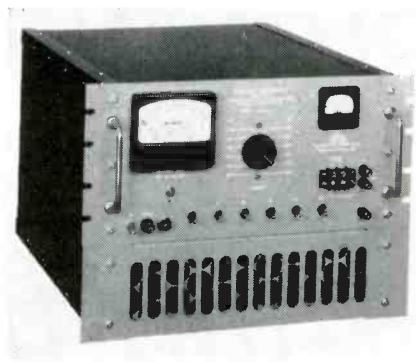


POWER SUPPLY

isolated miniature type

ELCOR INC., P. O. Box 354, McLean, Va. Model 4150-10A Isoply is the second in a series of new isolated miniature power supplies, featuring very low shunt capacitance from d-c output to ground. A novel transformer construction and special mounting of the rectifiers and filter circuit elements allows the entire secondary circuit to be capacitively as well as conductively isolated from ground. The low value of shunt capacitance (20 $\mu\mu$f) makes the supply suitable for use in a wide variety of high-speed direct-coupled circuits that require an ungrounded power supply. The Isoply is also very useful wherever bootstrapping is needed, as in pentode cathode followers and certain sweep generators. A leakage resistance in excess of 100,000 megohms and voltage breakdown exceeding 2,500 v are features that make the supply useful in special applications.

Model A150-10A features a regulated 150 v output conservatively rated at 10 ma maximum current. Maximum ripple is less than 0.01 v. The unit operates directly from 110-125 v, 60 cycles a-c. Dimensions are $1\frac{5}{8}$ in. wide by $2\frac{1}{4}$ in. long by $5\frac{1}{2}$ in. high. **Circle 447 on Reader Service Card.**



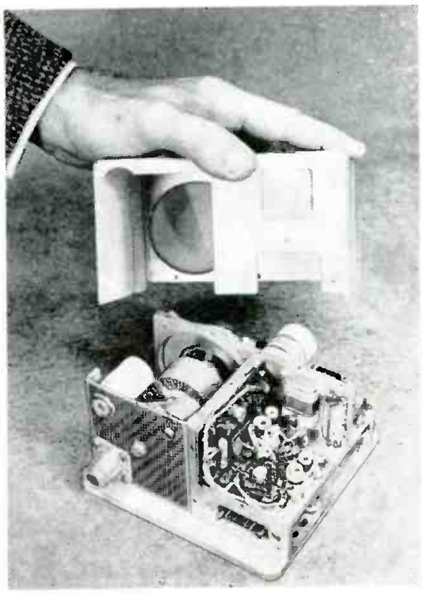
CURRENT GOVERNOR
is a transistorized unit

NORTH HILLS ELECTRIC CO., INC., 402 Sagamore Ave., Mineola, N. Y. Model CG12 "Current Governor" offers many firsts through transistorized current stabilization. It is a two terminal current stabilizer, modulator and electronic load. Completely transistorized, the CG12 features front panel control for selection of current levels in 50-ma steps from $\frac{1}{2}$ to 30 amperes. The stabilized current may be modulated 0-100 percent by external signals including sine wave, complex waveforms and d-c.

Together with its primary applications for constant current generation, and as a programmable electronic load, the versatile CG12 may be excellently applied to diode testing, transistor testing, magnetic core investigation, fuse testing, battery testing and wherever a modulated stabilized current is required. **Circle 448 on Reader Service Card.**

TRANSMITTER
extends telemetering range

TEXAS INSTRUMENTS INC., 6000 Lemmon Ave., Dallas 9, Texas. A new 200-w transistorized p-m transmitter has been announced which increases substantially the effective range of f-m/telemetering. The new equipment is complete in a single unit, requiring no amplification of the output. It is smaller and lighter than presently



available 50-w transmitters for similar duty, occupying only 67 cu in.

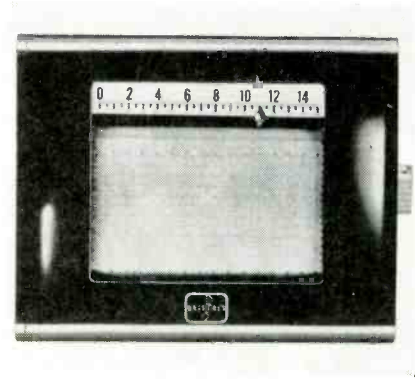
The new units transmit in the 215-235 mc range with frequency stability of ±0.01 percent up to 71 C. Higher frequencies are possible with only minor modifications. The basic unit also can be modified to operate at power outputs as low as 25 w. Operation at 200 w requires 12 cfm external cooling air. Integral "heat sink" provisions are ideally suited to missile requirements and stretching out the transmitter's operation during periods of rapid heat build up. High temperature silicon transistors are used in the oscillator, phase modulator, video amplifier, and frequency doubler circuits. The output stage utilizes a stacked ceramic tetrode with considerable excess capacity, and tubes are also used as drivers and multipliers. **Circle 449 on Reader Service Card.**

X-Y RECORDER
with 0.25 percent accuracy

THE BRISTOL CO., Waterbury 20, Conn., has announced a new electronic Dynamaster X-Y recorder. The new strip-chart recorder will automatically plot a continuous-curve showing the relationship of one measured variable to another.

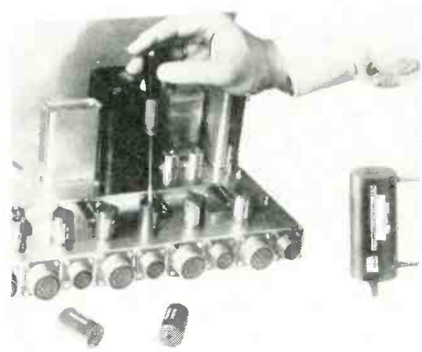
Some typical uses for the instrument included plotting temperature versus pressure in the process industries, position of intake parts versus gas flow in wind

Circle 239 Readers Service Card



tunnel research, location on web versus thickness in paper making, and speed versus torque in motor operation. Most other variables can also be handled.

The Dynamaster records on a 12-in. strip chart, and is available in pen speeds of up to 0.4 sec for full scale traverse to follow the most rapidly changing variables. **Circle 450 on Reader Service Card.**



WIRE WOUND RESISTOR
adjustable precision type

EASTERN PRECISION RESISTOR CORP., 675 Barbey St., Brooklyn 7, N. Y., announces Comp-U-Trim 113, an adjustable precision wire wound resistor, totally encapsulated to surpass all applicable MIL Specifications.

It is a precise trimming potentiometer embedded within the body of precision wire wound resistor. Similar temperature coefficent wire is used for both the main and trimming sections. With values up to 1.5 megohms, Comp-U-Trim 113 can be adjusted to 0.1 percent of the nominal value and trimmed to 0.001 percent. Special temperature coefficients and wider trimming variations are available on request. No. 20 Awg tin copper leads can be specified for printed circuit applications. **Circle 451 on Reader Service Card.**

COORDINATE CONVERTER
new analog computer

DYNALYSIS DEVELOPMENT LABORATORIES, INC., 11941 Wilshire Blvd., Los Angeles 25, Calif. Model 8-1101 high precision target acquisition computer is a special purpose unit which accepts d-c voltage representing X, Y, and Z coordinates and automatically performs transformation to azimuth angle, elevation angle, and slant range. Also available as an output signal is geographic range.

The computer, a completely self-contained unit, includes ten Dynalysis model 5-1103 computing amplifiers and four model 3-1030 servo resolvers. Total dynamic and static errors are less than one degree. **Circle 452 on Reader Service Card.**

PUNCHED CARD READER
used with control systems

THE PEERLESS ELECTRIC CO., Electronics Division, Warren, Ohio. A static punched card reader designed for use with industrial processing and control systems is now manufactured.

The card reader accepts an IBM or any other standard punched card having as many as 80 vertical columns with 12 punching positions in each column. The reader is equipped with Cannon Connectors for connection to associated control equipment.

As a punched card is put into the reading slot, rollers automatically place it in reading position. A signal light indicates the unit is "sensing" the card. An spdt switch automatically activates associated equipment.

When the card is no longer needed, it is ejected either manually or automatically. Cards inserted upside down are ejected immediately.

The company offers standard readers with four bottom plate configurations and a top plate having up to 690 electrically insulated connecting points. Unit dimensions are 15 by 16 by 6 in.; weight is 36 lb. Specification bulletin BR-7A gives full description and schematic drawings. **Circle 453 on Reader Service Card.**

DELAY LINES

measure 4¼ x 4¼ x 1¼ in.

CONTROL ELECTRONICS CO., INC., 1925 New York Ave., Huntington Station, N. Y., offers a new series of miniature variable delay lines in a large selection of total delays and characteristic impedances.

Typical of this series is model V-203, which has a 0.5 μsec total delay and 580 ohm characteristic impedance. At full delay its rise time is 0.035 μsec and attenuation

0.5 db. The delay is selected by a 60-position shorting-type rotary switch. The shorting feature provides an intermediate delay of one-half step so that the resolution is one part in 120. The switch has been tested mechanically for a quarter-million cycles of operation with no signs of wear. Delays up to 10 μsec and impedance up to 5,000 ohms are possible. **Circle 454 on Reader Service Card.**

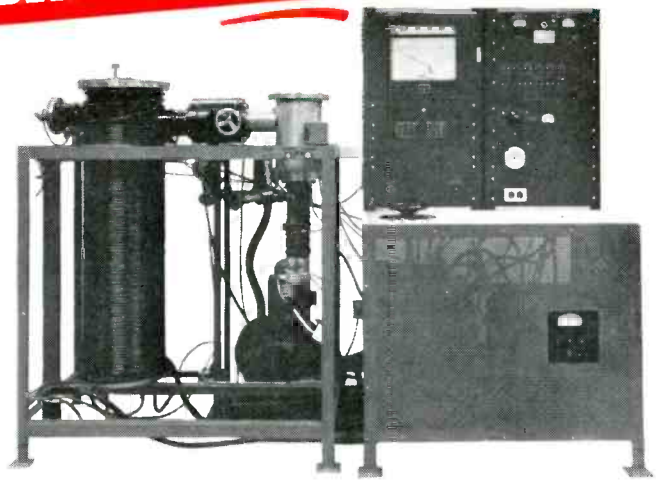
SAMPLING SWITCHES
high speed devices

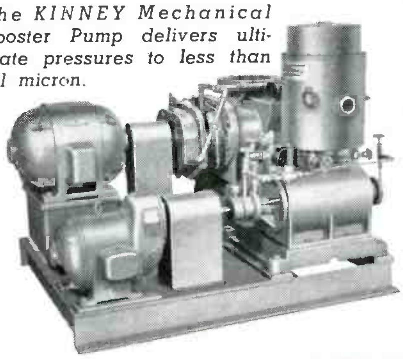
General Devices, Inc., P.O. Box 253, Princeton, N. J. announces a precision switch having miniature multipin connectors attached to cables of convenient length, designed for military and commercial applications.

Up to five poles with 60 shorting (make before break) channels or 30 nonshorting (break before make) channels per pole, the switch is equipped with the company's exclusive constant force perma brushes and lifetime semi-molded contact plate for long service free life. All poles are locked in precise phase relationship.

The special construction of the switch affords replacement of all brushes in a matter of minutes without force or phase adjustments. The cover plate is easily removed for inspection of the brushes and contacts. Both of the two rotors and all brushes may be replaced as a unit. The switch is easily adapted to a variety of motor drives and is equipped with a precision machined ball bearing output shaft. Approximate dimensions as shown are 3.488 in. in diameter by 3.480 in. in depth.

Typical applications include airborne and shipboard oscilloscope displays, stabilization of groups of





high-gain d-c amplifiers, error indicating systems, multichannel data systems and the like.

Current models include single or multiple pole, stacked, concentric, opposed, raised contact, segmented or printed circuit design. A brochure may be had upon request. **Circle 455 on Reader Service Card.**

FLAT-FACED CRT
small-sized, all glass

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass., has announced an improved version of the 3UP1, a small-sized, all-glass $1\frac{9}{16}$ in. by $2\frac{1}{8}$ in. rectangular flat-faced crt. A new two-piece bulb design permits the flat faceplate to have a uniform thickness which greatly improves this feature over the previously available tubes. Other features of the tube are a phosphor screen size of $1\frac{1}{8}$ in. by $1\frac{3}{4}$ in., electrostatic focus and deflection, $1\frac{9}{16}$ in. neck diameter, $7\frac{1}{2}$ in. tube length with a standard 12-pin base. For use as a display indicator, the 3UP1 can be made available with various screen colors and persistences. **Circle 456 on Reader Service Card.**

MINIATURE CHOPPER
has no moving parts

KEARFOTT CO., INC., Little Falls, N. J., announces immediate availability of an all-electronic chopper containing no moving parts, which for all practical purposes assures a minimum operating life of 5,000 hours.

Although used primarily as a d-c voltage into a-c voltage converter sensitive to the phase of the reference voltage it can be used to convert a-c into a d-c voltage.

Primary features include the following: zero phase shift, 180 deg dwell time; frequency range from 60 cps to 20 kc; unlimited life when properly applied; meets or exceeds the requirements of MIL-E-5272A; and standard 7-pin miniature socket plug-in base.

Characteristics of the No. 333058 chopper (used as modulator) are: reference power—6.3 v at 2 ma; load resistance—1,000 ohms to 1 megohm; load current—5 ma maximum; and d-c signal input—1 mv to 5 v. **Circle 457 on Reader Service Card.**

MEGOHMMETER
speeds production testing

KEITHLEY INSTRUMENTS, INC., 12415 Euclid Ave., Cleveland 6, Ohio. Many production and laboratory tests can be made faster and more accurately with the new model 510 megohmmeter. It measures six decades of resistance on a single six-inch mirror scale and has 5 to 10 times faster response than conventional ohmmeters.

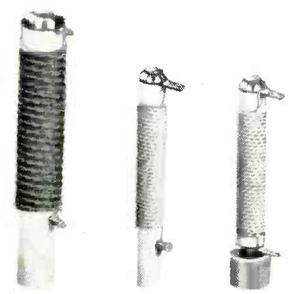
Typical uses are: rapid checking of insulation resistance of motor windings, capacitors, transformers, cables and many appliances; and measurements of surface and volume resistivity in insulating compounds. With its 5, 50 and

Circle 246 Readers Service Card

500 v test potentials, the instrument provides a selection of safe voltages for measuring all test samples and for checking voltage coefficients.

Features of the model 510 include elimination of range-switching, a linear scale with no compression at the high end, negligible drift, simple operation controls, and a guarded, completely shielded input.

Details are available in *Engineering Notes*, Vol. 5 No. 9. **Circle 458 on Reader Service Card.**



R-F CHOKES
for transmitting

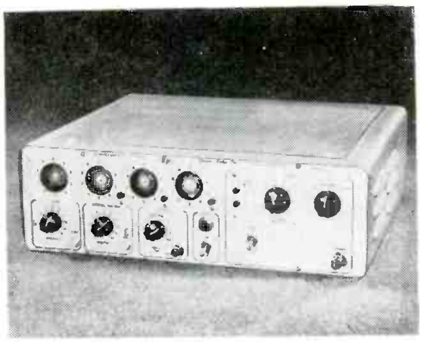
RAYPAR, INC., 7800 W. Addison St., Chicago 34, Ill., has introduced a new line of frequency-rated r-f choke coils. Six part numbers, RL-100, RL-101, RL-102, RL-110, RL-111, and RL-112, offer medium and high power units in three mounting types for use on frequencies between 3.5 and 31 mc, and 12 and 55 mc.

These application-designed chokes insure predictable performance on prescribed frequencies. Catalog bulletin RL 557-10 gives complete description. **Circle 459 on Reader Service Card.**

FREQUENCY INDICATOR
and counter

ELECTRO-PULSE, INC., 11861 Teale St., Culver City, Calif. A new solution to industrial counting and recurrence rate measurement problems, the model 7340C frequency indicator and counter is a low-cost reliable instrument easily operated by nontechnical personnel.

Advanced physical design fea-



tures printed wiring and modular construction, with snap-off top and bottom plates allowing full access for ease of maintenance.

The input signal (photocell, tachometer generator, or flowmeter) is counted during a known time base (0.1 sec, 1 sec, and 10 sec) and displayed.

A self-test switch position, for check of time bases and counters, is provided and the instrument may be used with an external time base. **Circle 460 on Reader Service Card.**

OCTAL SOCKET

for klystron tubes

GLOBE ELECTRICAL MFG. CO., 1729 West 134th St., Gardena, Calif. Assembly time can be reduced and rework eliminated by the use of a new moulded chassis mounted octal socket for the JAN-CRP-2K45 thermally tuned klystron tube. Self-aligning gold-plated contacts are flexibly mounted in slightly over-size orifices of a glass-filled diallyl phthalate socket body. The new socket provides accurate alignment and probe penetration in the waveguide mount which avoids any possibility of mismatch.

Design of the new klystron tube socket also eliminates both the need for insulated bushings and any contact shorting to the waveguide tube mount. Contact tabs are easily accessible for fast accurate circuit assembly. **Circle 461 on Reader Service Card.**

D-C POWER SUPPLY
voltage regulated

Opad Electric Co., 69 Murray St., New York 7, N. Y. Model 7M25 is a tubeless laboratory type regulated d-c power supply with a continuous duty rating of 0-150 v d-c at 2 amperes. Voltage regulation is held to ±1 percent and ripple is less than 0.03 percent of the average d-c at maximum output.

Extremely compact, the unit occupies only 8¾ in. of panel height. Depth behind the panel is 9 in.

Controls include a power switch, pilot light, indicating type line and load fuses, a 4½ in. 2-percent accurate d-c voltmeter and ammeter and a pair of 5-way insulated binding posts. An additional pair of output terminals are provided at the rear of the chassis.

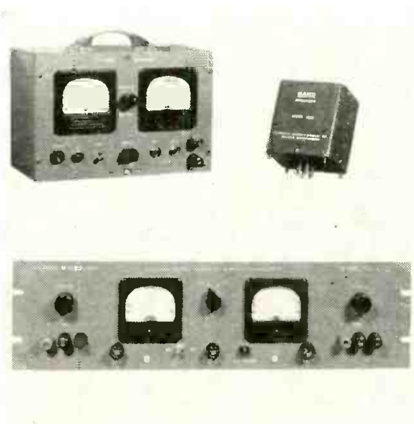
The equipment is also available in a cabinet for bench use. The bench unit is designated Model TM25B. **Circle 462 on Reader Service Card.**

TWIN TRIODES
for f-m tuner circuits

Radio Corp. of America, Harrison, N. J. The 6DT8 and 12DT8 are high-mu twin triodes of the 9-pin miniature type. They are intended for use as combined oscillator-mixer and r-f amplifier tubes in cathode-drive or grid-drive circuits of f-m tuners. The tubes which differ only in their heater voltage and current, may also be

used in a wide variety of applications in tv receivers.

The two units of each type are effectively isolated from each other by an internal shield having a separate base-pin terminal. This shielding arrangement enables the designer to achieve substantial reduction in antenna radiation and to obtain stable performance in h-f applications. In addition, the two cathodes in each type have separate base-pin terminals to provide the equipment designer with greater flexibility of circuit connectors. **Circle 463 on Reader Service Card.**



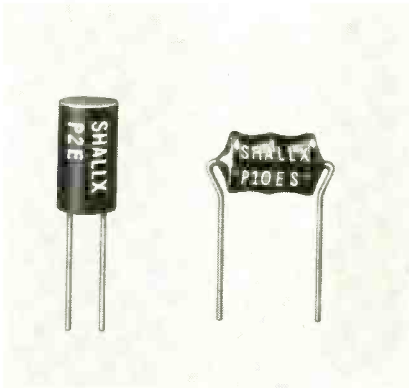
L-V POWER SUPPLIES
packaged for various uses

ELECTRONIC ASSEMBLY CO., INC., 5 Prescott St., Boston 19, Mass. Another source of transistorized power supplies is now available with the entry of the Minisource. These power supplies are semi-variable with nominal voltages ranging from 6 to 50 v and full load current ratings from 50 to 500 ma.

Designed for either 60 or 400

cycle operation, ripple and regulation factors are better than 0.5 percent; with temperature range of operation from −30 to +65 C. Units have passed shock and vibration tests.

The photograph shows how the units have been packaged for various design applications: for laboratory use, for incorporation with various types of instrumentation, and in special packaging for a variety of industry's needs. **Circle 464 on Reader Service Card.**

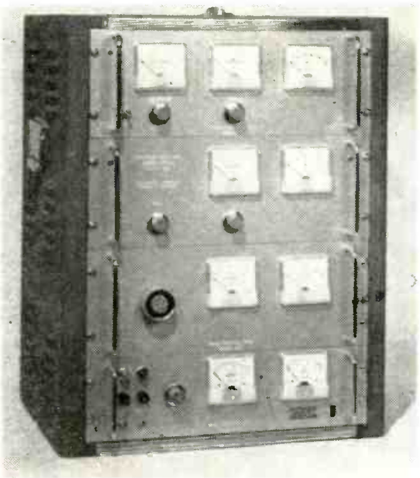


WIREWOUND RESISTORS
for printed circuits

SHALLCROSS MFG. CO., Collingdale, Pa. Two miniature precision wirewound resistors designed especially to meet the size and mounting requirements of printed circuits are available. Both are fixed noninductively wirewound types sealed in epoxy resin, and suitable for operation in ambients up to 125C. The distance between leads is closely controlled for manual or automatic insertion in printed circuit boards.

The P-2 resistor is only $\frac{27}{64}$ in. long and $\frac{13}{64}$in. in diameter. Termination is by means of two No. 20 axial leads at one end of the resistor. Resistances up to 200,000 ohms may be supplied to tolerance as close as 0.1 percent. The power rating for 1 percent tolerance has been tentatively established at 0.3 w for a 125 C ambient.

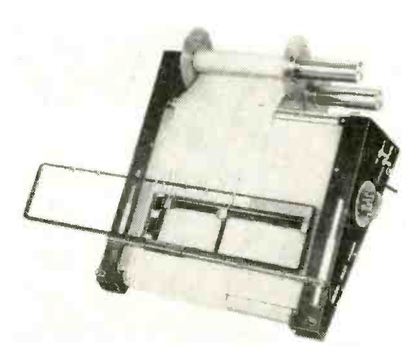
For higher resistance values the P10S resistor, $\frac{13}{32}$ in. long and $\frac{1}{4}$ in. diameter, is recommended. It has No. 20 axial wire leads at each end. The resistor will lie flat on a printed circuit board for vibration and shock resistance. Resistances up to 1 megohm may be supplied to tolerances as close as 0.1 percent. Power rating for 1 percent tolerance is 0.5 w for a 125 C ambient. **Circle 465 on Reader Service Card.**



TWT POWER SUPPLY

general purpose unit

WAVE PARTICLE CORP., P. O. Box 252 Menlo Park, Calif. Model 500 is a versatile general purpose traveling wave tube power supply which will operate most low-level and intermediate-level traveling wave tubes. Regulation is within 0.1 percent on the anode, helix and bias, within 1 percent on the solenoid and collector, within 1 percent line on the heater, and within 10 percent on the input. **Price is $2,200. Circle 466 on Reader Service Card.**

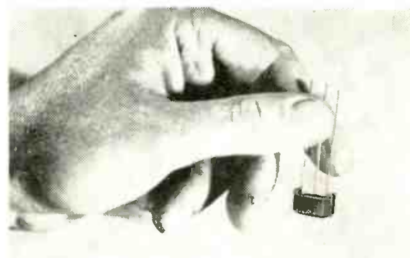


OSCILLOGRAM READER

priced at only $1,740

THE GERBER SCIENTIFIC INSTRUMENT CO., 162 State St., Hartford 3, Conn. Model R-1 data reader is a new, inexpensive oscillogram reader. It is capable of handling any number of linear or nonlinear channels, correcting for linear or nonlinear scale factors, as well as automatically correcting for the zero line location of each channel. Tracking, record damage and record tension problems have been virtually eliminated.

Features include film widths of 0-16 in.; 6-in. maximum roll diameter; expendable strawboard rolls which can be loaded right in the darkroom; designed for both reading and scanning; pushbutton operation forward and reverse from panel or with foot switch; special variable scale for linearizing all channels; markers provided for quick individual channel reference line location; vertical variable scale to count cycles, read frequencies, or space stations directly; X, Y type reading system, adjustable speed drive with variable transformer control, brake motor to stop instantly; cantilevered rolls for quick, easy loading. A bulletin is available. **Circle 467 on Reader Service Card.**

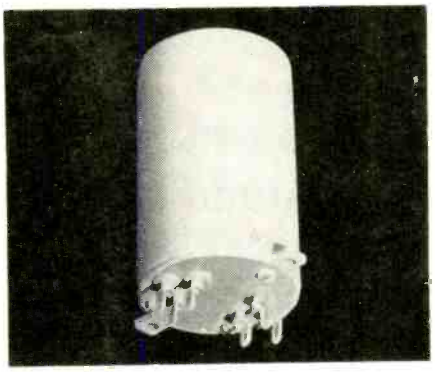


SELENIUM RECTIFIER
requires no filament supply

BRADLEY LABORATORIES, INC., New Haven, Conn., is manufacturing a new selenium rectifier, designed to replace a 6AL5 vacuum tube in tv circuits where the peak inverse voltage does not exceed 40 v.

Primary advantages of the new unit (model SE51K4D883) over the tube are that it does not require any filament supply, provides practically unlimited service life and will withstand current surges as high as 80 ma.

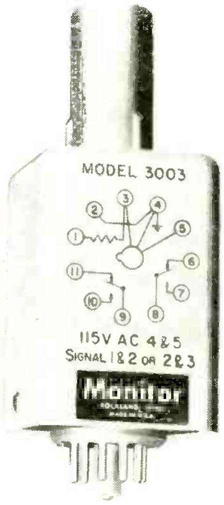
Specifications for the unit are: maximum applied voltage of 26 v rms; maximum d-c output voltage of 20 v; peak inverse voltage of 40 v. Rectifier plates are encapsulated in a molded phenolic housing whose low coefficient of expansion resists effects of changing temperatures. **Circle 468 on Reader Service Card.**



COMPONENTS OVEN
for capacitors and the like

BULOVA WATCH CO., Electronics Division, Woodside 77, N. Y., introduces their new AM-200 oven. The new oven is specifically designed for components such as capacitors, resistors and transistors.

The AM-200 oven cavity measures 1 in. in diameter by 2 in. in length. Temperature regulation is ±3 C over an ambient range of −55 C to +100 C. It is available with either plug-in or stud mountings. **Circle 469 on Reader Service Card.**



ELECTRONIC RELAY
multipurpose type

MONITOR CONTROLLER, 99 Grove St., Rockland, Mass. Model 3003 relay will operate with as much as ½ megohm in series with the contacts. Relay action is initiated by an external contact connected to the input circuit and the current through the contacts is less than 10 millionths ampere with 500,000 ohm contact resistance.

Operating time is less than 0.05 sec and the relay will drop out in 0.05 sec or less. Power amplification is about 12 million to one, as input power is less than 0.00005 w and the output circuit can carry up to 600 w. A cold cathode-type tube is used and power consumption is less than 2 w. The relay operates from 115 v, 50-60 cps power input. Contacts are dpdt with 5-ampere resistive load.

A few of the many delicate operations the model 3003 relay can perform are level control for filling containers, using a probe; temperature or pressure control where a mercury column or Bourdon tube contacts the relay; precision measurement at the anvils of a micrometer; control of oil refining apparatus and electronic sorting equipment. The relay lists at about $25. **Circle 470 on Reader Service Card.**

MULTIPLIER PHOTOTUBE

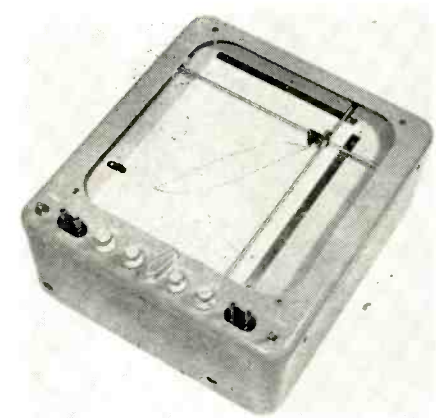
for scintillation counters

RADIO CORP. OF AMERICA, Harrison, N. J. The 7046 is a 14-stage head-on type of multiplier phototube intended for use in scintillation counters for the detection and measurement of nuclear radiation, and applications involving the measurement of low-level light sources.

The 7046 has fast response, high

current gain, high peak current capability and relative freedom from after-pulses. Its very small spread in electron transit time makes it particularly useful for fast coincidence scintillation counting.

Spectral response of the 7046 covers the range from about 2,500 to 6,500 angstroms, with maximum response occurring at approximately 4,200 angstroms. Design features are available on request. **Circle 471 on Reader Service Card.**



X-Y PLOTTER

with flat bed construction

MANDREL INDUSTRIAL INSTRUMENTS, division of Mandrel Industries, Inc., 5134 Glenmont Drive, Houston, Texas. The ER-90 X-Y plotter, with an input sensitivity as high as 1 mv per in., features a flat bed construction for full chart visibility and a slip-on pen plotting on standard 8½ in. by 11 in. paper. Reliable operation is insured by conventional chopper-stabilized amplifiers and standard 3-turn rebalance potentiometers in the null-seeking servo system plus a simplified cord drive system. The two axes are electrically independent.

Priced at $520, this recorder has a limit of errors better than 0.75 percent, and a repeatability better than 0.5 percent. **Circle 472 on Reader Service Card.**

BEAM POWER AMPLIFIER

with stacked construction

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y., is producing an audio beam power amplifier capable of maximum reliability in high ambient temperatures.

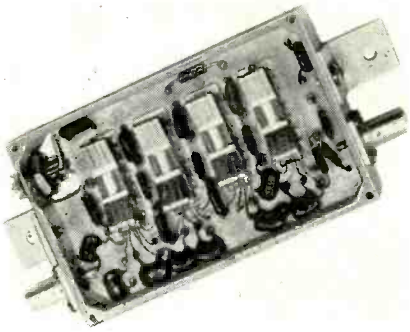
Designated type SN-2146B, the new tube, which makes use of the stacked ceramic construction, is capable of 4.5 w power output under class A conditions. Designed primarily for military equipment manufacturers the tube offers greater resistance to heat, shock, vibration, altitude and humidity than types hertofore available. **Circle 473 on Reader Service Card.**

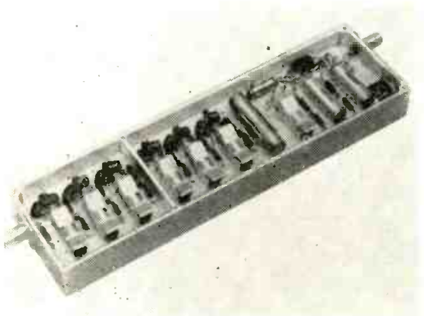
SYNCROVERTER CHOPPER
for specialty circuits

THE BRISTOL CO., Waterbury 20, Conn., has announced a new Syncroverter chopper with a center-tapped coil. This new chopper should prove useful in a wide variety of special driving circuit applications, such as flip-flop, push-pull, or pulsed type. It offers the same contact ratings and high degree of reliability in dry circuit applications as does the company's standard Syncroverter chopper.

As a result of this coil construction, the unit can also be used as a polar relay, when a biasing voltage is applied, or as a true differential relay, which operates at a given predetermined differential, rather than on a specific amperage value for either coil. Coil requirements vary according to application; typical applications require approximately 90 peak ampere-turns.

Ambient temperature limits for the new chopper are −65 to 125 C. The output wave form of the chopper is unaffected during severe shock and vibration. It is available in either the newly- introduced external-coil, low-noise version, or in the standard model. **Circle 474 on Reader Service Card.**



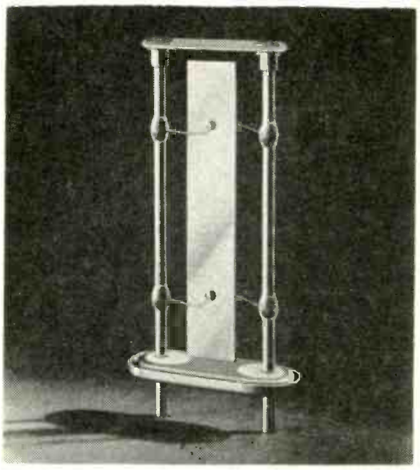


I-F AMPLIFIER
featuring fast recovery

LEL, INC., 380 Oak St., Copiague, L. I., N. Y., is in production on a new type of subminiature i-f preamplifier (model IF65) and main amplifier (model IF66) combination. Specifically designed for airborne use they are unique in their ability to detect 0.1 μsec r-f pulses at a −116 dbm level for a peak video pulse output of 125 v. Following a −16 dbm signal the combination will detect a −116 dbm signal within 0.9 μsec. **Circle 475 on Reader Service Card.**

COMPUTER ELEMENTS
transistorized, plug-ins

RANSOM RESEARCH, 323 W. Seventh St., San Pedro, Calif., has announced a line of computer elements for the design of industrial counting equipment, data processing equipment, logical control systems, digital systems and computer logic. They feature all transistor design, rapid design and construction, printed circuitry throughout, low power consumption, small space requirements and modular construction. **Circle 476 on Reader Service Card.**



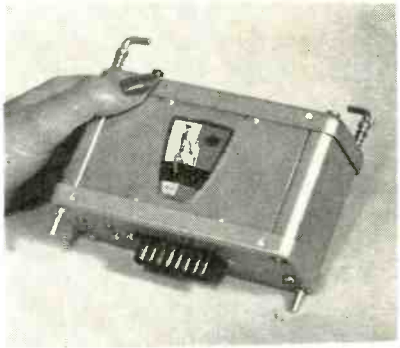
L-F CRYSTALS
meet MIL specs

REEVES-HOFFMAN DIV., Dynamics Corp. of America, Carlisle, Pa. These new low-frequency duplex crystal units are designed to provide accurate frequency control in the audio range of from 4 to 15 kc. Designated as type RH-8DP, they may be used in aircraft navigation equipment, telephone carrier systems, communication systems and test equipment. They are available in either standard 1½-in. HC-13/U metal holder, hermetically sealed, or in T6½ glass bulbs.

These crystals meet MIL C-3098 B specifications for shock, vibration, aging and moisture resistance. They are operable over a temperature range of −55 to +90 C with a stability of ±0.02 percent. **Circle 477 on Reader Service Card.**

LINEAR DEMODULATOR
designed for servo systems

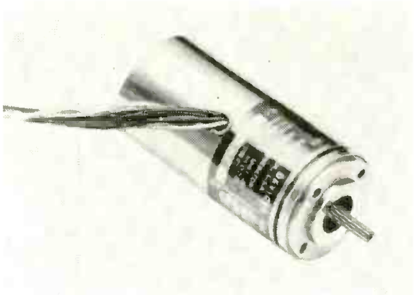
EMERSON ELECTRIC MFG. CO., Electronics and Avionics Div., Support Systems Laboratory, 8100 West Florissant Ave., St. Louis 21, Mo. Model IC-101 phase sensitive detector is a linear demodulator designed for high performance servo systems. Its principal feature is the combination of small time delay and low ripple component of



output. This particular model is designed for demodulating 400 cps carrier signals. Input signal range is from 0.025 to 15 v rms. The output ripple is less than 10 mv and the output impedance is 700 ohms.

Physically it is approximately 5 in. by 3 in. by 2 in. and weighs 15 oz. The PSD is mounted with "air-loc" fasteners to a mating Blue Ribbon connector which is supplied.

The basic circuit employed has been used by the company in many military applications such as the B-58 fire control system. Applications include recording instrumentation, servo detection, null indication and digiting. **Circle 478 on Reader Service Card.**



MOTOR TACHOMETER
new shorter version

EASTERN AIR DEVICES, INC., 385 Central Ave., Dover, N. H., has announced a shorter version of its size 11 motor tachometer. Shortened from 2.552 in. to 2.125 in., the new unit achieves improved electrical characteristics. This 115-v tachometer delivers 0.6 v per 1,000 rpm with 19 mv of total null. Lower nulls are readily available on request. Also of significance is the upper temperature rating of 150 C.

These units combine a high performance servo motor and a low inertia drag cup damping tachometer generator. They are available in a great many variations including voltage and power ratings aimed at transistor operation, special lead locations, the incorporation of precision gearheads which facilitate the mechanical design of servo systems, and adaptation to unusual environmental requirements.

The new improved modification of the size 11 motor tachometer meets Bureau of Ordance Mark 14 specifications. **Circle 479 on Reader Service Card.**

POWER SUPPLY

switching transistor type

ARNOLD MAGNETICS CORP., 4613 W. Jefferson Blvd., Los Angeles, Calif., has announced a 60-w switching transistor power supply that is regulated against both line and load variations simultaneously. Featured are small size and outstanding reliability.

The unit is used in aircraft, missile and commercial fields as a lightweight replacement for rotating equipment having 150 and 300 v d-c outputs. Bulletin 591-A is available. **Circle 480 on Reader Service Card.**

ELECTROMETER

vibrating capacitor type

NUCLEAR CORP. OF AMERICA, INC., 33-61 Crescent St., Long Island City 6, N. Y. The NUCOR vibrating capacitor electrometer is useful in measurement of direct currents to 10^{-16} amperes; resistances to 10^{-18} ohms. It features excellent zero stability (± 100 μv in any 12-hour period). Model 33B has an input resistance of 10^{-13} ohms. Model 33C's input resistance is 10^{-16} ohms. **Circle 481 on Reader Service Card.**

D-C AMMETER

in two range combinations

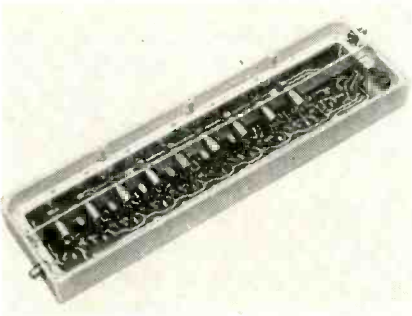
SENSITIVE RESEARCH INSTRUMENT CORP., New Rochelle, N. Y. Model

CHC is a direct reading heavy current d-c ammeter. It is available in two ranges: 0/1/5/10/20/50/100 amperes; and 0/1.5/3/7.5/15/30/75 amperes. Accuracy is 0.2 percent. Scale length is 6.3 in. Weight is 21 lb. Size is 16⅜ in. by 10½ in. by 8¾ in. high. Price is $750. Literature may be obtained on request. **Circle 482 on Reader Service Card.**

TINY TRANSFORMER

700 weigh less than 1 lb

GRAMER-HALLDORSON TRANSFORMER CORP., 2734 N. Pulaski Rd., Chicago 39, Ill., announces the release of the new Teenyformer, which is so small that it is completely hidden by the normal eraser on a lead-pencil. Designed for transistor applications, these transformers measure only 0.203 in. by 0.297 in. by 0.297 in. **Circle 483 on Reader Service Card.**



I-F AMPLIFIER

transistorized

LEL, INC., 380 Oak St., Copiague, L. I., N. Y., has introduced a new version of its series 80 transistorized i-f amplifiers. These units are now offered at frequencies up to 60 mc using either silicon or germanium transistors. Typical gain is 100 db, bandwidth 3 mc at 30 mc center frequency. Components are mounted on a printed circuit board which is supported in a cast aluminum frame. Electrical characteristics of the unit can be modified to meet specific application requirements. Reduced power, ruggedness and elimination of heat dissipation problems are some of the advantages obtained by their use in missile or radar systems. **Circle 484 on Reader Service Card.**

New Literature

Parabolic Reflectors. Andrew Corp., 363 E. 75th St., Chicago 19, Ill. Bulletin No. 8438 covers the company's heavy gage aluminum parabolic reflectors for experimental and special microwave work. Included are listings of diameters, focal lengths, type numbers and prices. **Circle 501 on Reader Service Card.**

Electromagnetic Flow Meters. Nuclear Corp. of America, Inc., 33-61 Crescent St., Long Island City 6, N. Y. Brochure 1200 is a six-page folder illustrating and describing the Magnaflow, a precision flow measuring instrument that converts, without inherent pressure drop, a liquid flow velocity instantly into a proportional voltage. Operating principles and specifications are given. **Circle 502 on Reader Service Card.**

Automatic Capacitance Bridge. Simmonds Aerocessories, Inc., Tarrytown, N. Y. Publication No. AD401-10 deals with the part No. 387011 automatic capacitance bridge designed for measuring aircraft fuel gage system capacitances. It contains information on applications, range, accuracy, power, mounting, dimensions and weight. Operating instructions are included. **Circle 503 on Reader Service Card.**

Precision Wire Wound Resistor. Eastern Precision Resistor Corp., 675 Barbey St., Brooklyn 7, N. Y., has available a brochure describing the Comp-U-Trim 113, a new adjustable precision wire wound resistor with a precise trimming pot imbedded within its body. The component described is ideally suited for computers, voltage dividers, computer integrating networks, summing networks, tuned circuits, variable RC networks and matched resistance networks. **Circle 504 on Reader Service Card.**

Pulse Circuit Components. CBC Electronics Co., Inc., 2601 North Howard St., Phildelphia 33, Pa. Bulletin No. 731 gives complete engineering data on miniature and subminiature pulse circuit components for radar, computers, and similar applications. Pulse transformers, packaged blocking oscillator circuits, and pulse circuit engineering kits are fully described with illustrations, dimensional data, and performance characteristics. Information formerly contained in bulletins BO and KA is brought up to date and condensed in two pages for quick reference. **Circle 505 on Reader Service Card.**

Electronic Lead and Hook-Up Wire. Belden Mfg. Co., P. O. Box 5070A, Chicago 80, Ill. Bulletin 8050 features the addition of Teflon insulated types E and EE, Mil Spec 16878-B hook-up wire to extend the company's wire and cable line. Illustrated and described are all Mil Spec wires made by the company for the electronic industry. **Circle 506 on Reader Service Card.**

H-V Power Supply. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio, has announced a new illustrated specification bulletin on the model 683 high-voltage power supply. Form 3000-7 "Victoreen Ultra-Stable Power Supply" covers principles of operation, gives suggested uses for the ultra-stable power supply, and lists detailed electrical and mechanical specifications. **Circle 507 on Reader Service Card.**

Data Reduction Systems. Fischer & Porter Co., Hatboro, Pa. Catalog 30A1200 is a six-page folder illustrating and describing the series 1200 industrial data logger and alarm scanner. Chief features of the system discussed include modular plug-in construction and flexible programming. **Circle 508 on Reader Service Card.**

Transistor Replacement Chart. Bendix Aviation Corp., Red Bank Division, Long Branch, N. J., has available copies of a new transistor replacement chart which gives information about the correct Bendix transistor to use when replacing weak or burned out transistors with Bendix units. Charts are available on request. **Circle 509 Reader Service Card.**

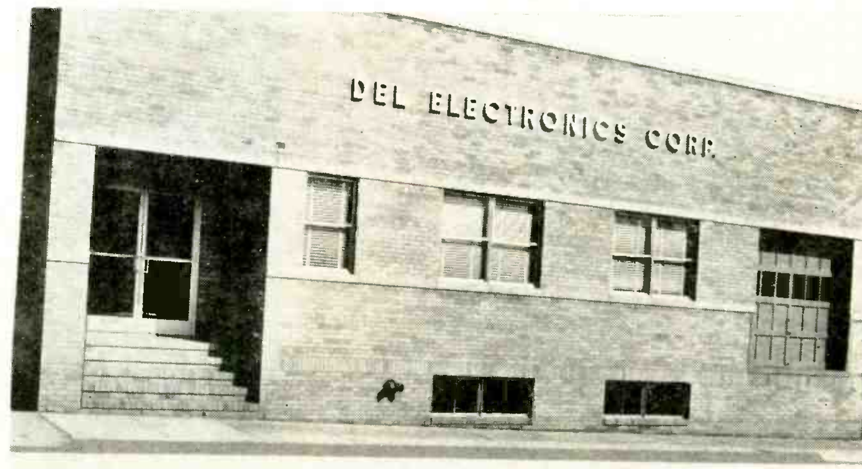
Edited by WILLIAM P. O'BRIEN

Electronics manufacturers expand plants and facilities by acquisition, leases or new construction. Top engineers and executives in the industry are promoted and move to new responsibilities. IRE names top award winners

Mt. Vernon Firm Quintuples Facilities

DEL ELECTRONICS CORP. has moved its operations to a new two story building at 521 Homestead Ave., Mt. Vernon, N. Y. The company is engaged in the design and manufacture of h-v power supplies and transformers to 200 kv up to 20 kva.

The new building provides the company with five times its former production facilities. Space has been allotted for research and development work and for a classified area for use in connection with an access permit recently granted the company by the Atomic Energy Commission.



Del Electronics Corporation's new quarters

Westinghouse Expands with Microwave Industry

Westinghouse plant expansion in Maryland

THE carrier-microwave department of Westinghouse Electric Corp. has expanded facilities in Halethorpe, Md., by constructing a new, modern office building adjacent to the manufacturing plant.

Many processes such as coil winding, filter making, and wiring, formerly accomplished elsewhere, are now done within the plant. Future plans for the shop include facilities for internal production of fabricated parts requirements.

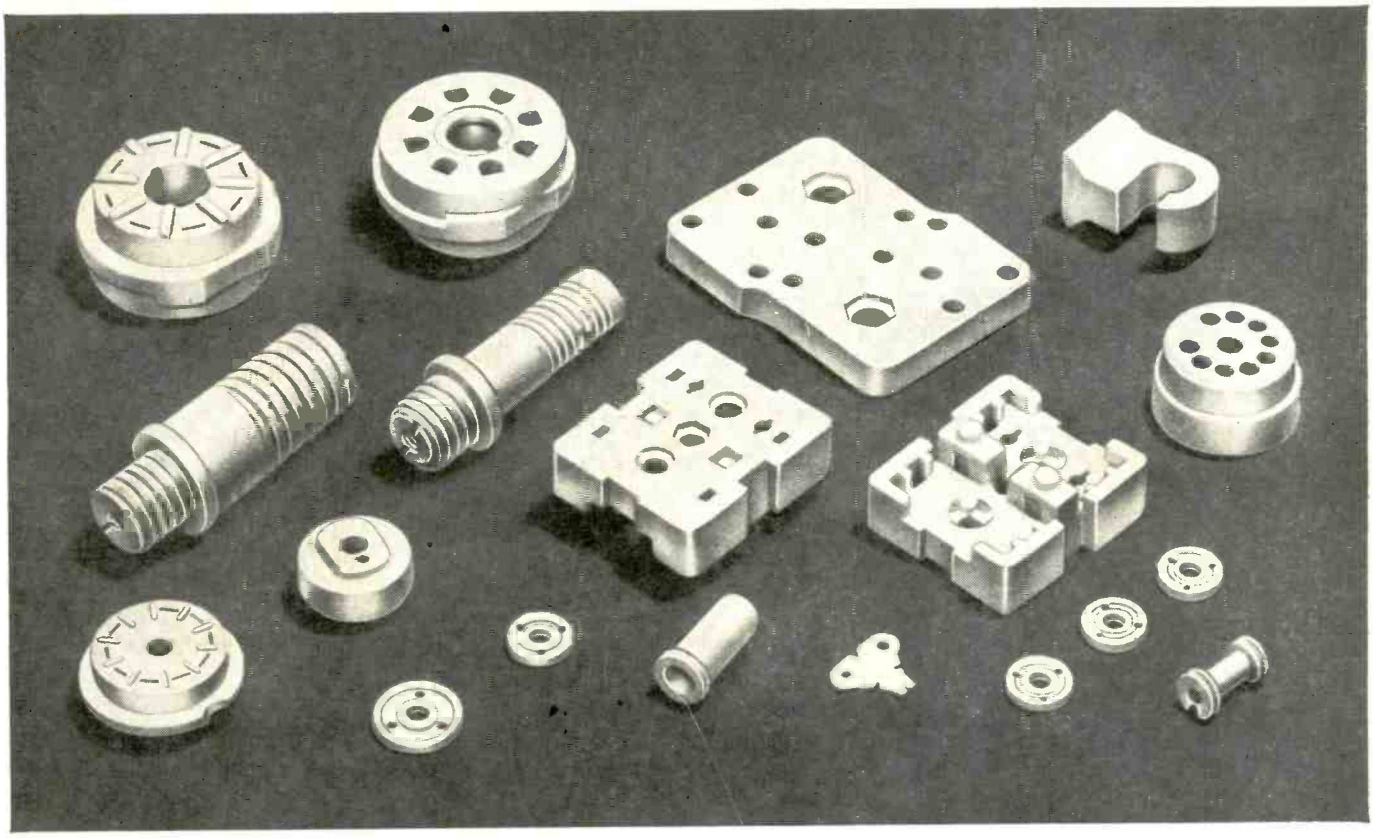
Nems-Clarke, Inc. Joins Vitro Corp.

As of September 1, Nems-Clarke, Inc., electronic manufacturers in Silver Springs, Md., became an operating division of Vitro Corp. of America. The company now is known as Nems-Clarke Co. Allen S. Clarke remains as president of the company. Ralph E. Harmon is vice president.

Allen Clarke has stated that the new affiliation will result in expanded manufacturing and deve

No. 1 solution to dielectric problems–

PRECISION STEATITE by GENERAL CERAMICS



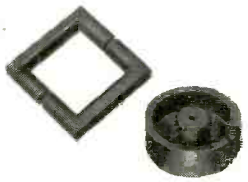
G-C steatite solves all of these problems . . . economically

- Widely varying ambient temperature
- Severe mechanical or thermal shock
- Permanence of dimensional accuracy
- Intricate shapes to close tolerance
- Efficient compaction of physical size
- Low electrical loss at high frequency
- High dielectric and mechanical strength
- Extreme immunity to environmental conditions

G-C electrical ceramics are news! Offering a far higher degree of dimensional accuracy than ever before possible, *precision* dielectrics provide a far greater design latitude in all types of electronic and electrical equipment. These new high accuracy ceramics are another example of General Ceramics progressive manufacture . . . better products at lower cost through advanced research and improved methods of production. Why not ask for all the facts on *precision* electrical ceramics, now! Write General Ceramics Corporation, Keasbey, New Jersey, Dept. E.

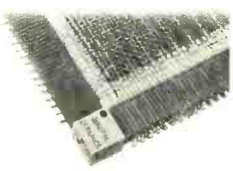
GENERAL CERAMICS

Industrial Ceramics for Industrial Progress . . . Since 1906

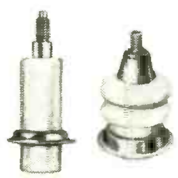


FERRAMIC CORES

FERRAMIC MAGNETIC CORES



MAGNETIC MEMORY PLANES



"ADVAC" HIGH TEMPERATURE SEALS

SOLDERSEAL TERMINALS

Circle 286 Readers Service Card

ment activity. A reorganization of the development laboratory is in process to broaden the base of the company's proprietary products.

While some changes in personnel will be necessary in order to accomplish this reorganization, such changes will be kept to a minimum. The company expects to greatly expand its development activity for the creation of new products in the fields of telemetry, medical electronics, photographic instrumentation, and communications equipment.

RIC Expands Engineering Facilities

H. A. BOGUSLAWSKI, vice president-engineering-sales of Rocke International Corp., New York, N. Y., has announced the following appointment: Baron C. de Beer is the new chief engineer, broadcast and communications. Before joining RIC he was associated with the Rediffusion group of companies (England) for a number of years and held the appointment of assistant chief engineer of the Jamaica Broadcasting Co. Prior to that he served for ten years in the communications branch of the RAF and held a commission as a Signal's officer. In this new capacity he will be responsible for the technical supervision and administration of both the broadcast and communications departments.

Maxwell C. Zeile moves to field engineering manager; in this capacity he will tour the overseas branches and agents making himself available for technical and commercial consultations. Before joining RIC in 1954, Zeile already had many years of experience in communications techniques. He also was chief of Instrument Laboratories for ISE in Argentina.

Electron Corporation Names Vice-President

FRANK BISCARDI has been named vice-president of the Electron Corp., a subsidiary of Ling Industries, Inc. He has been production manager of the corporation, which develops and manufactures closed-circuit tv cameras, since November 1956.

He was formerly electronics production engineer with General Electrodynamics Corp. in Garland, working on the development of the Vidicon type camera tube, and in charge of all phases of cathode-ray-tube production for Haydu Bros. of New Jersey, a subsidiary of Burroughs Business Machines.

IRE Names Top Award Winners

ALBERT W. HULL, consultant to the GE Research Laboratory, and W. R. G. Baker, vice-president of GE, were among those named to receive the 1958 awards of the IRE.

Dr. Hull was named to receive the Medal of Honor, the highest technical award in the radio-electronics field "for outstanding scientific achievement and pioneering inventions and development in the field of electron tubes."

The Founders Award, bestowed only on special occasions to outstanding leaders in communica-

Board of Directors and Officers of EIA 1957-58

A. W. Hull

W. R. G. Baker

tions and electronics, will be given to Dr. Baker "for outstanding contributions to the radio engineering profession through wise and courageous leadership in the planning and administration of technical developments which have greatly increased the impact of electronics on the public welfare."

Recipient of the Morris Liebmann Memorial Prize will be Edward L. Ginzton, Professor of Applied Physics and Electrical Engineering, Stanford U., "for his creative contribution to the generation and useful application of high energy at microwave frequencies."

Edward W. Allen, Jr., chief engineer of the FCC, was named to receive the Harry Diamond Memorial Award "for his technical and administrative contributions in the field of radio spectrum utilization."

The Vladimir K. Zworykin, Television Prize will go to Charles P. Ginsburg, Ampex Corp., Redwood City, Calif., "for pioneering contributions to the development of video magnetic recording."

Norden-Ketay Divisions Get New Buildings

RECENTLY Norden-Ketay's two Long Island divisions, Precision Components Division and Gyromechanisms Division, completed their moves to new, modern quarters.

A 31,000-sq ft addition to the corporation's Precision Components Division at Commack represents a 36-percent increase to that division and brings total area to over 85,000 sq ft.

Gyromechanisms Division moves to a modern, new 17,000 sq ft building at Huntington Station.

The addition to Precision Components Div., and the new Gyromechanisms Plant will replace temporary or geographically separated facilities and will consolidate the operations of each division in fully integrated plants.

Norden-Ketay, with headquarters in Stamford, Conn., has other divisions in Milford, Conn., White Plains, N. Y., Miami, Fla., and Gardena, Calif.

Missile Test Chief Named at Farnsworth

LAWRENCE G. HAGGERTY, president of Farnsworth Electronics Co., has announced that Vernon L. Haag has joined the firm as vice president in charge of missile test equipment.

Farnsworth, a division of IT&T Corp., is a major contractor supplying test equipment for the Bomarc missile system and other development projects in the U. S. Government's program of national defense.

Haag comes to Farnsworth from

the Gray Mfg. Corp. of Hartford, Conn., where for the past ten years he has been vice-president in charge of operations in the fields of engineering and manufacturing. He also was a member of the board of directors at Gray.

Previously, Haag held top management and chief engineering positions with Aerovox Corp., Sperry Gyroscope, Crosley Radio Corp., and Elgin Watch Co.

Brown Moves Up at RCA

G. H. Brown

APPOINTMENT of George H. Brown as chief engineer, Industrial Electronic Products, RCA, has been announced.

Since last January, Dr. Brown has served as chief engineer of the former RCA Commercial Electronic Products unit, which has been incorporated in the new Industrial Electronic Products organization.

In his new capacity, he will have engineering responsibility for all RCA industrial equipment and systems, including broadcast, communications, and industrial electronic equipment, and computer, telecommunication, and industrial control systems.

Acoustica Associates Inc. Takes New Quarters

ON SEPTEMBER 1, Acoustica Associates, Inc. — designers and manufacturers of ultrasonic cleaning units, ultrasonic soldering guns, liquid level sensors, and entire cleaning systems for industry—moved from Glenwood Landing to new and larger quarters at 26 Windsor Ave., Mineola, L. I., N. Y.

The greatly expanded facilities will enable Acoustica to meet the increased demand for their products.

Narda Promotes Robertson

Donald R. Robertson

PROMOTION of Donald R. Robertson to manager of The Narda Microwave Corporation's electrical assembly plant, Mineola, N. Y., has been announced. He has been plant manager of Kama Instrument Corp., Mineola, N. Y., since its acquisition by Narda in 1956, and previously was Kama's chief engineer. In his new capacity he will be responsible for both the planning and supervision of all Narda's electrical assembly operations.

Three Electronic Firms Merge

FORMATION of a new manufacturer of electrical and electronic components, known as National-El Ray Co., North Hollywood, Calif., has been announced. The new corporation combines the facilities and personnel of three existing companies: El Ray Motor Co., manufacturers of miniature a-c and d-c motors; Valco Engineering Co., makers of ceramic capacitors; and National Electronics Corp., manufacturers of filters, transformers and electronic heating elements for aircraft and missiles.

Two plants occupied by the predecessor companies have been renovated and new production techniques, the latest testing equipment for quality control and inspection, and general organization of production line layouts have been completed.

The two plants are located at 11747 and 11845 Vose St. in North Hollywood.

Daystrom Systems Builds New Laboratory

CONSTRUCTION has begun on a modern electronic laboratory in La Jolla, Calif., by Daystrom Systems, for research and development in the field of advanced automation.

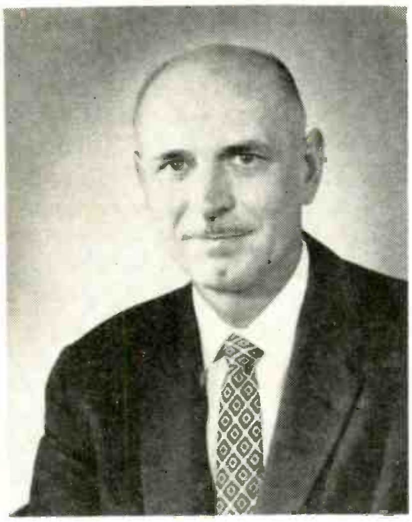
Daystrom Systems, division of Daystrom, Inc., is expected to move from present quarters in La Jolla to the first section of some 30,000 sq ft by the end of this year or early 1958.

The systems division is engaged in the advanced development of complete electronic systems for automatic control and data handling in the industrial, military and scientific fields.

Exec V-P Elected at AIL

ELECTION of Donald M. Miller, as executive vice-president of Airborne Instruments Laboratory, Mineola, N. Y., has been announced. He has been v-p in charge of the Engineering and Production Division of the company since 1946. AIL, organized in 1945, is active as a developer and manufacturer of military radar and electronics equipment as well as aviation instrumentation and industrial automation equipment.

In his new position Miller will, under the direction of Hector R. Skifter, president of AIL, assume responsibility for the overall direction and control of the company's



Donald M. Miller

operations. He will coordinate the activities of the various operating divisions and will be responsible for obtaining results in keeping with the company's policies and objectives.

Lynch Carrier Names Chief Network Engineer

LYNCH CARRIER SYSTEMS INC., manufacturers of telephone and telegraph carrier equipment, recently announced the appointment of Arie Slikkerveer, as chief network engineer, with responsibility for theoretical engineering design. He has been with the Lynch Co. for the past eight years in various responsible engineering capacities.

Airpax Appoints Chief Engineer

CLIFF N. WILLIAMSON was recently named chief engineer of the Central Engineering Division, Airpax Products Co., Fort Lauderdale, Fla. Williamson, who transferred to the Florida plant June 1, has supervised development of the company's line of Magmeter frequency detectors at the Middle River Plant in Baltimore, Md. Prior to that, he was senior vibrator engineer at the Cambridge Division, Cambridge, Md. He has carried out special studies of transistor power converters and development of magnetic components.

Before joining Airpax, William-

Cliff N. Williamson

son was vibrator engineer for Cornell-Dubilier and earlier for Radiart. From 1940 to 1946 he was with the Navy Dept. at Washington, D. C., with the Sonar Program.

Topp Establishes Communications Division

H. J. PETERSEN, president, Topp Mfg. Co., Los Angeles, A Division of Topp Industries, Inc., Beverly Hills, Calif., has announced establishment of a new Communications Division. He also announced that an initial contract in excess of one million dollars has been awarded the division by the CAA for ground-station omnirange equipment.

The new section will concentrate on the design and manufacture of communication and navigation devices for airline, business and private aircraft; also commercial ground station traffic control equipment.

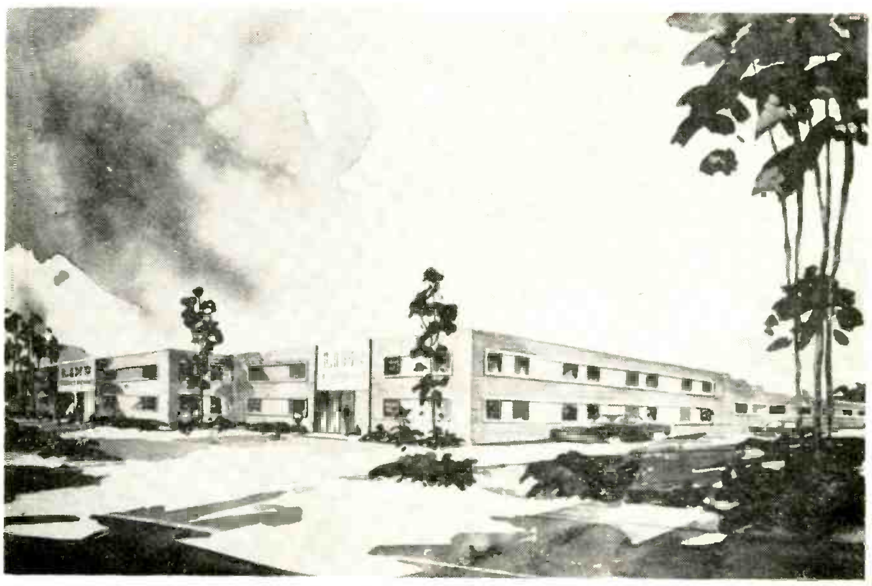
The new division will be housed in Topp's Plant No. 3 at 4949 W. 104th St., Los Angeles. The building, containing 5,400 sq ft of floor space, was leased by Topp less than a year ago to provide the firm with

New Plant for Ling Announced

LING ELECTRONICS, INC. has completed plans for expansion into a second, new plant in Los Angeles. The new buildings, located on a 150,000 sq ft site in Culver City will house administrative, engineering and sales as well as additional manufacturing facilities.

Ling Electronics specializes in the design and manufacture of high-power electronic equipment, including electronically-driven random and sine wave vibration testing systems used in missile, jet and special industrial testing; radio transmitters, and sonar and ultrasonic generators.

Special emphasis in the new building has been placed on engineering accommodations.



Ling's new quarters will look like this

expanded facilities for increased production.

Magnetic Core Moves

JOHN C. WEBB, president, Magnetic Core Corp., has announced the move of this company's general and executive offices from Ossining, N. Y., to their expanded manufacturing plant, John and Lawrence St., New Windsor, Newburgh, N. Y.

For many years this company has been a specialist in the manufacture of electronic powder metallurging.

IRE Establishes New Award

AN AWARD to be known as the Scott Helt Memorial Award has been established by the Administrative Committee of the Professional Group on Broadcast Transmission Systems of the IRE. This is the first Professional Group Award. It will be presented annually for the best paper published in the "Transactions" of the Group.

Scott Helt had been active in radio broadcasting and television for a period of 32 years until his untimely death in 1956. His last post was as patent administrator at Allen B. DuMont Laboratories, Inc.

Busse Joins Rheem Electronics

CLIFFORD A. BUSSE has been appointed engineering manager of the Electronic Division of the Rheem Mfg. Co., Rivera, Calif.

Prior to joining Rheem Electronics, Busse was with Farnsworth Electronics Co., a division of IT&T, where he served for six years in various management-technical capacities and most recently as assistant manager and chief engineer—missile test equipment.

Before his association with Farnsworth his experience included development work on industrial and broadcast equipment with

Clifford A. Busse

the E. F. Johnson Co. of Waseca, Minn., where he directed the design and development of transmitting components, high power r-f components, induction heating equipment and antenna systems.

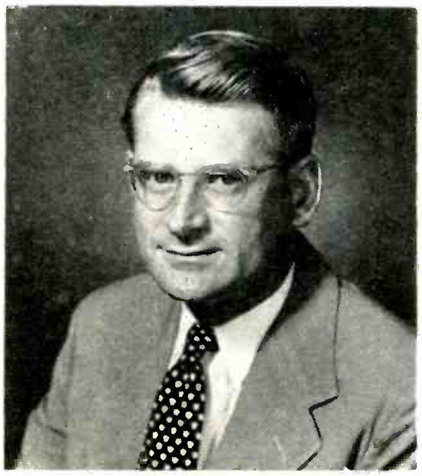
Jobbins Adds to Its Facilities

JOBBINS ELECTRONIC ENTERPRISES, Menlo Park, Calif., has recently announced an addition to its present facilities. The expansion will more than double its existing floor space and will alleviate a working space problem created by the organization's rapid growth.

The company has been manufacturing transformers, chokes, current and voltage regulated power supplies, coils, solenoids and electromagnets. The new addition allows it to expand its production capabilities.

USNOL Names Husten Fuze Dept. Head

ANNOUNCEMENT has been made of the appointment of Benjamin F. Husten as Head of the Fuze Department of the U. S. Naval Ordnance Laboratory, Corona. A government employee since 1938, Husten spent many years with the National Bureau of Standards, where he worked on the design of electronic devices for combustion research. Later, while engaged in research and development on mi-



Benjamin F. Husten

crowave frequency standards, he worked on the development of the first atomic clock and shares credit for its invention.

Husten has been at the Corona laboratory since 1951, working in both missile guidance and fuze development. In his new position, he will be responsible for guided missile fuze research, development, test, evaluation, and safety certification, as well as technical direction and contract administration for the Navy guided missile fuze research and development program.

Relay Company Formed

A NEW company, Reltron Corp., has recently been organized in Newton, Mass., to manufacture high-temperature subminiature relays. The company's relays are reliably operable to 250 C.

Meridian Metalcraft Sets Up New Section

C. W. PETERSON, President of Meridian Metalcraft, Inc., Whittier, Calif., has announced that the waveguide component manufacturing company recently set up a new and separate production test section. This has become necessary because of an increasing level of production test activity on commercial and military lightweight magnesium microwave devices.

Heretofore, production test work has been a part of the engineering department, responsible for both

R & D microwave work and production testing.

The current shift of production test function responsibilities, creating the new section under the quality Control Department, is part of a plant-wide reorganization and overall expansion.

Hahn Moves To Sales

Richard Hahn

APPOINTMENT of Richard Hahn as assistant sales manager—components, of The Victoreen Instrument Co. has been announced.

Hahn was previously associated with the Clevite Center of the Clevite Corp., Cleveland, Ohio, as an electronics engineer. Prior to this, he was a member of the research staff at Case Institute of Technology serving in government research on USAF projects.

West Coast Firm Builds $1 Million Plant

TEKTRONIX, INC., Portland, Ore., manufacturer of cathode-ray oscilloscopes, is building a new $1 million plant in a major expansion move.

Some operations will be moved from the firm's present plant near Beaverton, Ore., but both plants will continue to be operated, according to William Webber, vice-president.

The new plant is to be a modular-type structure of five units of 21,-

electronics BUYERS' GUIDE REVISIONS

1957-1958 Issue

CORRECTIONS:

Revised and corrected company listings under GLASS BONDED MICA. Use this list for sources in obtaining GLASS BONDED MICA.

ALLIED PLASTICS SUPPLY CORP., 75 Cliff St., New York 38, N. Y. ADV. PG. 247.

ELECTRONIC MECHANICS, INC., 101 Clifton Blvd., Clifton, N. J. ADV. PG. 508.

General Electric Co., Plastics Dept., Taunton, Mass.

Minerals & Insulation Co., 53 Central Ave., Rochelle Park, N. J.

MYCALEX CORPORATION OF AMERICA, 125 Clifton Blvd., Clifton, N. J. ADV. PG. 140, 141.

RELIANCE MICA CO., 341 39th St., Brooklyn, N. Y. ADV. PG. 695.

DYNAMOTORS

Advertising Page number for CONTINENTAL ELECTRIC CO., INC., 334 Ferry St., Newark 5, N. J. should be 557.

ADDITIONS:

COMMUNICATION SYSTEMS

3. Carrier Current
7. Microwave

Lenkurt Electric Co., Inc., 1105 County Rd., San Carlos, Calif.

PLATES, NAME—*Metal or Plastic*

CANADIAN RADIUM & URANIUM CORP., 630 Fifth Ave., New York 20, N. Y. ADV. PG. 665.

REGISTERS—*Shift*

EPSCO, INCORPORATED, 588 Commonwealth Ave., Boston 15, Mass. ADV. PG. 233-235.

SHUNTS—*Meter*

Ram Meter, Inc., 1100 Hilton Rd., Ferndale, Detroit 20, Mich.

WIRE—*Teflon Insulated*

TENSOLITE INSULATED WIRE CO., INC., 190 Main St., Tarrytown, N. Y. ADV. PG. 261-264.

DELETIONS:

CONTACTORS

FARMER ELECTRIC PRODUCTS CO., INC., 2300 Washington St., Newton Lower Falls 62, Mass. ADV. PG. 546.

FERRITES

COLUMBIAN CARBON CO., MAPICO COLOR UNIT, 380 Madison Ave., New York 17, N. Y. ADV. PG. 667.

000 sq ft each. They are rising in a 300-acre industrial park being developed by the Tektronix Employes Retirement fund. The firm recently completed a 32,000 sq ft warehouse in the park.

Volkert Forms Division in Pa.

FORMATION of a division, to be known as Vidmar, Inc., to produce drawer-type metal storage cabinets for industry, has been announced by Volkert Stampings, Inc., Queens Village, N. Y., manufacturer of precision metal stampings for the electronics industry.

Vidmar will occupy a new 44,000 sq ft plant in Williamsport, Pa., next year. The building is expected to be completed by March 1958, with production operations scheduled to begin two months later.

The Queens Village stampings operation will continue without change under its present management.

Burroughs Names Baird

APPOINTMENT of George A. Baird to the new post of associate director of engineering, responsible for engineering coordination of all commercial products manufactured by Burroughs Corp., has been announced.

Baird joined Burroughs in 1949

George A. Baird

at its Paoli, Pa., Research Center as a research associate. He became a project engineer in 1952 and was appointed manager of the Center's electromechanisms department in 1955, the post he held prior to his latest appointment.

Before joining Burroughs, Baird was a research assistant at the University of Pa., and a test engineer with GE Co.

Arizona U. Appoints EE Prof

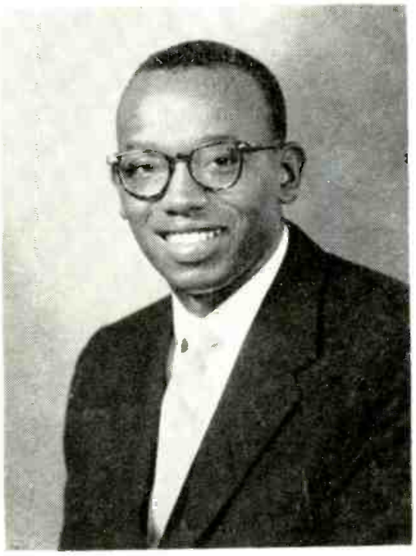
THE University of Arizona, Tucson, Arizona, has announced the appointment of Granino A. Korn as a professor of electrical engineering. Dr. Korn was previously active as a staff engineer, Military Operations Research Division, Lockheed Aircraft Corp., and as a consultant under his own name. He is co-author of "Electronic Analog Computers" and of a number of articles in engineering handbooks.

IRC Announces Recent Appointments

INTERNATIONAL RESISTANCE Co., Philadelphia, announces the recent appointment of Henry Schumer to chief engineer of its Asheville, N. C. plant. James Wilkes has been appointed manager, quality control, of the Philadelphia plant.

Schumer joined IRC in 1953 and

Henry Schumer



James Wilkes

has since held several positions within the quality control department, most recent being manager, quality control. Previously he had been associated with the Sonotone Corp.

Wilkes, who joined IRC in 1950, has also had considerable experience in the field of quality control. Prior to joining IRC, he was associated with Dumont Television.

Smith Enters Factory Rep Field

MYRON R. SMITH, recently resigned from his position as staff engineer with the Seattle Development Laboratory of Minneapolis-Honeywell Regulator Co., after 13 years in various engineering positions in Minneapolis and Seattle. Previously he was with the Collins Radio Co. of Cedar Rapids, Iowa, for nine years.

Smith has now opened an office to serve the Pacific Northwest as a factory representative. He is located at 4524 Roosevelt Way, Seattle 5, Wash.

Knopp Inc. Moves Into New Building

KNOPP INC., of Oakland, Calif., has moved into a new factory with four times the productive capacity, it has been announced by Harold P. Knopp, President. The new location is 1307 66th St., Oakland 8, Calif.

Founded almost 30 years ago by the late Otto A. Knopp, inventor, Knopp Inc. are manufacturers of high-precision electrical-testing devices and laboratory apparatus.

Hadrick Joins Simpson

Frank Hadrick

SIMPSON ELECTRIC CO., Chicago, Ill., has added Frank Hadrick to its engineering staff as chief field engineer (test equipment). Formerly chief tv field engineer for Admiral Corp., he was instrumental in developing their color tv training program.

In his new position, he will play an integral part in the design and development of the company's test equipment and will be available for consultation concerning tv and other electronic testing problems.

Core Measurements Man Joins G-L Electronics

JAMES R. JAQUET, an authority in the field of tape wound core measurements, recently joined the engineering staff of G-L Electronics, 2921 Admiral Wilson Blvd., Camden, N. J. In this new post he will be responsible for the company's measurement program on tape wound cores and bobbin cores.

Jaquet spent several years with Westinghouse Electric, where he concentrated on tape wound core measurements and magnetic component design. He is a member of the Working Group on Core Matching and Grading of the AIEE, and of Subcommittee 8.3.1 on Methods of Measurements of Bobbin Cores of the IRE.

AMF R&D Director Named

Thomas P. Evans

THOMAS P. EVANS has been appointed director of research and development of American Machine & Foundry Co. Evans joined AMF in 1951 as chief systems engineer, electrical. In 1952 he was appointed chief electrical engineer; in 1953, section manager of AMF's General Engineering Laboratories at Greenwich, Conn., and in 1954, technical director of the Laboratories. He was made deputy director of research and development in September 1955.

Electronic Associates Opens Overseas Operation

BELGIAN Minister of Foreign Trade, Henri Fayat, and C. L. Adamson, vice-president of Electronic Associates Inc., Long Branch, N. J., recently officially opened the U. S. firm's first overseas operation, the European Computation Center in Brussels.

The Center is equipped with two expanded analog computer systems and provides education to engineers in analog computer techniques, consultation service and rental time on the Center's machinery. It is staffed by qualified application engineers who specialize in problem analysis, programming, computer operation and solution evaluation.

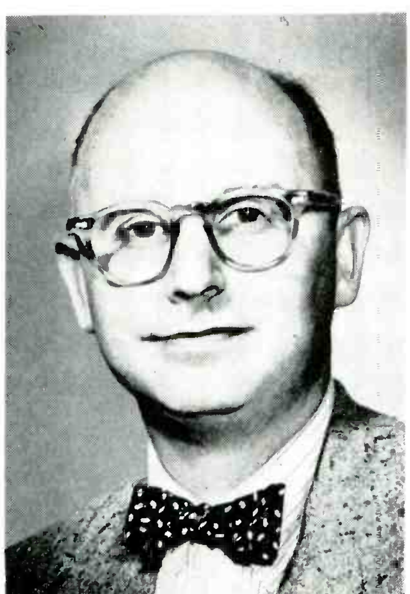
The European Computation Center will be directed by Dr. Bernard Murphy, a graduate of the University of Liverpool.

Lynch Carrier Systems Promotes Garzoli

FULVIO F. GARZOLI, who for the past several years has been a project engineer with Lynch Carrier Systems Inc., San Francisco, Calif., manufacturers of telephone and telegraph carrier equipment, has recently been appointed to the position of chief design engineer. In addition to telephone equipment design, F. F. Garzoli has worked in the field of aerial camera control systems and aerial navigational equipment design.

Davis Appointed Asst. Chief Engr. for Systems

BJ ELECTRONICS, Santa Ana, Calif., has named Raymond Davis as assistant chief engineer for Systems. He will also serve as staff assistant to John R. Harkness, vice presi-



Raymond Davis

dent and general manager, with responsibility for new product planning.

Davis joins the Borg-Warner electronic center following two years with Ramo-Wooldridge Corp., as a member of the technical staff, computer systems division.

Narda Acquires Two New Buildings

THE NARDA MICROWAVE CORP., Mineola, N. Y., has acquired two new buildings in the vicinity of the present plant at 160 Herricks Road, as a part of a general expansion program in all areas of the company's operations.

Transfer of manufacturing facilities, including electronics, assembly and production testing, into the first of the new buildings has been completed. This plant, containing approximately 6,500 sq. ft., will also house a new engineering laboratory.

Narda manufactures a complete line of coaxial and waveguide test instruments for microwave and uhf equipment.

Miller Joins Delco

DR. ROBERT FRANK MILLER, a former member of the faculty at

R. F. Miller

the U. of Wisconsin electrical engineering school, has joined the Delco Radio Division at Kokomo, Ind., as a research engineer in the Semiconductor Research and Engineering Dept.

Ranger Receives SMPTE Warner Award

COL. RICHARD H. RANGER, president of Rangertone, Inc., Newark, N. J., was recently chosen by the SMPTE to receive its Samuel L. Warner Memorial Award. Presentation of the award was made October 4 at the Sheraton Hotel, Philadelphia, during the Society's 82nd Convention.

Specifically, Ranger was selected "for the invention, development and application of a method of electronically synchronizing sound recorded on magnetic tape to the motion picture camera."

Data Processing Co. Organization Announced

A GROUP of the country's leading scientists and engineers, responsible for many of the outstanding electronic computer developments in industry and defense, have formed the Auerbach Electronics Corp., with headquarters in Narberth, Pa., a suburb of Philadelphia.

Heading the firm is Isaac L. Auerbach, until recently Director of the Special Products Division of the Burroughs Corp., a leader in electronic research and development.

The company will specialize in the application of data processing techniques in the fields of automation, industrial process control, telemetering, automatic test equipment, digital communications, and numerical machine tool control.

Isaac L. Auerbach

Weinschel Engineering Appoints Chief Engineer

ALBERT L. HEDRICH has been appointed chief engineer of Weinschel Engineering, Kensington, Md.

Hedrich joined this company in July 1957 after having been with the Diamond Ordnance Fuze Laboratories of the National Bureau of Standards, as a Section Chief, for the past 8 years. Prior to his association with the National Bureau of Standards he was with the Naval Ordnance Laboratory and Naval Research Laboratory.

Sperry Rand Elects Director

C. G. HOLSCHUH, president and general manager of the Sperry Gyroscope Co. Div. of Sperry Rand Corp., was recently elected a director of the corporation at a meeting of the board of directors.

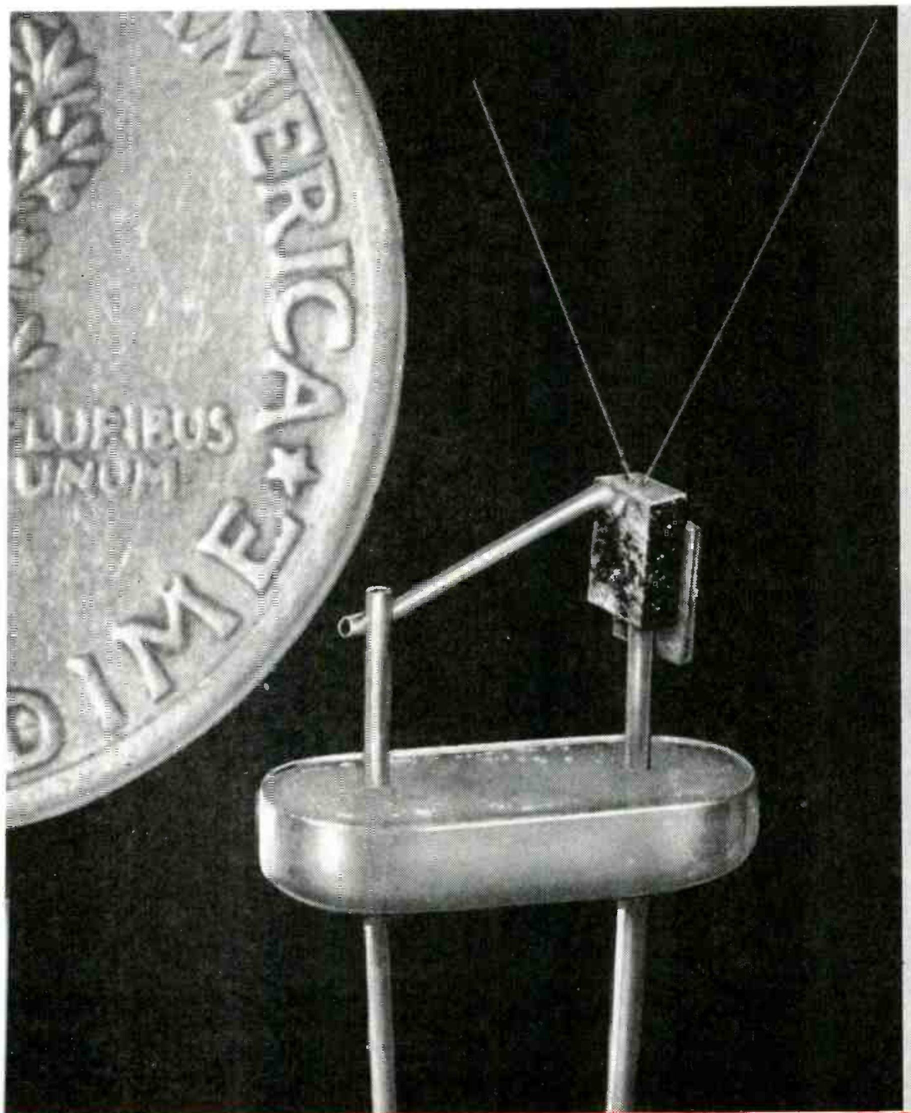
Holschuh began work at Sperry Gyroscope in 1933 and was promoted to various positions in engineering and production. He became executive vice-president and general manager of Sperry Gyroscope Co. Div., in 1955, and president and general manager in 1957.

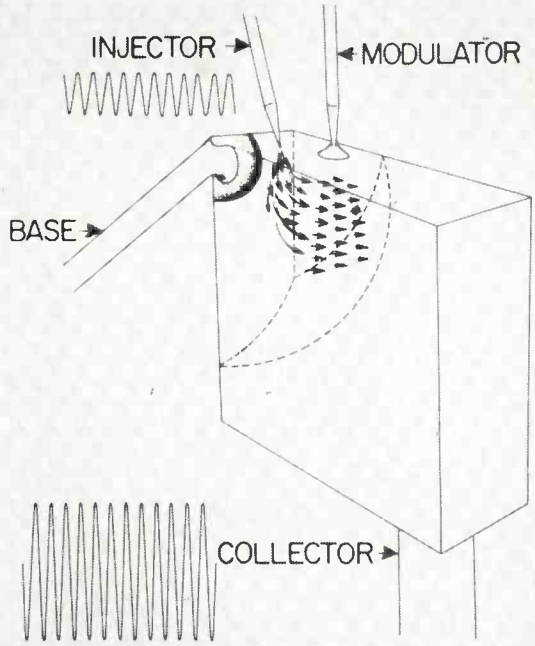
Kaiser Builds in Phoenix

KAISER Aircraft & Electronics has located an aircraft components facility at Phoenix, Ariz., and will build a one-story, 5,000 sq-ft unit which will have an initial work force of 50, mostly engineers and electronics technicians.

In moving a unit to Arizona, Kaiser joins a growing parade of electronics plants in the area. The new Kaiser plant will be managed by Lowell M. Shuck, former manager of the firm's Toledo electronics division.

Recent Achievements by Raytheon Scientists and Engineers





THE SPACISTOR. In July 1957, Raytheon scientists announced the "spacistor", a new semiconductor device that combines the advantages of the vacuum tube with those of the transistor. In the diagram above, voltage is applied between the "base" and "collector" so as to produce a high field and virtually no current. As voltage is applied at the "injector", electrons flow rapidly to the collector contact. The injector current is modulated by applying to the "modulator" a small signal which, since it draws negligible current, is amplified.

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New Books

Proceedings of the Third International Congress on High-Speed Photography

EDITED BY R. B. COLLINS
Academic Press Inc., New York, 1957, 416 p, $13.00.

THIS book is a collection of papers presented at the congress held under the auspices of the Department of Scientific and Industrial Research in London in 1956. The congress is the third of a series of international meetings which originated in Washington in 1952. The papers were carefully screened by a distinguished editorial panel and only reports of new work not previously published were accepted.

Speakers at the various sessions represented official and industrial agencies from such countries as England, France, Germany, Sweden, Holland, Switzerland, the United States and Japan.

▶ **Topics**—There were 15 sessions, each dealing with a group of similar topics: flash light sources, image-splitting and image-sampling techniques, inertialess shutters, application of high-speed photography to biology and medicine and to machine analysis, application to ballistics and explosives, instrument aids, photographic materials, X-Rays, film evaluation, Schlieren and interferrometric techniques, rotating mirror cameras, medium repetition rate cameras, application to aerodynamics and application to hydrodynamics.

Of the many papers appearing in this volume, a large number make little direct use of electronics. Where electronics is used, the text often merely mentions the fact. In other instances, incomplete block diagrams and circuit diagrams are given.

Mention is made below of a few of the papers which deal more directly with electronic circuits.

▶ **Shaped Light**—D. P. C. Thackeray's "Emission Control of Electric Discharge" (p 21) discusses the production of shaped light flashes which can be synchronized with a delay of only a few microseconds and provide steady level of light for a whole series of fast photographs. The illumination generated by the flash lamps is a function of time and the resistance of the discharge networks. Two pulse-forming networks are given. An added capacitor improves the rise time of the light generated by the flash lamps and a diode is used to improve the trailing edges.

H. E. Edgerton's "Small Xenon Flash Tube" (p 51) describes the development of a new small repetitive flash source which can have a multitude of applications. A schematic diagram is given of the circuit of a stroboscope in which this tube is used, as well as a table of typical performance data.

▶**Spark Light**—J. S. T. Looms' and R. J. North's "Short-Duration Spark Light Sources for Photography of High-Speed Airflow" (p 62) states the electrical principles involved in the production of flashes from sparks. The inductance of the circuit and the nature of the dielectric in the capacitor principally determine the variations of light intensity with time of duration of the spark. Some properties of constructed gaps are stated. Two sources which yield flashes suitable for Schlieren photography in the wind tunnel are described and details of their construction given.

▶ **Ballistic Range Instrumentation**—P. Devaux' "Flash Generators with Built-In Chronometry" (p 67) shows the improvement of precision of measurement had in spark generators. Several electronic circuits are given for control of the operation of flash light sources, applying them to instrumentation of a ballistic range: (1) a basic discharge and control circuit; (2) a pulse-shaping circuit; (3) an electronic switch circuit and (4) a pulse distributor. These basic circuits are combined with several others, not detailed, in a ballistic range setup of which the most outstanding characteristic is that the equipment measures the velocity of the missile under test and automatically determines the flash rate of the flash lamps which furnish illumination for the multiple flash photography.

P. Fayolle's "Chronograph for Delay-Line Multiple-Flash, High-Speed Camera" (p 190) makes use of a cathode-ray tube as a light source. Type 2D21 thyratrons trigger one another in tandem through R-C time-delay networks. A multiplier photocell with an amplifier stage of 200-kc to 10-mc passband converts light flashes into electric pulses. The small, brilliant spot on the face of a flying-spot cathode ray tube is used to advantage as a light source.

W. Baur's and K. Pfister's "A Quartz Generator for Time-Base Recording" (p 201) gives an excellent description of the pertinent details of a 1,000-cps crystal oscillator and the characteristics which make it of use as a time base in a movie camera.

A. E. Huston's "Magnetically Suspended High-Speed Rotors" (p 294) presents a unique oscillator circuit. Two potentiometers control standing current, vertical displacement and vertical velocity of the rotor.

In "A Five-Lens High-Speed Camera System of High Resolution" by B. W. Alwood, et al., (p 337), thyratrons, R-C delay circuits and relays are combined in circuits which control shutters and electronic flash lamps.

This book should be read by all electronics engineers, especially design engineers. It contains a wealth of information about high-speed photography and is full of ideas that can be adapted to design details. It is a valuable source of general information on high-speed photography as well as a guide line for anyone who has, or expects to have, a problem for which high-speed photography offers a solution.

The discussions at the end of each session are most enlightening

Continued

and valuable as ideas are exchanged, techniques evaluated, and future trends considered.

An extensive bibliography is given and there is an excellent review of the papers presented at the Congress, as well as chapters on the Exhibition of apparatus mentioned in the papers and the Film Program held in connection with the congress.—SAMUEL DORSEY, *Ridgecrest, Calif.*

Acoustical Engineering

BY HARRY F. OLSON
D. Van Nostrand Co., Inc., N. J., 1957, 718 *p*, $13.50.

SINCE 1940 "Elements of Acoustical Engineering" by Harry F. Olson has been a valuable part of the library of those working in acoustics. Now a revised and expanded work has been published, entitled "Acoustical Engineering". This book is relatively broad in scope so that it will be found useful not only to acousticians but also to those in allied fields of engineering.

The first three chapters consider the properties of sound waves, acoustical radiating systems and mechanical radiating systems, respectively. Chapter 4 describes dynamical analogies, comparing mechanical, electrical and acoustical elements. Fundamental design information is contained in chapter 5 on acoustical elements.

▶ **Transducers**—Microphones and loudspeakers are treated in the next three chapters. The various types of transducers are described in detail. Cross-sectional views, analogous circuits and response curves are presented, together with formulas for pertinent parameters such as electrical impedance, efficiency, etc. Curves are shown which describe characteristics of the various types of devices, including their radiation patterns and efficiencies. Chapter 9 on miscellaneous transducers is an acoustical potpourri considering very briefly such widely differing subjects as the electrical megaphone, volume limiters, and sirens.

▶ **Measurements**—Chapter 10 covers the broad area of acoustic measurements. The methods of measuring characteristics which are described includes response frequency, directionality, nonlinear distortion, phase distortion, electrical impedance and transient response. The testing of telephone receivers and phonographs is considered, along with measurements in architectural acoustics and miscellaneous areas of acoustics.

The remaining chapters: Architectural Acoustics and the Collection and Dispersion of Sound, Speech, Music and Hearing, Complete Sound Reproducing Systems, Means for the Communication of Information, Underwater Sound and Ultrasonics, treat such widely differing subjects that it is possible only to include brief descriptions of many types of instruments, measurements and characteristics. However, because of the wide area which is covered, many readers will find this book useful as a general reference on acoustic instruments and measurements.

Dr. Olson's latest book will prove even more valuable to all students and practitioners of acoustical engineering than its predecessor.—CYRIL M. HARRIS, *Electronics Research Laboratories, Columbia University, New York, N. Y.*

Thumbnail Reviews

Elementary Theory of Angular Momentum. By M. E. Rose, John Wiley & Sons, Inc., New York, 1957, 248 p, $10.00. Introduction to angular momentum based on series of lectures given at Oak Ridge National Laboratory.

The Vacuum Deposition and Properties of Thin Films. By L. Holland, John Wiley & Sons, Inc., New York, 1956, 541 p, $10.00. Thorough review of all techniques concerned with deposition of thin films for optical, electrical and chemical purposes.

Servicing Color TV. By R. G. Middleton, Gernsback Library, Inc., New York, 1957, 224 p, $2.90. Application of servicing techniques and instruments to color television receivers

Continued

written for technicians. Color sync servicing, chroma circuits and matrix testing covered in detail.

European and American Receiver Tubes Interchange Simplified. By H. A. Middleton, John F. Rider, Pub., Inc., New York, 19457, 72 p, $1.35. List of over 200 European tubes that may be replaced with American tubes and over 230 American-to-European conversions.

U. S. Research Reactors. U. S. Atomic Energy Commission, Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C., 1957, 72 p, $1.50. Description of more than 30 research reactors, now in operation or under construction, grouped according to major types. Examples of each type are given at length, features of others are illustrated and significant data given for all.

The Design and Conduct of Human Engineering Studies. By Alphonse Chapanis, San Diego State College Foundation, San Diego 15, Calif., 1956, 73 p. Principles and guides relative to conducting valid studies on the person.

Introduction to Electrical Applied Physics. By N. F. Astbury, Philosophical Library, New York, 1957, 241 p, $10.00. A brief survey of the physical sciences of greatest importance in electrical engineering including electromagnetic field and wave theory, electromechanical and electroacoustical systems and electronic devices. Treatment is suitable for graduate engineers.

Servosystems Laboratory Manual. Servo Corporation of America, 1957, 32 p, $2.00. Intended as a framework for an introductory laboratory course in servomechanism and feedback control systems, this manual stresses practical application of principles and presents seven integrated experiments.

Fasteners Handbook. By Julius Soled, Reinhold Pub. Corp., New York, 1957, 430 p, $12.50. This book should be of primary interest to engineers concerned with the production of electronic equipment. Subject headings include: Rivets, Inserts, Screws, Bolts, Studs, Nuts, Washers, Retaining Rings, Pins, Metal Stitching, etc.

1957 Registry of Public Safety Systems. Edited by Ethel V. Sleeper, Communication Engineering Book Co., Monterey, Mass., 1957, 132 p, $4.00. Listing of 20,000 mobile radio communications systems operated in police, fire, special emergency, highway maintenance and forestry conservation services. Licensees are also listed by frequency showing location and call letters.

Letters

Trade Name

DEAR SIRS:
I CALL your attention to the misuse of "Teletype" in the sixth paragraph of the pink block entitled "FCC Actions" on page 22 of the July 1, 1957 issue of ELECTRONICS.

At the same time I am glad to tell you that on page 20 of the same issue in the article entitled Microwave System Eases Overload, the common noun "teletypewriter" is correctly used.

I am sure in view of your most helpful attitude as revealed in the correspondence with our former general patent attorney, Mr. Harold B. Whitfield, who had called your attention to a previous misuse in the December 1955 issue of ELECTRONICS, that the instant misuse is inadvertent. However, I am obliged to call it to your attention because a misuse of our trade mark in such a significant and authoritative publication as ELECTRONICS cannot be disregarded.

F. S. EWING
General Patent Attorney
Teletype Corporation
New York, N. Y.

Demodulator-Limiter

DEAR SIRS:
I WAS interested to read the article "Demodulator-Limiter for Control System Signals" in the September 1957 issue of ELECTRONICS. The author has done a fine job of describing several features of this circuit. I would like to point out, however, that this circuit was described in the October 1956 issue of ELECTRONICS in the article "Photoelectric Analog Function Generator." In the latter article I described the circuit and pointed up its linearity, especially in the millivolt region, and its low null drift. These features were of prime importance in the function generator application, whereas Mr. Johanson makes good use of the limiting action of the circuit.

It will also be evident from a comparison of the schematics in

Continued

the two articles that there has been a reversal of the signal and load terminals. These two sets of terminals are essentially interchangeable due to the symmetrical design of the circuit.

R. A. SINKER
President, Electrol, Inc.
Los Angeles 35, California

Wrong Price

DEAR SIRS:

THANK you for publishing a review of Symposium on Minimum Property Values of Electrical Insulating Materials in your August issue, p 384. However the price was incorrectly given as \$1. The book is priced at \$1.75.

The receipt of an order for the book accompanied by a tear sheet from ELECTRONICS brought this to our attention.

FRED F. VAN ATTA
Assistant Secretary
American Society for Testing Materials,
Philadelphia, Pennsylvania

Erratum

DEAR SIRS:

I WOULD like to bring to your attention two corrections needed on your July 1 issue of ELECTRONICS.

On page 186 you published my Helical Scan Nomograph under the byline "Chester W. *Wood*." Although this is, perhaps, a small error when compared with the vast amount of work which goes into the layout and makeup of an issue of ELECRONICS, you can understand my disappointment.

I waited to satisfy my curiosity as to whether you would publish a correction in the August 1st issue. Either it was never called to your attention or I missed it as I was unable to find it.

I would also like to bring to your attention the fact that credit was not given to Donald G. Fink for either the equation of the nomograph or the drawing which I lifted bodily from his book, *Radar Engineering*.

CHESTER W. YOUNG
Sr. Research Engineer

Editor's Note: Our faces are red because we missed it when the issue came out. The name was set correctly by the printer when the type was set, but seems to have changed somehow during the running of the presses.

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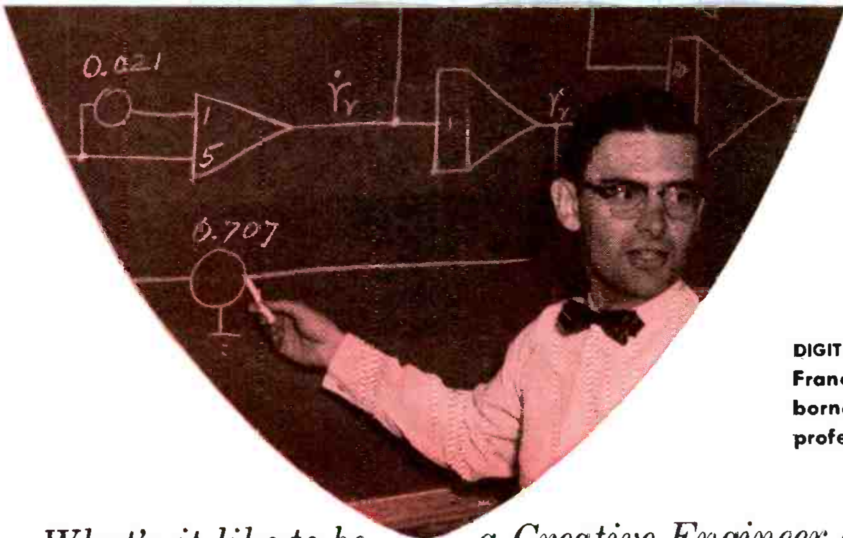
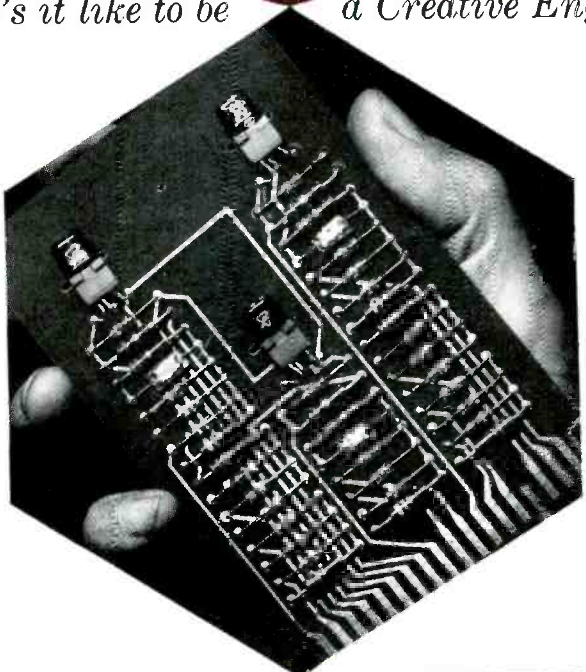


DIGITAL COMPUTER SYSTEMS ENGINEER Sherman Francisco tells why simulation studies of airborne computers offer a singularly challenging professional experience.

What's it like to be a Creative Engineer at IBM



"*Airborne* computers present a special challenge to the creative engineer, because their systems must be planned and designed with flight situations in mind. Through simulation studies, we test computer systems right in our own labs—simulating both the dynamics of the aircraft and the environmental conditions encountered. My biggest thrill? To see my first simulated bombing mission!"

For those who can qualify, the engineering of digital computer systems at IBM Owego offers one of the most challenging assignments in electronics today. You can use your experience in: Instrumenting mathematical equations; programming operational steps; simulation studies; real time control; digital-to-analog conversion.

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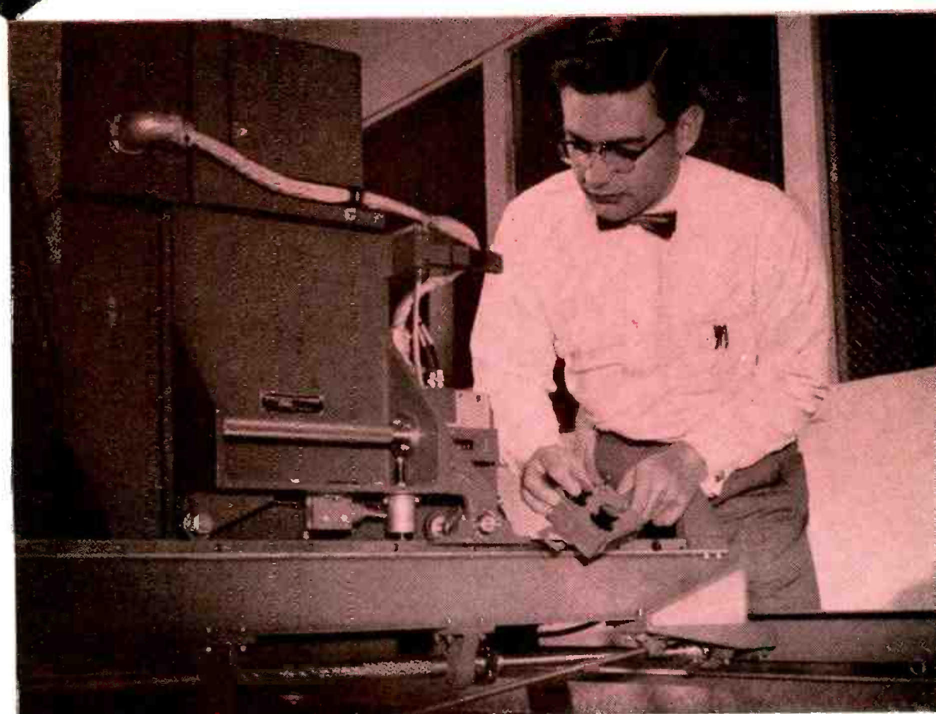

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ENGINEERS' QUESTIONS AT VOUGHT

"Old Indestructible" Paid a $3 Million Dividend in Data

When a missile can be flown . . . recovered . . . and flown again, it becomes an acquaintance. When a single *Regulus I* missile came home 15 times, it got a name.

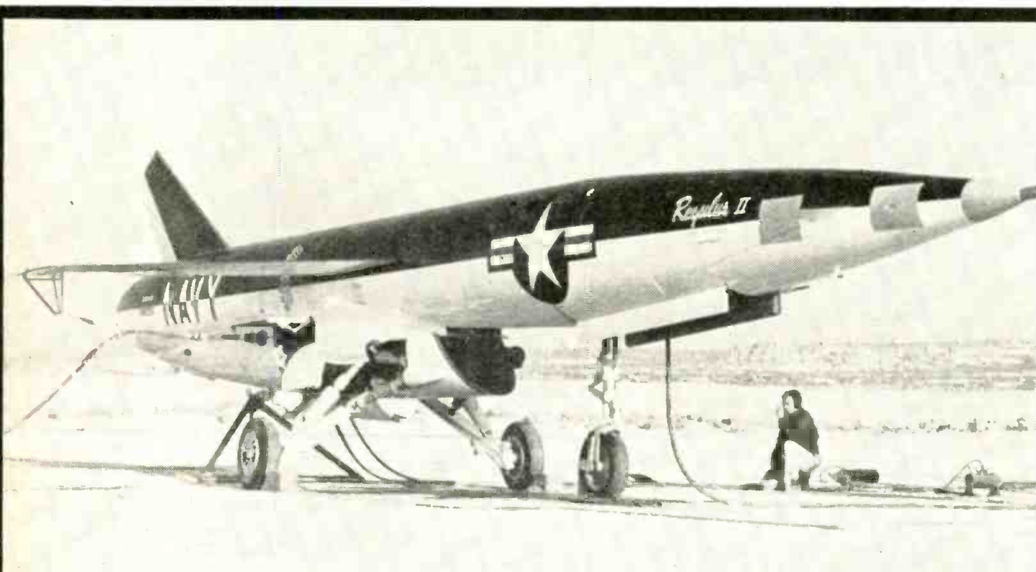
"Old Indestructible" began her career by returning flight test information to Vought engineers. The missile gave the acid test to new launching methods, guidance principles, performance maximums and telemetering channels. Three flights, and the bird had paid for herself in fat data installments.

When the missile had been picked clean by Vought reliability and systems men, she joined the Navy. Fleet submariners and surface seamen were ready to operate *Regulus* as a target drone and nuclear weapon. Old Indestructible was chosen to teach them.

The missile qualified six Navy teams in *Regulus* tactics, logistics and maintenance. Repeated launchings at 70,000 pounds thrust stretched her airframe. Flight and ground-run time on some components mounted above 1,000 hours. Operationally, however, the missile was sound when time came for her 16th and final flight, a shipboard launching in a simulated nuclear attack.

Thanks to Old Indestructible's dogged returnability, Vought engineers could design its reliability standards into every Navy-bound *Regulus*. Results were unprecedented. With the Fleet, *Regulus I* has completed well over 600 flights with outstanding on-target success probability.

Today, Vought missile men are using the recovery concept to foolproof a mightier missile. Their *Regulus II* has completed 20 flights to date. Significantly, six of these flights were made by one missile.



Swift, versatile Regulus II can strike from land or sea.

Nuclear subs, surface ships, shore batteries . . . they will all get the supersonic striking power of Vought's new *Regulus II*. This missile system weds marine and missile engineering, test range and shipyard, nuclear power and inertial guidance. It's a uniquely interesting and rewarding project — and one you can join through new, select openings.

For details on current openings in this and other Vought projects, write to:
C. A. Besio, Supervisor, Engineering Personnel, Dept. E-6

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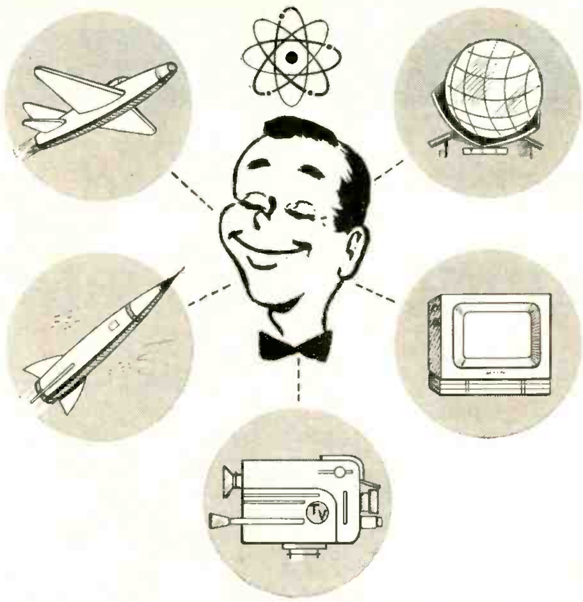

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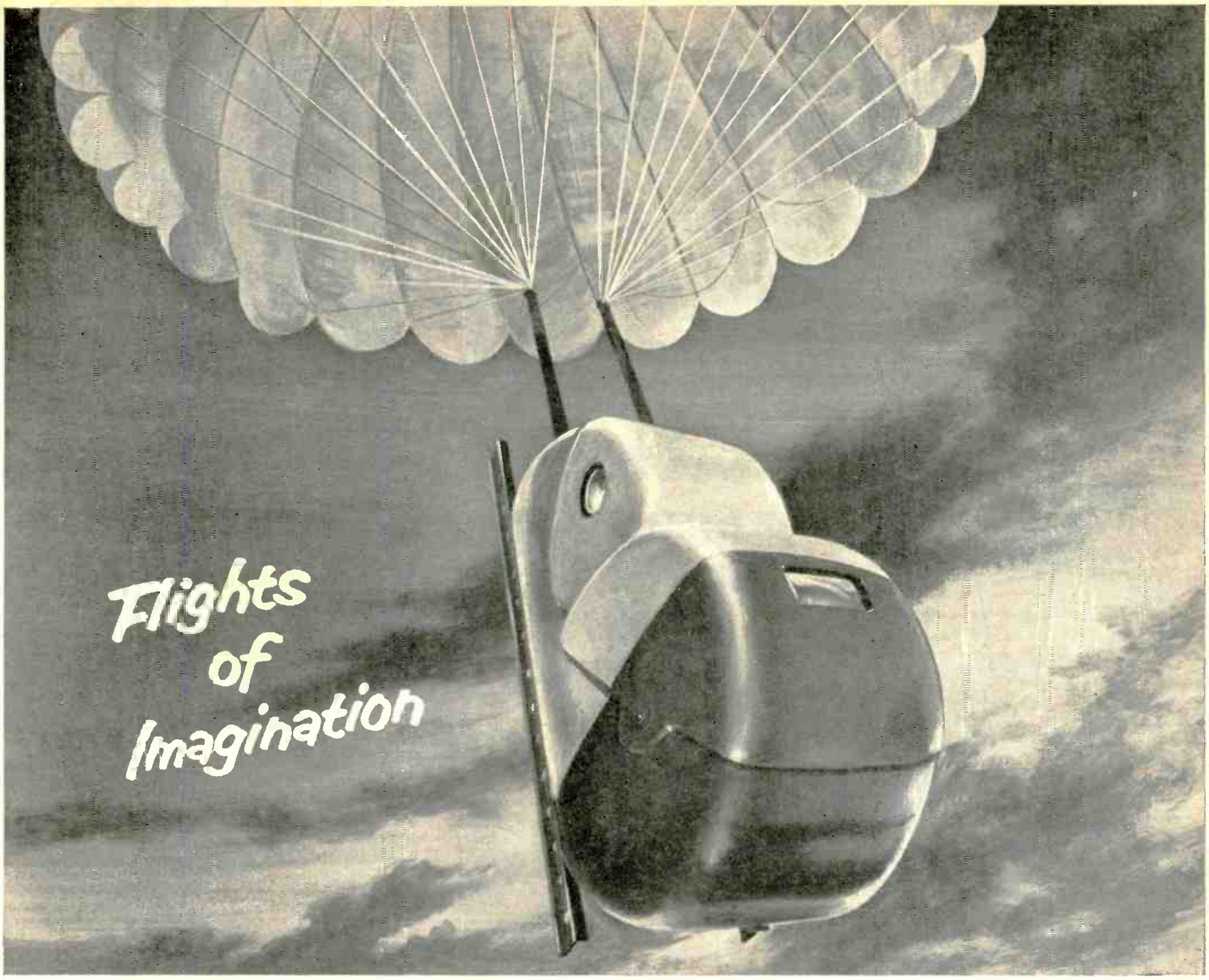

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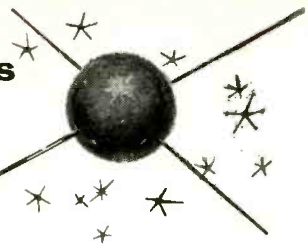

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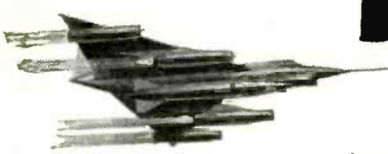

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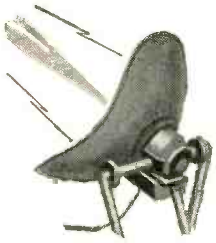

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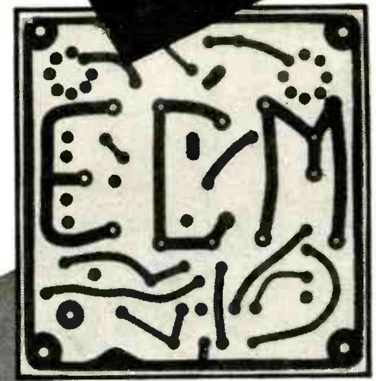

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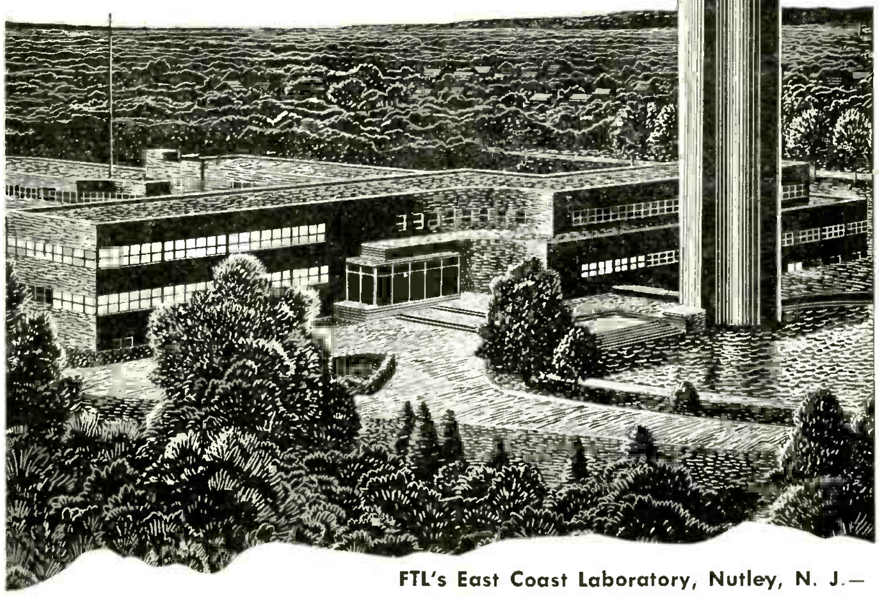

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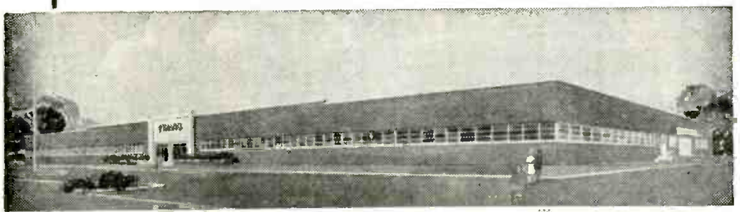

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250-TL	11.75
250R	3.50
WE-251A	39.50
WE-252A	6.50
QK253	150.00
WE-254A	1.95
FG-258A	75.00
WE-258B	5.00
259A	10.00
V-262	150.00
FP265	12.50
WE-269A	6.00
FG-271	22.00
WE-271A	5.00
WE-274B	.50
WE-282A	2.00
WE-282B	3.75
QK283A	150.00

QK284A	150.00
FP285	Q
WE-285A	4.50
WE-286A	3.25
WE-287A	2.00
WE-290A	7.00
WE-293A	8.00
GB-302	5.00
WE-305A	2.50
WE-308B	12.50
WE-310A	3.50
WE-311B	4.00
WE-312A	1.50
313CA	2.50
WE-315A	10.00
QK-319	100.00
WE-323A	7.50
VT327A	3.35
WE-336A	3.50
WE-338A	3.50
WE-348A	4.00
QK349/6249	250.00
WE-349A	4.50
WE-350A	2.50
350B	2.00
354C	5.00
WE-355A	8.50
WE-356B	3.00
WE-359A	1.00
368AS	1.00
335A	Q
WE-388A	1.00

KU-628	7.50
WL-652	20.00
HK-654	14.50
GL-672	20.00
WE-701A	1.50
WE-703A	1.25
WE-704A	.60
WE-705A	.75
706AY-GY	9.00
707B	2.00
WE-703A	.75
WE-709A	1.50
714A	7.50
715A	1.75
715B	2.50
717A	.50
720AY-EY	35.00
721A	.50
721B	6.75
722A	.75
723A/B	6.00
725A	2.25
726A	3.95
726B	9.50
730A	7.50
750TL	30.00
803	2.00
807	1.10
807W	1.25
811	2.90
811A	3.75
812A	3.50

SPECIAL

5″ DUAL GUN TUBE

Long persistency face, P7 screen. Value at $200.00. This tube has been rejected for military use.

Fully Guaranteed **$17.95**

VACUUM CAPACITORS

50 mmfd. 32 KV	8.00
75 mmfd. 20 KV	10.00
100 mmfd. 20 KV	12.50

Also Other Values

WE-393A	3.25
WE-394A	2.50
WE-396A	3.25
FP-400	20.00
WE-403A	1.25
403B/5591	2.50
404A/5847	11.00
WE-407A	2.25
WE-408A	1.75
WE-409A	4.00
WE-412A	3.75
WE-416B	25.00
417A	2.50
WE-417A	11.00
WE-421A	4.00
WE-422A	10.00
WE-423A	5.75
WE-428A	30.00
WE-432A	7.00
WE-432B	8.00
GL-434A	5.00
WE-438A	40.00
446B	1.00
WL-456	59.50
QK459	250.00
464A	1.75
X-481D	95.00
CK501AX	1.00
RH-507	20.00
508/6246	150.00
527	27.50
WL-530	17.50
559	.40
575A	10.00
CUE578	8.50
579B	Q
583	Q
KU-610	3.50
KU-627	6.50

813	8.50
814	1.75
828	8.00
829B	8.00
830B	.50
832A	7.00
833A	33.00
834	5.00
835	2.00
836	1.20
837	1.25
838	.70
845	2.00
850	4.75
851	7.50
852	4.00
861	15.00
865	.90
866A	1.15
866JR	1.25
869B	32.50
872A	1.00
884	.95
GL-889	35.00
GL-889A	50.00
889RA	100.00
891	125.00
891R	175.00
893A	275.00
902A	2.00
905	3.00
914A	Q
917	1.40
919	1.50
922	1.50
927	.75
931A	3.50
933	4.00

957	.35
958A	.35
959	1.15
991	.35
CK-1005	.35
CK-1007	.45
K1253P7	29.50
HY1269	3.00
1274	2.45
1603	3.50
1614	1.50
1619	.30
1620	3.50
1622	2.00
1623	1.25
1624	1.00
1625	.30
1626	.25
1631	1.00
1636	.75
1641	1.35
1850A	Q
1945	65.00
2000T	150.00
2050	1.00
2051	.65
HK3054	100.00
ZB3200	75.00
4210	Q
R-4330	9.00
R-4340	9.00
5517	1.00
5531	200.00
5544	25.00
5551/FG271	22.00
5553/FG258A	75.00
5559/FG57	6.75
5560/FG95	16.00
5588	75.00
5611	40.00
5618	2.75
5634	5.00
5636	2.40
5639	5.00
5639A	5.50
5641	3.75
5642	1.10
5643	3.75
5644	5.00
5645	4.50
5646	3.00
5647	3.50
5647A	5.00
5650/5981	50.00
5651	1.25
5654	1.25
5654/6AK5W/6096	2.50
5656	3.75
5657	100.00
5663	.75
5665	35.00
5667	100.00
5670	2.00
5670WA	4.00
5672	1.00
5676	.75
5678	.70
5683	5.75
5686	1.75
5687	2.00
5687WA	4.00
5691	4.50
5692	5.00
5693	3.00
5696A	1.25
5702	1.25
5702WA	3.85
5703	.75
5703WA	3.75
5704	1.15
5718	1.25
5719A	2.00
5725/6AS6W/6187	4.00
5726/6AL5W	1.00
5726/6AL5W/6097	3.00
5727/2D21W	1.25
5744	1.00
5744WA	4.50
5749/6BA6W	1.15
5750	2.00
5751	1.85
5751WA	3.50
5763	.85
5779	70.00
5780	150.00
5783	3.50
5783WA	5.25
5783WB	5.25
5785	1.50
CK-5787	3.50
5795	250.00
5814	.50
5814WA	2.75
5825	6.00

5829	.80
5829WA	3.50
5837	50.00
5840	2.85
5840A	4.00
5841	4.25
5842/417A	11.00
5844	1.25
5847/404A	11.00
5851	2.50
5852/TE5	6.00
5853	60.00
5855	35.00
5876	5.00
5879	1.25
5893	9.00
5896	3.00
5896A	3.25
5899	3.25
5902	3.75
5902A	5.00
5902A(CL)	2.50
5903	12.50
5906	8.50
5907	12.50
5908	12.50
5910	.50
5915	.50
5916	8.50
5932	3.00
5933/807W	1.25
5948/1754	100.00
5956	35.00
5962/BS101	4.00
5964	.80
5965	1.00
5967	9.50
5977A	3.00
5981	44.50
5982	149.50
5987	9.50
5992	6.75
5993/TE-10	8.00
6005/6AQ5W	1.75
6019	300.00
6021	2.50
6021-A	3.50
6029/403A	2.00
6037/QK243	39.50
6038	7.50
6046	.75
CK-6050	2.00
6072	3.25
6073	1.25
6074	2.50
6080	3.50
6080WA	6.00
6081/ATR407	22.50
6082	3.90
6088	1.50
6095	2.00
6096	1.30
6097	1.50
6099	1.40
6100/6C4WA	2.00
6101/6J6WA	1.90
6110	4.75
6111	3.75
6112	3.90
6115	44.50
6117	60.00
6130	4.25
6136	2.50
6147	3.00
6161	35.50
6169	Q
6184	9.00
6186/6AG5WA	2.25
6189/12AU7WA	2.50
6197	1.25
6199	27.50
6201/12AT7WA	2.75
6203	2.75
6205	4.50
6211	1.00
6263	9.50
6264	9.50
6278/C5F14	19.50
6280/416B	35.00
6339	20.00
6363	75.00
6406/QK428	200.00
6533	10.00
6611	12.00
6612	14.00
6783	8.50
6832	12.00
8012	1.00
8025A	2.00
9001	.65
9002	.45
9003	1.00
AX9903	16.00
D178461	50.00

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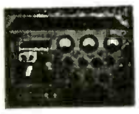
VD 7" Upright
VE-7" Table Type
VF-5" "B" Scope "5" P.P.I.
VG-24" Plotting Table
VJ-12" Upright
VK-12" Upright
VL-12" Upright R.H.I. IND.
All indicators are 110v 60 cyc.

RDO & APR-4

SEARCH RECEIVERS



The RDO is a very elaborate radar search receiver greately improved over the APR-4. The set uses APR-4 tuning units, but is much more versatile, having input metering. D.B. output meter, automatic noise limiter and greater selectivity and sensitivity. The RDO is recommended when only the very best will do. Input 110/60 cys.

BC-342 BC-312

1.5-18MC Communication Receivers. The BC-312 Operates From 12V D.C. The BC-342 From 110V 60 Cyc. These Sets Incorporate a Crystal Filter B.F.O. Antenna Tuner Etc. We Can Supply These Receivers in Large Quantities.

SHORAN

AN/APN-3-AN/CPN-2

The AN/APN-3 and AN-CPN-2 are Precision distance measuring installations. This equipment operates on 225 mc. The range is 250 miles with an accuracy of 25 feet. This equipment is widely used by by geological companies for prospecting and mapping. Power input is 110v 400 cyc and 28v DC.

COUNTER MEASURES EQUIPMENT

SEARCH DETECTION

AN/APR-4 38-4000 MC
AN/APR-2 300 1000 MC
AN/APR-5 1000-3100 MC
AN/APR-6 1,000-10,000 MC
RDO 38-4000 MC
SCR-616 145-600 MC

DIRECTION FINDING

AN/APA-17 300-10,000 MC
AN/APA-24 100-750 MC
AN/APA-48 140-300 MC

PANORAMIC AND PULSE ANALYZING

AN/APA-6 Pulse Analyzing
AN/APA-11 Pulse Analyzing
AN/APA-10 Panadaptor
AN/APA-38 Panadapter
AN/ARQ-5 18 80 MC Receiver Indicator
AN/ARQ 8 25-105 MC Barrage Rec-Trans Indicator
AN/ARQ-10 1.5 MC-50 MC Receiver-Trans. Jammer Indicator
AN/ARQ-1 Thru 12 also avail.
AN/APA-23 Signal and Time Recorder

NOISE GENERATORS

AN/URA-T1 AN/URA-2T MD-4/URA
Shot-Noise, Bagpipes, Tone, Random Keying, Output. These units will key any transmitter.

JAMMER TRANSMITTERS

AN/APT-1 thru 10 25-3,000 MC AN/APQ-15
AN/APQ-1 thru 20
AN/SPT-Series
SCR-596 1.5-30 MC Barrage Ground Jammer
TDY, MRQ, SPT, SPQ-TPQ-1AN/UPT-T1-T3, T4
Many other countermeasures equipments avail. both hi and low power. These equipments can be used to test new radar and computer systems for susceptibility to jamming and other countermeasures. We can supply complete setups covering any freq. from 100 KC 10,000 MC, with power supplies for mobile operation.

EE-94-95

CODE PRACTICE EQUIPMENT

This is 20 and 40 man code practice set. This equipment is a complete setup for a school to teach Morse Code up to 400 WPM. The set consists of a recorder, turntable, switchboard. TG-34 keyers, code keys, headsets, clock, timer, wire record set, oscillator, etc. We can supply this set from a current production contract. Write.

MAR POINT TO POINT RADIO SET

Portable 225-398 mc point to point 10 chan. crystal controlled voice and mew radio set. This is a very late radio set used for point to point and ground to air communication. The transmitter output is 8 watts on 10 pre-set crystal controlled channels instantly selected by a band switch. The REC is also crys. controlled on the trans. freq. The set is inclosed in 3 water proof shock proof cabinets that may be set up in a few minutes on location. This equipment is ideal where a reliable radio link easily transported is needed. Power input is either 24 VDC 115/230V AC or DC. Complete sets avail. Write

AN/PRC-6

47-55 MC HANDI-TALKIE

This is the Standard MIL. F.M. Handi-Talkie With a Range of About 1 Mile. The Set Operates From Batteries With an Output of .25 Watts, the Set is Self Contained With Its Own Antenna. Weight is Approx. 6 Lbs. The Set is Crystal Controlled and Will operate with PRC, SCR 508, 608 SCR-300 Etc. Quantities Avail.

AN/TRC-1-3-4

100 MC RADIO-RELAY EQUIPMENT

The AN/TRC series is a mobile portable set for duplex or simplex radio telephone point to point communication. This set will operate with the CF series carrier systems to provide multi channel operation. The operates on 100 MC with an output of 10 50 watts. The set is crystal controlled. Complete sets avail. Input 110v 60 cyc.

SCR-399-499

Mobile and fixed station high power radio sets; the SCR-399 is mounted in a HO-17 shelter. The SCR-499 is transported in carrying cases to be set up for field operation. Freq. of the sets is 2-18 mc. pwr output is 350w. Phone and C.W. 2 communication receivers are provided. Input is 110v 60 cys.

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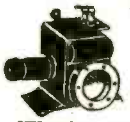
COMMUNICATIONS EQUIPMENT CO.

PULSE TRANSFORMERS



352-7150. Primary 50 ohms. Secondary 1000 ohms, 12,000v, 12.0 Amp. Pulse: 1 or 2 usec. at .001 duty ratio. Fitted with magnetron well and bifilar winding for filament supply $22.50

MAGNETRON PULSE TRANS. #964: Prim. imp. 30 ohms, 1600 v. pulse. Secondary imp. is 1250 ohms, 12 KV pulse. Turns ratio sec:pri. is 7.5:1. Duty ratio is 0.001 at 1.2 usec. Bifilar winding 1.2A......$8.50

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC. 16K-16 AMP DUTY RATIO: 001 400 CYCLE FIL. TRANS "BUILT-IN"....$17.50

GE #K-2499A Primary: 9.33 KV, 50 ohms imp. Secondary: 28 KV, 450 ohms. Pulse length: 1.05/5 usec. @ 635/120 PPS. PK Power Out: 1,740 KW Bifilar; 1.5 amps $62.50

GE #K-2748-A, 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk Sec. volts 11.5 KV Pk Bifilar rated at 1.3 Amp Fitted with magnetron well....$24.50

K-2745 Primary: 3½.8 KV. 50 ohms Z Secondary: 14/12.6 KV 1025 ohms Z. Pulse length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar 1-3 Amp. Has "built-in" magnetron well.....$32.50

PULSE NETWORKS

H-616 10KV, 2.2 usec., 375 PPS, 50 ohms imp...$22.50
H-615 10KV, 0.85 usec., 750 PPS, 50 ohms imp..$22.50
H-605: 25 KV, "E" CKT. 1.5 usec. 400 PPS. 50 Ohms Impedance, 5 sections $62.50
7-5E3-1-1200-67P, 7.5 KV "E" Circuit, 1 microsec. 200 PPS, 67 ohms impedance 3 sections....$7.50
7-5E3-3-200-67P, 7.5 KV. "E" Circuit, 3 microsec. 200 PPS, ohms imp. 3 sections....$12.50
G.E. #3E (3-84-810) 8-2.24-405) 50P4T; 3KV "E" /2000 PPS/50 ohms/2 sections....$6.00
G.E. #3E (3-84-810) 8-2.24-405) 50P1T; 3KV "E" CKT Dual Unit; Unit 1, 3 sections, 0.84 Microsec. 810 PPS, 50 ohms imp.; Unit 2, 8 Sections 2.24 microsec. 405 PPS, 50 ohms imp....$6.50
#632: "E" Network, 1600v, .6 usec/2 usec. 2000 PPS/350 PPS. 30 Ohms Imp....$7.50

PULSE MODULATOR

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: .001 max. Pulse duration: 0.5, 1.0, 2.0 microsec. input voltage: 115 v, 400 to 2400 cps. Uses: 1-715B, 1-829B, 3-'72's, 1-'73. New. Complete with pressurized housing $135

MICROWAVE PLUMBING

X-BAND—RG, 52/U WAVE GUIDE

PARABOLOID DISH, 18" diam. Spun Aluminum 8" Focus. For AN/APS-6....$4.50
3 CM. DIPOLE and Feed Assembly (May be used with above dish) 8-inches long....$5.00
FLEXIBLE SECTION 9 in. long, Cover-to-Cover $5.50
ROTARY JOINT (APS-6) Sperry PT #658275, 180 deg. rotation, choke to choke. Has "Built-in" Di-Coupler. 20 DB, with "N" Takeoff....$17.50
3 CM. DIPOLE FEED, 15" L. for APS-15....$14.50
MITERED ELBOW, Cast aluminum, 1¼" x ⅝" W.G. W. E. Flanges. "E" Plane....$3.50
3 CM. ANTENNA ASSEMBLY; Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan; over 160 deg. at 35 scans per minute, Elevation Scan, over 2 deg. Tilt. Over 24 deg....$35.00
Cross-Guide Directional Coupler, UG-40 output flange. Main Guide is 6" Long, with 90 Deg. "E" Plane bend at one end, and is fitted with Std. UG 39/UG 40 flanges. Coupling figures: 20 db Nominal...$22.50
Bulkhead Feed-thru Assembly....$12.00
Pressure Gauge Section with 15 lb. gauge....$10.00
Directional Coupler, UG 40/U take off 20db....$15.00
MAGNET AND STABILIZER CAVITY For 2J41 Magnetron $24.50
90 degree elbows, "E" Plane 2½ radius....$8.50
Beacon/receiver unit. Complete with dual klystron mount, TR/ATR section, duplexer, and 30 mc IF/-Mixer unit. Originally designed for 9000 mc receiving using 723A/B. New, less tubes....$22.50
Klystron mount for 732A/B. Front end of microwave receiver (SO-3), with balanced mixer crystal mt. and iris coupling for AFC. less tube....$15.00

10 CM.—RG48/U Waveguide

Waveguide-to Coax, adapter. Matches RG48/U waveguide to RG 44/U rigid coax. Complete with flanges. "T" match $15 00
10CM ECHO BOX: Tunable from 3200-3333 Mc. For checking out radar transmitters, for spectrum analysis, etc. Complete with pickup antenna and coupling devices $17.50
POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" connectors $12.50
LHTR, LIGHTHOUSE ASSEMBLY. Parts of RT39 APG 5 & APG 15, Receiver and Trans. Cavities w/ assoc. Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated $15.00
McNally Klystron cavity for 2K28 or 707B, tunes 2700-2900 mc. Complete with tuning vanes....$5.00

3000 MC WAVEMETER

Mfd. by G.E. for Armed Services 3000-3700 MC. Comes furnished with variable attenuator, coax. adapter cord. Cal. chart and pickup antenna. Has output jack for external meter or other monitor device. Resonance indicator is 3½ 20 microamp meter. Brand new, in portable wooden carrying case $75.00

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
BDAR83	14	..	375	.150	$6.50
POSX-15	14	2.8	220	.08	8.95
DM33A	28	7	540	.250	3.95
B-19	12	9.4	275	.110	5.50
			500	.050	
DA-3A*	28	10	300	.260	3.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	1000	.350	10.50
DAG-33A	18	3.2	450	.06	2.50
BDAR 93	28	3.25	375	.150	6.95

† Less Filter * Replacement for PE 94.
PE 94, Brand New....5.95

INVERTERS

800-1B Input 24 vdc, 62A. Output: 115 V, 800 cy. 7A. 1 phase. Used excellent....$18.75
PE-218H: Input: 25/38 vdc, 92 amp. Output 115V 300/500 cy. 1500 Volt-ampere. NEW....$32.50
PE206: Input: 28 vdc, 36 amps. Output: 80 V 800 cy. 500 volt-amp. Dim. 13 x 5½ x 10½. New.....$22.50
EICOR—ML 3011-5, Input: 13.75 V; 18.4A, Output: 115V/400~, 3ϕ. 0.95 PF. 100 VA. New....$37.50
LELAND #10563. Input: 28 vdc/12A. Output: 115 vac/400 cycle/3 phase, 115 va. Slightly used, ex. cond. $32.00

BROADBAND VIDEO AMPLIFIER

Navy type AM-518/SSA; input data: 2 channel, 70 ohms impedance each channel; output data: 2 channels, 50 ohms each channel: 1 to 4 volts overall gain; 100 cycle to 10 MC frequency range. Power required 115 volts, 1 phase, 60 cycle, 13½" wide x 17¼" high x 26½" deep, overall. Mfr. Bendix Aviation Corp. Used, excellent $112

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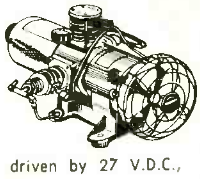
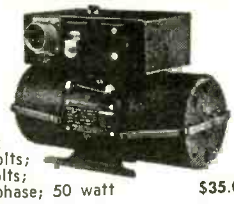


3 stage. Mfg. by Cornelius. Model 32-R-800. Type C-2; driven by 27 V.D.C., 21 amp motor, .6 cfm free air.

$69.50 each

INVERTERS



10042-1-A Bendix
DC Input 14 volts; output: 115 volts; 400 cycles. 1-phase; 50 watt $35.00

12116-2-A Bendix
Output: 115 VAC; 400 cyc; single phase; .45 amp. Input: 24 VDC, 5 amps. $35.00

12117 Bendix
Output: 6 volts; 400 cycles, 6 volt amperes, 1 phase. Input: 24 VDC; 1 amp. $15.00

12121 Bendix
Input: 24 volt D.C. 18 amp. 12000 r.p.m. Output: 115 volts, 400 cycle, 3-phase. 250 volt amp, 7 pf. $49.50

12123 Bendix
Output: 115 V; 3 phase; 400 cycle; amps. .5; Input: 24 VDC; 12 amp. $49.50

12126-2-A Bendix
Output: 26 volts; 3 phase; 400 cycle; 10 VA; 6 PF. Input: 27.5 volts DC; 1.25 amps. $24.50

12130-3-B Bendix
Output: 125.5 VAC; 1.5 amps. 400 cycles single phase, 141 VA. Input: 20-30 VDC. 18-12 amps. Voltage and frequency regulated. $49.50

12137 Bendix
Output 250 VA, 115 volts, 3 phase, 400 cycle, 1.25 amp., 0.8 pf. Input 27.5 volt DC, 20 amp. $59.50

12142-1-A Bendix
Output: 115 volts, 3 phase, 400 cycle, 250 VA. Input: 27.5 VDC, 22 amps. Voltage and frequency regulated. $99.50

12147-1 Pioneer
Output: 115 VAC, 400 cycles; single phase. Input: 24-30 VDC; 8 amps. Price $39.50 each

778 Bendix
Output: 115 volt, 400 cycle; 190 VA; single phase and 26 volt, 400 cycle, 60 VA, single phase. Input: 24 VDC. $37.50

10285 Leland
Output: 115 volts AC; 750 VA, 3 phase, 400 cycle, .90 pf and 26 volts. 50 VA single phase, 400 cycle, .40 pf. Input: 27.5 VDC 60 amps. cont. duty, 6000 rpm. Voltage and frequency regulated. $59.50

10339 Leland
Output: 115 volts; 190 VA; single phase; 400 cycle, .90 pf and 26 volts; 60 VA; 400 cycle, .40 pf. Input: 27.5 volts DC, 18 amps. cont. duty, voltage and freq. regulated. $49.50

10486 Leland
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 pf. Input: 27.5 DC; 12.5 amps.; cont. duty. $70.00

10563 Leland
Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 pf. Input: 28.5 VAC; 12 amps. $35.00

F16 Jack & Heintz
Output: 115 volts, 400 cycle, 1 or 3 phase, 250 VA pf. 9. Input: 27.5 volts, 20 amp. Electronic frequency and voltage regulated. $99.50 each

PE109 Leland
Output: 115 VAC, 400 cyc.; single phase; 1.53 amp.; 8000 rpm. Input: 13.5 VDC; 29 amp. $50.00

PE218 Leland
Output: 115 VAC; single phase pf. 90; 380/500 cycle; 1500 VA. Input: 25-28 VDC; 92 amps.; 8000 rmps.; Exc. Volts 27.5. BRAND NEW $30.00

MG149F Holtzer-Cabot
Output: 26 VAC @ 250 VA; 115 V. @ 500 VA; single phase; 400 cycle. Input: 24 VDC @ 36 amps. $40.00

MG153 Holtzer-Cabot
Input: 24 VDC; 52 amps. Output: 115 volts —400 cycles, 3-phase, 750 VA. Voltage and frequency regulated. $95.00

AN 3499 Eicor, Class "A"
Input: 27.5 volts at 9.2 amps. AC. Output: 115 volts, 400 cycles; 3 phase, 100 voltamp; N... (Una... ...inuous duty. Price $39.50 each

PRECISION AUTOSYNS

MFGD. BY ECLIPSE-PIONEER

AY 200-4-B	Power Transmitter	$12.50
AY 201-1-B	Multi-Power Transmitter	15.00
AY 201-2-B	Receiver	15.00
AY 201-3-B	Generator or Control Transformer	12.50
AY 201-4-B	Power Transmitter	15.00
AY 202-2-B	Double Shaft Receiver	15.00
AY 202-4-B	Double Shaft Power Transmitter	15.00
AY 221-3-B	Sine Cosine Resolver	12.50
AY 231-3-B	Differential	9.50

SELSYNS-SYNCHROS

1CT Cont. Trans. 90/55V 60 cy.	$37.50
1DG Diff. Gen. 90/90V 60 cy.	37.50
1F Syn. Mtr. 115/90V 60 cy.	37.50
1G Gen. 115V 60 cy.	37.50
1SF Syn. Mtr. 115/90V 400 cy.	12.50
2J1F1 Gen. 115/57.5V 400 cy.	7.50
2J1F3 Gen. 115/57.5V 400 cy.	10.00
2J1FA1 Gen. 115/57.5V 400 cy.	7.50
2J1G1 57.5/57.5V 400 cy.	5.00
2J1H1 Diff. Gen. 57 5V 400 cy.	7.50
2J5D1 Cont. Trans. 105/55V 60 cy.	17.50
2J5F Cont. Trans. 105/55V 60 cy.	17.50
2J5H1 Gen. 115/105V 60 cy.	17.50
2J5M1 Gen. 115/57.5V 400 cy.	17.50
5CT Cont. Trans. 90/55V 60 cy.	34.50
5D Diff. Mtr. 90/90V 60 cy.	34.50
50DG Diff. Gen. 90/90V 60 cy.	34.50
5F Syn. Mtr. 115/90VAC 60 cy.	34.50
5G Syn. Gen. 115/90VAC 60 cy.	34.50
5HCT Cont. Trans. 90/55V 60 cy.	42.50
5SDG Diff. Gen. 90/90V 400 cy.	12.50
60G Diff. Gen. 90/90V 60 cy.	25.00
6G Syn. Gen. 115/90VAC 60 cy.	34.50
7G Syn. Gen. 115/90VAC 60 cy.	42.50
R110 2A Kearfott Cont. Mtr. 115V 400 cy.	17.50
R200 A Kearfott Cont. Trans. 26/11.8V 400 cy.	15.00
R210-1-A Kearfott Trans. 26/11 8V 400 cy.	20.00
R220 T-A Kearfott Receiver 26/11.8V 400 cy.	20.00
R235-1A Kearfott Resolver 26/11 8V 400 cy.	22.50
C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C76136 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
C78249 Syn. Diff. 115V 60 cy.	5.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 22V 60 cy.	7.50
403 Kollsman Autosyn. Mtr. 32V 60 cy.	7.50
FPE-25-11 Diehl Servo Mfr. 75/115V 60 cy.	19.50
FPE-43-1 Resolver 400 cy.	25.00
FJE-43-9 Resolver 115V 400 cy.	19.50
999-C411 Kollsman 26V 400 cy.	15.00
1377-0410 Kollsman 26V 400 cy.	10.00
1515B-0410 Kollsman 26V 400 cy.	20.00
10047-2A Bendix 26V 400 cy.	12.50
2900 Transicoil 115V 400 cy.	15.00
15CX4a Synchro Transmitter MK 22 MOD 1	15.00 ea.

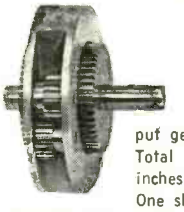
DIFFERENTIAL

Size 2-11/16" long 1-11/16" dia. 1-1 reverse ratio. ¼" shaft on each end; one shaft 25/32" long, one shaft 15/32" long. Input and output gear 1-23/32" dia. 53 teeth.

Stock No. 150

$3.50 ea.

SIMPLE DIFFERENTIAL



1 to 1 reverse ratio; 48 teeth on input and output gear, 1-1/32 inch diameter. Total outside diameter 1-25/32 inches. Shaft size is ¼ Inch. One shaft is 9/16" long; other shaft is 3/16" long. $5.00

Stock No. 151

CONDENSERS

10 mfd, G.E. 600 VDC w/mtg brackets	$.95 ea.
8 mfd. G.E. 600 VDC	.90 ea.
4 mfd, 600 VDC w/mtg brackets	.50 ea.
2 mfd, 600 VDC w/mtg brackets	.35 ea.
Mica, .01 mfd, 8000 volts, 20 amps, Type F3B	2.00 ea.

BALL DISC INTEGRATOR

Forward & Reverse 2¼-0-2¼. Input shaft spline gear 12 teeth 9/32" dia. ⅜" long. Output shaft 15/64" dia. x 15/32" long. Control shaft 11/32" x ⅜" long. Cast aluminum construction. Approx. size 3" x 3" x 2¾".

No. 145
$17.50 ea.

(All Shafts on Both Ball Bearing Supported)

SMALL DC MOTORS

(approx. size overall 3¾" x 1¼" dia.:)

5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled	$15.00 ea.
5069600 Delco PM 27.5 VDC 250 rpm	12.50
5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w. brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm 1x1x2")	5.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled	15.00 ea.
5BA10A118 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
5BA10AJ50, G.E., 12 VDC, 140 R.P.M.	15.00
206-1001 PM Planetary Gear Reduced Motor with Magnetic Brake. Mfgd. by Air Equipment 26 volts 600 ma 145 rpm	17.50
5BA10FJ33, G.E., 12 VDC, 56 R.P.M., reversible	15.00
806069 Oster series reversible 1/50 h.p. 10,000 rpm. 27.5 VDC 1⅝" x 3½"	5.00
C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm	3.00
7100-B-PM Hansen 24 VDC 160 rpm	7.50
SSFD-6-1 Diehl PM 27.5 VDC 10,000 rpm	4.00
6-volt PM motor mfgd. by Hansen 5,000 rpm 1¼" in dia., 2" long overall	4.00

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OA2WA	3.00
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OB3/VR90	.80
OC3/VR105	.50
OD3/VR150	.50
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EL-1C	1.50
1AD4	.80
1B22	1.00
1B24	5.00
1B35	3.25
1B35A	6.50
1B40	2.00
1B59	9.50
1B63A	16.00
1D21/SN4	5.00
1P21	30.00
1P22	4.00
1P25A	15.00
1P28	12.50
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2AP1	2.00
2AP1A	3.50
2BP1	3.50
2C36	35.00
2C39	4.00
2C39A	10.00
2C40	6.50
2C42	8.00
2C43	8.00
2C46	5.00
2C50	5.00
2C51	3.00
2C52	2.50
2D21	.75
2D21W	.95
2E22	2.00
2E24	2.00
2E26	3.25
2J33	12.50
2J51	200.00
2J52	50.00
2J59	50.00
2J61	7.50
2J62	3.00
2J64	75.00
2K25	12.00
2K26	30.00
2K28	27.50
2K29	35.00
2K30	75.00
2K33A	75.00
2K34	85.00
2K35	150.00
2K41	85.00
2K42	100.00
2K45	25.00
2K47	100.00
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2K50	100.00
2X2A	.75
3ABP1	50.00
3AP1	1.50
3AP11A	4.50
3B24	.75
3B24W	4.00
3B25	4.50
3B26	2.75
3B28	3.75
3B29	4.50
3BP1	2.00
EL-C3J	7.50
EL-C3J/A	9.50
EL-3C	3.50
3C23	3.50
3C24	2.00
3C30	3.00
3C33	5.00
3C45	4.25
3D22	9.50
3E22	5.00
3E29	8.50
3GP1	2.00
3J21	25.00
3J31	25.00
3JP1	7.50
3JP2	2.50
3JP7	7.50
3JP12	7.50
3KP1	7.50
3X2500A3	150.00
4-65A	13.50
4-125A	20.00
4-250A	32.50

4-400A	42.50
4-1000A	125.00
4B31	20.00
4B32	7.00
4C33	100.00
4D32	22.50
4E27	8.00
4J45	35.00
4J46	35.00
4J61	125.00
4PR60A	25.00
4X150A	18.50
4X500F	40.00
5AP1	2.50
EL-5B	4.00
5BP1	2.50
5BP1A	7.50
5BP2A	5.00
5C22	25.00
5CP1	2.50
5CP1A	7.50
5CP7A	8.50
5CP12	7.50
5FP14	5.00
5HP1	1.75
5JP1	7.50
5JP2A	5.00
5JP4	3.50
5JP5A	7.50
5JP11A	7.50
5LP1	12.50
5LP2A	7.50
5R4GY	1.20
5R4WGY	2.75
5RP1A	12.50
5RP11A	75.00
5SP1	30.00
5SP7	30.00
5UP7	12.50
5XP1	50.00
5XP11	50.00
5Y3WGT	1.00
EL-C6J	10.00
EL-C6L	5.00
6AC7W	.60
6AC7WA	4.75
6AG5WA	2.25
WE-6AK5	1.25
6AK5W	1.00
6AL5W	1.00
6AN5	2.15
6AN5WA	4.50
6AQ5W	1.75
6AR6	1.35
6AR6WA	6.00
6AS6	1.50
6AS6W	2.50
6AS7G	2.25
6AU6WA	1.85
6BA6W	1.15
6BE6W	2.00
6BL6	20.00
6BM6	25.00
6C21	15.00
6F4	2.25
6J4	1.15
6J4WA	2.25
6J6W	.85
6J6WA	2.25
6K4	2.00
6K4A	2.50
6L4	2.00
6L6WGA	3.25
6L6WGB	3.25
6Q5G	2.50
6SJ7WGT	2.00
6SK7W	.60
6SL7WGT	1.00
6SN7WGT	.75
6SU7GTY	2.00
6X4WA	2.50
6X5WGT	1.50
7MP7	15.00
7YP2	50.00
VX-10	4.00
12AT7WA	3.00
12AU7WA	2.50
FG-17	4.50
HK-24	2.00
HK-24G	2.00
26C6	.50
26Z5W	3.00
FG-27A	8.00
FG-32	4.50
FG-33	15.00
VX-33A	3.50
35T	4.00
35TG	2.00
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FP-54	75.00
VX-55	2.50

FG-57	6.50
RK-61	2.25
RK65/5D23	7.00
FG-67	6.75
HY-69	2.50
FG-81A	8.50
FG-95	13.50
100TH	6.00
102L	2.50
FG-104	30.00
FG-105	12.50
121A	2.50
122A	2.50
123A	2.50
124A	2.50
FG-172	15.00
FG-190	5.00
CE-203	5.00
203A	2.50
207	35.00
211H	10.00
CE-235A	5.00
FG-235A	55.00
242C	10.00
QK-243	40.00
244A	3.50
245A	5.00
249B	2.50
249C	2.50
250R	3.50
251A	40.00
252A	6.50
253A	2.00
254A	2.00
257A	10.00
259A	10.00
262B	4.75
FP-265	12.50
267B	3.50
268A	5.00
271A	7.50
272A	4.50
274A	2.50
274B	.50
275A	3.50
276A	10.00
279A	150.00
282A	2.00
282B	3.75
285A	4.50
286A	3.25
287A	2.00
293A	8.00
300B	7.00
304TH	17.50
304TL	17.50
310A	3.50
311A	3.50
313C	2.00
323A	7.50
323B	3.50
328A	3.50
336A	3.50
338A	3.50
339A	8.50
347A	2.50
350A	2.50
350B	2.50
354A	2.25
355A	7.50
375A	9.50
388A	1.00
393A	3.50
394A	2.50
403A	1.25
403B	2.25
404A	12.00
407A	2.25
408A	1.75
409A	4.00
417A	12.00
418A	17.50
420A	8.50
421A	4.00
429A	7.50
GL-434A	10.00
450TH	40.00
450TL	45.00
464A	1.00
GL-575A	10.00
631-P1	5.00
707B	2.00
715C	10.00
719A	10.00
721B	6.85
723A/B	6.50
725A	2.25
726A	4.00
726C	8.50
750TL	35.00
802	2.00

804	7.00
805	3.00
807	1.20
807W	1.25
810	10.00
811	2.85
812	2.50
813	8.75
814	1.75
815	1.75
816	1.50
828	8.00
829B	8.50
832A	6.50
834	5.00
835	2.00
836	1.15
837	1.25
845	2.00
850	5.00
866A	1.25
866 JR	1.25
868/PJ-23	1.50
869B	50.00
GL-872A	2.00
872A	1.00
874	.50
884	.95
885	.65
889RA	100.00
913	17.50
917	1.40
918	1.50
920	2.00
922	1.75
923	1.25
927	1.00
929	1.00
931A	3.75
959	1.15
CK-1006	3.00
1237	3.75
HY-1269	2.50
1274	2.50
1603	4.00
1614	1.50
1620	3.50
1624	1.10
1846	50.00
2050	1.00
2050W	2.50
5528	5.00
5550	30.00
5552	55.00
5553/FG258	75.00
5556	10.00
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5584	3.00
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5636	2.25
5636A	3.00
5637	2.75
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5639A	5.50
5640	5.00
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5642	1.10
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5647	3.50
5650	50.00
5651	1.20
5651WA	3.00
5654	1.20
5656	4.50
5663	.50
5667	100.00
5670	2.00
5670WA	3.50
5672	1.00
5675	8.00
5676	.75
5678	.75
5684	9.50
5685	10.00
5686	2.25
5687	2.00
5687WA	4.50
5691	4.50

5692	4.75
5693	3.50
5702	1.25
5703	.75
5704	1.15
5719	1.30
5720	17.50
5721	125.00
5725	2.50
5726	1.00
5727	1.25
5728	7.50
5734	13.25
5740	75.00
5749	1.15
5750	2.00
5751	1.85
5755	8.50
5763	.85
5783	2.50
5784	4.00
5796	6.50
5798	12.50
5800	6.00
5801	3.50
5803	3.00
5814A	2.00
5814WA	3.00
5819	30.00
5820	400.00
5824	2.50
5827	3.50
5828	6.00
5829	.80
5830	85.00
5839	5.00
5840	2.85
5842	12.00
5847	12.00
5854	.85
5881	3.25
5886	2.25
5894	16.00
5899	3.25
5902	3.75
5902A	5.00
5910	.50
5915	.50
5932	3.25
5933	1.25
5948/1754	100.00
5949/1907	75.00
5962	3.50
5963	1.25
5964	1.00
5975	2.50
5977	2.50
5979	6.00
5980	5.50
5981/5650	50.00
5993	8.00
5998	4.00
6005	1.75
6012	3.50
6021A	4.00
6037	40.00
6038	7.50
6073	1.25
6074	2.50
6080	3.50
6080WA	6.50
6087	4.00
6096	1.25
6098	6.00
6100	2.00
6101	2.25
6130	4.25
6134	4.75
6136	2.25
6137	2.00
6146	4.35
6186	2.25
6189	2.50
6201	3.00
6263	9.00
6264	9.00
6328	4.85
6463	1.85
6626	3.00
6627	2.50
6655	35.00
8005	4.00
8012A	3.00
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8014A	58.50
8020	1.25
9001	.70
9002	.50
9003	1.00
9005	2.50

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Searchlight Equipment Spotting Service

c/o ELECTRONICS,
330 W. 42nd St. N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment
Spotting Service
c/o ELECTRONICS
330 W. 42nd St., N. Y. 36, N. Y.

Please help us locate the following equipment components:

....
....
....

NAME ....
TITLE ....
COMPANY ....
STREET ....
CITY ....

11/1/57

this Searchlight Section of ELECTRONICS

is an index of reliable sources for Used and Surplus Equipment now available. Consult the **Searchlight Section** in regular monthly issues for later offerings.

If you don't see what you want—ask for it. Ask the advertisers. They are constantly adding to their stocks and may have acquired just what you need. And, when you have special items to dispose of, use the Searchlight Section of Electronics to help you locate buyers. . . . Send a list of your equipment and we will gladly give full information as to space and rates.

Classified Advertising Division

ELECTRONICS

P. O. Box 12 • New York 36, N. Y.

"For hard-to-find items try easy-to-find

ALVARADIO!"

INDUSTRIAL CONDENSERS

A) 80 mfd. 4,000 volts. General Electric. Cat. 14F204 .... $39.95
B) 100 mfd. 4,000 volts (Sprague Vit. Q) Cat. P15902 .... $49.95

COMPLETE UHF INSTALLATIONS

1) AN/GRC-32B GROUND RADIO INSTALLATION.
2) AN/CRD-6 DIRECTION FINDER INSTALLATION.
3) MAR UHF COMMUNICATION EQUIPMENT.

Write for prices and data.

1-222 SIGNAL GENERATOR-MICROVOLTER
Freq. range 8-15 MC. & 150-230 MC. Complete with all tubes and 5 MC. Calibrating Crystals. Self-contained 110 V. and 60 cycle power supply. With Schematic. Cost the Govt. approx. $700.00 Brand New.......... **$39.95**

RCA TV CAMERA

New. Surplus. We pay freight! Ideal for labs, industry, prisons, TV technicians, swim pools, medic, closed circuit TV, 1846 Iconoscope, 6-stage video amplifier and clipper.

$197.50

Test Equipment

AN/UPM-1, -7, -8, -10, -11
AN/GPM-14
LAE-1, -4
TS-32, -33, -34, -35
TS-36, -39, -45
TS-47, -56, -59
TS-62, -67, -74
TS-89, -92
TS-110, -111
UHF Micro-Volter Model 10
TS-125, -143
TS-182, -184
TS-204, -218, -277
TS-268, -294C
TS-488
I-56
IE-19
IE-35, -36

1,000's of other items
Tell us your needs!

Radar Equipment

APA, -6, -10, -11
APS-4, -6, -15
SCR-717, -720
SL APQ-13 TPS-10
APT-5A ART-26

GROUND ELECTRONICS

ARB	BC-342
ART-13	BC-344
BC-191	BC-348
BC-222	BC-375
BC-224	CRT-3
BC-312	TCS-12
BC-314	

AIRCRAFT ELECTRONICS

ARC-1	ARC-27
ARC-3	MN-62
ARC-4	MN-55
ARC-5	LP-21
ARC-12	LP-31
ARN-6	AS313-B
APN-9	RTA1B

SCR 718C

ALVARADIO INDUSTRIES

Established 1947. All items guaranteed.

Mailing Address:
P.O. Box 151-E, No. Hollywood, Calif.
Office-Warehouse:
5523 Satsuma Ave., No. Hollywood, Calif.
Cable Address: ALVARADIO

10 K 2 watt wire wound control w/shaft @ .08
35-35 mfg—350v plug in condensers, 90,000 pcs 18¢ ea. Special quantity prices to mfgrs. & exporters
NE47 Bulbs @ .06
2½" PM 1 oz. slug speakers @ 70¢
Ceramic condensers all sizes $15.00 M
American resistors ½ W $10.00 M
1 W $15.00 M
2 W $25.00 M
Micro switch normally closed 10,000 pcs low price for lot
Tubes JAN large quantities low prices. 6SH7. OD3. 395A. 125F7. 6SG7GT, 872A, 316A, 215A, 7193, 1642

BELVISION, INC.

254 Greenwich St., N. Y. 7, N. Y.
BArclay 7-6063

New Advertisements

received by November 1st will appear in the December issue subject to space limitations.

Classified Advertising Division
ELECTRONICS
P. O. Box 12 New York 36, N. Y.

TUBES

★ Brand New! Fresh! Guaranteed!
★ Nationally known brands!
★ Prices reduced from 5 to 30%!

BROADCAST TUBES

2H21	$25.00	310A	$3.50
2C51	3.00	311A	3.50
2E24	1.95	311B	4.00
2E22	2.35	313C	2.25
3C22	59.95	327A	3.40
3C33	5.00	328A	3.50
3E29	8.00	331a	6.00
3X2500A3	150.00	337A	5.00
4X150A	18.50	348A	4.00
4X150D	20.00	349A	4.50
4X250B	38.00	354A	8.00
4E27	7.00	356B	3.25
4-250	28.50	359A	1.10
4-125A	18.50	371A	1.00
4-400A	38.50	372A	2.10
4-1000A	125.00	373A	2.75
5D21	5.00	374A	2.75
5D23/RK65	7.00	381A	5.00
6C21	13.50	387A	4.00
15E	1.20	403A	1.25
24G	3.00	403B	2.50
HK24	2.50	404A	12.00
53A	5.00	407A	2.25
4E27A/5-125B HK54	1.95	408A	1.75
HY65	1.00	416B	25.00
100TH	6.00	417A	12.00
C100A	10.00	421A	4.50
101D	2.75	427A	10.00
101F	2.75	429A	7.50
104D	2.75	441A	5.00
121A	1.50	450TH	40.00
VT-127	1.00	471A	4.00
VT-127A	2.50	508	190.00
F-128A	7.00	575A	12.00
F129B	145.00	HK/654	15.00
VT-158	9.50	750TL	30.00
HF200	13.00	801A	.35
204A	22.50	813	8.50
211	.40	815	1.25
220B	55.00	828	8.00
227A	3.75	829	3.50
250TH	21.00	829B	8.00
250TL	12.00	830B	.45
251A	40.00	838	.70
252A	7.00	838W	2.50
253A	3.00	843	.35
254A	2.00	845	3.00
261A	7.00	852	4.00
262B	5.00	858	140.00
272A	5.00	864	.25
274B	.50	880	200.00
282A	2.00	889R	80.00
282B	3.75	1619	.30
287A	1.90	1620	3.50
300B	5.00	1625	.30
304TH	10.00	ZB3200	70.00
304TL	15.00	5680	130.00
305A	2.50	5736	110.00

5,000 SERIES & UP

5517	$1.00	5725/6AS6W	$2.75	6021	$3.00
5588	45.00	5726/6AL5W	.85	6045	2.00
5610	1.00	5744	1.00	6073	1.50
5633	4.00	5750	2.20	6080	3.50
5635	4.00	5751	2.00	6080WA	6.00
5636	2.40	5751WA	3.50	6096	1.30
5637	3.00	5763	.90	6098CT	1.90
5639	5.75	5783	3.75	6099	1.40
5641	4.00	5784	4.00	6100	2.00
5643	3.85	5784WA	6.00	6101	2.00
5644	5.00	5787	3.75	6106	8.00
5645	4.75	5787WA	4.75	6110	4.75
5646	3.75	5814	.50	6111	3.75
5647	3.75	5814A	1.50	6112	4.00
5651	1.25	5814WA	3.00	6116	45.00
5651WA	3.25	5829WA	3.50	6130	4.50
5654/6AK5W	1.25	5840	3.00	6136/6AU6WA	2.40
5654/6AK5W/6096	2.75	5840A	4.25	6147	3.00
5663	.95	5844	1.40	6159	3.00
5670	1.95	5851	2.50	6161	37.50
5670WA	4.00	5854	1.30	6189/12AU7	2.50
5672	1.00	5886	1.75	6201/12AT7WA	2.50
5677	5.00	5894	17.00	6211	1.00
5678	1.00	5896	3.00	6263	9.50
5687	2.00	5898	7.50	6279/5C22	27.00
5687WA	4.00	5899	3.25	6280/416B	35.00
5691	4.75	5899A	5.75	6386	5.00
5692	5.00	5902	4.00	6524	11.00
5696	.75	5932	3.00	7193	.20
5702	1.30	5933	1.50	8012	1.00
5702WA	3.85	5963	1.25	9001	.65
5703WA	3.85	5967	9.50	9002	.45
5704	1.20	5969	9.50	9003	.90
5718	1.25	5977	2.50	9004	.50
5718A	4.00	5977A	3.00	9006	.20
5719	1.49	5992	6.75		
5719A	2.75	5995	9.75		
		6000	2.00		
		6005	1.70		

RECTIFIERS & REGULATORS

OB2	$ .50	3B28	$4.00	313C	$2.25
OB2WA	2.25	3529	4.75	314A	80.00
OB3	.90	5R4GY	1.25	371A	1.00
OC3	.50	5R4WGY	2.50	371B	2.50
OC3	2.25	5Y3WGT	1.30	575A	10.00
OD3	.50	5X3	2.20	705A	.65
OD3W	2.25	6-4	.50	836	1.20
SB	2.00	6-7	.50	869B	32.50
SC	1.95	6-11	.50	872A	1.00
1V	.90	7H4B	.50	876	.75
2C53	9.00	15R	.25	878	.50
2X2	.25	RX21	5.00	VXR2700	6.00
2X2A	.75	100R/8020	2.75	991	.32
3B24	.65	249B	2.50	5931/5U4WG	4.00
3B24W	4.25	249C	2.50	8013	3.00
3B24WA	7.00	250R	3.95		
3B26	92.50	267B	4.95		

SCOPE TUBES

2AP1	$2.00	5CP11	$7.00
3AP1	1.50	5CP11A	8.50
3CP1	1.75	5FP7A	2.50
3DP1S2	4.75	5JP1	8.75
3FP7	1.00	5JP1A	25.00
3GP1	2.00	5NP1	2.00
3JP1	7.00	7BP1A	15.90
3W2P1	50.00	7CP1	4.99
3EP1	1.25	9LP7	10.00
5BP1A	8.50	12DP7	12.00
5BP4	2.25	51UCP11	25.00
5CP1	1.75	902P1	2.25
5CP1A	7.00		

KLYSTRONS

1K015XA/X481 B,C,D	$40.00	3K30	$90.00	723A/B	$6.50
SRX16	100.00	6BL6	24.00	726A	4.75
2K25	10.00	6BM6	27.50	726C.WE	18.00
2K28	24.00	6BM6A	28.50	726 C. RAY	11.50
2K43	100.00	V45	P.O.R.	5611	40.00
2K45	25.00	V50	75.00	5721	135.00
2K48	45.00	V52	P.O.R.	5981/5650	45.00
2K54	14.00	WL417A	2.00	6116	45.00
2K55	14.00	QK404	48.00	D178461/419A	48.00
		707B	1.75		

LIGHTHOUSE TUBES

2C39A	$10.00	2C46	$5.00	464A	$1.90
2C40	6.00	3C22	59.95	8011	1.00
2C42	8.00	446A	.50	8014A	60.00
2C43	7.75	446B	.75		

MAGNETRONS

2J21A	$4.75	4J31	$125.00
2J22	4.50	4J33	125.00
2J26	4.50	4J34	25.00
2J27	4.50	4J42	25.00
2J28	25.00	4J50	99.00
2J29	25.00	4J51	75.00
2J31	12.25	4J52	50.00
2J32	9.50	4J58	125.00
2J33	28.50	4J64	40.00
2J34	10.00	5J23	75.00
2J37	28.50	QK60	19.50
2J38	28.50	QK62	19.59
2J42	45.00	QK284	95.00
2J48	24.00	QK366	
2J49	32.50	QK367	
2J50	32.50	706AY-GY	9.50
2J51	130.00	720AY/CY	32.00
2J51A	148.00	728AY/CY	40.00
2J55	45.00	725A	2.50
2J56	38.00	5586	105.00
2J61	9.95	5657	100.00
2J62	4.00	5780	150.00
4J21	35.00	6177	75.00
4J26	45.00		

TR. AND ATR. TUBES

1B24	$5.50	1B40	$2.00	BL25/1B27	$12.00
1B24A	12.50	1B47	3.50	532A	.25
1B27	10.00	1B58	50.00	709A	.50
1B35	3.00	1Q22	40.00	724B	.65
1B35A	6.50	GA4	4.00	6232	17.00

THYRATRONS

C1K	$6.50	FG154	$9.00	2050	$1.00
1C	1.00	VT-158	9.00	VC-1258	16.00
2D21	.70	FG172	15.00	2050W	3.50
2D21W	.80	FG-271	22.00	2051	.65
3C45	5.00	323B	3.45	5559/FG57	8.00
4B25	5.00	354A	8.00	5796	7.00
C5B	.50	393A	3.35	5551/FG271	45.00
EL5B	5.00	394AWE	3.00	5948/1754	100.00
5C22	20.00	KU-627	7.00	5966/E36	33.50
C6M/5528	5.00	677	30.00	6130	4.50
FG-32	4.00	715C	10.00		
FG105	11.00	885	.75		

THIS IS PARTIAL LIST! Write for prices on thousands of other tubes now in stock.
SAME DAY SHIPMENT—ORDER NOW! Minimum order $10.00
All items F.O.B. Los Angeles, subject to prior sale and change of price without notice.
Write for unlisted items or call REpublic 5-0215. Cable: VHRADELECT. Bell Teletype: TWX LA 1460

V & H RADIO and ELECTRONICS

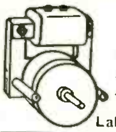
2029-2047 W. VENICE BLVD. LOS ANGELES 6, CALIF.

KOILED CORDS 3 wires $1.26
22 inches long stretches to 9 ft.

Only a few more left **GONIOMETER**
TYPE CFT-47372 — 250 to 1500 K.C.

nightlighter — Automatic lightswitch. Darkness throws the switch—turns lights on at dusk . . . off at dawn. Fools burglars who watch for signs of an empty house. Same as your city buys for $45 on top of street lamp posts. $15.95

TELECHRON Motors



1 RPM	$3.95	3. 6 RPM	$3.15
2 RPM	2.90	60 RPM	4.85
3 RPM	3.90	3 RPHr	2.35
4 RPM	3.90	1 RP 2Hr.	2.80
		1 RP 12Hr.	3.25

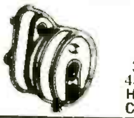
1 RPM—50 Cycles, $1.85
Laboratory Special 1 of Each Motor $25

PLEASE INCLUDE POSTAGE

D-E-L-A-Y-E-D A-C-T-I-O-N LIGHT SWITCH
Shuts light off automatically almost a minute later. Keeps porch or garage light on after you shut it off $3.50
DEALERS WRITE FOR PRICES.

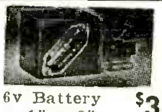
6 Watt Most POWERFUL TELECHRON MOTOR
110 V, 60 Cy
1 RPM 6.50

HAYDON TIMING MOTORS



1 RPM 110v 60cy	2.60
1 RPM 230v 60cy	1.00
2 RPM 230v 60cy	1.00
30 RPM 110v 60cy	2.60
450 RPM, yes 450 RPM	1.30
HANSEN Synchron 4 RPM	4.24
CRAMER 4 RPM	4.65

DIEHL or DELCO
P.M. motors. Made for 24 volts. Will work at lower speed at 12v. or 6v Battery or Rectifier. Size 1" x 1" x 2". $3.75



BLAN EST. 1923
64 U Dey St.
New York 7
N. Y.

COMMUNICATIONS EQUIPMENT & TEST EQUIPMENT

SEND US YOUR LIST OF REQUIREMENTS

ALL THE BEST & FINEST AT LOW PRICES

Also Maintenance Manual AN/ARC-27 1953 Revision

MAIL, WIRE OR TELEPHONE FOR QUOTE

MONTGOMERY EQUIPMENT CO.

14315 BESSEMER ST. VAN NUYS, CALIFORNIA
TEL: STate 6-4657 *Telegraph YHV Van Nuys*

These "Searchlight" advertisements

are live opportunities in the Electronic field.

Each announcement represents a current Want or Offering of an organization or individual in the field. Some have money-saving possibilities, others are opportunities for more business; many offer equipment—used or surplus new.

"Searchlight" advertisements are constantly changing. New opportunities are constantly finding their way into this great Want medium, each issue. Regular reading of the "Searchlight" pages can be as important to you as reading the editorial sections; Editorial matter is news of the industry; Advertising is NEWS OF OPPORTUNITIES offered in the Industry.

for EVERY business WANT
"Think SEARCHLIGHT first"

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RELIABILITY FACTORS FOR GROUND ELECTRONIC EQUIPMENT

Methods and working data to help designers build greater reliability into military electronic equipment. Pinpoints causes of poor reliability. Discusses electrical and mechanical factors, human engineering, and components. Gives results of failed-parts studies. **Edited by Keith Henney, 280 pp., 196 illus., $8.50**

ELECTRONIC ENGINEERING

Techniques of circuit analysis for radar, television, electronic control, instrumentation, and computers. Gives alternate methods for many circuits, and provides means for combining circuits of different types. Examples relate techniques to practice. Discusses solid state theory, and transistors as circuit elements. **By Samuel Seely, Prof. & Chrmn., Dept. of Elec. Engrg., Syracuse U. 525 pp., 782 illus., $8.00**

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Presents theory and practical techniques for analyzing linear control systems subjected to random inputs. Treats concepts of probability and random time functions in detail. Develops techniques for designing systems containing constant and time-varying components. Provides computational methods for use on computers. **By J. H. Laning, Jr., and R. H. Battin, Instrument Lab., Mass. Inst. of Tech., 429 pp., illus., $10.00**

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Over 500 questions and complete answers to help engineers pass state license examination. Covers mechanical, electrical, civil, and chemical engineering, and includes engineering economics and land surveying. Latest questions—suitable for all states. Author has worked on New Jersey examination preparation for 19 years. **By William S. Lalonde, Jr., 462 pages, 234 illustrations, $6.50.**

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FORTUNE Magazine editors tell how 4 billion dollars for research is opening new business opportunities. Reveals who does research, who pays, how it is carried out, what is accomplished and *what it means to you*. By Editors of FORTUNE. 308 pp., 21 illus., $4.00

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Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus few cents for delivery costs, and return unwanted book(s) postpaid. (We pay delivery costs if you remit with this coupon—same return privilege.)

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- ☐ Seely—Electronic Engineering—$8.00
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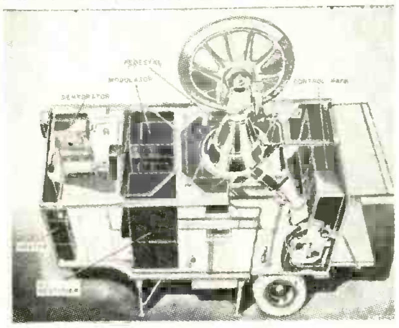
SCR 584

RADAR TRAILER

IN STOCK AS NEW—COMPLETE
FULLY EQUIPPED. 10 CM.
SEARCH AND TRACK. PPI.

A Rare Opportunity. Call Us



RADIO-RESEARCH INSTRUMENT Co.
550 — 5 Ave., N. Y. 36, N. Y. Tel: JU 6-4691
PAUL J. PLISHNER

WANTED!

VRC
PRC
TRC
&
GRC
Equip.

We also need ART-13 BC-224
BC-348, APN-9. What else have you?
J. J. CANDEE CO. Dept. E.
4002 W. Burbank Blvd., Burbank, Calif.
Phone: VIctoria 9-2411

ART-13 APR-4 BC-348

BC-221, BC-342, BC-312, ARC-1, ARC-3, DY-17, Teletype Printers, Boehme Keyers, BC-610E

ALLTRONICS-HOWARD CO.
Box 19, Boston 1, Mass. (Richmond 2-0048)

GENUINE OAK WOOD
Antique
TELEPHONES!

As is $9.00 complete. Tested working order $12.00. Shipments FOB Simpson, Pa. Write for free list.
TELEPHONE ENGINEERING CO.
Dept. E-11 Simpson, Pa.

IF THERE IS
Anything you want
that other readers of this paper can supply
OR—
Something you don't want
that other readers can use, advertise it in the
Searchlight Section

• SPECIAL OFFERING •

• TUBES •

25,000–VR150	.27
15,000–2C4 2½ V. gas thyratron tube	.50
100,000–1U4	.30
50,000–6J4	.40
50,000–6BA6	.35
50,000–12AT7	.55
10,000–956	.20
2,000–805	2.50
1,000–838	.20
10,000–1625	.20
50,000–1626	.05
10,000–1632	.20
2,000–1960	.20
2,000–5676	.50
5,000–5654/6AKSW	1.30
2,000–5841	1.25
1,000–CK1026	1.25
500–533AX	1.25
1,500–5829WA	2.00
500–6111	2.50
200–5896	2.50
100–5647	2.50
1,100–5977	2.00
500–2C39A	7.50

MOST ARE JAN BOXED

500–5AP1	3.00
2,000–5CP1	3.00
200–861	5.00
200–851	5.00
2,000–371B	.50
2,000–826	.35
2,000–6107/BS212 Anton Integrated	1.00
2,000–6108/BS213 Anton Integrated	1.00
2,000–958A	.20
2,000–26D6	.50
10,000–6SG7GT	.20
50,000–6U7G	.10
10,000–6J7G	.15
10,000–6K7G	.15
5,000–VT67 (30 special)	.10
5,000–VT25A (10 special)	.15
2,000–2C34	.15
50,000–1N22 Diode Ind. Box	.07
25,000–1N23 Ind. Box	.15
2,000–WL1B32/532A	.15
100–5CP7A	4.00

1,000–6J4WA	1.00
200–2C43	7.00
2,000–RK73	.20
1,000–843	.15
1,000–865	.15
500–2E29	.50
1,000–7AG7	.55
2,000–12KAGT	.25
1,000–12K8 metal	.35
500–6SN7WGT	.75
600–REL36	.30
1,000–902PI	1.00
10,000–954	.10
10,000–955	.25
10,000–957	.25
100–Magnatron 5J26 orig. carton	150.00
5–Magnatron QK264 orig. case	750.00
400–450TH orig. Omac	35.00
1,000–837	.80
2,500–6ACW	.55
20,000–6SD7GT	.17
5,000–6SN7	.50

50,000—½ Mg. vol. control ¾" dia. screwdriver shaft $50.00 per thousand

• RESISTORS •

HAVE ON HAND 5 MILLION RESISTORS, 3 million micas, 1,500,000 ceramics CHEAP

Silver ceramic trimmers
types TS2A 1½ to 4½, 3/13, 4/30, 7-45, have 20,000 of each $150 per M jobber box

1,000 relays 115VAC double pole single throw 30 AMP. height 6104/20A Leach $4.00

1,000 2½ round 0 to 5 mills meters ind. boxed, black scale full def. $2.50

Geiger Counter radiation detector
500 type WF10A list $119.50 $29.95
500 type WF12A list $149.50 39.95
ind. boxed guaranteed mfg. by largest mfg. in world

50,000 Fire Chief of POF dry chemical fire extinguishers 40¢ ea. in quantity only

Johnson 829B sockets 122/101 $1.00

2,000 UNICITE cinch 829B socket 75¢

500 Circuit breaker switch cat. no. AM10510M6 2 Amps. 115 VAC curve 3 H. P. $2.00

250 Crouse-Hinds obstruction light, red—EOL type, waterproof, ideal for airport use, industrial fence lighting, outdoor waterproof, agal socket. Cost $12.50 ind. box $4.00

10,000 telephone type 28V relays ind. box—all types of contacts available $35 per hundred.

Have 4,000—10MFD—600V—CAT25F339 ceramic ins. with brackets $1.05

10,000—2MFD—600V—Bathtub side terminals type DYR cans 35¢

50,000—1MFD—600V—CP69 rect. mounting bracket, bottom but terminals 12¢

50,000—2000MFD—15VDC electrolitic, alum.—can plug in for octal socket 30¢

100,000—35-35—350V electrolitic, alum. can plug in for octal socket 15¢

10,000—Pyramid metalized MPDKR 1.5/8 8 MFD 150V.D.C. 225VTDC standard bathtub container, side terminals, type DYR can 50¢

5,000—Hammerstund variable cap. .0001 large size trans. type. ceramic insulators 2.500 volt 23 plates large spacing $1.25

DISCOPHONE SALES CO, INC

35 Vestry Street New York 13, N Y WOrth 6-0512

Wire Or Call Collect — Samples On Request

"TAB" THAT'S A BUY

NEW SILICON "SILTAB"® JUNCTION HIGH TEMPERATURE RECTIFIERS
OPERATION TO 190°C, HIGH POWER & SMALL IN SIZE, LO-VOLTAGE DROP, HI-EFFICIENCY

MAX DC AMPS	HALF-WAVE 35VAC 16VDC	70VAC 32VDC	105VAC 48VDC	140VAC 64VDC	FULL WAVE 1φ BRIDGE 36VAC 32VDC	72VAC 64VDC	105VAC 95VDC	140VAC 125VDC	245VAC 220VDC
20	VA35 $15	VA70 $20	VA105 $25	VA140 $30					
40	VA35‡ $15	VA70‡ $20	VA105‡ $25	VA140‡ $30	XD36 $60	XD72 $83	XD105 $95	XD140 $109	XD245 $190
60	VE35 $43	VE70 $65	VE105 $75	VE140 $85					
80					XD36‡ $60	XD72‡ $83	XD105‡ $95	XD140‡ $109	XD245‡ $190
120	VE35‡ $43	VE70‡ $65	VE105‡ $75	VE140‡ $85					

MAX DC AMPS	FULL WAVE 3φ BRIDGE 36VAC 48VDC	72VAC 96VDC	105VAC 144VDC	140VAC 188VDC	175VAC 235VDC	210VAC 283VDC
60	YE36 $89	YE72 $124	YE105 $142	YE140 $164	YE175 $188	YE210 $218
120	YE36‡ $89	YE72‡ $124	YE105‡ $142	YE140‡ $164	YE175‡ $188	YE210‡ $218
200	YJ36 $267	YJ72 $370	YJ105 $440	YJ140 $530	YJ175 $640	YJ210 $700
450	YJ36‡ $267	YJ72‡ $370	YJ105‡ $440	YJ140‡ $530	YJ175‡ $640	YJ210‡ $700

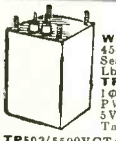
MAX DC AMPS	F.W. CENTER—TAP 1φ VAC 36VCT 16VDC	VAC 72VCT 32VDC	VAC 103VCT 48VDC	VAC 144VCT 64VDC	VAC 210VCT 94VDC	VAC 280VCT 127VDC
40	WD18 $29	WD36 $41	WD54 $49	WD72 $59	WD105 $78	WD140 $100
80	WD18‡ $29	WD36‡ $41	WD54‡ $49	WD72‡ $59	WD105‡ $78	WD140‡ $100

MAX DC AMPS	HALF-WAVE 3φ VAC 18/3X 14VDC	VAC 36/3X 28VDC
200	TJ18 $138	TJ36 $236
450	TJ18‡ $138	TJ36‡ $236

MAX DC AMPS	HALF-WAVE 6φ VAC 18VCT/6X 22VDC	VAC 32VCT/6X 39VDC	F.W. 6φ BRIDGE VAC 9VCT/6X 11VDC	VAC 24V/6X 30VDC	VAC 105V/6X 144VDC
360	RN18 $290	RN32 $360	RS9 $540	RS24 $590	RS144 $900
900	RN18‡ $290	RN32‡ $360	RS9‡ $540	RS24‡ $590	RS144‡ $900

‡FORCED AIR COOLED 1000 F.P.M.! ALL OTHERS SELF COOLED

450 MA CHOKE $3 @



W.E. Mfgr for U.S.N. Rated 4Hy 450ma/3KV/27 ohms hermetic Sealed & Cased 4½x3½x4¼"x10 Lbs. #CH1001 SPECIAL $3@

TRANSFORMERS all 115V/60cy/1φ PRIMARYS VAC. H'Sealed PWR&FIL/U.S.N. 6V@8A/5V@3A&1200VCT @ 200ma. Tapped pri .... $6.50@, 2for$12

TP502/5500VCT@650ma/WST/USN $39
TPF52/778VCT@200ma/5V@3A, 6.3VCT@5A .... $4@, 3for$11, 25for$70
TPF53/540VCT @ 30ma/6.3V@2A, $2@ ... 4/$7
TPF54/150V @ 30ma/6.3V @ 1A, $1.49@ ... 3/$4
TPF55/4.5KV@10ma/650VCT@275ma/6.4V@10A & 5V@8A/2.5V@3A. $7@, 2for$12
TPF56/900VCT@35ma/2x2.5V @ 2A $3@, 2for$5
TPF57/2500@10ma/2.5V@2A/H'SLD $4@, 3/$10
TPF58/5850, 5400, 5000VCT @ 40ma/$9@
TF01/2.5V@2A $1@ TF02/2.5VCT @ 10A/5KV $4@. TR4000R/2x6v.@1A ea $3.45
TF03/2.5VCT@10A/12.5KV .... $7@, 2/$11
TF04/32V@1A/..$3.45@. TF09/20V@1A/..$2@
TF05/7.5VCT/12A/15KV KENYON .... $9@
TF06/2X12V@2A/or 24V@2A $4@ .... 2for$7
TPH isolation 110to220&440VAC/150W $4@.
MIL-T-27 TRANSF Hermetic Sealed
TFM10/6.3V/1.2A/$2: TFM11/5VCT@3A/6.3VCT@5A .... $5@, 2for$9
TFM12/2x5V@3A/&2x5V@2A .... $5@, 2for$9
TFM13/2x2.5V@6A at 3KV .... $5@, 2for$9
TFM14/6.3VCT@9A/&2x6.3@1.2A $6@, 2for$11
TP513 up to 1250VCT@1000ma has taps pri & secd Mil/T-H'sld Acq$81@ Special $12
TP508 Pri230V. Secd 1550VCT&taps@167ma. Can use on 115Vinpt. Secd 800VCT@200ma, $6
TP509 Pri220V/Secd 1088VCT@320ma $5
TP510 Pri220V/Secd860VCT@525ma $3
TP514 Pri/110,220,440V—Secd880VCT@735ma G.E./USN Acq$79@ .... $9@, 2 for $15
TP515XP Pri/115V-Secd 2000VCT@700ma Mil-T/H'sld & Companion Choke 1.8Hy@11Ω/700ma & Oil Capacitors & Bridge 866A(4) Tubes&Fil Transformers $45

CH1033 Choke 1.8Hy@11Ω/700ma. $6@, 2for$10
CHOKE 1000 Hys @ 5 ma/12KV insulation $3@
CH1029 CHOKE 8Hy @ 750 ma/G.E. ... $12@
CH1030 CHOKE 6Hy @ 1.25 A/G.E. ... $18@
CH1031 CHOKE 0.6 Hy @ 3.2 A/G.E. ... $10@
CH1032 CHOKE 10Hy @ 350 ma/G.E. ... $5@
CH1033 CHOKE 2.5 Hy @ 800 ma/G.E. ... $7@
CH1034 CHOKE 5 Hy @ 500 ma/G.E. ... $6@
CHOKE 8Hy @ 150ma/USN H'sld $2@, 3 for $5
CHOKE 20Hy @ 75ma/$1@.
Write for Transformer Catalog!

RF INTERFERENCE FILTERS 200 amp/130VAC ... $12@
Laboratory Insts—Write for Catalog!
KEPCO #141 New V'Reg/400V@150ma ... $139
SORENSON Model #E12-15 New V'Reg 95to 130V output 12V@15A magnetic regulated $225
DUMONT V'Reg 30KV&400VDC Supply ... $25
TS174U/$199, TS47APR/$180, TS34AP/$75

WRITE FOR INDUSTRIAL CATALOG

NEW G.E. PHONO CARTRIDGES

4G061/LP or 4G063/78 Diamond ... $15
4G050/LP & 78 Sapphire ... $7
4G053/LP & 78 Diamonds ... $25
4G052 LP & 78 Diamond & Sap ... $17

WRITE for HI-FI CATALOG

Guaranteed Phono Replacement Needles —Registered 1 Year Gtd.
Single Diamond $7: Dual Diamond $14.00 Dia/Sapphire $8.00@ *Send Cartridge Name & Number Postpaid U.S.A.*

New Variable Voltage X-frms

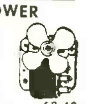
SUPERIOR-GR-STACO
0-132v-1.25A $7.23
0-135V/3A 10.63
Cased 0-135V/7.5A 19.55
Uncased/0 135V/7.5A 15.30
Cased/0-270V/3A 22.10
Uncased/0-270V/3A 17.00
Cased/0-135V/15A 39.10
Cased/0-270/9A 39.10
Uncased 0-135V@30A 44.10
Uncased 0-270V@12A 44.10
Uncased 0-135V@60A 113.00
Uncased 0-270V@30A 113.00
Uncased 0-270V@60A 189.00
100BU3-3 φ @ 240/out 0-240/520W/1.2A $36
300BU3-3 φ @ 230/out 0-230/1.2KVA/3A 50
600BU3-3 φ @ 230/out 0-270/3 5KVA/7.5A 57
1500B3-3 φ @ 230/out 0-270/7KVA/15A 132
3000B3-3 φ @ 230/out 0-270/14KVA/30A 164
3000B6-3 φ @ 230/out 0-270/28KVA/60A 354

Delivery From Stock! Mfgr's We Stock For/U At Lowest Qty Price!

PRECISION POTENTIOMETERS

HELIPOT, MULTIPOT Ten Turn/0.5% ohms 100, 1000, 5000, 20K, 30K, 100K ... $6.98@, 2 for $12
Heli & Multipot 3 Turn 60Ω 5KΩ $5.98
TIC & Frchld one rev—10KΩ. $3@, 2/$5
Micropot 901S/0.1% LinZB; 20K, 100KΩ .... $10@, 2for$18, 6for$48
Micropot-Microdials .... $4@
GR$301/10,000 ohm/4Watt .... .95@
GR$314/50,000 ohm/8Watt .... 2.45@
DeJur 20,000 ohm/12Watt .... 3.00@
TRIMPOT Miniature 2,000 ohms CW .... $1@

$1 MINIATURE FAN BLOWER



COOL THAT TUBE EQUIPMENT or TRANSISTOR. TAPPED for 6&12VAC/60cy. Also on 400 cys as well. BARBER COLEMAN Mfgr. $1@. 12 for $10
DC MINFAN 12 to 28VDC $3
Dual Blower 115v/60cy $11
28v/100CFM Blower $2.49
Oster Miniature 400cy Blower $3

STEVENS ARNOLD PRECISION DC-AC CHOPPER TYPE CH365

SPDT/COIL 26VDC800. Ω IMP 60Cys/830 Ω 400Cys/1100 Ω. Use as Chopper Reg$20@ SPECIAL .... $2.50@, 5for$10

New "TESKEL"® SELENIUM RECTIFIERS* to Your Specs Any Current.

Quick Deliveries! *Write for Quantity Prices.* ***Specials in 24 hours ! ! !***

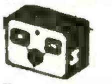
***FULL WAVE BRIDGE & †C.T. • DATED & ONE YEAR GTD.**

MAX DC AMP	Single Phase Full Wave Bridge 18VAC 14VDC	36VAC 28VDC	54VAC 42VDC	72VAC 54VDC	130VAC 100VDC	266VAC 217VDC	3-Phase Bridge 3-Phase 16VAC 2/VDC	3-Phase 30VAC 36VDC	3-Phase 120VAC 150VDC	3-Phase 208VAC 256VDC
1	$1.50	$2.30	$3.75	$5.30	$8.75	$27.90	$3.75	$4.90	$21.45	$39.75
2	2.35	3.35	5.40	6.45	11.70	33.60	4.75	5.95	24.90	47.90
3	3.00	4.15	6.30	9.60	13.45	42.90	5.40	6.85	27.60	63.30
4	3.70	7.50	11.30	16.15	25.00	49.80	6.75	7.95	31.15	69.75
6	4.45	8.85	12.90	19.30	32.85	63.90	7.90	9.30	48.45	81.90
10	6.50	12.60	19.90	27.90	42.30	99.70	9.00	14.25	63.60	117.75
12	8.10	15.90	22.50	32.75	45.90	111.45	10.75	16.15	69.75	137.90
20	13.20	25.40	38.00	52.50	79.45	177.90	16.20	24.75	124.15	165.75
24	16.15	32.40	44.90	63.60	86.35	210.60	18.60	31.70	149.70	279.90
30	19.80	37.80	56.45	78.75	120.75	256.15	21.60	34.95	189.60	363.75
36	24.90	48.45	72.45	95.70	147.60	326.70	24.75	39.30	225.75	399.60
50	33.45	63.75	121.50	135.75	192.75	445.90	31.60	46.75	297.90	591.75

BATTERY CHARGER STACKS*† REPLACEMENT OR CONVERSION. *FAN COOLED*

Type	CR20R†	CR32D†	BR18R*	BR18C*	BN18R*
Input	10VAC/CT	16VAC/CT	18VAC	18VAC	18VAC
Output	6VDC/100A	6VDC @ 100 Amp &	12 VDC @	50 Amp	6V/80A & 12V/40A
	$14	$20	$24	$26	$20

"TEK-AP"® TABPAKS!
High Current Power Supplies
One Year Guarantee



Variable 0-28 VDC. Completely built. Ready to go. Full Wave Selenium Rectifier, Transformer, Variac, Meters, Pilot Light, 4" Volt & Amp Meters, Switch, Terminals & Fuse. Hvy Duty Steel Cabinet. Std. 115V/60cy **Input or 220V† (3 phase) to order.**

Stock Number	Continuous Rating	With Meters
T28V5A*	0-28 WVDC at 5 Amp	$57
T28V5ACC	5 Amp (1% Ripple)	84
T28V5A2CC	5 Amp 0.1% Ripple	155
T28V12A	0-28 VDC at 12 Amp	138
T28V12ACC	12 Amp (1% Ripple)	168
T28V12A2CC	12 Amp 0.1% Ripple	250
T28V24A†	0-28 VDC at 24 Amp	175
T28V24ACC†	24 Amp 1% Ripple	250
T28V24A2CC†	24 Amp 0.1% Ripple	345
T28V50A†	0-28 VDC at 50 Amp	325
T28V50ACC†	50 Amp (1% Ripple)	450
T28V100A†	0-28 VDC at 100 Amp	550
T28V100ACC†	100 Amp (1% Ripple)	750
T35V16ACC†	0 to 35V @ 16 Amp/.5% Rip	210
T35V25ACC†	0-35V @ 25 Amp (1% Rip.)	370
T35V50ACC†	0-35V @ 50 Amp (1% Rip.)	639
T60V1ACC	0-60 VDC @ 1 Amp/1% Rip	108
T60V2ACC	0-60 VDC @ 2 Amp/1% Rip	139
T60V5ACC	0-60 VDC @ 5 Amp/1% Rip	225

Variable 0-130 VDC Completely built. Includes Isolation Transformer, Selenium F.W. Bridge, Rectifier, 4" Rectangular Volt & Ammeter Specify for 115 or 230VAC/1φ/60cy input.

T130V5A†	0-130 VDC at 5 Amp	$225
T130V5ACC†	5 Amp (1% Ripple)	275
T130V10A†	0-130 VDC at 10 Amp.	275
T130V10ACC†	10 Amp 1% Ripple	369

Includes 4" Meters 2% Acy. *2" Meters

"TABTRAN" Rectifier Xfmrs

Sec'd Series Volts (DUAL† 0-9-15-28-&-0-9-15-18 Sec'ds 0-3-6-9-12-15-18-21-24-27-30-33-36 Volts

TR4001 @ 1 Amp† ea/sec/w $4.95
TR4002 @ 2 Amp† ea/sec/w 7.20
TR4003 @ 5 Amp† ea/sec/w 9.45
TR4005 @ 12 Amp† ea/sec/w 16.70
TR4006 @ 24 Amp† ea/sec/w 35.65
TR4007 @ 50 Amp†* per ea sec wndg. .. 59.65
TR4008 @ 100 Amp†* per ea sec wndg. .117.00
† Wndgs in Series at Ratings shown; Parallel 2X Current, Voltage outpt. 0-9-15-18.
*Dual Pri 115 & 230VAC/60cys INPUT

"TABTRAN" Rectifier Chokes

CR6001/ 1 Amp/0.1 HY/1.4 Ohm $3.50
CR6002/ 2 Amp/0.1 HY/.67 Ohm 5.45
CR6003/ 5 Amp/.07 HY/.6 Ohm 9.45
CR6004/12 Amp/.01 HY/.1 Ohm 14.75
CR6005/24 Amp/.001 HY/.025 Ohm 29.75
CR6006/50 Amp/.001 HY/.001 Ohm 47.85

New Hi-Capacity Condensers

CE156M 6000MFD 15V ... $2@; 2/$3: 10/$12
CE502M 2000MFD 50V ... $4 ea. 10 for $30
CE2005M 500mfd@200V .... $6@
CE20025M 2500mfd @ 200V .... $12@
Brackets for Capacitors @ 25c each

NEW 230 TO 115 V AUTOFORMERS

For 220v/60cy Input. To 110-120V or Step up. † With Cord Plug & Receptacle.
TPA050/50W* $2.55
TPA075/75W† 3.65
TPA100/100W† 4.00
TPA200/200W† 5.75
TPA250/250W† 6.75
TPA500/500W† 8.25
TPA750/750W† 11.79
TPA1000/1KW† $16.95; TPA2000/2KW* $22.50
TPA2000/2KW* $34; TPA3000/3KW* $51
**Less Cord, Plug & Receptacle.*

NEW! LOW PRICED HIGH CURRENT BASIC INDUSTRIAL SUPPLIES

Consisting of Transformer & Full Wave Bridge Rectifier mtd and wired, fused, outlet, pilot light & ventilated grill & chassis or cabinet. **Ready to deliver constant DC Power. 1 yr. Gtd. Input 115VAC/60cys, 220V or 3φ to order!**

Stock Number	Continuous Rating	Unit Price
B28V/5A	28 WVDC at 5 Amp	$45
B28V/5ACC	5 Amp (1% Ripple)	69
B28V/12A	28 VDC at 12 Amp	90
B28V/12ACC	12 Amp (1% Ripple)	135
B28V/24A	28 VDC at 24 Amp	139
B28V/24ACC	24 Amp (1% Ripple)	189
B28V/50A*	28 VDC at 50 Amp	225
B28V/50ACC*	50 Amp (1% Ripple)	350
B28V/100A*	28 VDC at 100 Amp	439
B28V/100ACC*	100 Amp (1% Ripple)	600
B100V1A	100 VDC @ 1 Amp	39
B115V1.5A	115 VDC @ 1.5 Amp	52
B115V5A*	115 VDC @ 5 Amp	120
B220V5A*	220 VDC @ 5 Amp	234
B115V5ACC*	115 VDC @ 5 Amp/1% Rip	169
B115V10ACC*	115 VDC @ 10 Amp/1% Rip	275
B220V10ACC*	220 VDC @ 10 Amp/1% Rip	468

* 115 & 230 VAC/60cy/1φ Input

New Isolation & Control Transformers

Indoor Power Type Elec/Static-Shielded Primary 115&230V & Secondary 1;5/230V 1φ 60 cys. Also 230/460 V Same Price

TPP050/50W $10	TPP075/75W $12
TPP100/100W $13	TPP150/150W $14
TPP250/250W $17	TPP500/500W $25
TPP750/750W $32	TPP1000/1KW $39
TPP2000/2KW $59	TPP30000/3KW $81

New 5-Way Binding "TEK-AP"® POSTS

Similar to Superior DF30*, takes plugs, tips' lugs wire. 1/16" to 1/4" panels.
BP30*, 30 Amp, 29c @ 12/$3.25 .... 100/$22
BP10*, 10 Amp, 18c @ .... 100/$15
BP60*, 60 Amp, 75c @ .... 50/$30
BP100, 100 Amp, $1 @ .... 24/$18
Mfrs. write quantity prices & Blue Prints

New Variable 0 to 6 & 12 Volt D.C. Power Supplies

12 Amp Battery Eliminator, Charger, Model RR, Plater, Aircraft, Marine or any DC Reg. Extra Hvy Duty Selenium Rectifier, 2 Meters V. & A. Dsgnd far Cont. Service and up to 20 Amp. Intermittent overload. 10% ripple. **Model T612V12AC $33.00**
T612V12ACC only 0.5% Ripple at 5 Amps $43.00

"TEK-AP"® New 1&3φ400 Cys Power

3φ 400 cys /115v/750 watt & 1φ/400 cys 26v @ 250 watts with voltage adjustment. Operates 115 & 230v/ 60CY/1φ Input, 28VDC @ 60 amps Filtered to inbuilt Inverter, V/adj & Freq/adj & R.F.Filter All in Cabinet.
T4750B Basic Supply $475

"TEK-AP"® 1φ 400 cys/115v/485 watts Power Supply Pckg Input 115v/60cys
T4485B $299

NEW VARIABLE 0 to 6 & 12V. SUPPLIES

6 V @ 50 AMPS & 12 V @ 25 Amps FILTERED 2% RIPPLE 115VAC/60 CY/1φ INPUT ONE YEAR GTD.
T612SNACC $200

NEW 24—28VDC RELAY VDC SUPPLIES

Cased Filtered Ready to Work
B24VAR 24VDC at 1 amp Filtered $6
B24VER 24VDC at 2 amp Filtered $11
B24VJR 24VDC at 5 amp Filtered $21

SINCE 1945 CERTIFIED TUBE TESTING AGEING & PRESELECT FACILITIES WRITE!

TUBES
"TAB" TESTED *INSPECTED* GUARANTEED!!!

WRITE FOR COMPLETE TUBE LIST

6AG5 $ .69	RK20 $8.00	100L $11.29	OZ4 $ .60	2J21A $4.00	3D23 $5.00	534X $2.00
6C4 .49	24G 2.00	G104 29.00	C1A 10.50	2J22 3.70	3E29 8.00	536X 1.49
6C21 14.00	25A6 1.19	G105 11.00	C1B 2.88	2J26 9.29	3J31 35.00	538X 1.45
6CA7 3.49	25A7 2.19	152L 32.00	1B3 .78	2J27 4.00	3K23 160.00	539X 2.00
6CB6 .80	25BQ6 1.39	F200 10.25	1B21 3.78	2J31 9.00	3K27 150.00	541X 2.00
6D4 2.39	25L6 .72	242 12.50	1B22A 5.00	2J32 9.00	3K30 200.00	543X 2.00
6F4 2.49	25T 7.00	245 14.75	1B23 5.00	2J33 19.00	3S4 .68	544X 1.45
6H6 .59	25Z5 .72	249B 3.30	1B24 5.00	2J34 14.00	3X2500 80.00	547X 2.00
6J4 1.72	25Z6 .75	249C 4.25	1B26 1.00	2J36 24.00	408A 2.00	548 2.00
6J5 .59	26A7 3.69	250H 19.45	1B27 9.00	2J37 9.00	367A 24.00	571 1.49
6K6 .59	FG27 8.28	250L 19.45	1B29 2.42	2J38 24.00	4B25 15.00	725A 2.00
6L6 1.19	28D7 .89	252A 14.35	1B35 3.00	2J39 50.00	4B26 7.50	726B 18.00
6N7 .99	FG33 15.00	H254 9.35	1B37 12.00	2J48 9.00	4B27 4.70	726C 12.00
6S4 .59	GZ34 1.54	254A 2.35	1B38 41.00	2J50 49.00	4B32 8.00	805 5.00
6SA7 .69	EL34 3.49	257B 7.40	1B41 48.00	2J55 50.00	4C35 19.00	807 1.19
6SB7 1.19	35T 4.49	259A 21.75	1B42 4.00	2J56 35.00	4-125 32.00	808 .85
6SC7 .89	35Z5 .57	274A 4.75	1B46 1.88	2K22 13.00	4E27 7.50	809 2.40
6SG7 .79	EL37 2.49	275A 3.40	1B53 25.00	2K23 11.00	4E27A 10.00	810 9.40
6SJ7 .69	TZ40 2.00	276A 19.75	1B63 19.00	2K25 13.00	4J22 98.00	811 2.50
6SK7 .72	50L6 .69	300B 4.90	1C 1.39	2K28 27.00	4J31 60.00	812 3.30
6SL7 .89	HK54 3.85	H300 19.45	1D21 4.70	2K30 125.00	4J50 95.00	813 8.00
6SN7 2/$1	T55 9.00	303A 8.45	1R5 .78	2K33A 39.00	4J51 215.00	814 2.35
6SQ7 .74	RK60 1.17	304H 12.50	1S4 .78	2K39 180.00	4J52 43.00	815 1.85
6T8 .98	RK61 2.50	304L 16.50	1T4 .78	2K41 125.00	4PR60 39.00	826 2/1.00
6U8 .98	HY65 2.90	310B 8.50	1U5 .89	2K42 125.00	4-65 15.00	423A 5.00
6V6 .90	KT66 3.45	313C 2.60	1X2A .68	2K43 125.00	4-125 32.00	829B 8.00
6X4 .39	75T 15.50	322A 57.50	2C22 5/1.00	2K44 125.00	4X150 19.00	832A 6.00
6X5 .49	80 .59	323B 13.25	2C26 5/1.00	2K45 34.00	4-250 36.00	836 1.20
6Y6 .89	EM81 2.39	339A 9.85	2C33 .85	2K47 110.00	4X500 45.00	418A 16.00
7C29 69.00	EC81 1.25	349A 4.95	2C39A 11.00	2K48 55.00	4-1000 70.00	845 3.50
10Y 3/1.00	EZ81 1.05	350A 2.45	2C40 6.00	2K50 169.00	5AW4 1.10	866A 1.20
12AT6 .59	EC82 1.05	350B 1.75	2C43 7.00	2K55 15.00	432B 20.00	872A .95
12AT7 .89	83 .95	351A 12.75	2C44 .25	2K56 60.00	5C22 25.00	884 1.15
12AU6 .63	83V .89	357B 43.50	2C51 2.00	2X2 3/1.00	5D21 5.00	889A 75.00
12AU7 .69	EC83 1.19	368AS 4.59	2C52 2.00	3B22 1.25	5D23 7.00	891R 170.00
12AX7 .79	EF86 1.29	387A 3.95	2C53 9.50	3B23 3.00	5J29 4.00	892 237.00
12AY7 1.29	EB91 .81	394A 3.45	2D21 .68	3B24 1.50	5J33 5.00	931A 4.00
12BA6 .65	EC90 1.26	434A 2.00	2D29 3.00	3B24W 4.00	5R4 1.25	954 10/1.00
12BA7 .99	EF94 .96	450H 44.00	2E22 2.00	3B27 3.00	5Y3 .59	955 3/1.00
12BE6 .59	EK90 .99	450L 44.00	2E24 2.25	3B28 3.50	403B 2.00	957 3/1.00
12BH7 .99	EZ90 .79	460 11.50	2E25 7.00	3C22 57.00	6J 18.00	991 5/1.00
12CU6 1.45	EB91 .81	473 165.00	2E26 3.00	3C23 3.95	6A5 3.00	1850A 36.00
12SA7 .69	EC90 1.26	502X 1.50	2E27 .70	3C24 1.72	6AC5 1.00	2050 1.25
12SJ7 .75	EF94 .96	503X 1.00	2E30 2.00	3C31 1.00	6AC7 .79	5654 .79
12SK7 .75	EK90 .99	512X 2.00	2E31 2.00	3C33 6.00	6AD4 3.00	396A 2.75
15E 1.19	EZ90 .79	522X 2.00	2E32 1.22	3C34 6.00	6AD6 1.29	404A 11.00
FG17 3.49	EB91 .81	525X 2.00	2E35 2.00	3C37 19.00	6AD7 1.39	403A .85
19BG6 2.15	FG95 16.00	531X 2.00	2E36 2.00	3C39 80.00	6AE5 1.89	WE417A 11.75
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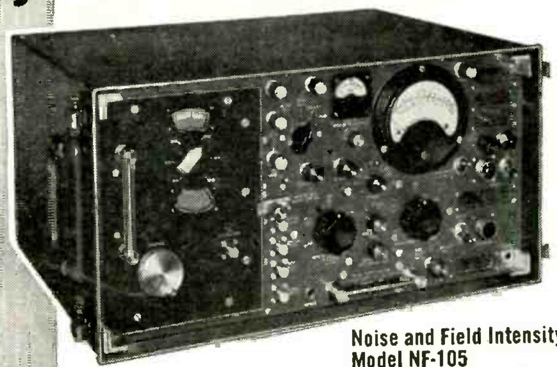

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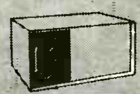

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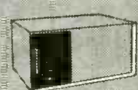

T2/NF-105: 200-400MC

T3/NF-105: 400-1000MC

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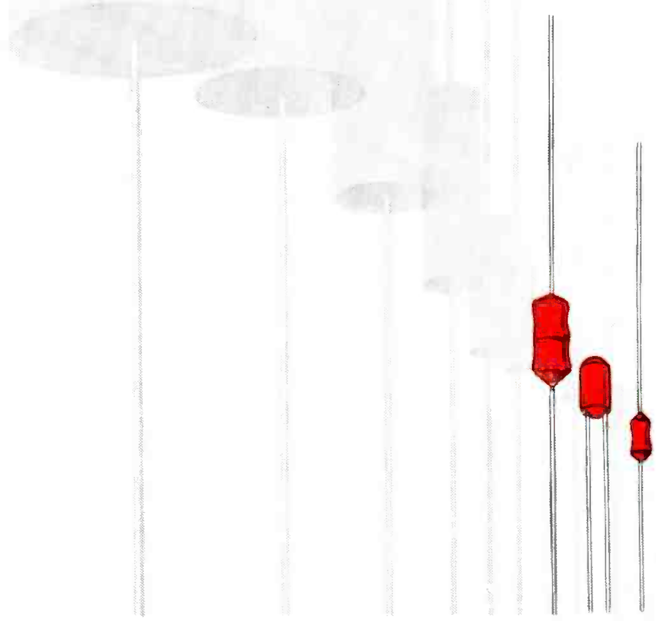

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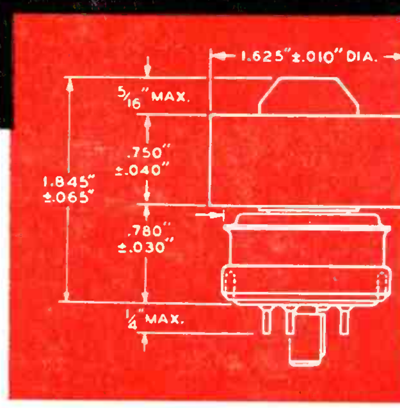

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DC Plate Volts	1500	2000
DC Plate Ma.	250	250
Driving Power (watts)	1.5	2.5
Power Output (watts)	260	370
At 500 Mc.		
DC Plate Volts	600	1250
DC Plate Ma.	170	200
Driver Power Output (watts)	15	30
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