electronics

AUGUST 1, 1957

A McGRAW-HILL PUBLICATION • PRICE ONE DOLLAR

NEW TUBE BOOSTS RADAR'S RANGE

BUTLER OSC

See pg 246

DO-TS

Deci-Ouncer Transformers

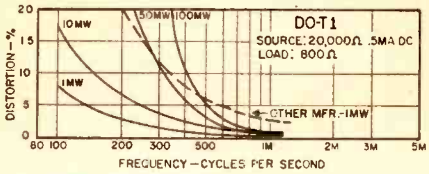
REVOLUTIONARY TRANSISTOR TRANSFORMERS

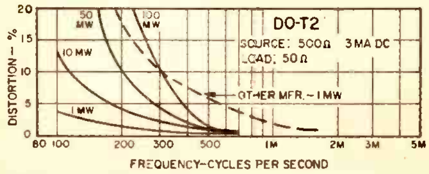
of unequalled power handling capacity and reliability

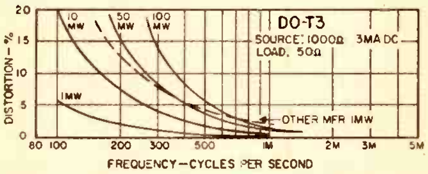
Hermetically Sealed to MIL-T-27A Specs.

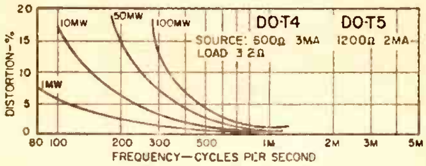
TYPICAL DO-T PERFORMANCE CURVES

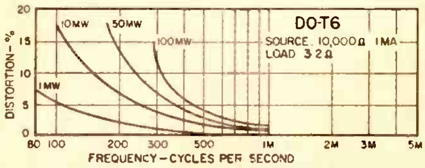
Power curves based on setting output power at 1 KC, then maintaining same input level over frequency range.

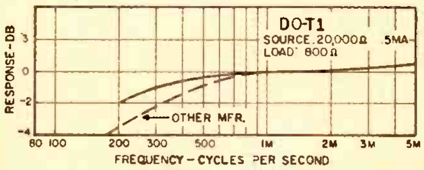


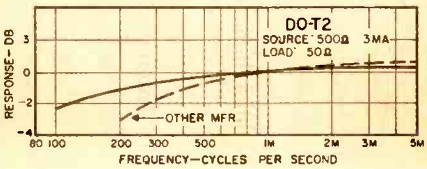


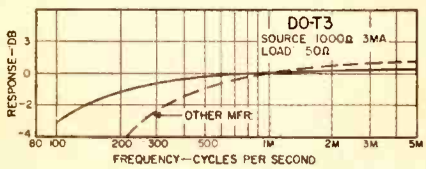


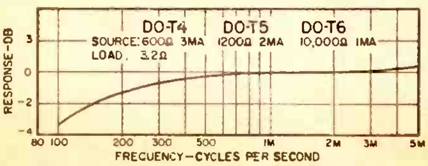












*DO-T units have been designed for transistor application only . . . not for vacuum tube service. **Pats. Pending

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)

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AUGUST 1 • 1957

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BOOSTS RADAR'S RANGE—Cross-field Platinotron developed by Raytheon can be used as high-power broadband microwave amplifier for scanning without moving reflector, for boosting power of existing sets or serving as frequency-stabilized oscillator (see p 164)....................COVER

FEATURES

CONTINUED ON NEXT PAGE

contents

continued

SHOP

▶ **ULTIMATE MANUSCRIPT** . . . The editors are constantly trying to determine which articles are the most popular with the readers of ELECTRONICS. This is done by mail surveys and through personal conversations with engineers in the field.

Certain subjects are always popular, and we have noticed in recent years that any article with the word "transistor" in the title has a high readership.

In looking for the impossible, an article that would attract every reader, one of the editors has suggested a title that we believe is sure to get 100-percent readership.

The title is "Transistorized Hi-Fi Audio Amplifier Receives, Controls and Transmits Signals for Automatic Production of Printed Circuits for Guided Missiles."

Anybody want to take a crack at writing it?

▶ **HIGH STANDARDS** . . . We have been sincerely flattered. Recently, one of the largest communication equipment manufacturers, going through the throes of organizing an internal electronics engineering publication, called on us for help.

Staffers of the new venture needed to codify various aspects of style and handling of manuscripts. After studying the problem, and numerous publications, they decided to be guided by our methods. We were called to furnish material and reference sheets suitable for the purpose.

electronics

AUGUST 1, 1957 Vol. 30, No. 8

Member ABC and ABP

TALK

We await with interest the first issue.

▶ **CONSTANT READERS** . . . Some time ago we wrote about a graduate class in missile guidance principles using ELECTRONICS articles as reference reading.

We have since learned from A. E. Nashman of the Guided Missile Laboratory of Federal Telephone Labs (ITT) and coordinator of the course that all members of the class are working engineers in electronics with two to nine years experience and 50-percent of them read our magazine regularly.

▶ **HO-HUM** . . . Some of the news periodicals recently carried a short story about a certain tape recorder, said to be the "world's smallest." Announced that it would be put on the market soon.

Surprised us a bit, since the technical details and complete circuit were published a year ago in ELECTRONICS, July 1956.

▶ **THE LEAD FEATURE** . . . It all started when Ampex first announced its video tape recorder.

Contacting the company for the technical story, associate editor Haig Manoogian was told by the author, Ross Snyder;

"While the demand for technical articles on the new VR-1000 Videotape Recorder would easily exhaust the ability of every engineer we have to write, even if we were to put them to work at nothing else for months to come, we certainly consider ELECTRONICS of such importance to the entire electronic engineering profession that we feel an obligation to provide you with an article which is satisfactory to you and to your readership."

We can't think of a nicer way for an author to accept a bid. We particularly appreciate his comment on our magazine, because we found out he has been reading it since he was 14 years old.

Follow-up in the normal business of publishing and handling of details involved sixteen letters, three telegrams, four coast-to-coast phone calls, two to Chicago and a couple of lunches.

The article starts on page 138 of this issue. We bylined it with Ross' name to give it a specific reference source, although he feels the credit belongs to many.

"Because I have drawn so freely on the laboratory notes of our Video Laboratory Staff in writing the article, the article really should be published under the byline of the Staff, rather than by me. While I will have assembled the words, it is certainly the combined effort of the staff which produced the information, and all should be credited."

ELECTRONICS congratulates Ampex Corp. for the Emmy Award the company received for its video tape recorder development from the Academy of Television Arts and Sciences. The two-inch tape travels at a speed of 15 inches per second while the recording heads revolve

Published three times a month, with an additional issue in June, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder, **Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y.** Longacre 4-3000. Publication Office 99-129 North Broadway, Albany 1, N. Y. See panel below for directions regarding subscription or change of address. Donald C. McGraw, President; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice President, Publications Division; Ralph B. Smith, Vice President and Editorial Director; Joseph H. Alen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

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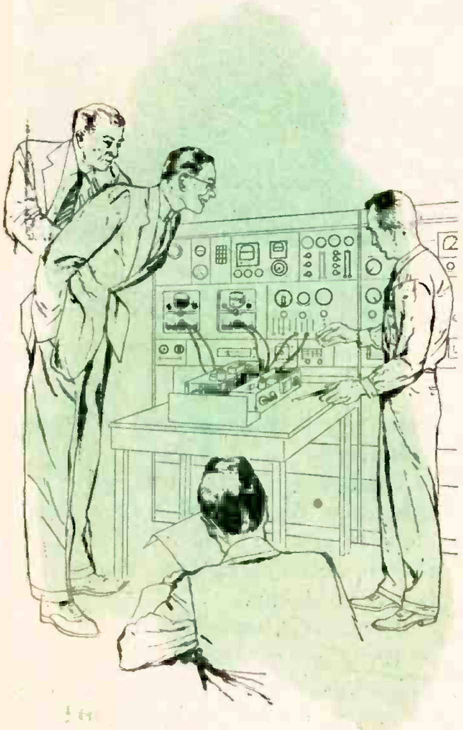
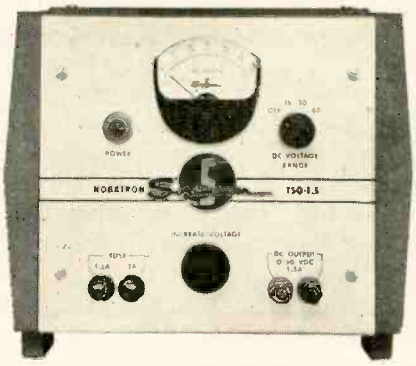
These new T-Nobatrons are the perfect solution to the problem of providing well-regulated voltages for the development and testing of transistor circuits. They provide stable DC output voltages in three ranges, with fine resolution. Excellent transient response for line and load pulses. Simple tubeless construction means greater reliability, lower cost, Also ideal for many other applications in these voltage ranges, such as relay testing and computer circuitry development.



• **DUAL RACK INSTALLATION**

ELECTRICAL CHARACTERISTICS

Model	T50-1.5	T60-5	T120-2.5
AC Input (60 ~, 1φ)	95-130	95-130	95-130
DC Output Voltage (three ranges)	0-10	0-10	0-25
	0-25	0-25	0-50
	0-50	0-60	0-120
Output Current (amps.)	0-1.5	0-5	0-2.5
Regulation, line: 105-125 V	±1%	±0.5%	±0.5%
For wider input	±2%	±1.0%	±1%
Internal Resistance, typical (ohms)			
low-voltage range	1.2	0.35	1.3
middle range	2.1	0.55	2.0
high range	4.5	1.0	4.0
Ripple (mv)	50 max.	50 max.	50 max.
Time Constant (line)	0.08 sec.	0.08 sec.	0.08 sec.
(load)	0.15 sec.	0.15 sec.	0.15 sec.



MODEL T50-1.5

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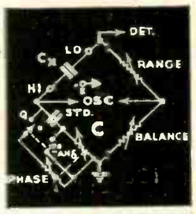
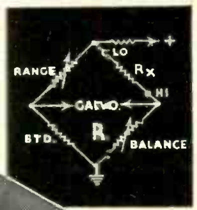
Inductance from 1 μH to 100 H, Capacitance from 1 $\mu\mu$F to 100 μF, and Resistance from 0.1 Ω to 10 MΩ. Single direct-reading LCR dial — no multiplying factors involved. Continuously variable a.c. bridge voltage and automatic detector sensitivity control.

L at 1 or 10 kc

C at 1 or 10 kc



R at d.c.



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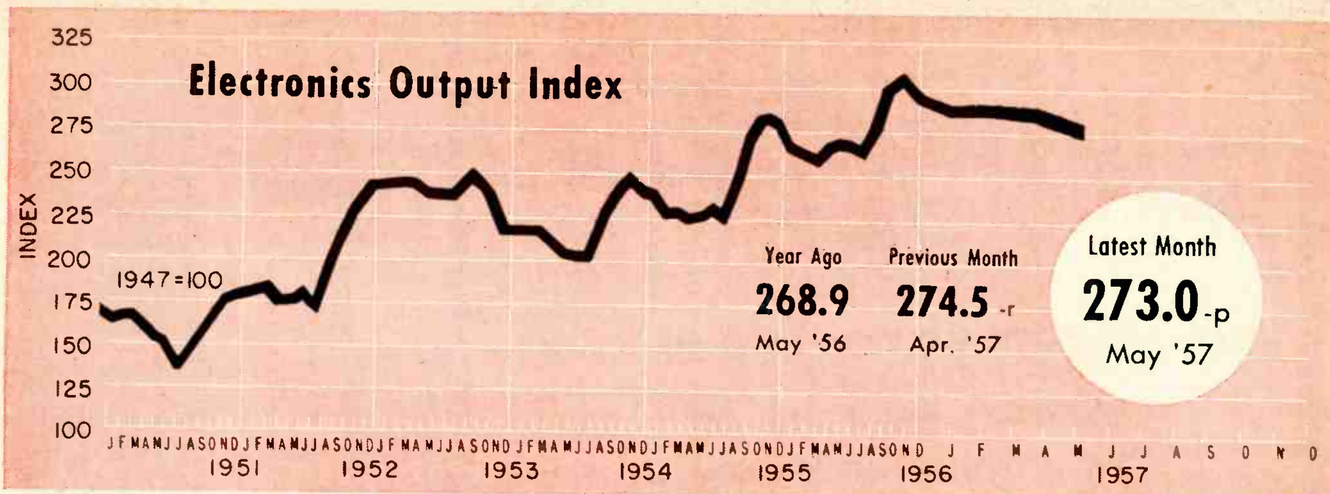


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month May '57	Previous Month April '57	Year Ago May '56
Television sets, total	342,386	361,246	467,913
With UHF	41,596	42,374	58,116
Color sets	nr	nr	nr
Radio sets, total	1,023,771	1,115,813	1,060,165
Auto sets	396,151	380,452	282,611

RECEIVER SALES

(Source: RETMA)	May '57	April '57	May '56
Television sets, units	399,757	337,965	392,080
Radio sets (except auto)	547,480	543,092	566,357

RECEIVING TUBE SALES

(Source: RETMA)	May '57	April '57	May '56
Receiv. tubes, total units	32,836,000	27,970,000	33,015,000
Receiv. tubes, value	$28,955,000	$25,384,000	$27,145,000
Picture tubes, total units	758,328	629,838	906,737
Picture tubes, value	$14,031,519	$11,394,043	$16,123,625

INDUSTRIAL TUBE SALES

	Quarterly Figures		
(Source: NEMA)	Latest Quarter 1st '57	Previous Quarter 4th '56	Year Ago 1st '56
Vacuum	$11,224,707	$12,408,371	$8,754,054
Gas or vapor	$3,332,357	$3,223,612	$3,394,059
Magnetrons and velocity modulation tubes	$15,359,108	$15,890,681	$15,136,522
Gaps and T/R boxes	$1,409,463	$1,242,745	$1,455,558

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 April '57	Previous Month Mar. '57	Year Ago April '56
TV stations on air	515	515	489
TV stations CPs—not on air	126	126	114
TV stations—new requests	72	60	29
A-M stations on air	3,049	3,040	2,872
A-M stations CPs—not on air	154	145	118
A-M stations—new requests	306	308	275
F-M stations on air	529	526	534
F-M stations CPs—not on air	22	23	13
F-M stations—new requests	22	17	6

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Mar. '57	Feb. '57	Mar. '56
Aeronautical	50,940	50,859	45,488
Marine	61,818	61,246	55,175
Police, fire, etc.	22,625	22,500	20,216
Industrial	34,316	33,879	28,454
Land transportation	9,505	9,484	8,849
Amateur	159,896	158,232	146,699
Citizens radio	24,782	23,888	16,262
Disaster	343	343	327
Experimental	765	735	666
Common carrier	2,696	2,666	2,185

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	April '57	March '57	April '56
Prod. workers, comm. equip.	380,600-p	386,500-r	379,300
Av. wkly. earnings, comm.	$79.19 -p	79.59 -r	75.33
Av. wkly. earnings, radio	$76.61 -p	76.80 -r	72.00
Av. wkly. hours, comm.	40.2 -p	40.4 -r	40.5
Av. wkly. hours, radio	39.9 -p	40.0	40.0

SEMICONDUCTOR SALES ESTIMATES

	May '57	April '57	May '56
Transistors, Units	2,055,000	1,774,000	897,862

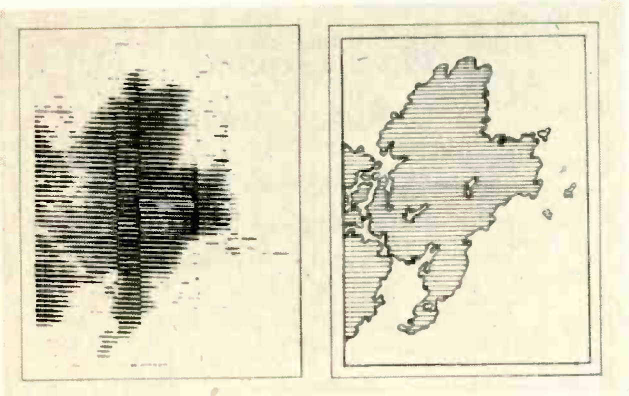
STOCK PRICE AVERAGES

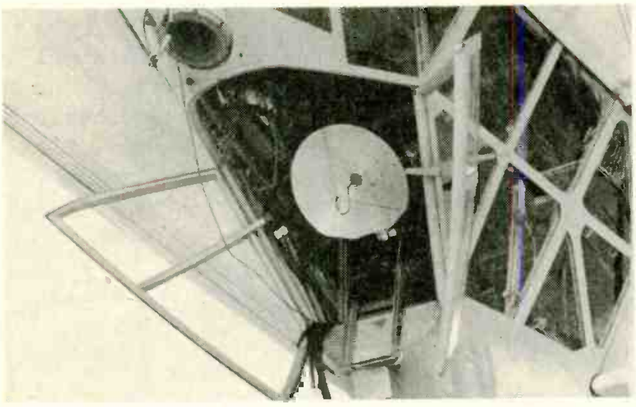
(Source: Standard and Poor's)	May '57	April '57	May '56
Radio-tv & electronics	51.69	50.48	60.43
Radio broadcasters	69.18	68.04	70.87

p—provisional r—revised nr—not reported

FIGURES OF THE YEAR

	TOTALS FOR THE FIRST FIVE MONTHS 1957	1956	Percent Change	1956 Total
Television set production	2,178,361	2,862,177	—23.9	7,357,029
Radio set production	6,098,951	5,585,390	+ 9.2	13,981,800
Television set sales	2,420,633	2,428,888	— .3	6,804,756
Radio set sales (except auto)	2,909,548	2,551,272	+14.0	8,332,077
Receiving tube sales	185,847,000	188,619,000	— 1.5	464,186,000
Cathode-ray tube sales	3,710,646	4,376,142	—15.2	10,987,021





RADIOMETRIC map of Cape Ann, compared with chart reproduction, (left) produced by experimental passive radar system installed in Navy blimp (right) shows what results when . . .

Passive Radar Technique Uses Microwaves

Operating technique similar to infrared except system detects microwave radiation

CHANCE downward deflection of an antenna, during World War II measurements of atmospheric absorption of K-band energy by a group at MIT's Radiation Laboratories, resulted in the discovery that microwave energy is radiated from the ground and its intensity varies with the type of object.

Subsequent work by a group at Air Force Cambridge Research Center propagation laboratory has lead to the development of a detection system using this phenomonon. The system is based on radiometric principles and is called passive radar.

▶ **How It Works**—Microwave energy that the passive radar antenna receives is a form of noise which must be distinguished from the noise generated in the receiver itself. Basically, this is done by alternately blocking and passing the noise signal to the receiver, through use of a chopping wheel in the input waveguide section, amplifying this signal and phase detecting it to null out the effects of the receiver's internally generated noise.

The resultant signal is integrated in a low-pass filter and applied to a strip recorder to drive the pen. This produces an apparent temperature profile of the objects scanned. Frequencies used in technique were 1.25, 3.2 and 8 cm.

▶ **Theory**—Although the bulk of energy radiated from earthly objects is in the infrared range, every object whose temperature exceeds absolute zero radiates electromagnetic energy throughout the spectrum. The system, a form of microwave radiometry, uses the black body (perfect radiator—perfect absorber) as a reference.

Frequently, a non-black body temperature is given in terms of an equivalent black body temperature. The equivalent temperature is the product of its absolute temperature and its emissivity which is defined as the ratio of the object's radiation to that of an equivalent black body at the same temperature. Thus a body of water whose absolute temperature is 400 K and whose microwave emissivity is 55 percent will emit radiation equivalent to a black body at 220 K.

A passive radar antenna aimed at the water would not only pick up this radiation but would also seen energy reflected from sky radiation.

▶ **Detectability** — Two objects at the some temperature can be discriminated owing to their different emissivities. For example, water has an emissivity of 45 percent and a reflectivity of 55 percent while land runs approximately 90 and 10 percent respectively.

Thus the energy radiated from the ground is about 70 percent greater than that radiated from the water providing more than a sufficient difference to discriminate between the two.

Other factors affecting discrimination are: angle between antenna beam and objects, antenna beamwidth and polarization and the receiver's minimum detectable signal level, which is primarily a function of bandwidth in this application.

▶ **Comparison** — Present passive radar techniques do not yield results that are comparable to infrared or radar. One advantage, however, is that the system does not radiate, thus matching infrared in its security from detection. Further advantages accrue through its being lighter, smaller and less complex than active radars.

Passive radar resolution is inherently inferior to infrared owing to its lower operating frequency, however its ability to discriminate between different types of targets can be as good or better than either infrared or active radar.

▶ **Future** — Early experimental equipment used at the Air Force Cambridge Research Center employed conventional radar receiver components. Use of traveling-wave tubes and new techniques to obtain wideband receiver operation should provide a significant improvement in response time and ability to discriminate to the point where such systems might compete with present infrared and radar surveillance systems.

NEON sign, hooked to radar timer, lights up, driver slows down when . . .

Sign Flashes Speed Warning

Radar here, computer in France mark auto speed

ELECTRONICS keeps popping up in the automotive world. Two recent reports involve adaptations of old standbys, computer and radar, in speed checking.

▶ **Speed warning**—A radar timer was hooked into a neon sign by Motor Vehicle Research, Inc., of New Hampshire. The sign says "Slow Down You Are Speeding" when a passing motorist exceeds a set limit.

The only one in use is set up in front of the Portsmouth, N. H., Air Force Base. Officials report the motorist takes his foot off the gas 9 out of 10 times. Houston police are reported interested.

▶ **Racing**—Standings of the 50 entrants in the classic 24-hour Le Mans race in France were reported hourly from an IBM computing center set up at the auto pits.

Use of the computer was in calculating performance index, which varies with size and motor of the car as well as speed.

Computer input was punched cards containing details on the cars and timekeeper reports. Output was an hourly stencil for officials and press.

New England Outlook Bright

Electronics industry sparks Yankee tradition of developing new products

PLANT SPACE of New England's electronics industry increased about 23 percent between January 1953 and October 1955 and the section has ambitious plans for future expansion. If the plans are carried out, electronics firms will spend $67 million for new plant and equipment, expand manufacturing space by 18 per cent and add about 8,000 workers in the next few years.

▶ **Research** and development activities are playing an important role in developing new products and jobs in New England's electronics industry. The number of companies having research and development programs expanded by over 50 per cent between 1950 and 1954, and annual expenditures for such activities advanced from $26 million to $42.6 million. Over half the employees of New England electronics concerns in 1955 were working on products developed by research within the past five years.

The Federal Reserve Bank of Boston conducted its first study of New England's electronics industry in 1953. That study disclosed that employment in the industry increased rapidly between January 1951 and January 1953 and depended heavily on government contracts. To ascertain current plans of electronics manufacturers and

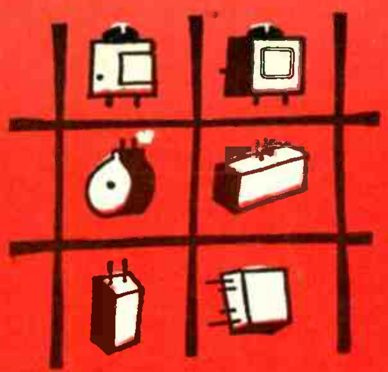
(Continued on page 10)

HIDDEN TREASURE!

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

TOP OF THE LADDER . . .

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

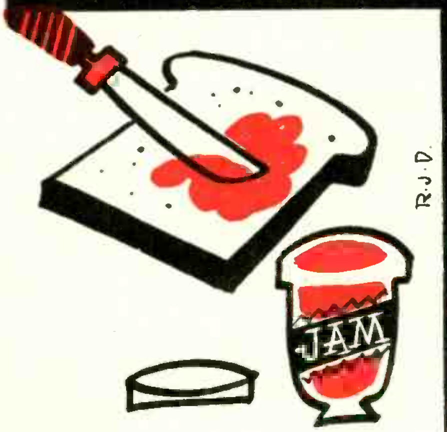


CROSS-SECTION OF A HUGE SELECTION!

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

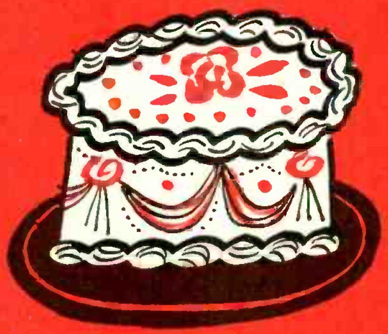
WHICH AD DO YOU LIKE BEST?

they all tell the same basic story



WANT JAM ON IT?

Burnell supplies the extras in service, courtesy and sheer engineering value. Your inquiries on toroids, filters and related networks will be handled promptly.



HOW ABOUT SOME ICING?

Burnell provides the "top layer" that makes all the difference. Your toroid and filter problems are solved by the most advanced engineering in the field—by Burnell.

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Burnell success depends on meeting your exact needs. If the toroidal component you require is not already on our files, we will make it to your exact specifications.

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CREAM COSTS NO EXTRA

Depend on Burnell for toroids, filters and related networks whether you require standard components, or special, custom-designed equipment.

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TELETYPE: PASADENA 7578
TELEPHONE: RYAN 1-2841

first in toroids, filters and related networks

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major developments since 1953, a second survey of the electronics industry has been completed.

▶ **Expansion Plans**—Between January 1953 and October 1955, 115 electronics manufacturers spent $48.5 million for new plant and equipment in New England. Three-quarters of this amount went for new machinery and equipment. Manufacturing floor space increased from 10,086,771 square feet in January 1953 to 12,431,700 square feet in October 1955.

Capital expenditures of electronics manufacturers located in Boston area totaled nearly $28 million during the 33-month period. But only 21 per cent of this was invested in plant facilities. In the rest of New England the ratio was 32 per cent. Smaller manufacturers generally increased their floor space at a more rapid rate than concerns with over 200 employees, although the largest firms accounted for the bulk of new plant construction as well as equipment expenditures.

Ninety-three of the 123 electronics manufacturers surveyed in October 1955 said that they were planning to expand in New England. Only 13 manufacturers said they were planning to expand their manufacturing facilities outside New England.

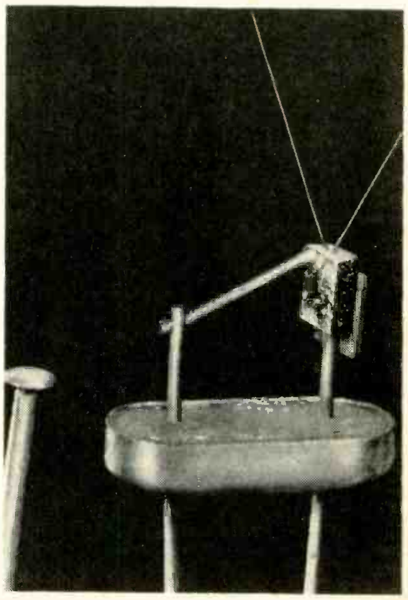
▶ **Encouraging Growth** — Steps suggested most frequently to encourage the growth of the electronics industry in New England involve improved tax treatment, better financing, expanded educational facilities for training engineers and technicians, and industrial development activities to promote New England.

Spacistor Promises 10,000-mc Amplification

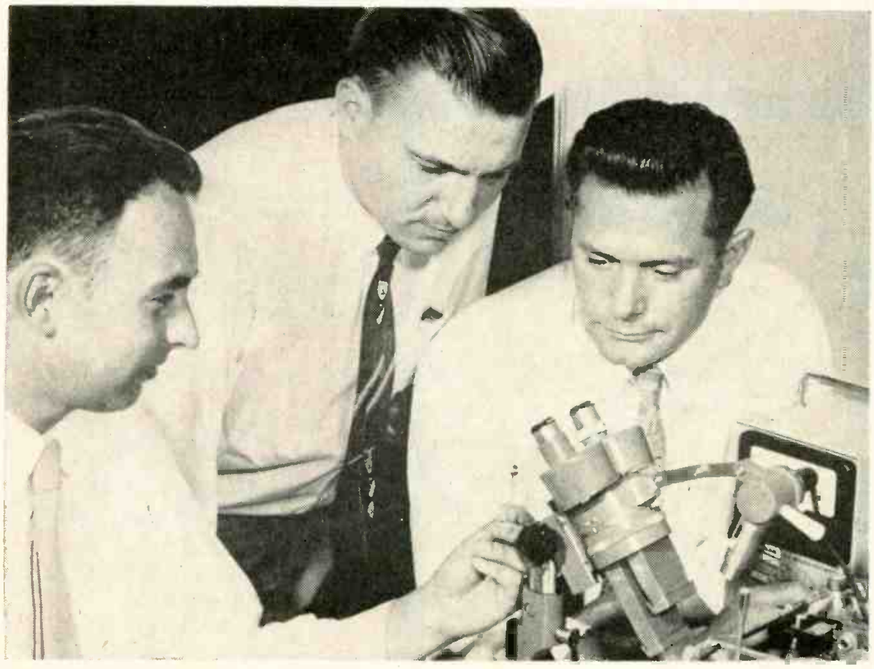
New four-lead semiconductor looks better than tubes and transistors, works up to 500 C

TINY AS the head of a pin is Raytheon's breakthrough in semiconductor amplifiers, operating on a wholly new principle which combines many of the best properties of vacuum tubes and transistors. Utilization of the high field strength at a reverse-biased junction gives acceleration of charge carriers so their transit time is greatly reduced, leading the way to reliable amplification at frequencies up to 10,000 mc.

▶ **Temperature Limits** — When made from germanium or silicon, spacistors have the same 200 C temperature limit as present transistors. An important advantage of the new device is its independence of charge-carrier lifetime, making it feasible to use other semiconductor materials. With silicon carbide, for example, it should be possible to operate at up to 500 C, to meet requirements for missiles and aircraft of the future.



PINHEAD and transistor base show size of experimental spacistor assembly. Thin leads are modulator and injector



TEAMWORK of these three men resulted in the spacistor, being held by Hermann Statz before Robert Pucel (center) and Conrad Lanza

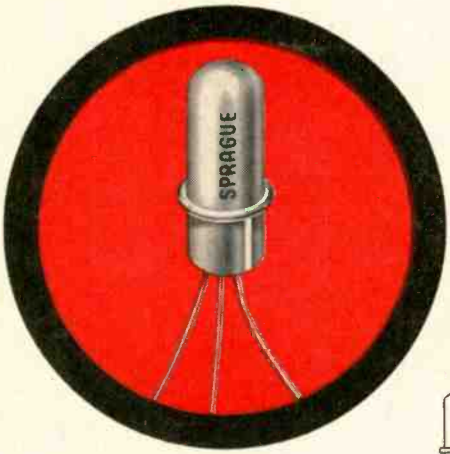
▶ **Construction**—The end of a pellet of semiconductor material is soldered to the collector lead. A base connection is made to the other end of the pellet.

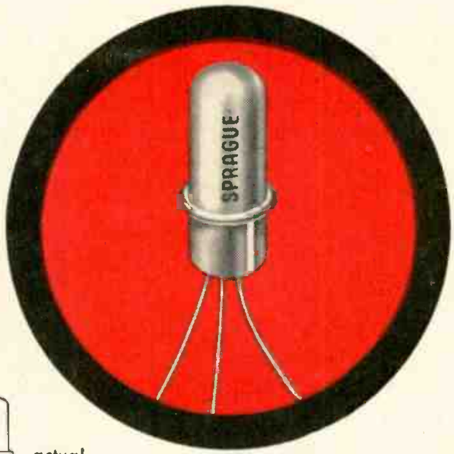
In an intermediate space-charge region on the pellet are mounted a tungsten-wire pressure contact serving as injector and a gold-wire

(Continued on page 12)

2N344/SB101
for Medium Gain Amplifiers

	Min.	Typ.	Max.
hfe	11	23	83
fmax	30	45	—





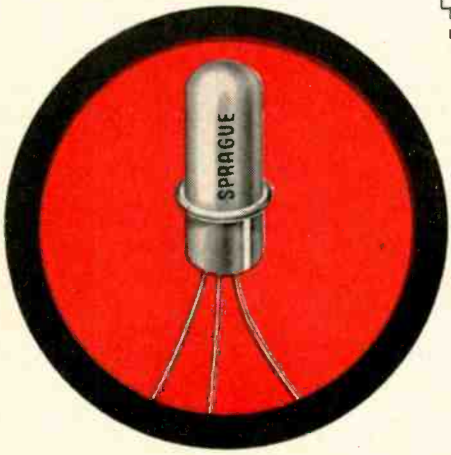
2N345/SB102
for High Gain Amplifiers

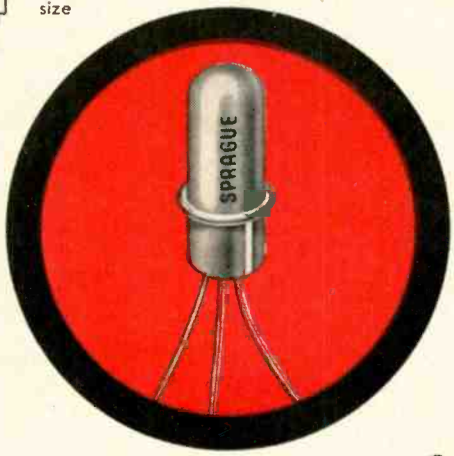
	Min.	Typ.	Max.
hfe	25	40	110
fmax	30	45	—

actual size

2N346/SB103
for High Frequency Oscillators

	Min.	Typ.	Max.
hfe	10	—	—
fmax	60	90	—





2N240/SB5122
for Computer Switching

	Min.	Max.
hfe	16	—
fmax	30	—
T_s	—	80

IN VOLUME PRODUCTION *Now!*

For general high frequency applications, and for high speed computer switching circuits, design around Sprague surface barrier transistors. They are available now in production quantities from a completely new, scrupulously clean plant, built from the ground up especially to make high quality semi-conductor products.

The four transistor types shown are the most popular. Orders for these units are shipped promptly. What's more, surface barrier transistors are reasonably priced. High quality and excellent electrical characteristics make them an economical solution to many difficult circuit requirements.

Sprague surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type number are manufactured to the same specifications and are fully interchangeable. You have *two* sources of supply when you use surface barrier transistors!

WRITE FOR COMPLETE ENGINEERING DATA SHEETS ON THE TYPES IN WHICH YOU ARE INTERESTED. ADDRESS REQUEST TO THE TECHNICAL LITERATURE SECTION, SPRAGUE ELECTRIC CO., 35 MARSHALL ST., NORTH ADAMS, MASS.

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HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS

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alloyed contact containing p-type doping material to serve as modulator. The injector and modulator are input leads, while base and collector provide the output.

▶ **How It Works**—Three d-c voltage sources make the injector, modulator and collector all positive with respect to the base. The input signal is applied in series with the modulator bias battery, and the corresponding amplified output signal is obtained across the load in series with the collector battery. At low frequencies, the resulting power gain is over 70 db. Voltage gains of 3,000 have already been achieved with the present input impedance of 30 megohms.

▶ **Status**—Though still in the research stage, the new spacistor shows great promise for important airborne and portable application where both tubes and transistors are today inadequate. For communication systems in the range from 1,000 mc to 10,000 mc it appears particularly attractive, because of its excellent frequency response combined with the small size and low power drain of transistors. Theoretical life is unlimited, both input and output impedances are very high, and multiple-stage circuitry is as simple as for vacuum tubes.

Business Briefs

▶ **Purchase** of Fairchild Engine & Airplane's Electrotechnics division by Mid-Continent Manufacturing's Datran Electronics division announced

▶ **Merger** plans of P. R. Mallory of Indianapolis and Radio Materials of Chicago disclosed. Stockholders of the Chicago concern are to receive 176,488 shares of Mallory common stock for their Radio Material shares: Mallory common closed at 46¼ on date of announcement. At that price the Mallory stock payment would be worth $8.2 million

▶ **Stockholders** of Thompson Products meeting this month to vote on proposal to issue $20 million in convertible subordinated debentures. Proceeds will be used to provide additional working capital and to enable company to take advantage of growth opportunities

▶ **Private placement** of 100,000 shares of common stock of Consolidated Electrodynamics through Blyth & Co. recently announced. The $4.3 million realized from the placement will provide working capital needed for company growth

▶ **Jointly-owned** affiliate formed by Amphenol Electronics of Chicago and Gas Purification and Chemical Co., Ltd. of Great Britain. The new company, Amphenol Great Britain Ltd., will manufacture and sell Amphenol products under an exclusive license in the United Kingdom and Commonwealth nations. Gas Purification and Chemical is an investment company with 17 subsidiary companies intimately connected with the English electronics industry

▶ **Merger** agreement concluded between Digitronics Corp. and Key Electric Corp., both of Long Island, N. Y. Digitronics Class A stock will be exchanged for all outstanding stock of Key Electric

Hotels Are Big Market For Gear

Fifty-million dollars spent last year on electronic systems

PUTTING electronics into a hotel having more than 1,000 rooms costs the owner $300,000 to $500,000. This estimate includes items like tv and radio sets, public address systems, heating and air-conditioning controls, closed-circuit tv.

There are about 100 U. S. hotels with more than 1,000 rooms. Only a handful have been built in the past few years.

▶ **Market**—There are 14,000 hotels with less than 1,000 rooms in the U. S., according to the American Hotel Association Red Book director. These contain some 1.4 million rooms, represent a fat market for things like tv sets and electronic controls.

In 1952, 40 percent of guest rooms in U. S. hotels had tv sets an AHA survey showed. Twenty-four percent of public areas (lobbies, cocktail lounges) had sets. Although unwilling to estimate present degree of saturation, AHA notes that in past year rate of installing tv sets has increased sharply.

▶ **Service**—In some hotels guests can register from their cars, dealing with clerks over closed-circuit tv. Electronically controlled elevators speed guests to rooms. Maids are routed to rooms when checkouts are reported via special intercom circuits.

Heating, air conditioning, ventilation is becoming electronically controlled. Minneapolis-Honeywell expects to sell $5-million worth of this equipment annually in ten years.

Hotels spent $50 million in 1956 for electronic gear, its installation and maintenance, guesses Eli M.

(Continued on page 14)

... SENDUST POWDER CORES

They use NON-STRATEGIC MATERIALS
... you can avoid alloy shortages

Try SENDUST CORES in these typical applications

- **Cores for loading coils**
- **Cores for filter coils**
- **Transformer cores for voice and carrier frequencies**

Write for a copy of the Sendust Core Bulletin SDC-110, containing data on standard core sizes, electrical and magnetic properties, standard permeabilities, etc.

ADDRESS DEPT. E-78

Arnold sells SENDUST Powder Cores in this country under exclusive license from The Tohoku Metal Industries Co., Ltd., of Japan. They are available in a wide selection of sizes, ranging from .800″ O.D. to 3.346″ O.D.—and in permeabilities of 10, 13, 25, 30, 50 and 80, although not all sizes are available in all permeabilities.

SENDUST cores possess magnetic properties that are generally superior to iron powder cores, but inferior to Mo-Permalloy powder cores in the audio and carrier frequency range. The eddy current loss for SENDUST cores is lower than that of Mo-Permalloy powder cores, but the hysteresis loss of SENDUST cores is substantially higher, and they also have higher values of electrical resistivity. In other characteristics of powder cores, the two types are somewhat similar, but SENDUST cores contain *no scarce or strategic materials and can offer a core source in times of alloy shortage.*

Sample SENDUST cores as well as production quantities are available from stock. *For more detailed information, send for technical data sheet* SDC-110.

WSW 6320

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Lurie, president of American Communications Corp. He sees 25-percent increase in 1957.

Microwave Energy Freeze-Dries Food

Dried foodstuffs can be stored indefinitely without refrigeration

NEW TECHNIQUES for preserving food without refrigeration uses microwave energy for freeze-drying perishables. Process, still in laboratory stages, was announced to food technologists by Raytheon's food laboratory.

Foodstuffs are held in vacuum at below-freezing temperatures while microwave energy is applied. As food dries, energy bypasses dried portions, follow receding ice volume to center of food.

▶ **Advantages** — Process requires only 6 hours; conventional procedures take 24-36 hours. Dried products can be held indefinitely at room temperatures. Conventional methods use heat, run risk of damaging food as dried outer parts, acting as insulator, force drying temperature up.

▶ **Flavor** — Nutrients are safeguarded in the microwave process and there is no significant alteration in flavor. Dried foodstuffs can be restored to original freshness by being immersed in water, which is soaked up like a blotter.

▶ **Applications** — Army and Navy are the most likely users of foods prepared this way, since its volume is strikingly reduced(three-quarters of a steak is water) and refrigeration unnecessary. Hospitals may use dried body tissue.

THREE views of missile show antenna types used on beam-rider as . . .

Navy Unveils Operational Version of Talos Missile

Electronics involved still kept under wraps at military electronics conference

PRODUCTION of the Talos missile, shown publicly for the first time at the national military electronics conference, is proceeding under a \$27-million contract received by Bendix Aviation early this year. Estimates of electronics share in this project were unavailable for security reasons.

Close inspection of the device however gives some idea of the type of electronics employed.

▶ **Front-end**—Nose of the missile contains eight flush-mounted strip antennas and four probe-type units as shown in the photographs. Fifth probe may possibly be used to sense yaw or angle-of-attack.

The missile switches to a homing system during the final phases of attack, thus it seems reasonable that one set of antennas guides the missile up the ground-based radar beam until switch-over when the other set takes over for the final attack.

▶ **Packaging**—Missile's flight-sustaining power is obtained by ramjet principle requiring hollow construction (center photo). All electronic equipment must therefor be housed in an annular ring about 4-inches thick. Packaging and temperature requirements for components would appear to be more stringent owing to their inclusion in the shell of such a stovepipe.

▶ **Reliability**—In a talk to the IRE members, Lt. Gen. C. S. Irvine, USAF, pointed out that during the next ten years speeds of Mach 10 and altitudes far exceeding anything now known will require electronic devices that are absolutely reliable.

To achieve this end a concerted effort on the part of the entire electronics industry now to improve the reliability of present-day missiles as well as manned aircraft.

VHF Controls Power Plants

VHF RADIO SIGNALS are now being used to control automatically two hydroelectric generating plants. This is part of an experiment to

(Continued on page 16)

see if standard f-m equipment designs will transmit reliably enough for automatic control.

Nova Scotia Light and Power has nine plants, six of which are operated automatically from one control center. They are close enough to control point to be connected by land lines. The seventh will be hooked on shortly.

The remaining two, Nictaux and Paradise, are so distant that the cost of land lines would be excessive. Since only a small number of channels is needed, multichannel microwave was discounted as being wasteful and expensive.

Radio was tried using vhf. Major change required was switching from tone to d-c keying. During the past year the new technique had its bugs worked out. For example, a separate power supply was added so that the receiver would operate during transmissions. The operation is now rated a success. Other Canadian power firms have expressed interest.

There is one drawback to similar operations in the U. S. The part of the spectrum used is in the 152-174 mc band. This is reserved for mobile systems in the U. S.

Military Electronics

▶ **Mobile combat** computer for solving military problems ranging from battle strategy and tactics to logistics is being developed by Sylvania under $1-million plus Army contract.

MOBIDIC (mobile digital computer) will fit into 28-ft. air-conditioned trailer. Special uses are combat surveillance, scientific or analytic computation, air traffic control and artillery target assignment.

▶ **High-intensity** noise-system, developed by RCA, permits quick, economical pre-flight laboratory tests of electronic components and assemblies used in jet aircraft and guided missiles. Equipment simulates in-flight noises up to 145 db, minimizes costly operation of jet engines to perform environmental component testing.

▶ **High-speed** TRANSAC C-1,100, Philco's new Transistor Automatic Computor, will go into one of Navy's jet fighters. Occupying less than four cu ft, TRANSAC handles computational problems encountered in flight.

▶ **Transistorized** intercommunications system (ICS), first installed in Douglas' A3D Skywarrior over a year ago, will be adapted to all versions of the A3D and the AD-5Q.

▶ **New series** of electronic data processing machines will go into operation at Hill AFB, Utah this fall.

Computers Get Smarter, Study Semantics

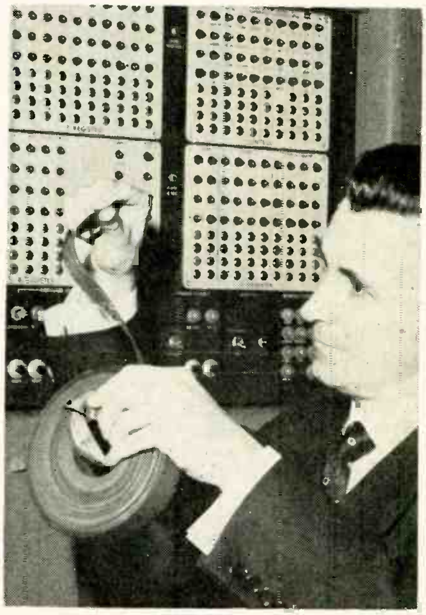
Cal Tech man teaches one how to translate; another is ready to control plant processes

ADD two more items to computer files. From California come reports of an idomatic translator and a transistorized process control computer for industry.

▶ **Linguist**—At a press show arranged by ElectroData, a Cal Tech technician showed how to turn an ordinary $250,000 computer system into a linquist.

Peter Toma made a Datatron translate excerpts from Russian, French, German and Spanish into English. The computer gagged a bit on German sentence structure but otherwise did fine.

▶ **Semantics** — Toma's system assigns semantic codes to sentence units. It is intended to interpret idiomatic meaning rather than give word-for-word translations.



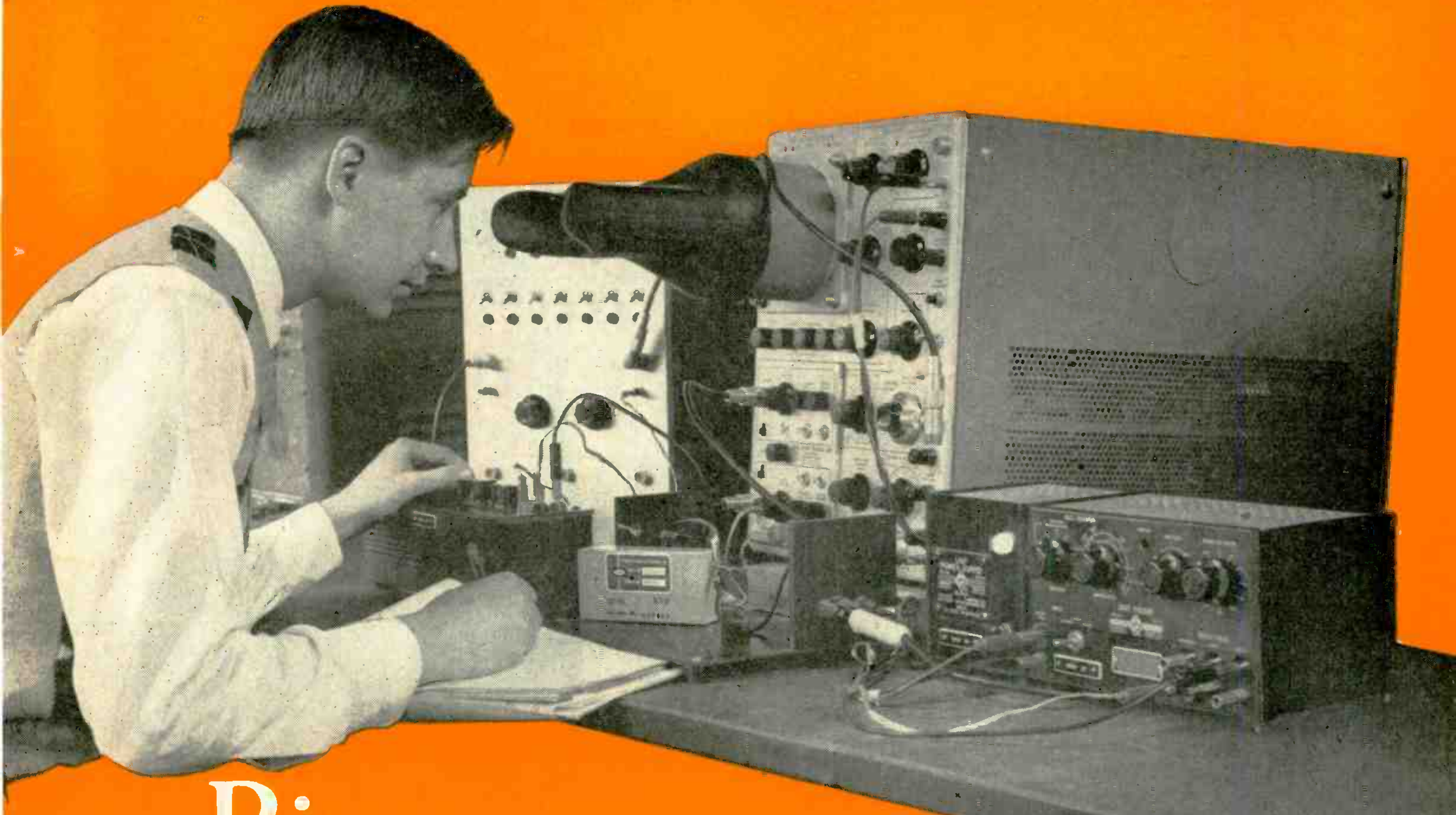
PUNCHED paper tape feeds computer that translates Russian, French, German and Spanish into English.

Special 500-word dictionaries are coded on paper tape then fed into the computer's memory. Items to be translated are coded and compared with the dictionary.

▶ **Future**—In time, Toma hopes to store complete languages in high-capacity magnetic tape memory files. He figures there are no more than two million sentence units in most languages.

▶ **Processing** — A new transistorized digital computer made by Ramo-Wooldridge is designed for process control in such industries as oil, chemicals, metals and paper, it can also handle scientific com-

(Continued on page 20)



A Big Little Pulser . . .

GR Type 1217-A Unit Pulser, $235

Photo courtesy Richard D. Brew and Company, Inc.

Low Cost *Small Size* *General Ease of Operation*

Wide Range, both in Pulse Width and Repetition Rate

Good Pulse Shape even at short pulse durations

Hard-Tube rather than Gas-Tube operation makes high repetition rates possible — permits bright and easily discernable oscilloscope traces at fast sweep speeds

Built-in Time Delay allows the leading edges of pulses to be visible on most oscilloscopes

Several Unit Pulsers can be easily combined to form an economical generator of composite signals

. . . These are but a few of the outstanding features built into the General Radio Unit Pulser to make it one of the most versatile pulse generators available today. In short, the Pulser has been designed to meet the need for a low-cost, general-purpose instrument of laboratory-quality.

Typical of Pulser users is Richard D. Brew and Company, Inc., Concord, New Hampshire, manufacturer of ultrasonic, lumped-constant and distributed-constant delay lines. They use the Pulser both in development and production testing. The varied requirements of these measurements call for flexible test equipment, and Brew, like many others, has discovered that the Unit Pulser's built-in features give "built-in versatility" at no extra cost.

Repetition Rate: 30 and 60 cycles; 100 c to 100 kc in X1, X2, and X5 steps; 15 c to 100 kc continuous with external drive (25v rms is sufficient for locking)

Pulse Duration: 0.2 μsec to 60,000 μsec

Pulse Shape: Positive and negative pulses available; rise time 0.05 μsec, fall time 0.15 μsec; pulse top is flat to within 5% of maximum amplitude; overshoot is adjustable

Amplitude: Continuously variable; 20 volts maximum open circuit for either polarity; negative pulse of 50 volts if positive terminal is grounded

Output Impedance: 200 ohms, positive pulses; 1500 ohms, negative pulses

Price: 1217-A Unit Pulser, $235
1203-B Unit Power Supply, $40

Type 1219-A Unit Pulse Amplifier, $200: Provides a maximum of 55 watts peak power at a wide range of impedances; current pulses up to 600 ma, and voltage pulses in excess of 250 volts at pulse durations as small as 0.1 μsec and repetition frequencies up to 2 Mc.

Write for the Pulse Equipment Bulletin for full information.

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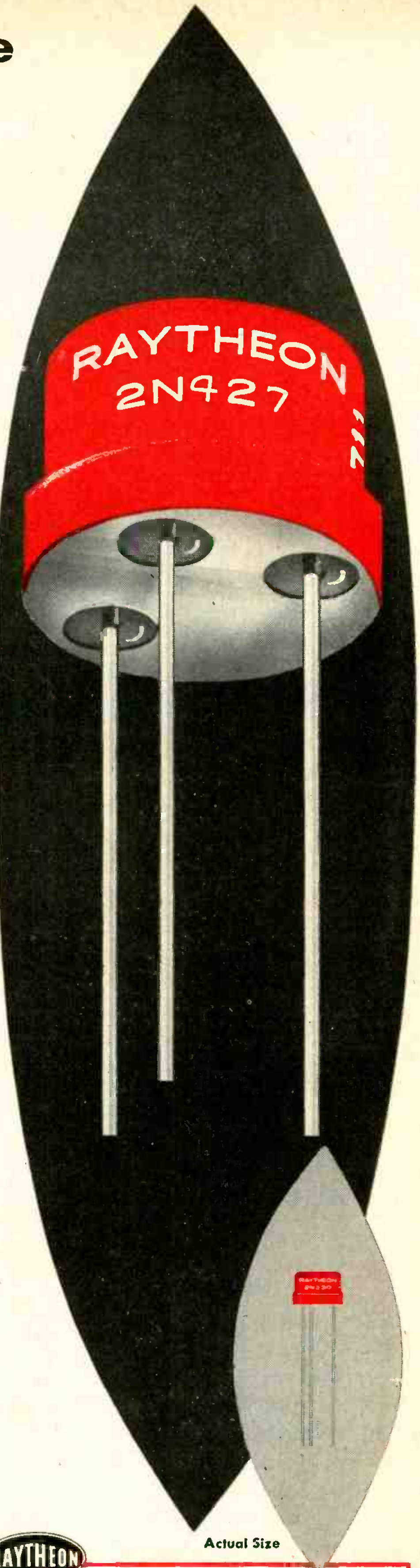
NEW in the JETEC 30 package

RAYTHEON

PNP Fusion-Alloy

GERMANIUM TRANSISTORS



Actual Size

0.200″ pin circle diameter
Designed for printed circuits and automation
−65°C to +85°C junction operating range
Extreme reliability due to Raytheon's fusion-alloy process

NEW RAYTHEON TRANSISTORS FOR COMPUTER SERVICE

Type	V_{ce} max. Volts	$f_{\alpha co}$ Mc	h_{fe_1} ($I_b = -1$mA)	h_{fe_2} ($I_b = -10$mA)	Grounded Emitter Switching Data at $I_c = 50$mA: I_b "on" and "off" mA	Rise Time μs	Storage Time μs	Fall Time μs
2N425	−20	4	30	18	5.0	0.5	0.25	0.3
2N426	−18	6	40	24	3.3	0.5	0.25	0.3
2N427	−15	11	55	30	2.5	0.4	0.25	0.3
2N428	−12	17	80	40	1.7	0.1	0.25	0.3

For above four types ... $I_c = -400$mA max.; $Z_{sat} = 1.5$ ohms for I_c of 100 mA

RAYTHEON TRANSISTORS FOR SPECIAL PURPOSE RF SERVICE

Type	Replaces	V_{ce} max. Volts	I_c max. mA	$f_{\alpha co}$ Mc	C_c μμf	Beta 1Kc	Beta 1Mc	Power Gain at 2Mc db	Extrinsic Base Resistance ohms
2N416	2N113/CK761	−10	−200	10	12	45	10	18	60
2N417	2N114/CK762	−10	−200	20	12	75	20	25	75

RAYTHEON TRANSISTORS FOR PORTABLE RADIOS

Type	Replaces	Circuit Usage	V_{ce} max. Volts	$f_{\alpha co}$ Mc	Cc μμf	Power Gain at 455Kc db	Conv. Gain db
2N413	2N111/CK759	Oscillator	−15	3	12 av.	—	—
2N413A	2N111A/CK759A	IF Ampl.	−15	3	12 ±2	32	—
2N414	2N112/CK760	Converter	−15	5	12 av.	—	26
2N414A	2N112A/CK760A	IF Ampl.	−15	5	12 ±2	35	—
2N415	2N271/CK766	Converter	−10	10	12 av.	—	30
2N415A	2N271A/CK766A	IF Ampl.	−10	10	12 ±2	39	—

For above six types . . . $I_c = -200$mA max. "A" types are for IF amplifiers with fixed neutralization

For all types on this page: Dissipation Coefficient = 0.4°C/mw (free air); Collector Cut-off Current ≅ 1.0 μA at −20V.

RAYTHEON

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RAYTHEON SEMICONDUCTOR DIODES and RECTIFIERS

All illustrations are actual size

DIFFUSED JUNCTION SILICON RECTIFIERS

A — STUD TYPE

Type	Peak Inverse Volts	Average Rectified Current Amps. (150°C)	Reverse Current (max.) at PIV µA	Type	Peak Inverse Volts	Average Rectified Current Amps. (135°C)	Reverse Current (max.) at PIV µA
CK846	100	1.0	2	1N253	95	1.0	10
CK847	200	1.0	2	1N254	190	0.4	10
CK848	300	1.0	2	1N255	380	0.4	10
CK849	400	1.0	2	1N256	570	0.2	20
CK850	500	1.0	2				
CK851	600	1.0	2				

B — WIRE-IN TYPE

Type	Peak Inverse Volts	Average Rectified Current Amps. (150°C)	Reverse Current (max.) at PIV µA
1N537	100	0.25	2
1N538	200	0.25	2
1N539	300	0.25	2
1N540	400	0.25	2
CK844	500	0.25	2
CK845	600	0.25	2

SILICON POWER RECTIFIERS

C

Type	Peak Inverse Volts	Average Rectified Current Amps. (125°C*)	Reverse Current (max.) at PIV mAdc
CK774	25	5	5
CK775	60	5	5
CK775-1	125	5	5
CK776	200	5	5
CK777	325	5	5

*Case Temperature

GOLD BONDED GERMANIUM DIODES

D

Type	Peak Inverse Volts	Average Rectified Current (max.) mAdc	Reverse Current at −10V µA
1N305	60	125	2
1N306	15	150	2
1N307	125	50	5

GENERAL PURPOSE GERMANIUM DIODES

E

Type	Peak Inverse Volts	Average Rectified Current (max.) mAdc	Reverse Current µA	at V
1N66	60	50	800	−50
1N67	80	35	50	−50
1N68	100	35	625	−100
1N294	60	50	800	−50
1N297	80	35	100	−50
1N298	70	50	250	−40
VHF and UHF				
1N295	40	35	200	−10
CK715	40	35		

BONDED SILICON DIODES

D

Type	Peak Inverse Volts	Forward Current (min.) at +1V mAdc	Average Rectified Current mAdc (25°C)	Reverse Current µA	at V
1N300	15	15	65	0.001	10
1N300A	15	30	80	0.001	10
1N432	40	10	55	0.005	10
1N432A	40	20	70	0.005	10
1N301	70	5	45	0.05	50
1N301A	70	18	65	0.05	50
1N460	90	5	45	0.1	75
1N460A	90	15	60	0.1	75
1N303	125	3	40	0.1	100
1N303A	125	12	55	0.1	100
1N433	145	3	40	0.1	125
1N433A	145	10	50	0.1	125
1N434	180	2	35	0.1	150
1N434A	180	7	45	0.1	150
1N302	225	1	30	0.2	200
1N302A	225	5	40	0.2	200
CK863	300	1	20	0.3	275
CK863A	300	3	30	0.3	275

RAYTHEON

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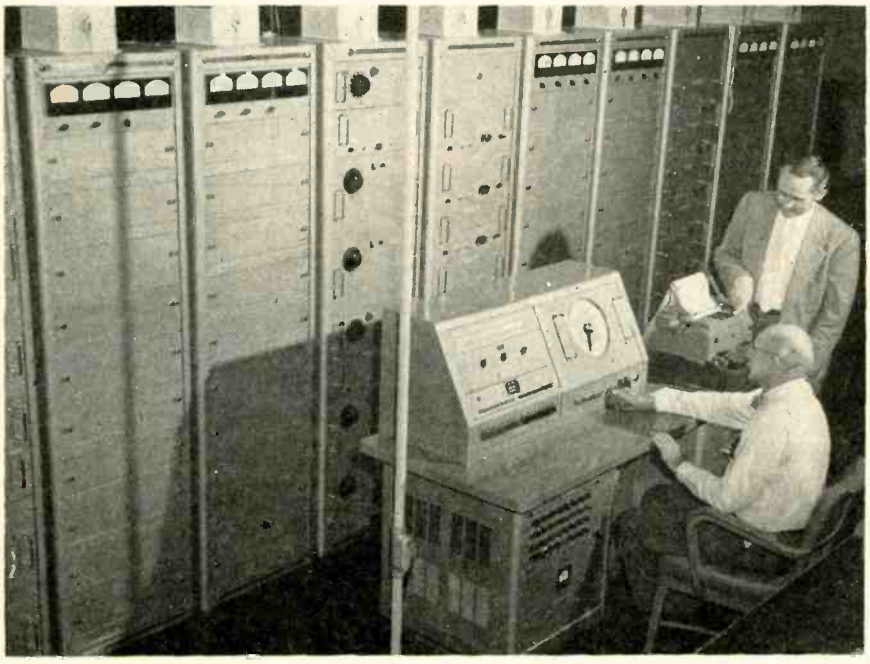
putation and data logging.

It will automatically read process instruments, compute relationship of readings to process objectives, compute control actions needed and activate process mechanisms or adjust control loops.

The computer, called the RW-300, is comparatively small, 55 by 28 by 36 inches and weighs 400 pounds.

▶ **New phase** — Ramo-Wooldridge people have been predicting for some time that computers are ready to move into a new phase of development. Most computers operate on descriptions without taking part in the processes described. Industry, they believe, needs take-part computers akin to those in automatic aircraft navigation and weapons control systems.



OPERATOR at console records four test readings for each of 800 tubes, transistors or crystal diodes as . . .

Rack Cuts Test Time One-Third

EXPERIMENTAL electronic components are being tested at ARDC's Wright Air Development Center more accurately, with less personnel and in one-third the time by using an automatic testing device developed by Systems Development, Incorporated.

▶ **Testing** — Electron tubes, transistors and semi-conductors are placed into any of the automatic life test and data recording rack's 800 sockets. Four test points are provided for each socket. Tests, lasting as long as 1,000 hours, are then conducted without further attention by the operator. Results are recorded by electric typewriter.

When set on automatic, the control console gives accurate readings on all 800 specimens at the rate of less than 10 seconds per specimen. When the set is switched to manual operation a reading can be taken on a particular specimen.

Special environmental chambers for heat, vibration and altitude tests are currently being installed. Components will be placed in these chambers with lead wires connected to sockets in the automatic test specimen racks.

Complete environmental and age testing of components will then be possible without removing them from fixtures.

Bank Teller-Vision Hastens Service

Closed-circuit tv camera, installed in the bookkeeping department of the Bank of Belmont, North Carolina, links the main building with its new Glenway drive-in branch, located 100 feet away. As shown above, requested information from the files is placed under the cam era for transmission to RCA portable receiver in branch

Hawaii Cable Ready This Fall

36-circuit, $37-million project will provide operator dialing to phones on Oahu and mainland

FIRST undersea telephone link between Hawaii and the West Coast will go into operation in the fall after laying of two 2,400-mile cables. The $37-million project will provide for operator dialing of calls over 36 voice circuits.

▶ **New cable**, which will connect Point Arena, Calif. and Hanauma Bay, Oahu, is 85 percent owned by the AT&T Long Lines Department and 15 percent owned by the Hawaiian Telephone Co. It will provide three times the capacity of the 14 existing radiotelephone circuits which are subject to atmospheric disturbances and fading.

Each of the twin cables contains 57 amplifiers spaced about 43 mi apart. The amplifiers have a life

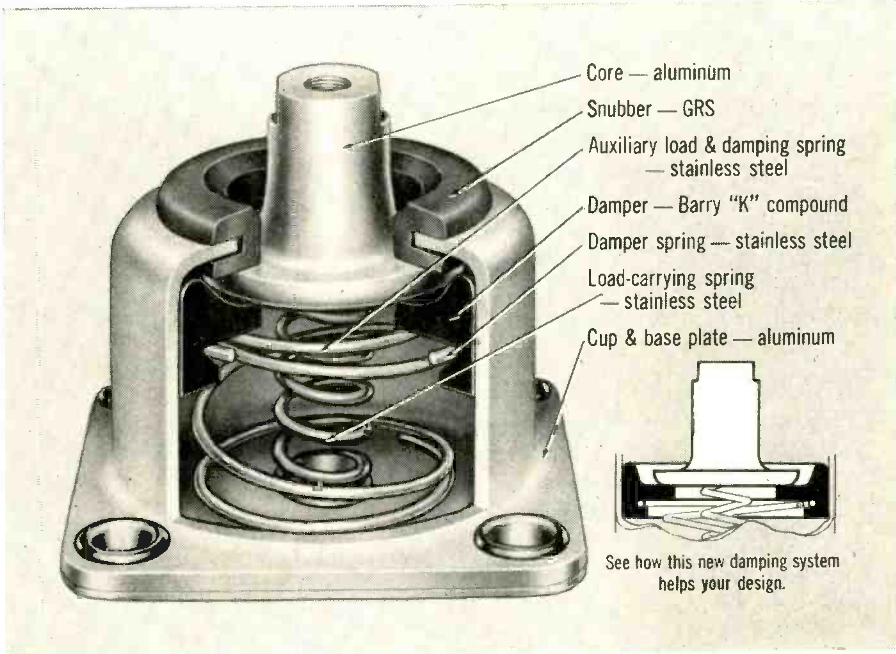
(Continued on page 22)

Barry's New "LO" Mount Meets MIL-C-172B at low cost

— with this extra vibration isolation that adds reliability to your design.

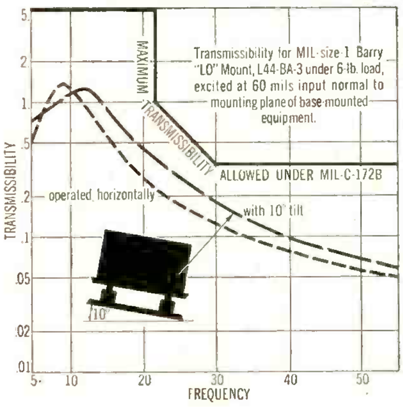
We designed for lower cost — *and developed a better mount for MIL-C-172B*. Even at 10° inclination, the new Model L44 Mount performs effectively. And its other characteristics, too, far exceed requirements of MIL-C-172B.

The basically simple and versatile construction of this new isolator lets us match characteristics to your specification. Your design now gains added reliability with a mount that more than satisfies MIL-C-172B — and at low cost.



MIL-size 1 "Lo" Mount shown 1½ times actual size

Extra-low transmissibility and low natural frequency



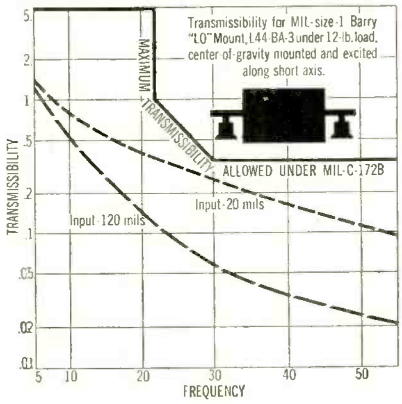
This low transmissibility — below 2 at resonance in all load ranges — is a major advantage of the Model L44 isolator. It accommodates high-amplitude inputs, even at resonance, without snubbing. Typical isolation at 10° inclination is also shown above.

Very low rocking modes

In base-mounted systems, transmissibility of rocking modes under horizontal vibration is reduced to the point where they are indiscernible. This is due to the combination of inherently low ratio of horizontal-to-vertical stiffness plus horizontal *self-centering* friction damping.

For center-of-gravity designs

Independent horizontal damping makes the "Lo" mount especially suited for installation in the plane



of center-of-gravity of the equipment. The natural frequency of the system shown above is below 5 cps.

Controllable characteristics

These exceptional characteristics result from the unique Barry spring and friction-damping design pictured above. And these characteristics can be controlled to give high performance with a wide variety of equipment. Horizontal and vertical damping can be controlled independently. Special versions of the "Lo" mount will control transmissibility at resonance for a given input . . . or handle very high-amplitude inputs at resonance without snubbing.

Physical characteristics

The L44 Mount is dimensionally interchangeable with MIL size 1 isolators. It is available in 7 load ranges from 0.25 to 10 pounds per mount in long- and short-core models. It meets all environmental as well as vibration requirements of Procedure I, MIL-E-5272A. Temperature range is −85F to 250F. Weight is 1½ ounces per mount.

SEE IT AT WESCON

The new Barry "Lo" Mount will be on display at Wescon, with engineers on hand to tell how you can use it in your design.

Write today for Data Sheet 57-05.

BARRY CONTROLS
INCORPORATED

WESTERN DIV. BURBANK, CAL.

BARRY B MOUNT

SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

707 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

expectancy of 20 years and use three vacuum tubes plus 60 other components. They were manufactured at the Hillside, N. J. plant of Western Electric.

▶ **Teletypewriter** and radio broadcast transmission will also be provided over the new cable system, which is similar in design and construction to the 2,250-mi Atlantic cable system and the 900-mi Port Angeles, Wash. to Ketchikan, Alaska cables. The Hawaiian cable will be in deeper water, striking a depth of thre miles at one point.

▶ **An operator** in Honolulu will be able to dial a number in any one of about 6,500 mainland communities. Similarly, operators in hundreds of mainland cities can dial any subscriber on Oahu, where 95 percent of Hawaii's telephones are located.

About 2,500 volts are required from each end to operate the system.

FCC Actions

▶ **Gets** a new commissioner. Upon retirement of chairman George C. McConnaughey, John C. Doerfer succeeded to chairmanship and new commissioner Frederick W. Ford was added. Ford was chief of FCC Broadcast Bureau's hearings division

▶ **Ceases** to issue more f-m broadcast simplexing authorizations. F-m stations presently engaged in functional music operations on a simplex basis are given six months to switch to multiplex

▶ **Sets up** two committees to prepare United States proposals for revision of International Telegraph Regulations. Revisions are among the things to be discussed at the Administrative International Telegraph Conference in its fall meeting in Geneva, Switzerland

▶ **Schedules** RETMA witness W. R. G. Baker as last man to testify in hearings concerning frequencies above 890 mc. Baker will present association's views in September after Commission's recess

▶ **Grants** authority to the Grace Immanuel Baptist Church, Detroit, Mich., to transmit religious programs from Detroit for broadcast by station CKLW, Windsor, Ontario, Canada

ONE of the forty-six men assigned to a special State Police unit along the Indiana Toll Road works to keep the highways safe as . . .

High-Band Mobile Patrols Turnpikes

Police-maintenance microwave-vhf hookups provide quick control

EFFECTIVE communications are provided for law enforcement officers and maintenance crews by a communication system in operation along the Indiana Northern East-West Toll Road. Extending in both directions from a control center near South Bend, the combination microwave-vhf system provides complete integration of mobile radio units, telephones and teletypewriters located at various points of the road from one end to the other.

▶ **Network**—The system was engineered by General Electric at a cost of a half-million dollars. In all, the system provides seven microwave stations, 10 vhf base stations, a dozen fixed station units for toll plazas and 65 mobile radios for use in police cars, maintenance vehicles, tow trucks and snow-removal units.

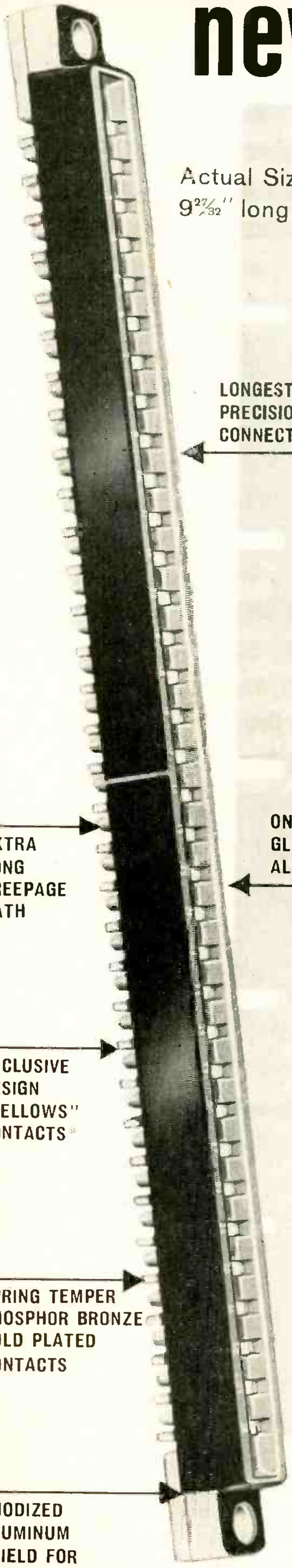
Engineers who designed the system say the police-maintenance microwave hookup is 110 miles long, providing instantaneous communication along all 157 miles of the twin-lane highway.

Each interchange in the system is equipped with a vhf base station for quick communication to five major maintenance buildings housing offices, police personnel, maintenance trucks and road machinery. All five maintenance

(Continued on page 24)

new!...printed circuit

Continental Connector



Actual Size
$9\frac{27}{32}$'' long

LONGEST
PRECISION MOLDED
CONNECTOR KNOWN

EXTRA
LONG
CREEPAGE
PATH

ONE PIECE
GLASS REINFORCED
ALKYD MOLDING

EXCLUSIVE
DESIGN
"BELLOWS"
CONTACTS*

SPRING TEMPER
PHOSPHOR BRONZE
GOLD PLATED
CONTACTS

ANODIZED
ALUMINUM
SHIELD FOR
HEAT DISSIPATION

*Pat. Pending

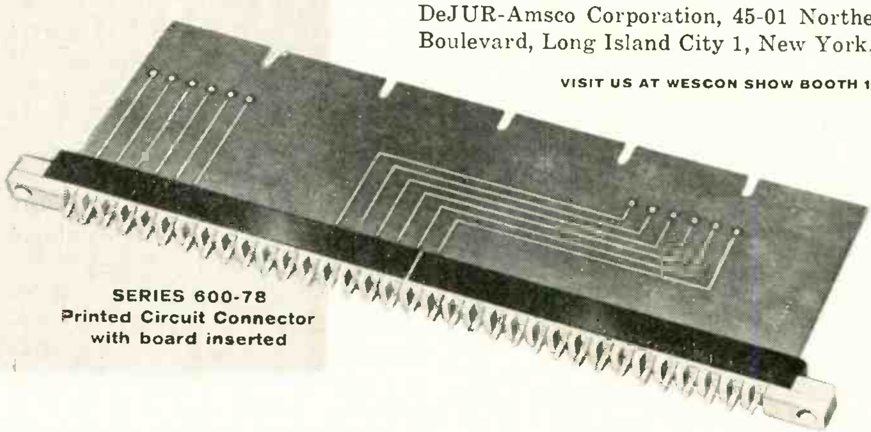
designed for use in one of the country's largest military data processing systems

Again, Continental Connector proves its reliability and engineering know-how with this remarkable new printed circuit connector. Overall length is actually $9\frac{27}{32}$"... the longest, single piece precision molded connector known!

Standard molding compound is high impact reinforced glass Alkyd (other molding materials available on request). 34 contacts have .250" spacing including heavy barriers for extra protection and long creepage path. Patented "Bellows Action" contacts are conservatively rated to accept printed circuit board thickness of .054 to .072", while maintaining low contact resistance and positive spring action grip over entire printed circuit contact area. Maximum board length is $8\frac{3}{4}$". Self-alignment of "Bellows" Contacts* allows for any residual warpage of printed circuit board. An anodized aluminum shield for dissipating heat is available as an optional accessory when required (see illustration).

Our engineering staff is available for developing other unique design printed circuit connectors that may solve your special connector problems. For complete technical specifications, write to Electronic Sales Division, DeJUR-Amsco Corporation, 45-01 Northern Boulevard, Long Island City 1, New York.

VISIT US AT WESCON SHOW BOOTH 1017



SERIES 600-78
Printed Circuit Connector
with board inserted

you're always sure with **DeJUR** electronic components

progress in SIGHT SOUND SCIENCE

Circle 63 Readers Service Card

buildings have two identical vhf circuits, one for patrol use and the other for maintenance. Complete duplicate equipment has been installed for standby purposes, permitting automatic transfer to standby devices if some portion of the regular transmission fails.

Handsets and loud speakers are located at various places in each building. Speakers linked to the police radio system are located in the patrol barracks and those containing maintenance messages are installed in maintenance areas. Telephones in each of the maintenance buildings are linked with an automatic switchboard.

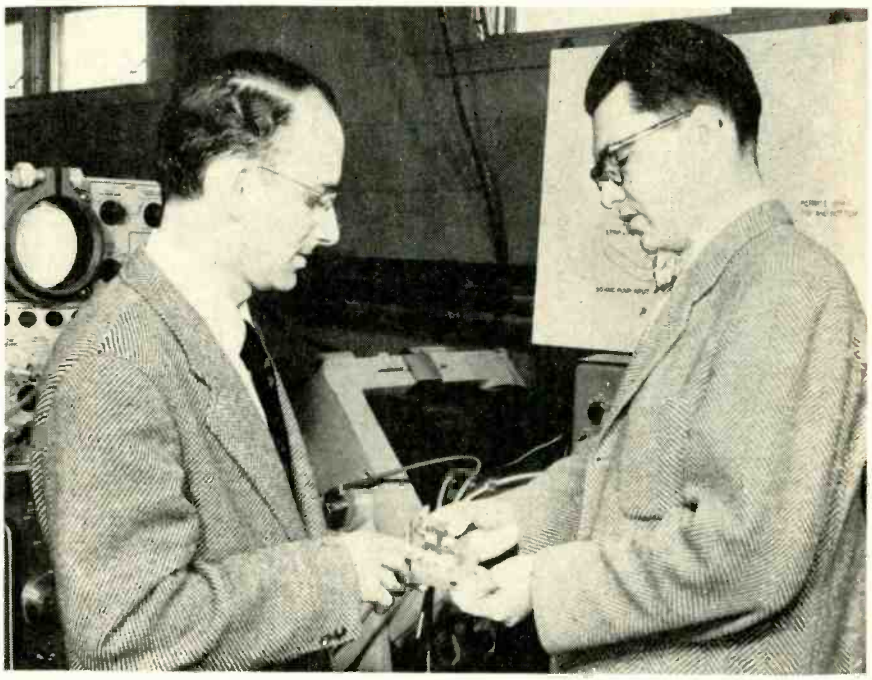
By dialing a code number, individuals using telephones in maintenance areas may be connected with the microwave transmission system.

The South Bend control center is operated by police personnel at all times. Lights on the control console indicate whether normal or standby equipment is in use at various points in the system. Light signals also show which base station receivers are in use and whether calls in some buildings are being originated with handsets.

▶ **Massachusetts**—The first portion of a half-million dollar communications system also installed by GE on the Massachusetts east-west turnpike is now in operation. High-band mobile two-way radio units were placed in service for state police patrolling the road as the new super-highway opened.

When completed, the system will be one of the most modern in the nation. One-hundred mobile radio units for police cars and highway maintenance crews will be controlled from a dispatch center at Chicopee, Mass., where vhf and microwave equipment will be linked to provide communications coverage for approximately 180 miles.

A selective-calling feature included in mobile units will assure privacy between departments using the combined police and highway maintenance facilities.



NEW experimental amplifier is checked prior to assembling into complete unit (below) for testing as . . .

Solid State Gains New Amplifier

Experimental ferrite microwave device operates at room temperature

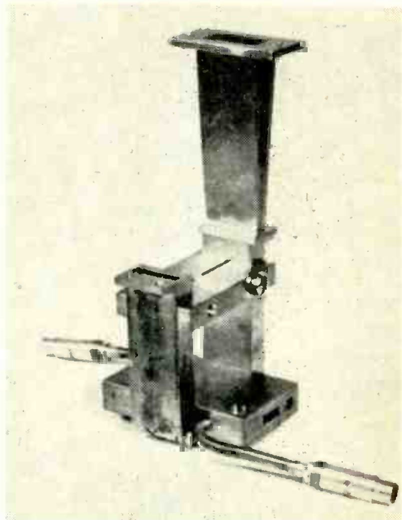
ATTESTING to the continued increasing interest in solid-state devices, the successful operation of a ferromagnetic amplifier in the microwave frequency range by Bell Telephone engineers marks another step forward in this field.

▶ **Principle**—Operation of the device is based on the fact that nonlinear coupling in a ferrite sample placed in a cavity which is simultaneously resonant at two signal frequencies will produce amplification or oscillation.

Microwave power at a frequency equal to the sum of the two signal frequencies coupled with a properly oriented d-c magnetic field causes gyromagnetic resonance at the sum frequency. Through nonlinear coupling in the ferrite, the lower frequencies can be amplified.

By increasing the sum-frequency power, oscillation at the lower frequencies can be produced. Also, frequency conversions can be made.

▶ **Tests**—In one experiment, a cavity was designed to be resonant at frequencies of 4,000 and 4,800 mc, with the sum-frequency set at 8,800 mc. Oscillations and frequency conversions were observed at both the lower frequencies.



EXPERIMENTAL ferrite microwave amplifier

▶ **Applications** — It appears that these amplifiers can be designed for any portion of the microwave spectrum and preliminary results indi-

(Continued on page 26)

now . . . **0 TO 32 VOLT, 0 TO 25 AMPERE,** *low cost, continuously adjustable*

DC POWER SUPPLY

by **PERKIN!**

IMMEDIATE DELIVERY...$449.00†

Thousands of electronics laboratories and aircraft firms are presently using the PERKIN Model M60V DC Power Supply as an economical and practical solution to their DC power needs where AC line stabilization and precise load regulation are not required.*

Conservatively Designed

Smooth Stepless Voltage Control

No Tubes, Moving Parts or Vibrating Contacts.

Filtered

Model No. M60V

SPECIFICATIONS:

DC OUTPUT: 0-32 volts, 0-25 amps.

REGULATION: ±1% (a) at 28 Volts D.C.—Increases to 2% max. over the range 24-32 V.; does not exceed 2 volts regulation over the range 4-24 volts D.C.; (b) from 1/10 Full Load to Full Load; (c) at a fixed AC Input of 115 volts.

RIPPLE: 1% rms @ 32V. and Full Load—2% rms max. @ any voltage above 4 volts.

AC INPUT: 115 Volts, Single Phase, 60 cps.

MOUNTING: Cabinet 20⅜" wide x 16½" deep x 13⅞" high or 19" rack panel (19" wide x 14¾" deep x 12¼" high.)

WEIGHT: 130 lbs.

*If these are required, write for specifications on Model MR 1040-30A (5-40V. @ 30 A) or 28-30 WXM (24-32 V. @ 30 A.), which are stabilized for AC line changes and regulated to ±½%.

When you require a power supply, SPECIFY PERKIN, for a wider range of standard models and immediate delivery from stock. There are over 15,000 Perkin units in operation in industry today.

†For rack panel units without meters. Wire factory collect for prices for units with cabinet and meters.

For a prompt reply on your application, write factory on your letterhead.

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SALES OFFICES: Chicago: PA 56824 · Philadelphia: BR 5-2600 · Seattle: LA 9000 · Minneapolis: MI 6-2621 · Atlanta: TR 6-3020 · Winston-Salem: 4-0750 · Charlotte: ED 2-7356 · Redwood City, Calif.: EM 9-3354 · Albuquerque: 5-9897 · Phoenix: AM 5-0274 · Denver: AL 5-1196 Euclid, Ohio: RE 2-7444 · Dayton: WA 5426 · Canada: Agincourt, Ontario: AX 3-7011 Foreign: New York: BR 9-1296.

OTHER **PERKIN** STANDARD

DC POWER SUPPLIES

28 Volt Models

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

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

6, 12, 115 Volt Models

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

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

PERKIN POWER SUPPLIES

cate adequate bandwidth. It is expected to have a much lower noise level than conventional microwave amplifiers making it applicable to the fields of radio astronomy, microwave relaying and radar.

COMPLETELY transistorized low-power computer programs logical data when . . .

Computer Checks Computer Design

SOME 9,000 solid state devices make possible a new easy-to-maintain general-purpose digital computer about the size of a television console.

Developed for the Air Force by Bell Telephone Laboratories, the computer, named Leprechaun, will be used for programming and logical design research on computers for military use.

About 5,000 transistors, no tubes, are used. Circuits are so simple that Leprechaun may be adapted for a variety of jobs; complexity is in the wiring rather than in the changeable components.

Leprechaun is a pure binary computer using an 18-bit word. Arithmetic operations are asynchronous, in parallel, at average speeds of 25,000 additions or 2,500 multiplications a second.

The computer uses direct-coupled transistor circuits, and a 1,024-word magnetic core memory.

World Radio Sets Gain 20%

Total estimated at 130,498,400 excluding U. S. and Canada, up 20% since 1954

RADIO receivers in all countries except the U.S. and Canada are estimated at 130,498,400 by the U.S. Information Agency.

This is a 20-percent increase over the estimate made from a similar survey in July 1954.

Here's how the total breaks down by areas: Western Europe—64,737,100, Eastern Europe—16,600,000, Yugoslavia—600,000, Arabic countries—2,141,500, Non-Arabic Asia—4,295,600, Non-Arabic Africa—1,158,100, Far East—19,488,000, Latin America—21,478,100.

► **Leaders**—Top five in Western Europe are: West Germany (including West Berlin)—14,475,000; United Kingdom—14,157,000; France—10,205,000; Italy—7 million; and Spain—3 million.

USSR leads Eastern Europe with 6,100,000; East Germany—3,400,000; Czechoslovakia—2,916,000; Poland—2,034,000; Hungary—1,250,000.

Egypt leads the Arab countries of the Near East with 716,000; the territory comprising the former French Moraccan zone—335,000; Algeria—312,000; Syria—250,000; Iraq—125,000.

Turkey leads non-Arabic Asia with 1,198,400; India—1,129,000; Iran—590,000; Greece—500,000; Israel and Pakistan—each 335,000.

► **East**—Japan tops the Far East with 13,250,000; Australia—2,100,000; Communist China—1,100,000; Indonesia—650,000; New Zealand—517,000.

Brazil is first in Latin America with 6,000,000; Argentina—5,500,000; Mexico—3,200,000; Colombia—1,800,000; Cuba—1,250,000.

Union of South Africa leads non-Arabic Africa—815,000; Madagascar—60,000; French Equatorial Africa—50,000.

SUBWAY gate crashers are spotted on tv screen as . . .

Closed Circuit Tv Guards Turnstiles

NEW YORK CITY'S Transit Authority is considering installing closed-circuit television guards in its subway stations.

A tv system was recently placed in the busy 42nd Street and Eighth Avenue station, near Times Square, by General Precision Laboratories.

► **Prospects**—It was removed after a trial period, but an Authority spokesman says he expects closed tv will be used again in the future.

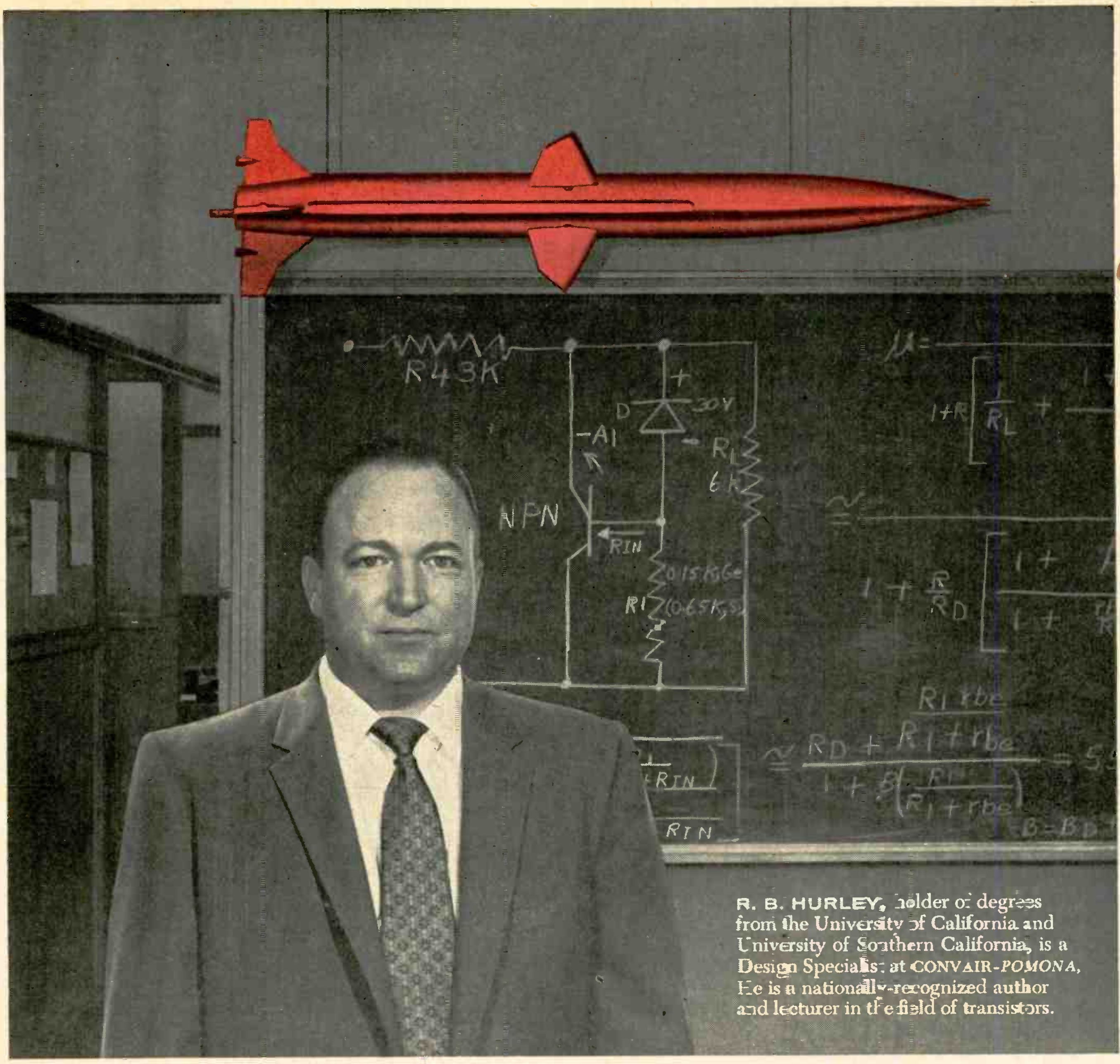
How many stations would be equipped and at what cost is not known. The city has almost 500 subway stations. The value of the trial installation was $3,000.

► **No freeloaders**—The camera was trained on an exit gate and connected by coaxial cable to a change booth 175 feet away.

The object was to spot riders attempting to enter the gates without a city employee's pass. Usual procedure is to station policemen at gates during rush hours.

The authority is also considering

(Continued on page 28)



R. B. HURLEY, holder of degrees from the University of California and University of Southern California, is a Design Specialist at CONVAIR-*POMONA*. He is a nationally-recognized author and lecturer in the field of transistors.

"Engineers—here's how we're taking part in the electronics revolution toward solid state devices"

"Here at CONVAIR-*POMONA*, we are constantly studying ways to apply the new miniature solid state electronic devices: the diode, rectifier and transistor. So new is this semiconductor infant, and so vast its future – both for the military and industry – that our teams of electronics engineers actually 'go to school' under some of the foremost experts in the field.

"As the *first* fully-integrated missile plant in the U.S., CONVAIR-*POMONA* designs and builds the Navy's TERRIER supersonic missile. And, realizing the potential value of solid state devices in meeting the critical requirements of such airborne missiles, we initiated a 'transistor program' early in 1953. This program has multiplied many times to become one of the most important in the industry.

"You, as an engineer, can appreciate the tremendous expansion that will come in the application of solid state electronic devices in the next few years. And you can readily understand the advantages of studying and working with these devices, guided by the advanced thinking you will find at CONVAIR-*POMONA*.

"You'll like the atmosphere here, where you see and feel accomplishment. And you will enjoy living in Southern California's beautiful Pomona valley. For greater career opportunity – *for your future's sake* – send for more information about CONVAIR-*POMONA today!* Write to: Engineering Personnel, Dept. 3-G."

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POMONA
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CONVAIR IS A DIVISION OF GENERAL DYNAMICS CORPORATION

closed-circuit tv to monitor station platforms, particularly at night and in little used stations, as a deterrent to crime.

Financial Roundup

NINE out of eleven firms which reported earnings last month showed higher net profits in 1957 over comparable 1956 periods.

Annual earnings of Ampex Corp. set a new high in the firm's history.

Greatest net profit growth was registered by Topp Industries whose net profits this year were more than five times that of 1956.

Company	Net Profit 1957	1956
American Cable & Radio 3m	$291,745	$318,977
Ampex Corp. 12m	1,087,000	311,000
Avco Manufacturing 6m	5,232,621	28,716
Barry Controls 5m	107,000	76,000
Consol Electronics Ind 6m	1,154,803	1,174,441
Daystrom 12m	2,459,000	1,784,000
Dynamics Corp. Am. 3m	308,003	307,322
IT&T 3m	5,900,448	5,514,548
Litton Industries 9m	1,271,000	687,000
Sperry Rand 12m	49,612,352	46,348,878
Topp Industries 12m	466,796	92,062

Meetings Ahead

Aug. 20-23: 1957 Western Electronic Show and Convention, IRE, WCEMA, Cow Palace, San Francisco, Calif.

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

Aug. 26-Sept. 4: American Radio Relay League, National Convention, Palmer House, Chicago.

Aug. 28-Sept. 7: National Radio and Television Exhibition, Earls Court, London.

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

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

Sept. 17-18: National Technical Meeting on Machine Tool Automation, RETMA, AIA, NEMA, NMTBA, Ambassador Hotel, Los Angeles, Calif.

Sept. 24-25: Sixth Annual Conference On Industrial Electronics, IRE, AIEE, Morrison Hotel, Chicago, Ill.

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

Oct. 7-11: American Institute of Electrical Engineers, Fall general meeting, Chicago, Ill.

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

Oct. 9-12: Audio Engineering Society, 1957 Convention, N. Y. Trade Show Building, N. Y. C.

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

Oct. 21-26: Institution of Radio Engineers Australia, annual convention, IRE, Hotel Australia, Sydney, Australia.

Oct. 21-26: International Conference on Ultra High Frequency Circuits and Antennas, Societe Des Radioelectriciencs, Paris, France.

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

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

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

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

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

Gaseous Diffusion Aids Transistors

High frequency characteristics expected to extend transistor markets

TRANSISTORS, produced by gaseous diffused-junction process, are breaking out of testing and development and into volume production..

▶ **Last month,** Texas Instruments announced commercial availability of its new diffused silicon diode rectifier. One of T. I's major 1957 highlights is the introduction of its new diffused process silicon transistor.

▶ **By year end** Motorola expects to be producing diffused germanium and silicon transistors in quantity.

Western Electric is manufacturing gaseous diffused transistors for military applications, expects to make extensive use of them in telephone communications.

The gaseous diffused-junction transistor was developed about a year ago by Bell Telephone Labs. Since then the process has been made available to more than 50 Bell licensees.

High-frequency characteristics result from microscopically thin transistor sandwich layers produced in the process.

Industry Shorts

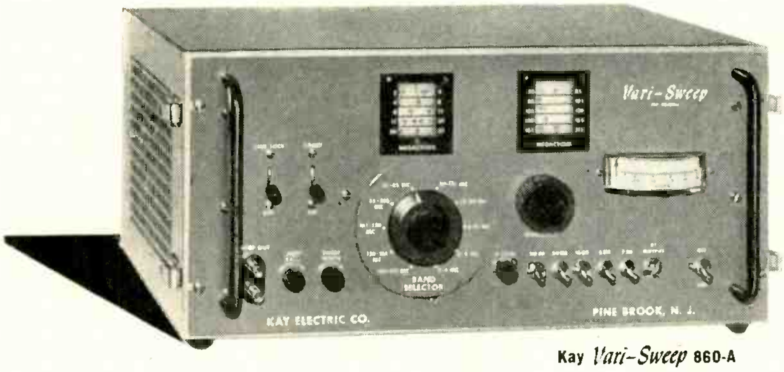
▶ **Ultrasonic** drill, developed by Lockheed, will bore holes as small as five thousands of an inch in miniature ferrite cores that are impervious to steel drills.

▶ **Propaganda** expenditures of Russia and Communist China are variously estimated at from $1 to $3 billion annually, roughly 10 to 30 times the amount the United States spends on its program of truth. It is estimated that the Russians alone spend more money to jam our Voice of America broadcasts than we spend on the whole U. S. Information Agency budget.

▶ **Signals** broadcast by the National Bureau of Standards station at Fort Belvoir, Va., each day at 1600 UT alert IGY scientists throughout the world to coordinate solar-terrestrial observations simultaneously.

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:

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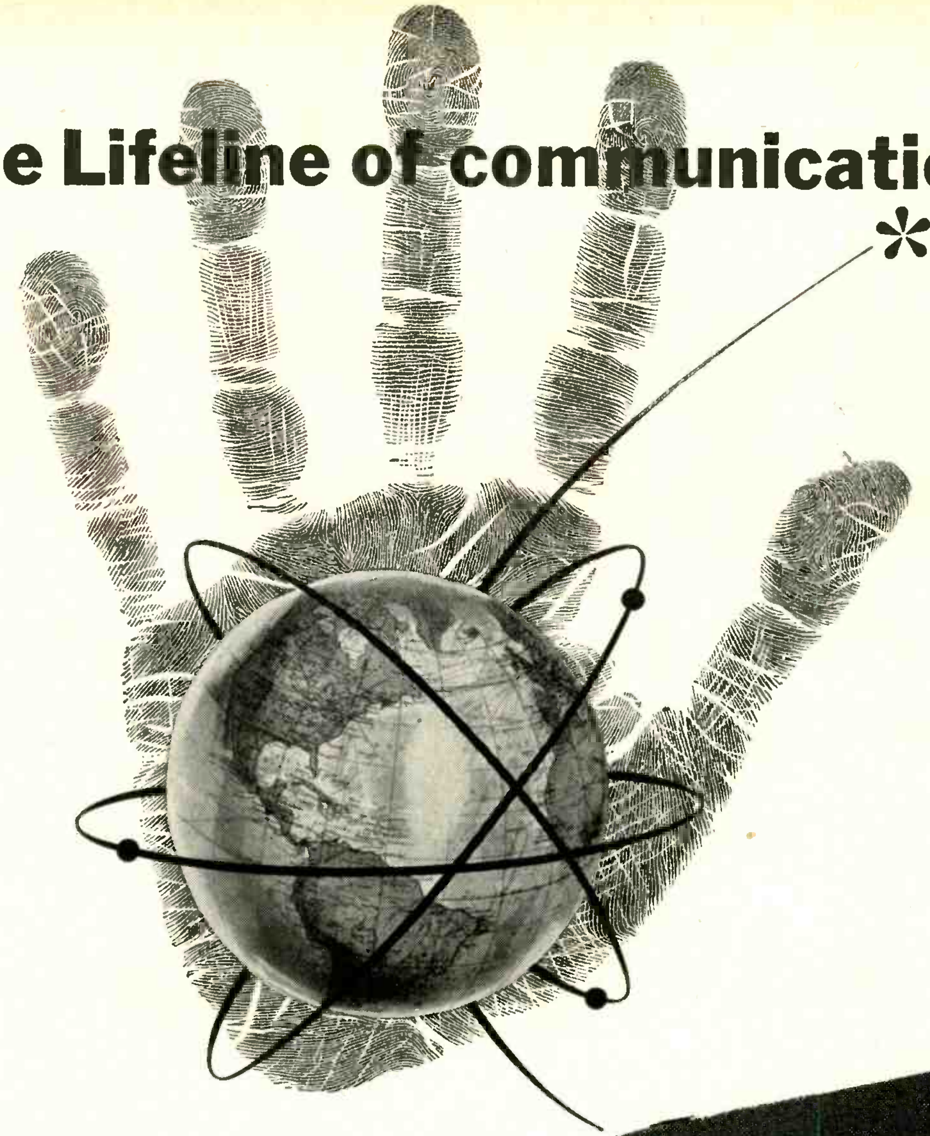
The Lifeline of communication . . . *



More than eighty countries use Marconi telecommunications equipment. The total telephone channel miles of Marconi radio multi-channel systems would go 15 times round the world.

Marconi's have supplied broadcasting or television equipment to eighty countries. Most of the equipment used by the British Broadcasting Corporation and the British Independent Television Authority and its programme contractors is Marconi's. Marconi's demonstrated 'compatible' colour television in 1954.

Thirty-two airforces rely on Marconi radio, radio navigational aids and radar. For the past two years Marconi's have been in quantity production with Doppler Navigators for British and Commonwealth governments. Many of the world's major airports use Marconi radio communications, beacons and radar.

All the radio beacons round the coasts of the British Isles and Eire and many in other major seaways have been supplied by Marconi's.

These few statements give some idea of the manufacturing achievement of Marconi's, who also maintain larger research facilities devoted to radio electronics than any other European company. Moreover Marconi College was the world's first school for wireless engineers. Courses there are the coveted privilege of the world's most promising radio engineers.

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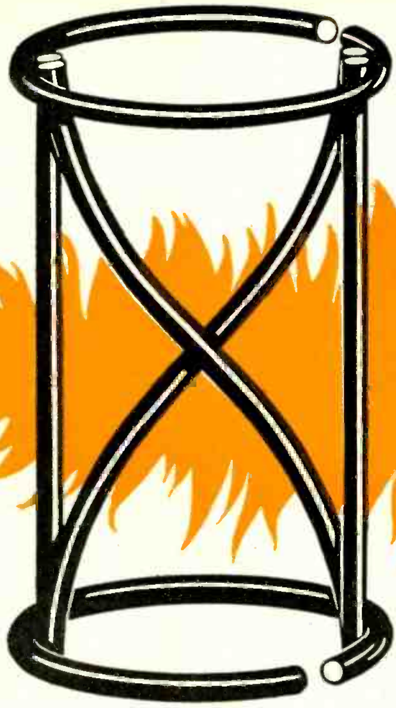
LG 20

Circle 68 Readers Service Card



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BH VINYL-SIL

. . . retains rated dielectric and flexibility after 2800 continuous hours at 130°C

Today's insistence on insulation with high heat endurance — higher processing temperatures, wire enamel compatibility, hotter operation — has emphasized the importance of BH Vinyl-Sil.

Available in two types — BH Vinyl-Sil 8000 and BH Vinyl-Sil 105 — both with 8000 volt minimum dielectric breakdown, and meeting all requirements of ASTM, NEMA* and MIL-I-3190B* Class B-A-1 specifications. BH Vinyl-Sil 105 also offers no capillary attraction to water and is the first vinyl sleeving to be Underwriters' Laboratories recognized for 600 volt, continuous wet or dry operations at 105°C.

BH Vinyl-Sil Sleevings are specially fabricated of braided glass fibers, then continuously coated by a patented process with a uniquely stabilized vinyl chloride compound. High standards of manufacturing developed in over seven years pioneering experience with vinyl-glass sleevings is your assurance of reliable operational performance.

Data sheets and testing samples are yours for the asking — just write, giving a few facts about the insulation problems to be encountered — we'll make recommendations and send you appropriate samples.

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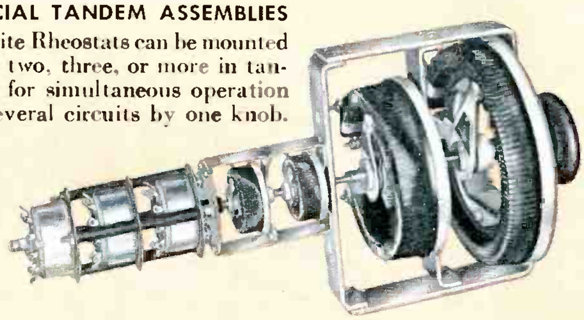
with special features

Ohmite offers not only a line of *standard* rheostats but also rheostats with a wide variety of *special features*. Illustrated are only a few. All have the distinctive Ohmite design features: smoothly gliding metal-graphite brush; all-ceramic construction; insulated shaft and mounting; windings permanently locked in place by vitreous enamel. You will find the special rheostat feature you need in the dependable Ohmite line.

SPECIAL TANDEM ASSEMBLIES
Ohmite Rheostats can be mounted with two, three, or more in tandem for simultaneous operation of several circuits by one knob.



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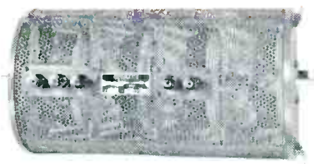
Extra-long bushings and shafts for panels up to 2″ in thickness. Seven bushing lengths.

SCREW DRIVER SLOT SHAFT
Shaft ends slotted for operation with a screw driver where few adjustments are needed.

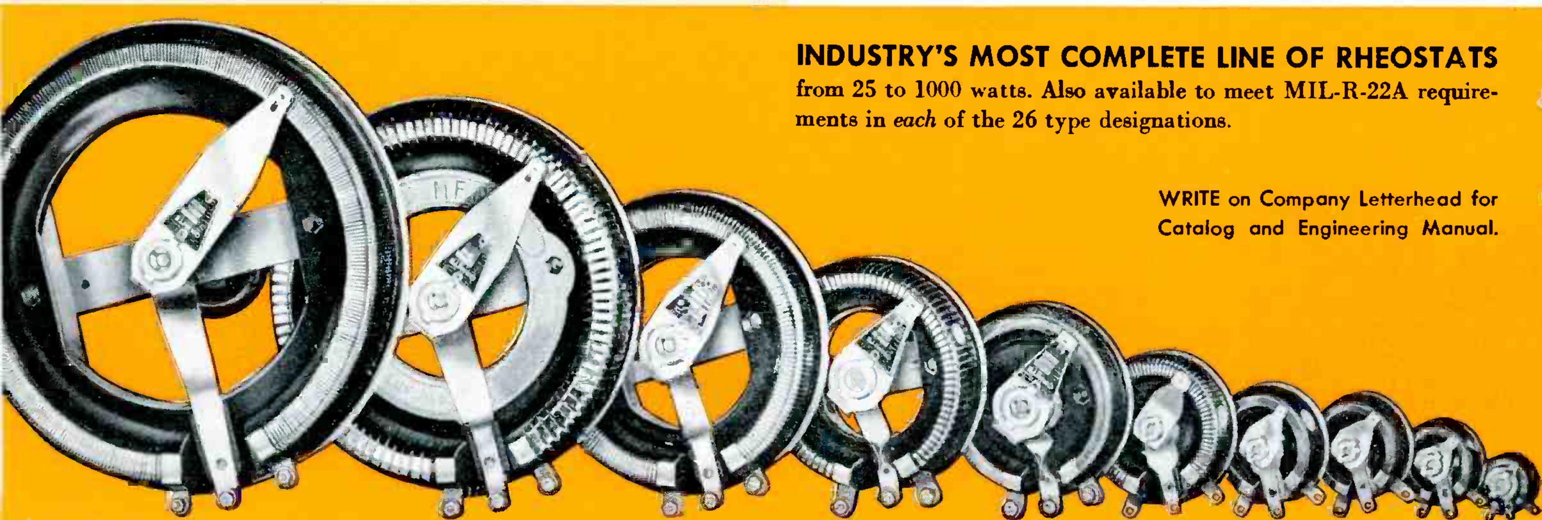


VENTILATED CAGES
Prevents mechanical injury to rheostat or human contact with electrically "live" parts.

SENSITIVE SWITCH
Opens or closes circuit with minimum movement of control knob shaft. Extremely dependable long life switches.

TOGGLE SWITCH
Is operated with a positive snap by the rheostat arm at either end position. Used for heavy-duty applications.

WITH OFF POSITION FEATURES
Opens circuit at high or low resistance position with *snap-action* (illus.); opens circuit at high resistance position with *dead lug* off position; or has *dead section* off position.



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from 25 to 1000 watts. Also available to meet MIL-R-22A requirements in *each* of the 26 type designations.

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TAP SWITCHES · TANTALUM CAPACITORS

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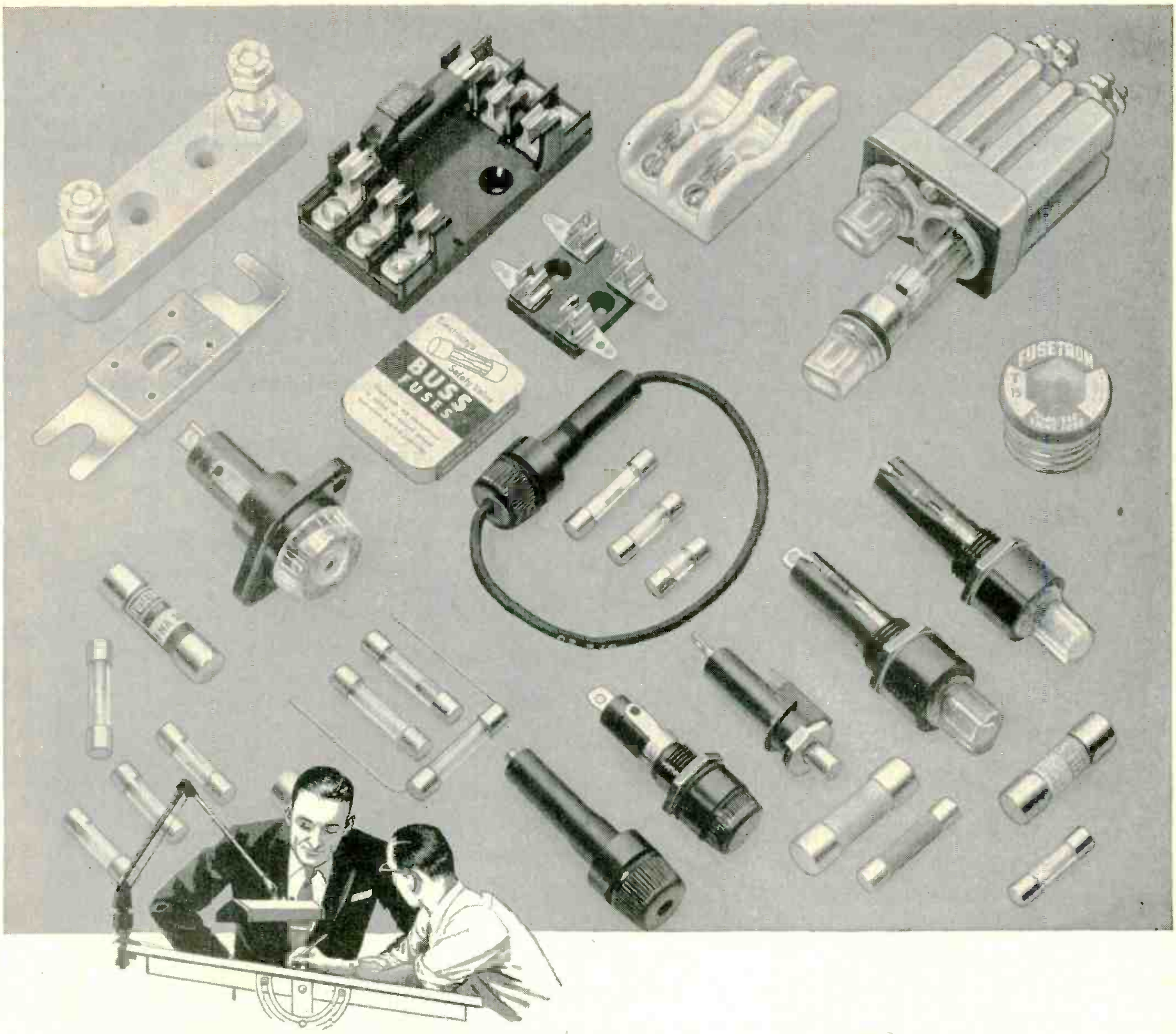

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To make sure of proper operation under all service conditions . . . every BUSS fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

This careful testing is your assurance BUSS fuses will provide equipment with maximum protection against damage due to electrical faults.

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Complete Line—There is a complete line of BUSS fuses in sizes from 1/500 ampere up . . . plus a companion line of fuse clips, blocks and holders.

If your protection problem is unusual . . .

. . . let the BUSS fuse engineers work with you and save you engineering time. If possible, they will suggest a fuse already available in local wholesalers' stock, so that your device can be easily serviced.

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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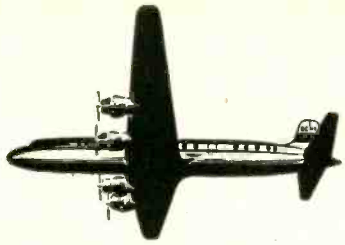
BUSS

Makers of a complete line of fuses for home, farm, commercial, electronic, automotive and industrial use.

Circle 1 Readers Service Card

AEROCOM'S 1046 H.F. TRANSMITTER



POWER + STABILITY

1000 WATTS WITH .003% STABILITY

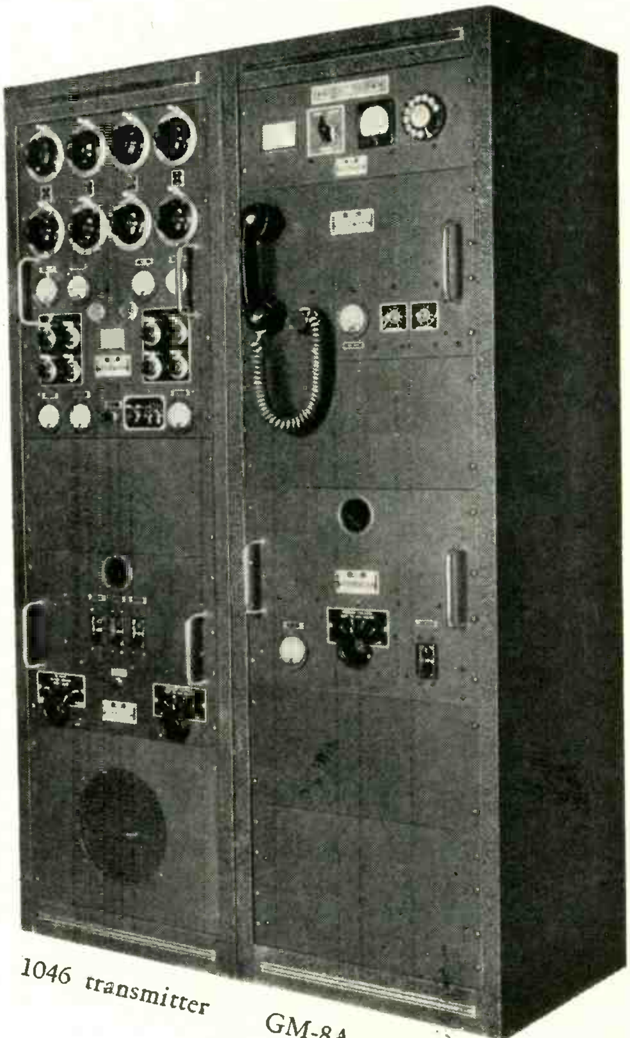
Rugged, versatile general purpose H. F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0° to +50°C.). Excellent for point-to-point or ground-to-air communications.

Multi-channel operation on telegraph A1, or telephone A3 with GM-8A modulator... new Aerocom 1046 can be *remotely controlled* with TMC-R at control position and uses only one pair of telephone lines. In A3 operation, the local dial control panel is located in modulator cabinet.

Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to +50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

Complete technical data on request



1046 transmitter

GM-8A modulator

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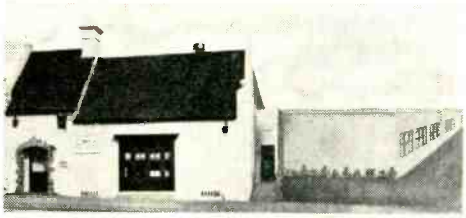

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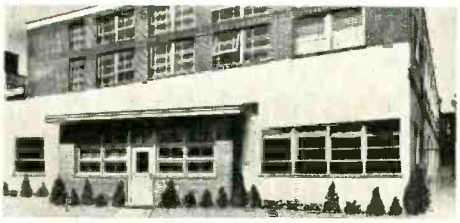

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Circle 3 Readers Service Card

FILTRON'S mobile shielded laboratory and the Convair F-102, the Air Force's new supersonic delta-winged Fighter.

r-f mobile laboratory uses ACE enclosure for on the spot tests

Measurements of radio interference from aircraft once was a real problem FILTRON Company, Inc., manufacturers and designers of r-f filters and suppression systems, realizing that aircraft could not get to a shielded lab, took the problem to Ace. Together, they developed the Mobile Radio Interference Laboratory pictured above. It's a completely equipped r-f lab shielded on all sides by a standard Ace RFI Design* Enclosure. The prefabricated galvanized steel panels and frames mount directly on a flat-bed Chevrolet truck. Accessories include air conditioning and power generators to operate all necessary equipment.

FILTRON's lab on wheels has traveled many thousands of miles, a lot of it over rough bumpy roads. The Ace enclosure is still completely "radio-tight" supplying more than its guaranteed 100 db attenuation at all frequencies from 14 kc to 1000 mc.

This mobile lab is one of many unique Ace applications. Our complete line of screen and sheet, copper and galvanized enclosures probably includes the solution to your shielding problems—whether you're in military, industrial, or medical work. An Ace sales engineer would be glad to show you how. Our catalog is a good start. Write for your free copy.

*Lindsay Structure

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First and Finest in Shielded Enclosures

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Precision-built to rigid government specifications, a broad selection among Eastern pumps offers flexibility to your choice. Modifications can be made, or custom-made units designed to suit your project. Trim in size, light in weight, Eastern Aircraft Pumps give reliable long-term service.

★ ***PRESSURIZATION***
Eastern pressurization units for airborne electronic equipment are available in many capacities to handle a broad range of requirements. Units consist of an air pump and motor assembly, pressure switch, check valve, tank valve, and terminal connectors. They meet government specifications and can be modified to your needs.

eliminate the "BUGS"

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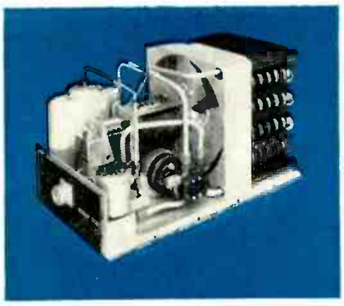

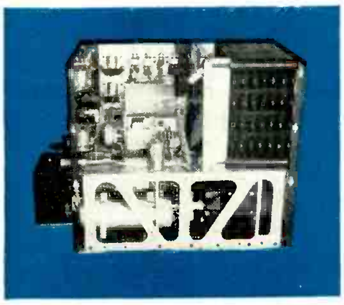

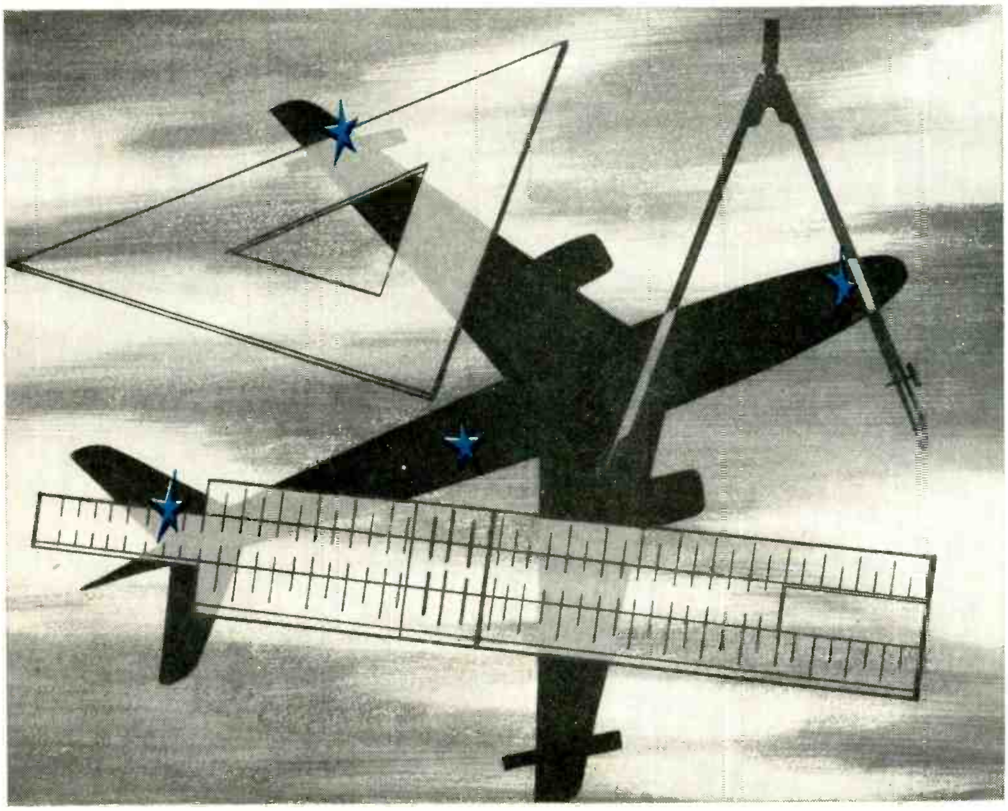

★ ***COOLING UNITS***
Hold temperatures to safe operating limits in liquid cooled electronic tubes or similiar devices. By virtue of long experience and using standard component parts, Eastern can suit your specific needs at a minimum cost for equipment.

★ ***REFRIGERATION-TYPE***
Enable specified components to be held to fairly constant temperatures by use of various types of refrigeration units. Because of the variation in methods possible, Eastern units fill every requirement where the use of a refrigeration cycle is called for.

★ *SPECIAL UNITS*
Eastern's continual research and development program keeps pace with the growing aviation industry. As new problems occur with progress in aircraft development, Eastern units are constantly developed to fill their function as planes fly higher, or faster, or with greater load capacity.

Eastern welcomes the chance to help engineers "take out the bugs" with equipment that cools, pressurizes, or pumps. From the extensive line of existing units, new adaptations, or custom-made designs, Eastern is ready to meet every challenge for equipment that handles your needs *the best today . . . better tomorrow.*

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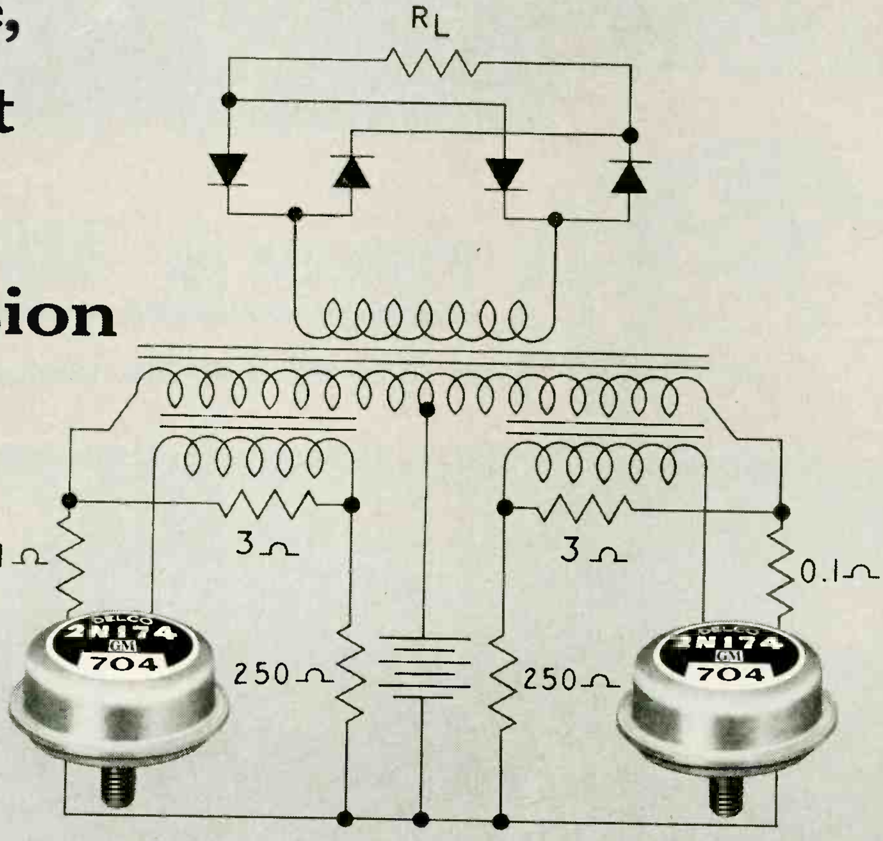
Reliable, Efficient DC Conversion



Industry's Highest Power Transistors

Low saturation voltage of Delco Radio 2N173 and 2N174 opens new opportunities for converter economy, efficiency and reliability

The excellent electrical characteristics of Delco High Power transistors permit the conversion of *low* DC voltage to *higher* DC voltage—with a high degree of efficiency—in a wide range of applications. This proved performance offers greater reliability than will be found in corresponding vibrator circuits.

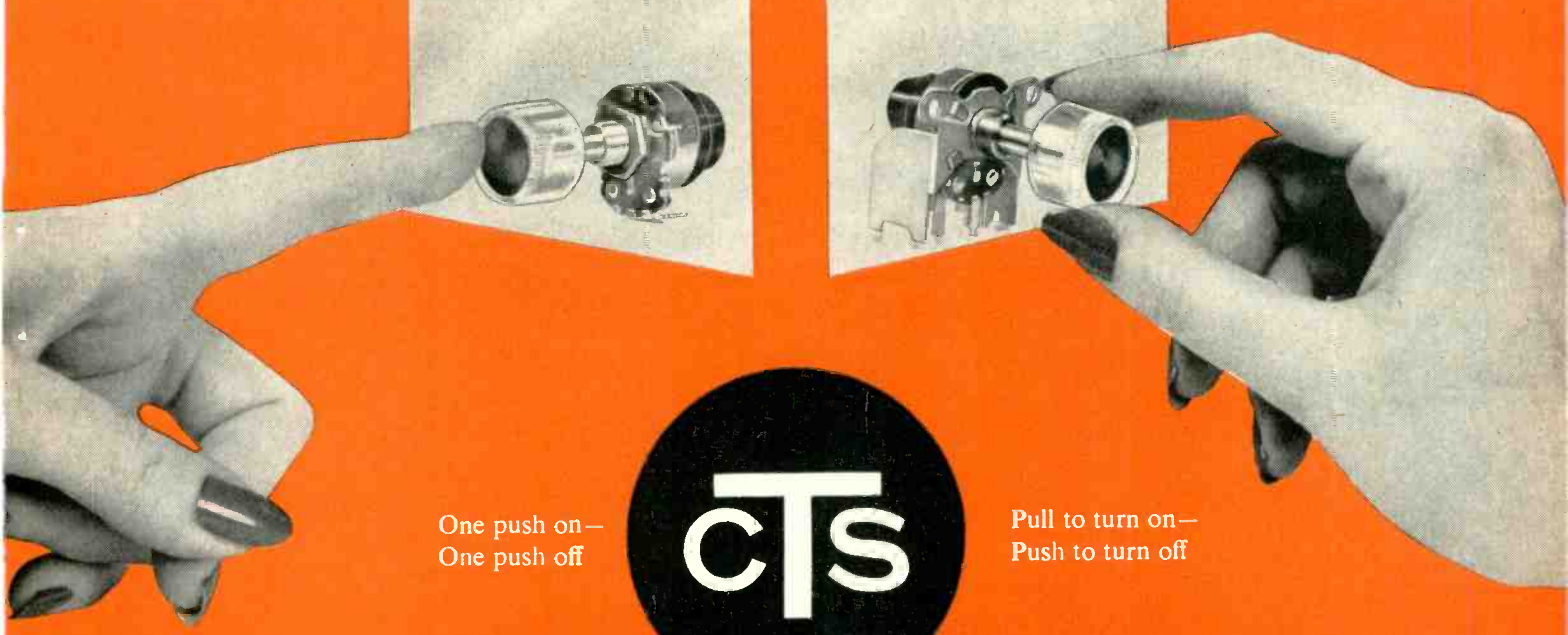
The low saturation voltage of Delco 2N173 and 2N174 transistors also reduces their internal power dissipation in conversion applications to an insignificant degree so that little self-heating is apparent. The result is an overall economy which permits converters of smaller size . . . important in many applications.

TYPICAL CHARACTERISTICS

	2N173	2N174
Properties (25°C)	12 Volts	28 Volts
Maximum current	12	12
Maximum collector voltage	60	80
Saturation voltage (12 amp.)	0.7	0.7
Power gain (Class A, 10 watts)	38	38
Alpha cutoff frequency	0.4	0.4
Power dissipation	55	55
Thermal gradient from junction to mounting base	1.2°	1.2°
Distortion (Class A, 10 watts)	5%	5%

DELCO RADIO DIVISION OF GENERAL MOTORS
KOKOMO, INDIANA

PUSH-PUSH PULL-PUSH



One push on—
One push off

Pull to turn on—
Push to turn off

Two new switch-controls

Volume setting unaltered by ON-OFF operation

Just switch on and walk away. No coming back or waiting for further adjustment after warm-up.

Volume can be changed instantly as desired by rotating shaft . . . or can remain indefinitely at any selected setting regardless of on-off switch operations.

Push-push switch available with either 3 amp 125V rating (Type J) or 6 amp 125V rating (Type TJ). Pull-push switch available with 3 amp 125V rating (Type K). Both switches available in many special terminal and control combinations.

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The most complete line of variable resistors and associated switches available is manufactured by CTS. Consult CTS Specialists on all your control problems.

WEST COAST MANUFACTURERS:
Many types of variable resistors now in production at our South Pasadena plant. Your coil, transformer and compression molding business also invited. Prompt delivery. Modern versatile equipment. L. A. phone CLinton 5-7186.

Burton Browne Advertising

CHICAGO TELEPHONE SUPPLY *Corporation*

ELKHART • INDIANA

The Exclusive Specialists in Precision Mass Production of Variable Resistors

A NEW STAR FOR ALL-WEATHER FIXES

EDO AIRBORNE LORAN

Model 345

For Cockpit Installation

26 Pounds Total Weight

Compact scope and command control designed for cockpit installation. 34-tube receiver (not shown) occupies ¾ ATR rack.

Now, the long-awaited aircraft loran, designed primarily to fill the needs of transoceanic flying and packaged for cockpit installation, is announced by EDO. Built specifically to meet airline requirements, this new lightweight unit is designed for instrument panel mounting, convenient to the pilot.

It's no longer necessary to pay a heavy weight penalty for the added safety and convenience of loran gear. Edo's new set weighs only 26 pounds completely installed.

Built to the highest electronic standards, the Edo Model 345 gives quick, directly read time difference readings for accurate plots in a matter of seconds. No calculation, no computations, no tables, no special training needed to operate. As simple to use as any other pilot-operated radio navigation aid.

A development of Edo's years of research, design and production of dependable marine loran sets and other high performance electronic equipment, the Model 345 contains the latest miniaturized circuitry. Its compact remote control console and clear, easily read 3-inch scope fit neatly into the restricted space of an airplane instrument panel.

If you are interested in detailed specifications and operating data, please write for particulars.

FEATURES OF THE EDO MODEL 345

- 3-inch scope easily read even under bright light conditions. Does not require a special hood. Can be mounted directly in instrument panel, or other accessible spot.
- Pilot-operated command control gives directly read solution to problem. No calculations, no tables, no special training needed to operate.
- Loran receiver containing 34 tubes. Features low power consumption — only 175 watts, 115 v 400 cycles; 25 watts, 24 v DC.
- No-drift signal assured by special oscillator control.
- Highly accurate voltage regulation for dependable operation.
- Complete fail-safe feature.

BROCHURE AVAILABLE ON REQUEST

The Edo Corporation

College Point, Long Island, New York

Manufacturers of a Trusted Line of Marine and Airborne Electronic Equipment

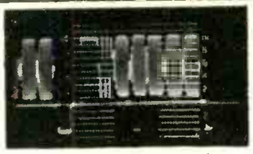
THEY'RE CHECKING VIDEO EVERYWHERE

WITH THE FAMOUS TELECHROME INCORPORATED

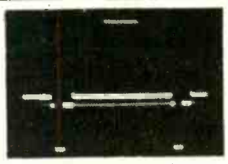
Model 1003-B

PORTABLE VIDEO TRANSMISSION TEST SIGNAL GENERATOR

★ Completely self contained ★ Portable ★ Multi-frequency burst ★ Stairstep ★ Modulated stairstep ★ White window ★ Composite sync ★ Regulated power supply.

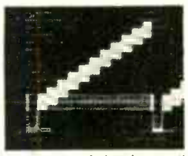


MULTI-FREQUENCY BURST AMPLITUDE vs FREQUENCY. Check wide band coaxial cables, microwave links, individual units and complete TV systems for frequency response characteristics without point to point checking or sweep generator.



WHITE WINDOW

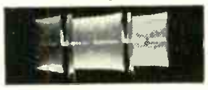
LOW & HIGH FREQUENCY CHARACTERISTICS. Determine ringing, smears, steps, low frequency tilt, phase shift, mismatched terminations, etc. in TV signals or systems.



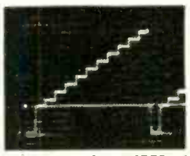
STAIRSTEP SIGNAL modulated by crystal controlled 3.579 mc for differential amplitude and differential phase measurement. Checks amplitude linearity, differential amplitude linearity and differential phase of any unit or system.

Model 1003-C includes variable duty cycle stairstep (10-90% average picture level).

Model 608-A HI-LO CROSS FILTER for Signal analysis.

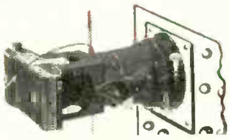


MODULATED STAIRSTEP signal thru high pass filter. Checks differential amplitude.



MODULATED STAIRSTEP signal thru low pass filter. Checks linearity.

1004-A VIDEO TRANSMISSION TEST SIGNAL RECEIVER for precise differential phase and gain measurements. Companion for use with 1003-B.



1521-A OSCILLOSCOPE CAMERA—Polaroid type for instantaneous 1 to 1 ratio photo-recording from any 5" oscilloscope.

TELECHROME INCORPORATED

DELIVERY 30 DAYS

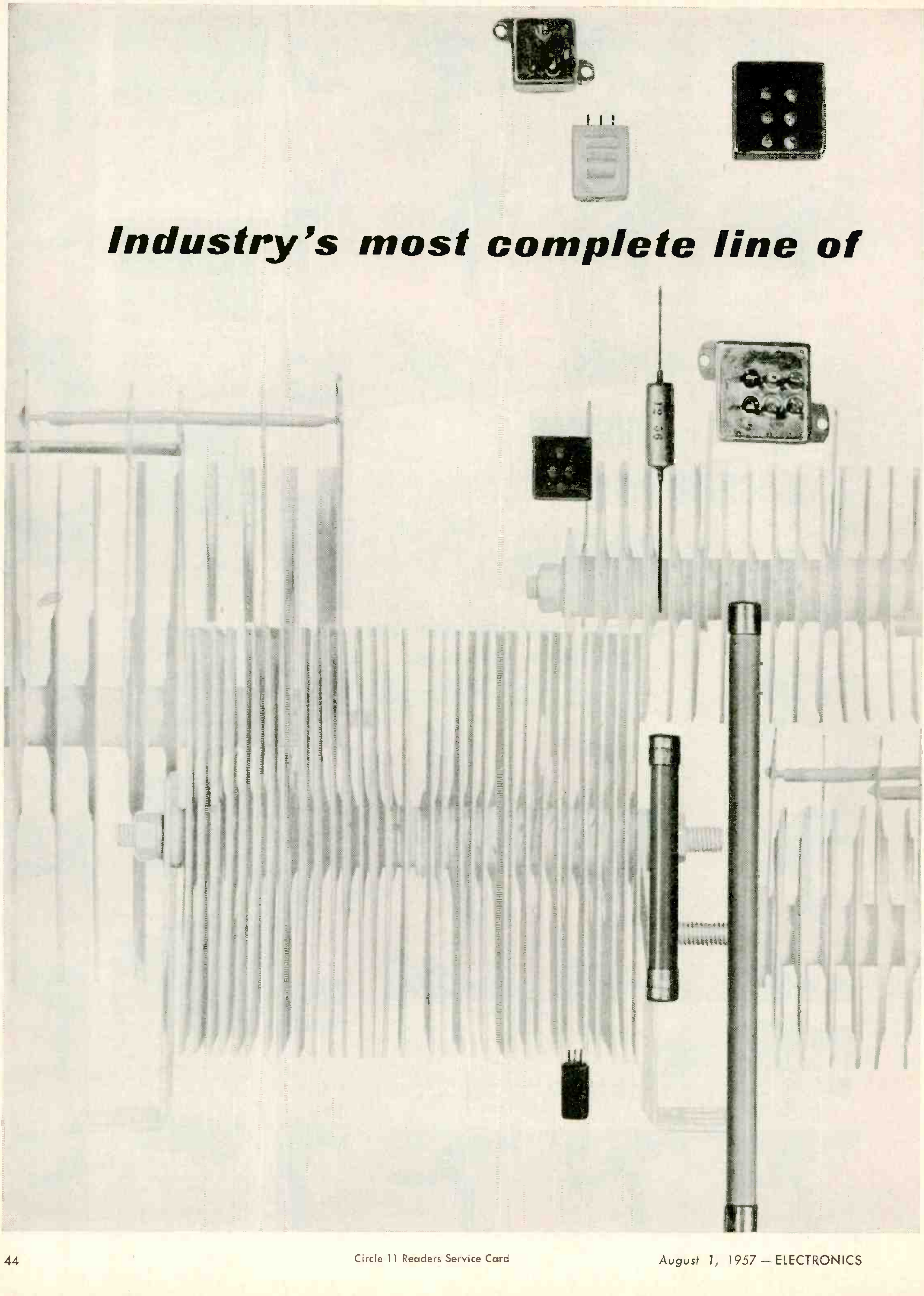
Literature on the above and more than 100 additional instruments for monochrome and color TV by TELECHROME are available on request.

The Nation's Leading Supplier of Color TV Equipment

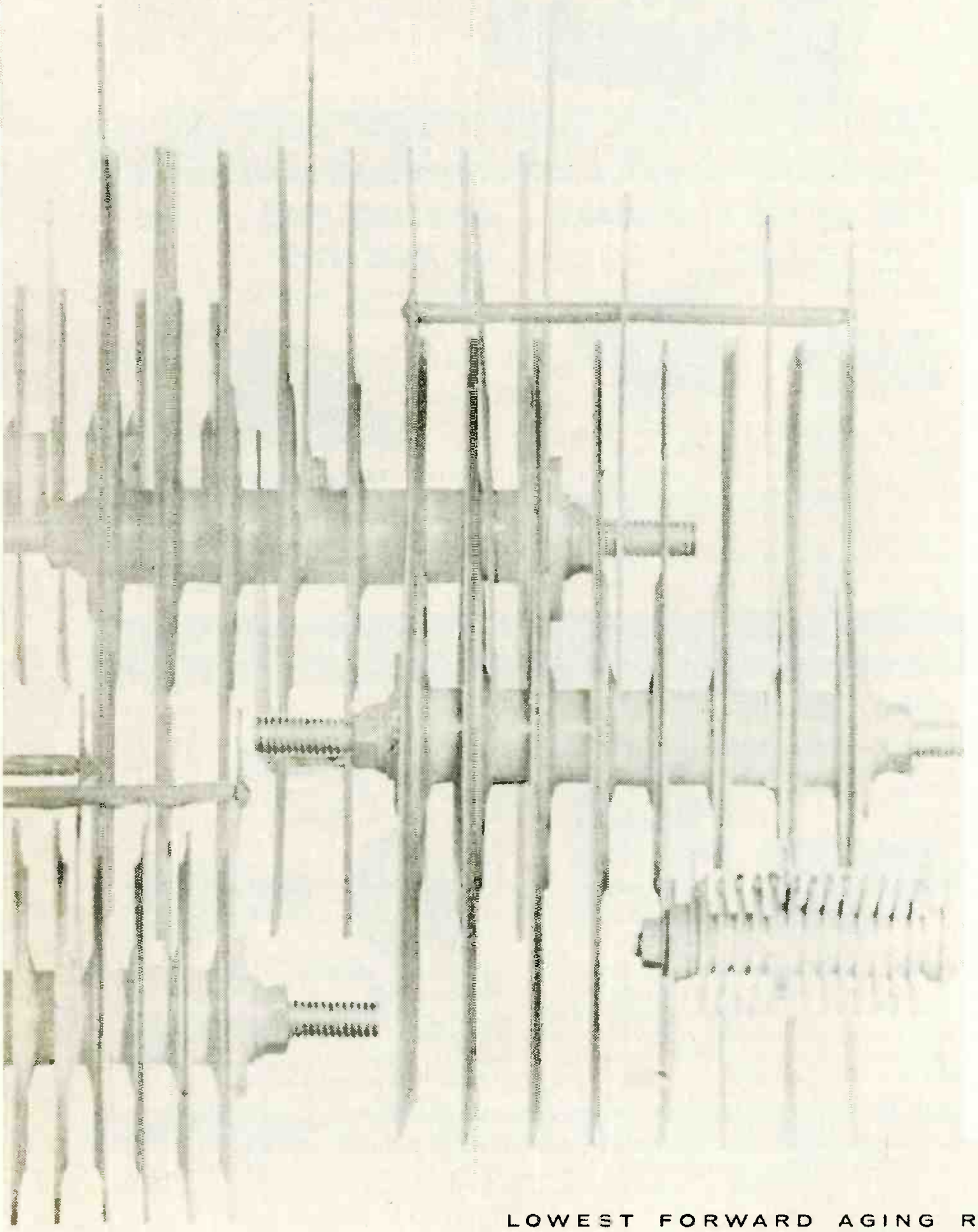
28 Ranick Drive Amityville, N. Y.

Lincoln 1-3160

Circle 10 Readers Service Card


Industry's most complete line of

control and power rectifiers



Now available from a single source . . . a *complete* line of selenium rectifiers for d-c power supply, battery chargers and electronic circuitry.

Whether your needs are for 6 to 100,000 volts; 1.5 milliamp or 10,000 amperes; stacks, cans or cartridges (with a wide range of configurations), Westinghouse has a rectifier to meet your specific requirements.

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%. Reverse leakage actually decreases with use. This superior performance . . . with up to 90% 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-22089

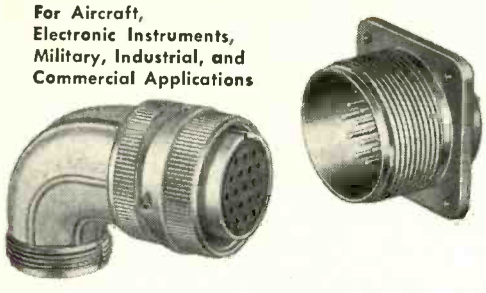
LOWEST FORWARD AGING RATE IN THE INDUSTRY!

YOU CAN BE SURE...IF IT'S

Westinghouse

AN (STANDARD)

For Aircraft, Electronic Instruments, Military, Industrial, and Commercial Applications



Standard AN-A, AN-B, AN-C... meet Specification MIL-C-5015C. **Plastic inserts.** 15 diameters, 260 insert layouts, 6 shell styles. AN3100 to AN3108 with all accessories. Interchangeability an outstanding feature. Many type assemblies directly available through distributors.

connect with CANNON PLUGS

AN-E (INT. AN-M)

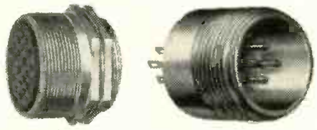
Where Vibration Resistance and Moisture Proofing Are Needed

AN-E Series... environment resisting. Replaces "old" AN-M. Meets Specification MIL-C-5015C. Resilient inserts. Completely sealed from cable to cable. Integral clamp and bushing. Grounding lugs. Interfacial sealing with grommet and grommet follower.

The "AN" and associated series connectors offer the

GS (HERMETICALLY-SEALED)

For Use Under Critical Pressure Conditions



Hermetically sealed connectors... with steel shells and contacts to withstand high pressures. Available in GS (AN type), KH, RKH, U, BFH, TBFH. Insulation is Canseal glass material, fused under high temperature to shell and contacts... giving *true hermetic sealing* when soldered or brazed to housing.

STEEL SHELL FIREWALL

For Open Flame Protection Wherever High Temperatures Are Involved

AN-K and Cannon FW Firewall Connectors... offer you the greatest variety of this type of connector. Cannon made the first firewall connector and continues the leader in the field. Wall—or box-mounting receptacles. Straight or angle 90° plugs. Crimp-on contacts. Inserts of asbestos-filled or glass-filled materials.

CONNECTORS SUITABLE FOR **POTTING**

For Resistance to Moisture, Fuel Oil, Gasoline, etc.

CA06 and CA3106 Types... developed for the Bu Aer Standard AN3106 type minus the end bell. Special plastic "cups" supplied for use as a mold while potting the rear of the connector. Weight saving. Grounding means available. Plastic or resilient inserts.

widest selection of types for all applications to Spec. "MIL"

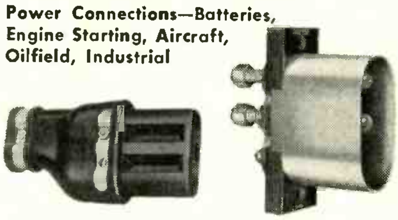
AF, F (VIBRATION PROOF)

For Points of High Vibration Where Extra Strength Is Needed

Vibration Proof CA310*F—CAO*AF Solid Shell, Resilient Insert Connectors... Feature extra strong coupling nuts... in hex, spline, knurled types for airline use. In wall—or box-mounting, cord-connecting type receptacles. Straight or angle 90° plugs.

AN EXTERNAL POWER

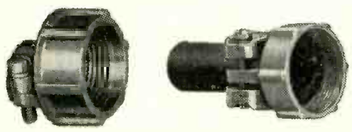
Power Connections—Batteries, Engine Starting, Aircraft, Oilfield, Industrial



CA2551, AN2552, AN3114 and Other Cannon Types Offer Most Complete and Varied Line... in single, double, and three contact fittings. Really rugged! Designed and built for safe, positive connection and long-lasting service.

AN ACCESSORIES

Cable Clamps, Conduit Fittings, Dummy Receptacles, Junction Shells, Dust Caps, Bonding Rings, Bushings, Adapters



Featuring High-Quality Materials and Workmanship... including AN3057, AN-3057A, AN3420, AN3054, AN3055, AN30-56, AN3058, AN3064, AN3066, AN3068, AN3111, 2120, 2245, 17530, 2209, 2182. Adaptable to all makes of AN connectors.

Cannon Plugs—standard of quality for the industry

W

For Underwater and Severe Moisture Conditions

W Waterproof Series... used underwater and on equipment operating in swamps, rivers, lakes, with underground cables — wherever conditions require thoroughly sealed fittings. Exceptionally rugged. AN type inserts. Acme threads on coupling nuts. Special rubber sealing ring. Special heavy duty cable clamp available.

OTHER SERIES... Audio Types–External Power Connectors–Switching Types–dc Solenoids–Guided Missile Launching Connectors–Miniatures and Sub-Miniatures.

Write Today for new, completely revised, up-to-date AN11 bulletin!

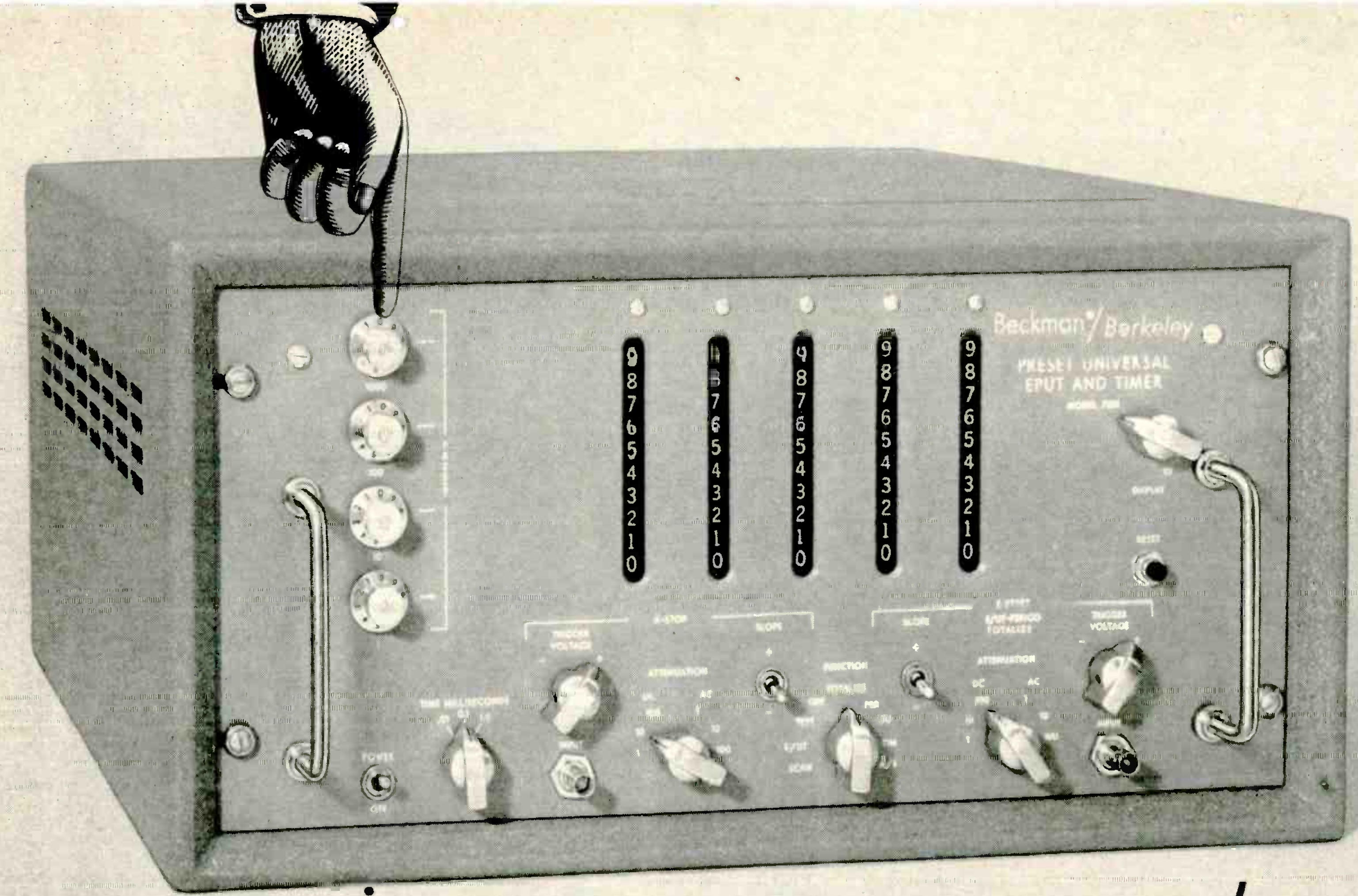
CANNON ELECTRIC

Since 1915

Please Refer to this Magazine or to Dept. 120

CANNON PLUGS

CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles 31, Calif. Factories in Los Angeles; Salem, Mass.; Toronto, Canada; London, England; Melbourne, Australia. Manufacturing licensees in Paris, France; Tokyo, Japan. Contact our representatives and distributors in all principal cities.



NEW from Beckman® / Berkeley

Variable Time Base Universal EPUT® Meters
For Direct Digital Readout Without Conversion!

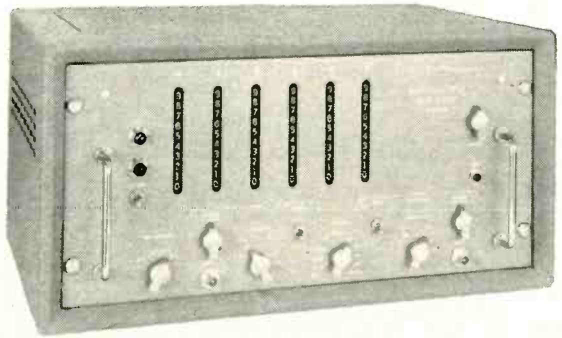
NEW MODELS 7351
(shown on preceding page) and 7361

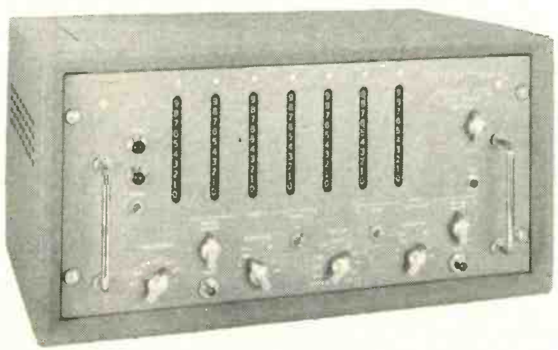
With their variable preset "count down" time bases, Models 7351 (100 kc) and 7361 (1 mc) Preset Universal EPUT* Meters are unique multipurpose instruments. Regardless of transducer conversion factors, results may be read in direct digital form by merely selecting the proper time base. These instruments will measure time intervals of any number of periods from 1 to 10,000 over the frequency range 0 to 10 kc, totalize a selectable sequence of events, divide frequency, function as single preset counters, generate pulses of varying frequency.

Applications include precise measurement of velocity, pressure, flow, viscosity, low and high frequency, frequency ratio and period, and tachometry.

NEW MODEL 5230 PORTABLE UNIVERSAL EPUT* METER

Combines many features of the popular Beckman/Berkeley 7000 series in a new, light-weight portable instrument to perform the functions of a counter, timer, time interval meter, EPUT* meter, frequency, frequency ratio or period meter. Printed circuitry contributes to compact design, increased reliability and economical cost.





MODELS 7350 and 7360 UNIVERSAL EPUT* METERS

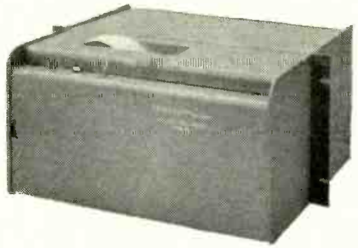
DESCRIPTION—These truly universal instruments combine high-speed electronic counting with a precision time base in multi-purpose circuitry. They function as counters, timers, time-interval meters, EPUT* meters, frequency, frequency ratio or period meters, or as secondary frequency standards.

All models have provision for standardization against WWV and may be coupled to external frequency standards. Connections are provided for driving Berkeley digital printers, data converters, or in-line remote readout units.

FEATURES

1 *0.1 v rms sensitivity*
2 *Step attenuators; trigger-adjusted noise discriminators*
3 *More stable frequency dividers*
4 *Electronic (not relay) reset*
5 *External frequency standard input connection*
6 *AC or DC coupling of all input circuits; 10 megohm input impedance*
7 *Multivoltage accessory socket to power photocells, etc.*
8 *Binary-coded output with direct connection to digital printers, data converters, inline readouts, etc.*
9 *Crystal-controlled time marker output*
10 *Unitized modular design*
11 *Larger, brighter readout numbers*
12 *Modern-styled all-aluminum cabinets*

ACCESSORIES



MODEL 1452 DIGITAL PRINTER

Automatically and permanently records information from any Berkeley 5571 or 7000 Series instrument, prints data in digital form on standard adding machine tape from printer and scanner in one compact unit. May be modified to print "Time" or "Code" information simultaneously with data. Rack or bench mounted: available in up to 8 digits. One printout every 0.85 seconds. Price (6-digit), $950.00.

MODEL 5916 IN-LINE READOUT

Large, illuminated in-line IN-PLANE figures reduce fatigue and error. Ideal for remote observation of data. Connects directly to any Berkeley 5571 or 7000 Series instrument. Presentation rate up to 15 per second; accepts binary voltages. Price (six digit unit), $775.00.

TRANSDUCERS

A large number of transducers especially designed for use with Berkeley counting, timing, and frequency measuring equipment are available. These include tachometer pick-ups, photocells, and light sources. Specifications and technical description on request.

SPECIFICATIONS & PRICES

BRIEF SPECIFICATIONS	Model 5230	Model 7350	Model 7351	Model 7360	Model 7361
RANGES-FREQUENCY	0 cps to 100 kc	0 cps to 100 kc	0 cps to 100 kc	0 cps to 1 mc	0 cps to 1 mc
TIME INTERVAL	100 μsec to 10^4 sec	10 μsec to 10^6 sec	10 μsec to 10^5 sec	1 μsec to 10^7 sec	10 μsec to 10^6 sec
PERIDD	0 cps to 10 kc	0 cps to 100 kc	0 cps to 10 kc	0 cps to 1 mc	0 cps to 10 kc
TIME BASES	0.1 and 1 sec	10 μsec to 10 sec	Time Interval* Generator	1 μsec to 10 sec	Time Interval* Generator
CODED OUTPUT FOR DRIVING DIGITAL RECORDER, ETC.	$30.00 extra	yes	yes	yes	yes
COUNT CAPACITY (READOUT)	4 digit	6 digit	5 digit	7 digit	6 digit
ACCURACY	± 1 count, ± oscillator stability				
OSC. STABILITY	1 part in 10^5 per day	3 parts in 10^6 per week	1 part in 10^6 per day	3 parts in 10^6 per week	1 part in 10^6 per day
INPUT SENSITIVITY	0.25 v rms	0.1 volt rms**			
INPUT IMPEDANCE	1 megohm, direct	10 megohm, dc or ac coupled			
TRIGGER SLOPES	Positive or negative				
CABINET DIMENSIONS	12"H x 8"W x 14"D	10¼"H x 20¾"W x 16½"D (Rack Panel — 8¾" x 19")			
APPROX. SHIPPING WT. LBS.	30	60	50	60	50
PRICE: (F.O.B. FACTORY)	$575.00	$945.00	$1295.00	$1245.00	$1445.00

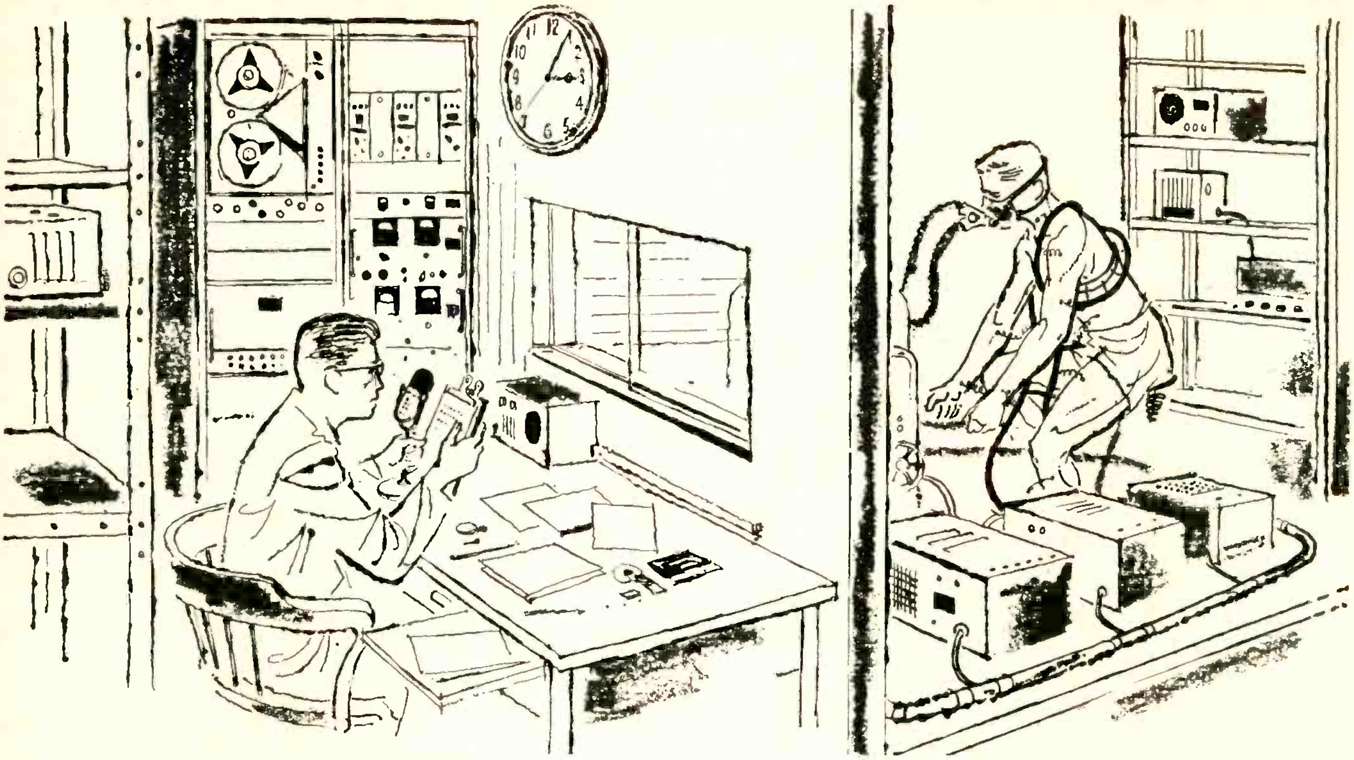
*Variable from 0.1 millisec to 0.9999 sec in 0.1 millisec increments and from 1 millisec to 9.999 sec in 1 millisec increments

**Modification for 5 millivolt sens. @ 5 cps available, $50.00 extra

NEW SPECIAL PRODUCTS SECTION SPEEDS SERVICE

A new department with complete specialized engineering, model shop and manufacturing facilities is ready to give prompt service on special modifications to standard Beckman/Berkeley instruments, or supply special equipment to your specifications.

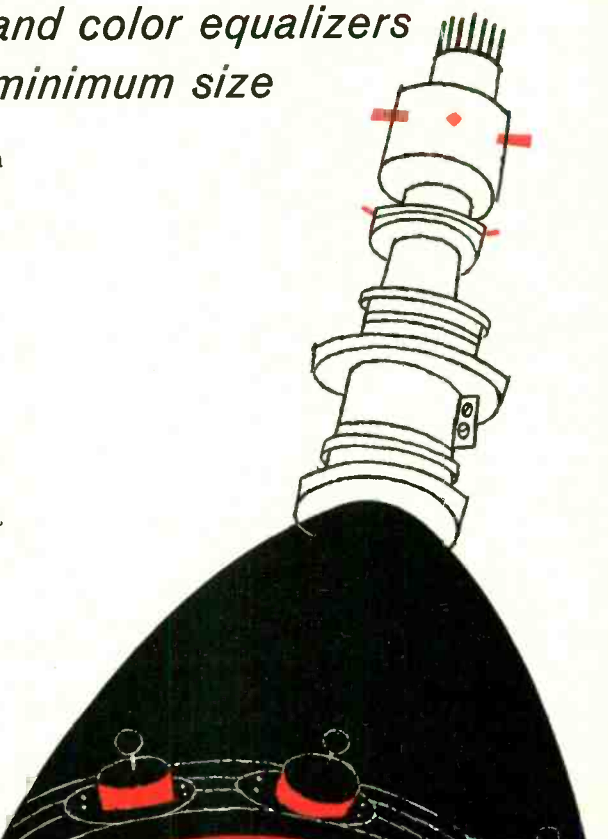
Complete technical specifications on Beckman/Berkeley Universal EPUT* meters and accessories are available promptly on request. Please address Dept. G-8



in color tv, too

CRUCIBLE PERMANENT MAGNETS

for beam correctors, color purifiers and color equalizers give maximum energy . . . minimum size



Designers of electronic and control equipment can count on a *consistently higher* energy product with Crucible alnico magnets. *It means greater power from a minimum size magnet!*

And they're available in practically any size you want—from a fraction of an ounce to several hundred pounds. What's more, Crucible alnico permanent magnets can be sand cast, shell molded, or investment cast to your exact size, shape, or tolerance requirements.

Crucible has been a leading producer of these permanent magnets ever since alnico alloys were developed. And their manufacture is backed by over a half century of fine steelmaking experience. That's why so many magnet applications begin at Crucible.

Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

FLASH...
an *Original Idea!

You Can Count On... to Pay Off!

Series 120? Reset Magnetic Counter

It's the **Original Equipment* idea . . . which simply means that, when you're figuring on electrical or mechanical counters in any new product, it pays to *design them in, when you begin.*

For then Veeder-Root quite likely can save you time and money by adapting or modifying a *standard* counter to your needs, instead of a special which you might specify on your own. This solves the counter problem . . . and saves you time in engineering, purchasing and assembly.

What's more, you give your product new sales-advantages: Direct-reading digits, instead of hard-to-read dials and verniers . . . instant remote indication if needed . . . up-to-the-minute performance records that serve as a basis for production-*Count*rol, and as proof of your performance guarantee. So don't let counters take a back seat in your new-product plans. *Design them in, when you begin* . . . it pays in many ways. Do you have the newest Veeder-Root Catalog? Write

Everyone Can Count on
Veeder-Root
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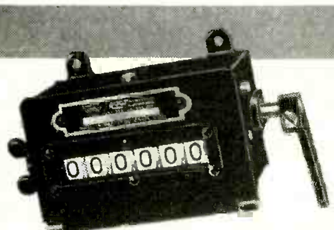
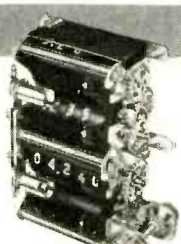
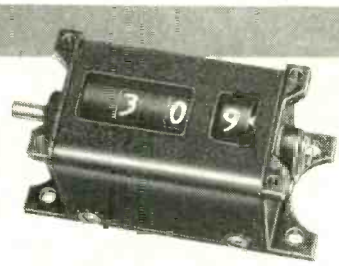


Series 1380
Box-Type Counter (Ratchet, Revolution, or Geared)

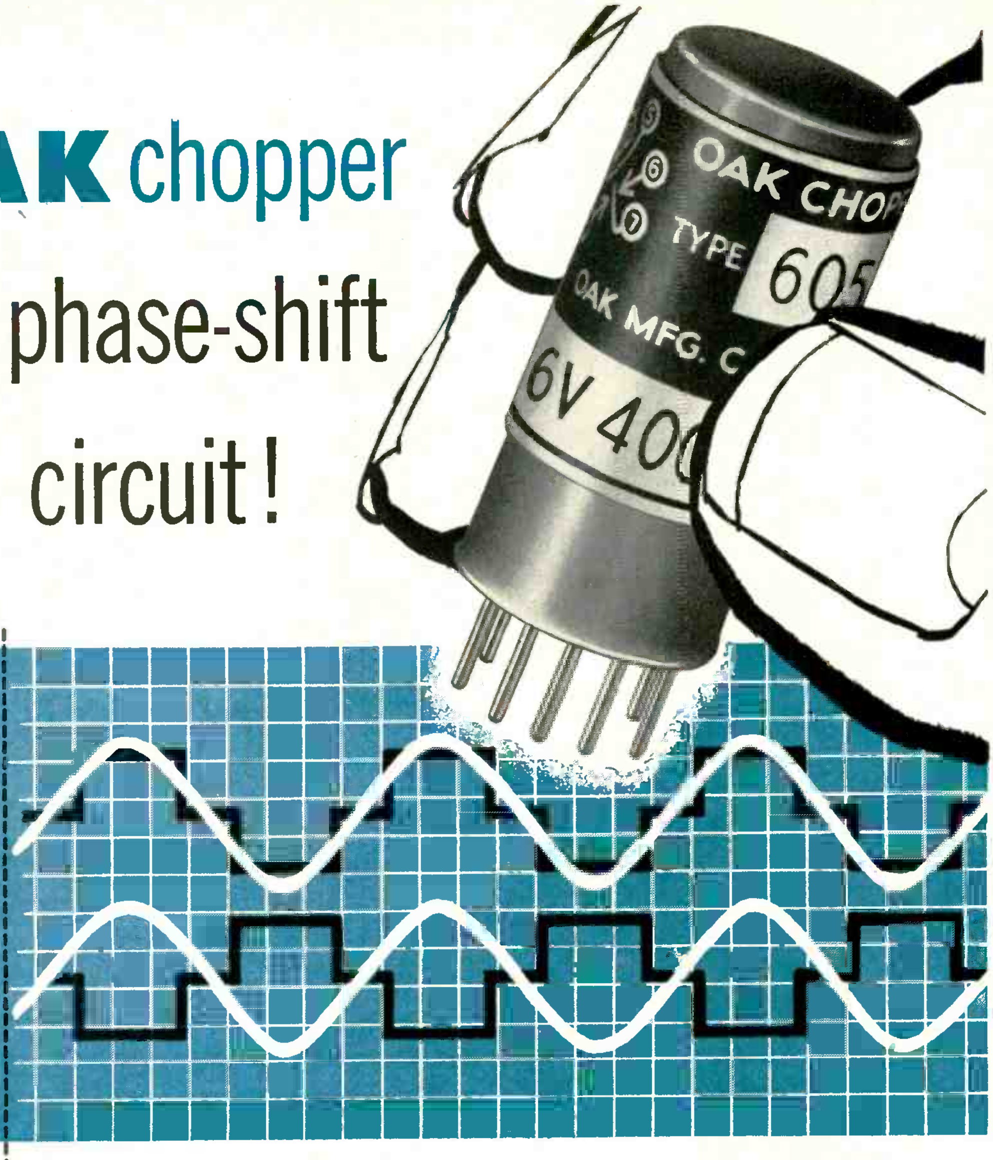


4-bank Counter for Radio Transmission Equipment



360-degree Bearing Counter

new OAK chopper needs no phase-shift circuit!



HAS 0° or 180°
PHASE-LAG
"DESIGNED-IN"

SPECIFICATIONS

Coil: Current, 25 ma; impedance, 190 ohms; resistance, 160 ohms.

Contacts: Dwell time, 150-160°; rating, 100 V, 2 ma. Resistance, less than 200 milliohms.

Phase Change: ± 10° At constant 400 cps under all conditions of use and life.

Noise: Less than .5 millivolt RMS into 1 meg.

Vibration: 10-55 cps.

Weight: Less than 1 oz; dia. 11-16".

Height: Seated, 1⅝".

Inherent in every device of the vibrating reed type are two phase-lags—an electrical phase angle resulting from the current lagging the applied voltage in the drive coil, and a mechanical angle due to the inertia of mass in the moving reed, lagging further behind flux from the driving current.

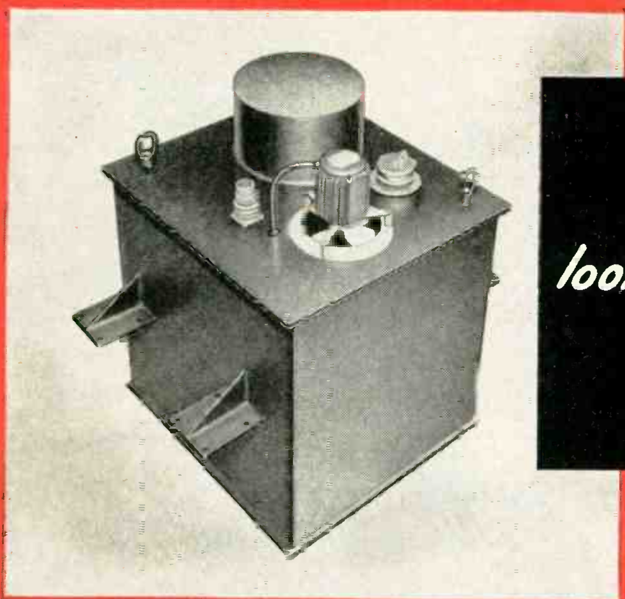
In OAK's new Type 605 Chopper, these two lags have been carefully brought to a total of 180°. Thus, the chopper can be so wired to be exactly 180° out of phase, or reversed to be 360° out (in phase). This design eliminates the R-C circuit ordinarily needed to bring this coincidence of voltage and output phase—saving circuitry, parts, and weight.

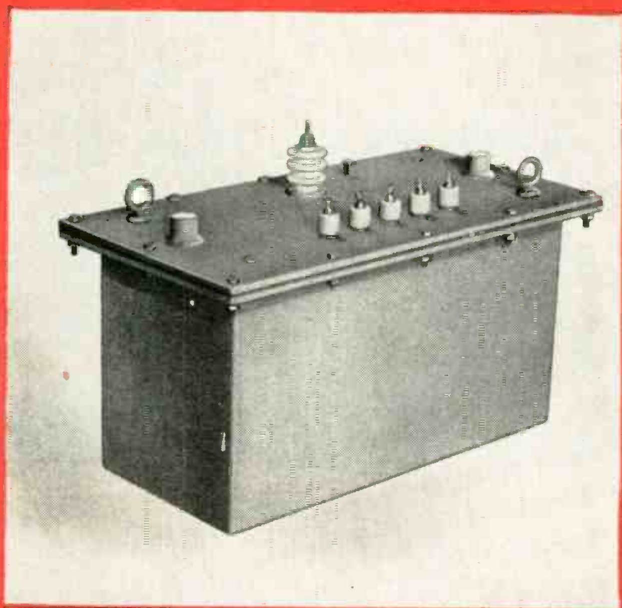
Shown at the left is the new chopper with side mount. Also available with flattened and pierced pins, solder loops, or as a vertical flange mount unit.

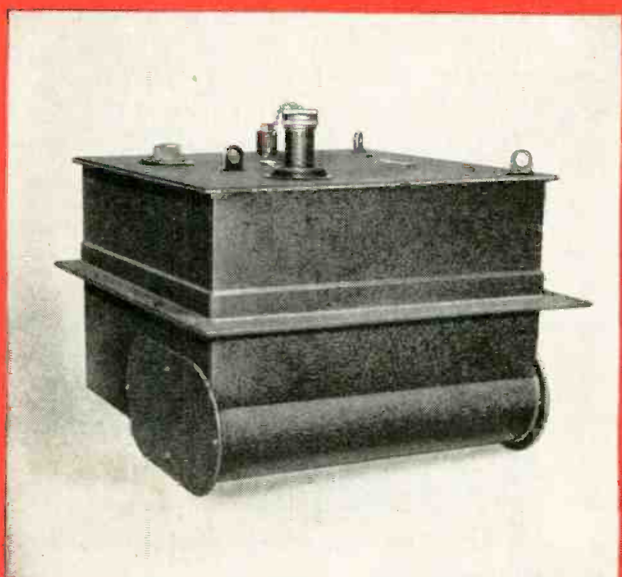
OAK MFG. CO.

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

Switches • Rotary Solenoids • Special Assemblies • Choppers • Vibrators







look to MOLONEY ELECTRIC for...

UNIT RECTIFIERS

(using semi-conductors)

And Get These Inherent Advantages!

Long Life • Rugged • Lightweight

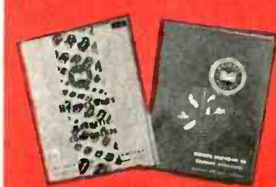
No tubes to replace

Completely Packaged Unit

Now available—a Moloney power transformer, filter reactor and capacitor, where required, and either silicon, selenium, or germanium semi-conductors combined in a neat, compact unit to give single phase or three phase rectification at any frequency. These units are manufactured in all types from a minimum rating of five kilowatts.

Save *your* Engineering man hours! Just give us input and output characteristics, service, and applicable specifications. Then let Moloney simplify your Engineering and Procurement with a coordinated job—from A. C. to D. C.

Moloney know-how and experience can be applied to your particular power supply problems to produce a better unit tailored to your needs. Check with your Moloney representative today!



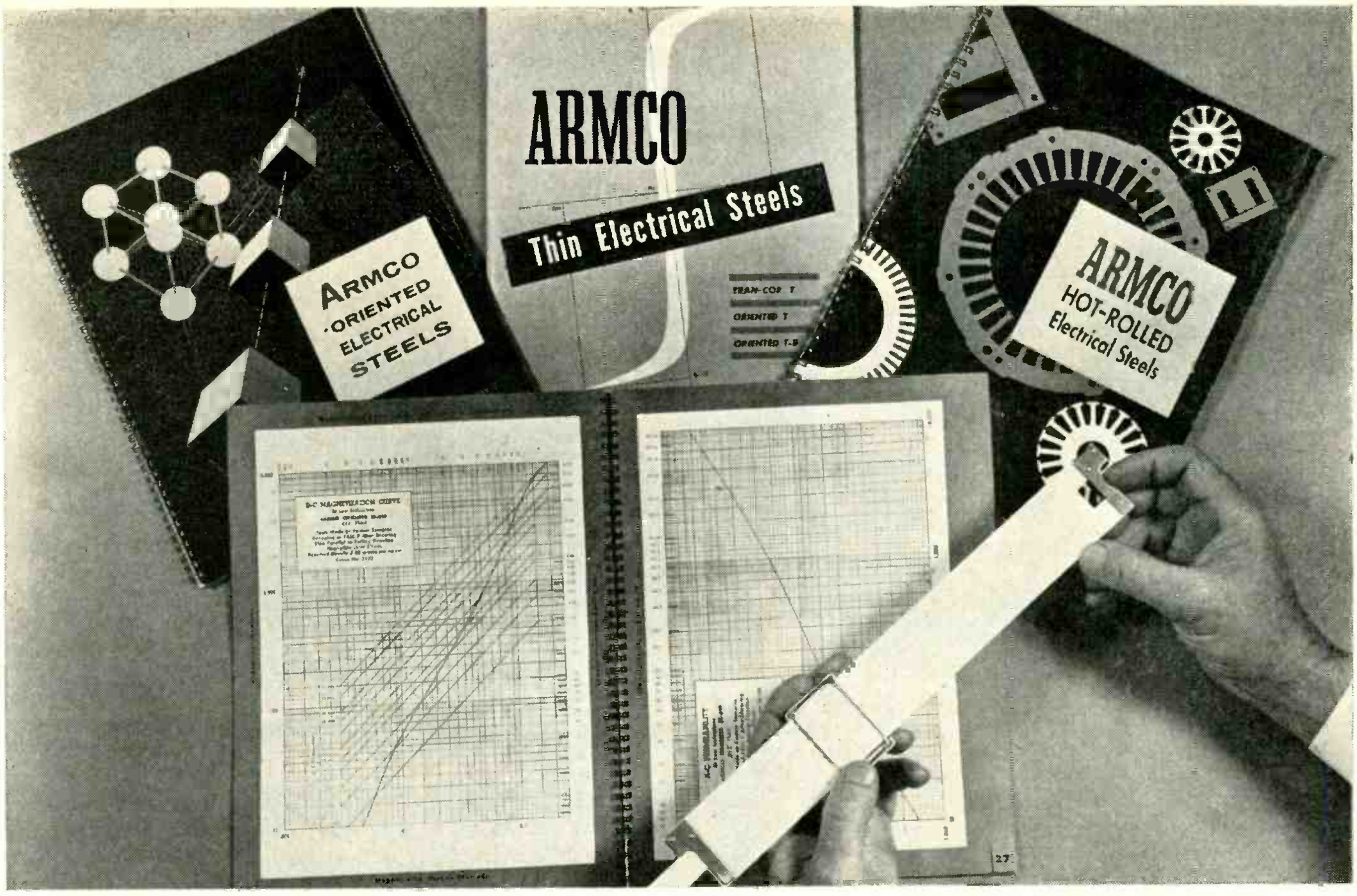
Write for Catalog SR 207 "HyperCores for Magnetic Components" and Catalog ST 3506 "Magnetic Components for Electronic Applications"

ME57-14

MOLONEY ELECTRIC CO.

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

FACTORIES AT ST. LOUIS 20, MO., AND TORONTO, ONT., CANADA



ARMCO ELECTRICAL STEELS HELP YOU TAKE THE "GUESSTIMATING" OUT OF DESIGN

When you use Armco Electrical Steels in designing products, you have a two-way opportunity to make performance in service more closely approach designed performance. One reason is that accurate data on magnetic and electrical properties are available; another is the consistent high quality of Armco Steels.

Design Data

You can calculate the performance of your product more precisely with available design data on Armco Hot Rolled, Oriented, and Thin Electrical Steels. Your selection of grade and gage can be based on precise data that helps assure guaranteed performance. You don't have to make educated guesses based on empirical formulae or extrapolation of meager data.

Consistent High Quality

More than a half century of electrical steel production and research has made possible the consistent high quality of Armco Electrical Steels. You are assured uniform magnetic properties. This, plus special Armco processing, produces fabricating qualities and tolerances that enable you to achieve the full magnetic potential of each grade.

Special Grades Offer Added Advantages

Besides standard grades of electrical steel, Armco produces many special grades that offer you unusual opportunities to improve the performance and reduce the cost of your products. For example, there is Armco A-6 for high permeability at low and moderate inductions; Armco Thin Electrical Steels with exceptional magnetic properties for high frequency applications.

Write us at the address below for complete information and design data. Just tell us what you make.

Armco Steel Corporation 1867 Curtis St., Middletown, Ohio

Please send me information on
- ☐ Armco Hot Rolled Electrical Steels
- ☐ Armco Oriented Electrical Steels
- ☐ Armco Thin Electrical Steels

Name________________________

Company________________________

Street________________________

City____________Zone_____State________

ARMCO STEEL CORPORATION

1867 Curtis Street, Middletown, Ohio

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

Circle 19 Readers Service Card

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/600 ohms. $475.00.

200CD — popular precision instrument for audio and ultrasonic tests. 5 cps to 500 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.

200T — custom-engineered for telemetry, carrier current tests. 250 cps to 100 KC, output 160 mw/10 volts; 20 volts open circuit. $350.00.

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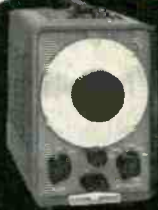
4170A Page Mill Rd., Palo Alto, Calif., U.S.A.
Cable "HEWPACK" • DAvenport 5-4451
Field engineers in all principal areas

World's most complete line of fast, accurate, easy to use oscillators!

202C — replaces famous 202B for low frequency measurements. 1 cps to 100 KC. Output 160 mw/10 volts; 20 volts open circuit. $200.00.

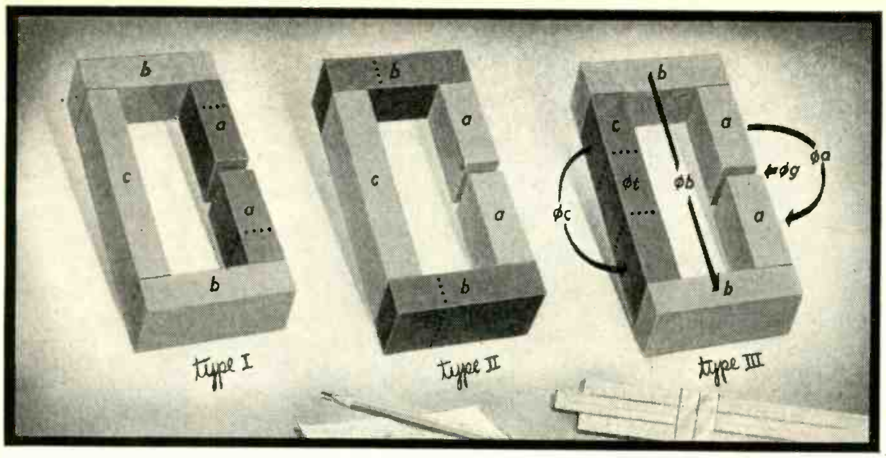
202A — for servo, vibration, medical and other very low frequency measurements. 0.008 to 1,200 cps. Output 20 mw/10 volts. $465.00.



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

4170

Circle 21 Readers Service Card



How You Can Save Time Estimating Leakage Factors for Magnetic Circuits

Computing even approximate values for leakage flux in magnetic circuits is a time consuming job. The research department of Indiana Steel recently undertook a series of studies, supported by the U.S. Air Force, to simplify these computations. Dr. R. K. Tenzer reported the results of this work, which reduce the time in computing leakage flux up to 90% by diminishing the number of mathematical operations necessary.

The investigations were done on circuits with permanent magnets; the results were also found applicable to unsaturated electromagnetic circuits when the coil-covered parts were treated as permanent magnet parts.

After checking values obtained by this method with actual measured values for many Type I, II, and III magnetic circuits, deviations were found to be less than $\pm$ 10%.

Leakage Flux, Leakage Factor

Because of magnetic leakage, only a part of the total flux through the neutral zone of the permanent magnet is found in the air gap. The difference between these two values is known as leakage flux. Mathematically this is:

$$\phi_L = \phi_t - \phi_g. \qquad (1)$$

In practical design, leakage is best considered as a factor stated thus:

$$\sigma = \frac{\phi_t}{\phi_g} = 1 + \frac{\phi_L}{\phi_g}. \qquad (2)$$

For simplification, the flux can be assumed to follow three basic, probable paths: ϕ_a between parts a, ϕ_b between parts b, and ϕ_c along part c. The equation above then becomes:

$$\sigma = 1 + \frac{\phi_a + \phi_b + \phi_c}{\phi_g}. \qquad (3)$$

With $\phi = mmf \times P$, this formula can be written:

$$\sigma = 1 + \frac{1}{P_g}\left(\frac{mmf_a}{mmf_g} P_a + \frac{mmf_b}{mmf_g} P_b + \frac{mmf_c}{mmf_g} P_c\right). \qquad (4)$$

Letting the *mmf* ratios be denoted by K,

$$\sigma = 1 + \frac{1}{P_g}\left(K_a P_a + K_b P_b + K_c P_c\right). \qquad (5)$$

This becomes the basic equation for numerical calculations of leakage factors after introducing simple expressions for leakage permeances and mmf ratios.

Simplified Leakage Permeances

The following formulas have been found satisfactory for leakage permeances between soft steel parts:

$$P_a = 1.7 \times U_a \times \frac{a}{a + L_g} \text{ where } U \text{ is} \qquad (6)$$

cross-section perimeter;

$$P_b = 1.4 \times b \times \sqrt{\frac{U_b}{c} + .25} \qquad (7)$$

where U_b/c is greater than .25 and less than 4. The total length of part b is used.

Since permanent magnets have a neutral zone which does not contribute to leakage, the value of 2/3 of the magnet's total length is used when computing leakage permeances—this is the effective length a' and b' to compute P'; thus the two equations above become:

$$P'_a = 1.7\, U_a \frac{.67a}{.67a + L_g} \qquad (6a)$$

and

$$P'_b = 1.4 \times .67b \sqrt{\frac{U_b}{c} + .25} = .67\, P_b. \qquad (7a)$$

When part c consists of a permanent magnet (Type III) its permeance can be calculated as:

$$P_c = .5\, U_c\,. \qquad (8)$$

The permeance of the air gap itself is

$$P_g = A_g / L_g\,. \qquad (9)$$

Simplified MMF Ratios

Simplifying the *mmf* ratios is done by neglecting the reluctance in *soft steel parts;* so

$$mmf_a = mmf_b = mmf_g \text{ or } K_a = K_b = 1 \quad (mmf_c = 0 \text{ so } K_c = 0). \qquad (10)$$

Since the *mmf along permanent magnet parts* is not constant, integral values ($\overline{mmf}$) are used. Experiments showed that 2/3 of the mmf_g was the effective *mmf* for leakage flux between permanent magnet parts; thus

$$\overline{mmf_a} = \overline{mmf_b} = \overline{mmf_c} = 2/3\, mmf_g$$

or

$$K_a = K_b = K_c = 2/3. \qquad (11)$$

Basic Formulas

By inserting the permeances for soft steel into equation (5), the general formula becomes:

$$\sigma = 1 + \frac{L_g}{A_g}\left(K_a \times 1.7\, U_a \frac{a}{a + L_g} + K_b \times 1.4\, b \sqrt{\frac{U_b}{c} + .25} + K_c \times .5\, U_c\right). \qquad (12)$$

This formula contains only constants and dimensions; and by the two following rules this can be modified into the three basic equations for the Type I, Type II, and Type III circuits.

Rules: (1) For leakage flux paths between soft steel parts, use total lengths and constant K of 1. (2) For leakage flux paths between permanent magnet parts, use 2/3 of lengths and K of .67.

The following provide the leakage factors for the three types of circuits:

Type I:

$$\sigma = 1 + \frac{L_g}{A_g} \times .67 \times 1.7\, U_a \frac{.67a}{.67a + L_g}$$

Type II:

$$\sigma = 1 + \frac{L_g}{A_g}\left(1.7\, U_a \frac{a}{a + L_g} + .67 \times .67 \times 1.4b \sqrt{\frac{U_b}{c} + .25}\right)$$

Type III:

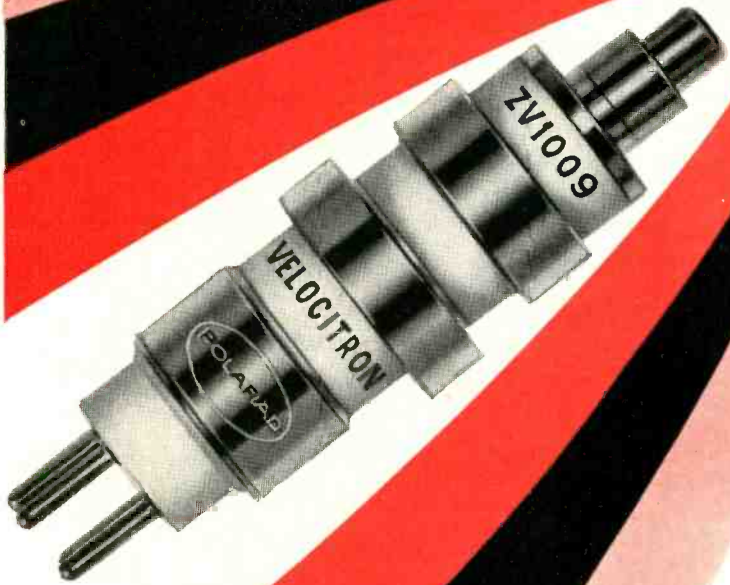
$$\sigma = 1 + \frac{L_g}{A_g}\left(1.7\, U_a \frac{a}{a + L_g} + 1.4b \sqrt{\frac{U_b}{c} + .25} + .67 \times .5\, U_c\right)$$

For variations on these basic formulas, write today for the April-June issue of *Applied Magnetics* which also shows examples of the formulas in use.

NEW DESIGN MANUAL READY

Write today for your copy of the newest edition of the Indiana Permanent Magnet Design Manual No. 6. Write to Dept. A-8.

NOW! the first all ceramic klystron tube for 1600 to 6500 mc



RUGGEDIZED POLARAD ZV1009 VELOCITRON*†

a physical and electrical replacement for klystron tubes 6BL6, 5836

The new Polarad ZV1009 all ceramic Velocitron is a **premium**, rugged tube designed for high temperatures, vibration and mechanical shock.

As a replacement for glass klystrons: the ZV1009 is less microphonic and less fragile. It is equipped with standard 4-pin connection.

As a basic design element: The all ceramic ZV1009 allows for higher ambient temperatures than any glass tube currents available. It is completely hard soldered.

SPECIFICATIONS: ZV1009 VELOCITRON

Reflector Mode	1¾	2¾	3¾
Cavity Mode	¾	¾	5/4
Frequency	2800	3200	5000 mc
Power Output Cutoff Voltage (approx.)	+3	+3	+3 volts
Reflector Voltage (approx.)	–220	–120	–220 volts
Resonator Voltage	325	325	325 volts
Control Electrode Voltage (Full Power Output)	+10	+10	+10 volts
Cathode Current (average)	28	28	28 ma
Electronic Tuning Range (between Half Power Points—minimum)	6	6	6 mc

Write directly to Polarad for complete data and design information.

*Registered U.S. Trademark †Manufactured under Western Electric Patents

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POLARAD ELECTRONICS CORPORATION

43-20 34th Street • Long Island City 1, N. Y.

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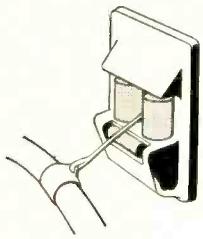
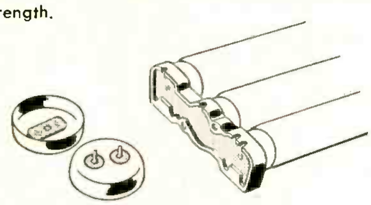
Plants in Norristown, Pa. and La Verne, Calif.

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

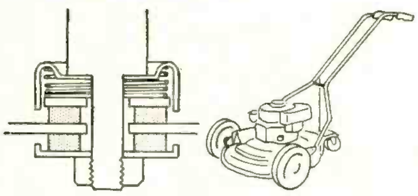
Tips for designers



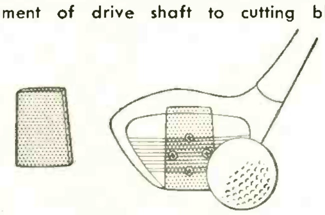
Hose reel rollers, made of Taylor Grade C thick-walled phenolic tubing, are part of cable attachment for gas pumps . . . selected for good wear and corrosion resistance, high mechanical strength.



Fluorescent tube ends are fabricated of Taylor Grade X phenolic laminate . . . for mechanical strength, electrical insulation qualities, good punching and machining qualities.



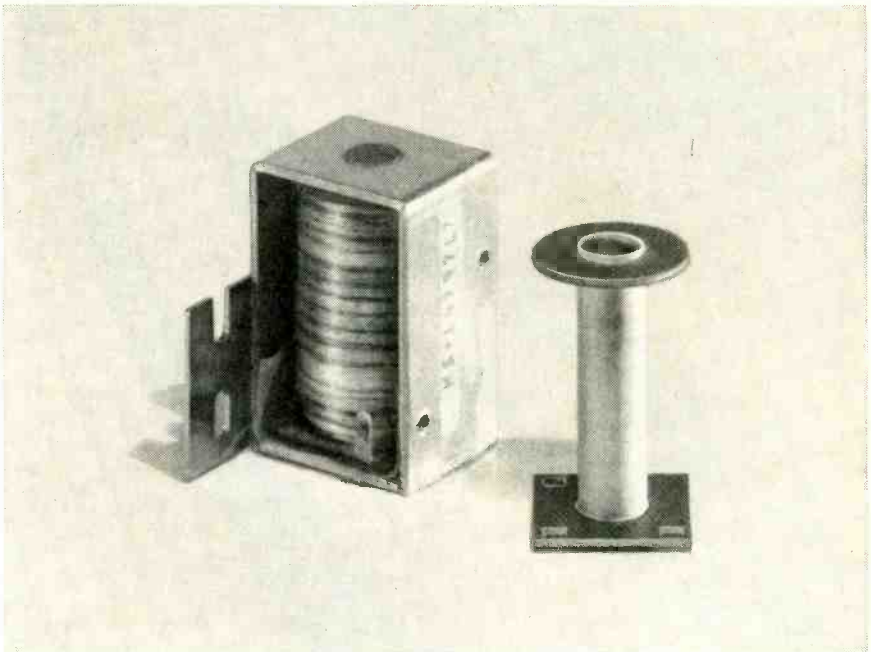
Rotary lawn mower utilizes abrasion resistance of Taylor phenolic laminate washer in slip-clutch attachment of drive shaft to cutting blade.



Insert in face of golf club, made of Taylor vulcanized fibre . . . withstands severe impact . . . gives long-lasting, long-hitting surface.

TAYLOR SUPERIOR COPPER-CLAD LAMINATES

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



Both end pieces and the tube of this coil form assembly for radio frequency transformers are fabricated by Taylor for the Guardian Electric Mfg. Co. Taylor Grade G-5 sheet and tubing are used . . . for high mechanical strength, for high arc, flame and heat resistance, as well as superior tensile, flexural and impact strengths.

Accurate laminated plastic components can shorten your production steps . . .

If close-tolerance work—such as this coil form assembly for radio frequency transformers—is one of your problems, then check with Taylor. This complete part was fabricated to very close tolerances by Taylor's Fabrication Division. The material—Taylor Grade G-5 laminate sheet and tubing—was selected for its high mechanical strength and for superior arc, flame and heat resistance.

Precision fabrication of laminates and vulcanized fibre is difficult . . . but Taylor can and is doing it, in a great variety of Taylor grades, and to extremely close tolerances. Many manufacturers have solved their fabrication and assembly problems with the help of this Taylor facility, by having parts supplied completely fabricated to specified tolerances, ready for final assembly. With specialized equipment and advanced techniques, Taylor is prepared to simplify your production problems, safeguard delivery schedules, and eliminate inventory headaches.

You can put Taylor's Fabrication Division to work right now, helping to improve your product. Design to closer tolerances—Taylor can do the job. Taylor is equipped to handle any kind of fabrication—punching, drilling, grinding, forming, milling, and turning. You improve your product . . . reduce material costs.

Taylor's fabricating facilities and engineering staff are at your service. Contact your nearest Taylor sales engineer for a discussion of your particular requirements.

How to take an entire laboratory for a ride

Get complete mobile data despite shock and limits of space

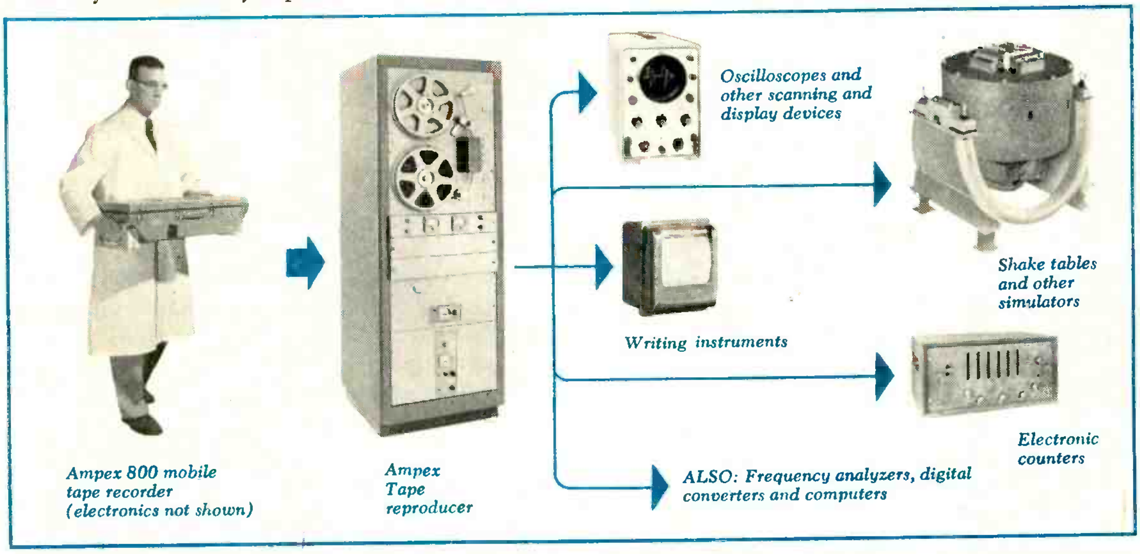
This is the easy way – no such blue-sky dream as a shock-mounted, air-conditioned brick building on wings or wheels. The earthbound laboratory has a "double" that rides on airplanes, vehicles or ships or goes to location by manpower, muleback or dolly. The secret . . . an Ampex 800 mobile tape recorder which simultaneously gathers data for the laboratory's writing, viewing, simulating and computing instruments. Despite adverse environment, Ampex 800s closely match precision and versatility of laboratory tape recorders.

AIRBORNE APPLICATIONS

Ampex 800s are widely used for environmental data, radio signals, radiation information, weapon countermeasures, flight parameters, etc.

At one airforce facility, the Ampex 800 rides in one aircraft to record telemetered signals from another (unmanned). Altitude greatly extends the horizon and tracking distance over which line-of-sight telemetered signals can be received.

Aircraft companies are tape recording vibrations, sounds, and other data far outside the range of other recording techniques. And in one major company's flight-test program, 420 channels of data are multiplexed onto a one-inch tape.



Only this mobile tape recorder and its associated equipment undergo the hazards and space limitations of the mobile test situation.

Reproduction of the tape recreates the original transducer voltage patterns, providing every other laboratory instrument with the same input it would have received if it too had been carried on the test. Data slowdown, speed-up, filtering, etc. can be used.

Ampex 800 tape transport, showing small size and ease of handling. This is the largest of the recorder components.

GROUND, SHIPBOARD AND VEHICLE USE

The Ampex 800 is light and rugged, withstands handling and sets up quickly and easily. A research group studying earth-transmitted shock waves carries the Ampex 800 right to locations next to railroad tracks, airfields, highways and other areas of interest. An oil company uses a truck-mounted 800 to log oilwells in the fields.

The equipment stands shock, vibration and noise. In a shipboard installation, the Ampex 800 gathers data on closeby underwater explosions, enduring shocks transmitted through the ship. At an eastern jet-engine test facility, dolly-mounted Ampex 800s are wheeled out to the cells and get accurate data in an area of intense noise.

Do you have a mobile data acquisition problem on which we can help? Or would you like this tape-recording series mailed to you direct? For either request, write Dept. E-6

MAGNETIC TAPE APPLICATIONS BY AMPEX

ONE OF A SERIES 6

Series FR-100

Series 800 Mobile and Airborne

Model FR-200 Digital

Series FL-100 Loop Recorders

Series FR-1100

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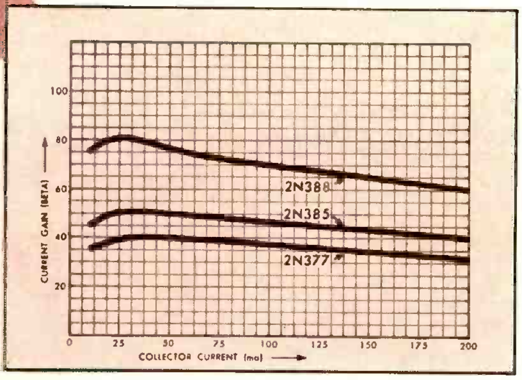
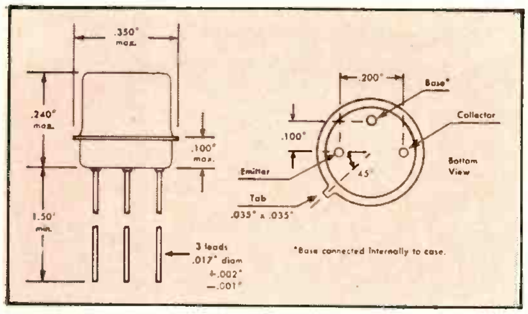
New Computer

Types 2N 377....2N 385

Stability during life sets new standard for reliable use



Typical current gain vs. collector current



Triangular basing arrangement of the new computer transistors lends itself to printed circuit board insertion and dip soldering techniques.

New Sylvania NPN germanium alloy junction transistors, types 2N385, 2N377 and 2N388, are specifically designed for computer use. Higher, more constant beta over a wide range of operating conditions and fast switching time make the new Sylvania units ideal for computer and switching applications. They meet environmental tests typical of those required in military applications. In addition, the new Sylvania computer transistors meet RETMA size group 30 dimensions.

The outstanding characteristics of the new Sylvania transistors have been achieved in two ways—by new non-symmetrical design and by additional production steps. The optimum size relationship between emitter and collector has been determined for superior collector efficiency. This inherently better design is stabilized in production by carefully controlled surface treatment.

New Sylvania techniques are not only responsible for higher beta in the 2N385, 2N377 and 2N388 but for more constant beta at changing current levels. In addition, the design of the three types significantly improves leakage stability. Total dissipation is conservatively rated at 150 mw with ambient temperature at 25° C.

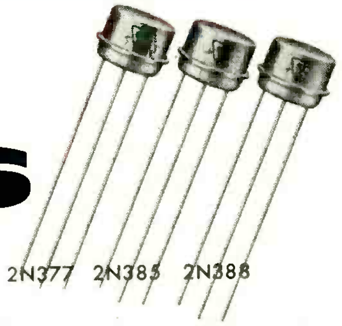
Thus, new and greater stability and reliability for computer and switching operations are built into these latest transistor developments from Sylvania. Call your Sylvania representative for further information.

"Sylvania—synonymous with Semiconductors"

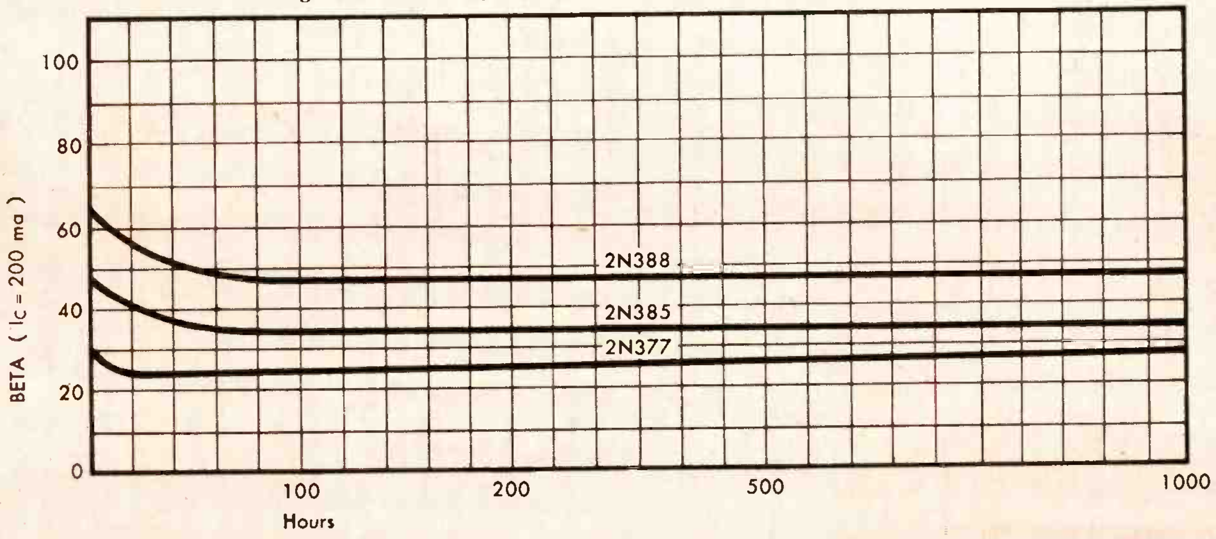
Circle 25 Readers Service Card

Transistors

....2N 388



1,000-hour evaluation of the new Sylvania transistors at 100° C shows a new high in beta stability throughout the test after a small initial change.



Typical Characteristics (25°C)

	2N385	2N377	2N388
Collector Cut-off Current, I_{CO} V_{CB} = 25.0 emitter open	5 ua	6 ua	6 ua
Emitter Cut-off Current, I_{EO} V_{EB} = 15.0, collector open	5 ua	6 ua	6 ua
Current gain, B V_{CE} = 0.75, I_C = 30 ma	60	40	80
Current gain, B V_{CE} = 0.75, I_C = 200 ma	45	30	60
Frequency Alpha Cut-off, $F_{\alpha co}$ V_{CE} = 5.0, I_C = 10 ma	6.0 Mc	4.0 Mc	8.0 Mc
Collector Current I_C (−5,10K) V_{CE} = 20 V, R_{BE} = 10K, V_{BB} = −5V	10 ua	10 ua	10 ua
Storage or junction temperature	100° C.	100° C.	100° C.

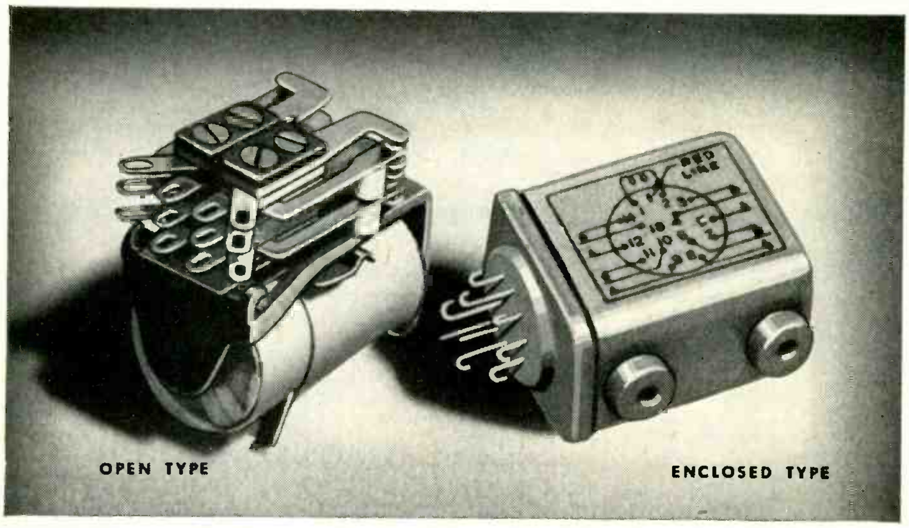
SYLVANIA

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

LIGHTING • RADIO • TELEVISION • ELECTRONICS • ATOMIC ENERGY

Circle 26 Readers Service Card

R-B-M Miniature Multipole Relays of Proven Reliability



Light weight, Small Size Open and Hermetically Sealed Types for Electronic and Communication Application

APPLICATION: R-B-M Miniature Multipole Relays are used where the prime factors in switching electronic circuits are small size, light weight and reliability. These proven designs are produced for switching low power circuits, low capacitance circuits and power circuits. 125° C insulation now available on some versions. Coils can also be designed for plate circuit.

CONSTRUCTION:

Magnet Frame—Four sizes available on open type relays and three sizes on hermetically sealed type.

Contacts—Cross-bar palladium welded to nickel silver springs or button contacts on Beryllium copper springs.

Terminals and Mountings—Glass headers provided with either solder or plug-in type terminals with many various types of mountings available. Octal type plug-in headers can be provided on the HL enclosure. Plug-in terminals to fit either 9 or 14 pin standard sockets. Maximum of 14 pins for solder connections.

TYPICAL SPECIFICATIONS*

Open	Maximum Coil Resistance (OHMS)	Minimum Power Requirements Per pole at 25° C (WATTS)	Maximum Contact Form With rated current at 32 V.D.C. or 115 V.A.C. (non-inductive load)	Maximum Coil Watts	Enclosed
SM	9,000	.2	4 PDT 5 Amps. or 3 Amps. 6 PST 3 Amps.	3.75	HSM
SMD-2	9,000	1.0	SPNO Parallel Contacts Make 80 Amps. Break 20 Amps. at 32 V.D.C.	3.75	HSMD-2
SC	18,500	.16	4 PDT 5 Amps. or 3 Amps. 6 PST 3 Amps.	4.5	HPSC
SA	18,500	.14	4 PDT 5 Amps. or 3 Amps. 6 PST 3 Amps.	4.5	HLSA
SM-RF	9,000	.2	SPNO, SPDT, DPNC, SPNC, DPNO	3.75	HSM-RF HLSM-RF
SAD-2	18,500	1.0	SPNO Parallel Contacts. Make 80 Amps. Break 20 Amps. at 32 V.D.C.	4.5	HLSAD-2

*Other ratings and specifications available.

For additional information write for Bulletin No. 1050

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***ESSEX ENGINEERED**
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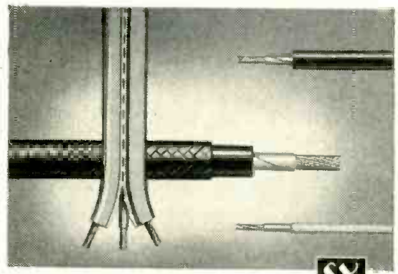
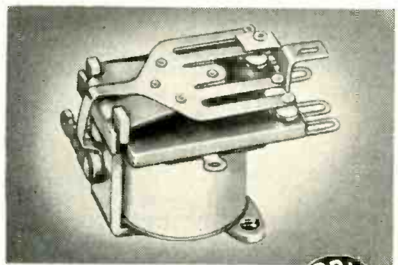


WIRE AND CABLE

A full "Extra Test" line of lead, appliance, automotive and refrigeration wires, plus submersible pump cable and 200° C. Sil-X insulations are examples of the versatility of "Essex Engineering".

Wire and Cable Division
Fort Wayne, Ind.



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The Type MS Miniature Sensitive Relay is ideal for any application requiring a compact, highly reliable single pole D. C. device, where a low cost solution is required because of volume usage and competitive problems. Request Bulletin No. MS-1.

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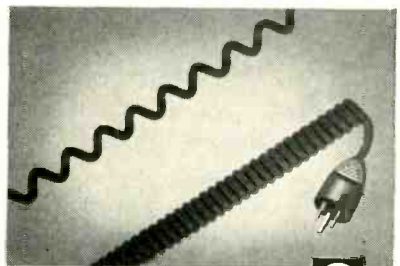

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The "spring" in Coiled Cords automatically synchronizes with moving components that are electrically powered. There are no looping, tangling cords in the way . . . because Coiled Cords extend and retract as needed. Write for new literature.

Cords Limited Division
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SX® **ESSEX WIRE CORPORATION**

A SPECIAL ADVERTISEMENT Presented by INLAND TESTING LABORATORIES, Cook Technological Center, Morton Grove, Illinois

Dr. Leslie W. Ball

Dr. Ball is a leading scientist devoted to reliability efforts and programs, and is a prominent consultant to top management in aircraft and missile industries. His independent evaluation of the "HELPR" Program follows:

The State of the Art:

NEW TOOLS ARE HERE TO UPGRADE RELIABILITY *NOW!*

Dr. Leslie W. Ball

In 1940 Winston Churchill stirred the conscience of American industry by his confident plea . . . "Give us the tools and we will finish the job." Our industry did respond magnificently and gave the Allied Armed Forces the tools with which the immediate job of destroying the dictatorships was finished.

But we know only too well that neither in peaceful competition nor in military defence can industry rest upon past achievements. New tasks of staggering magnitude always will arise to challenge the imagination and guts of our industrial management and to challenge the thinking and action abilities of our design, production, test, and quality control engineers.

Today, a new challenge to managers and engineers is stark in its clarity, and voracious in its demand for action. Clearly, the marriage between the science of electronics and the science of systems engineering has been, and will continue to be prolific in the procreation of complex equipments that increase the productivity of peace-time industry and radically improve the potential effectiveness of our military defence. It is evident further that many top managements have seized upon these opportunities.

In those industries that are adopting automation, and throughout our defence program, decisions have been taken to entrust the future to the abilities of complex requirements. In the case of some equipments it is merely the financial future of a single company that has been committed. In the case of military equipment, our future in the world has been committed to the belief that complex weapon systems based on electronic equipment can be made to perform adequately in all respects.

DRAMATIC PERFORMANCE

In the first flush of excitement over the potentialities of radically new equipments, the abilities and energies of both managers and engineers usually have been concentrated on obtaining dramatic performance. In multitudes of offices and laboratories throughout the nation, equipment performance abilities worked out on the drawing board or predicted by electronic computers have been received with enthusiasm and adopted as target. As time has brought the conversion of calculations and predictions into actual hardware, it has become painfully evident that the ominous forebodings of a small band of pioneers, now known as "Reliability Engineers," were not without substance.

Much has been written about the fundamental relationships between unreliability and complexity in electronic equipments and about the incompatibility of extracting the last ounce of high performance out of equipments that must be reliable under conditions of high environmental stress and limited maintenance skill. So, today, the managers, upon whose shoulders rests the heavy responsibility for having taken decisions to commit their companies or their defence programs to complex high performance systems, must undertake an agonizing reappraisal of their electronic equipments within these systems.

BLUNT QUESTION

The blunt question that faces them is, "Must we retreat to simpler, lower performance devices, or is there an immediate line of reliability upgrading action whose cost is within reason and whose effectiveness is beyond question?"

The answer to this vital question is not to be found in academic discussions of the abstractions of reliability nor in the ivory towers of higher mathematics. It is to be found in the testing and analytical laboratories where countless analyses have been made of equipments that have failed in service or in which failure has been produced by simulation in the laboratory of service stresses.

The answer to the question "Must we retreat?" is a confident "No, we need not retreat. There is a path to electronic equipment reliability whose cost is within reason and whose effectiveness can be assured."

To define the path to reliability specifically and clearly, we must first express the underlying causes of equipment unreliability in engineering management terms.

Both technological advances and management action have provided the systems engineers with the tools that they need to work out complex system performance, and to generate sound preliminary designs. Unfortunately, in the electronic industry the detail designer, the production engineer, the test engineer, and the quality control engineer have not been provided with all the tools that they need to follow through from a preliminary system

State of the Art: NEW TOOLS ARE

design to delivery of a completely reliable finished product.

A FUNDAMENTAL CAUSE OF ELECTRONIC UNRELIABILITY IN TODAY'S ELECTRONIC EQUIPMENT IS THAT DESIGNERS ARE REQUIRED TO DESIGN CIRCUITS, QUALITY CONTROL ENGINEERS ARE REQUIRED TO CONTROL CONFORMANCE, AND TEST ENGINEERS ARE REQUIRED TO PLAN EVALUATION PROGRAMS WITHOUT MUCH OF THE BASIC HANDBOOK TYPE OF DATA ON WHICH THE RELIABILITY OF ALL OTHER TYPES OF ENGINEERING EQUIPMENT DEPENDS.

To illustrate this deficiency, suppose that the management of an aircraft company had made excellent provision to obtain systems engineering and a preliminary design for a new super performance complex rocket-powered plane and then assigned the task of detail design, quality control and test planning to their staff. But, with the provision that they would be denied anything approaching complete knowledge of the strength, endurance and failure characteristics of the materials and components of which the system was to be built.

The opinion of their customer and of other managers would be that this was a preposterous way to manage an engineering project, and unreliability in the product would be a foregone conclusion. *And yet, inadequacy in the organized knowledge of strength, endurance and failure of component parts is characteristic of almost all military and industrial electronic equipment projects.*

Management thinking about the provisions that they must make for providing their staffs with adequate knowledge of electronic component parts can be helped greatly by the following definition: "Any equipment component or part is inherently unreliable until every mode of failure is known, understood, measured and controlled."*

Throughout the mechanical engineering industries the truth and significance of this definition is accepted as self evident. Moreover, large quantities of organized knowledge on understanding, measurement and control of every mode of failure of mechanical parts are contained in engineering handbooks. For example, in the case of reciprocating machinery unreliability caused by the phenomena of fatigue is no longer tolerated because an understanding of the design and manufacturing factors that can permit fatigue to occur, together with tables and curves showing the relationship between stress level and number of cycles to failure and established quality control procedures, are all available in the form of handbook data.

URGENT NEED

The problem of the component part failures that cause unreliability in electronic equipment is analogous to fatigue failure in metal parts, but there are at least two important differences, each of which makes the need for handbook data more urgent.

First, the stresses imposed upon the part are more diverse. That is, the effects of placing an electronic component part in a complex circuit require rather more analysis and more types of data than required for the determination of the stresses on a part in a mechanical structure.

Second, the number of modes of failure resulting from variety in the materials and methods of construction of electronic parts are much greater than for purely structural parts that can fail only by such well known phenomena as tensile fracture.

Third, whereas mechanical parts are characterized by long service and laboratory testing histories that have resulted in well organized and widely published handbook data, electronic parts have either not existed long enough or have not been studied intensively enough for such handbook data to be available.

The contrast between disciplines in electronic and mechanical engineering is obvious. In the electronic industry, management and engineers must undertake immediate and imaginative action to generate and distribute handbook type data. This would embrace the understanding, measurement and control of all types of electronic component parts whose failure contributes to unreliability.

We may assume that this statement is beyond question, and the real issue for management and engineers to decide is "WHAT IS THE FASTEST, MOST ECONOMICAL AND MOST EFFECTIVE METHOD TO GENERATE HANDBOOK DATA?" The possibility of each company being dependent only on its own component part testing programs must be ruled out, because the cost is prohibitive and the time taken to get the job done on limited testing facilities would be hopelessly excessive.

IMPORTANT PECULIARITY

In this regard a very important peculiarity of electronic component parts must be recognized. This peculiarity may be called "the existence of minority groups in the manufactured population." For example, consider a population of one thousand capacitors produced by a particular manufacturer. From the point of view of performance, all these capacitors will belong to a single homogeneous population, but, from the point of view of reliability, the population is by no means homogeneous.

If the thousand capacitors were subjected to circuit stresses and to external environmental stresses, some of them would become "early failures" and others would become "random failures." Suppose that out of the thousand, ten are potentially early failures and another forty are potentially random failures. If a test sample of, say, six capacitors were chosen from among the nine hundred and fifty that will fail by wear out, the results of this test program would be completely useless and dangerously misleading because they would tell nothing of the unreliability that would be caused by the ten early and the forty random failures.

It follows that it is vitally important to subject the whole population of one thousand capacitors to an ambitious test program that includes statistical design of experiments, detailed analysis of failures, and statistical interpretation of results.

Even in equipments where a high failure rate of, say, one part in a thousand can be tolerated, the test sample size should consist of several hundred parts. In equipments where failure rates of only one in a hundred thousand can be tolerated, the sample size and consequently, the cost of the test program must be increased correspondingly.

IT IS THEREFORE APPARENT THAT EVEN LARGE ELECTRONIC EQUIPMENT COMPANIES CANNOT AFFORD TO UNDERTAKE TEST PROGRAMS TO GENERATE ALL THE KNOWLEDGE OF ELECTRONIC COMPONENT PARTS THAT THEY REQUIRE, AND THAT THEY MUST SUPPLEMENT THEIR OWN WORK BY PARTICIPATION IN A PROGRAM SUBSCRIBED TO BY A LARGE GROUP OF COMPANIES.

A second cost aspect is that the recording of test data by technicians reading indicating instruments is incompatible with the enormous number of readings that must be made to generate the amount and accuracy of data required for handbook purposes. Consequently, the principle of automation must be applied to the recording of data during component part testing programs.

Both the above cost considerations lead to the conclusion that electronic equipment manufacturers can reduce the cost of reliability programs radically by sub-

*"Management Use of Laboratory Testing to Achieve Reliability." A Paper presented to the University of California at Los Angeles Engineering Management Symposium in January 1955 by Leslie W. Ball.

HERE TO UPGRADE RELIABILITY NOW!

scription to testing programs performed in a competent laboratory, where sample sizes of thousands can be handled and where data can be recorded automatically.

STEADY FLOW

The general relationship between such a laboratory and the subscriber to such a program must go far beyond the mere provision of testing facilities and automation instrumentation. The laboratory must provide the subscriber with a *steady flow* of organized knowledge that makes it possible for the subscriber to diffuse throughout his whole organization "knowledge, understanding, measurement and control" of all the modes of failure of the electronic component parts used in the company's products.

While the above statement summarises the service that must be rendered and leaves no doubt that the benefits to be gained by subscription to this laboratory program will far exceed the cost to the subscriber, and while the brochure offered by the "HELPR" program provides detailed information to the individual engineer, it is to be expected that the subscriber's management will want a more specific summary of what will come out of the testing program, and of the identity of the departments within his organization that will use the output, and of the ways in which they will use it.

On the basis of work already done in similar, but much more restricted testing programs, the following five specific types of output and six specific types of application by subscriber's personnel may be identified.

FAILURE RATE CURVE— CIRCUIT STRESS

For each type of component part it is generally recognised that some particular circuit stress is of primary importance in regard to failure rate and reliability. For example, in the case of capacitors, the voltage across the capacitor is accepted as the primary circuit stress. Test programs for each type of part will result in a family of curves in which failure rate is the ordinate, time is the abscissa, and one curve is plotted for each value of the primary circuit stress.

In general, the curves will have a characteristic shape which in many cases will be the familiar three part curve showing early, random and wearout failures. The corresponding time intervals may be called the "infant mortality screening period," "service period" and "over-age period." Quite apart from numerical values of the failure rates, knowledge of the shape of these curves and of the duration of the infant mortality screening, service and over-age periods are vital to intelligent decisions on quality control and preventative maintenance requirements.

RELIABILITY INDICES

For those component parts that show a "random" failure rate in the service period, a single value for failure rate index may be established. In other cases an average value in the service range may be selected as characteristic of the part. All these values could be prepared in summary tabulated form suitable for use as reliability indices during the precalculation of the reliability to be expected from any new type of electronic equipment.

FAILURE RATE CURVES— ENVIRONMENTAL STRESS

It is well known that the failure rate produced by a primary circuit stress can be greatly modified by the environment in which the part operates. For example, in the case of capacitors the ambient temperature will have a major effect upon the failure rates produced at any given voltage.

It is recognized further that, when environmental stress becomes severe, entirely new modes of failure not directly related to the circuit stress are produced and that these new modes of failure will have their own characteristic failure rates. The test program should produce curves showing both the modification of circuit stress failure rates with environments, such as temperature of vibration intensity, and other curves showing failure rates produced by the environment in the absence of circuit stress.

MODE OF FAILURE ANALYSES

If the laboratory's service to the subscriber finished with the production and mathematical analysis of failures, the most constructive and universally applicable reliability upgrading information would be lost. The laboratory service should include detailed disassembly and analysis of the physical, chemical and mechanical modes of failure of each type of component part. The results and interpretation of these analyses will be available to the subscriber and to the manufacturer of the part.

CORRELATION OF FAILURE RATES WITH DESK ANALYSES

Obviously, test programs must be performed upon component parts bought from particular vendors, and, consequently, test results presented under the above four categories would be specific to each vendor. However, it would be chronically wasteful to limit the output of the test program simply to the products of the vendor supplying test items.

By careful analysis of the design characteristics of the parts, combined with knowledge of the manufacturing processes and quality controls used by the vendor, it is possible to establish extremely valuable correlations between failure rates and design and manufacturing factors. These correlations are universally applicable to the products of all vendors. The laboratory should seek to establish such correlations and will present the results in the form of technical reports to the subscribers.

USE OF TEST RESULTS

BY SUBSCRIBER'S PURCHASING DEPARTMENT

The results of the test programs will be of direct benefit to the purchasing departments in the selection of component part vendors. Even when a particular vendor's parts have not been included in the program, the subscriber's purchasing department would be able to make use of the test results in evaluating the materials and process controls used by the supplier.

BY SUBSCRIBER'S PRELIMINARY DESIGN DEPARTMENT

Whenever a new system or equipment is offered in a preliminary design proposal, it is a good management practice to require a precalculation of the expected reliability of the equipment if it is to be built from state of the art component parts. Although at this time the exact number of parts and the circuit stresses that will be imposed upon them are unknown, certain assumptions can be made based on similarities between previous equipment and proposed equipment. By combining these assumptions with reliability indices for the component parts, a precalculation can be made.

BY SUBSCRIBER'S DESIGNERS

During the design phase, decisions must be made on the general degree of part derating and on the amount of money, space and weight that will be allowed for reduction of environmental stresses. The test program would provide specific numerical values to guide both the amount of action needed and to indicate which changes will be most effective.

BY SUBSCRIBER'S PARTS APPLICATION ENGINEERS

It is well known that the failure rate for a given part depends greatly on the circuit stresses imposed upon it and that, in some cases, circuit stresses that are of little importance to the performance of the equipment are of major importance to its reliability. The test program should provide specific data for identifying the nature and magnitude of circuit stresses that must be considered by the part application engineer in determining the suitability of a particular part for a particular application.

BY SUBSCRIBER'S TEST ENGINEERS

Each electronic equipment manufacturer must make use of a great deal of testing in his own plant for both design and quality control purposes. For example, in the case of custom parts, such as special potentiometers, the subscriber must write his own specification and specify his own test methods. The results of the "HELPR" laboratory program would be valuable in indicating which tests are likely to be most effective for a particular type of component, and to give some significance to them when the size of the test sample has to be very small.

BY SUBSCRIBER'S QUALITY CONTROL ENGINEERS

It is generally true that the reliability of electronic equipment can be greatly improved by much more widespread use of non-destructive testing methods on the manufacturer's receiving inspection line and by cautious use of what is now called production environmental testing. The "HELPR" laboratory program would provide clear indications of which types of non-destructive testing can be most effective and information that should be sought by non-destructive methods.

In the case of production environmental testing, if this is done without the guidance of comprehensive knowledge of the shape of the failure rate curves and the duration of the infant mortality period, there is a very real danger that the environments will increase rather than decrease the unreliability of the equipment. However, with the type of information that the central laboratory program would provide, major improvements in reliability from carefully selected and controlled production environmental tests can be confidently expected.

* * *

The net result of all the above outputs from a central laboratory program and the application of these results by the subscribers could be momentous. Whereas, without a major program for generating handbook data on component parts, the electronic industry may have to retreat from the degree of performance and sophistication in designs now going into production. *With the proposed program, the horizons for the electronic industry become unlimited.*

Certainly in the case of industrial automation, the difference between a record of unreliability and a record of reliability will not only be a major factor in the success or failure of individual companies, but it will be the difference between a vast new surge of growth for the electronic industry as a whole, and a rapid saturation and ensuing stagnation if the market is limited to only those applications that can tolerate unreliability.

In summary, the new branch of the engineering profession that we call reliability engineers have done an outstanding job in recognising the nature of the problem, in analyzing its causes, and in delineating the path that must be taken to overcome the problem.

It is now up to the managers and the responsible engineers throughout the electronic industry to decide whether the American Electronic Industry will advance rapidly and lead the world in producing successful complex equipment, or whether we will hesitate and fall upon the hurdle of unreliability.

The "HELPR" PROGRAM

WIRE OR WRITE TODAY for the 52-page book, "The Handbook of Electronic Parts Reliability Program"—A Detailed, Systematic Approach. There is no obligation, just ask for the "HELPR" Book. Address:

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INLAND TESTING LABORATORIES,
Cook Technological Center,
Morton Grove, Illinois

INLAND TESTING LABORATORIES

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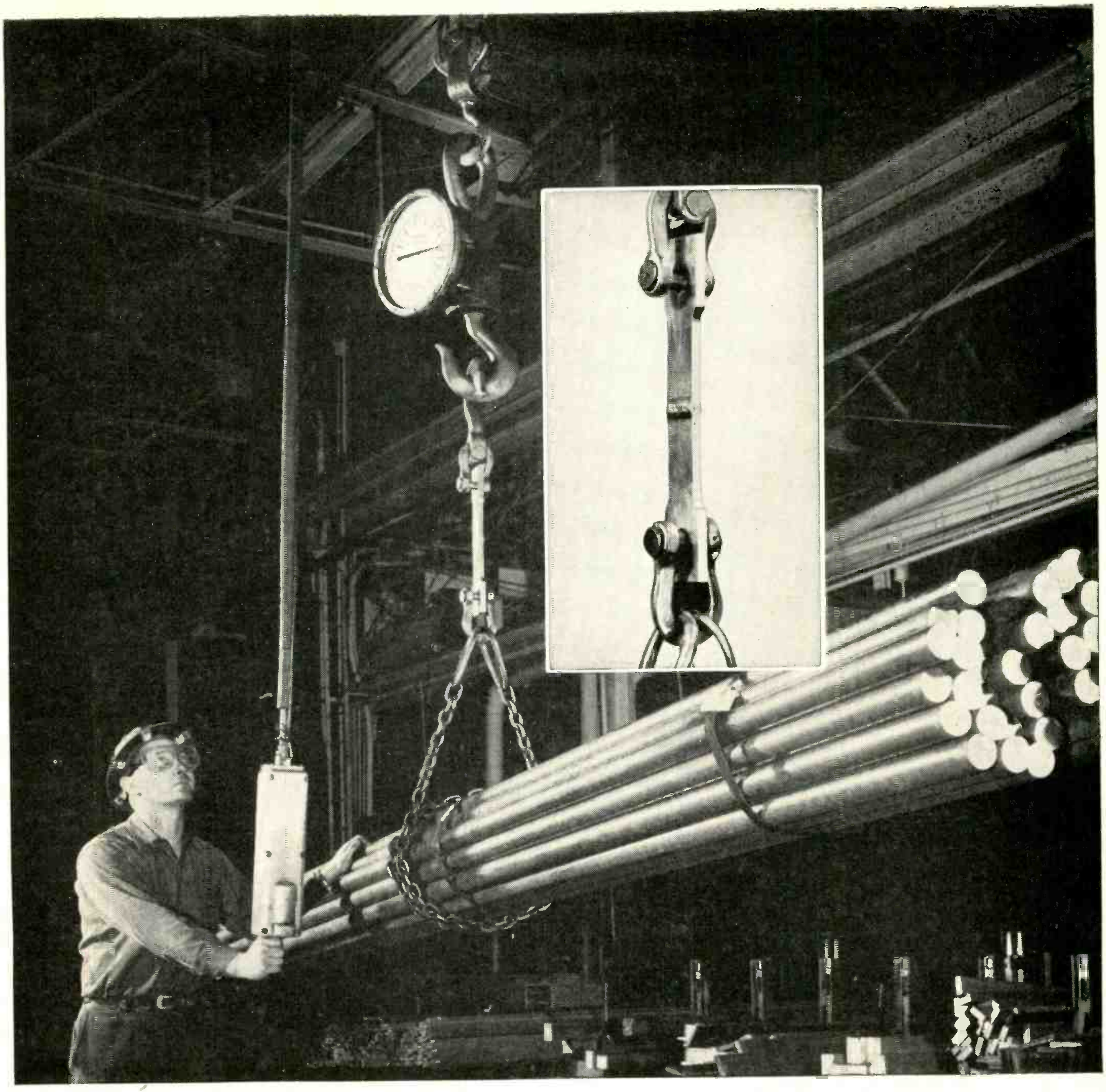


Weld Strength! Magnesium has 95% weld efficiency

In the picture above, a small arc-welded magnesium bar is supporting a load of four tons. This is one example of what we mean by "strong" when we say magnesium is light but strong. Its weld efficiency, the relationship between the strength of the parent metal and a welded joint, is very high. AZ31B magnesium alloy plate, tensile strength 35,000 psi, has a welded joint tensile strength of 33,000 psi, or a weld efficiency of 95%!

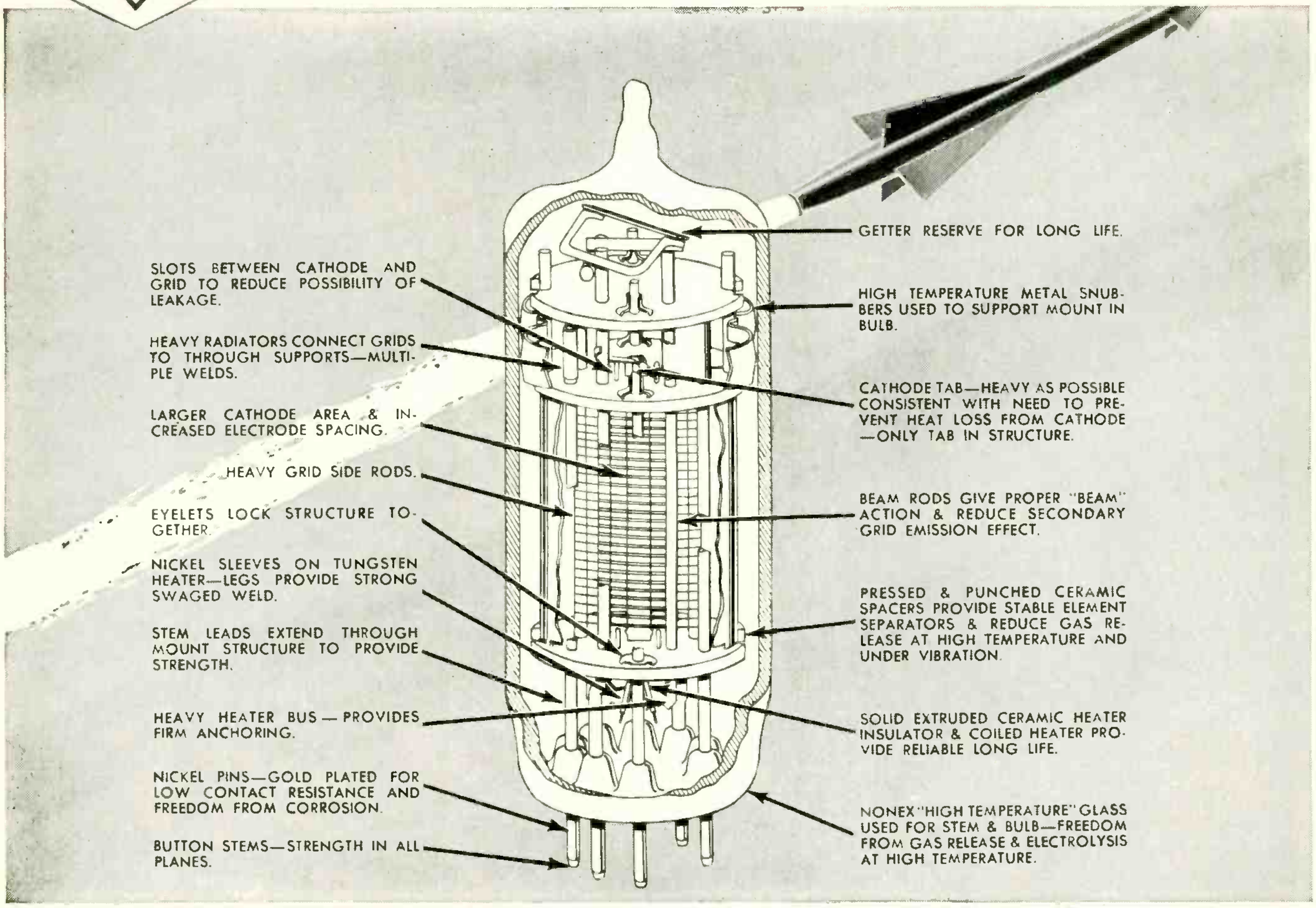
Magnesium can be arc welded, gas welded, or welded by electric resistance (spot, seam or flash). Magnesium plate ½" thick can be joined by arc welding in one pass. It can also be readily joined by most any other method: riveting, bolting, screwing, adhesive bonding and self-fastening devices.

These facts spotlight just one of the many reasons magnesium does a better job in many fabricated metal products. For more information, contact your nearest Dow sales office, or write to us. THE DOW CHEMICAL COMPANY, Magnesium Department, Midland, Michigan, Dept. MA1403M.

YOU CAN DEPEND ON DOW

Circle 28 Readers Service Card

HY-G-300 **ELECTRON TUBES FOR SURVIVAL**



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HY-G-300

TUBES ARE AVAILABLE FROM STOCK

Bulb Size	Dbl. Triodes Volt Amp.	R. F. Pentodes	Gate Pentodes	Rectifiers FullWave	Beam Power	Power Triodes Passing
T-12	—	—	—	—	—	6080WB 6082A
T-11	—	—	—	—	6384 6889	—
T-9	—	—	—	6853	—	—
T-6½	6851 6854 6900	6582A	6486A	6754	6094	6877 6900

Retma Type No.	Retrofit For	Generic Type	E_f	I_f	Bulb	Bendix Type No.
6080WB	6080 6080WA	6080	6.3	2.5	T-12	TE-46
6094	—	6AQ5-6005	6.3	0.6	T-6½	TE-18
6853	6106 5Y3	5Y3	5.0	1.7	T-9	TE-45
6384	6AR6 6098	6AR6	6.3	1.2	T-11	TE-27
6854	6385	2C51 5670	6.3	0.5	T-6½	TE-47
6486A	6486	6AS6	6.3	0.25	T-6½	TE-43
6582A	6582	6AK5	6.3	0.25	T-6½	TE-44
6754	412A	—	6.3	1.0	T-6½	TE-36
6851	5751	—	6.3	0.5	T-6½	TE-42
6877	—	Half of 6080	6.3	0.8	T-6½	TE-48
6900	5687	5687	6.3	0.9	T-6½	TE-54
6889	—	—	6.3	1.2	T-11	TE-52
6082A	6082	6082	26.5	0.6	T-12	TE-55

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Bendix AVIATION CORPORATION

 Circle 29 Readers Service Card

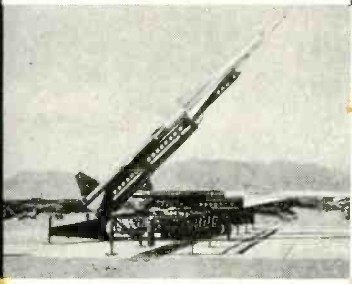
At Boeing, Seattle, Washington

MIL-W-5086 low tension airframe wire is used in low voltage circuits throughout the B-52 Intercontinental Jet Bomber.

At Douglas, El Segundo, California

MIL-W-5274A hook-up wire is used in the electrical, radio and radar components of the A4D Skyhawk and F4D Skyray.

FOR MILITARY SPEC WIRE AND CABLE

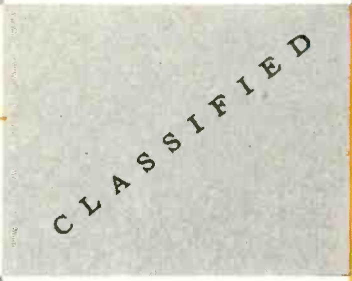


At Western Electric, Burlington, N. Carolina

MIL-W-76A is used in the computer section of the *Nike Ajax* missile, wiring the input, calculator and output sections.

At Raytheon, Waltham, Massachusetts

MIL-W-16878B high-temperature hook-up wire is used in *classified* airborne navigation and bombing radars.



leading manufacturers choose Brand quality, Brand service

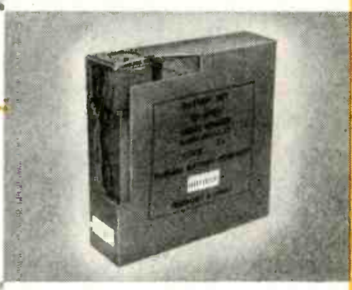
Turbo-Brand wires are manufactured under a program of scientific quality control to exceed the rigid requirements of these and other manufacturers the world over. Available as single conductors or as custom-designed multi-conductor cables, Turbo-Brand cable may be specified to incorporate any number of conductors, any combination of wire types, and any predetermined lay-up pattern.
Your inquiry is invited.

At Chance-Vought, Dallas, Texas

MIL-C-7078A shielded air frame wire is used near radio and radar apparatus to assure distortion-free operation of electronic equipment on the F7U-3 fighters.

At Burgess Battery, Freeport, Illinois

JAN-C-76 general purpose hook-up wire is used to interconnect cells of dry batteries for portable military equipment.



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Electrical and Electronic Wires and Cables • Harnesses and Cable Assemblies • Plastic and Coated Insulating Tubings • Identification Markers

At North American Aviation, L. A., Calif.

MIL-C-17B coaxial cable is used in high frequency radio and radar circuits on the F100 Super Sabre fighters.

Circle 30 Readers Service Card

TOUGH THERMOSTATS SAY "RELAYS FOR SISSIES"

Snap-Action Thermoswitch Units Boss Big Loads Without 'Em

"Relays? Who needs 'em?"

ASHLAND, MASS. — If you want to control good-size electrical loads with a precision thermostat, and you don't want to bother with relays, Fenwal has just the thing.

Fenwal has two series of snap-action Thermoswitch® units, more than twelve models, all based on the same idea — and they don't need relays.

The idea is this:

A liquid responds to temperature changes by expanding or contracting, and moves a bellows assembly. The bellows assembly works a snap-switch with a push-rod, making or breaking a circuit.

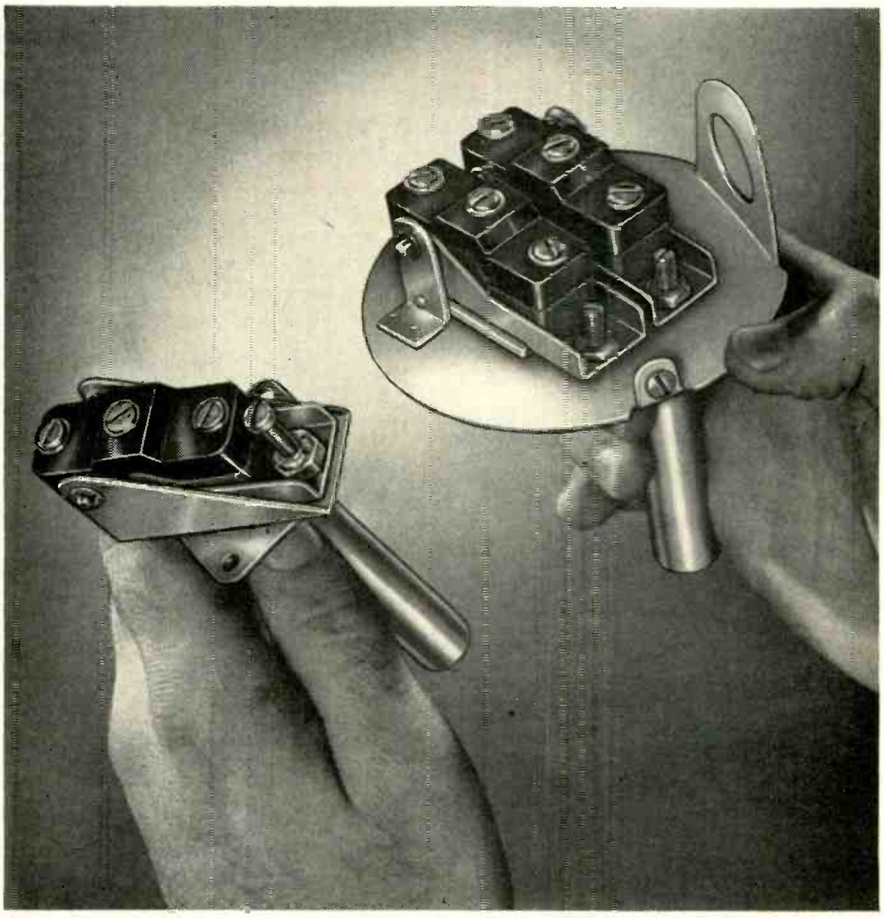
This arrangement will let you control electrical loads up to 20 amps, 115-250 volts A.C., or 10 amps, 125 volts, D.C., without relays, and with a high degree of accuracy.

Fenwal's two series of these remarkable units are called the 20000 and the 22000. The first has only one snap-switch, and the second has two. Two snap-switches and one unit, of course, give you compact control for two-stage heating or cooling.

As for adjusting temperatures — your own men can do it simply in the field. An easy-to-get-at set screw on each switch does the trick. On the double switch models, each switch is set independently.

As for accuracy and speed of response — the units control to within $\pm 2°$ F.

As for cost — Fenwal has designed both series of snap-action THERMOSWITCH controls along "building block" lines to save you money. That is, Fenwal can assemble specialized units for you from a selection of standardized temperature ranges, head types, "application-rated" snap-switches, and mounting styles.



THESE TWO FENWAL SNAP-ACTION THERMOSWITCH UNITS — control loads up to 20 amps, 115-250 volts A.C., or 10 amps, 125 volts D.C. — without relays. These are only two of the twelve models available from Fenwal's Series 20000 (one-switch) and Series 22000 (two-switch) snap-action units.

The temperature ranges you can choose extend from $-75°$F. to $+300°$F.

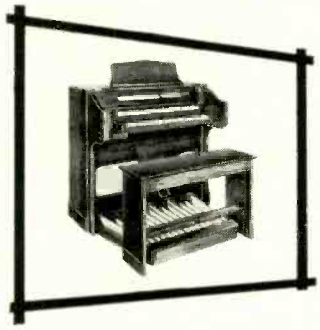
If you choose these controls for your application, you will not be choosing an untried product. You will be joining a large group of satisfied users who have put them to work in such varied equipment as air conditioners, hot-drink vending machines, laundry equipment, and dishwashers.

Designers — write for details on the Fenwal Series 20000 and 22000 snap-action THERMOSWITCH units. You will want those details at your fingertips. Write to **Fenwal Incorporated, 208 Pleasant Street, Ashland, Massachusetts.**

Fenwal

CONTROLS TEMPERATURE
. . . PRECISELY

Cut assembly costs in half with larger printed circuits



The dependable quality of Formica copper clads has reduced the risk of costly rejects. This enables electronics manufacturers to design the larger circuits that reduce labor costs as much as 50%.

Such sensational labor savings have actually been demonstrated by Allen Organ Co., Macungie, Pa., manufacturers of electronic organs. Allen officials also report increased production and simplified field service of organs have resulted from the use of higher quality Formica copper clad laminates.

The quality that has made larger circuits practical is the Formica development of cold punching and better machineability and higher insulation resistance.

Why not cut your assembly costs with larger circuits? You can do it with complete confidence with Formica copper clad laminates. And remember, Formica gives you the widest choice of base laminates, including over 12 grades made of paper and nylon, glass and cotton cloth . . . impregnated with epoxy, phenolic and melamine resins.

For complete information, send today for Copper Clad Technical Data, form 688. Formica Corporation, subsidiary of America Cyanamid, 4530-7 Spring Grove Ave., Cincinnati 32, Ohio.

● Circuits by the yard

Larger circuits reduce wiring time from 8 hours to 4. Made from Formica XXXP-36, the cold punching copper clad that assures greater accuracy through dimensional stability.

FORMICA 4

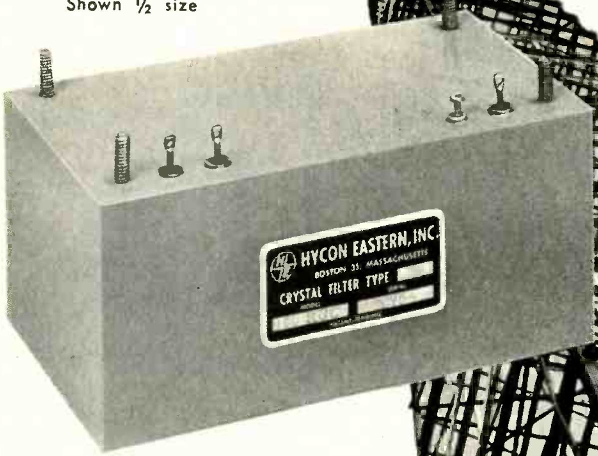
Subsidiary of CYANAMID

Save your engineering time – use Formica 4, the complete laminated plastics service. FI-1426

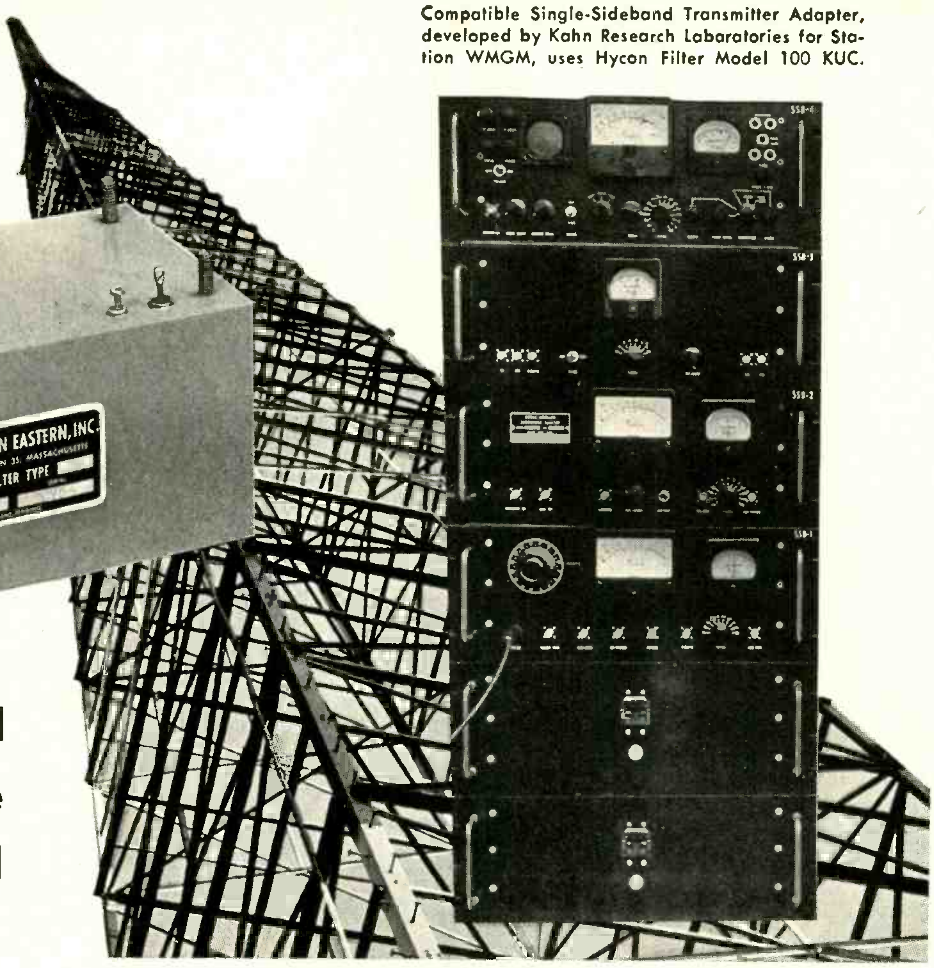
1. Application engineering 2. Research 3. Fabricating 4. Customer stock service

Circle 32 Readers Service Card

Hycon Filter Model 100 KUC
Shown ½ size



Compatible Single-Sideband Transmitter Adapter, developed by Kahn Research Laboratories for Station WMGM, uses Hycon Filter Model 100 KUC.



Radio Tower of Broadcast Station WMGM (50,000 watts)

Accurate phase and frequency response for Single-Sideband Transmission . . .

another problem solved by HYCON FILTERS

The first domestic broadcast installation of the Compatible Single-Sideband Modulation Method has recently been completed by Broadcast Station WMGM of New York City on an experimental basis. Advantages of this system are improved fidelity, improved range in the presence of co-channel interference, resistance to fading and reduction in spectrum space. Because of their ability to meet the stringent requirements for the SSB frequency selective networks, Hycon Filters were chosen for this installation by Kahn Research Laboratories, designers of the CSSB Transmitter Adapter.

Whether your selectivity problems are in transmission or reception, AM or FM, mobile or fixed equipment, Hycon quartz crystal Filters offer you these advantages: LOW COST — standard models; LOW DISTORTION—passband uniformity within ±½ db; HIGH STABILITY — inherent in crystal resonators, also freedom from microphonic behavior; ZERO MAINTENANCE — hermetically sealed, requiring no realignment or readjustment. Hycon Eastern, Inc. can assist you in the selection of filter characteristics best suited to your needs. *Write for Crystal Filter Bulletin.*

ELECTRICAL SPECIFICATIONS (Model 100 KUC)

Carrier Frequency: 100 KC
Attenuation at carrier +300 cps: 2 db maximum
Attenuation at carrier +6000 cps: 2 db maximum
Attenuation at carrier −300 cps: 60 db minimum
Insertion Loss: 10 db maximum
Passband Response Variation: ±½ db
Impedance: 8200 ohms
Dimensions: 5⅜" x 3" x 2⅜"

ALSO AVAILABLE: Model 100 KLC—Lower Sideband
Model 100 KPA—Carrier Selection

"Bridging the Gap Between Science and Technology through Electronics"

WESCON SHOW
Booth 816

HYCON EASTERN, INC.

75 Cambridge Parkway Dept. A-8 Cambridge 42, Mass.

Affiliated with HYCON MFG. COMPANY, Pasadena, California

Manufacturers of: Crystal Filters, Ultra Stable Oscillators, and Magnetic Tape Indexing and Search Units

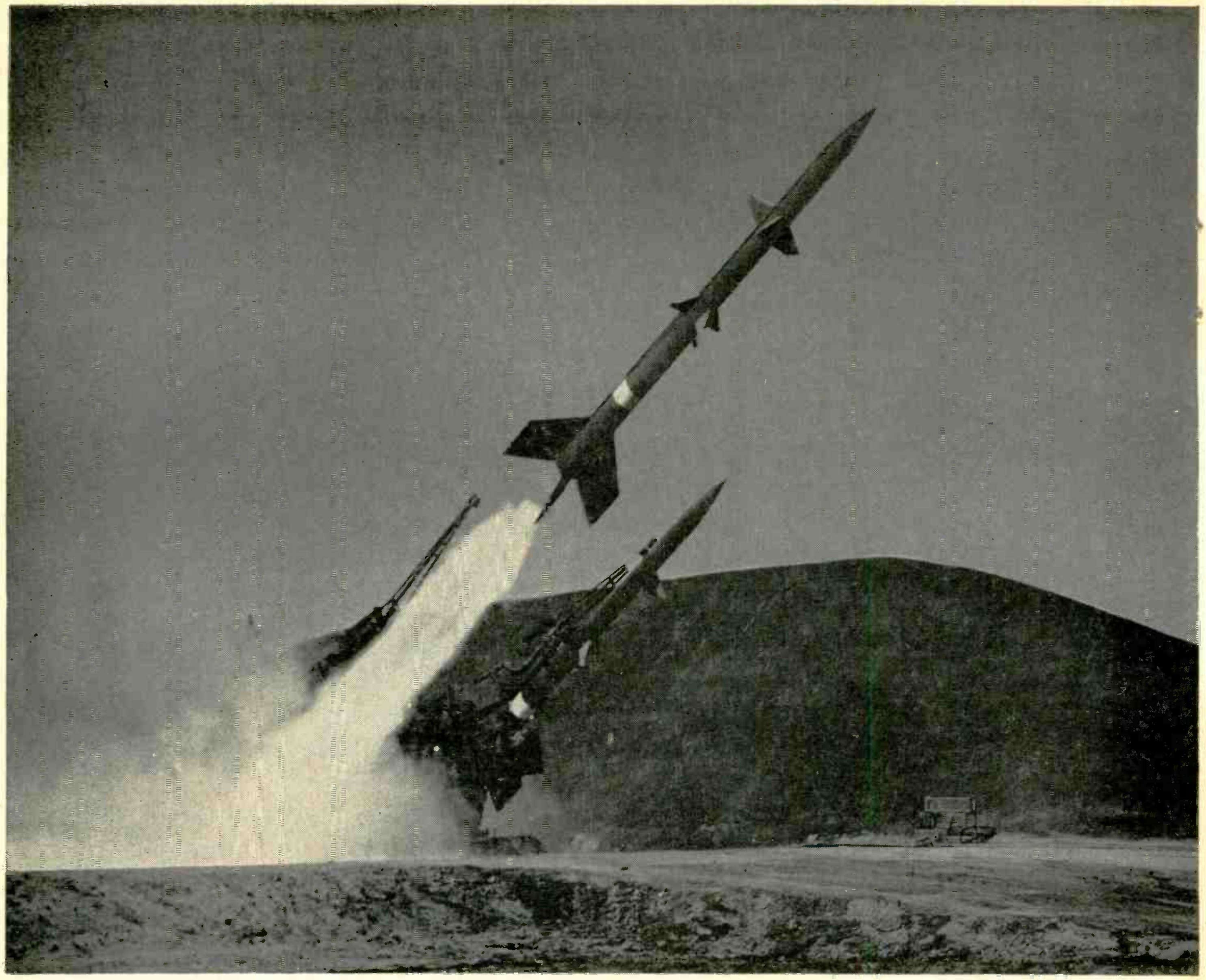


PHOTO COURTESY OF U.S. NAVY

Where there must be no slipups there will be no slipups
– if you depend on CTC

Looking for reliability?

CTC guarantees its components unconditionally — in any quantity from one to millions. CTC quality control includes material certification, step-by-step inspection in production, and finally rigid inspection of finished product. There is reliability for you.

For samples, specifications, and prices, write to Sales Engineering Department, Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast stocks maintained by E. V. Roberts & Associates, 5068 West Washington Blvd., Los Angeles 16 and 988 Market St., San Francisco, Calif.

CTC

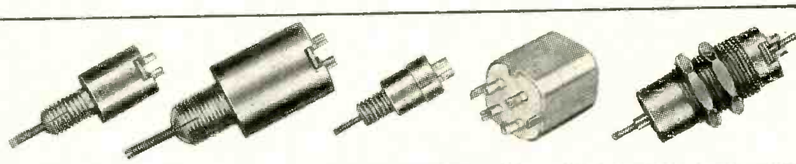
CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components
custom or standard

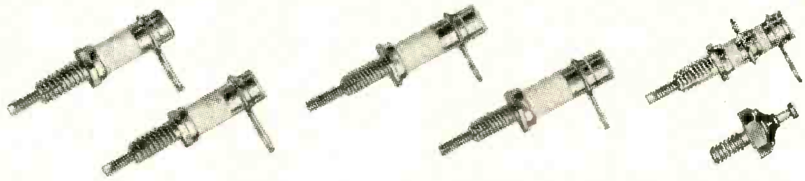
See CTC's Guaranteed Components on Display at Booth 1820, 1957 Wescon Show, San Francisco Cow Palace, August 20th to 23

Ten families of CTC quality components — guaranteed unconditionally in any quantity

CTC QUALITY SHIELDED COIL FORMS
Miniaturized. Highly shock resistant. Mechanically enclosed, completely shielded for maximum reliability.

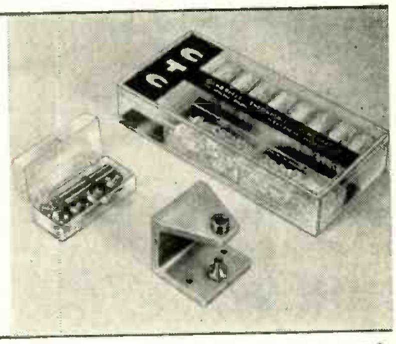


CTC QUALITY CAPACITORS
Miniaturized Variable Ceramic Capacitors that outperform much bigger capacitors. (*Extreme right*): Stand-Off Capacitors with ceramic dielectric. Rugged R-F by-pass capacitors for high quality equipment. Shock-, vibration-, humidity-resistant.

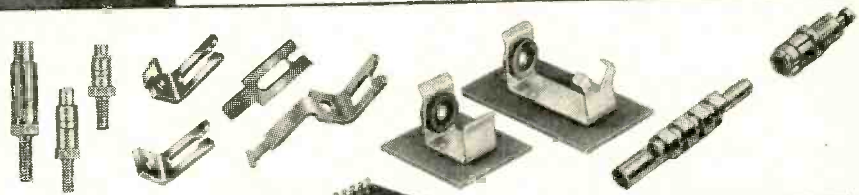


CTC QUALITY WOUND COILS IN STANDARD VALUES
Precision wound on slug-tuned ceramic coil forms, with silicone Fibreglas collars and mounting hardware. Available in bulk or in kit form (illustrated).

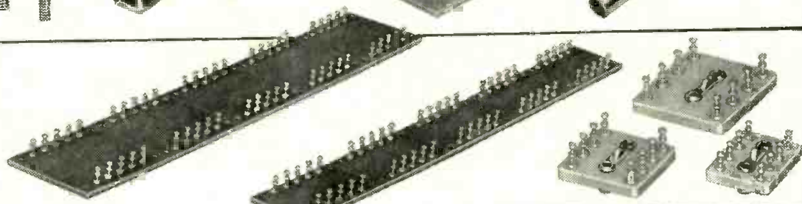
CTC QUALITY KITS
Design your electronic equipment around standard components, using four convenient CTC kits: Coil Form Kit, Coil Kit, Choke Kit, Solder Terminal Kit (illustrated).



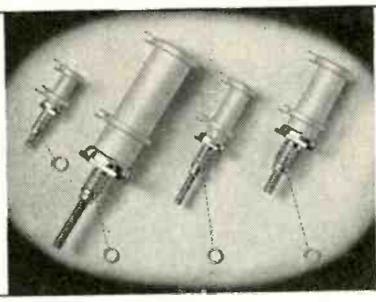
CTC QUALITY DIODE CLIPS
Seven different types, including spring-loaded units primarily for holding fragile diode pigtail leads from .005″ to .085″ in diameter. CTC also offers lines of quality battery clips and miniature plugs and jacks.



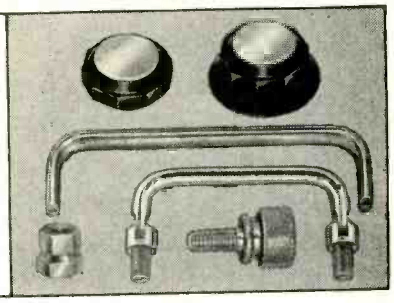
CTC QUALITY TERMINAL BOARDS
Custom-made, standard all-sets, standard ceramics. Variety of materials available — paper, cloth, nylon, glass laminates — phenolic, melamine, epoxy, silicone resins. Moisture — and fungus-proofed.



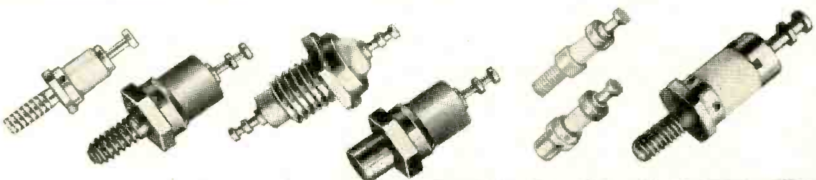
CTC QUALITY PERMA-TORQ COIL FORMS
Constant-tensioning devices for tuning cores of standard CTC ceramic coil forms. Keeps coils tuned as set despite shock, vibration.



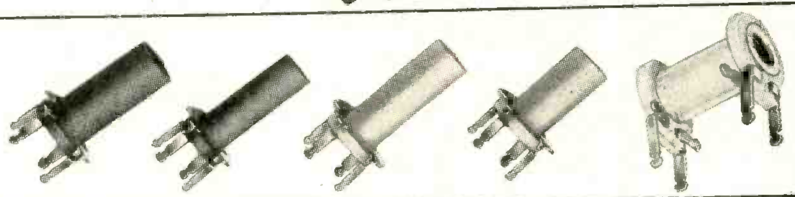
CTC QUALITY KNOBS AND PANEL HARDWARE
Selected materials, carefully processed and finished. Metal parts polished before plating. Hard-wearing surfaces, lasting lusters.



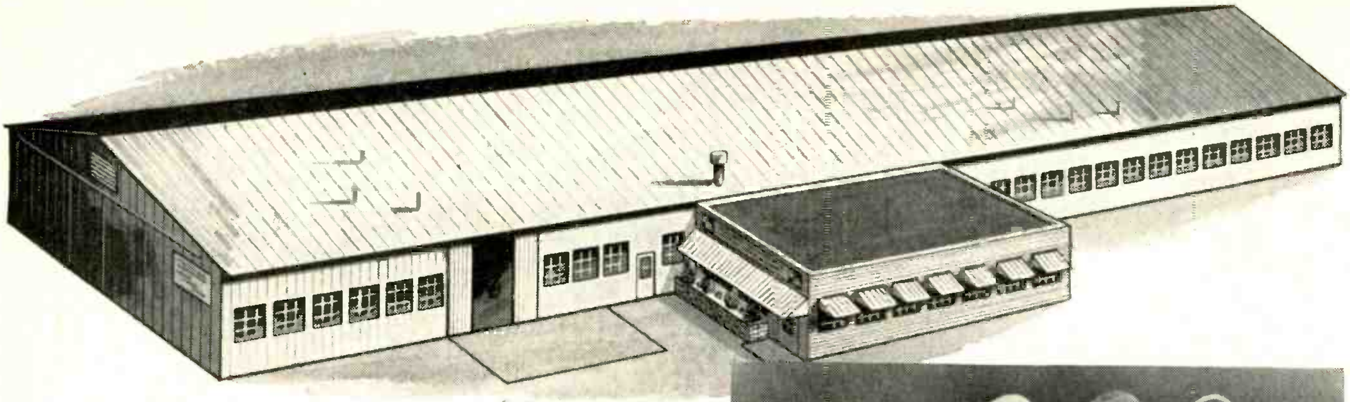
CTC QUALITY INSULATED TERMINALS
Wide variety of stand-off and feed-through models in Teflon and ceramic. Extremely resistant to shock, vibration, moisture and temperature. Solder terminals hold even after prolonged soldering operations.



CTC QUALITY PRINTED CIRCUIT COIL FORMS
Phenolic and ceramic types. Can be soldered after mounting. Available as forms alone or wound as specified. Two- to six-terminal models.



Circle 36 Readers Service Card

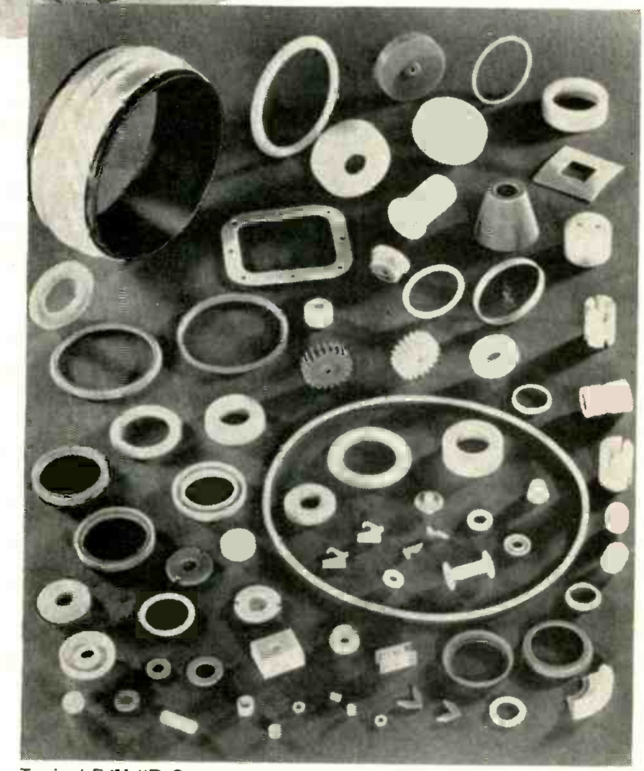


Raybestos-Manhattan acquires California plant to provide West Coast users with R/M Teflon* products

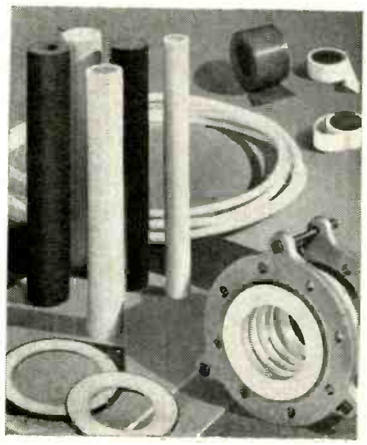
Raybestos-Manhattan has purchased the Graef Engineering Co., in Paramount, Calif., to serve Western and Southwestern manufacturers as a nearby source of R/M "Teflon," "Kel-F," Nylon and Raylon (a mechanical grade of "Teflon") products. Key personnel will be retained. The plant is fully equipped to extrude, mold and machine "Teflon," "Kel-F" and Nylon products and to spray-coat metal parts with "Teflon" and "Kel-F." It will also stock "Teflon" sheets, tubes, rods and tapes in standard, certified and stress-relieved grades; bondable sheets and tape, gaskets, mechanical packings, expansion joints, and flexible couplings.

Raybestos-Manhattan, a pioneer in fabricating these materials, is one of the largest producers of "Teflon" products for aircraft, electronic, electrical, chemical and various other industrial applications. Call on R/M's experience and skill to help you solve problems involving high temperatures and corrosive fluids and gases.

*A Du Pont trademark



Typical R/M "Teflon" products manufactured at Raybestos-Manhattan's newly acquired plant at 15010 South Downey Ave., Paramount, Calif.



OTHER R/M "TEFLON" PRODUCTS: rods, sheets, tubes and tape; centerless ground rods held to very close tolerances; stress-relieved molded rods and tubes; gaskets; expansion joints and flexible couplings; bondable "Teflon"; braided metal- and rubber-covered flexible hose; and Raylon (R/M trade name for mechanical grade "Teflon" which has many of the characteristics of virgin "Teflon"). Write for complete data.

RM

RAYBESTOS-MANHATTAN, INC.

PLASTIC PRODUCTS DIVISION, MANHEIM, PA.

FACTORIES: Manheim, Pa.; Bridgeport, Conn.; Paramount, Calif.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Engineered Plastics • Asbestos Textiles • Mechanical Packings • Industrial Rubber • Sintered Metal Products • Rubber Covered Equipment Abrasive and Diamond Wheels • Brake Linings • Brake Blocks • Clutch Facings • Laundry Pads and Covers • Industrial Adhesives • Bowling Balls

RHODIUM PLATING... AN ECONOMICAL, HARD, WHITE, CORROSION-RESISTANT SURFACE!

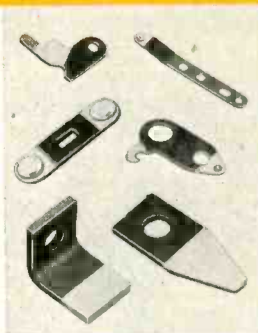
The characteristics of Rhodium make it extremely well-suited for many electrical and electronic applications. It increases efficiency when a low-resistance, long wearing, oxide-free contact is required. It assures low noise level for moving contacts, no oxide rectification, low and stable contact resistance. Wear on slip rings and commutators is greatly reduced. Resistance to marine and practically all industrial atmospheres is so effective that it is widely used on safety alarm contacts, where positive contact must be assured after periods of long inactivity.

The corrosion-resistant properties of Rhodium Plating make it particularly applicable for printed circuits (long wear and low noise) and ultra-high frequencies (eliminating partial rectification and unwanted signals).

Rhodium plated reflectors are recognized as the finest made. Rhodium plating is unsurpassed when used with the open arc.

Write for complete catalog material and details.

FINE WIRE of ductile and non-ductile material meets the expanding requirements of industry with highest quality.



PRECIOUS METAL CONTACTS resist chemical attack and effects of the electrical arc to provide long life, unvarying performance.

SUPER-SENSITIVE DEOXO® INDICATOR measures the faintest traces of oxygen or hydrogen present as impurities in other gases.

BAKER PRECIOUS METALS

BAKER & CO., INC.

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ENGELHARD INDUSTRIES

RESEARCH MAINTAINS BAKER'S LEADERSHIP IN PRECIOUS METALS

Circle 38 Readers Service Card

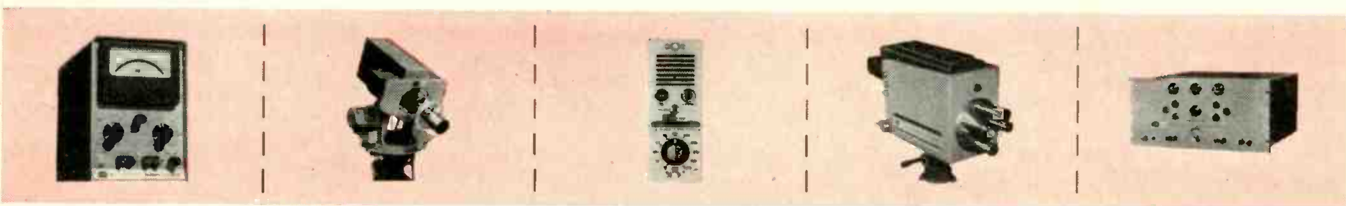
A NEW NAME

KIN TEL

for **KAY LAB** *products*

The same company, the same engineering and manufacturing facilities, the same world-wide staff of field engineers, but a new name more descriptive of the Company and its products.

LOOK FOR **KIN TEL** ON:



UNIVERSAL DC MICROVOLTMETERS | INDUSTRIAL TELEVISION EQUIPMENT | MICROVOLT LEVEL BROADBAND DC AMPLIFIERS | BROADCAST TELEVISION EQUIPMENT | ABSOLUTE DC POWER SUPPLIES AND METER CALIBRATORS

On these and many other electronic products the name KIN TEL means outstanding instruments and television equipment.

WESCON...BOOTHS 1603-1604

Representatives in all major cities

Write, wire, phone today for demonstration

KIN TEL
[KAY LAB]

ELECTRONICS FOR COMMUNICATION · MEASUREMENT · CONTROL

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

THE ONE UNIVERSAL METER

MICROVOLTS TO KILOVOLT

100 UV TO 1000 V · 100 UUA TO 100 MA · AS 80 DB DC AMPLIFIER · MODEL 203

The **KIN TEL** Model **203** is a combination DC microvolt-ammeter and amplifier. It provides an exceptionally wide range of measurements. Fifteen voltage ranges cover from 100 microvolts full scale to 1000 volts full scale, with 100 megohms input impedance. Ten current ranges cover from 100 micro-microamperes full scale to 100 milliamperes full scale. As little as 10 microvolts or 10 micro-microamperes may be measured with accuracy. The uncluttered zero-center meter face instantly indicates polarity on a mirrored scale. When used as a DC amplifier, the instrument features exceptionally low drift with high gain, very high input impedance and low output impedance. Gains up to 80 db with less than 10 microvolts drift may be obtained. The Model **203** utilizes **KIN TEL'S** unique chopper stabilized circuit to provide high sensitivity with previously unobtainable drift-free stability and high input impedance.

APPLICATIONS: Electronic, medical, geophysical, chemical, metallurgical research and development ... transistor production and circuit design ... thermocouple calibration ... null detector ... recorder driver amplifier ... and as a general purpose laboratory instrument wherever dc voltage and currents are measured or amplified.

SPECIFICATIONS

Voltage Range (full scale)	$100\mu v$ to 1000v
Current Range (full scale)	$100\mu\mu a$ to 100 ma
Input Impedance	10 megohms below 10 mv, 30 megohms at 30mv, 100 megohms above 30mv
Impedance Accuracy	±1.5%
Accuracy on All Ranges	±3% of full scale
Maximum Gain as Amplifier	80 db ±1.5%
Output Rating	1v across 1000Ω
Output Impedance	less than 5Ω
Drift (after 15 min. warmup)	$10\mu v$ equivalent input
Price	$550.00

Rack Mounting available as Model 203R

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KIN TEL

[KAY LAB]

STABILITY *locked in!* WITH CHOPPER AMPLIFIERS

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

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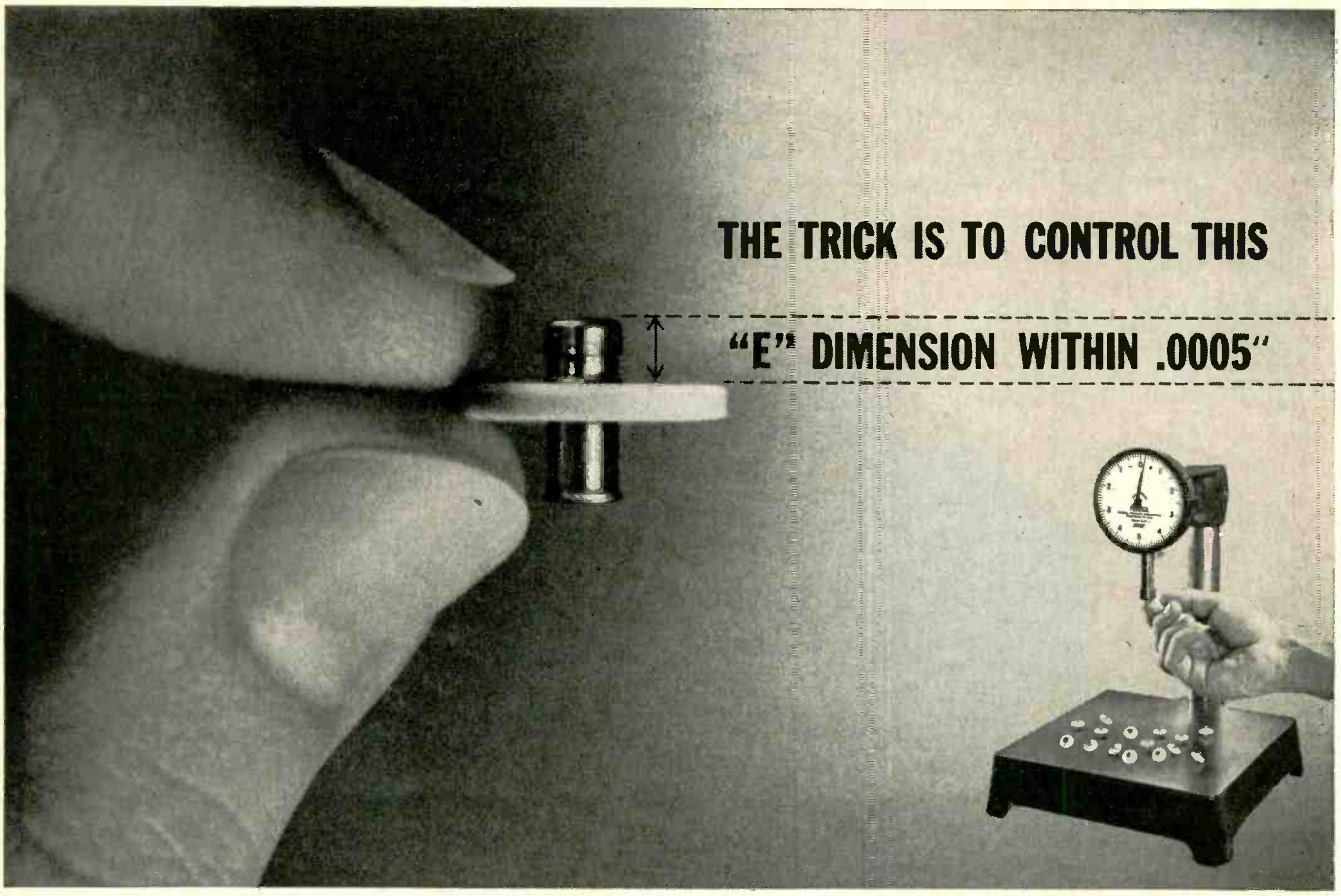


Dial indicator gage measures the critical "E" dimension.

Precision disc cathodes simplify assembly of TV picture tubes

Because Superior Tube guarantees such close tolerance in disc cathode "E" dimension, makers of TV picture tubes can save the time and cost of compensating for variations.

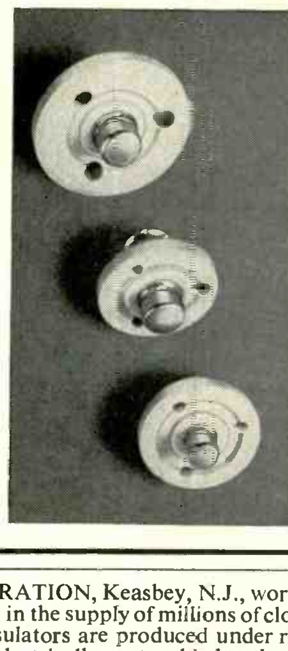
Cathodes can be used universally in different tubes, and are interchangeable with each other during electron gun assembly. This means both manufacturing efficiency and quality control can be significantly improved.

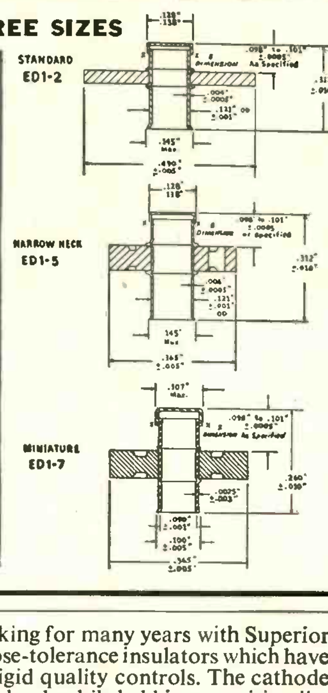
In addition, Superior Tube precision disc cathodes offer these four important advantages:

1. **Separate cap alloy.** *Permits use of best alloys for both cap and shank in varying applications.*
2. **Slight flare of shank opening.** *Easier insertion of heater. Less abrasion of heater coating during normal expansion and contraction.*
3. **Shadow groove in ceramic.** *Inhibits electrical leakage between cathode and No. 1 grid.*
4. **Chemically clean shank interior.** *Minimizes heater-cathode leakage.*

Superior Tube disc cathodes are available in three sizes: standard, narrow neck making possible shorter tubes, and miniature for 3-gun color TV picture tubes. Write for complete information to Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.

AVAILABLE IN THREE SIZES



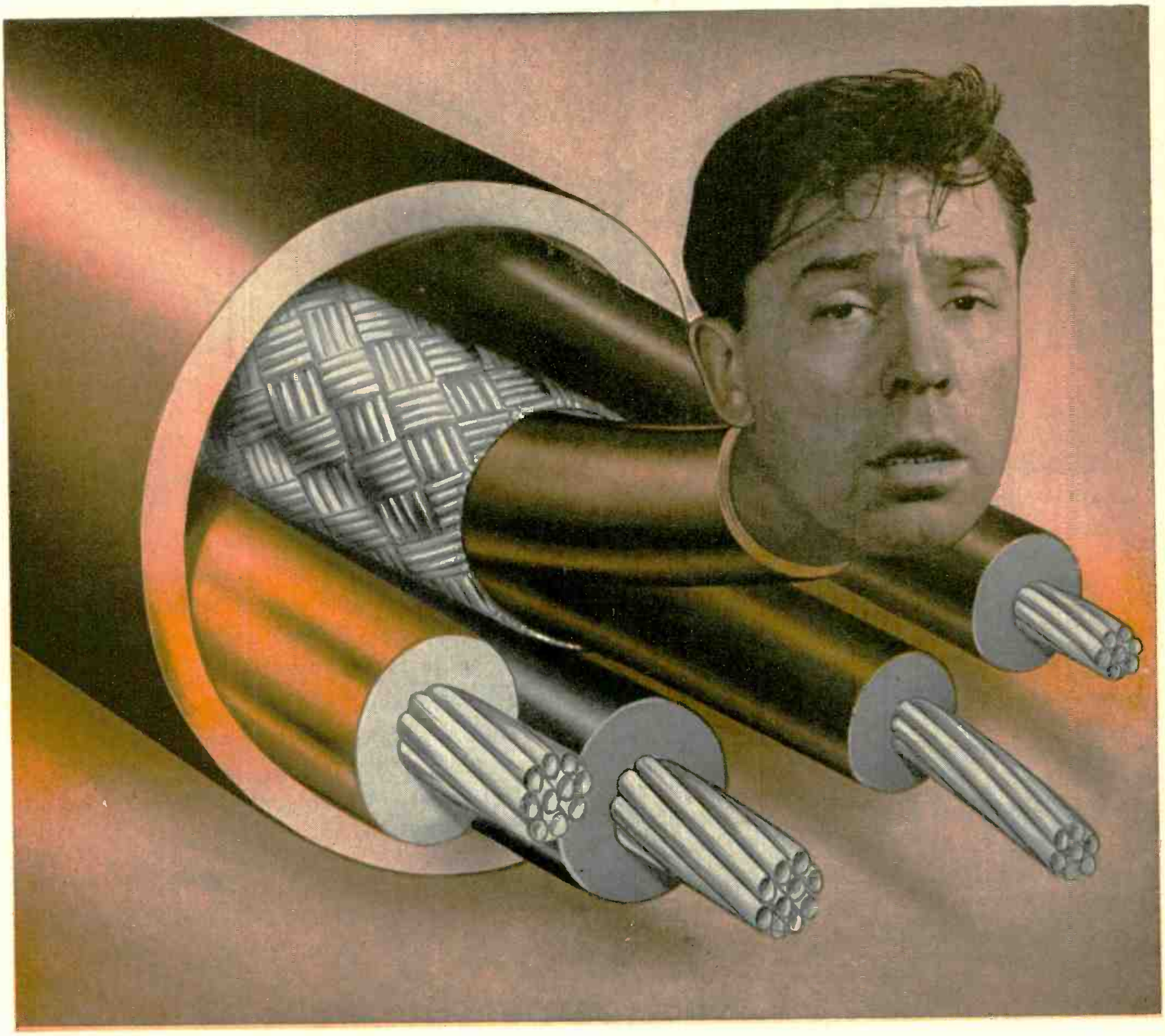


HOW SUPERIOR DOES IT—GENERAL CERAMICS CORPORATION, Keasbey, N.J., working for many years with Superior Tube's engineers, has developed mass-production methods resulting in the supply of millions of close-tolerance insulators which have greatly assisted in achieving this uniform "E" dimension. These insulators are produced under rigid quality controls. The cathode shank is double-beaded to the ceramic to insure tight fit. The cap is electrically spot-welded to the shank while held in a precision jig.

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.

Got Your Neck Out On A Cable Problem?

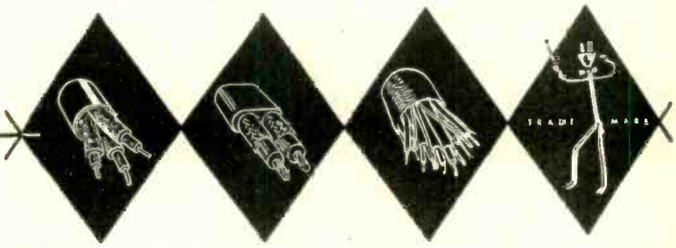


PHALO Will Haul It In For You!

Here is a pretty painful spot . . . and many necks are lost this way!
If your neck is out where the wrong cable decision could materially damage it . . . make the move that will put your adam's apple in back of your collar again . . . the move to PHALO!
Be among the necks that stay unstretched when the problem is custom cables . . . or wires . . . or cord sets.

This catalog will tell you a lot — ask for it!

PHALO PLASTICS CORPORATION
Corner of Commercial Street
WORCESTER, MASSACHUSETTS



Circle 42 Readers Service Card

A MESSAGE TO AMERICAN INDUSTRY • ONE OF A SERIES

Is Industry Creating A New Breed of "Bonus Babies"?

THE STARTING SALARIES offered to this year's June graduates give the impression that industry is creating a new breed of "bonus babies." This is the term baseball fans apply to sturdy youngsters whose talent for hitting and throwing gets them payments of up to $100,000 and other benefits for signing a contract.

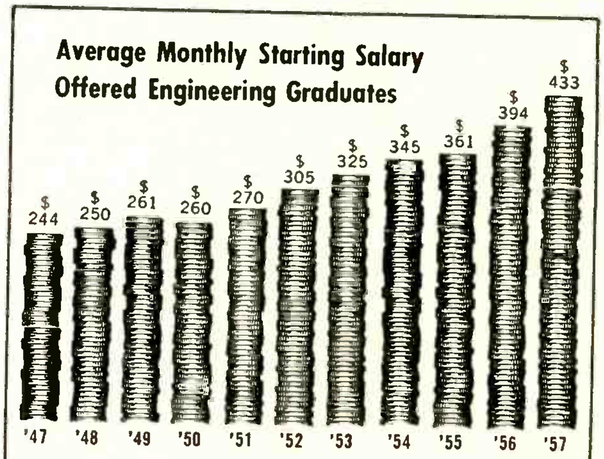
For several years industry's demand for young college graduates, especially in science and engineering, has outrun the number receiving degrees. Competition for these young people has steadily pushed up the starting salaries and has induced many companies to indulge in lavish recruiting programs. This year engineering graduates are being offered well over $400 a month, and even liberal arts graduates find numerous offers at $400 or more. Only ten years ago the salaries offered senior engineering students averaged less than $250 a month.

But any employer who assumes that high starting salaries alone will assure him the number of June graduates he wants is likely to be disappointed. A recent study by the McGraw-Hill Classified Advertising Division shows that most young engineers and scientists going into industry are more interested in their opportunities and in a company's future than they are in the size of their first paycheck.

Money Isn't Everything

In the McGraw-Hill survey, 2,596 recently-hired engineers and scientists employed in 57 companies listed the factors they had considered before accepting a position. The replies of the younger engineers and scientists—those with less than five years' experience — have great significance for employers who want to make any impression in the highly competitive market for college graduates.

- **Potential growth of the company** was listed by more young engineers and scientists than any of the 42 other items on the list as a factor that influenced greatly their decision in accepting a position.
- **Challenging opportunity** was second.
- **The company's prestige and reputation** ranked third.



Data: National Industrial Conference Board, from annual surveys by Dr. Frank S. Endicott, Northwestern University.
Note: These figures were compiled during the fall previous to graduation and have risen by commencement in recent years.

● **Progressive research and development program** was fourth.

● **Starting salary** ranked only **seventh.**

Job and Future Most Important

As a group, the factors relating to the nature of the job, its future and the company's future had by far the greatest influence in attracting young engineers and scientists to their present positions. These include three of the top four attractions—potential growth of the company, a challenging opportunity and a progressive research and development program. Other factors in this group are the company's facilities, quick advancement, self-direction or little supervision, chance to work in a certain field, small size of company and rewards for individual accomplishment.

The second most important group of attractions had to do with prestige. These include the company's prestige and reputation, executive or professional standing and association with leading men in the field. **Third in importance were financial considerations**—starting salary, regular salary increases, financing of relocation, paid vacations and holidays.

A less important group of factors influencing young scientists and engineers were essentially social. Geographic location and educational facilities in vicinity ranked fairly high. But recreational facilities, suburban or country living, pleasant housing and cultural considerations had little appeal.

Ranking lowest, by a good margin, were factors having to do with security—permanent position; health, life and surgical insurance; retirement or pension plan; and sick leave.

It is interesting to note that some of the factors which influenced the **smallest** percentage of young engineers and scientists were country club memberships, use of company car, at-cost or low-cost eating place, travel opportunities abroad and being able to buy the company's products at a discount.

A Lesson For Employers

The lesson of this survey to employers who hope to recruit more young engineers and scientists is clear. High salaries and other financial appeals are important. But, **at a time when high starting salaries are offered in abundance, our young graduates are interested even more in being with companies that will grow and in jobs that will permit them to grow. They are interested in jobs that offer opportunities for advancement, financially and professionally.**

* * *

Were the young scientists and engineers who participated in the survey trying to impress somebody with their motives? If so, it could only have been to impress themselves, for all were asked to return their questionnaires unsigned.

What Factors Influence the Job Selections of Young Engineers and Scientists?

Factors Influencing Decision Greatly	Percent Listing Factor
Potential growth of company	55%
Challenging opportunity	53
Company's prestige, reputation	44
Progressive research and development program	41
Geographic location	37
Permanent position	35
Starting salary	34
Educational facilities in vicinity	33
Regular salary increases	31
Chance to work on specific project, or in certain field	27
Company's facilities (laboratories, technical libraries, etc.)	25
Tuition for graduate study	25

Based on replies by recently-hired engineers and scientists with less than five years' experience to questionnaire distributed by McGraw-Hill Classified Advertising Division.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

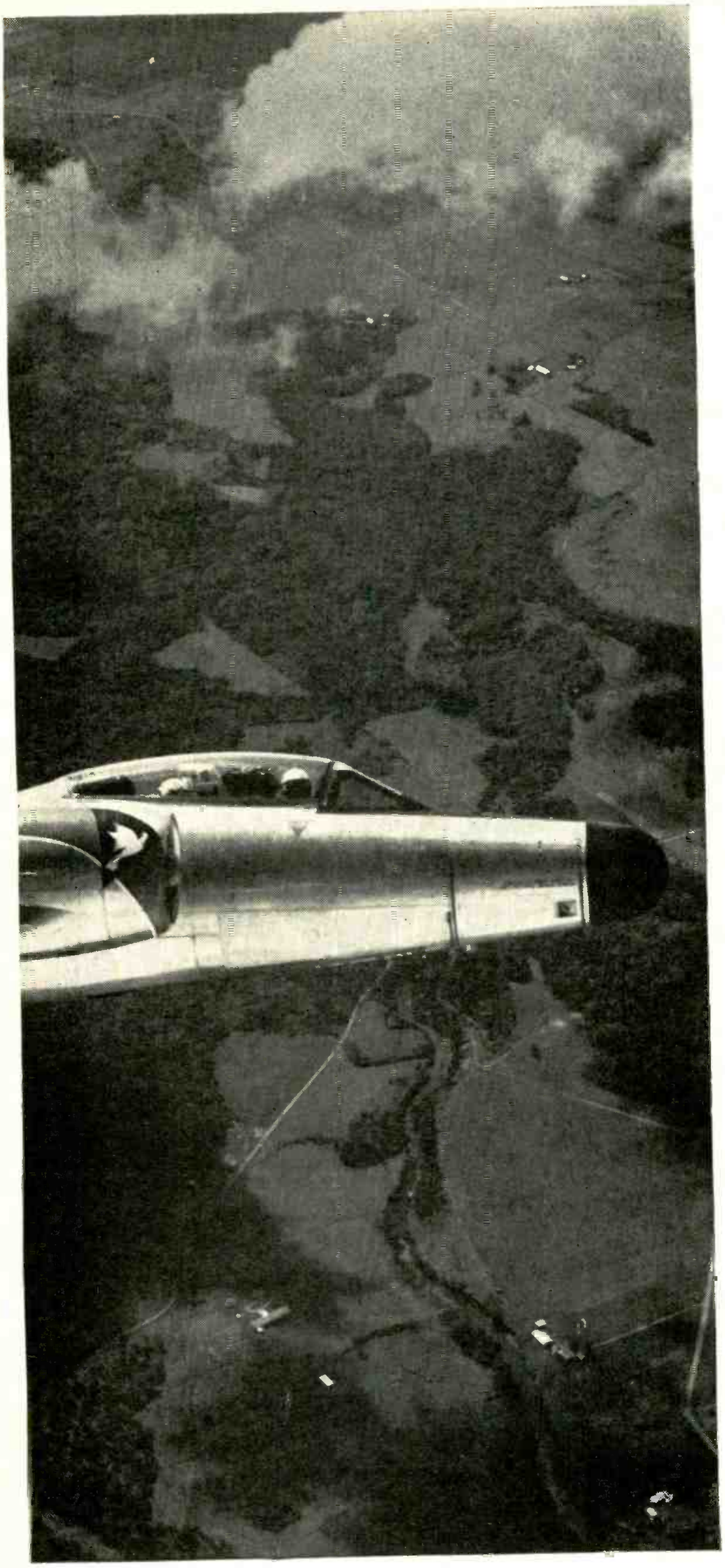
Donald C McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

Another Example of CREATIVE MAGAMP ENGINEERING By Westinghouse

Circle 43 Readers Service Card



World's Lightest Magnetic Amplifier Regulator Unit . . . Capable of Voltage Regulation Plus or Minus 1 Volt up to 120° C.

The high altitude missile-carrying CF-100 Mark VI, designed and developed by Avro Aircraft Ltd., of Canada, is undergoing advanced flight testing. Complete dependability and fast response are critical in control and power supply components for these all-weather aircraft. That's why Westinghouse transformer-rectifier unit with MAGAMP* static control was specified — it assures electrical system reliability over a wide range of temperatures and altitudes on aircraft and guided missiles.

Using a 12-phase amplifier and silicon rectifiers, Westinghouse can obtain an output of 5.6 kw . . . yet the unit occupies less than one cubic foot and weighs only 62 pounds. By designing reactors that will operate at 200°C internal temperatures, Westinghouse engineers are able to provide the only magnetic amplifier voltage regulator on the market that will operate at a sea-level temperature of -55°C to +120°C.

This is an example of Westinghouse creative MAGAMP engineering to solve today's problems and tomorrow's applications. For information or engineering assistance on your specific control problems, call your Westinghouse sales engineer, or write Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

*TRADE-MARK

J-22030

MAGAMP STATIC REGULATOR CHARACTERISTICS

INPUT
190 to 210 volts rm-3 phase

OUTPUT
28 volts at 200 amperes

FREQUENCY RANGE
380 to 420 cps

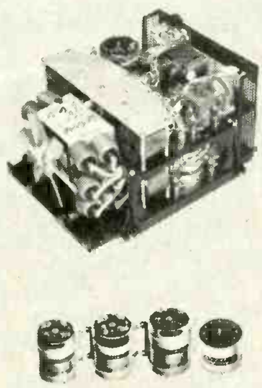
RIPPLE
1.5-volt peak ripple

TRANSIENT RESPONSE
0.2-second maximum

EFFICIENCY
Minimum of 80% at full load

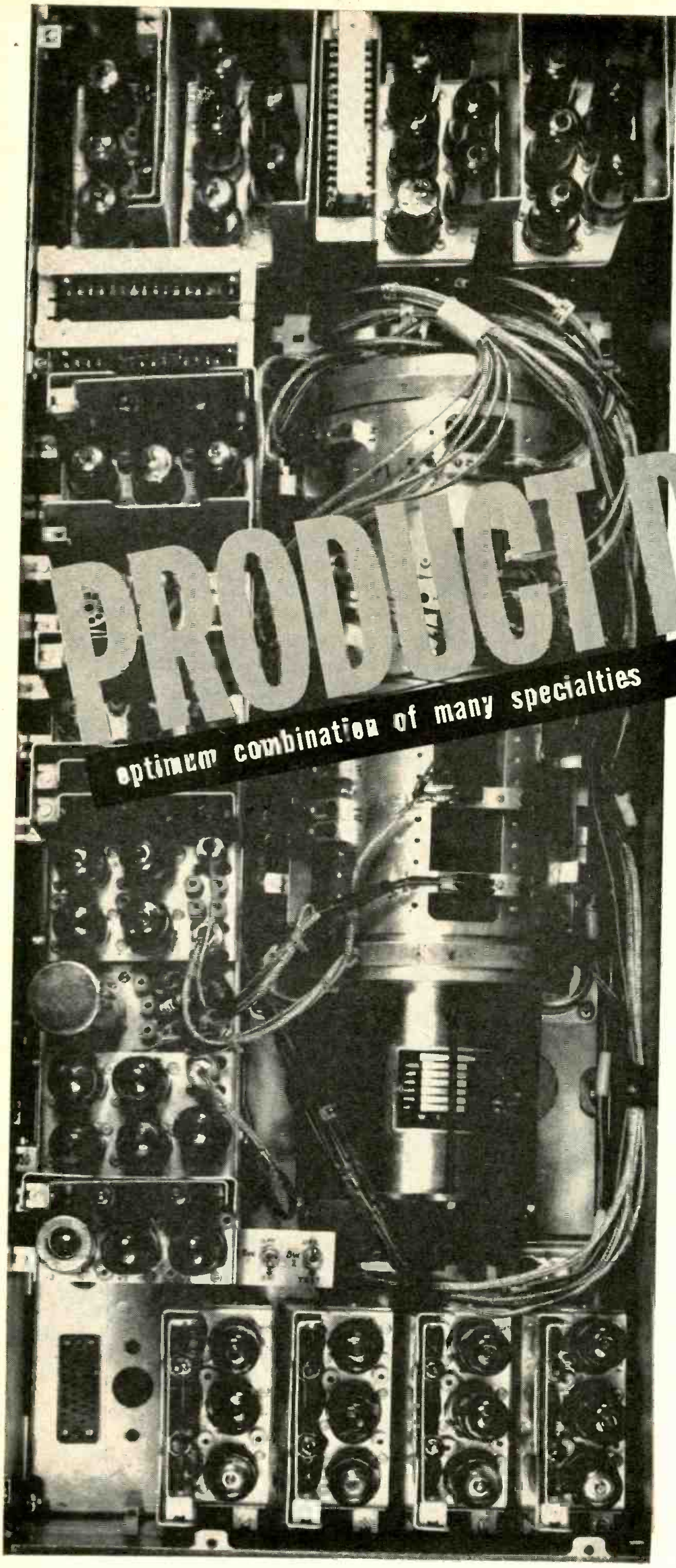
PERFORMANCE
As specified in MIL-E 5272 A

LIFE
1,000 hours minimum with no maintenance or adjustments.



YOU CAN BE SURE...IF IT'S **Westinghouse**

Circle 44 Readers Service Card



RELIABILITY ANALYSIS.
MAINTAINABILITY. HEAT TRANSFER.
COMPONENT APPLICATION.
MINIATURIZATION.
ECONOMY

PRODUCT DESIGN

optimum combination of many specialties

Electronic Product Design at Hughes is the optimum of many and varied specialties. This expert coordination of specialists has resulted in the solution of complex packaging problems, including the airborne Electronic Armament System and the Falcon guided missile.

New projects soon to be underway concern developing practical solutions to the theoretical and actual problems associated with Electronic Product Design.

These Hughes projects have both military and commercial application, assuring you of an unlimited future. Engineering positions to be filled include the following: Reliability, Component Application, Electromechanical Development, Miniaturization and Packaging, Chemical and Metallurgical, Applications and Precision Electronics Test-Supervisor.

Investigate this opportunity to combine challenging work with the ideal living conditions in suburban Los Angeles. Send your resume to the address below.

THE WEST'S LEADER IN ADVANCED ELECTRONICS

HUGHES

RESEARCH AND
DEVELOPMENT LABORATORIES

SCIENTIFIC STAFF RELATIONS
HUGHES AIRCRAFT CO., ROOM 2046-C
CULVER CITY, CALIFORNIA

DIRECT DISPLAY CATHODE RAY

STORAGE TUBES BY HUGHES

TONOTRON* Halftone Storage Tube . . . for Radar PPI Display or Closed-Circuit TV.

Such distinct advantages as controllable long persistence and ability to cover the entire grey spectrum contribute to the versatility of the Hughes TONOTRON direct display storage tube. Because the TONOTRON electron tube has an over-all length of only $11\frac{3}{8}''$ ($\pm\frac{3}{8}''$), it can be installed in many existing radar indicator housings in both military and commercial aircraft. Brilliance of 1000 foot-lamberts at 10 kv enables the pilot to view radar presentations in full daylight without using a vision-restricting viewing hood. When used in narrow band, slow scan television, the TONOTRON storage tube eliminates need for costly coaxial cables or microwave transmitters and receivers, since pictures can be transmitted over conventional radio channels or telephone lines.

Brilliant halftone presentation in weather radar.

Maximum contrast makes ground radar read "like a map."

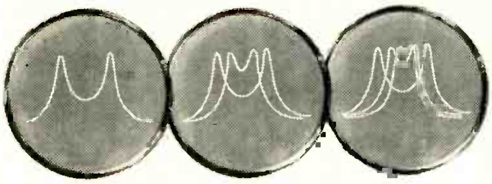
Resolution of 80 lines per inch in narrow-band TV.

Action can be frozen for subjective examination.

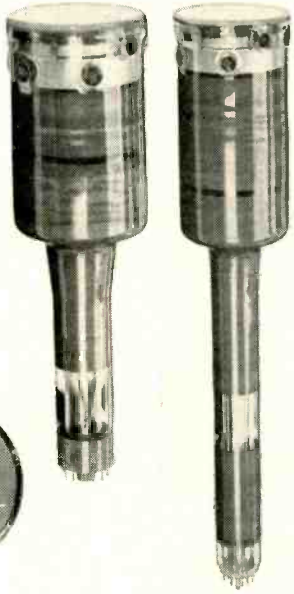
MEMOTRON® Oscillograph Storage Tube . . . for Retaining Displays of Electrical Phenomena.

Traces and transients may be visibly retained on the face of the Hughes MEMOTRON direct display storage tube as long as desired—and successive waveforms can be displayed and retained for analysis and comparison without needless photography.

When permanent records are required, photographs may be taken with a single camera exposure setting, since all displays occur at the same brightness regardless of differences in writing speeds.



A technique for plotting a family of curves, representing a coupled circuit with varied parameters.



TYPOTRON® Character-Writing Storage Tube . . . for Use as a Read-Out Device for Computers.

When used in such digital computer applications as programming aid, solution read-out and trouble-shooting, the Hughes TYPOTRON direct display storage tube effectively monitors a problem as it goes through various phases toward a solution.

A choice of 63 characters is available for presentation of data in words, numbers or symbols at speeds of at least 25,000 characters per second. Written information remains visible indefinitely without fading or blooming until intentionally erased.

Presentation of printed data is displayed with $\frac{1}{8}$-inch characters.

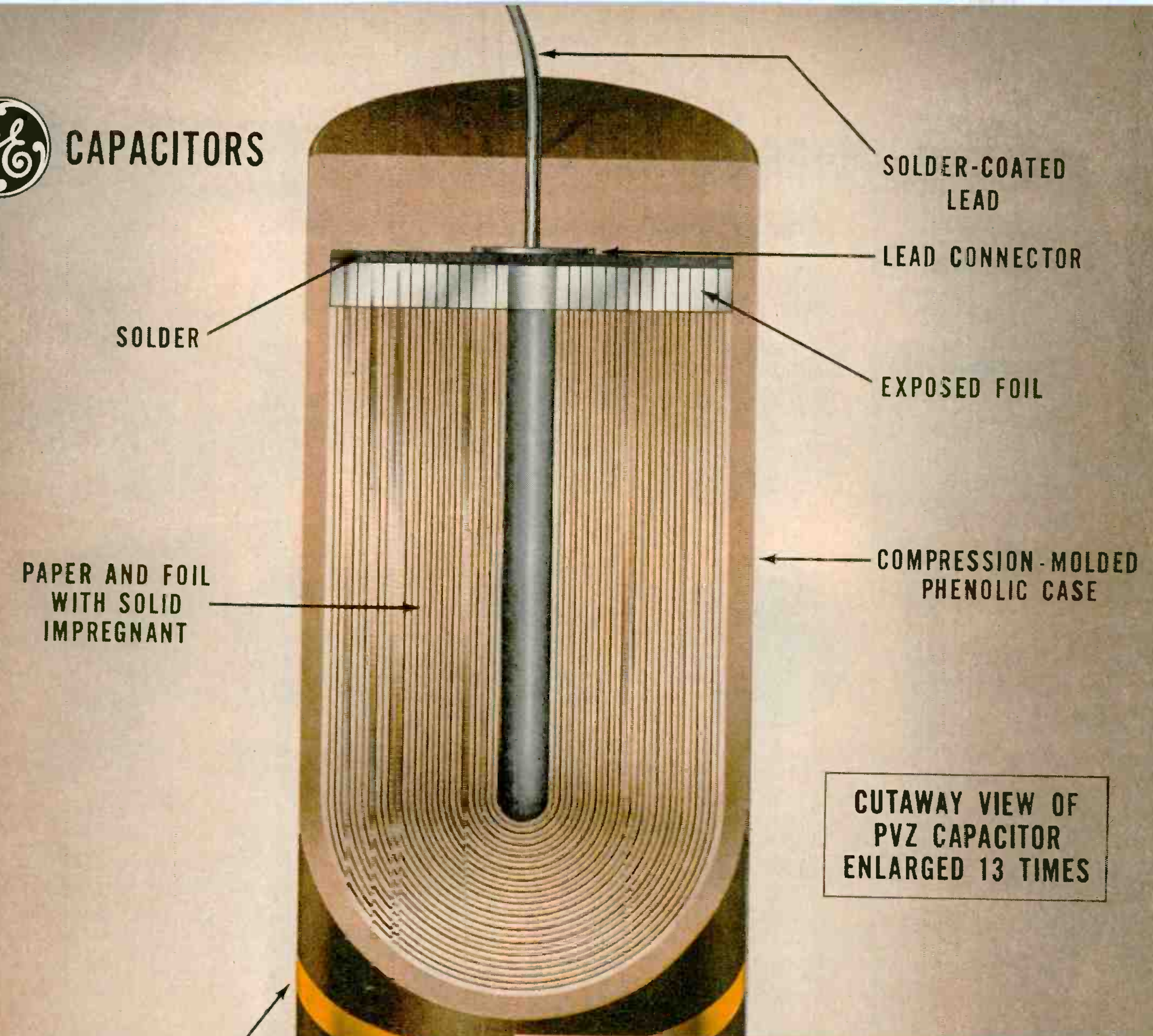
You are invited to see demonstrations of Hughes direct display storage tubes at Booths 2910-11-12-13, Western Electronics Convention, San Francisco, August 20 through 23. For additional information, write to: HUGHES PRODUCTS • Electron Tubes, International Airport Station, Los Angeles 45, California.

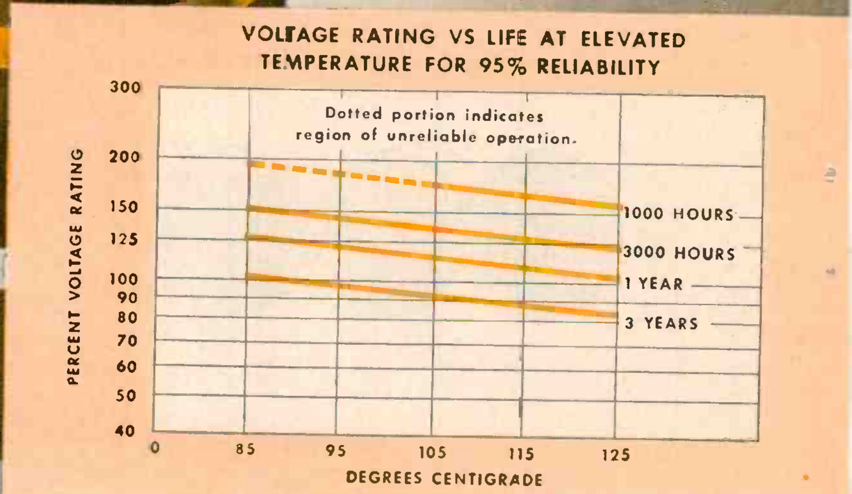
Creating a new world with ELECTRONICS

HUGHES PRODUCTS

* *Trademark of Hughes Aircraft Company*

CAPACITORS





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

Solve critical space and temperature problems with subminiature PVZ* capacitors

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

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

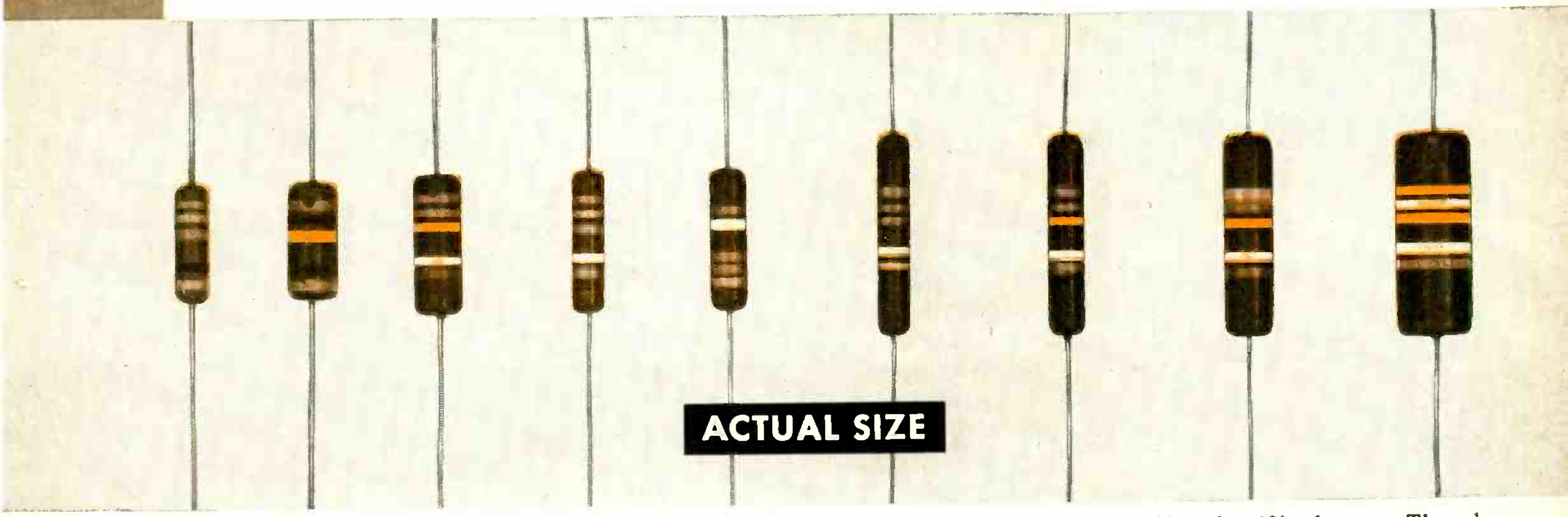
Completely solid after molding, PVZ capacitors feature the following advantages:

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

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

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

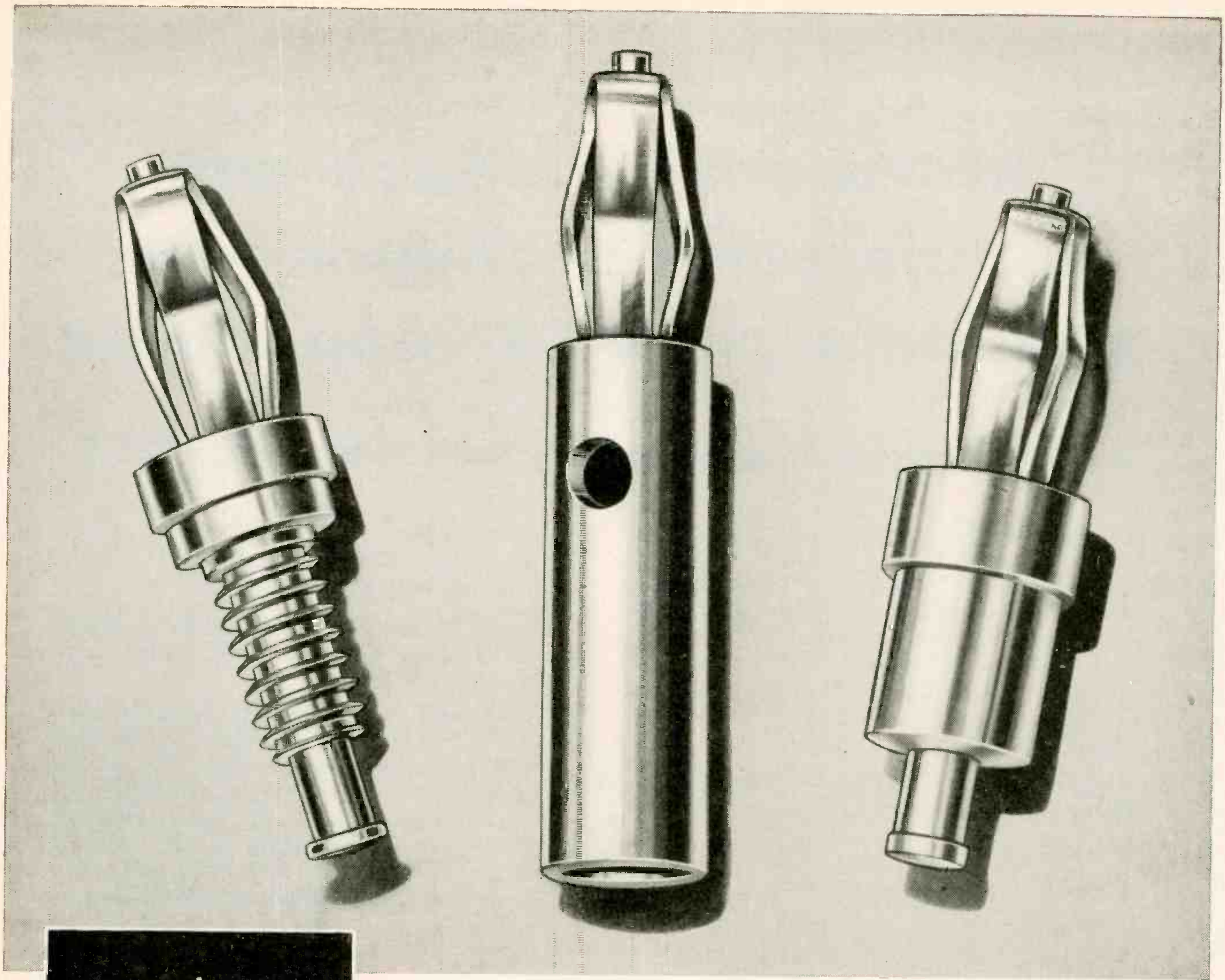
*Trademark of the General Electric Co.



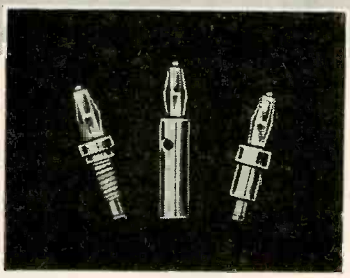
PVZ CAPACITORS range in size from .175″ diameter by .625″ length to .375″ diameter by 1.0625″ length. Capacitance ratings are available with ±20%, ±10%, and ±5% tolerances. The color code indicates microfarads, volts, and capacitance tolerance.

Progress Is Our Most Important Product

GENERAL ELECTRIC



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

Circle 46 Readers Service Card

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

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

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

POLYETHYLENE MOUNTING FOOT

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

NYLON SNAP-IN NUT

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

QUICKEY FASTENER

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

THREAD CUTTING FASTENER

Re-usable, self-locking, vibration-proof fastener cuts clean, deep threads on unthreaded chrome-plated studs. Available for 1/8", 3/16" and 1/4" studs.

PLUG BUTTONS

Snap into 1/8" to 3" dia. holes. Can be embossed with ornamental or functional designs . . . various finishes, shapes and sizes.

FISHTAIL RATCHET PLATE

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

TRIMOUNT STUDS

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

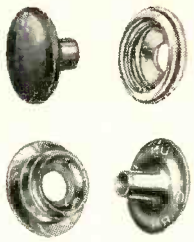
V-LOCK TEENUT

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

SOL-A-NUT

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

DURABLE DOT FASTENER



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

CARR FASTENER COMPANY

Division of United-Carr Fastener Corp., Cambridge 42, Massachusetts

MAKERS OF **DOT** *FASTENERS*

Circle 47 Readers Service Card

Phelps Dodge modern

fits new

First for Lasting Quality—from Mine to Market!

enamel wire

exacting coil designs!

New processes and controls assure uniform quality:

1 Uniform over-all size—for uniform windings.

2 Uniform softness with high tensile strength for tighter windings, reduced breakage.

3 Uniform spooling, larger packages for lower-cost windings.

4 Uniform property balance for good flexibility, solvent resistance and dielectric strength.

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

Visit Our Booth No. 1111 at WESCON Show, August 20-23, 1957

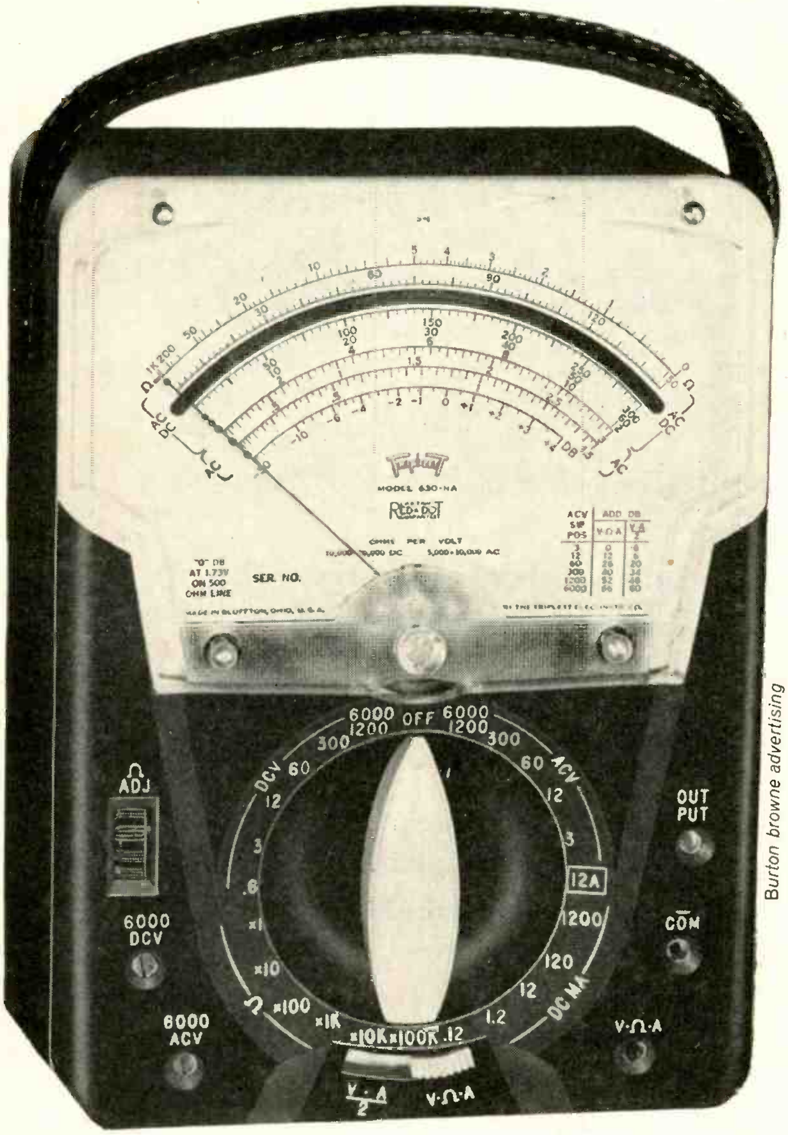
PHELPS DODGE COPPER PRODUCTS
CORPORATION

INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA

Circle 49 Readers Service Card

Model 630-NA

Volt-Ohm-Milliammeter $74.50



Burton browne advertising

All this in one V-O-M

70 Ranges... nearly double those of conventional testers

Meter protection against overloads

Frequency compensated... for accurate readings through 20,000 cps audio.

Highest accuracy—1½% DC to 1200 volts, 3% AC to 1200 volts: mirror scale and knife-edge pointer to eliminate parallax.

AC-DC on same scale.

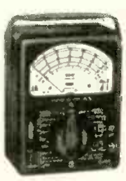
Reads 0.1 ohms through 100 megohms.

Incorporating the famous Triplett SINGLE KNOB CONTROL, Model 630-NA comes complete with snap-out batteries (standard D cell for longer life), test leads, alligator clips, non-skid rubber feet and thorough instruction book. OTHER LEADING TRIPLETT FEATURES: Low resistance contacts through banana plugs—completely insulated heavy molded case—clear plastic front with longer easily readable scales—standard sensitivities as used in electronics field.

TRIPLETT ELECTRICAL INSTRUMENT COMPANY • Bluffton, Ohio

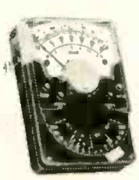
THE MIGHTY NINE V-O-M LINE

631
Combination V-O-M—VTVM



630
The Popular All-Purpose V-O-M

630-A
A Good Lab and Production Line V-O-M

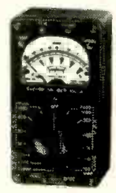


310
The Smallest Complete V-O-M With Switch

630-T
For Telephone Service

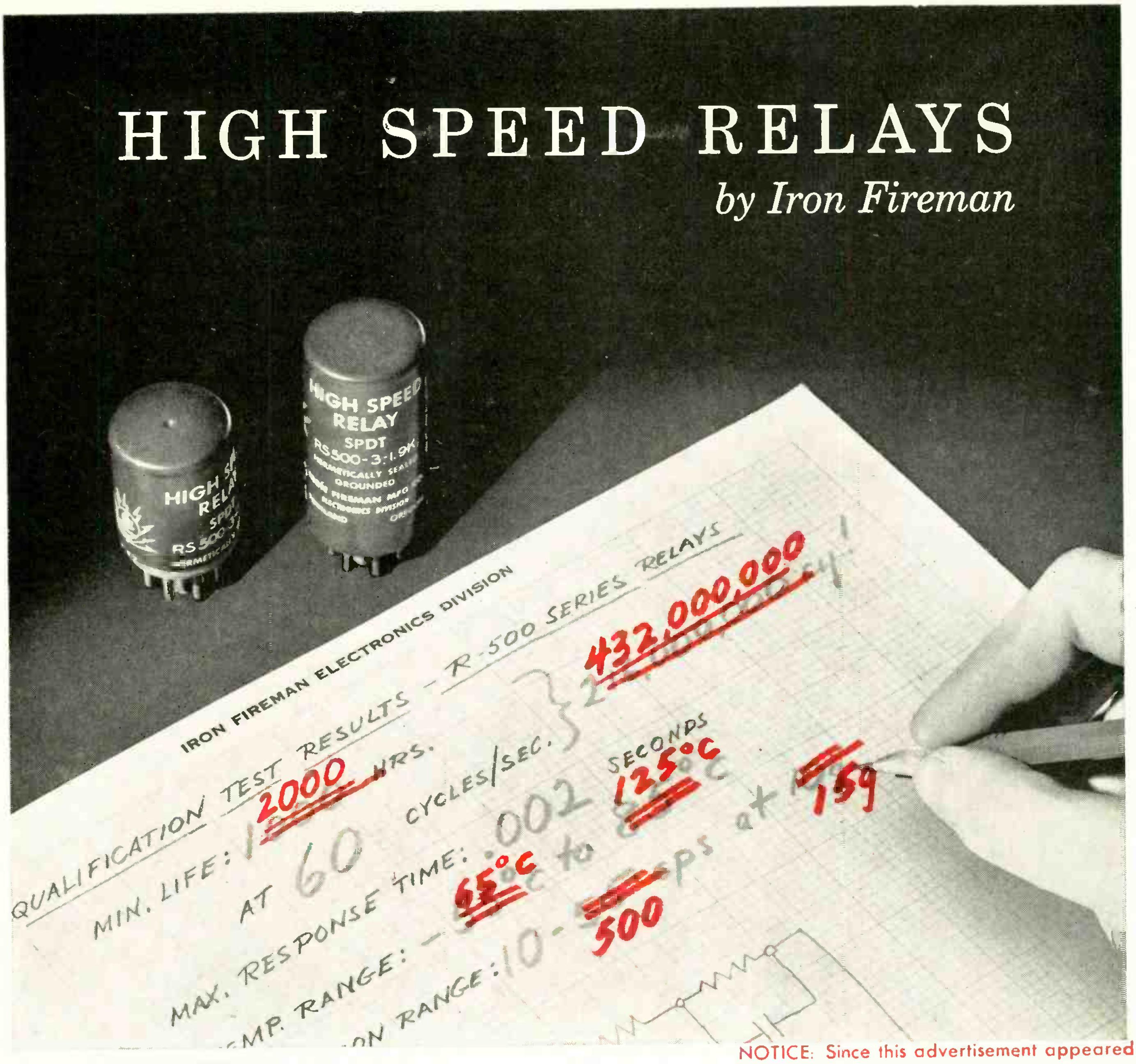
666-HH
Medium Size For Field Testing

625-NA
The First V-O-M With 10,000 Ohms/Volt AC



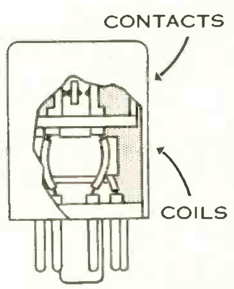
666-R
Medium Size With 630 Features

Circle 50 Readers Service Card



NOTICE: Since this advertisement appeared last month, continued testing to more rigid requirements have given the results shown in red.

TWO SEALED CELLS



A brand new design

This Iron Fireman high speed relay is a completely new design. It features improved performance and reliability.

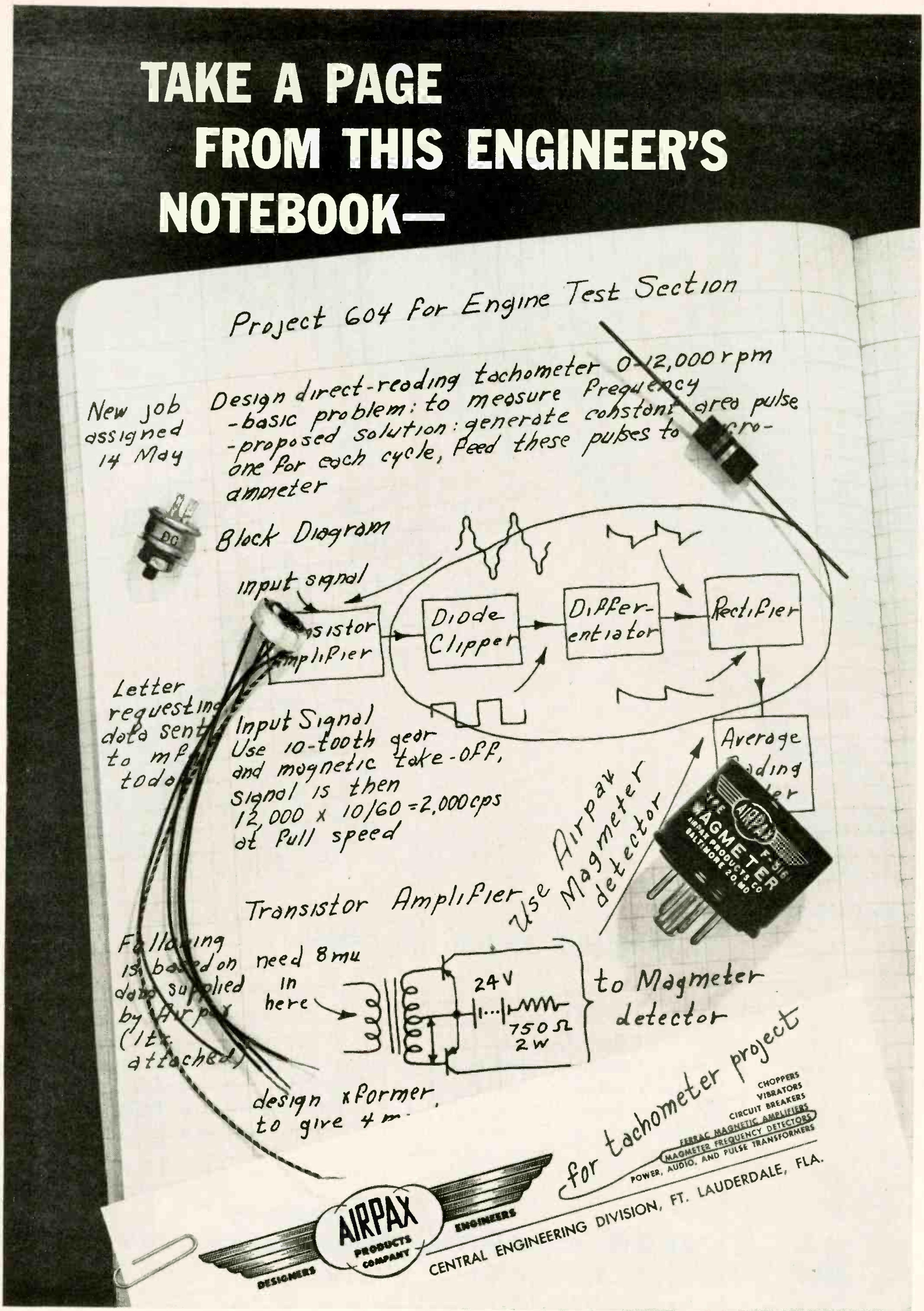
The contacts are enclosed in a separate hermetically-sealed compartment within the outer case—which is also hermetically sealed. This double sealing in inert gas eliminates any possibility of contact contamination. Not even volatile emanations from warm coils or wires can affect the contacts.

This is but one of the factors contributing to exceptional service life. Complete performance data available on request. Write to the address below for information on high speed or sensitive relays.

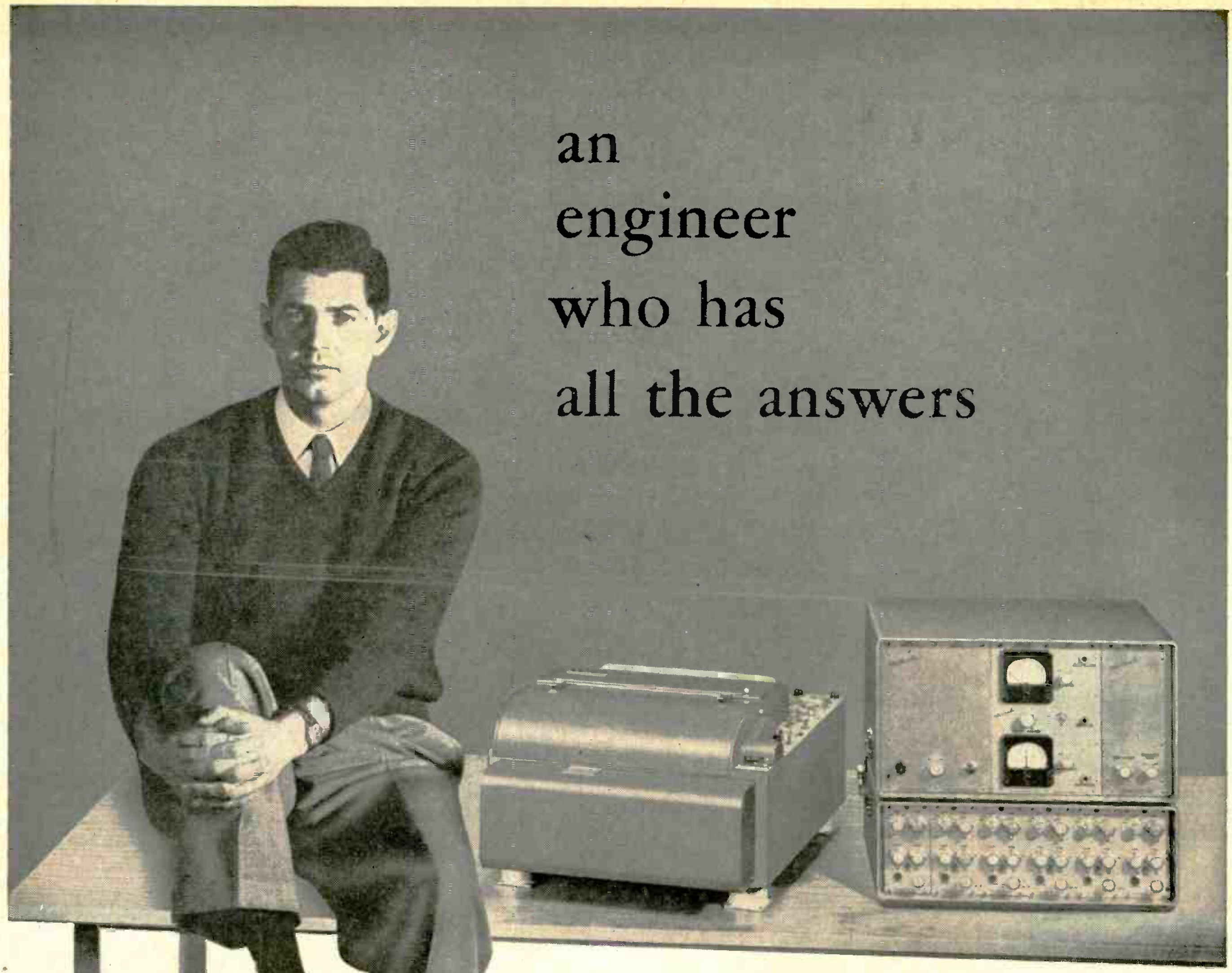
IRON FIREMAN® *Electronics* DIVISION

2838 S. E. NINTH AVENUE, PORTLAND 2, OREGON

Circle 51 Readers Service Card


TAKE A PAGE
FROM THIS ENGINEER'S
NOTEBOOK—
Project 604 for Engine Test Section
New job assigned 14 May
Design direct-reading tachometer 0-12,000 rpm
-basic problem: to measure frequency
-proposed solution: generate constant area pulse
one for each cycle, feed these pulses to
ammeter
Block Diagram
input signal
Diode Clipper
Differentiator
Rectifier
Average
Letter requesting data sent
Input Signal
Use 10-tooth gear
and magnetic take-off,
signal is then
12,000 x 10/60 = 2,000 cps
at full speed
Use Airpax Magmeter detector
Transistor Amplifier
need 8 mu in here
24 V
750 Ω 2 W
to Magmeter detector
design xformer to give 4 m
attached)
for tachometer project
AGMETER
AIRPAX
BALTIMORE 20, MD
CHOPPERS
VIBRATORS
CIRCUIT BREAKERS
FERRAC MAGNETIC AMPLIFIERS
MAGMETER FREQUENCY DETECTORS
POWER, AUDIO, AND PULSE TRANSFORMERS
DESIGNERS
AIRPAX
PRODUCTS COMPANY
ENGINEERS
CENTRAL ENGINEERING DIVISION, FT. LAUDERDALE, FLA.

an engineer who has all the answers



This engineer is fully equipped, with his Heiland Dynamic Recording System, to record a complete range of phenomena . . . strain, vibration, pressure, acceleration, temperature, impact and many others.

The 700-C Series Recording Oscillographs can put up to 60 traces on 12″ wide recording paper at speeds from .03 to 144 in. per sec., with frequency response from DC to 3,000 cycles per second. Power supply is 28 volts DC or 115 volts AC. Both the oscillograph and the amplifier system (either carrier or linear/integrate) may be bench, shock, or vibration mounted, or installed in a standard relay rack without modification.

Whether your measuring and recording needs are for dynamic testing of guided missiles or aircraft; structural tests of buildings, bridges or ships; performance tests of heavy machinery or electrical equipment; riding quality evaluation of automobiles, trucks, or railroad coaches; physiological or medical research; or similar applications in all fields of industry, science and engineering—it will pay you to let a Honeywell Industrial Engineer show you why the Heiland System is unmatched for sensitivity, stability, and dependable performance. Call your nearest Minneapolis-Honeywell Industrial Sales Office today . . . *and* write for Bulletins 101K and 701K.

MINNEAPOLIS
Honeywell
HEILAND INSTRUMENTS

H HONEYWELL

5200 E. EVANS AVENUE • DENVER 22, COLORADO

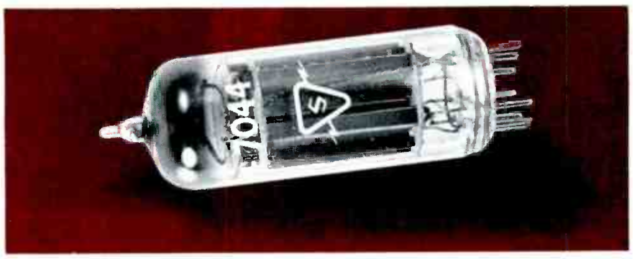
Circle 53 Readers Service Card

Electron Tube News —from SYLVANIA

Meeting Industry's New Challenges—Everywhere in Electronics

IN COMPUTER TUBES . . .

Sylvania releases another new computer tube, the 7044, featuring high perveance



Advanced duo triode computer tube released by Sylvania, type 7044, features high perveance and dissipation capabilities and for many applications is a replacement for type 5687. Optimized design featuring leakage slots and the best alloys to preclude interface resistance contribute to a long and stable life.

Type 7044 supplements Sylvania's extensive line of tubes for computer applications which includes types 5844, 5963, 5964, 5965, 6211, 6350, 6814, 7AK7, 6145, 6888 and 5915A.

CHARACTERISTICS

RATINGS:

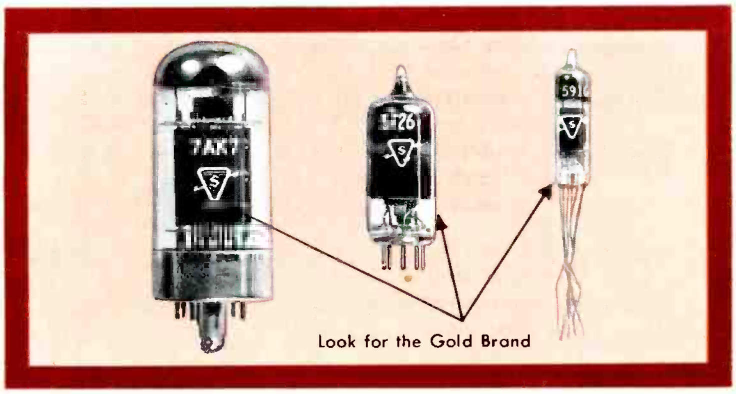
Heater Voltage	(Series)	12.6 Volts
	Parallel	6.3 Volts
Heater Current	(Series)	450 Ma
	Parallel	900 Ma
Plate dissipation per section		4.5 Watts
Total plate dissipation		8.0 Watts

TYPICAL CHARACTERISTICS:

Plate Voltage	120 Volts
Grid Voltage	−2 Volts
Plate Current	36 Ma
Transconductance	10,000 umhos
Amplification Factor	19
Plate Resistance	1,900 Ohms
Grid Voltage for Ib = 200 ua (Eb = 150V)	−12 Volts
Plate Current (Eb = 90 V Ec adjusted for Ic = +250 ua)	50 Ma

IN RELIABLE TUBES . . .

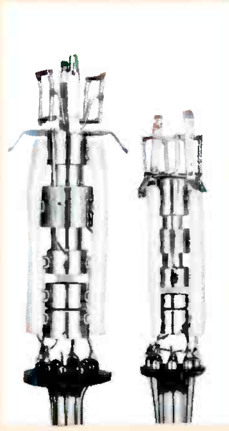
Sylvania's Gold Brand means extra dependability and reliability



Now all Sylvania reliable receiving tubes are distinguished by the famous Gold Brand that already identifies the premium dependability of Sylvania subminiatures. The Gold Brand assures you of airborne and computer tubes with extra accuracy and dependability.

Sylvania Gold Brand tubes meet extra critical specifications throughout the entire tube-making operation. This extensive quality control is possible because Sylvania itself furnishes nearly every tube part. As a result, extra-critical specifications can be applied to the production of components throughout the manufacturing of tubes.

IN TV PICTURE TUBES . . .



New Sylvania non-ion trap electron guns for 90° and 110° deflection with electrostatic focus.

New non-ion trap electron guns reduce tube length, eliminate external ion trap magnet

Sylvania, trendsetter in electron tube design, offers two new improvements for television picture tubes:

- **For 110° deflection—a small neck, non-ion trap gun with electrostatic focus**
- **For 90° deflection—a standard neck non-ion trap gun with electrostatic focus.**

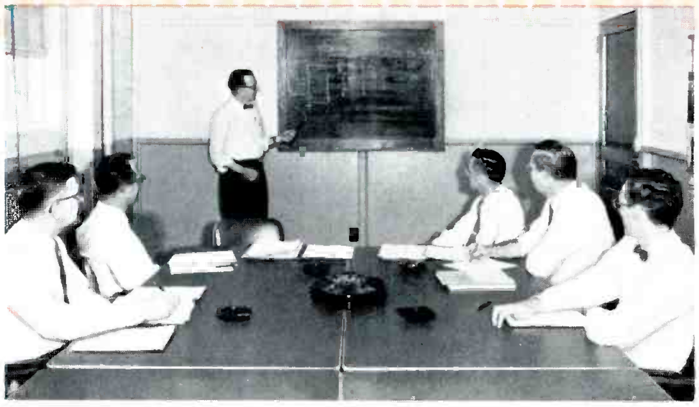
Both new guns permit reductions in overall tube length of up to a full inch. They also make possible important cost savings by eliminating the need for external ion trap magnets.

The small neck gun for 110° deflection is available in the conventional base design with flexible stem leads or in the rigid pin base design with nylon cap.

Meeting Industry's New Challenges—

IN DYNAMIC TESTING . . .

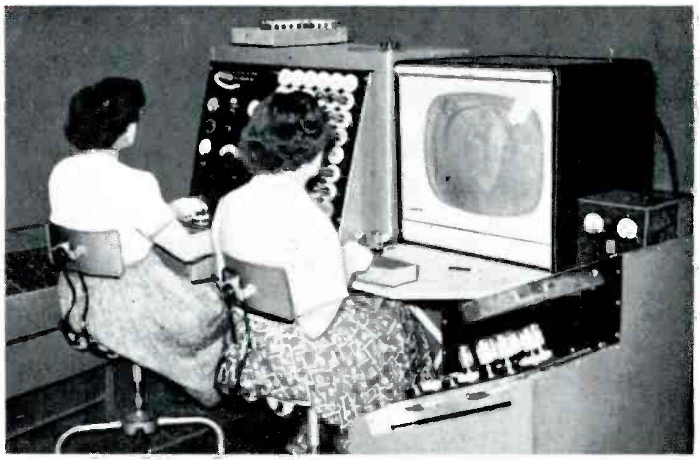
Sylvania expands its Dynamic Testing Program to include every key TV type



JEMC group, comprised of top engineering and production personnel in Sylvania's receiving tube operations, sets standards for the Dynamic Testing Program.

Sylvania's expanded dynamic testing program now covers every important family of tube types used in today's critical TV receiver circuits. Individual Sylvania receiving tube types are evaluated in actual circuit environments that simulate current TV set designs. This extra quality check substantially reduces line rejects for receiver manufacturers and gives greater reliability and improved TV set performance at lower cost.

Sylvania's Joint Engineering and Manufacturing Committee, JEMC, meets weekly to keep testing specs current. The group, made up of key engineering and manufacturing management personnel, establishes specifications that assure better performance levels under actual operating conditions.



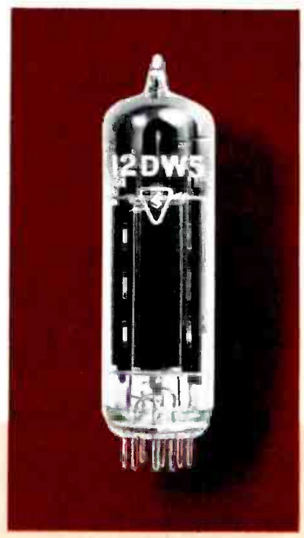
Sylvania tubes undergo arc tests in TV receiver circuits as part of its extensive Dynamic Testing Program.

IN ADVANCED DESIGN . . . new filament designed for 1B3GT and its new short version, type 1G3GT

New heater design shown at right

Sylvania introduces a new coil filament design that improves the performance and extends the life of the standard 1B3GT. This new development replaces the conventional filament shield with a hooked coil design that reduces shorts and arcing and increases emission.

Sylvania's new 1G3GT, a miniaturized version of the 1B3GT, incorporates the new filament coil design, is a full ½ inch shorter in overall length, and exhibits the same characteristics as the 1B3GT.



IN 110° DEFLECTION TUBES . . .

New TV Deflection Pentode

Sylvania offers a new tube development, type 12DW5, to meet the requirements for large-screen 110° vertical deflection. It also has application in 110° off-the-line circuits.

This new beam power amplifier with a T 6½ bulb size, is an original Sylvania design. It is already creating interest in the TV industry for many 1958 receiver designs by leading television manufacturers.

For series-string circuits, the new 12DW5 features high peak-positive plate voltage, high zero bias current and adequate plate and screen dissipation. To supplement the 12DW5, Sylvania offers the 6DW5 with a 6.3-volt, 1.2-ampere heater characteristic.

Vertical Deflection Ratings (Pentode Connected)	
Plate Voltage	330 Volts Max.
Grid No. 2 Voltage	220 Volts Max.
Peak-Positive Pulse	
Plate Voltage (absolute max.)	2200 Volts
Plate Dissipation	11 Watts Max.
Screen Dissipation	2.5 Watts Max.
Zero Bias Characteristics (Instantaneous Values)	
Plate Voltage	60 Volts
Grid No. 2 Voltage	150 Volts
Grid Voltage	0 Volt
Plate Current	260 Ma
Grid No. 2 Current	20 Ma

Everywhere in Electronics

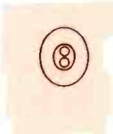
—IN GUIDED MISSILE TYPES

. . . Structural advantages earmark Sylvania tubes expressly designed for guided missile use

Possibly the biggest single factor behind the wide acceptance of Sylvania's Guided Missile subminiature tubes is the fact that each type was designed from start to finish under a new philosophy born of thorough investigation of Guided Missile requirements.

From closer control of raw materials to tighter parts tolerances and new manufacturing techniques, nothing was spared to design and produce the most missile-worthy tubes available.

Wider grid-to-cathode spacing



Consistent with tube functioning requirements optimum grid-to-cathode spacing provides greater protection against flicker shorts and minimizes vibrational noise.

Adequate mica bearing surfaces

Tight, solid fitting is achieved between mica and cathode and mica and grid side rods through close parts tolerances and optimized bearing surface between the parts and mica.

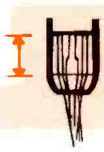
Shortest mica-to-mica spacing

Shortened mount adds structural rigidity and relocates natural resonances beyond the frequency range encountered in missile operations.

Plate tabs and bent stems

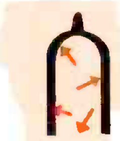
Whenever possible, plate tabs are used and stem leads are bent, eliminating extra connectors and welds. A more rigid mount and improved reliability are achieved.

Lowest mica-to-header spacing



This structural advantage is inherent in the button-header design which makes possible shorter spacings without interfering with tube assembly.

Special bulb glass



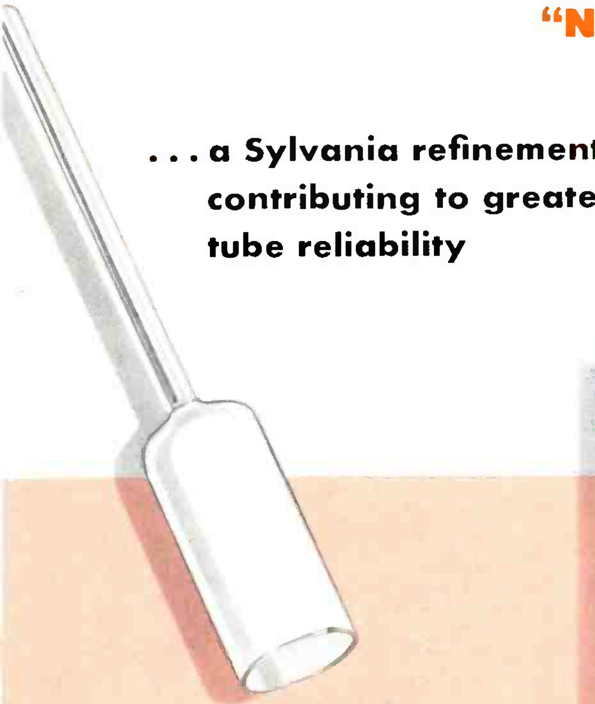
Special new glass is employed in the guided missile tubes. The new hard glass makes possible bulb temperatures of 250° C. at a plate voltage of 250 volts.

"NEW CONCEPT" BULB

. . . a Sylvania refinement contributing to greater tube reliability

The new concept bulb is a typical Sylvania refinement which places greater controls over raw materials and physical tolerances.

From header to top seal, the new concept bulb is controlled for uniform wall thickness. The combination of more uniform bulb and closer mica spacing tolerances provides a tighter fitting, more rugged mount.



Uniform wall thickness is maintained through "new concept" bulb fabricating techniques.

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BUSINESS REPLY CARD
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SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway
New York 19, N. Y.

Meeting Industry's New Challenges —Everywhere in Electronics

IN 12-VOLT HYBRID TYPES . . .

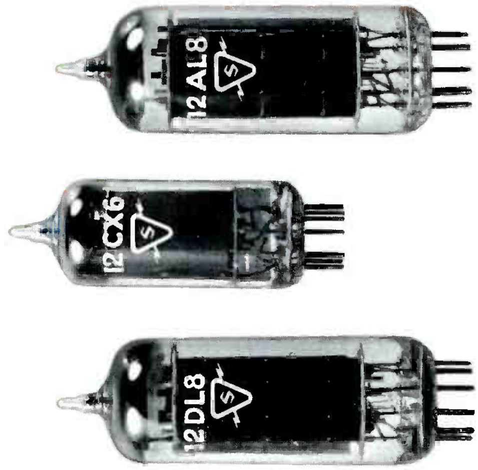
Sylvania's three new tubes, 12CX6, 12AL8 and 12DL8, meet needs of 1958 auto radio designs

Three new 12-volt hybrid receiving tubes from Sylvania are becoming the mainstays in 1958 auto radio designs. They are types 12CX6, 12AL8 and 12DL8.

Type 12CX6, a new rf-if pentode, is a Sylvania original design that is becoming one of the most popular auto tubes in 1958 lines. It has high transconductance of 3,100 micromhos and high plate resistance which is relatively unaffected by variation in the automobile supply voltage.

The 12AL8 is a medium mu triode and space-charged tetrode. It can be used as an audio amplifier and a transistor driver, or a trigger tube in remote control sets.

The 12DL8 is a new duo diode and space charge tetrode for transistor driver service and other applications.



Three new 12-volt hybrid tubes from Sylvania for 1958 auto radio designs.

IN SPECIAL CRT'S

Expanding CRT program produces Type 5UP1— more to come as development continues

Sylvania announces the availability of the Type 5UP1 general-purpose cathode-ray oscilloscope tube. It's among the first in Sylvania's plans to enter the special CRT program on a full-scale basis. Already in various stages of development and planned for early production are such cathode-ray types as the 3JP7, 3RP1, 5AHP7A, 7ABP7A and 12ABP7A.

To meet its projected goals, completely separate development and production facilities have been established to meet industry's special needs.

SYLVANIA

Please send additional information on the items checked below.

- ☐ Computer type 7044
- ☐ Type 12DW5—6DW5
- ☐ Type 1G3GT
- ☐ Guided Missile types
- ☐ Hybrid auto radio types 12CX6, 12AL8, 12DL8
- ☐ Special purpose cathode-ray tubes
- ☐ Non-ion trap TV picture tubes

Name ____________________

Address ____________________

Company ____________________

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

NO MORE EXTERNAL BOOSTER AMPLIFIERS...

with the new combination resolver-booster by Reeves INSTRUMENT CORPORATION

An outstanding advance in MINIATURIZATION without sacrifice of performance or precision.

Shown FULL SIZE in the illustration above, this latest Reeves achievement in miniaturization for airborne applications takes up a fraction of the space occupied by a conventional resolver with external boosters. Yet performance, accuracy and dependability are in every way equivalent or better.

The new Reeves Combination Resolver-Booster consists of the time-proven R151 Precision Resolver with two PLUG-IN TRANSISTORIZED BOOSTER AMPLIFIERS built onto it as shown. The amplifiers provide standardization for transformation ratio and phase shift over a wide range of temperatures. Specifications given are maintained for production units without culling. Additional data on request.

specifications

Transformation ratio: 1.000 $\pm$ .001
Phase shift: 0° $\pm$ 3'
Functional accuracy: 0.1%
Input impedance: over 8 megohms
Frequency: 400 c.p.s. $\pm$ 5%
Max. amplitude: 14 V. r.m.s.
Temp. range: —55° C. to 80° C.
Power requirements:
30 V. d.c. @ 6 ma. per amplifier

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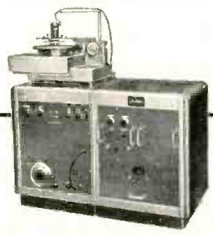
BOOTH NOS. 2421-2422
WESCON SHOW
San Francisco, August 20-23

REEVES CONTINUOUS RESOLVER CHECKER



Provides continuous 360° check on resolver functional accuracy, and yields permanent record of results.

Reeves
INSTRUMENT CORPORATION

9RV57

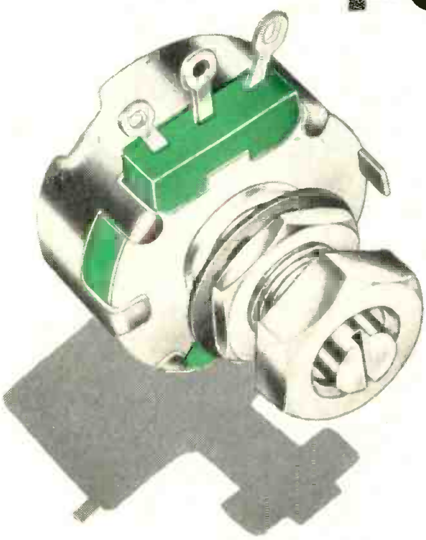
REEVES INSTRUMENT CORPORATION

A SUBSIDIARY OF DYNAMICS CORP. OF AMERICA, 201 EAST 91st ST., NEW YORK 28, N. Y.

MOLDED

COMPOSITION ELEMENT POTENTIOMETERS

Twice Actual Size



1. Pre-molded and pre-selected resistance element.
2. Molded control base affording exceedingly low conductance, particularly in the presence of high humidity.
3. Single-member carbon contact, providing contact with resistance element and collector terminal, simultaneously.
4. No metal-to-metal movable contacts. Exceptionally long life.
5. "Zero backlash" or "Zero rock" shaft-to-contact assembly. Provides maximum order of "setability."
6. Gold-plated terminals insure solderability.
7. Shafts provided with grease seal, thus excluding moisture.
8. Flexible design readily permitting various mechanical adaptations.
9. No visible openings.
10. No rivets. Terminals permanently molded in resistance element and control base.
11. Mating surfaces of housing are sealed to prevent entrance of dust and moisture.
12. Full 2-watt rating at 70° C.
13. High order of resistance stability.
14. Salt-spray corrosion resistant.

Write for detailed literature. Let us quote on your requirements.

CLAROSTAT ®

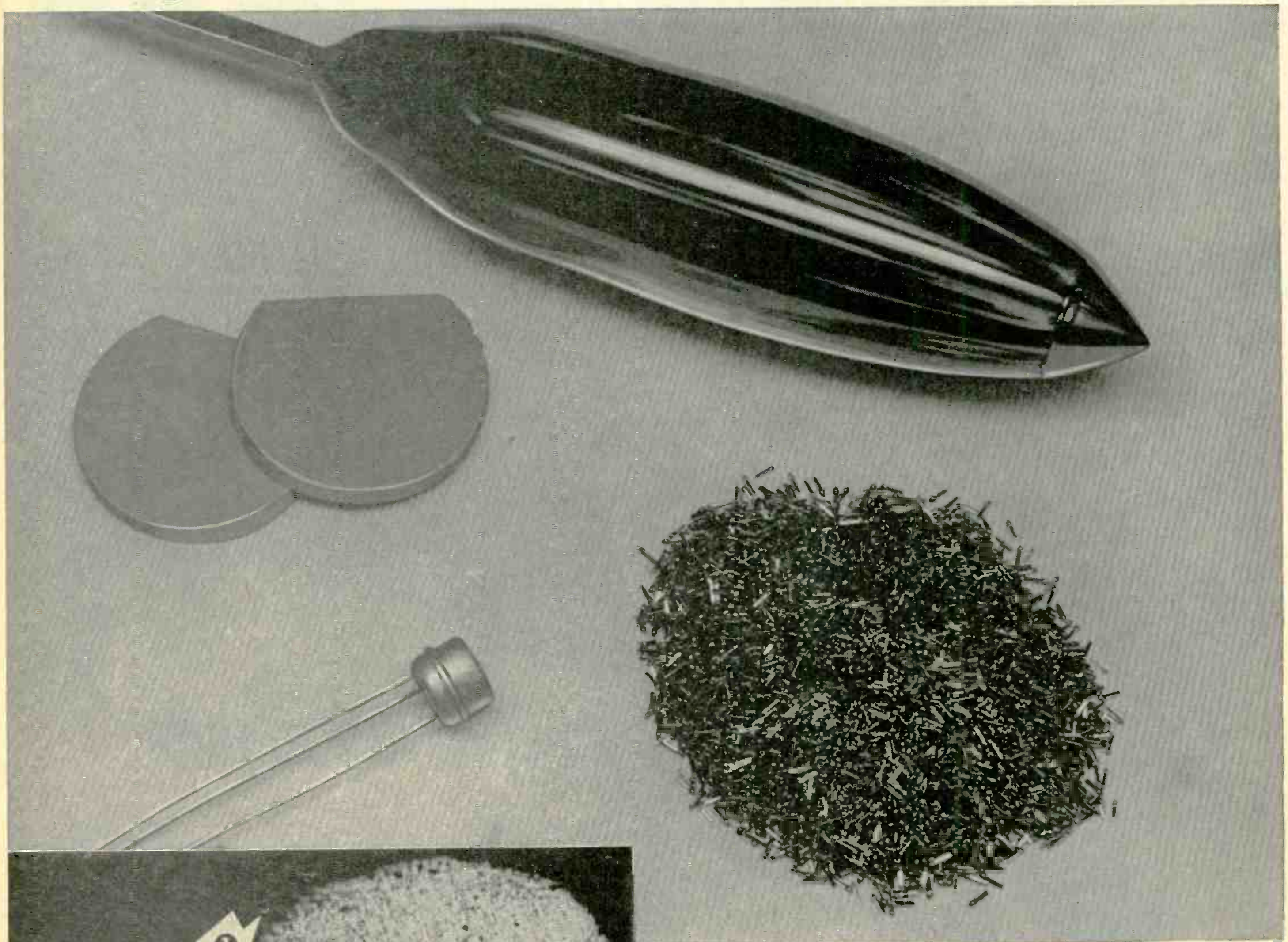
CLAROSTAT MFG. CO., INC., DOVER, NEW HAMPSHIRE

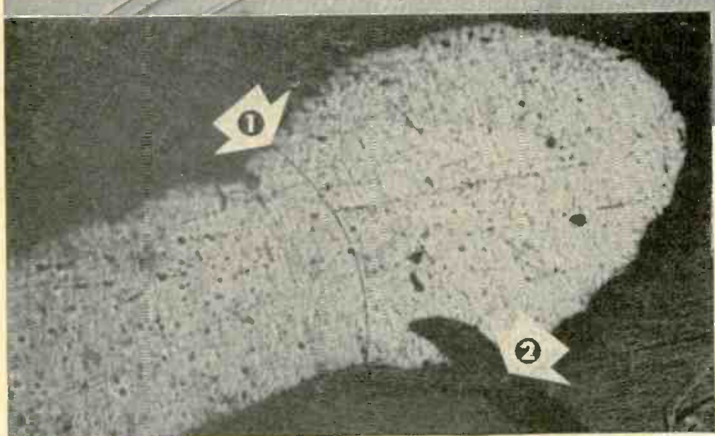
In Canada: **Canadian Marconi Co., Ltd., Toronto 17, Ont.**

Circle 72 Readers Service Card

Using the diffused-meltback process

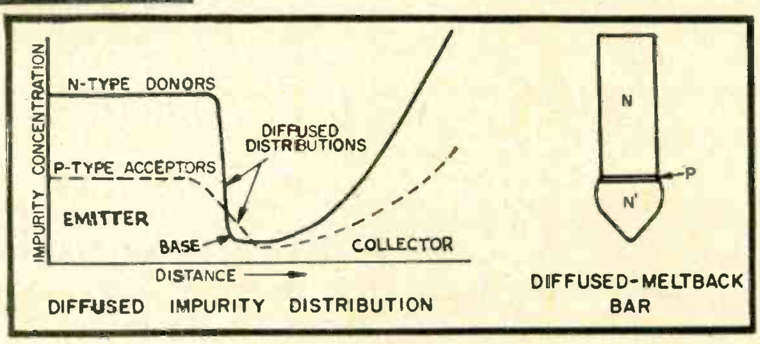
G.E. gets the most from silicon...





Before going through the diffused-meltback operation, a crystal of silicon is sawed into wafer-form: wafers are then diced to produce 4000 to 5000 individual silicon bars. Photomicrograph at left shows size-comparison of a silicon NPN bar, or pellet, with human hair (Arrow 2). "Tear drop" at end of bar is formed during meltback process. Micro-thin base, or "P", region (Arrow 1) is created through G-E diffusion technique. Base regions of 2-micron size are made with relative ease.

Curves illustrating impurity distribution after diffusion. P-type impurities in the high concentration side of the meltback junction diffuse, within solid semiconductor, into "plateau" region of low impurity concentration. High resistivity "plateau" contributes to elimination of punch-thru effects.



to put the most into transistors

High degree of uniformity and control in junction formation. General Electric's diffused-meltback process was developed by Dr. I. A. Lesk of the G-E Advanced Semiconductor Laboratory. The development came about as the result of Dr. Lesk's efforts to create a transistor manufacturing process that would yield high-quality results at reasonable cost.

Not only does the G-E diffused-meltback process result in a maximum number of transistors from a single crystal (4000 to 5000 NPN transistors), *but it offers an extremely high degree of uniformity and control in transistor junction formation.*

Opens the door to high frequency performance. Diffusion of a melted-back silicon bar, or pellet, is the final step in the diffused-meltback process. It's the stage in which the micro-thin base, or "P" region is formed, establishing the final NPN transistor structure. Because the actual diffusion is accomplished over a high temperature heating cycle lasting several hours, the need for split-second accuracy is eliminated. The result is a high degree of process control.

By proper choice of the initial impurity concentrations and the time and temperature of the diffusion cycle, heavily-doped base regions as thin as 2 microns are easily obtained. *These micro-thin, uniform base regions are the "open-sesame" to extremely reliable high frequency transistor performance.*

Ordering Data—G-E Silicon NPN Transistors

High Frequency Amplifier Type			
ask for:	**2N429**	(formerly 4JD4A2)	
Computer DCTL Type			
ask for:	**2N430**	(formerly 4JD4A3)	
General-Purpose Amplifier Types			
ask for:			**Beta**
	2N431	(formerly 4JD4A4)	9 to 30
	2N432	(formerly 4JD4A5)	20 to 55
	2N433	(formerly 4JD4A6)	45 to 100

High current gain. Silicon NPN transistors feature inherent high current gains and high frequency cut-offs. The diffused meltback process permits mass production, since it combines the principles of impurity segregation and solid-state diffusion.

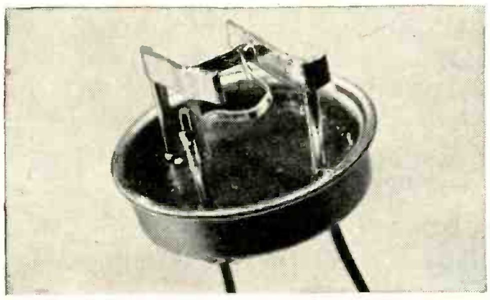
G-E silicon NPN transistors are nominally rated for 25 megacycles, but with useful gain to 50 megacycles—the highest frequencies offered by any mass-produced silicon NPN triode on the market today. All production units are aged at extremely high temperatures for over 150 hours. This is to provide maximum stability of I_{co} and current gain (beta).

The header assemblies of G-E silicon NPN transistors are constructed of high-purity materials. A gold-silicon alloy is used for end connections: the base lead is pure aluminum. There are no solders or fluxes, eliminating any danger of transistor "sleeping sickness" caused by corrosion at soldered junction points.

Outstanding For Switching Applications and Linear Amplifier Use. The gold-alloy mountings, with a melting temperature of over 350°C represent the lowest melting point of the entire transistor assembly structure. The G-E Series 4JD4A silicon transistors provide reliable operation to 150°C, with storage temperatures to 200°C.

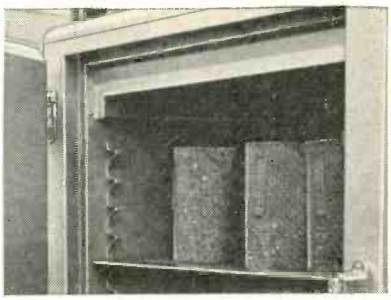
With well-controlled high frequency characteristics and a low saturation resistance of 20 ohms, G-E silicon NPN transistors are "naturals" for switching applications and linear amplifier use.

Would you like complete specification information? Please contact your nearest G-E Semiconductor Products district office, or write to General Electric Company, Semiconductor Products, Section S2587, Electronics Park, Syracuse, N. Y.



View of uncapped G-E silicon NPN diffused-meltback transistor, showing mounted silicon bar with aluminum base lead connected. Bar ends attached using a gold-alloy mounting technique. No solders or fluxes are used.

Diffusion furnace. Operator places quartz vials, with large quantity of silicon bars, in furnace. Diffusion occurs through high-temperature heating cycle lasting several hours.



An aging oven in which G-E silicon NPN transistors are aged at extremely high temperatures for over 150 hours. Provides maximum stability of I_{co} and current gain (beta).

CUSTOMER CONFIDENCE 10th ANNIVERSARY SEMICONDUCTOR PROGRESS

Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 74 Readers Service Card

Another Application for FERRITES

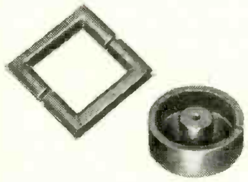
ARC selects FERRAMIC® CORE for Automatic Direction Finder

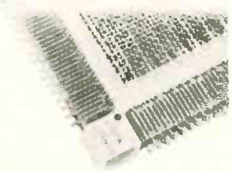
Streamlined loop design saves weight, reduces air drag and increases sensitivity

Aircraft Radio Corp. selected General Ceramics Ferramic "E" Material for their new sub-miniature direction finder because it permitted a new concept of aircraft antenna design. Weight reduction of 80%, less air drag due to elimination of the cumbersome air core loop, and 50% lower cost were accomplished. Sensitivity was greatly increased. When your application involves magnetic material from 10 kcs. to 20,000 mcs. — ask the General Ceramics engineering advisory service for help in solving your problem. Address inquiries to General Ceramics Corporation, Keasbey, N. J.—Dept. E.

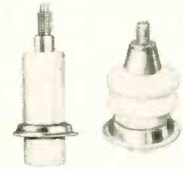
GENERAL CERAMICS

Industrial Ceramics for Industrial Progress... Since 1906


FERRAMIC CORES


MAGNETIC MEMORY CORES AND PLANES


PRECISION STEATITES


"ADVAC" HIGH TEMPERATURE SEALS


SOLDERSEAL TERMINALS

NEWS ABOUT VARIAN STALOS *

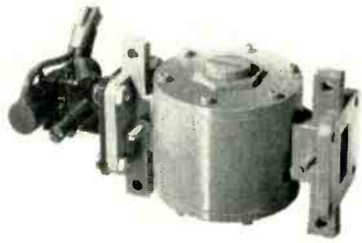
NEW WIDE TUNING RANGE
Cavity tunable, depending on klystron used, between 8200 and 10,000 Mc.

HIGH Q STABILITY

* Frequency stabilized local oscillators

without electronic components

X-Band Stalo Cavity VA-1280B
Shown with VA-201B klystron



X-Band Stalo Cavity VA-1281B
Shown with VA-201B klystron

Here's a line of High Q cavities offering commercially practical frequency stabilized local oscillators utilizing direct cavity stabilization. These Varian Stalo cavities provide a high degree of short time frequency stability.

As an example, with the combination of a VA-1280B cavity and VA-201B klystron, a short term frequency stability of approximately one part in 10^9 has been achieved. The stabilization factor of the cavity is completely independent of the oscillator fluctuations or external disturbances — an important advantage over stabilization systems utilizing the feedback principle. Elimination of all electronic components except the klystron oscillator also affords greater reliability and longer life.

Varian Stalo Cavities, in models for C-band through K_a-band, offer stabilization factors (ratio of oscillator modulation sensitivity to modulation sensitivity of the stabilized oscillator) from 15 to over 100. Important applications include stabilization of signal sources in high power klystron transmitters . . . airborne uses in conjunction with receiver local oscillators . . . laboratory and test applications. Used with Varian's new highly stable reflex klystron oscillators, Varian Stalos provide stability comparable to that of many crystal controlled oscillators.

The combination of a VA-1281B cavity and a VA-201B reflex klystron will provide excellent long term stability. A long term stability of approximately ±1 Mc, over a 100°C ambient temperature range, can be achieved with a well-regulated power supply.

Cavities designed to meet specific requirements are available on special order. Complete Stalo packages are also available including power supply and klystron, with single-knob control over a limited tuning range.

COMPLETE TECHNICAL DATA AND SPECIFICATIONS are now available.

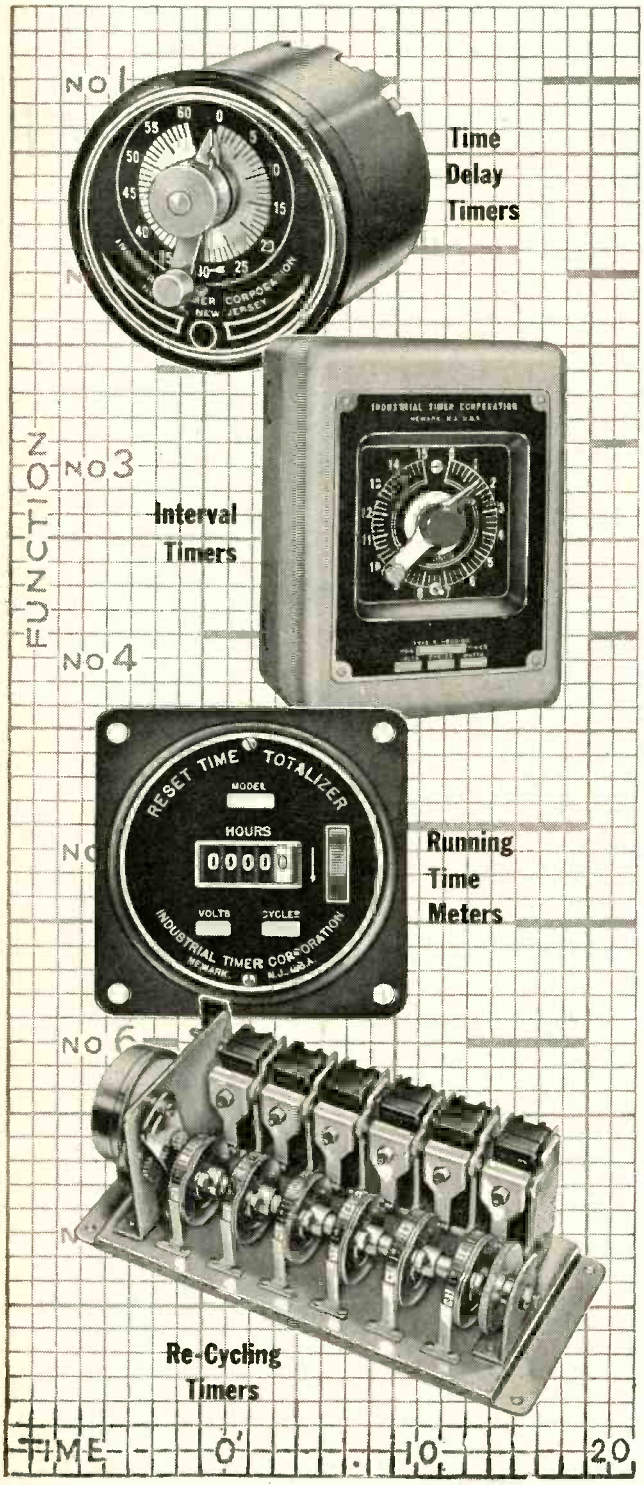
Your inquiry is cordially invited.

THE MARK OF LEADERSHIP

VARIAN associates
PALO ALTO 1, CALIFORNIA
Representatives in all principal cities

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, R. F. SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

Need a "SPECIAL" TIMER ...need a "STANDARD"?



Here's why WE can give you the fastest service

When you want a timer, you want one that fits your needs 100% — and you want it *fast*. Get in touch with Industrial and you'll get both. Because:

In our 20 years of experience, we have developed over a *thousand combinations* from our 17 basic types, to meet the widely varying needs of our customers. Therefore — many jobs that would seem to require a "special" timer are in fact a "standard" timer with us. Here is *one* tremendous saving of time for you.

When you *do* need a special timer, this same wealth of experience goes to work for you at once to design it. Our Engineering Department not only originates new designs, but also develops modifications for that purpose. That's why requests for special timers can be filled without delay.

Each method — designing for a standard timer or for a special timer — has its advantages. Designing for an already available timer means lower costs, faster service, simplified replacements.

Designing for a special timer has its advantages too. It means you'll fulfill your needs 100% — no need to limit your designing horizons. Either way — standard or special — you'll get the timer you want most promptly from Industrial.

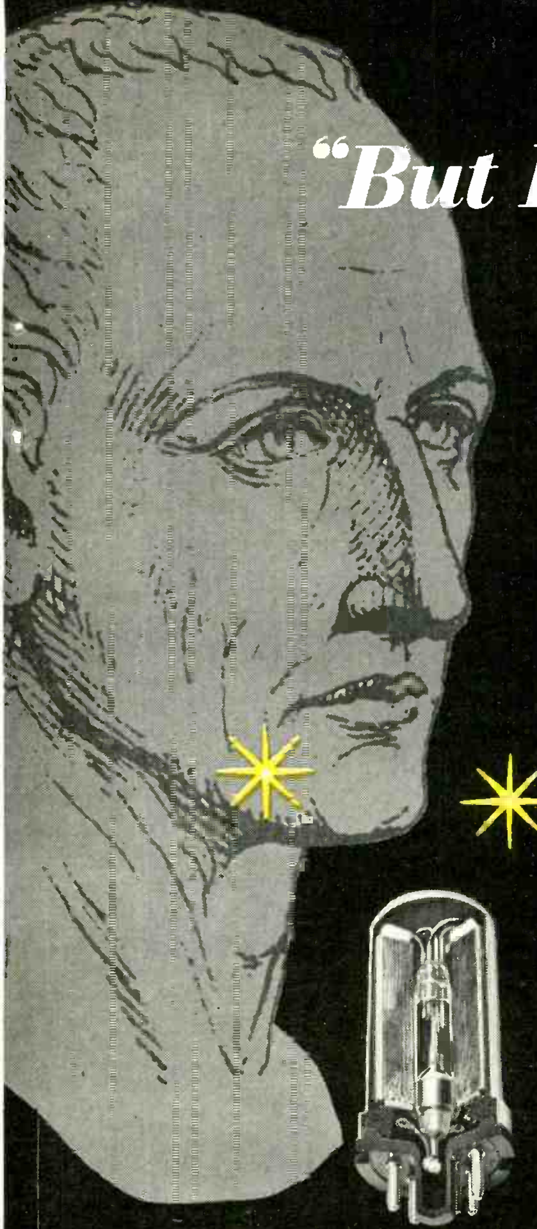
Or perhaps you need quick service on timers for automatic controls. Here too Industrial Timer is your first source of supply. For in this field Industrial has a big head start. True, each automatic control job is a bit different from the rest. But the record shows that our years of timer experience has given us the special knowledge it takes to give you the right answers in near-record time.

So, for the utmost in all-round timer service, it's Industrial that offers you this outstanding combination: deliveries "Immediate on Standards . . . First on Specials." Plus the experience of one of the foremost group of timer engineers in the nation.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION
1409 McCARTER HIGHWAY, NEWARK 4, N. J.



"But I am constant as the northern star"

—Julius Caesar Act III Sc. 1

You know what to expect from CLARE Mercury-Wetted-Contact Relays—always. Their performance is CONSTANT.

Constant contact stability—No contact chatter—none at all.

Constant contact resistance—Repetitive measurements on individual relay contacts are constant to a few milliohms. Resistance of single contacts, including resistance of internal wiring between base terminals, ranges between 25 and 40 milliohms. Contact deterioriation cannot occur in this relay.

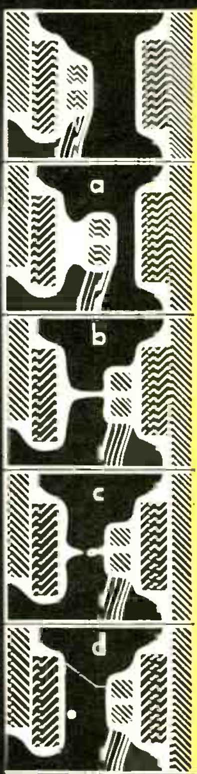
Constant operate time—Varies by only about 0.1 millisecond under constant drive conditions.

Constant pull-in current—Repetitive operating precision of given relay is within 1% of its minimum operating current. This precision is substantially independent of number of operations or ambient temperature.

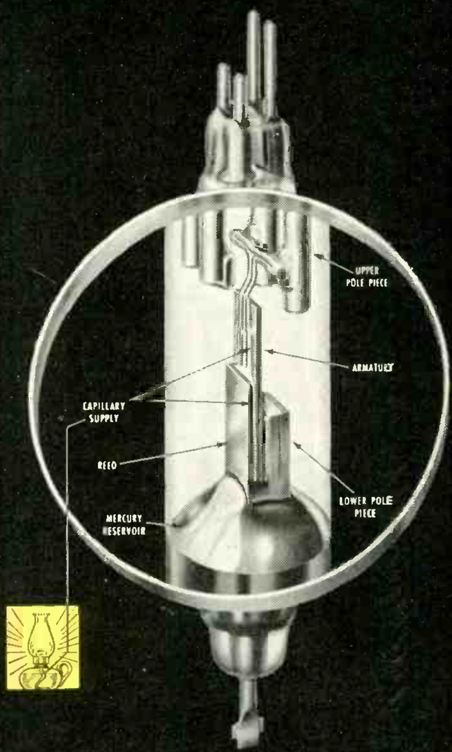
Constant adjustment—Requires no maintenance whatever. No possibility of change in adjustment. This remains true even after thousands of millions of operations.

If you have a job for which none but the best relay is good enough, it can cost you much more to settle for less than this CLARE RELAY. For complete information contact your nearest Clare representative or address C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare & Co., 659 Bayview Avenue, Toronto 17. Cable address: CLARELAY.

Send for CLARE Sales Engineering Bulletins Nos. 120 and 122



Drawings (left) from high-speed photographs show the cycle. (a) Filament of mercury forms between the contacts as they separate. (b) This becomes narrower in cross section and (c) finally parts at two points, allowing globule of mercury to fall out. Mercury flows up the capillary path, replaces amount lost, restores the equilibrium. (d) The momentary bridging of the parting contacts—and the extremely fast break that ends it—minimizes the arc and adds greatly to contact load capacity. Contact closure between the two liquid surfaces bridges mechanical bounce and prevents any chatter from appearing in the electrical circuit.

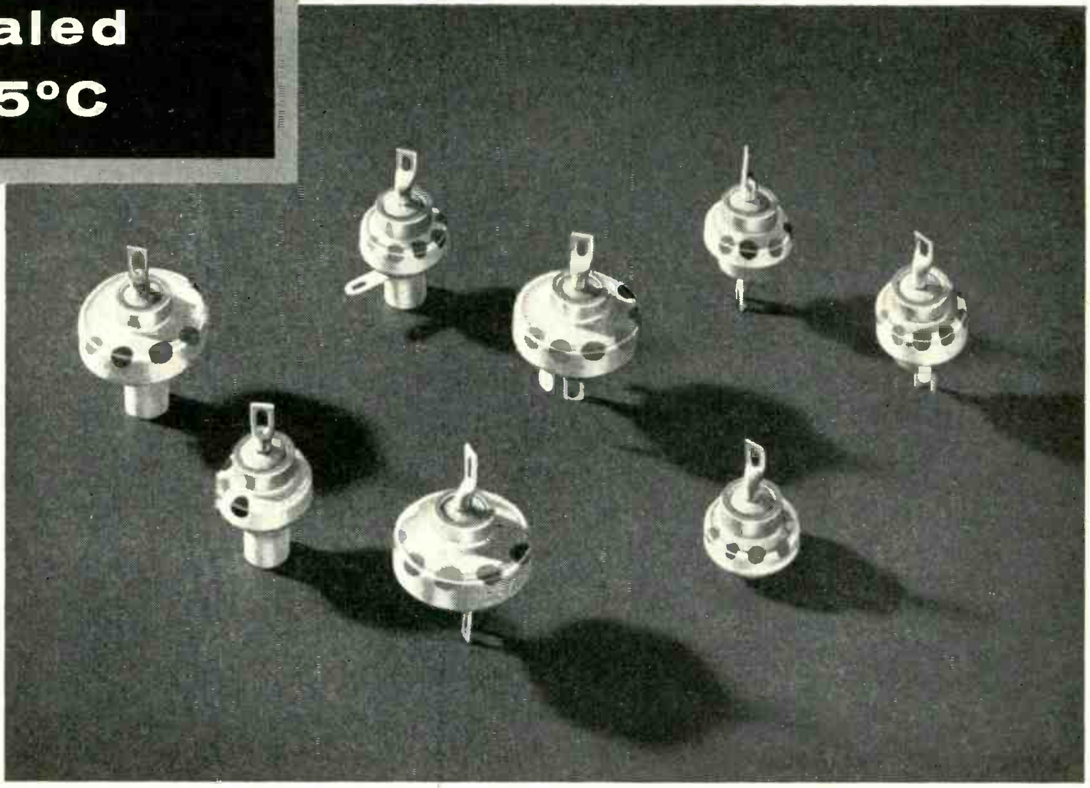


Contacts of CLARE Mercury-Wetted-Contact Relays are constantly renewed. By capillary action, like that of a lamp wick, a new film of mercury coats each contact with every make and break.

CLARE RELAYS

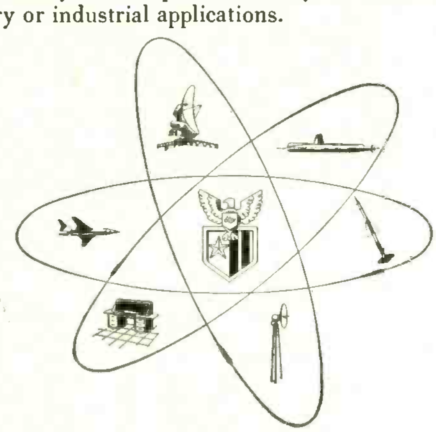
FIRST in the industrial field

Hermetically Sealed 125°C



SANGAMO SILVERED MICA BUTTON CAPACITORS

HIGH RELIABILITY MANUFACTURING FACILITIES
Sangamo's "controlled conditions" facilities for the exclusive manufacturing of high reliability capacitors assure really fine capacitors for your most critical military or industrial applications.



Sangamo's design engineers have developed these hermetically sealed mica button capacitors especially for high frequency applications under severe humidity and temperature conditions.

The unique internal design results in low inherent inductance —ideal for application at frequencies up to 500 megacycles per second in tuning, coupling and by-pass circuits. The silver plated case serves as both the low potential terminal and as an electrostatic shield.

These units meet all requirements for V.H.F. and U.H.F. applications and meet Joint Army-Navy specification MIL-C-10950B (proposed). Operating temperature range is from —50°C to 125°C. Specify these high reliability capacitors for your most critical applications. Write for new Catalog 2311 on Sangamo Silvered Mica Button type capacitors.

FIVE TYPES AVAILABLE—Stand-off with ground lug, Stand-off without ground lug, Feed-thru without mounting lugs, Stand-off without pedestal, and Feed-thru with mounting lugs.

SANGAMO ELECTRIC COMPANY
Electronic Components Division

SPRINGFIELD, ILLINOIS

SC57-6

Sperry's combination radar test sets integrate all testing functions

Faster, simpler radar maintenance is the pay-off with the Sperry Combination Test Sets. One set does the job of three or more standard test units but requires one-quarter the space and weighs half as much! Here are the five functions each Sperry test set performs:

POWER METER: Directly measures average power of radar transmitter with accuracy of ± 1.0 db.

FREQUENCY METER: Indicates directly the frequency of both receiver and transmitter.

SPECTRUM ANALYZER: Accurately displays power vs. frequency spectrum of transmitter signals from single or multi-pulse systems. Display is stable at all pulse widths and repetition rates.

SYNCHROSCOPE: Simple general-purpose synchroscope functions as an "A" scope and displays radar video signals or similar wave forms—no need for auxiliary synchroscope.

SIGNAL GENERATOR: Accurately and directly calibrated output signal level is variable over complete range. Choice of pulse, frequency or external modulation.

With no additional equipment you can also measure transmitter peak power, repetition rate, transmitter pulse width, T.R. recovery time, duplexer losses, transmission line VSWR. Designed for tough operating conditions, these sets comply fully with military specification MIL-T-945A. Your nearest Sperry district office will gladly supply you with complete operating data.

Visit our booths 2309-2310 at the Wescon Show.

Microline Model 570
16⅜" L x 15⅝" W x 15⅞" H

COMPLETE LINE OF TEST SETS

Band	Microline* Model	Military Type	Frequency
L	670		400-450mc
S	590B	UPM-44B	2700-3500mc
C	551A	SPM-5	5100-5900mc
X	570	UPM-32	8500-10500mc
K	557		23500-24500mc
V	580A	UPM-14	34000-35600mc

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

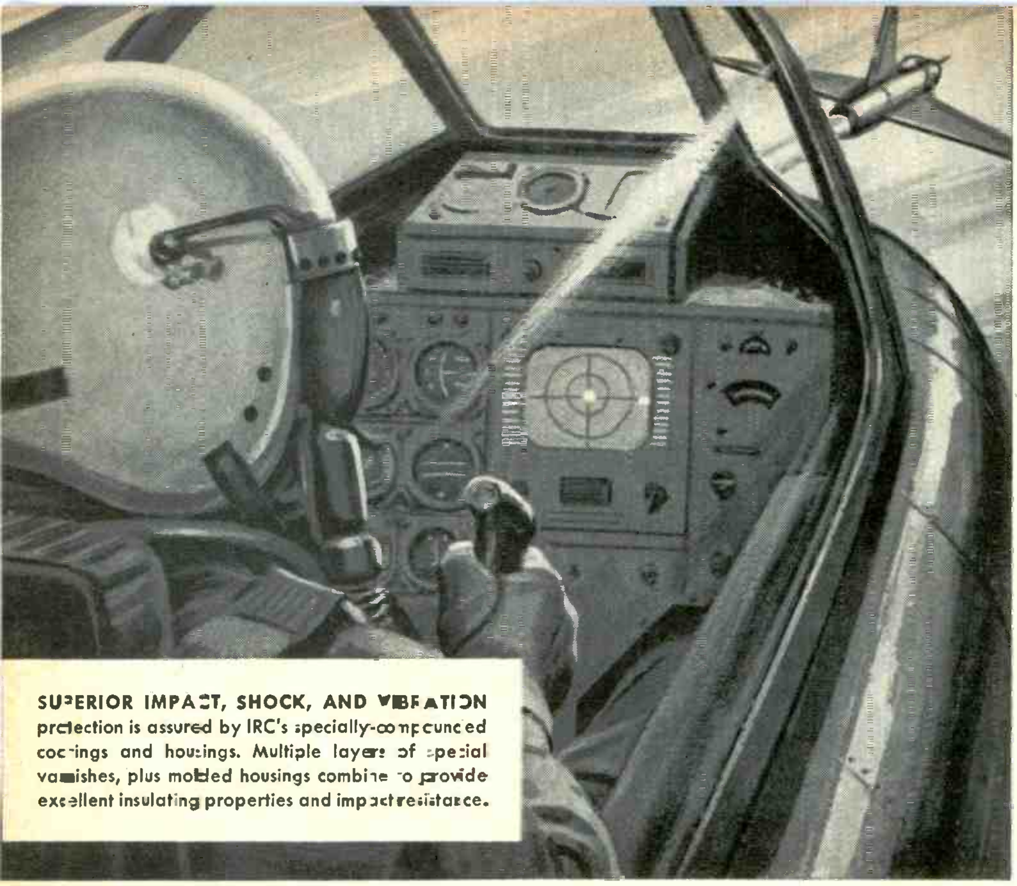
MICROWAVE ELECTRONICS DIVISION

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 79 Readers Service Card

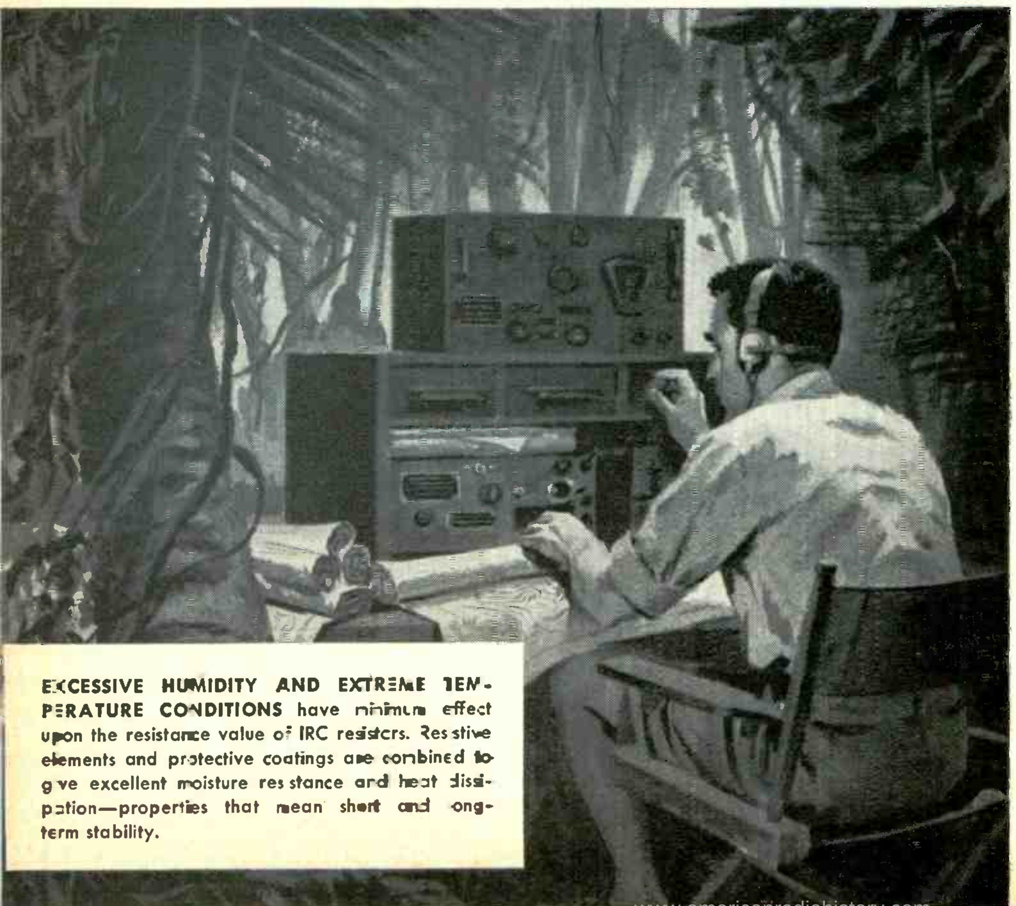


SUPERIOR IMPACT, SHOCK, AND VIBRATION protection is assured by IRC's specially-compounded coatings and housings. Multiple layers of special varnishes, plus molded housings combine to provide excellent insulating properties and impact resistance.

In a sense, a resistor is simply a mechanical device for packaging ohms. So it's easy to see why the materials entering into the mechanical package are extremely important to resistor performance. That's why more than one-third of the 200 technicians at IRC are occupied in developing insulating coatings and housings that give *extra* protection against mechanical damage, humidity effects, and temperature variations.

Extra IRC® resistor protection pays off

...but you pay no more for it!



EXCESSIVE HUMIDITY AND EXTREME TEMPERATURE CONDITIONS have minimum effect upon the resistance value of IRC resistors. Resistive elements and protective coatings are combined to give excellent moisture resistance and heat dissipation—properties that mean short and long-term stability.

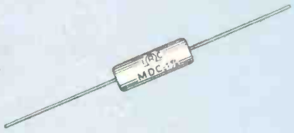
Out of this never-ending activity come coatings and molding compounds that are custom-tailored for each and every type of resistor. As a result, every IRC resistor gives far more protection from damage and ambient conditions than any other of its type!

How IRC resistors give added protection

molded resistors

TYPE BT Fixed Composition Resistors

TYPE BW Insulated Wire Wound Resistors

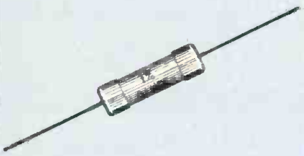


TYPE MD Molded Deposited Carbon Resistors

TYPE PW Insulated Wire Wound Resistors

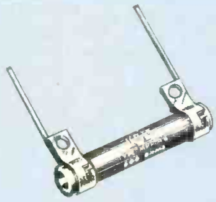
Plastic compounds used in IRC molded resistors are all specified by IRC to combine excellent insulating properties, moisture resistance, and impact resistance.

varnish coated resistors

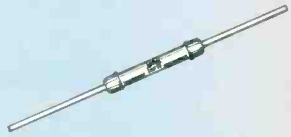


TYPE DC Deposited Carbon Resistors

TYPE MV High Voltage Resistors



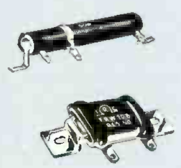
TYPE MP High Frequency Resistors



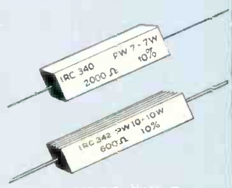
TYPE HFR High Frequency Resistors

Where mechanical damage isn't a major problem, IRC resistors give excellent protection at lower cost through the use of IRC-developed varnish coatings. Because several layers are applied and cured under specially controlled conditions, these resistors offer superior humidity and temperature characteristics.

cement insulated resistors



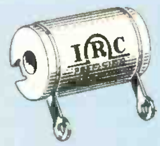
TYPE PWW TYPE FRW Power Wire Wound Resistors



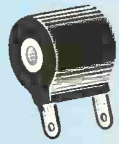
TYPES PW-5, PW-7 & PW-10 Small Insulated Power Resistors

The special cement coatings used to insulate IRC power resistors give excellent mechanical protection. Type PWW Resistors, for example, withstand a transverse pressure of 25 pounds. These exclusive IRC cements also permit maximum heat dissipation and give superior moisture protection.

impregnated and encapsulated resistors



TYPE WWJ Precision Wire Wound Resistors



SERIES "PH" Encapsulated Precision Wire Wound Resistors

Type WWJ Resistors feature a special compound that thoroughly impregnates the winding and remains stable at varying temperatures. This compound not only gives maximum mechanical protection, but also serves as an insulating barrier and minimizes moisture effects. In IRC encapsulated resistors, the same epoxy resin is used for both the core and the outer housing, thus minimizing the effects of expansion and contraction due to various temperature conditions. This epoxy resin also imparts excellent insulating and moisture-resistant properties to the housing.

VISIT IRC
BOOTH 521-522

Wherever the Circuit Says

1957 WESCON SHOW
August 20-23
San Francisco

IRC

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Hycor Company, Inc., Vega Baja, P.R. (subsidiary)

INTERNATIONAL RESISTANCE COMPANY
Dept. 237, 401 N. Broad St., Philadelphia 8, Pa.
In Canada: *International Resistance Co., Ltd., Toronto, Licensee*

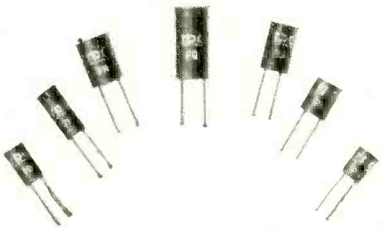
Please send technical bulletins describing ☐ Fixed Compositions ☐ Deposited Carbons ☐ Low Power Wire Wounds ☐ Power Wire Wounds ☐ High Voltage Types ☐ High Frequency Types ☐ Precision Wire Wounds ☐ Encapsulated Precisions

*Name*________________

*Company*________________

*Address*________________

*City*____________ *State*______

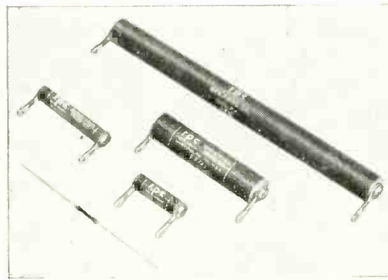


Printed Circuit Precision Resistors

To meet the requirements for printed circuitry, RPC has developed Type P Encapsulated Wire Wound Precision Resistors. Miniature, single ended units designed for easy rapid mounting on printed circuit panels with no support other than the wire leads. Many newly developed techniques are employed in the manufacture of Type P Resistors. These units can be operated in ambient temperatures up to 125°C. and will withstand all applicable tests of MIL-R-93A, Amdt. 3. Available in 6 sizes, rated from 1/10 watt to .4 watt. 1/4'' diameter by 5/16'' long to 3/8'' diameter by 3/4'' long. Resistance values to 3 megohms. Tolerances from 1% to 0.05%.

rpc

HIGH QUALITY RESISTORS FOR ELECTRONICS



High Frequency Resistors

Used where requirements call for very low inductance and skin effect in circuits involving pulses and steep wave fronts. Depending on size and resistance value, these resistors are usable at frequencies to over 400 mc. Resistance values range from 20 ohms to 100 megohms with tolerance of 20% to 5%. 2 types available.
TYPE F resistors (shown) in 8 sizes from 9/16'' long x 0.10'' diameter to 6½'' long x 9/16'' diameter, with lugs or wire leads. Power ratings 1/4 to 10 watts.
TYPE G resistors (not shown), in 6 sizes up to 18½'' long. Power ratings 10 to 100 watts.

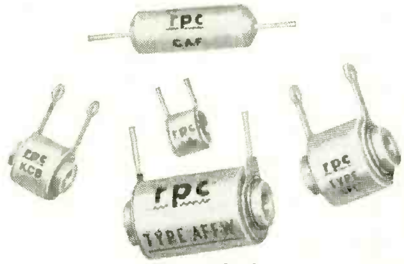
High Voltage Resistors

Type B Resistors are stable compact units for use up to 40 KV. These resistors are used for VT voltmeter multipliers, high resistance voltage dividers, bleeders, high resistance standards and in radiation equipment. They can be furnished in resistance to 100,000 megohms. Available as tapped resistors and matched pairs. Sizes range from a 1 watt resistor 1 inch long x 5/16 inch diameter rated at 3500 volts, to a 10 watt resistor 6½ inches long x 5/16 inch diameter rated at 40 KV. Low temperature and voltage coefficients. Standard resistance tolerance 15%. Tolerances of 10%, 5% and 3% available. Tolerance of 2% available in matched pairs.

RPC is a widely recognized supplier of high quality resistors to industry, Government Agencies and the Armed Forces. Advanced production methods, modern equipment and scientific skill enables RPC to manufacture resistors of *highest quality* in *large quantities* at *reasonable cost.* Modern manufacturing plant is completely air conditioned and equipped with electronic dust precipitators to insure highest production accuracy. RPC resistors are specified for use in instruments, electronic computers, radiation equipment, aircraft equipment and scientific instruments.

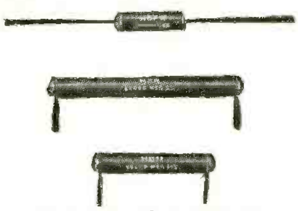
Test equipment and standards for checking and calibrating are equalled by only a few of this country's outstanding laboratories. Our ability to produce resistors of highest quality coupled with prompt delivery have established RPC as a leading manufacturer of resistors. Small or large orders are promptly filled.

Representatives in principal cities. For full information send for latest catalog.



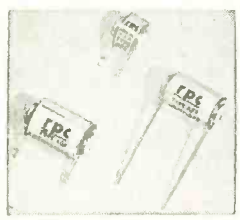
Unsealed Precision Wire Wound Resistors

Unsealed precision resistors are wound on steatite forms and are used for all general requirements. They can be furnished with all resistance alloys in tolerances from 1% to .02%. These resistors will meet the requirements of MIL-R-93A, Amdt. 2, characteristic B. Special winding techniques, impregnation and thermal aging result in resistors of exceptional stability. They are available in a wide variety of sizes, styles and terminal types. Matched resistors, networks and special assemblies can be supplied.



High Megohm Resistors

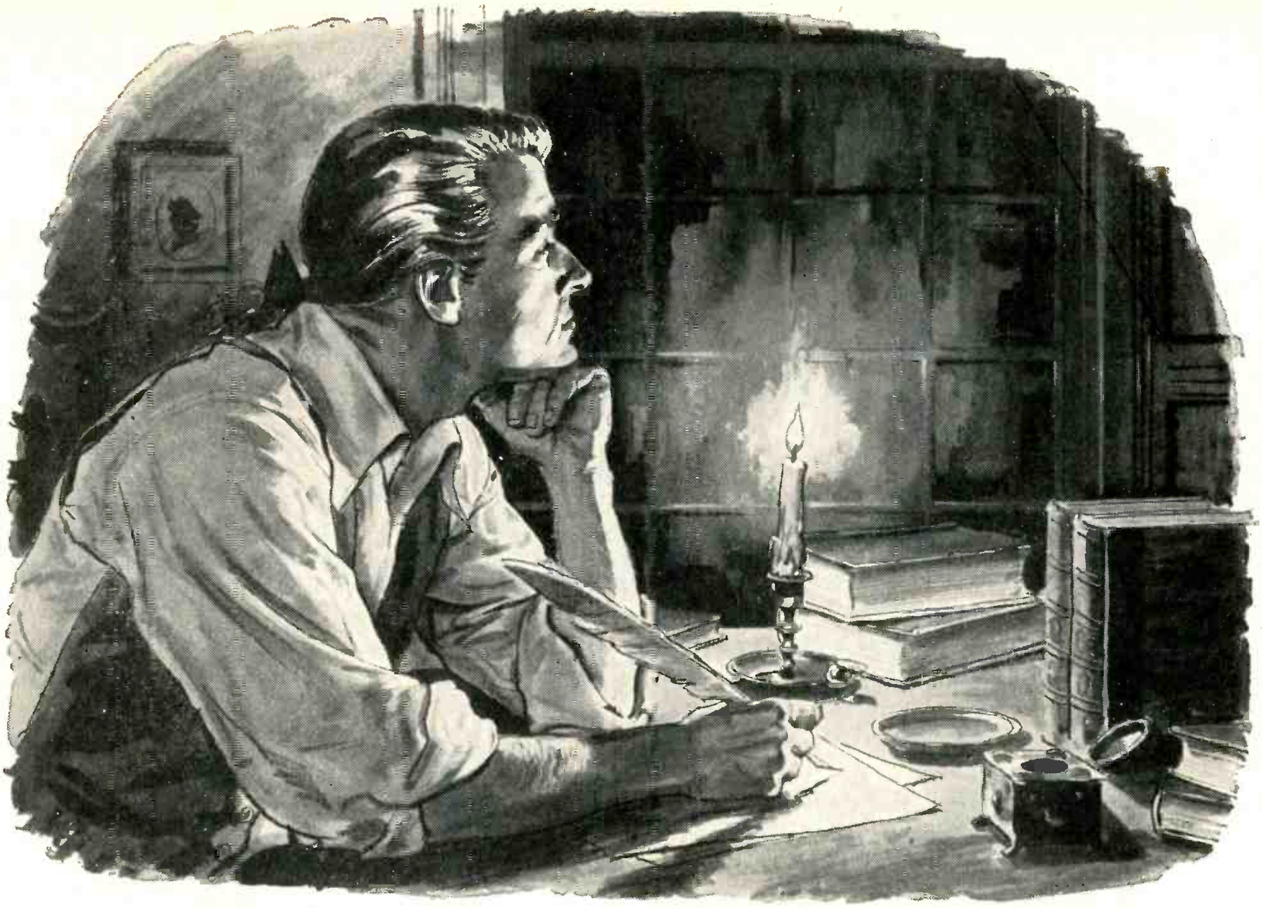
Type H Resistors are used in electrometer circuits, radiation equipment and as high resistance standards. Resistance available to 100 million megohms, (10^{14} ohms). For utmost stability under adverse conditions Type HSD and HSK Hermetically Sealed are recommended. Eight sizes from 7/8 inch to 3 inches long are available. Voltage rating to 15,000 volts. Low temperature and voltage coefficients. Standard resistance tolerance 10%. Tolerance of 5% and 3% available. Also matched pairs 2% tolerance.



Wire Wound Precision Resistors

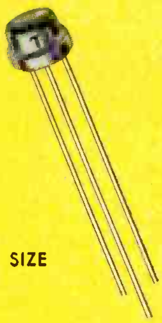
Type A Precision Resistors are widely used for all general requirements. They are available in a wide variety of sizes, styles and terminal types. They can be furnished with all resistance alloys in tolerances from 1% to .02%. Type A will meet the requirements of MIL-R-93A, Amdt. 2, Characteristic B. Special winding techniques, impregnation and thermal aging result in resistors of exceptional stability. Matched resistors, networks and special assemblies can be supplied.

RESISTANCE PRODUCTS CO. 914 S. 13th Street HARRISBURG, PA.



Transitron

Silicon Transistors



ACTUAL SIZE

Type	Minimum Common Emitter Current Gain, B	Maximum Collector Voltage V_{ce} Peak (volts)	Typical Cut-off Frequency (mc)	Maximum Collector Cut-Off Current at 25°C at V_c Max. (ua)
ST42	40	45	11	.5
ST32	40	30	11	.5
ST12	40	15	11	.5
ST33	30	30	17	.5
ST13	30	15	17	.5
ST41	20	45	10	.5
ST31	20	30	10	.5
ST11	20	15	10	.5

Send for Bulletin TE-1353

. . . for high temperature operation

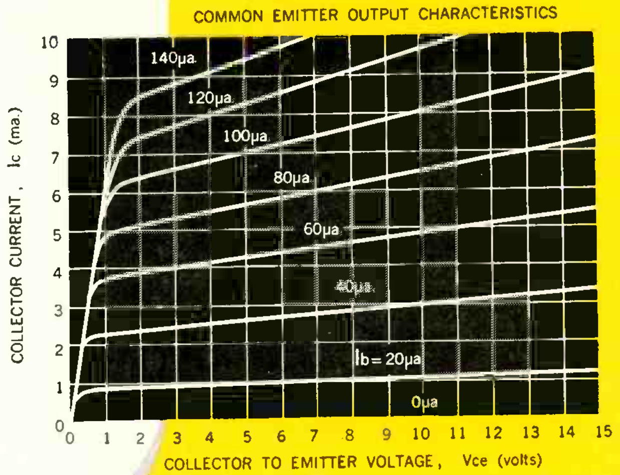
Transitron's NPN silicon transistors are designed for a wide range of small signal applications in the power range up to 200 mw. They will provide dependable operation up to 175°C in circuits such as RF and IF amplifiers, video and audio amplifiers, servo control, switching, and many others.

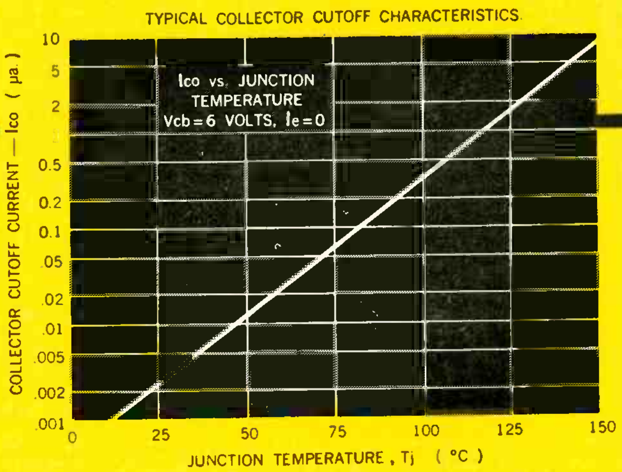
Manufactured by diffusion in the liquid phase during crystal growth, these transistors are essentially free of parameter drift and instability common in conventional grown junction transistors. Through close process control, these units have exceptionally low I_{co} up to their maximum voltage and temperature ratings. As a result, performance reliability can be achieved even at higher voltage levels.

For environmental stability, extensive temperature cycling and storage as well as mechanical and hermetic seal tests are included as a regular part of the manufacturing process.

FEATURES . . .

- Low I_{co}, typically under .02 ua
- Operation to 175°C
- 200 mw Power Rating
- High Frequency Operation
- High Temperature Tested
- Excellent Stability
- Welded Hermetic Seal





Visit Booth 2801-02
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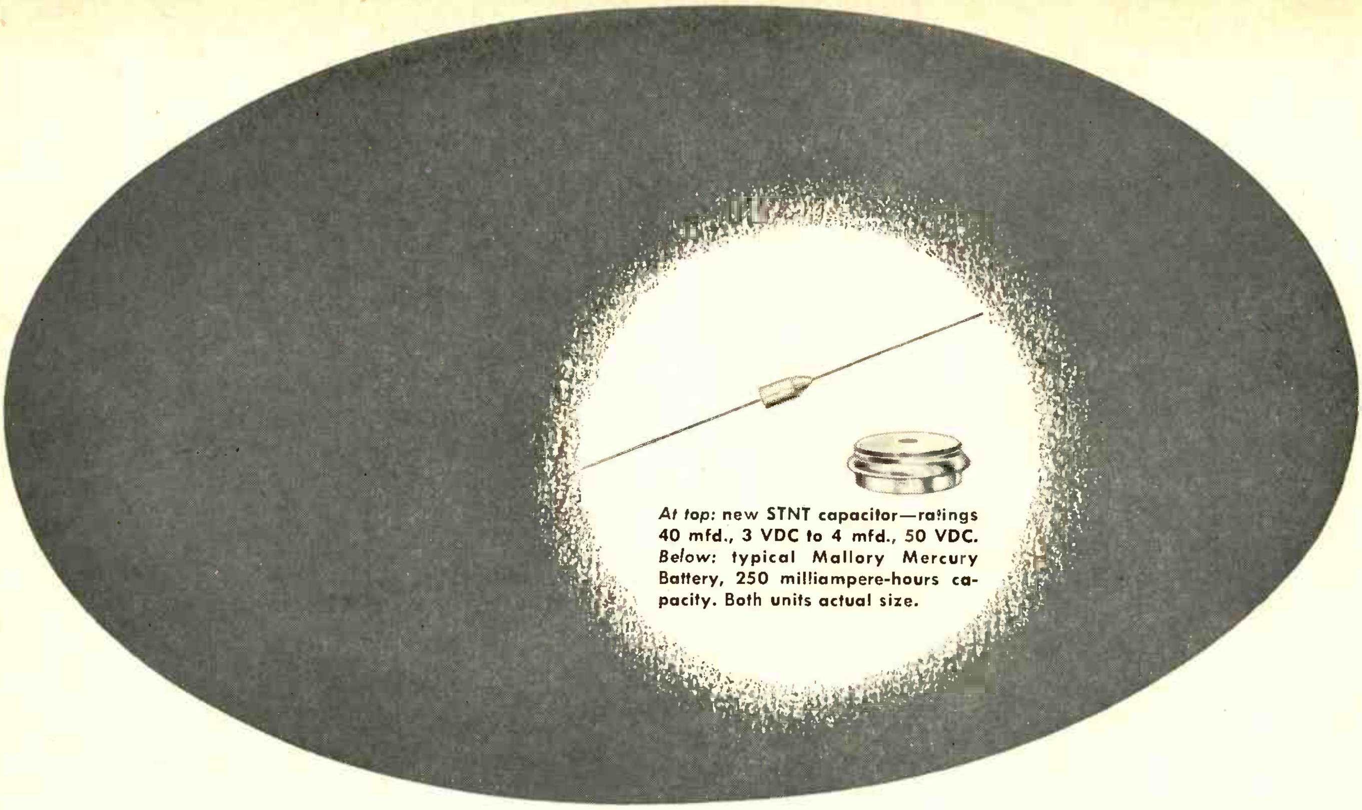

At top: new STNT capacitor—ratings 40 mfd., 3 VDC to 4 mfd., 50 VDC. *Below:* typical Mallory Mercury Battery, 250 milliampere-hours capacity. Both units actual size.

Big Performance in Subminiature Size —for your Transistor Circuits

The new transistorized products that you are designing can be engineered to even smaller size, and to even higher standards of performance, by using Mallory subminiature batteries and capacitors.

Mercury Batteries, pioneered and developed by Mallory are outstanding for high milliampere-hour capacity in extremely compact size. The unique combination of the electrochemical cell system and structure used in Mallory Mercury Batteries gives a constant energy discharge that offers the ideal power source for transistors. They last for several years on the shelf, and need no recuperative periods between use. They withstand extremes of temperature and humidity far beyond conventional batteries.

Mallory Subminiature Capacitors cover a complete range of sizes and characteristics to match your applications. Newest and smallest is the STNT—only 0.145″ in diameter and 0.250″ long; available in ratings from 40 mfd., 3 VDC to 4 mfd., 50 VDC. Other models include: ultra-miniature TAW tantalum capacitors in 1 to 6 mfd. ratings; TAP tantalum capacitors for −55 to +80° C, rated 2 mfd./90 VDC to 30 mfd./6 VDC; TNT tantalum capacitors with double the capacity of STNT, in slightly larger case size; and type TT miniature aluminum electrolytics.

Mallory application engineers can give you valuable assistance not only in selecting the subminiature components for your application, but also in coordinating circuit designs for peak over-all performance. Write today for technical data and for a consultation.

Expect more . . . get more from

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See us at Wescon . . . The Mallory Booth is 1312

At the zero second everything must function without failure. ANDREW HELIAX cable is used in postassembly and preflight checkouts of missile radio frequency systems. The cable forms a closed circuit over which interrogation and response signals are transmitted between checkout equipment and airborne radio frequency packages. The HELIAX cable runs from a mobile trailer to connecting points on the missile.

The ruggedness of HELIAX makes it well suited to this challenging task, where its low VSWR, low RF leakage and low attenuation give accurate measurement of systems performance. Flexibility permits the cable to be taken down, recoiled and subsequently reused many times.

If you require similar characteristics in a cable, consider the special advantages of HELIAX.

HELIAX is normally supplied as an assembly, complete with end fittings factory attached, reducing installation labor and improving quality.

Complete uniformity throughout its entire length gives HELIAX *superior* electrical characteristics.

HELIAX is always less difficult, less costly to install, *easier to handle*.

HELIAX is available in 7/8" size (Type H0) and 1 5/8" size (Type H1).

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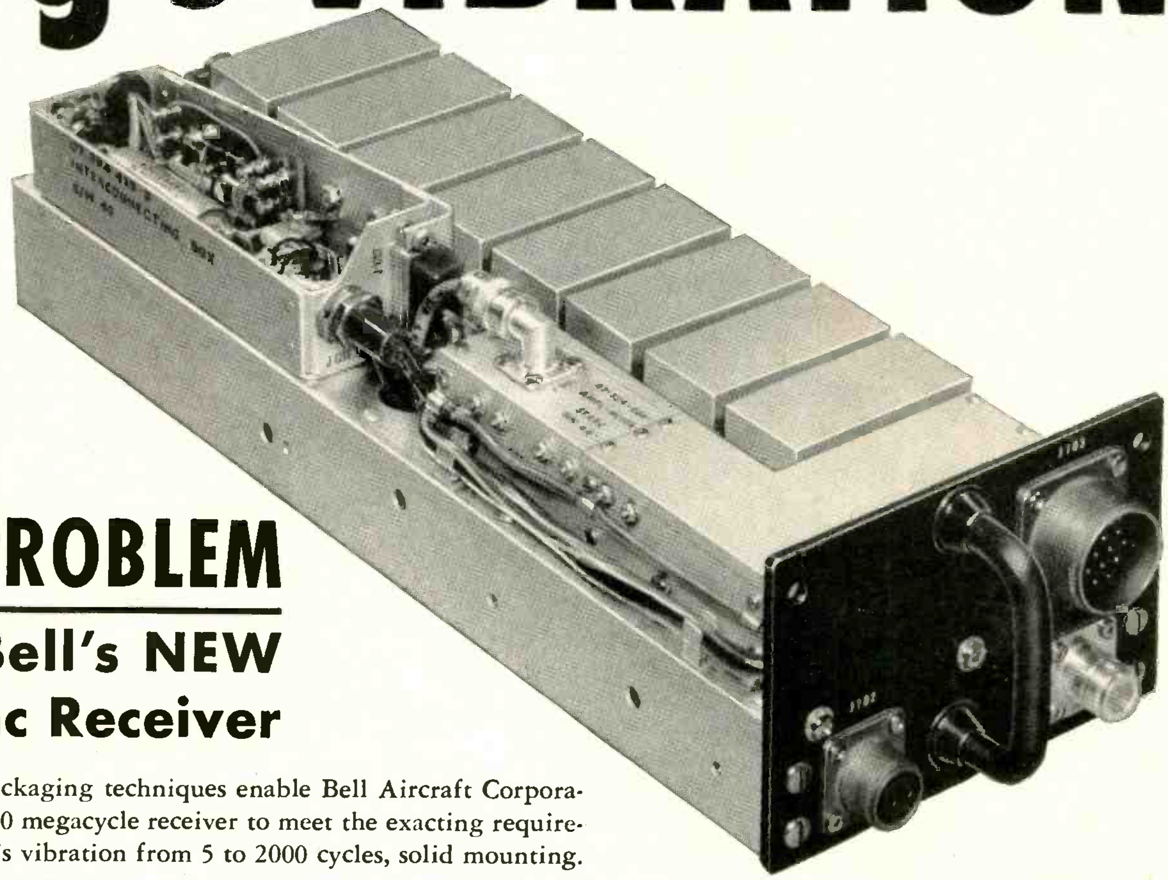
15 g's VIBRATION



NO PROBLEM

with Bell's NEW 400 mc Receiver

Modular packaging techniques enable Bell Aircraft Corporation's new 400 megacycle receiver to meet the exacting requirement of 15 g's vibration from 5 to 2000 cycles, solid mounting.

Now thoroughly proven and in production, this receiver is available immediately for any application where demodulated control signals are needed for the activation of command systems requiring a high signal-to-noise ratio, high sensitivity and stability, and a wide audio bandwidth with low harmonic and phase distortion. It is equally at home in guided missiles — as a range safety instrument — or as a ground monitor receiver.

The new 400 mc receiver is only one of many examples of the ability of Bell Aircraft's new *Avionics Division* to design, develop and produce avionic systems, units and components for any needs, however complex. If you have design or production problems in this field, write, wire or phone: Sales Manager, Avionics Division, BELL AIRCRAFT CORP., Post Office Box One, Buffalo 5, New York.

ELECTRICAL SPECIFICATIONS

TYPE: FM 300 KC Deviation
TUNING RANGE: 406 to 420 megacycles
Plug-in assemblies to extend range to 500 mcs available
OSCILLATOR: Crystal controlled
SENSITIVITY: 5 microvolts or better for 10 db quieting
INPUT IMPEDANCE: 50 ohms
BANDWIDTH: 1.15 mcs ± .1 at 3 db
IMAGE AND SPURIOUS RESPONSE: Better than 60 db
OUTPUT: ± 0.5 db 40 cps to 40 kc 3 db at 100 kc
3.5 volts RMS 500 ohms closed circuit
SQUELCH: Adjustable squelch relay from 10 to 100 microvolts input
POWER INPUT: Less than 50 watts. Power supplies available for 115V - 400 cps or 28VDC

MECHANICAL SPECIFICATIONS

DIMENSION: 3.6 x 5.5 x 15.25 inches.
VOLUME: 300 cubic inches
WEIGHT: 10 pounds
MOUNTING: Solid — 9 mounting screws
OPERATING ENVIRONMENTS: 15 g's
5 to 2000 cycles -55° to +72°C

THIS NEW BOOK telling of many new and unusual developments in the field of Avionics is yours for the asking. Send request on your letterhead to: Sales Manager, Avionics Division, BELL AIRCRAFT CORP., Post Office Box One, Buffalo 5. N. Y.

See this new receiver at Bell Aircraft's Avionics Division Display at WESCON Booth 1209-1210

BELL *Aircraft* CORP.
Avionics Division
BUFFALO, N. Y.

Circle 84 Readers Service Card

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- Handy & Harman is the leading manufacturer of silver and silver alloys for industry.
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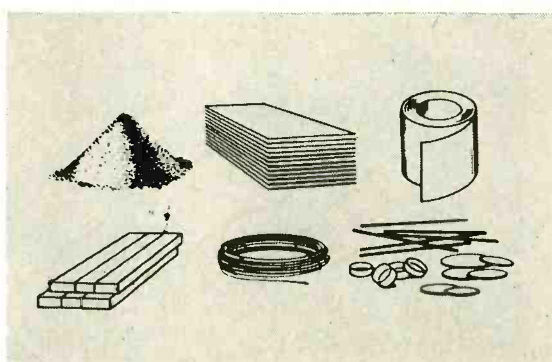
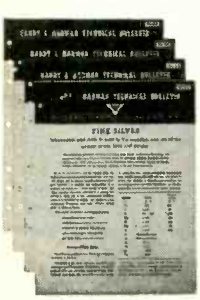
This experience and knowledge is at your call. Whatever your silver requirements, Handy & Harman is anxious to be of service.



Here are some of the forms Handy & Harman manufactures:

- Fine Silver (wire, strip and foil)
- Silver anodes and grain for plating
- Silver contact alloys
- Silver powders
- Silver flakes and paints
- Silver brazing alloys
- Silver electronic solders
- Silver sintered metals
- Solder-flushed silver alloys
- Silver chloride and oxide
- Coin Silver (wire and strip)
- Silver Bi-metals



For your information file

We have four Technical Bulletins giving engineering data on the properties and forms of Handy & Harman Silver Alloys. We would like you to have any or all of those that particularly interest you. Your request, by number, will receive prompt attention.

Fine Silver	Bulletin A-1
Silver-Copper Alloys	Bulletin A-2
Silver-Magnesium-Nickel	Bulletin A-3
Silver Conductive Coatings	Bulletin A-4

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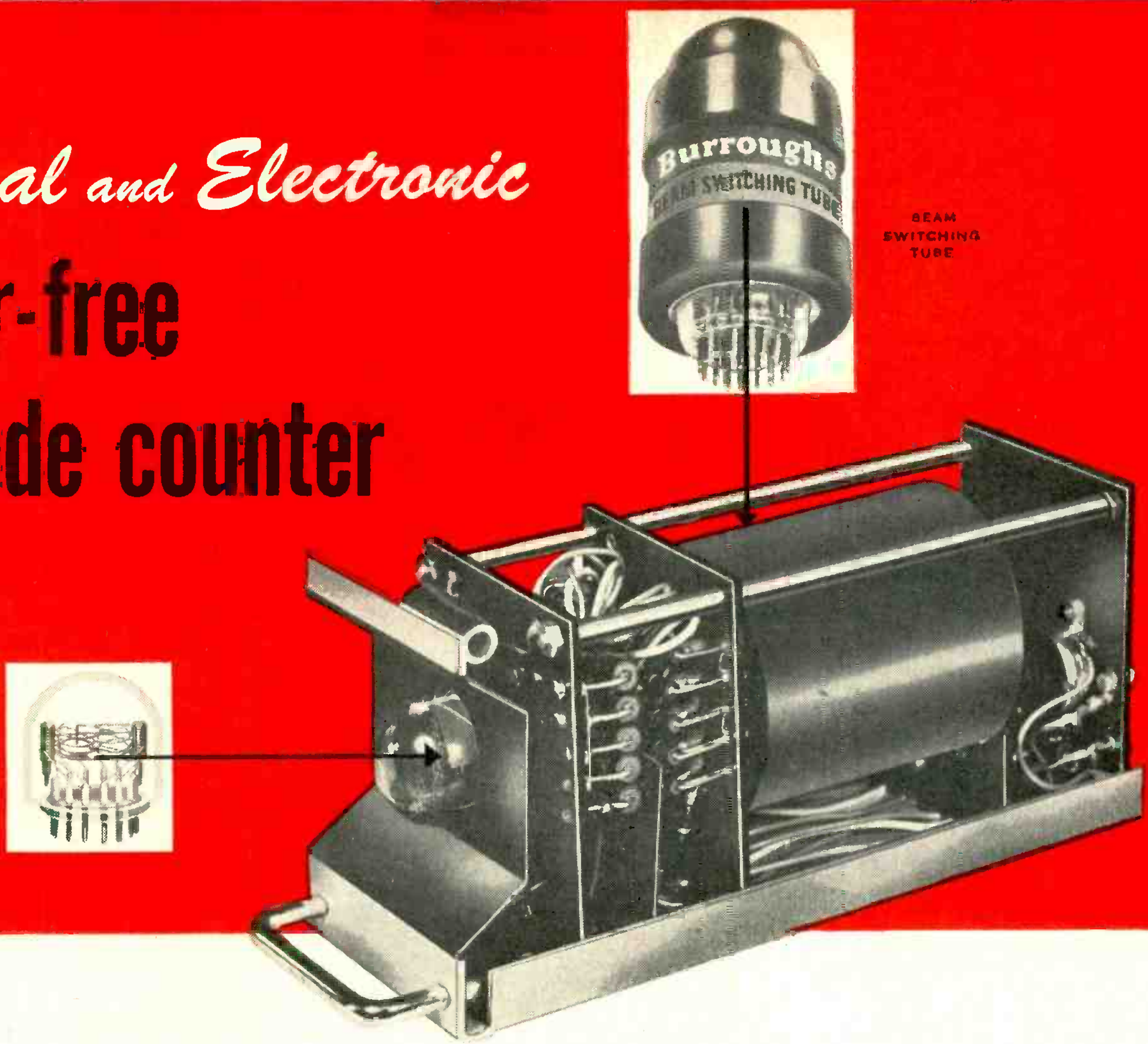
Visual and Electronic

error-free decade counter



MOST EASILY READ UNIT *Ever Made*

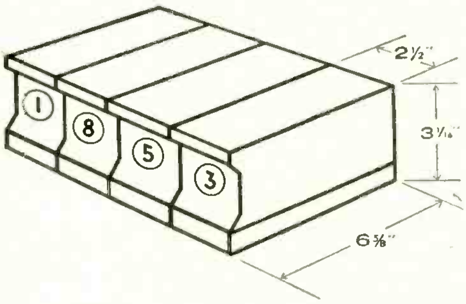
NOTE THESE OUTSTANDING FEATURES

- NIXIE READOUT IN-LINE FIGURES VISIBLE 30-40 FT.
- RELIABILITY OF BEAM SWITCHING TUBE
- OPERATION WITH FULL TOLERANCE VARIATION OF ALL COMPONENTS.
- SMALLEST PANEL HEIGHT (3-1/16")
- MINIMUM HEATER WATTAGE
- PLUG-IN DESIGN
- PROVISION FOR MECHANICAL OR ELECTRONIC ZERO-SET
- UNITS CASCADED DIRECTLY

AVAILABLE IN THE FOLLOWING MODELS

DC-101	10 KC
DC-102	100 KC
DC-103	1 MC

Burroughs new Decade Counter with an all-electronic numerical readout is available. The unit consisting of the **Burroughs Beam Switching Tube** and **NIXIE Indicator Tube** is the first Decade Counter which displays numerical information that is directly controlled by a single counter tube.

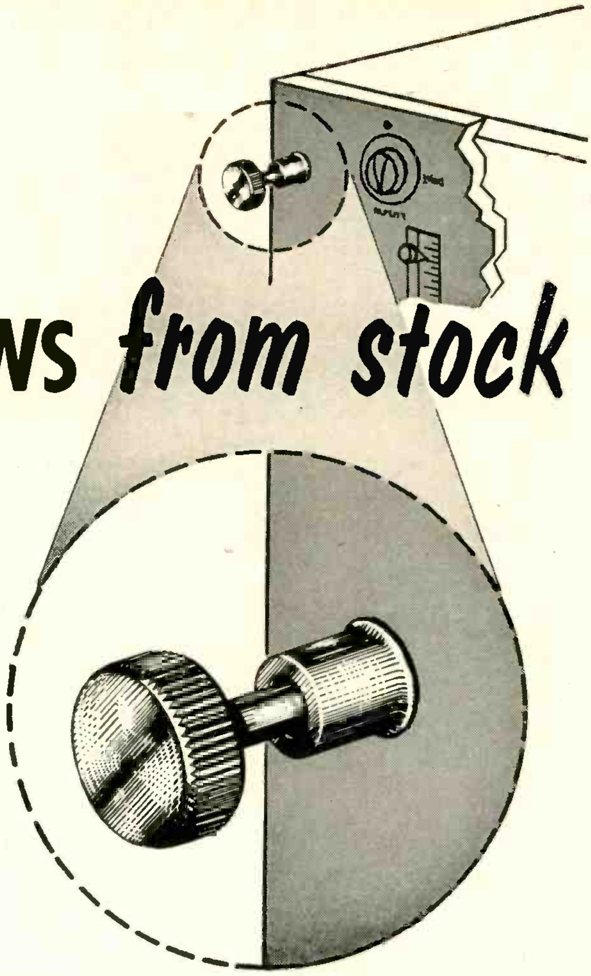


Electronic Tube Division

BURROUGHS CORPORATION

Plainfield, New Jersey

reduce costs with SOUTHCO® CAPTIVE PANEL SCREWS from stock



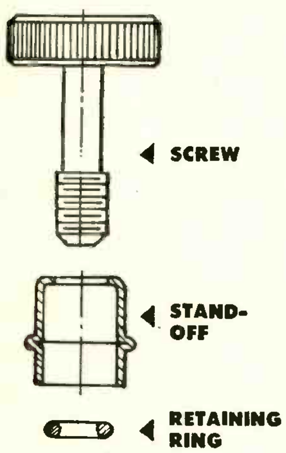
Here's a low-cost retractable screw fastener to save you assembly time and to eliminate the frequent need for costly special design fasteners. Unmatched for fast, economical use by assemblers of electronic units and other paneled cabinets.

"Floating" screw insures easy alignment no matter how many screws are engaged in a single panel. No special skills or tools needed; installation fast and simple.

3 head sizes and 3 standard thread sizes available. On special order, slotted heads, stainless steel screws, and extra long screws.

Write for complete information. Southco Division, South Chester Corporation, 233 Industrial Highway, Lester, Pa.

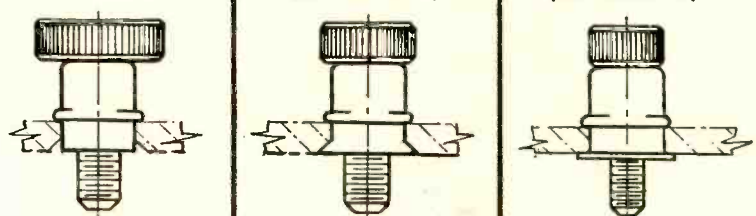
3 SIMPLE COMPONENTS



EASILY INSTALLED
Stand-off is flanged into panel. Screw is inserted into oversize hole in stand-off and locked in place by retaining ring, which is passed over threads to seat behind last thread.

A SIZE FOR EVERY NEED

LARGE HEAD (3/4" diameter)	MEDIUM HEAD (9/16" diameter)	SMALL HEAD (7/16" diameter)
1/4"-20 thread	1/4"-20 and 12-24 thread	10-24 thread



Screw and stand-off are brass, nickel plated. Retaining ring is durable vinyl plastic.

Choice of stand-offs for each screw size to accommodate panel thicknesses from 1/16" to 17/64".

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SOUTH CHESTER CORPORATION • LESTER, PENNSYLVANIA

Quick facts on the

401

GENERAL PURPOSE LOW-FREQUENCY OSCILLOSCOPE

The new standard of the industry . . . It features: DC to 100 kc bandwidth; identical X- and Y-amplifiers; 100 mv (10mv/cm) full scale sensitivity on both axes; precision calibrated sweeps from 50 msec/cm to 4 usec/cm (125, msec/in to 10 usec/in); and continuous sweep expansion up to 3 times without disturbing sweep controls. Beam gate circuitry is included for complete retrace blanking. Hard-tube circuitry for generating recurrent and driven sweeps is also incorporated. Cathode-ray tube is a 5ADP- operated at 3000 volts potential.

Price **$462.00**

403

EXTREMELY HIGH SENSITIVITY FROM D-C TO 300 KC

The most sensitive oscilloscope commercially available. Has a sensitivity range of 5 mv to 500 volts full scale, continuously variable, and a bandwidth of D-C to 300 kc. Maximum drift is 1 mv per hour after warmup. The high gain D-C amplifier permits measurements from most transducers without pre-amplification. 19 calibrated linear sweeps from 0.5 sec/cm to 0.5 usec/cm are available. Any 10 cm portion of 50 cm of expanded screen is positionable on screen. Y-amplifier is accurate to 5% overall.

Price **$580.00**

404

HIGH REPETITION RATE PULSE GENERATOR

Hard tube circuitry (no hydrogen thyratrons) eliminates all bumps and squiggles — assuring hair-line firing of sharp-edged pulses. Provides repetition rates to 100,000 pps, or single pulses by manual triggering. Jitter between trigger and pulse is less than 0.002 usec maximum. Pulse rise and fall time is 0.018 usec maximum, and pulse width is continuously adjustable between 0.05 and 100 usec. 59.5 db of attenuation in 0.5 db steps is available with no pulse degradation. Maximum pulse output is 50 V into 50 ohms; trigger output is 25 volts. Internal delay from 2 usec before trigger to 8 usec after.

Price **$675.00**

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Circle 87 Readers Service Card

DUMONT® 400 series

405

MULTI-PURPOSE VACUUM-TUBE VOLTMETER

High precision measurements on both A-C and D-C are now possible with a single meter. May be used for off ground operation — measures up to 1000 volts D-C off ground. 121 megohm D-C input resistance. Useful for A-C voltage measurements from 20 cps to 700 megacycles. Measurements on either A-C or D-C can be made down to 0.1 volt, full scale. Meter includes seven continuously calibrated resistance ranges, an illuminated mirror-backed scale, dual input, and has very low drift (plus/minus 3 mv max. on any range). Amplifier output available with gain over 60 db. D-C and filament supplies are regulated.

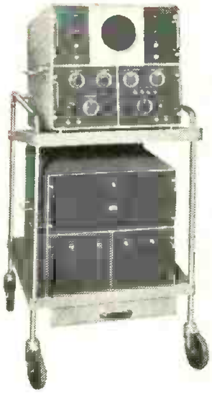
Price **\$265.00**

407

TRANSISTORIZED PRE-AMPLIFIERS

The perfect accessory for any scope. It provides common mode rejection up to 10^6:1. Differential gain of 10. Frequency response is 0.15 cps to 10 kc. Completely self-contained and extremely compact — powered by battery with life of 1000 hours. Negligible internal noise and drift is featured. Circuitry is temperature compensated.

Price **\$125.00**



410

HIGH FREQUENCY OSCILLOSCOPE

For complete quantitative investigations from D-C to beyond 50 megacycles. Building block design permits selection or physical interchange of desired units. High sweep rate — up to 250 kc. Y-amplifier rise time is less than 7 millimicroseconds. Calibrated sweeps from 0.02 sec/cm to 0.01 usec/cm are provided. Sensitivity is from 0.2 to 200 volts full scale. A-C or D-C sync is available with level selection. Type K-1546 cathode-ray tube is operated at 24,000 volts. Unit sections ready for immediate insertion in standard relay racks.

Price **\$3,500.00**

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Note: All prices for 60-cycle areas.

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Circle 88 Readers Service Card

AiResearch servo-controller for a pilotless guidance system

Simple servo-amplifier...actuator system achieves maximum speed of response with high stability

Because most missiles and drones are self-destructive, it is important that the components in their guidance systems be both highly accurate and dependable and be producible in quantity at low cost. The AiResearch servo-controller meets the above requirements.

It operates as follows: an AiResearch servo-amplifier weighing less than .7 of a pound amplifies electric signals from an inertial guidance source and converts them to command signals. These in turn are transmitted to an AiResearch electrically-powered light weight linear actuator which adjusts control surfaces of missile or drone to maintain a predetermined course.

The servo-controller can operate from either a DC or AC power supply. It can also be designed to take signals from celestial, telemetering or pre-programming sources to maintain or readjust the course of its pilotless air vehicle. It is another example of the AiResearch Manufacturing Division's capability in the missile field.

Inquiries are invited regarding missile components and sub-systems relating to air data, heat transfer, electro-mechanical, auxiliary power, valves, controls, and instruments.

Outstanding opportunities for qualified engineers.

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AiResearch Manufacturing Divisions

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at the

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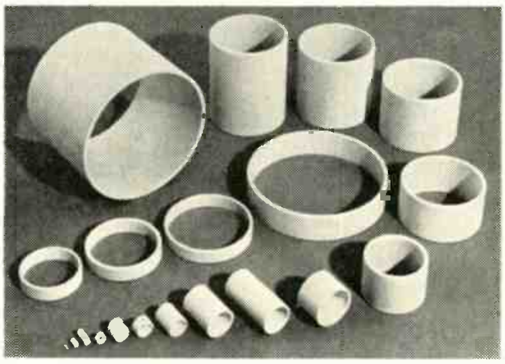
ideas
in high strength
ceramics



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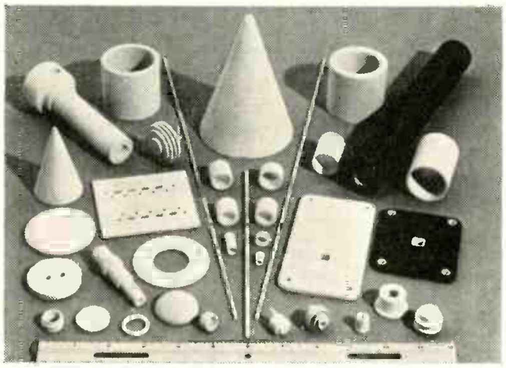

SEE examples of COORS high strength ceramic used in both low and high frequency circuits.

SEE the new line of COORS standard terminal insulators—high temperature metalized and brazed for high temperature applications.

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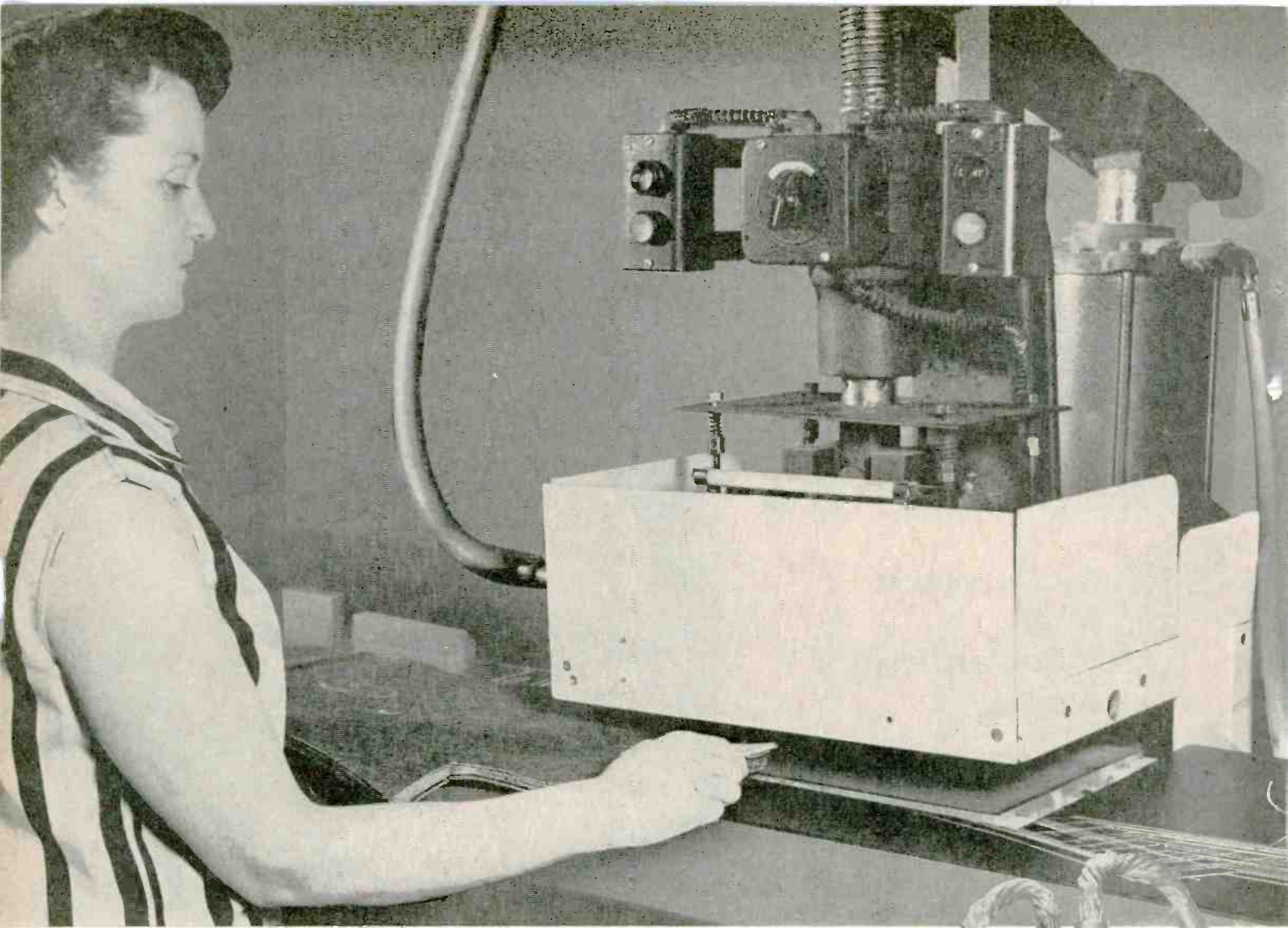
Manufacturers of High Strength Alumina Ceramics



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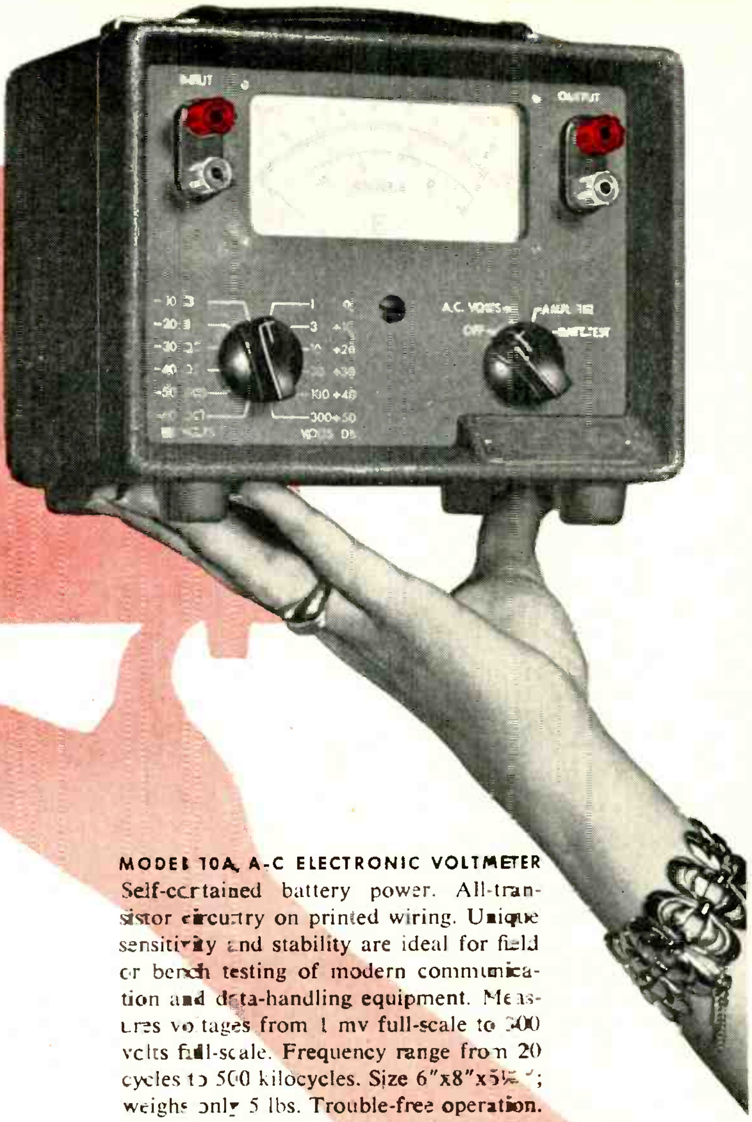

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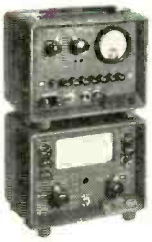
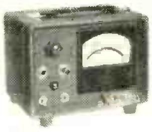
MODEL 10A, A-C ELECTRONIC VOLTMETER
Self-contained battery power. All-transistor circuitry on printed wiring. Unique sensitivity and stability are ideal for field or bench testing of modern communication and data-handling equipment. Measures voltages from 1 mv full-scale to 300 volts full-scale. Frequency range from 20 cycles to 500 kilocycles. Size 6"x8"x5½"; weighs only 5 lbs. Trouble-free operation. Competitively priced.



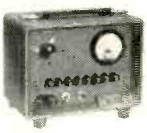
MODEL 25A
TEST OSCILLATOR (TELECOMMUNICATIONS)
8 preset frequencies (pushbutton)
Balanced output—600 ohms impedance

MODEL 15A
MULTI-RANGE A-C VOLTMETER
Balanced input—30 cps to 300 kc
1 mv to 300 v full-scale



MODEL 14A, TRUE-RMS A-C VOLTMETER
0.5 mv full-scale
Response: 10 cps to 500 kc

MODEL 20A
TEST OSCILLATOR
15 cps to 150 kc
0.5-ohm output impedance



MODEL 21A
TEST OSCILLATOR (PUSHBUTTON)
8 preset frequencies
15 cps to 150 kc

MODEL 11A, DBM/DBA METER
For bridging 600-ohm circuits
Balanced input—50 cps to 25 kc

MODEL 40 SERIES
CARRIER FREQUENCY ATTENUATORS
0.2 db accuracy, d-c to 600 kc
1-db steps to 82 db

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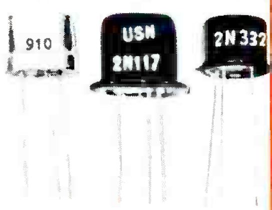
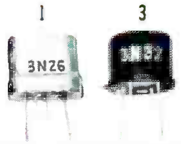
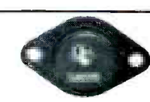
T/I SILICON TRANSISTORS

For your high temperature applications, TI silicon transistors are available in a choice of soldered cases for use in existing equipment, oval welded cases to meet U.S.N. specs, and round welded cases for new designs.

	1.	2.	3.	Dissipation at 25°C W	Small Signal Current Transfer Ratio h_{fe} (min.)	(max.)	Collector Current I_c mA (max.)	DC Current Transfer Ratio h_{FE} (min.)	(max.)	Collector Breakdown Voltage-V BV_{CBO} (min.)	Saturation Resistance R_{CS} Ohms (max.)	Alpha Cutoff Frequency h_{ab} mc (min.)
small signal 1 2 3 		2N117										1
	903	USN2N117	2N332	0.150	9	20	25			30 **45**	300	1
		2N118										2
	904	USN2N118	**2N333**	0.150	18	40	25			30 45	300	2
	904A	2N118A	2N334	0.150	18	90	25			30 **45**	300	8
		2N119										2
	905	USN2N119	**2N335**	0.150	36	90	25			30 45	300	2
	910		2N336	0.150	76	333	25			30 **45**	300	
switching  3			2N337	0.125			20	20	55	40	300	20
			2N338	0.125			20	45	150	40	300	10
high frequency 1 3 			3N32	0.125			10	Power Gain: 20 db (min.) at 4.3 mc				
			3N33	0.125			10	Power Gain: 18 db (min.) at 12.5 mc				
			3N34	0.125			10	Power Gain: 16 db (min.) at 30 mc				
	925 3N26			0.125			10	Power Gain: 15 db (min.) at 12.5 mc				
	926 3N27			0.125			10	Power Gain: 14 db (min.) at 30 mc				
medium power 1 3 	**951**		2N339	**0.750** 1	9		60			**50** 55	300	
	952		2N340	**0.750** 1	9		50			**80** 85	350	
	953		2N341	**0.750** 1	9		40			120 125	400	
	2N243		2N342	**0.750** 1	9	32	60			60	350	
	2N244		2N343	0.750 1	28	90	60			60	350	
power 	970			8.75			140	3		120	200	
high power 	2N424			37.5	10 (large signal)		2 amp	10		60	10	
	2N389			37.5	10 (large signal)		2 amp	10		60	6	

		Former Designation	Dissipation at 25°C mW	Collector Voltage-V (max.)	Collector Current mA (max.)	Beta (min)	(max.)	Conversion Gain db (min.)	(max.)	IF Gain db (min.)	(max.)	Audio Gain db (min.)	(max.)	Power Gain db (min.)	Alpha Cutoff Frequency mc (avg.)
VHF tetrode pnp 	3N25	501	25	−15	−2	65 (des. cen.)								10@ 100mc	250
high frequency pnp 	2N248		30	−25	−5	20 (des. cen.)								10@ 18mc	50
radio converter and IF  npn	2N253		65	12	5					28	32 at 455 kc				
	2N254		65	20	5					32	36 at 455 kc				
	2N172	830	65	16	5			22	28						
	2N145		65	20	5					30	33 at 455 kc				
	2N146		65	20	5					33	36 at 455 kc				
	2N147		65	20	5					36	39 at 455 kc				
	2N148		65	16	5					32	35 at 262.5 kc				
	2N149		65	16	5					35	38 at 262.5 kc				
	2N150		65	16	5					38	41 at 262.5 kc				
	2N148A		65	32	5					32	35 at 262.5 kc				
	2N149A		65	32	5					35	38 at 262.5 kc				
	2N150A		65	32	5					38	41 at 262.5 kc				
pnp	2N252		30	−16	−5			30	—						
	2N308	375	30	−20	−5					39	42 at 455 kc				
	2N309	376	30	−20	−5					41	44 at 455 kc				
	2N310	377	30	−30	−5					37	—	28*	—		
audio output pnp 	2N185	252	150	−20	−150							Class A: 39 Class B: 26	—		
	2N238	310	50	−20								37	42		
	2N291	357	300	−25	−200							Class A: 31 Class B: 22	—		
general purpose  npn	2N364	200A	150	30	50	9	19								2.5
	2N365	201A	150	30	50	19	49								3
	2N366	202A	150	30	50	49	—								3.5
pnp	2N367	300	150	−30	−50	9	19								0.7
	2N368	301	150	−30	−50	19	49								1
	2N369	302	150	−30	−50	49	—								1.3
power pnp 	2N250	356	25W	−30	−3A	30	Class B Power Output: 10W					Class A 30			
	2N251	356A	25W	−60	−3A	30	Class B Power Output: 40W					Class A 30			
phototransistor npn 	800		65	20	5										

* Audio voltage gain $= \frac{E\ Out}{E\ In}$ in recommended circuit

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T/I SILICON DIODES AND DIODE/RECTIFIERS

GENERAL PURPOSE

Type	Max. Reverse Working Voltage	*Min. Junction Break-down Voltage	Min. Forward Current 25°C mA	V	Max. Ratings at 25°C: † Reverse Current µA	Dissi-pation mW	Avg. Rectified Forward Current ma	Max. Ratings at Elevated Temperatures: Ambi-ent Temp. °C	† Reverse Current µA	Dissi-pation mW	Avg. Rectified Forward Current mA	Typical Capacity µµf f=100kc Temp=25°C IV=−12V‡
600C		30	3	1	8 @10 V	100	25	100	20 @10 V	40	15	2 5
601C		50	3	1	0.04 @10 V	100	25	150	40 @10 V	20	10	2 5
604C	4 7	5 5	60	1	0 1	150	100	150	50	40	40	20
606C	6 8	7 5	35	1	0 1	150	90	150	50	40	35	16
608C	10	11	25	1	0 1	125	75	150	50	20	25	12
610C	15	17	12	1	0 1	125	60	150	50	20	20	7
612C	22	25	7	1	0 1	125	50	150	50	20	20	5
614C	33	37	5	1	0 1	125	35	150	50	20	15	3 5
616C	47	52	3	1	0 2	100	30	125	40	20	15	2 5
618C	68	75	1 5	1	0 2	100	25	125	40	20	10	2
620C	100	110	0 9	1	0 2	100	20	125	40	20	8	1 4
622C	150	170	6 5	4	0 2	90	15	100	30	30	5	1 2
624C	220	250	3	4	0 4	80	10	71	20	40	5	1
IN645	225	275§	400	1	0 2	600	400	100	15		150	9
IN646	300	360§	400	1	0 2	600	400	100	15		150	9
IN647	400	480§	400	1	0 2	600	400	100	20		150	9
IN648	500	600§	400	1	0 2	600	400	100	20		150	9
IN649	600	720§	400	1	0 2	600	400	100	25		150	9

VOLTAGE REFERENCE **

Type	Rev. Breakdown Voltage at 25°C (measured at 5 mA reverse current) (min.)	(max.)	Max. Total Power Dissipation mW at 25°C	at 150°C	Min. Forward Current at 25°C at +1V ma	Max. Average Rectified Forward Current mA at 125°C	at 150°C	Max. Reverse Current at −1V µA at 125°C	at 150°C
650C	3 7	4 5	150	40	125	125	50	0 1	20
651C	4 3	5 4	150	40	100	120	45	0 1	20
652C	5 2	6 4	150	40	75	110	40	0 1	20
653C	6 2	8	150	40	60	100	40	0 1	20

* Measured at 0.1 ma. Current increases rapidly above this point.
† At maximum working voltage except for Types 600C and 601C.
‡ On types 604C, 606C and 608C reverse voltage was reduced below breakdown voltage.
§ At 100° C.
** All low voltage reference diodes are available with ±5% tolerances between 3.7 and 10 volts

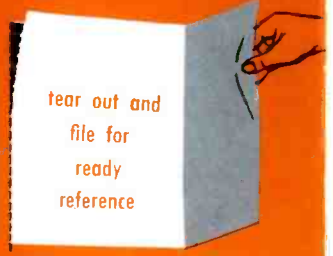
T/I SILICON RECTIFIERS

	Type	Welded Case	Application	Recurrent Peak Inverse Voltage V at 25°C	at 150°C	Average Rectified Forward Current at Max. PIV mA at 25°C	at 150°C	Recurrent Peak Current -55°C to +150°C* -65°C to +150°C† mA	Altitude at Max. Rating (FT)	Avg. Output Current Full-Wave Operation at -55°C to +150°C mA	AC Anode Voltage (per section) -55° C to +150°C V
1.	1N588	Axial	HV Half-Wave	1500	1000	25	10	150*	70,000		
	1N589	Axial	HV Half-Wave	1500	1000	50	25	250*	70,000		
2.	1N1130	Cathode Stud	HV Half-Wave	1500	1000	300	150	900†	70,000		
	1N1131	Anode Stud	HV Half-Wave	1500	1000	300	150	900†	70,000		
3.	T/I-680	Plug-in	HV Full-Wave	1500	1000	—	—	—	—	50	350
4.	1N538	Axial	Half-Wave	200	200	750	250	2.5 A at 25°C	100,000		
	1N539	Axial	Half-Wave	300	300	750	250	2.5 A at 25°C	100,000		
	1N540	Axial	Half-Wave	400	400	750	250	2.5 A at 25°C	100,000		
	1N1095	Axial	Half-Wave	500	500	750	250	2.5 A at 25°C	100,000		
	1N1096	Axial	Half-Wave	600	600	750	250	2.5 A at 25°C	70,000		

← FOLD OUT FOR T/I TRANSISTORS / RESISTORS AND PANEL INSTRUMENTS →

Complete listings of

T/I SEMICONDUCTORS, RESISTORS AND PANEL INSTRUMENTS



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SEMICONDUCTOR-COMPONENTS DIVISION

T/I PRECISION PANEL INSTRUMENTS

STANDARD RANGES

2% ACCURACY (Except as noted)

BAKELITE

direct current

MICROAMMETERS (See Note 1.)

Range	Scale Div.	Ohms Approx. Resis.
0-50	50	1150
0-100	50	1150
0-200	40	380
0-500	50	200

MILLIAMMETERS

Range	Scale Div.	Ohms Approx. Resis.
0-1	50	50
0-5	50	4
0-10	50	3
0-25	50	4
0-50	50	2
0-100	50	1
0-200	40	0 5
0-500	50	0 2

AMMETERS (See Note 2.)

Range	Scale Div.	
0-1	50	
0-2	40	
0-5	50	50
0-10	50	mV
0-20	40	Move-
0-30	30	ments
0-50	50	
0-60	30	

VOLTMETERS (See Notes 3&4.)

Range	Scale Div.	Per Volt
0-2	40	1000
0-5	50	1000
0-10	50	1000
0-20	40	1000
0-50	50	1000
0-100	50	1000
0-200	40	1000
0-300	30	1000
0-500*	50	1000
0-800*	40	1000

*See Note 5.

VOLUME UNIT METERS (See Note 17.)

alternating current

MILLIAMMETERS

Range	Scale Div.	Ohms Approx. Resis.
0-10	50	2400
0-20	40	710
0-50	50	90
0-100	50	20
0-200	40	7
0-500	50	1

AMMETERS (See Note 6.)

Range	Scale Div.	Ohms
0-1	50	0 27
0-2	40	0 06
0-5	50	0 011
0-10	50	0 0024
0-20	40	0 0005
0-50	50	0 0005
0-75†	75	0 0005

†See Note 5.

VOLTMETERS (See Note 7.)

Range	Scale Div.	Per Volt
0-1 5	30	3
0-3	30	10
0-5	50	10
0-8	40	12
0-10	50	15
0-15	30	15
0-30	30	35
0-50	50	65
0-100	50	110
0-150	30	110
0-300	30	110
0-500‡	50	110
0-600‡	30	110

‡See Note 8.

RECTIFIER TYPE VOLTMETERS (See Notes 4&9.) 5% ACCURACY

Range	Scale Div.	Per Volt
0-1 5	30	1000
0-2	40	1000
0-5	50	1000
0-10	50	1000
0-20	40	1000
0-50	50	1000
0-150	30	1000
0-300	30	1000

THERMOAMMETERS (See Note 10.) 5% ACCURACY

Range	Scale Div.	
0-1	50	All
0-3	30	Self-
0-5	50	Con-
0-10	50	tained
0-15	30	Units

HERMETICALLY SEALED AND RUGGEDIZED

direct current

MICROAMMETERS (See Notes 1 & 16.)

Range	Scale Div.	Ohms Approx. Resis.
0-50	50	2400
0-100	50	1200
0-150	30	1000
0-200	40	400
0-300	30	400
0-500	50	200
0-800	40	100

MILLIAMMETERS (See Note 16.)

Range	Scale Div.	Ohms Approx. Resis.
0-1	50	100
0-5	50	5
0-10ƒ	50	3
0-25	50	4
0-50	50	2
0-100	50	1
0-300	30	0 3
0-500	50	0 2

ƒSee Note 11.

AMMETERS (See Notes 11, 12 & 16.)

Range	Scale Div.	
0-1	50	50
0-3	30	mV
0-5§	50	Move-
0-10§	50	ments

§See Note 12

VOLTMETERS (See Notes 3, 4, 13 & 16.)

Range	Scale Div.	Per Volt
0-3	30	1000
0-5	50	1000
0-10	50	1000
0-20	40	1000
0-50	50	1000
0-100	50	1000
0-200	40	1000
0-300	30	1000
0-500**	50	1000
0-800**	40	1000

**See Note 14.

alternating current

MILLIAMMETERS (See Note 15.)

Range	Scale Div.	Ohms Approx. Resis.
0-10	50	2150
0-50	50	100
0-100	50	20
0-500	50	1

AMMETERS (See Notes 6&15.)

Range	Scale Div.	Ohms
0-1	50	0 2
0-3	30	0 03
0-5	50	0 01

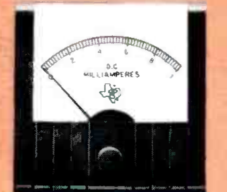
VOLTMETERS (See Notes 7&15.)

Range	Scale Div.	Per Volt
0-3	30	10
0-5	50	10
0-10	50	15
0-25	50	33
0-50	50	65
0-100	50	110
0-150	30	110
0-300	30	110

RECTIFIER TYPE VOLTMETERS (See Notes 4, 9&15) 5% ACCURACY

Range	Scale Div.	Per Volt
0-1	50	1000
0-3	30	1000
0-5	50	1000
0-10	50	1000
0-25	50	1000
0-50	50	1000
0-150	30	1000
0-300	30	1000

Where rapid, reliable delivery is essential, rely on T/I



Standard bakelite models available in a wide selection ranging from 2½-inch round through 4¾-inch rectangular semi-flush.

Hermetically sealed units available in 1¾-inch square, 2½-inch round and 3½-inch round enclosures. Hermetically sealed and ruggedized, DC only, in 2½-inch round and 3½-inch round.

NOTES

1. Center zero instruments available.
2. Panel instruments above values specified supplied as 50mV movements for use with separate shunts.
3. Panel instruments above values specified supplied as 1mA movements for use with separate external multipliers.
4. Higher resistance ranges available.
5. Available only in 3½-inch round and square and 4-inch models.
6. Panel instruments above values specified supplied as 5-ampere movements for use with separate external current transformers.
7. Higher ranges supplied for use with potential transformers or external multipliers.
8. Ranges up to 600 volts available in 3½-inch round and square and 4-inch meters.
9. Rectifier-type microammeters and milliammeters also available.
10. Lower ranges available with separate external thermocouples.
11. 1¾-inch unit not available above 10 mA range.
12. Available only in 2½-inch and 3½-inch ruggedized.
13. 1¾-inch unit not available self-contained.
14. Available only in 3½-inch units.
15. Hermetically sealed models only.
16. Accuracy of 1¾-inch unit is 3%
17. Available in 3½-inch round, 3-inch square and 4¼-inch semi-flush units.

T/I PRECISION DEPOSITED CARBON RESISTORS

industrial line (±1%)†

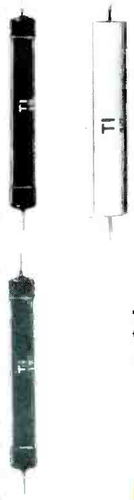
Part No	Wattage Rating	Resistance Range	Body Length	Body Diameter	Maximum Continuous Working Voltage
CD1/2PA	1/2	25 ohms to 2 meg	1/2	5/32	350
CD1/2MA	1/2	25 ohms to 2 meg	19/32	11/64	350
CD1/2SA	1/2	90 ohms to 9 meg	13/16	11/64	350
CD1A	1	25 ohms to 10 meg	15/16	19/64	1000
CD2A	2	100 ohms to 30 meg	2-1/16	19/64	2000

MIL-Line* (±1%)†

Part No.	MIL Desig-nation	Watt-age Rating	Resistance Range	Body Length	Body Diameter	Maximum Continuous Working Voltage
CD1/4R	RN10	1/4	40 ohms to 1 meg	1/2	3/32	300
CD1/2PR	RN15	1/2	25 ohms to 2 meg	1/2	5/32	350
CD1/2MR	RN20	1/2	25 ohms to 2 meg	19/32	11/64	350
CD1/2SR	None	1/2	90 ohms to 9 meg	13/16	11/64	350
CD1R	RN25	1	25 ohms to 10 meg	15/16	19/64	1000
CD2R	RN30	2	100 ohms to 30 meg	2-1/16	19/64	2000

hermetically sealed line (±1%)†

Part No.	MIL Designation	Wattage Rating	Resistance Range	Body Length	Body Diameter	Maximum Continuous Working Voltage
CDH1/2P	RN20	1/2	50 ohms to 2 meg	19/32	13/64	350
CDH1/2M	RN70	1/2	50 ohms to 2 meg	3/4	1/4	350
CDH1/2S	None	1/2	90 ohms to 9 meg	1	17/64	350
CDH1	RN75	1	100 ohms to 10 meg	1-1/8	3/8	1000
CDH2	RN80	2	100 ohms to 30 meg	2-1/4	3/8	2000



*MIL-LINE resistors are available on special order with KEL-F or Vinyl protective sleeving.
†Resistors with 2% and 5% tolerances also available at reduced prices.
Resistors to ½% tolerance or values outside tabulated ranges available upon request.
Special models available in quantity lots.
Nominal lead length 1½ inches #20—0.032 diameter tinned copper.
All units calibrated at 25° C.

SEMICONDUCTOR-COMPONENTS DIVISION

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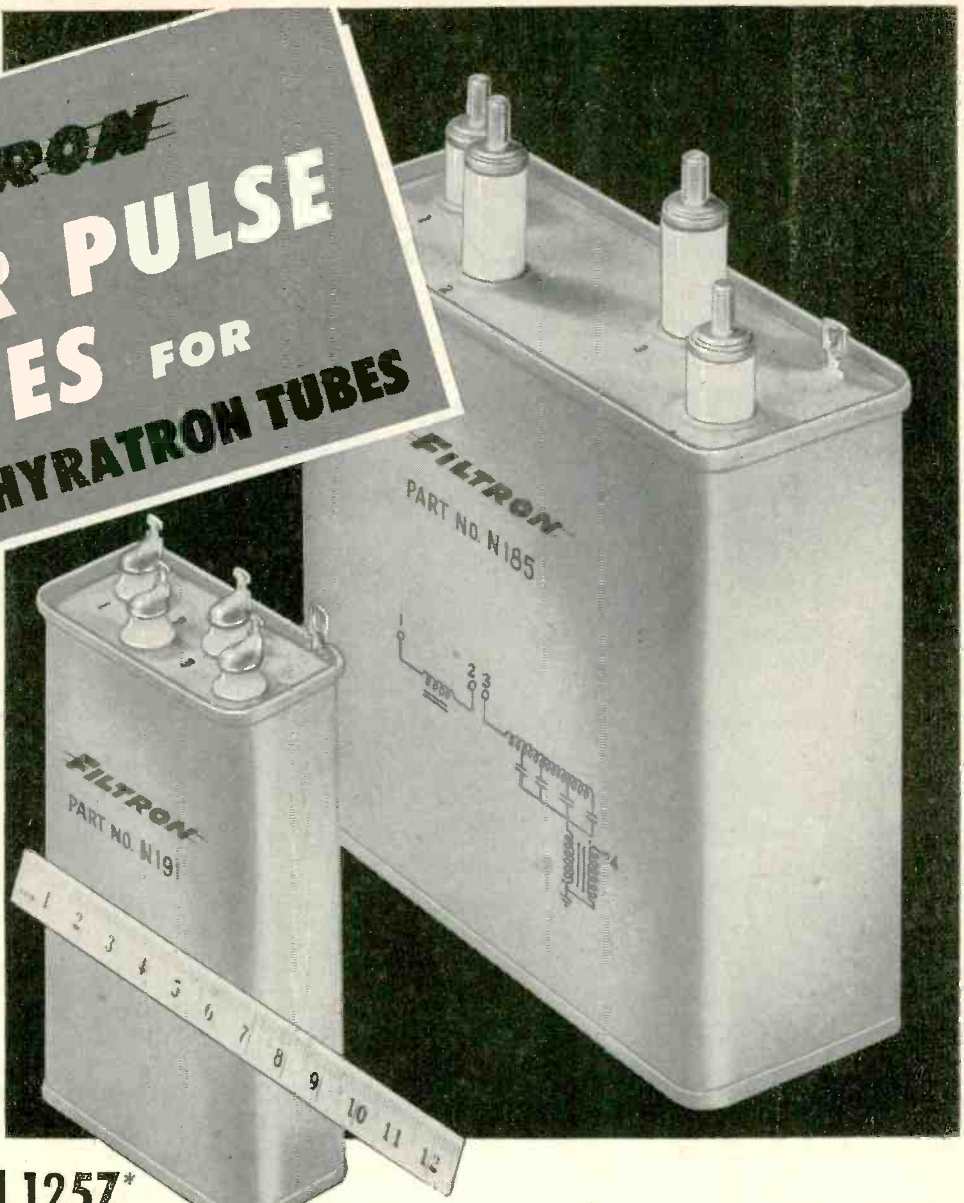
FILTRON TRIGGER PULSE PACKAGES FOR HYDROGEN THYRATRON TUBES



Trigger pulses according to latest MIL-E-1 spec for Hydrogen Thyratrons 5949/1907, 5948/1754 and 1257*

EACH PULSE PACKAGE INCLUDES CHARGING REACTOR, PULSE FORMING NETWORK AND PULSE TRANSFORMER SPECIFICALLY DESIGNED FOR THIS APPLICATION.

FILTRON TRIGGER PULSE PACKAGE N-191
For 5949/1907 and 5948/1754 thyratrons
Size: 1³⁄₁₆" x 2½" x 4¼" high (4¾" overall)
Input: 550 VDC @ 26 MA max.
Output (thyratron grid disconnected)
- Pulse Width: 2 μsec min at 70% amplitude
- Amplitude: 1000 V peak positive
- Rise Time: 0.35 μsec max. 26-70%
- Impedance: 70 ohm nominal
- Repetition Rate: 0-1500 pps

FILTRON TRIGGER PULSE PACKAGE N-185
For 1257 thyratron
Size: 2¼" x 5¾" x 5½" high (7" overall)
Input: 4 KVDC @ 82 MA max.
Output: (thyratron grid disconnected)
- Pulse Width: 2 μsec min. at 70% amplitude
- Amplitude: 2500V peak positive
- Impedance: 15 ohm nominal
- Repetition Rate: 0-1250 pps

*There is no MIL specification for the 1257 type thyratron, but the pulse package characteristics conform to the latest extant specifications for this tube.

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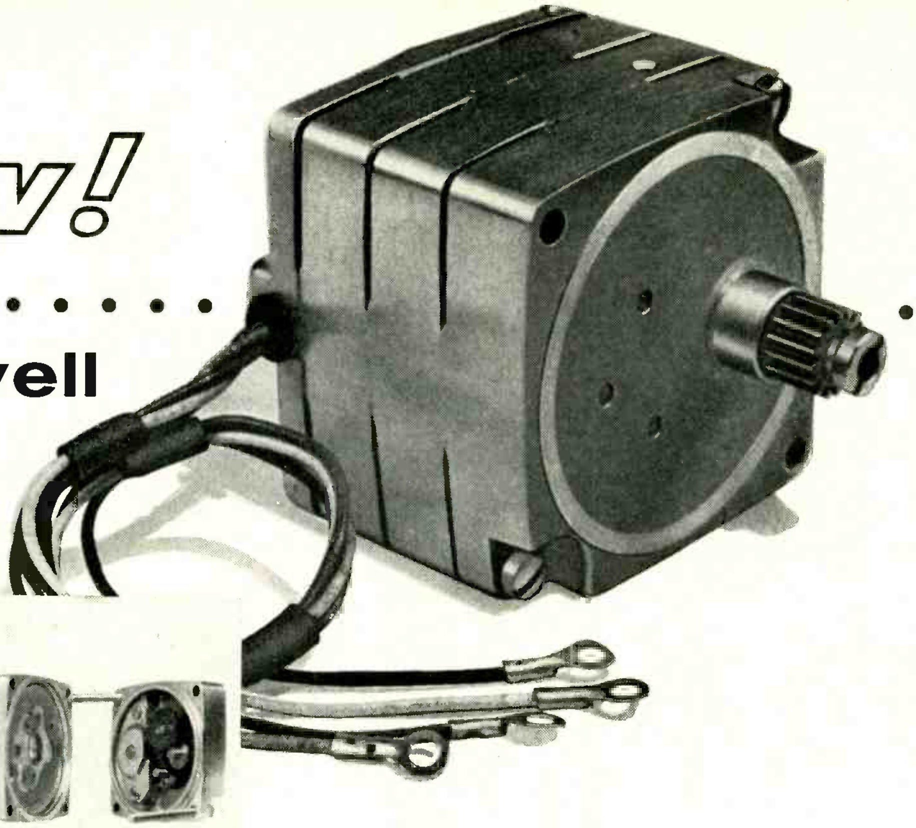
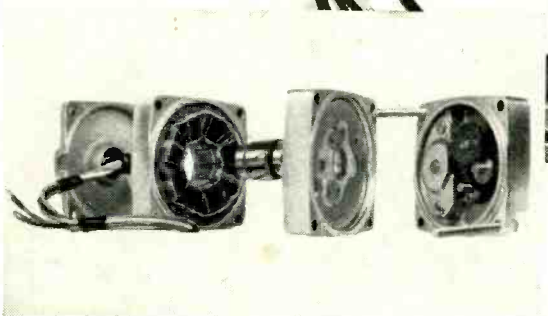
Honeywell Motors





for chart drives, servos, balancing circuits, remote positioners

Now from Honeywell come these newly-designed synchronous and two-phase motors of highest quality. New, sectioned die cast housing . . . new wicking to prevent oil leakage . . . ball bearings to reduce friction . . . printed circuits . . . are some of their many maintenance-saving features. What's more, you can replace any part in two minutes, usually without disconnecting the leads from your installation.

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TWO-PHASE INDUCTION

Nominal No-Load RPM*	Gear Ratio	Intermittent Rated Load (oz.-in.)	Max. Starting Torque (oz.-in.)	Power (watts)† Loaded	Current (amps.) Loaded	Temp. Rise Deg. F
330	44:1	4	10	7.6	.11	70
148	10:1	5	20	7.0	.11	70
44	30:1	15	50	7.6	.11	70
22	60:1	30	120	7.6	.11	70

†6.0 watts in field winding, balance in amplifier winding.

SYNCHRONOUS

RPM*	Gear Ratio	Pull-In Torque, Min. (oz.-in.)	Continuous Torque (oz.-in.)	Power (watts) Loaded	Current (amps.) Loaded	Temp. Rise Deg. F
180	10:1	12	12	19	.21	100
180	10:1	3.5	4	13	.11	65
90	20:1	14	12	11	.095	55
60	30:1	13.5	12	13	.11	65
30	60:1	27.5	12	13	.11	65

*1/6 less at 50 cycles. Some speeds availobe at 25 cycles.

Weight: 29 oz. Write for Specification S900-3.

Honeywell

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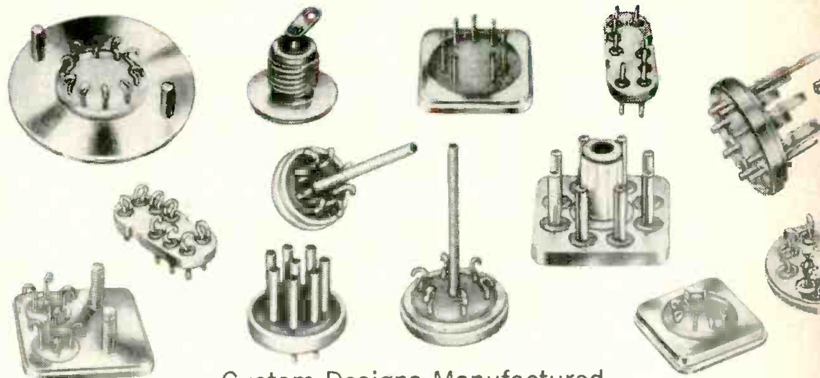

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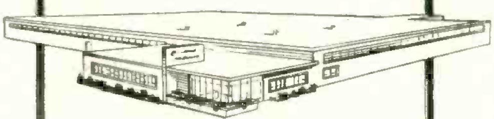

The Murray Hill facility is newly equipped throughout. Tighter quality controls, testing and inspection plus vastly increased production mean better products, faster than ever before.

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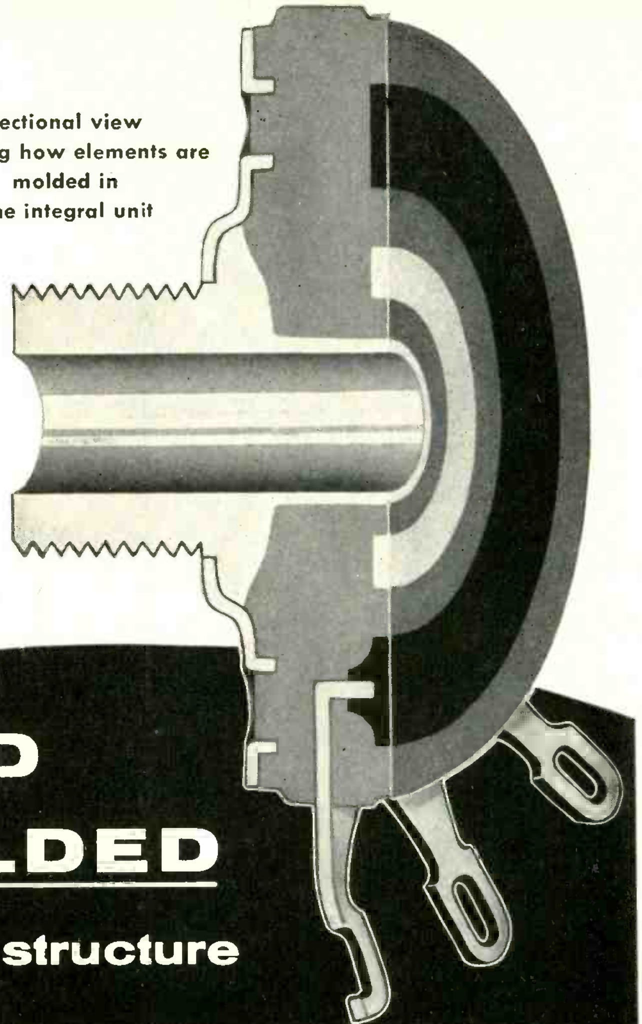
ALLEN-BRADLEY

QUALITY

variable resistors

Sectional view showing how elements are molded in one integral unit

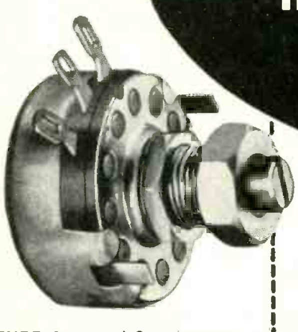


When successful circuit operation depends upon a variable resistor that is not affected by moisture, heat, cold, or age . . . the Allen-Bradley units are the answer. The solid "one piece" hot-molded structure has insulation, terminals, faceplate, and threaded bushing imbedded in the plastic body. With the resistance element as an integral part of the mold—not an added film or paint—it can be made to satisfy any resistance-rotation curve. Write for full details, today.

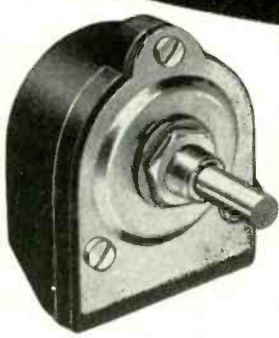
SOLID HOT-MOLDED

in one integral structure

for long life and low noise level



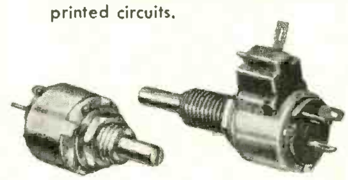
TYPE J—rated 2 watts at 70C ambient. Total resistance values from 50 ohms to 5 megohms. Available in single, dual, and triple units with various types of adjusting shafts, and with built-in line switch.



TYPE H—rated 5 watts at 40C ambient. Total resistance values from 50 ohms to 2.5 megohms. Good for over 100,000 cycles with no appreciable resistance change. Max. voltage 750 v, d-c.

TYPE T—rated ½ watt at 70C ambient. Plastic cover serves as actuator, making unit extremely flat. Total resistances from 100 ohms to 5 megohms.

TYPE F—rated ¼ watt at 70C ambient. Diameter ½". Standard tapers. Slotted shaft. Designed for printed circuits.



TYPE G—rated ½ watt at 70C ambient. Diameter ½". Plain or lock-type bushings; plain or slotted shaft. Available with line switch (right).

A-B QUALITY

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ALLEN-BRADLEY

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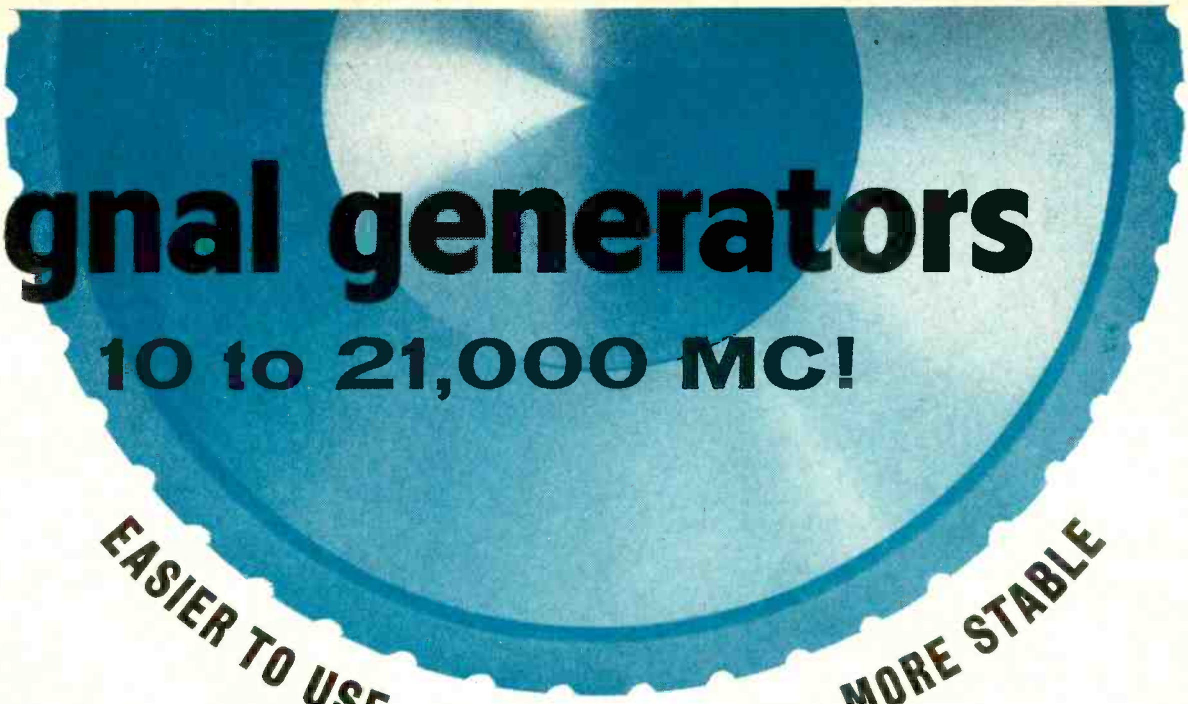

signal generators

10 to 21,000 MC!

EASIER TO USE • MORE ACCURATE • MORE STABLE

11 TO CHOOSE FROM

With *-hp-* signal generators, frequencies are directly set and read on one dial. Output voltage is directly set and read. No calibration charts are required. Most *-hp-* generators offer internal pulse, FM or square wave modulation; some include external pulsing and FM'ing. New *-hp-* 626A (10 to 15.5 KMC) and 628A (15 to 21 KMC) offer 10 mw output, SWR 1.2.

-hp- signal generators outsell other signal sources by approximately 2:1. Engineers report the reasons are simpler operation, versatility, trouble-free performance, and exceptional value.

Instrument	Frequency Range	Characteristics	Price
-hp- 608C	10 to 480 MC	Output 0.1 μv to 1 v into 50 ohm load. CW, pulse or AM mod. Direct calibration.	$ 950.00
-hp- 608D	10 to 420 MC	Output 0.1 μv to 0.5 v into 50 ohm load. CW, pulse or AM mod. Direct calibration and crystal calibrator check	1,050.00
-hp- 612A	450 to 1,230 MC	Output 0.1 μv to 0.5 v into 50 ohm load. Pulse, CW or amplitude modulation to 5 MC Direct calibration.	1,200.00
-hp- 614A	800 to 2,100 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW or FM modulation. Direct calibration.	1,950.00
-hp- 616A	1,800 to 4,000 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW or FM modulation. Direct calibration.	1,950.00
-hp- 618B	3,800 to 7,600 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW, FM or square wave modulation. Direct calibration.	2,250.00
-hp- 620A	7,000 to 11,000 MC	Output 0.1 μv to 0.223 v into 50 ohm load. Pulse, CW, FM or square wave modulation. Direct calibration.	2,250.00
-hp- 623B	5,925 to 6,575 MC; 6,575 to 7,175 MC; 7,175 to 7,725 MC	Output 70 μv to 0.223 v into 50 ohm load. FM or square wave modulation. Separate power meter and wave meter section.	1,900.00
-hp- 624C	8,500 to 10,000 MC	Output 3.0 μv to 0.223 v into 50 ohm load. Pulse, FM or square wave modulation. Separate power meter and wave meter section.	2,265.00
-hp- 626A	10,000 to 15,500 MC	Output 1 μμwatt to 10 mw. Internal or external pulse, FM, or square wave modulation. Direct calibration.	3,250.00
-hp- 628A	15,000 to 21,000 MC	Output 1 μμwatt to 10 mw. Internal or external pulse, FM, or square wave modulation. Direct calibration.	3,000.00

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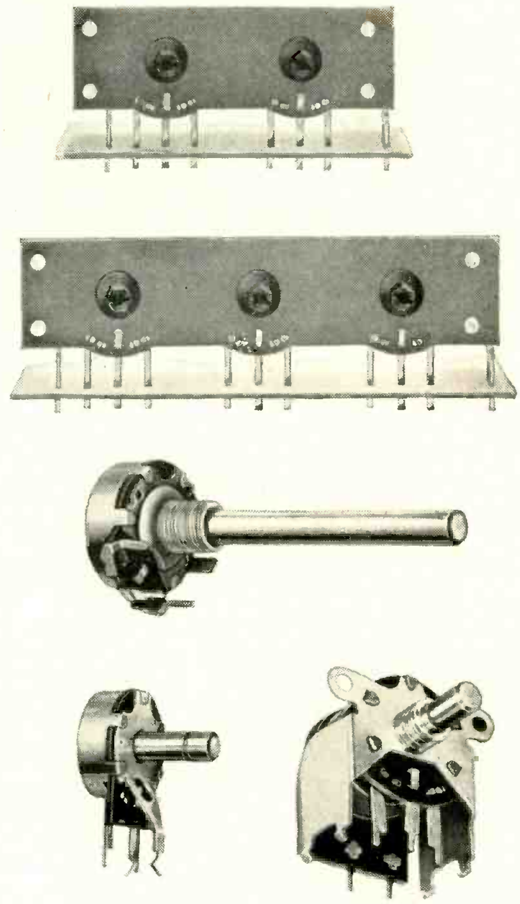
FIELD ENGINEERS IN ALL PRINCIPAL AREAS

complete coverage, outstanding value

Printed Circuit Controls by Mallory



Newest in the Mallory line of simplified controls for printed circuit applications—single or multiple resistance wafers applied directly on a phenolic panel which can be mounted by standard printed circuit construction techniques. Terminals are also available for solderless wire wrap assembly!

Any way you look at it . . .

Mallory controls are best for your printed circuit design

Here's good price and performance news for equipment manufacturers—a way to save on component cost and save on assembly cost wherever single or multiple secondary controls are used. Featuring the same high-stability resistance material as conventional Mallory controls, these elements are bonded direct to phenolic panels which can be mounted by simple printed circuit assembly methods.

Units of up to three controls can be mounted and wired in a single operation. Resistance values up to 10 megohms per single control, and numerous combinations of controls are available.

Other Mallory controls for printed circuit equipment, using the same high-stability resistance element made by Mallory's own special process, offer the designer and manufacturer a wide choice of mounting techniques. Included are models for mounting horizontal to, or vertical to the printed circuit.

All models have precision positioned mounting lugs designed for fast, accurate assembly. All are available in a wide range of circuit values and resistance tapers to suit specific design requirements. Special low end taper for transistor volume control is now available.

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And now—available on standard models, Mallory's new floating-ring line switch. Pull, it's on—push, it's off. Long-life contacts, reduced volume control wear, and clean, crisp switch action give your design another modern merchandisable touch.

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electronics

W. W. MacDONALD, Editor

AUGUST 1 • 1957

CROSS TALK

► **TWO PREOCCUPATIONS** . . . In the middle and far west on a business swing, we found big manufacturers in many fields uniformly preoccupied with two major questions: what to do about the high cost of money needed for expansion, and how to stimulate consumer buying still at a high level but showing signs of wavering.

The answer to the first preoccupation we'll leave to the nation's top economists, gladly. For the answer to the second we'll go along with our own company's top economist, as we do on most things, and suggest that expenditure for research and development leading to truly new products is almost certainly the only key.

► **MICRO-MINIATURE** . . . Work on miniaturization of component parts to go with transistors has progressed to the point where, believe it or not, the transistor itself is nearly the largest component in certain assemblies.

Smaller transistors will be the next step.

► **EXHIBIT DOLLARS** . . . Trade shows within the electronics industry itself have long been considered a mixed blessing, stimulating business on the one hand and costing time and money on the other. General sentiment places high value on those that are already established, resists splinter operations.

Decision to display or not to display becomes increasingly difficult as electronics penetrates more deeply into other industries; more and more electronics booths are seen at outside shows, and some of them do pay off. These do not yet seriously clip into our own shows, but they could.

If and when they do, the following oversimplified approach might help: (1) Decide how much time and money can be spent on this type of promotion. (2) Arrange shows in order of primary audience importance. (3) Start at the top of the list with adequate space and work down. (4) When the allocation runs out, stop.

► **HOME ELECTRONICS** . . . More electronic devices for the home, and for other man-in-the-street uses, are coming, but it is hard to put the finger on the precise nature of such devices of the future.

One thing is, however, becoming apparent. The low cost of printed circuits when applied to relatively simple equipment for which there is a volume market can speed the day. Use in many electrical and electronic toys now being shown the trade for the Christmas market is a good example.

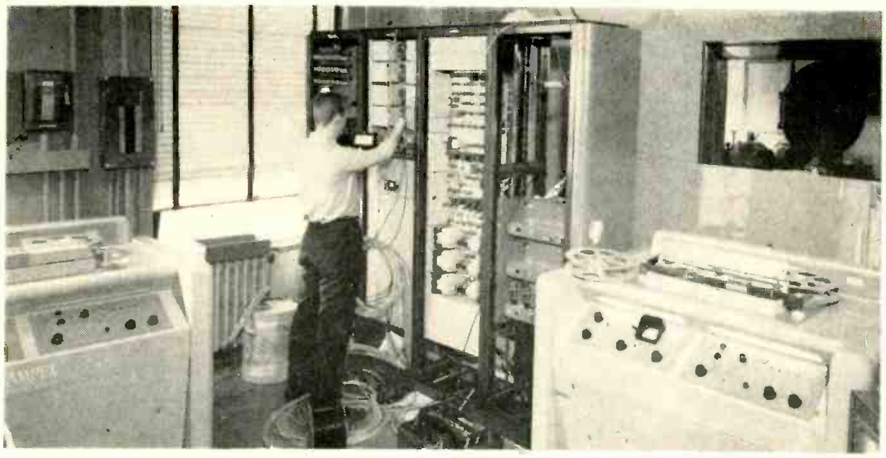
► **DEFINITION** . . . *Specification;* Collection of loopholes loosely held together by wistful verbiage.

LOOKING AHEAD . . .

Underwater detecting techniques have been radically improved, can protect a country against submarine attack as radar protects it against air attack, will lead to commercial byproducts

Expected leveling off of expenditures to find engineers will not indicate reduction of industry need so much as it does tightening up by government on what it is willing to allow taxwise and otherwise for such recruiting

Infrared is by no means alone in the passive detection field; all bodies radiate some microwave radio energy in the centimeter region under certain conditions and this energy can be separated from circuit and other noise



Technician wires rack equipment in ABC's Chicago video-tape recorder installation

By ROSS H. SNYDER
Ampex Corporation
Redwood City, California

VIDEO TAPE RECORDER

SUMMARY —— Low tape speed and extended high-frequency response are achieved in magnetic tape recorder by revolving four recording heads transversely across tape while tape moves only fast enough to keep successive tracks from overlapping. Recorded tapes have signal-to-noise ratios of 34 to 36 db with better than 300-line resolution and high contrast ratio

THREE POSSIBLE WAYS to extend the uppermost frequency response of magnetic tape recorders have been investigated. The brute force techniqe pulls the tape past the heads fast enough so a 4-mc signal appears on the tape as a wavelength about the same as the shortest used in audio. A second approach uses a number of channels in a time-multiplex arrangement. Both of these methods present mechanical difficulties.

This article described a third approach that revolves the head rapidly across the tape, while the tape moves only fast enough to keep successive transverse tracks from overlapping one another. This method presents a series of problems which are unique, but which are soluble in a practical, manufacturable machine.

Video-tape Recorder

As illustrated in Fig. 1, the Ampex recorder has four heads mounted at the outer circumference of a rotating disk with their gaps parallel to the disk axis.

Each head is spaced as nearly as possible at 90 deg from the next on the disk. With a disk diameter of about 2 in. and a rotational rate of 14,400 rpm (240 rps), the writing speed or relative head-to-tape velocity is about 1,500 ips.

The reel-to-reel tape velocity depends upon the width of the tracks which are to be laid down, one after another, transversely on the tape and upon the necessary space between them. These tracks are 10 mils wide, with an edge-to-edge separation of 5⅝ mils and a center-to-center spacing of 15⅝ mils. It is thus possible to obtain a great reduction in tape speed and to operate at the familiar 15-ips velocity. Using thin tape, 64 min of recording are obtained on a 12½-in. diam reel of 2-in. wide tape.

A 120-deg arc is described during the complete sweep of a head transversely across the tape.

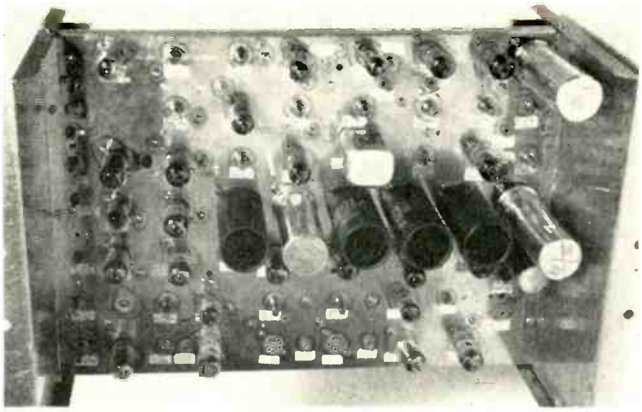
Since all four heads are fed the same currents during recording, there is a duplication of information toward the end of one track on the tape and at the beginning of the succeeding one. Advantage is taken of this duplication in the switching system used to deliver continuous transient-free signals during replay.

With four heads performing 960 sweeps transverse to the tape each second or each 15 in. of tape, one frame occupies ½ in. of tape longitudinally and the 525 horizontal lines which make up one full tv frame are recorded on 32 successive sweeps or tracks on the tape. Each track carries 16 or 17 horizontal lines of television information.

Three Tracks

The recorded tape has three separate, but synchronized magnetic tracks as shown in Fig. 2. The first (Fig. 2A) is the series of transverse video tracks; the second (Fig. 2B) is the sound track that accompanies the picture, which is im-

Playback of first regularly scheduled broadcast of CBS using video-type recording



Rack-mounted video processing amplifier corrects deformation of demodulated signal during playback

USES REVOLVING HEADS

pressed at the top of the tape; the third (Fig. 2C) is a signal that comprises a record of the alternating currents which fed the rotating disk motor during that recording.

During recording the sound track is wiped clean by the preceding erase head, for maximum signal-to-noise ratio.

Erasure has proved to be unnecessary on the control track. Even after erasure of the top 100 mils of the tape (for the sound track) and the destruction of the lower 100 mils of the recording by the control-track recording head, more than 90 deg of arc are still recorded on each transverse track. The overlap of information is approximately two tv picture lines, or around 130 μsec. During replay this allows a generous time interval during which electronic switching from head-to-head can take place.

Tape Transport

The transport mechanism used is similar to that found in many professional magnetic audio recorders. As illustrated in Fig. 3, the tape is supplied from a reel on the left; it is stabilized in its motion by passing around an idler whose motion is dominated by a heavy flywheel. It passes by the rotating video head assembly then goes on to a stationary pair of heads on one stack.

Of this stack, the upper one is an erase head which clears a 100-mil strip at the upper edge of the tape. The lower head records the control track in a similar strip along the bottom edge of the tape, without erasure. The tape then moves to a second stationary head stack which contains only the combination audio track record-replay head.

The tape next passes between a

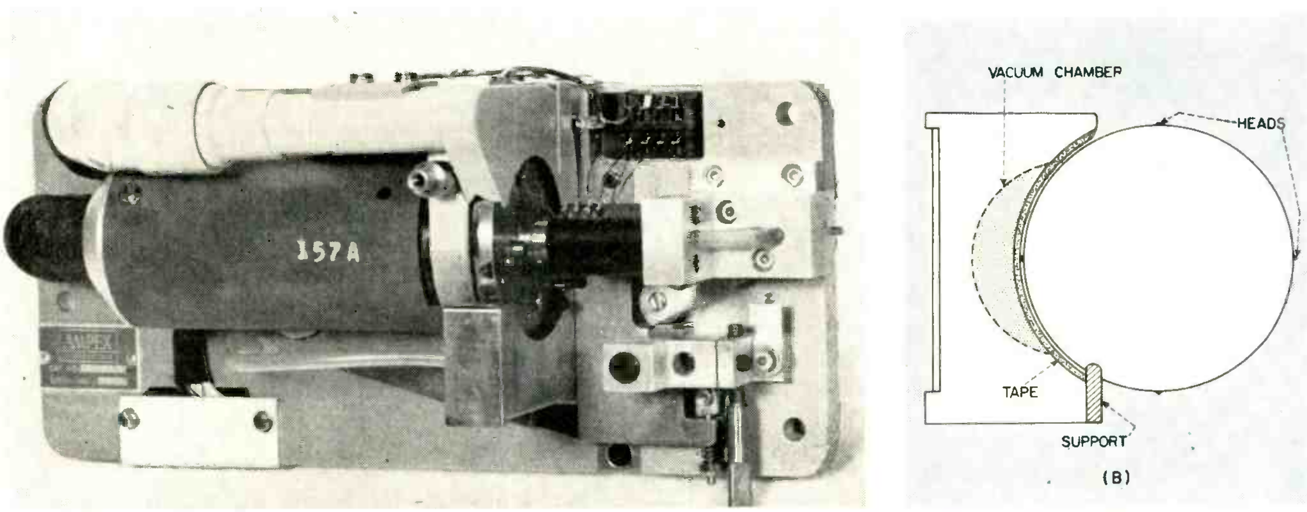


FIG. 1—Head subassembly (left) includes rotary heads, motor, commutator and vacuum guide chamber (right) to align tape

drive capstan and its pressure idler, around a takeup idler and on to a tape takeup reel at the right. The erase, audio and control track magnetic heads are stationary.

Guiding of the tape past the rotating disk is accurately, yet delicately controlled by the concave guide, shown in Fig. 1, which is used to cup the tape around the disk. The relation of tape to rotating heads must necessarily be intimate and good head contact at nearly constant pressure is required. This is accomplished by maintaining the fit of the concave guide within small tolerances to the exact path of the rotating heads and through the use of vacuum applied from the guide side of the tape.

System Operation

The recording system is shown in block form in Fig. 4.

During both recording and replay, an intimate relation must exist between the rotation of the revolving heads and that of the capstan. This process begins at the time the signal is recorded.

While recording, the 60-cps power-line frequency is first applied to a frequency multiplier, which produces a 240-cps signal. This signal drives a three-phase power amplifier during the original recording which in turn supplies 240-cps power to the synchronous motor which drives the rotating disk.

A portion of the revolving mechanism is coated half black and half white. A light source is focused on this revolving black and white disk and reflected into a photo cell to produce a 240-cps square-wave output. This is passed through a frequency divider, coming out at 60 cycles. The signal is then passed through a filter, whose output is a clean 60-cps sine wave, which in turn is fed to a power amplifier, whose output drives the capstan motor.

The whole chain is electrically analogous to a mechanical gear train, coupling the rotation of the capstan firmly to the rotation of the head disk. Neither the head disk motor nor the capstan motor are driven directly by the 60-cps power line frequency, although the power which is supplied to the disk-driving motor is directly derived from the incoming 60-cps signal.

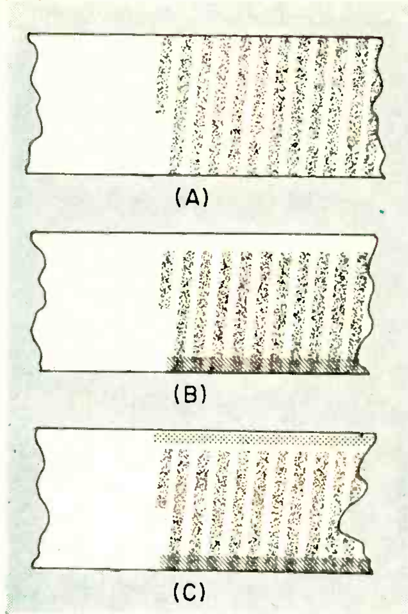


FIG. 2—Signal pattern after passing video head drum (A) paired audio-erase and control-track record heads (B) and audio-record head (C)

The power supplied to the capstan is generated from the actual motion of the revolving heads, enslaving the capstan to the head disk. Thus, during the recording process, the tape is moved precisely 62.5 mils longitudinally during each complete revolution of the head disk. During this period, four lateral tracks are recorded, one for each head, each track being separated from the next by a center-to-center space of $15\frac{5}{8}$ mils.

Control Track

During this process, the 240-cps output of the photocell is also fed, through a bandpass filter and a series of amplifiers, to the control track head, which records the signal longitudinally on the control track at the bottom of the tape (Fig. 2B). This control track becomes the magnetic equivalent of the sprocket-holes of a sprocketed film machine. Since the 240-cps signal is derived directly from the revolving heads, the signal on the control track bears a direct relation to the spacing of the lateral tracks on the tape and this information is available as a reference to control the relative positions of the head disk and capstan shaft during replay.

When the recorded video tape is to be played back, power line frequency is again multiplied to 240 cps, amplified and fed to the head disk motor, driving it at a rate which is at least approximately correct, for the purpose of tracing the previously recorded magnetic tracks. Again, the photocell produces a signal corresponding to the revolutions of the disk, this signal, once more being fed through a 240-cps bandpass filter and then, not to the control track recording head, but instead as one of two 240-cps signals to a phase comparator in the capstan servo amplifier chassis.

The second of these two 240-cps signals is that derived from the recorded control track, which is simultaneously amplified and fed to the phase comparator. The resultant signal is a function of the phase difference between the two signals. This is applied to a low-pass filter and then to the grid of a reactance tube which is one of the frequency-determining elements of a conventional Wien-bridge oscillator.

The oscillator functions nominally at 60 cps, but is slightly modified, up or down, by the correction-signal from the phase comparator. This signal is then fed to the power amplifier which drives the capstan in the same relation to the rotating disk, within narrow limits, as it did during the recording process.

Once the disk is adjusted on center to the tracks at the beginning of replay, the servo system holds the relation constant and the revolving heads indefinitely trace accurately the recorded video tracks.

The output of the photocell can also be used to determine in advance, the approximate moment during playback when it will be

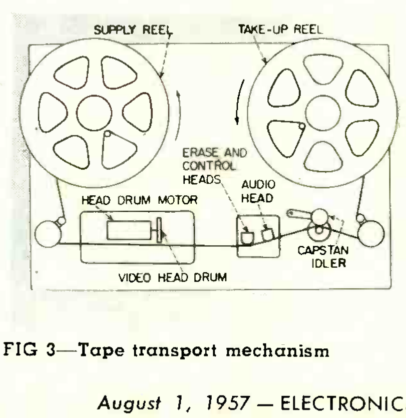


FIG 3—Tape transport mechanism

necessary to switch from one playback head to the next.

Editing and Splicing

There is a means of identifying that line on the tape which represents a vertical synchronizing pulse. The tape is wiped with a harmless solution that renders the magnetic recording visible. Since the vertical pulses have a characteristic and recognizable appearance, they may be located with precision. In equipment of more recent development they are used to identify the line along which the tape may be cut and spliced to another tape similarly cut.

Modulation System

It was necessary in the development of the recorder to seek a means of recording and reproducing the range from d-c to 4 mc or more and not just the upper end of that spectrum. A modulation system came naturally to mind, a f-m system being immediately appealing and ultimately adopted, in an unusual form.

Classically, it is assumed that the highest modulating frequency used in an f-m transmission system will not exceed one-tenth the carrier frequency and that deviation will be large compared with maximum modulating frequency. This implies a carrier of 40 mc, so the use of f-m would have to be abandoned, if these conditions were to be observed.

Recording the 40-mc carrier frequency requires either a large increase in head-to-tape velocity, or a large reduction in the shortest wavelength handled or both. It seemed as if a low-frequency carrier might do. Since it was desired that the range of modulating frequencies be large, compared with the total transmissible bandpass, it was evident that it was also desirable to use an f-m system in which the frequency of deviation was small with relation to the frequency of modulation. Thus, both classical assumptions in f-m transmission were to be violated.

Deviation Ratio

When the ratio of deviation to maximum modulating frequency is small, one pair of the sidebands is attenuated. When the ratio of deviation to modulating frequency is 0.1, the second pair is only 0.1 percent of the unmodulated amplitude of the carrier; where this ratio is 0.5, the second pair is still only 3 percent of the unmodulated amplitude of the carrier, while the first pair has increased to 24 percent of the unmodulated carrier amplitude. It can be seen that an unbalanced sideband condition is developed as the ratio of deviation to modulating frequency is decreased.

The exact solution to the dominant equation for the case where the ratio of deviation to modulating frequency is less than one-half is in the literature.[1] When this solution is applied to a series of sidebands under the conditions obtaining in the video-tape recorder, where carrier frequency equals 5 mc and deviation frequency is 1 mc or less, the unbalance of sidebands becomes quite great. These are no longer the relatively simple upper and lower sideband relations of the classical f-m system, but a new species of transmission system which might be called semi-single-sideband f-m transmission or just lopsided f-m.

In single sideband transmission of a-m signals, it is only necessary to handle enough of the vestigial sideband to insure that the filter employed does not introduce undesirable phase shift at the carrier frequency. With the lopsided f-m system, however, intelligence is preserved in the series of instantaneous frequencies which are created by the two side bands simultaneously. Since it is in the deviation that the intelligence lies, both its upper and lower excursions are meaningful.

In the case of the video-tape recorder, when the carrier is 5 mc, maximum modulating frequency is 4.5 mc and deviation is held to 500 kc; the head-tape system must efficiently pass frequencies from 5 mc less 4.5 mc or 500 kc, up to 5 mc plus the deviation frequency or 5.5 mc.

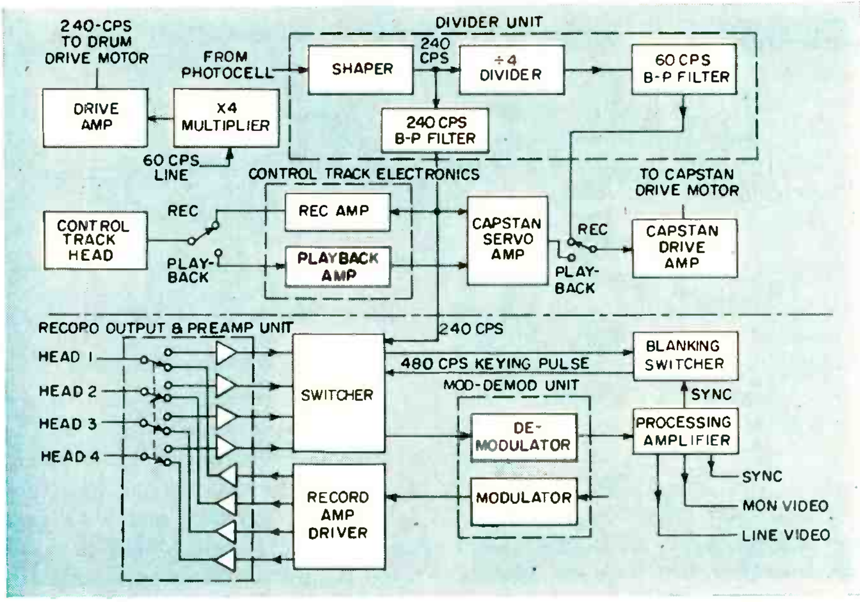


FIG. 4—System block diagram is divided into control system (top) and video (bottom)

This configuration of carrier, modulating frequency and deviation can encompass the television spectrum within the recordable bandpass of the magnetic recording system required. It is a comparatively simple matter to preserve frequency relations approaching d-c in an f-m system. At a later stage of development it may be preferable in handling the lowest frequencies to use d-c restoration techniques in the interest of simplified video amplifier circuitry.

Signal-to-Noise-Ratio

In f-m, when the ratio of deviation to modulating frequency is large, the bulk of the transmitted energy is in the sidebands and the noise rejection capability of the system is greatly superior to that of a-m systems. As this ratio is decreased the advantage decreases and finally disappears entirely when the f-m sideband energy is less than that which is obtained in 100-percent amplitude-modulation.

In the video-tape recording system, the deviation is 1 mc or less, giving a ratio of 0.25 or less. This results in a wide-band signal-to-noise ratio which is less than that which would be obtained with an a-m system. It was found that by holding within the tape velocity figures which were the aim, a signal-to-noise ratio well in excess of 30 db was attained over the 4-mc bandwidth.

Distortion

The classical assumption that carrier frequency in an f-m system should be ten times the highest modulating frequency or more, was made to avoid the distortion which the higher modulation frequencies must suffer as they approach the carrier frequency. The effect of distortion of video frequencies in the band above 1 mc in the video-tape recorder is a certain amount of zig-zagging of closely spaced vertical lines.

Not only is this effect evident only on such visual material, but the effect of the blurring is greatly reduced by the nature of human vision. When images thus distorted are viewed by the eye, which integrates its experience over a substantial period of time, the result is entirely acceptable, even for images representing a horizontal resolution of 300 lines or better.

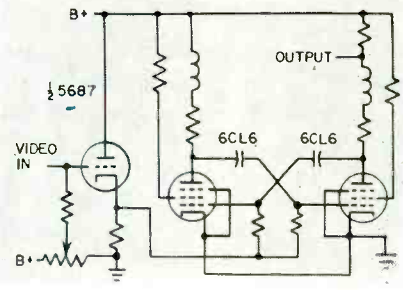


FIG. 5 Basic modulator used for recording

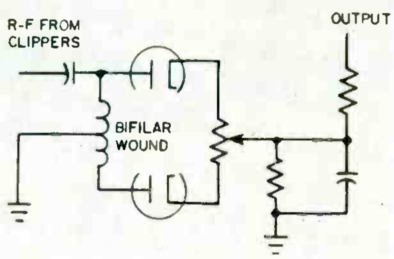


FIG 6—Basic demodulator for playback

Modulator-Demodulator

The circuitry employed in the modulator and demodulator of the video-tape recorder is lacking in novelty. Where deviation does not exceed a megacycle, and with carriers which do not exceed perhaps 6 mc, a multivibrator type of oscillator whose frequency is controlled by direct application of video to its control grids is entirely satisfactory and simple to maintain.

As shown in Fig. 5, two 6CL6 tubes are connected as a multivibrator, with special attention to switching time; the grids of the 6CL6 tubes are driven by one section of a 5687. The multivibrator output is amplified through conventional wideband video amplifiers and then applied in parallel to the two 815 tubes which drive the heads. Each section of the 815's drives a single head continuously during recording.

During replay, the output of each head is fed to its own preamplifier; the four channels feeding into a switcher. From the switcher a single channel of f-m r-f is fed to limiters. The last of these feeds into a bifilar coil, shown in Fig. 6, with a grounded center-tap. This coil resonates outside the system bandpass and the slope of the resulting response curve forms an f-m to a-m translator.

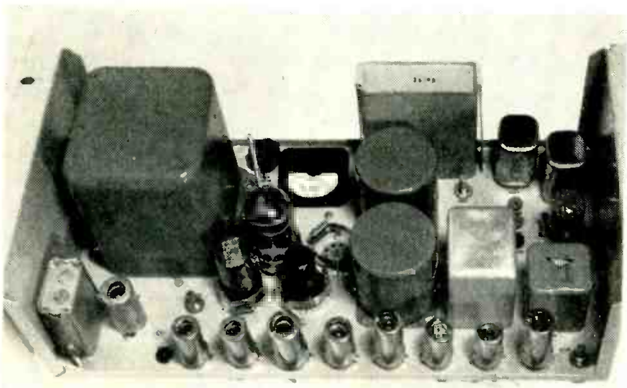
The resulting a-m is rectified through full-wave diodes, which feed a variable resistor acting as a balance control for the carrier. A low-pass filter, next in the chain, further reduces the level of carrier in the output.

Good linearity is readily achieved, so that grey-scale transfer is substantially undistorted.

Playback Switching

During replay, it is necessary to derive the amplified output signal from one head at a time, switching from one preamplifier to the next at a moment in the transmission when minimum disturbance will be introduced into the reproduced picture and later to demodulate the amplified r-f output of the playback heads. The electronic switching arrangement shown in Fig. 7 was developed for this purpose.

A network of coincidence gates is employed with a get-ready signal sent to each gating tube in turn from the 240-cps photocell source; a go signal is delivered with pre-



Rack-mounted capstan-drive servo control chassis supplies 240-cps driving signal to capstan

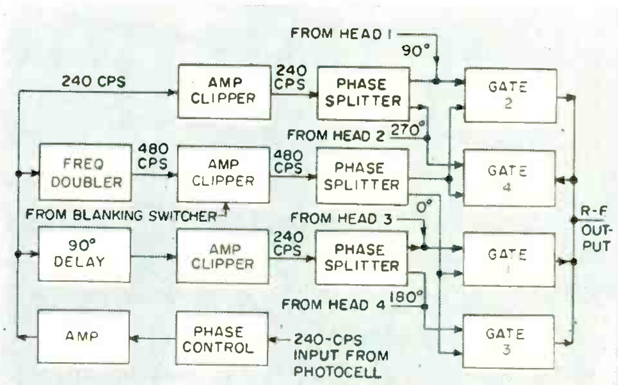


FIG. 7—During playback, electronic switcher derives output from one head at a time

cision to each gating tube from the television signal itself. Switching occurs only on the back porch of a horizontal pulse. Therefore it does not appear in the reproduced picture, even as a transient.

The 6BN6 gating tubes pass the r-f signal to their plate circuits only when each of two grids are raised to a predetermined level of bias. Thus the coincidence of two positive bias signals is used to trigger each of the four gates, consecutively.

The photocell output is delivered to the sequential switcher, as well as to the servo amplifier control system. This 240-cps signal, whose phase is directly related to the instantaneous position of the rotating head disk, is fed through a vernier phasing control to a 90-deg lag network that controls two related channels in conjunction with other signals. The same signal is continuously fed to a frequency doubler and an in-phase network.

The in-phase 240-cps signal is clipped and fed to a phase splitter, which produces two signals, one in phase and one 180-deg out of a phase. These two signals are applied to the gating tubes, the in-phase signal to one of the grids of gate 1, the opposite phase to one of the grids of gate 3. These are the same grids to which the amplified r-f from heads one and three are fed.

The 240-cps signal, which is fed through a 90-deg lag network, is similarly clipped, fed to a phase splitter, and applied to the control grids of gates two and four. In the same way, these gates receive the amplified r-f output of heads two and four at intervals of 90 and 270 deg.

Gate Keying

To cause these gates to pass r-f at the desired times, appropriate positive swings of a 480-cps square wave are applied to the coincidence grids of these gating tubes. The necessary 480-cps square-wave signal is obtained from a frequency-doubler whose input is also fed from the common 240-cps source.

Symmetry of the 480-cps signal is controlled, permitting the instant of switching to be adjusted with vernier accuracy to the desired angular position of the heads on the tape. With a rise time of about 0.05 μsec, this 480-cps square wave gives the final go signal to each switching operation, so that interruption of the composite signal is exceedingly brief.

The 480-cps square wave, like the two 240-cps control signals, is fed through a phase splitter, one phase going to gates one and three, the other to gates two and four.

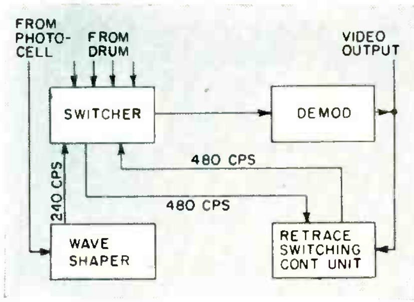


FIG. 8—Retrace control switcher prevents overlap of information in playback

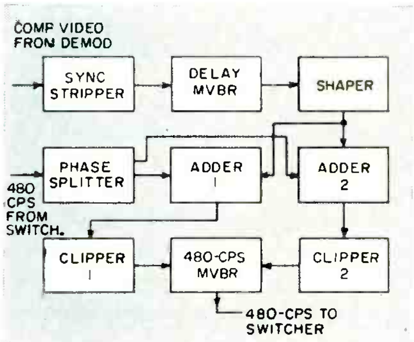


FIG. 9—Elements of retrace switching control unit

The sequence of operations, then, begins with the appearance at the control grid of gate 1 of the r-f signal from head 1. The 240-cps control signal is at this time going positive. The phase of the 480-cps square wave is such that it too goes suddenly positive at one point in the rotation of the head disk. At this moment, the gating tube begins to conduct r-f.

All four gating tubes are parallel in their outputs, and an r-f video signal is fed to the input of the demodulator, which follows the switcher.

About 90 deg later in the rotation of the head disk, the 240-cps delayed signal goes positive at the control grid of gate tube 2. This tube is fed from the opposite phase of the 480-cps control-signal from gate 1, so it too goes suddenly positive at the screen grid of this second gate and the tube conducts.

Since this rapid occurrence is coincidental with the negative phase of the 480-cps signal at gate 1, the gate ceases to conduct at the same moment that gate 2 begins to conduct. Gates three and four are both in the negative-going portion of the 240-cps control signal which is applied to them, so that gate 2 is, at this moment, the only one conducting. The same sequence of events occurs next at gate three, as the rotating head disk reaches approximately another 90 deg of rotation.

Retrace Control Switcher

Since approximately two television lines of information are duplicated from track to track on the magnetic tape, the bottom of one line contains the same information as the top of the succeeding track. A rearrangement of the get-ready, go signal procedure is desirable to locate the moment of switching.

If the line carrying the 480-cps wave is opened before it feeds the corresponding phase splitter, and this signal is delayed momentarily in accordance with the synchronizing information in the television signal, the switching can be done during retrace when the crt beam is off the television screen. The arrangement used is shown in Fig. 8. The retrace switcher control unit, shown in Fig. 9, contains a 480-cps multivibrator oscillator, which is locked jointly to the 480-cps photocell-derived signal and to the synchronizing pulses in the demodulated r-f video signal. Over a relatively narrow range, this oscillator's frequency may be varied, effectively delaying its output with respect to the 480-cps switcher signal, so that the exact moment at which the outgoing 480-cps square-wave goes positive may be made to coincide with a desired point in the controlling video signal.

As illustrated in Fig. 10, the switching time may be positioned on the back porch interval, which places the switching transients on the extreme left-hand side of the reproduced picture, out of view. Should the video signal fail, the multivibrator oscillator in the re-

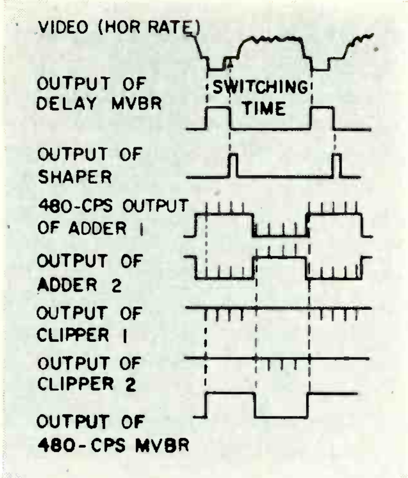


FIG. 10—Waveform relationships in retrace switching control unit

trace switcher will continue to send triggering pulses to the 480-cps multivibrator, insuring continuous output regardless of the nature of the incoming video signal.

If, for example, a synchronizing pulse should be missing from the train coming off the tape and the time should arrive when switching must occur from one head to the next, the unit will wait for a brief interval. When no synchronizing pulse appears, the unit will switch to the next head anyway, with minimal loss in signal from the tape.

The 480-cps signal, which originates in the sequential gating switcher, is thus modified and suitably delayed by the retrace switching control unit, so that, upon reinjection, it will cause the gating tubes to switch from channel to channel only at such a point in the sequence of video signals that there will be no visible effect.

Processing Amplifier

Because of the distortion which is necessarily introduced into the signal by the closeness of carrier and modulating frequency in the f-m system, because of the shape of the overall bandpass and because of the effect of minute amounts of hunting in the rotating drum, the waveform of the demodulated composite video signal suffers a certain amount of deformation. This is of minor importance to the video information, but of considerable importance to the shape of synchronizing pulses. A processing amplifier therefore follows the demodulator.

Through relatively conventional video techniques it strips off synchronizing information, reconstitutes it and adds it to the video information once more, to produce a composite signal which conforms to FCC television transmission standards.

The relative level of picture and synchronizing signals may be varied in the processing amplifier. From this chassis is derived the information which governs the retrace control switcher. The monitor and video line outputs are also fed from this unit.

Present Development

Performance of the video-tape recorder, in the form in which it exists in 1957, has been considerably improved over that obtained from the experimental unit first displayed in 1956.

The development of special tape, horizontally oriented, with surface smoothness much finer than that normally provided (or needed) in audio tape, specially formulated oxides of particularly good short-wavelength resolution capability and improved mechanical characteristics have all combined to make possible the routine realization of signal-to-noise ratios of 34 to 36 db, with occasional attainment of ratios as high as 40 db.

Head manufacturing techniques have also been refined reducing the abrasion effect, both on the tape and on the heads, to the point where a substantial number of heads have proved usable well beyond the 100 hours which were originally considered a practical norm. Tape too is proving capable, under these improved conditions, of being reproduced many more times without deterioration and of being recorded and rerecorded for an aggregate of well over the 100 passes of the revolving heads which at first were thought to be the practical maximum.

Head Deterioration

Deterioration in heads due to wear does not produce deterioration either in resolution or in the linearity of grey-scale transfer; in fact, resolution improves slightly as heads wear and only the eventual increase in noise tells of the approaching end of the useful life of the heads.

The same is true of tape. Neither resolution nor grey-scale linearity are affected by the gradual abrasion of the tape which occurs in use. Instead, the signal-to-noise ratio slowly begins to deteriorate, signifying the end of the useful life of the tape.

Linearity of grey-scale is an inherent advantage of the video-tape recording process due to the modulation system used. There are no operating controls on the recorder which are capable of affecting the linearity of the grey-scale transfer characteristic.

Differential gain measurements typically give readings of under 10 percent; this remains constant, being quite independent of head or tape condition. The live appearance of the video-tape reproduction is as much due to linear grey-scale transfer characteristic as to any other operating characteristic of the machine.

Resolution of better than 300 lines, with high contrast ratio, is readily obtained.

Tape Duplication

Experience with the recorder in daily network operation has established the practicality of making duplicate tapes from an original. While there is no method of making copies except by connecting one or more video-tape units as recorders, while another is used as a replay machine, the number of copies which may be made in this manner is substantially unlimited.

First-generation copies of an original video-tape recording are deteriorated in hardly any visible way, resolution and grey-scale linearity being substantially identical to the original. A slight rise in noise occurs, but if this is already well below visibility in the original the copy will appear virtually the same as the original.

The author thanks the many contributors who made this article possible.

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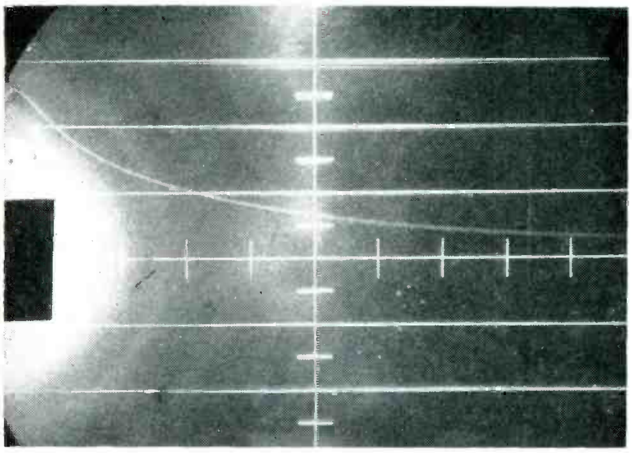

Signal waveform represents semiconductor lifetime of approximately 15 microseconds

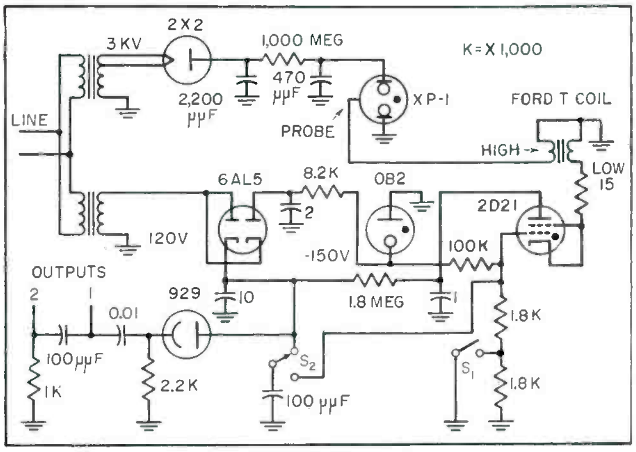

FIG. 1—Gas-discharge tube is triggered through pulses applied to bare-wire probe touching tube envelope

PULSED LIGHT TESTS MINORITY-CARRIER LIFE

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SUMMARY —— Xenon discharge tube is rapidly pulsed to illuminate semiconductor material creating hole-electron pairs. Voltage drop across material is observed on oscilloscope to determine minority-carrier lifetime

OF VARIOUS possible ways of measuring minority-carrier lifetime in semiconductor materials,[1] the photodecay method has advantages[2, 3] in versatility and simplicity.

A constant current is passed through a sample of the semiconductor. A short pulse of illumination on the semiconductor creates hole-electron pairs, reducing the resistivity and in turn the voltage drop across the sample. Observed on an oscilloscope this voltage returns more or less exponentially to its steady state value after the light pulse. The carrier lifetime is equal to the time-constant of this exponential decay.

Circuit

Figure 1 shows the circuit diagram for the light source. The desired short light pulses are produced by a small xenon-filled discharge tube.[3, 4]

The voltage applied to the XP-1 is not sufficient to make it break down. Accordingly, it is triggered with a high voltage produced by stepping up a thyratron discharge with an auto ignition coil. The trigger is applied by a bare-wire probe touching the outside of the tube close to the end of the grounded electrode.

When S_1 is closed, the 2D21 operates as a free-running relaxation oscillator with a period of several seconds. When S_1 is open (single-shot position), the negative grid bias is great enough that the 2D21 does not fire. When depressed, switch S_2, which is normally spring-loaded in the upper position, applies a positive firing pulse to the grid of the 2D21 thyratron.

Output 1 gives a replica of the light waveform, while output 2 is its time derivative. Thus the signal at output 2 goes negative at the end of the light pulse and could be used to trigger just at that time.

This equipment has been used with silicon to measure lifetimes as short as 5 to 10 μsec. This does not seem to be a limit, since the light pulse decays in less than 1 μsec.

The writer wishes to acknowledge the assistance of T. Tohver, now at Queen's University, who did much preliminary work on this circuit.

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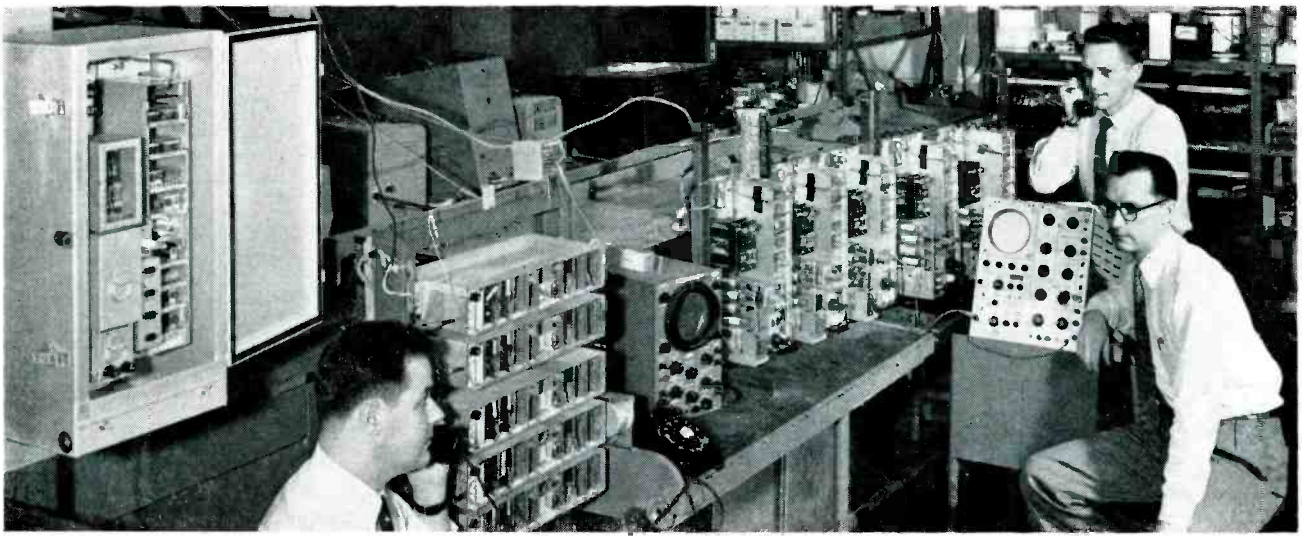


Laboratory setup for checking overall transmission quality of transistorized carrier system

RURAL CARRIER SYSTEM

SUMMARY —— Selective calling of up to ten telephone subscribers per wire pair is possible with transistorized transmitter and receiver using double-sideband transmission and operating over line losses of 35 db. Subscriber receiver response is flat within 0.5 db as a result of circuit stabilization

APPLICATION OF CARRIER transmission to rural telephone lines has been rather slow for many reasons, mainly economical. Systems could not, until recently, be proven-in over such short distances due to high cost per channel. Now that the cost of the equipment and maintenance has become competitive with that of constructing new wire lines, subscriber carrier operation becomes feasible.

Numerous requirements must be met. Overall quality of transmission should not be substantially inferior to that in other types of carrier equipment, which means that the transmitted bandwidth response should be flat between 250 to 2,500 cps. Crosstalk and noise must be kept low and reliable operation under extreme climatic conditions should be maintained.

Use of transistors takes of advantage of low power drain and small size, which is always attractive for pole-mounted units especially if standby power is required.

System

The system shown in Fig. 1 uses double sideband transmission and operates over line losses up to 35 db at carrier frequencies.

The five channels at the central office connect to the line through a line coil. The subscriber terminals drop off at convenient points along the line. Since carrier channels operate over voice-frequency physical circuits, it is necessary to isolate all subscriber telephones connected across the line. This isolation is accomplished by pole-mounted low-pass filters, which present high bridged impedance to the carrier frequencies.

Ringing and dialing are performed by interrupting the carrier while compandors are used, optionally, in cases where excessive line noise or crosstalk is encountered.

Fig. 2 and Fig. 3 show in block form the arrangement of circuit.

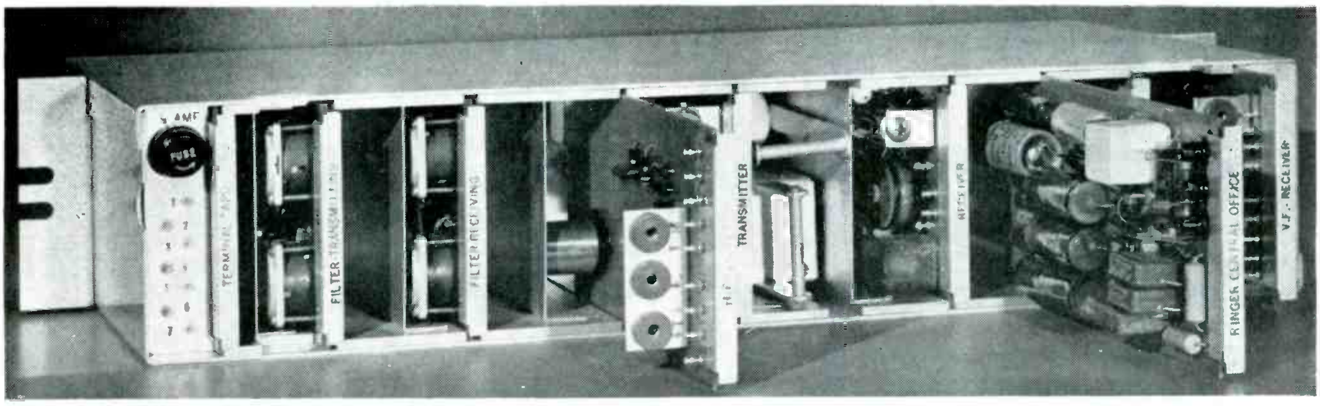
Voice signals from the central office line are routed through the hybrid and level adjusting pads to the modulator in the transmitter. When compandors are used, the compressor unit replaces the pads. The modulated wave is amplified to the line level and passed through transmitting filter to the line.

Subscriber Signals

The signals from the subscriber are selected by the receiving filter, adjusted to proper level, amplified, detected and delivered to the hybrid through the expandor, if used, or through the voice-frequency receiving pads.

The voice-frequency signal is then routed through the hybrid into the central office.

Transmission at the subscriber end is essentially the same. Dialing by subscriber is accomplished as



Central office terminal shows how individual circuits are arranged on cards for easy insertion and removal

By B. R. STACHIEWICZ

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A Division of General Dynamics Corp.
Rochester, New York

USES TRANSISTORS

follows: when the subscriber lifts his receiver a d-c circuit through the dial contacts, voice-frequency loop and the winding of relay *SR* is completed. Direct current, supplied by a power pack located on the pole-mounted terminal, flows in this circuit. Upon dialing, this current is interrupted causing the *SR* relay to operate. The contacts of this relay are arranged to short the output of the transmitter when the station is on-hook or the dial contacts are open. When the subscriber goes off-hook, the channel carrier is automatically transmitted. Thus dialing information is transmitted by switching the carrier frequency on and off.

At the central office the interrupted carrier is picked-off at the base of the detector stage, amplified and rectified by the signal a-c amplifier and used to drive relay contacts in series with the ring wire from the central office. The operation of this relay completes the d-c circuit through the hybrid winding and the central office relay. Pulses of d-c are thus obtained in the central office relay winding, which reproduce the dialing pulses generated at the subscriber end.

To call the subscriber, the ringing voltage of any frequency up to $66\frac{2}{3}$ cycles from the central office modulates the carrier wave transmitted to the subscriber. At the subscriber terminal those signals are amplified and detected in the receiver amplifier circuit. A special d-c amplifier located on the ringer card amplifies and rectifies the ringing signal and drives a mercury relay. The armature of the relay vibrates at the ringing frequency and the contacts are connected in the vibrator circuit. The output of the vibrator is applied to the subscribers voice-frequency extension at a magnitude that operate the

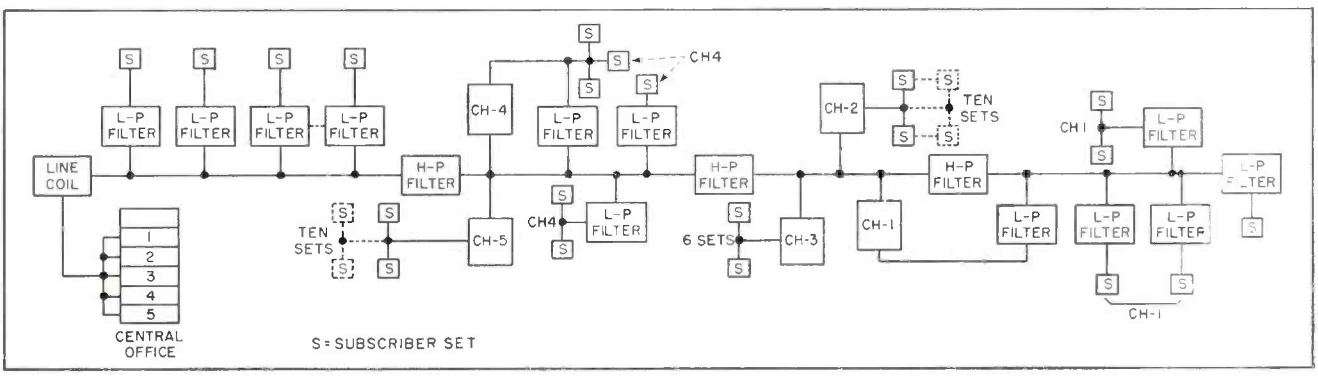
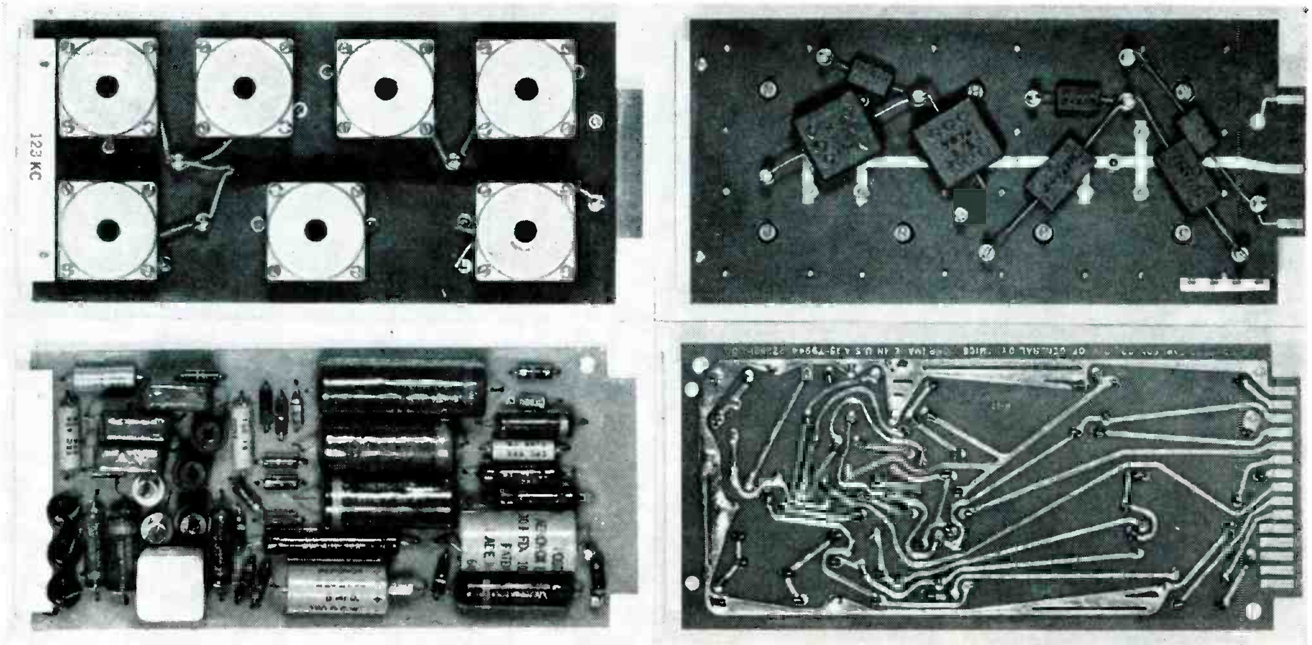


FIG. 1—Block diagram shows how rural subscribers are serviced by one wire pair



Card technique is demonstrated in construction of filters (upper left) and receiver (lower left). Underside wiring of each card is shown adjacent to it

bell in the subscriber telephone.

The tripping during the ringing period is accomplished by the contacts of relay *RT* which open the vibrator circuit as soon as the subscriber answers the phone.

Tripping during silent period is accomplished through the operation of relay *SR*. The contacts of this relay are wired to an electronic gate which, when operated, disables the ringing amplifier by applying negative bias to the emitter of the first transistor.

The 1-kc tone generator located on the ringing card at the central office terminal identifies the ground on the ring wire. With no ground, the oscillator is shut-off while grounding turns the oscillator on and its frequency modulates the outgoing carrier. At the subscriber end the 1-kc tone is picked-off, amplified and operates a relay that applies ground to the outgoing ring wire. When the called subscriber answers, the tone amplifier is disconnected from the circuit and does not interfere with speech transmission.

Receiver

Figure 4 shows the receiver circuit. The received amplitude-modulated wave is passed through the input transformer and into a common-base amplifier-regulator stage. Partial regulation is achieved in this stage and signals are then amplified in a high-gain, feedback-stabilized, common-emitter amplifier. The following stage acts as a detector, amplifier and regulator for the detected voice-frequency signal. Carrier leak is eliminated by a low-pass filter following the detector and final amplification is achieved in a feedback-stabilized grounded emitter voice amplifier.

Regulation occurs in the input stage and the detector. This approach eliminates the necessity of using a d-c amplifier in the control loop. Transistor d-c amplifiers are difficult to stabilize against variations of operating point resulting from the effects of I_{co}, especially if ambient temperature varies considerably. This decision was also supported by the fact that the wide range of ambient temperatures over which the equipment should operate would make it difficult, in the case of a d-c amplifier, to stay within power ratings of germanium transistors. Since economy considerations did not permit use of silicon transistors the idea of a d-c stage was abandoned.

It was proposed to regulate signal variations of +5 db to −10 db from nominal input to ±1 db at the output. This meant that with a conventional regulator, a control current change of 1 db should result in a 10 db change in input stage gain. Performance of this kind may be achieved by multiplication of control current or the use of bucking current to increase the

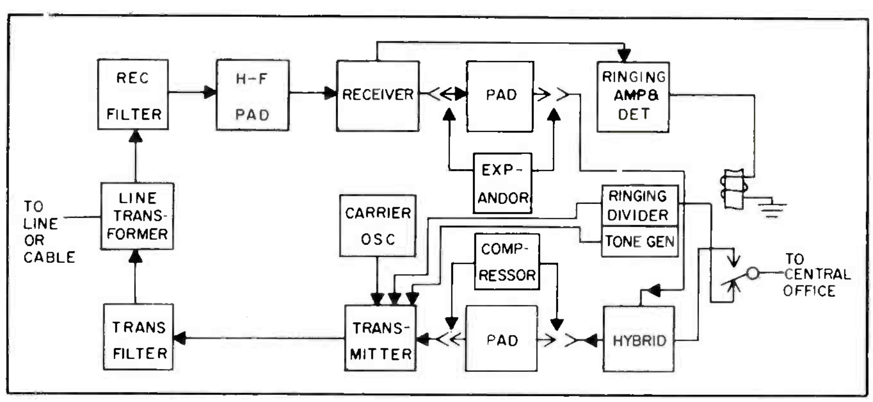


FIG. 2—Central office terminal equipment block diagram shows how subscribers' dialing to central office is fed from receiver to ringing amplifier and detector to operate relay connecting hybrid into circuit

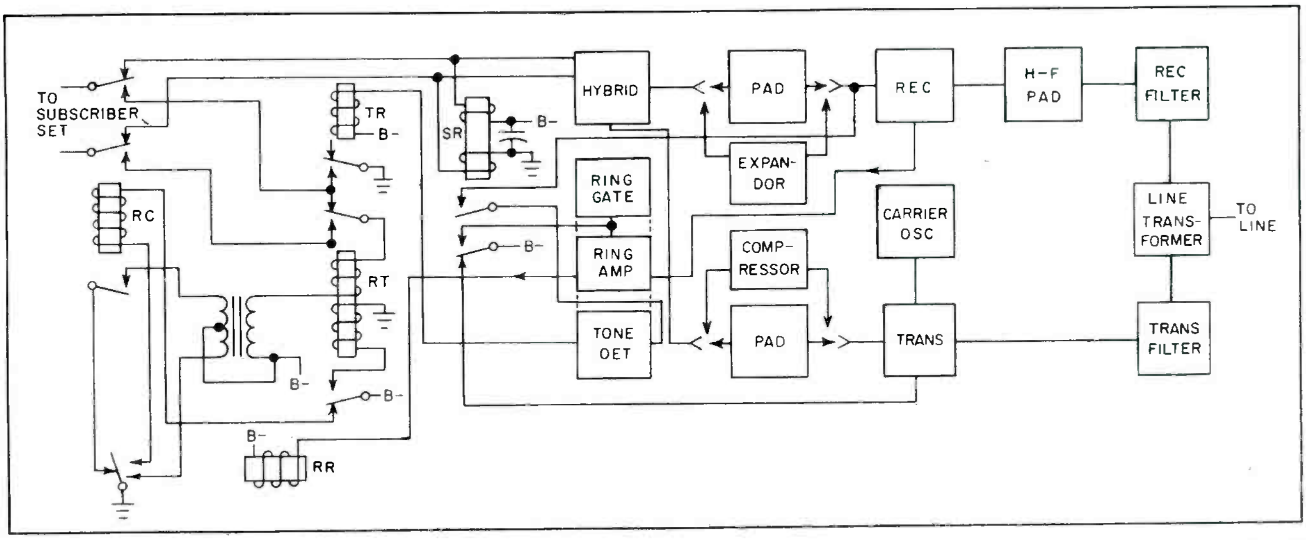


FIG. 3—Subscriber terminal equipment block diagram shows how ringing signal is fed from receiver to ringing amplifier to relay *RR* which vibrates at the ringing signal frequency and activates other relays to feed sgnal to subscriber set

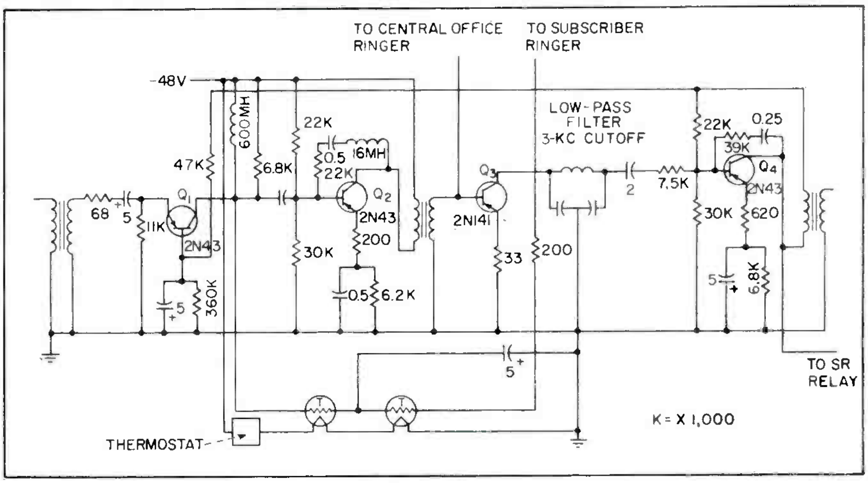


FIG. 4—Schematic of transistorized receiver (right) used in both terminal sets

ratio of current variation. However, the solution adopted consists in regulating the input stage only as much as would be required to prevent circuit overload under the condition of maximum input signal and to achieve the remaining regulation in the output stage. Thermistors are used as variable elements to achieve slower action.

A common-base configuration of the first amplifier stage was dictated by several considerations. Feedback could not be used due to the variable gain requirement and consequently no easy method of flattening the frequency response and of combating distortion and intermodulation effects was on hand. The frequency cut-off of the grounded-base transistor is extended by a factor of $1/1\text{-}\alpha$ over the grounded emitter response. Better linearity of characteristics can also be obtained with the base grounded resulting in decreased intermodulation and distortion products.

The high output impedance of this configuration was utilized by connecting the thermistor as the a-c load impedance of the stage. The gain obtained is then directly proportional to the value of the load impedance.

The second stage consists of a conventional grounded-emitter transistor amplifier. Both shunt and series feedback are used to stabilize the input and output impedances. Frequency response over the required range of 24 to 138 kc is held flat within ± 0.5 db. Feedback is sufficient to stabilize the gain of the stage against manufacturing variations in transistors and against varying temperature and voltages.

Output

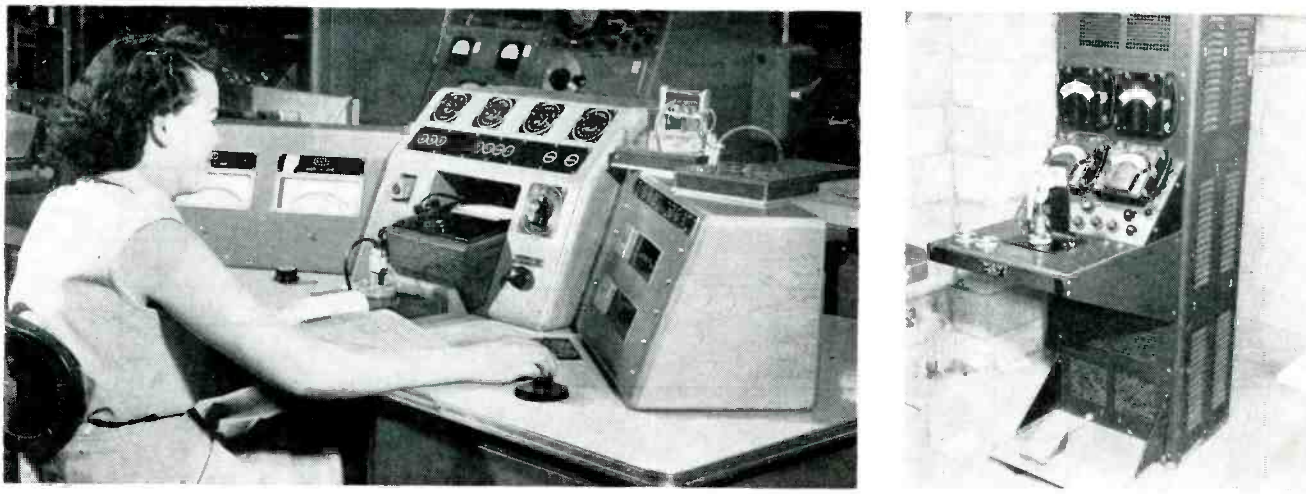
The output of this amplifier is transformer-coupled to the detector stage. The speech intelligence is recovered and the d-c current resulting from the rectified carrier is used as the control current in the regulator loop. A thermistor, the resistance of which varies with this current, is the load. Stage gain is thus proportional to the load impedance and additional regulation is obtained.

The low-pass filter following this stage eliminates higher frequencies present and passes the voice signals to the output amplifier. Here, shunt and series feedback are used to stabilize the gain and the impedances. An output of up to +7 dbm is obtained with distortion not exceeding 5 percent.

Indirect heating is provided for thermistors under low ambient temperatures to insure proper circuit operation.

Climatic tests performed on this circuitry indicated an output stability of ± 1 db under all conditions with distortion not exceeding 4 percent at the output.

The author acknowledges the work of R. L. Layburn who developed most of the circuitry and D. F. Jamieson and H. V. Buck, the electrical and mechanical engineers. Filters and transformers were designed under W. L. Brune.



Production type core tester (left) has automatic testing features. Yield at first operational test point increased from 70 to 90 percent on introduction of this method. Developmental model of core tester is shown at right

Core Tester Simplifies

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SUMMARY — Procedure using results obtained from dynamic tests made on core material prior to winding simplifies magnetic amplifier design by proper interpretation of standard test values of circuit constants. Normalized design equations for the most common magnetic amplifiers are given and their application to specific design problems discussed

DESIGNING A REACTOR for a magnetic amplifier requires that a choice be made of core and type of magnetic material.

Since it is not practical to measure core characteristics under actual amplifier operating conditions in production, these conditions are simulated in a core tester. This article will describe a method for core test[1,2]. It consists of using a half-wave rectified current to drive the core flux to saturation once each cycle. A d-c control current resets the flux during the off half cycle and an average-sensitive voltmeter measures the voltage in a pickup winding as shown in Fig. 1.

Core Correlation

The correlation between core test and amplifier operation rests on the basic assumption that a core, when operating in an amplifier, reduces the volt-time integral across the load by absorbing or supporting a value of volt-seconds proportional to the flux change in the core. Under this condition, the voltage induced in the pick-up winding of the tester corresponds to the voltage induced in the amplifier output winding when the core controls the load voltage and under conditions of equivalent applied control magnetizing force, the amplifier output can be calculated from core test measurements.

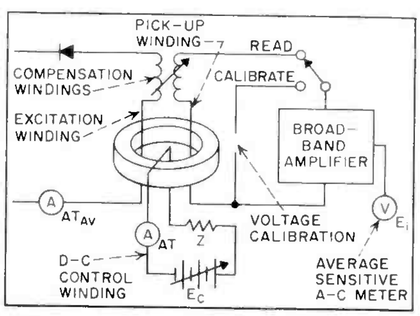


FIG. 1—Test circuit of constant-current flux-reset method of measuring dynamic core properties

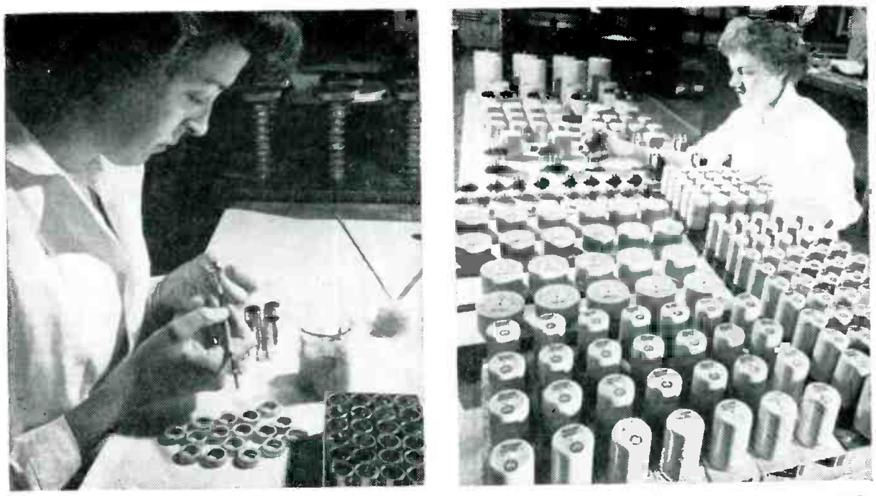
Design Procedure

A typical curve of induced voltage, V_i against d-c control ampere turns AT for an oriented, 50-percent nickel-iron core is shown dotted in Fig. 2.

In application it is convenient to represent the linear portion of the core-test curve by a straight line approximation. The equation is:

$$V_i = G_i AT + C$$

where



Operator applies finishing touches to a group of nickel-iron alloy cores (left) while another operator inspects finished group of magnetic amplifier reactors (right)

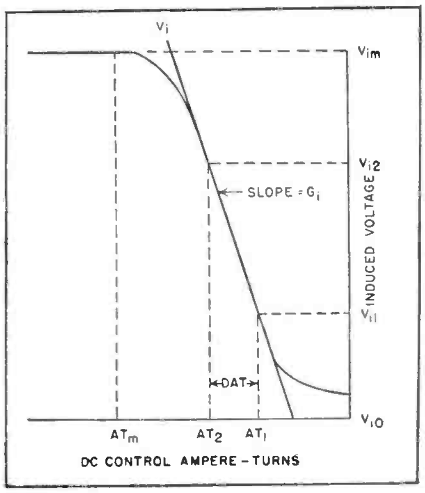


FIG. 2—Linear region of dynamic core test data shows test points

Ferro-Amplifier Design

G_i = slope = $(V_{i2} - V_{i1}),/DAT$ AT = total control ampere turns and $C = V_{i1} - G_1 AT_1$.

The general steps followed in designing a magnetic amplifier reactor are:

Assume a core size and material appropriate for the application.

Assume percentage of available winding area to be used for load windings. This assumption is based on experience and type of application.

Compute load winding turns necessary to support supply voltage and compute wire size to fit in available space.

Compute winding resistance and power output level to suit requirements. This is similar to a normal transformer design problem and depends on insulation system and other factors.

Design control and bias turns to meet operational requirements. Here the core test data is applied directly to the design. The amplifier performance can be expressed as a function of core properties and the number of turns. These expressions are solved for the control and bias turns to yield the required performance.

Select wire sizes for control and bias windings so windings will fit in available space and so winding resistance will meet other operational requirements.

Calculate other facets of performance characteristics and check with requirements.

As in all transformer and reactor design, there is no short, simple path to the ultimate and it should be realized that in going through these steps some retracing is necessary. The primary advantage of having the core test data available is that a great deal can be done by calculation rather than by experiment.

Table I—**Normalization of Core Test Values**

Direct Value	Normalized for Core Size	Equivalent Magnetic
V_{io} (volts/turn)	$\frac{V_{io}}{A_c}$ (volts/turn/sq. in)	$B_m - B_r$ (gauss)
AT_1 (ampere-turns)	$\frac{AT_1}{l_m}$ (ampere-turns/inch)	H_l (oersteds)
DAT (ampere-turns)	$\frac{DAT}{l_m}$ (ampere-turns/inch)	....
V_{im} (volts/turn)	$\frac{V_{im}}{A_c}$ (volts/turn/sq in.)	B_m (gauss)
G_i (volts/amp-turn²)	$\frac{G_i l_m}{A_c}$ (volts/amp turn²-in.)	(gauss/oersted)

where $B_m - B_r = V_{io}/2.22fA_cX10^{-8}$, $B_m = V_{im}/4.44fA_cX10^{-8}$, $H_l = 0.4\pi AT_1/l'_m$, $\mu_d = G_i l'_m/0.4\pi X4.44fA'_cX10^{-8}$, A_c is the effective core cross-section area in sq in., A'_c is the effective core cross-section area in cent. in., l_m is the mean magnetic path length in inches and l'_m is the mean magnetic path length in centimeters.

Amplifier Equations

To develop the expressions for amplifier performance in terms of core test data, consider the half-

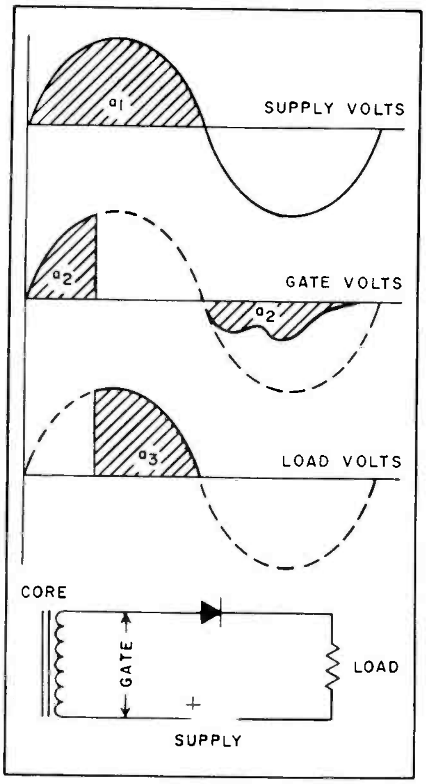


FIG. 3—Ideal half-wave amplifier characteristics used to develop core test data expressions

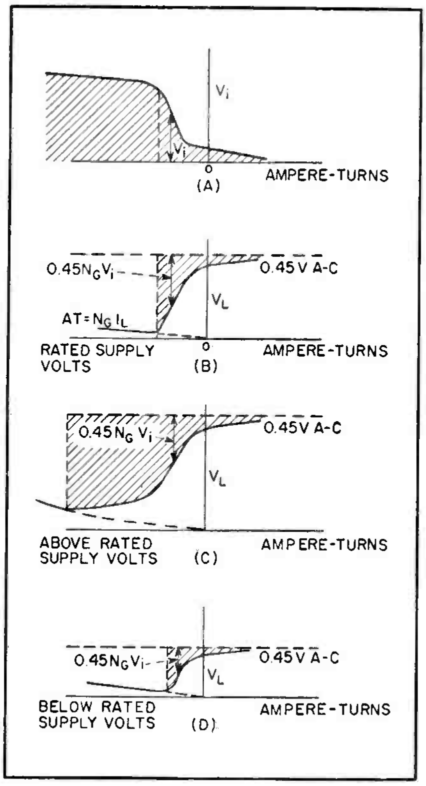


FIG. 4—Typical core-test curve (A) and half-wave amplifier characteristic curves (B, C and D) demonstrate correlation

wave self-saturating amplifier of Fig. 3.

From Kirchhoff's laws, load voltage equals supply voltage minus voltage across gate winding. Integrating this relation with respect to time over a positive half cycle results in

$$\text{area}_3 = \text{area}_1 - \text{area}_2$$

The a-c supply voltage is read in rms volts, the load voltage in d-c volts and the gate voltage on an average sensitive, rms calibrated meter so

$$V_L = 0.45(V_{a\text{-}c} - V_G)$$

V_G is obtained from the core test data as V_i, induced voltage per turn.

$$V_G = N_G V_i$$

The correlation between core test values and the characteristic curve of a half-wave amplifier is shown in Fig. 4.

For values of ampere turns below the cutoff point where the core no longer reaches saturation the load current is given approximately by

$$I_L = AT/N_G$$

The equation for practical cases considering rectifier and winding losses is

$$V_L = 0.45P(V_{a\text{-}c} - N_G V_i)$$

where P is the loss factor $P = R_L/(R_L + R_W + R_F)$, R_L is the load resistance, R_w is the winding resistance and R_F is the rectifier equivalent forward resistance.

Rectifier reverse leakage can be approximately considered as:

$$V_L = 0.45P[V_{a\text{-}c} - N_G G_i(N_c I_c \pm C_1)]$$

where L = leakage factor $= L/1 - 0.9\ G_i\ (N_G^2/R_{RR})$ and $C_1 = 0.9\ N_G\ (V_{ac} - N_G\ C/R_{RR})$.

The quantity R_{RR} is equal to rectifier equivalent reverse resistance, $N_c\ I_c$ is equal to applied control ampere turns and C is equal to $V_i - G_i\ AT$.

Figures 5 and 6, give the design equations for several commonly used circuits.

In full-wave amplifier circuits the cores are complementary in resetting and this reduces the power necessary to normally reset the cores.

The accuracy of the calculations depends on the average value of net magnetomotive force effective in producing flux reset, regardless of wave form, and gate circuit limiting of the rate of flux reset so it does not appreciably affect the total amount of flux reset.

Standard Values

Important features of the core test characteristic curve are expressed by a set of standard test values.

The peak value of excitation ampere turns AT_p must assure saturation of the core. This value can be set on the basis of the d-c magnetic properties of the material since the magnetization time lag is normally small in the positive saturation region. The values of the test points V_{i1} and V_{i2} must be chosen to lie within the linear re-

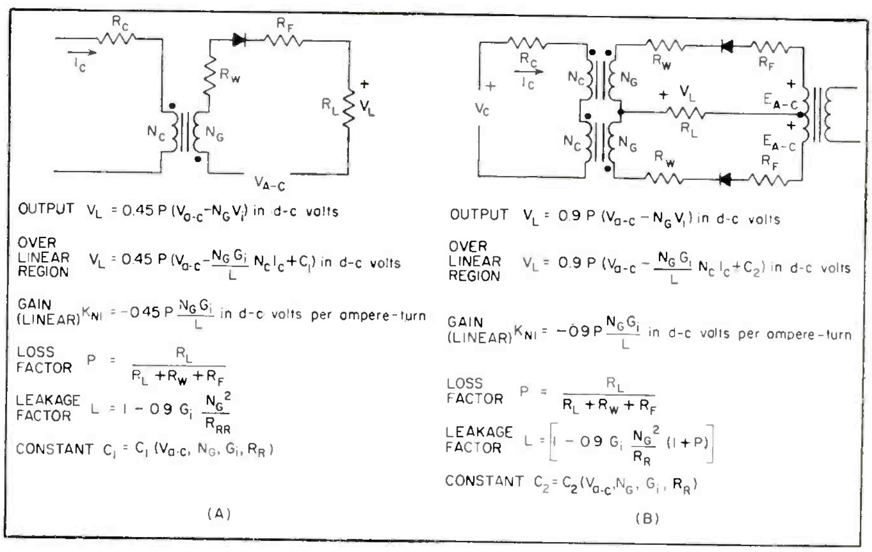


FIG. 5—Circuit and core-test equations for half-wave amplifiers (A) and a full-wave center-tapped amplifier (B)

gion of the curve for all cores of the type to be tested. In practice, it is possible to specify values of V_{i1} and V_{i2} that satisfactorily represent the linear region for all cores of any given size and material.

Measurement of the saturation-induced voltage, V_{im}, is most convenient if performed at a specified value of control ampere turns AT_m. This point is chosen on the basis of the largest anticipated effective a-c loop width. The standard test values shown in Fig. 2 and their interpretation are as follows:

V_{io} is the induced voltage at zero control ampere turns. This value corresponds to the difference between the residual flux and the saturation flux.

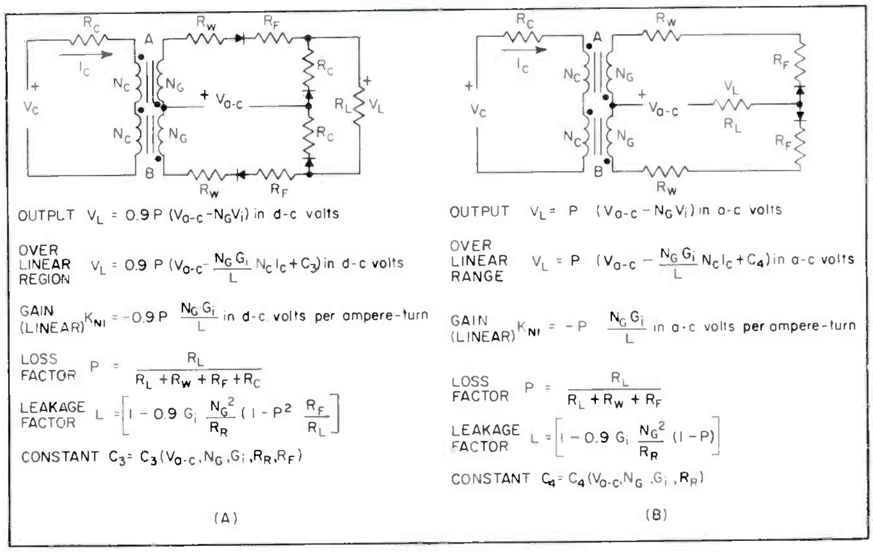


FIG. 6—Circuit and core-test equation for full-wave bridge-circuit amplifier (A) and full-wave doubler-circuit amplifier (B)

Gain

AT_1 is the ampere turns required for a specified induced voltage value V_{i1} approximately one-third of the saturation voltage.

DAT is the differential ampere turns required to change induced voltage from V_{i1} to a second value of induced voltage V_{i2} approximately two-thirds of saturation voltage. The inverse of this value corresponds to the slope or gain of the control characteristic curve. This gain corresponds to the differential permeability of the effective a-c hysteresis loop followed by the core in amplifier operation. The gain of a core, G_i, is defined by

$$G_i = V_{i2} - V_{i1}/DAT = \text{volts/turn/amp-turn.}$$

V_{im} is the saturation-induced voltage as obtained at a large specified value of control ampere turns AT_m. This value of induced voltage corresponds approximately to a flux change from positive saturation to negative saturation each cycle. It is very nearly the maximum voltage per turn the core is capable of supporting at the test frequency.

Core test values expressed in actual values of induced voltage per turn and ampere-turns of control current are most useful for amplifier design work. For other purposes, such as core-size influence and material property investigations, normalizaion of core test values is necessary. A summary of these normalized values is given in Table I.

Normalizing

Normalization of core test values removes the gross effects of core size but core shape has also been found to influence core magnetic properties.[3] The critical parameter is the ratio of minimum to maximum magnetic path lengths. For toroidal cores this corresponds to the ratio of inside to outside diameters or id/od ratio. The only core property affected by the id/od ratio is the core gain. In terms of normalized core gain or differential permeability, the id/od influence is given for Hipernik V material material approximately by:

$$\mu_d = \mu'_d 0.144[(1+r)/(1-r)] \quad \text{if} \quad r < 0.75$$
$$\mu_d = \mu'_d \quad \text{if} \quad r > 0.75$$

where μ'_d is the differential permeability for a thin ring core and r is the id/od ratio.

Typical ranges of core tester characteristics are given in Table III for the common types of magnetic materials.

Table III—Typical Core Test Magnetic Characteristic Ranges for Various Materials at 400-cycles

	Test Values				Test Conditions			
Core Material (Toroidal Cores)	$B_m - B_r$ kilogauss	H_d Oersteds	d	B_m kilogauss	AT_p Oersteds	B_1 kilogauss	B_2 kilogauss	$A - T_m$ Oersteds
Highly-oriented 50 percent nickel-iron (2-mil strip Hipernik V)	0.9 to 1.4	0.15 to 0.24	15 to 50 $X\,10^4$	14.0 to 15.3	2.0	10.5	21	0.359
Non-oriented 50 percent nickel-iron (2-mil strip Hipernik)	1.4 to 3.5	0.08 to 0.16	15 to 50 $X\,10^4$	12.0 to 14.0	2.0	10.5	21	0.359
Mo-permalloy and Supermalloy type Materials (1 or 2-mil strip)	1.3 to 3.1	0.015 to 0.05	40 to 90 $X\,10^4$	5.7 to 8.7	1.0	5.25	10.5	0.135
Oriented 3 percent silicon-iron (5-mil strip Hipersil)	1.3 to 3.5	0.39 to 0.54	2.6 to 11 $X\,10^4$	14.4 to 17.5	4.0	10.5	21	1.58

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VIDEO SCANNER

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SUMMARY —— System under development for determining differences in two photos taken from same point in space at different times produces a standard width line at each point of contrast change as scanner passes over pattern. Applications include aerial surveys and study of microscopic growth

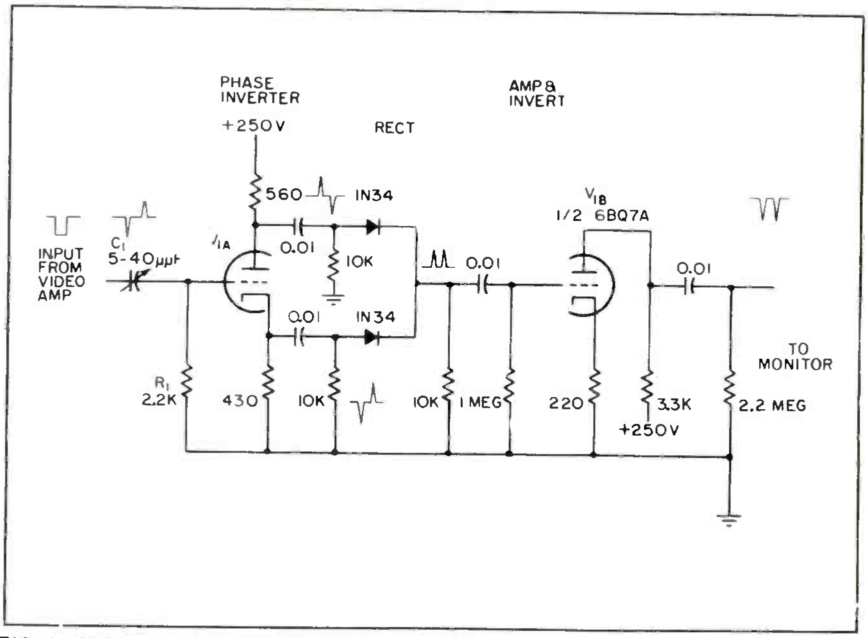


FIG. 1—Video differentiator and full-wave rectifier with waveforms at various points

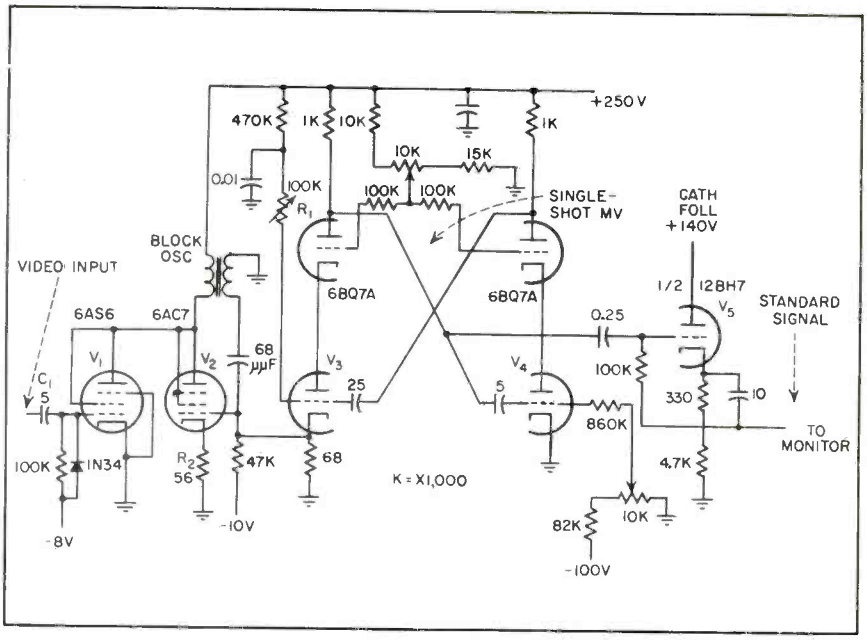


FIG. 2—Blocking oscillator and single-shot multivibrator provide standardized constant amplitude, constant line-width patterns from differential signal

EXPERIMENTS are being conducted to determine whether two patterns or photographs can be recognized electronically as being fundamentally identical, although they differ completely in relative tone and density, even to the extent of being inverses of each other.

The circuit shown in Fig. 1 is used to differentiate and full-wave rectify the video signal obtained by scanning a simple pattern with a vidicon tv camera.

Differentiation of the video waveform is provided by R_1 and air trimmer capacitor C_1. Tube V_{1A} is a split-load phase inverter whose output is full-wave rectified by the two crystal diodes and then amplified and inverted by V_{1B}.

Since the duration and intensity of the differentiated signal depends on the difference in tone across a contrast border, two differentiated full-wave rectified signals will not agree perfectly unless the tones and contrasts in each original pattern are indentical.

Figure 2 is a schematic diagram of a video standardizer circuit used to produce standardized constant-amplitude, constant-line-width patterns from the differentiated signals. Biased blocking oscillator V_2 generates 0.1-microsecond trigger pulses for the single-shot multivibrator consisting of tubes V_3 and V_4. The output of the multi-vibrator consists of constant amplitude pulses whose duration may be controlled between 0.1 and 0.4 microsecond by varying R_1.

When the blocking oscillator produces 0.1-microsecond pulses with a peak amplitude of 20 volts, the peak current through R_2 is approxi-

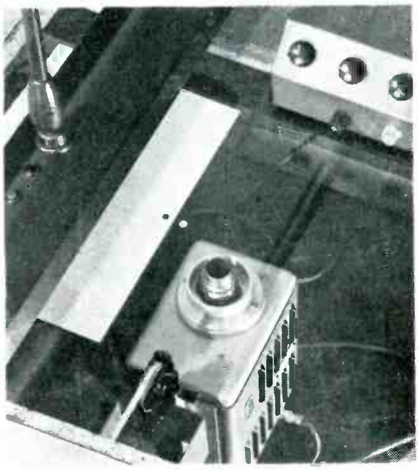
Matches Photo Patterns

mately 330 ma. The average current at a pulse repetition rate of 1 mc is approximately 20 ma because of the sinusoidal pulse shape. Trigger signals are coupled directly from the cathode of the blocking oscillator to the cathode of V_3 which is normally conducting. Positive-going standardized pulses are then coupled through cathode follower V_5 to the video monitor.

Pattern Matching

Figure 3 is a series of photographs of the tv picture obtained at consecutive stages in the video processing of a simple pattern. The pattern in Figure 3A contains two tonal extremes which might be encountered in any experiment—a white object on a black field and a black object on a white field. The simple differentiated picture in Figure 3B is the normal differentiated signal obtained at the grid of V_{14} in Fig. 1. Figure 3C is the full-wave rectified input signal to the blocking oscillator in Fig. 2 and Figure 3D is the standardized output signal obtained from the single-shot multivibrator in Fig. 2.

Horizontal tv scanning is not the best type of scanning to use for this purpose, as evidenced by the break in the tops of the two circles in Fig. 3D. These breaks are explained by the fact that the direction of the scanning spot was tangent, rather than normal, to the contrast border at this point. This condition can be corrected by



Camera setup used in experimental pattern matching tests shown in Fig. 3

using an isotropic scanning system.

The rapid-scan tv signal, however, permits slow movement of the original patterns so that the patterns being matched need not be stationary.

The amount of high-contrast detail in the geometrical pattern can be measured by the current drain in the multivibrator circuit. Since a constant amount of energy is delivered for each differentiated pulse which is above the bias level of the blocking oscillator, the plate current drawn by the multivibrator varies directly with the amount of detail present in the original pattern. Such a process might be useful for statistical studies of photographic data.

The ultimate purpose was to develop a variable-width gate signal to gate out all corresponding points in another identical pattern whose video scanning signal has been delayed by a fraction of a microsecond.

This is perhaps the only way of obtaining a perfect null between two slightly imperfect patterns, where the imperfections can be masked off by the broadened lines in the gate signal. In this manner it is possible with alignable patterns to display only the new information.

The patterns shown in Fig. 3 represent approximately one sq in. of scanned area. To work at short distances of the order of one in. it was necessary to modify the standard 16-mm lens assembly of the vidicon camera by building an adjustable lens mount as shown on the front of the camera.

Applications

The matching technique studied in these experiments can be used for matching areas on various types of photographs when the photographs have been taken from the same point in space. The resolution of this system is, however, limited by the resolution of the tv camera so that only small areas can be examined using the present scheme.

The techniques described were developed under Air Force Contract AF 30(602)-1404 in conjunction with the Intelligence Laboratory of Rome Air Development Center.

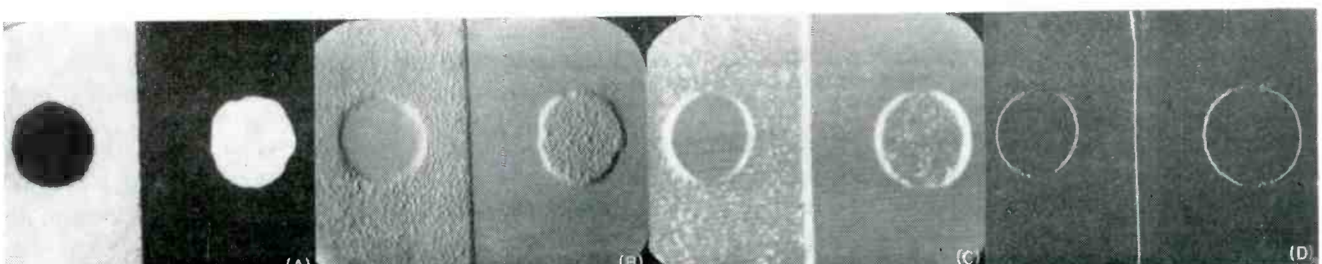


FIG. 3—Original video pattern (A) when differentiated (B) and rectified (C) is converted to standardized line-width pattern (D)

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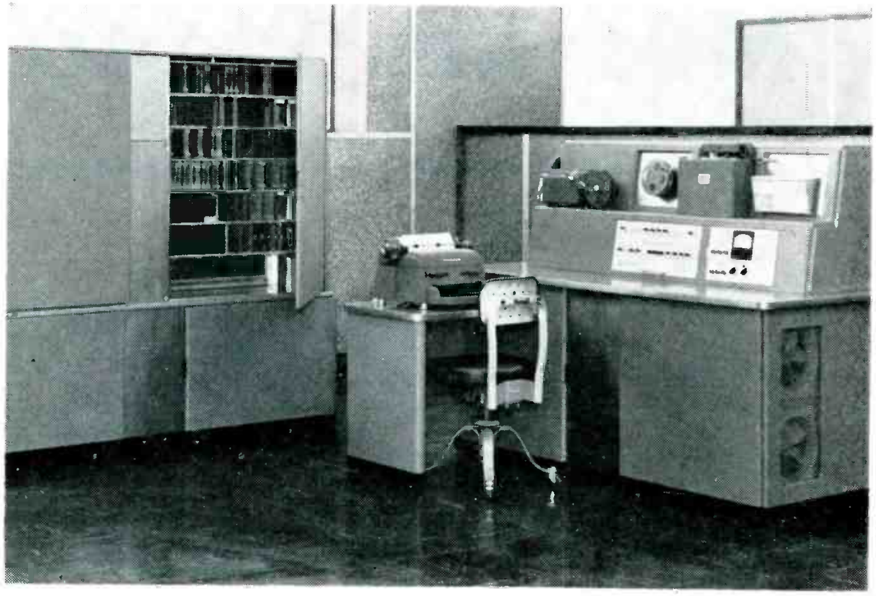


Series-type magnetic amplifiers are used throughout Univac magnetic computer

MAGNETIC COMPUTER

SUMMARY —— Complementing series-type amplifiers handle information rates up to 2.5 mc in all-magnetic computer operating at 660-kc information rate which, when properly programmed, has a speed equal to Univac I. Design considerations included in the 1,500 magnetic amplifier circuits and various types of core materials and their figures of merit are presented

MAGNETIC AMPLIFIERS are beginning to replace electron tubes in high-speed digital computers. The Ferractor, a magnetic amplifier capable of operating at frequencies as high as 2.5 mc, represents an increase in power-gain bandwidth product an order of magnitude over that previously considered practical with magnetic circuitry.

Complementing Amplifier

Figure 1A shows the basic magnetic-amplifier circuit used. This circuit is similar to one proposed for lower frequency operation. Operation is divided into two separate periods by the carrier or power pulses applied to terminal 3. The positive half of the power pulse is the output period during which rectifier D_1 can conduct and an output occur. During the negative part of the carrier voltage, D_1 is biased in the reverse direction, presenting a high impedance so the load is effectively disconnected from the core. This is the input period.

During this period, an input can occur without transferring energy by transformer action to the output circuit. The core material has a rectangular hysteresis loop and the volt-second characteristic of the positive half of the power pulse is adjusted to switch the core from $-B_r$ to $+B_r$ during the output period with input grounded. The power pulse then operates the core from $+B_r$ to $+B_r$ over a low-impedance portion of the hysteresis loop and substantial output results.

If, during the input period, a positive pulse is applied to terminal 1 that switches the core from $+B_r$ to $-B_r$, then at the start of the succeeding half-pulse period the power pulse will find the core at $-B_r$ and will just succeed in switching the core to $+B_r$ during this half-pulse period. The core will traverse a high-impedance portion of the hysteresis loop and low output will result.

Time relations are shown in the voltage waveforms of Fig. 1. This is a complementing amplifier. It will produce an output when no input is received and no output in the event of an input. An input signal is followed by an output period in which there is no output. Then there are two input periods during which there is no input, each one followed by the corresponding output. Finally, another input is followed by an output period with zero output.

The combination of D_3, R_2 and $-V$ shown is a constant-current

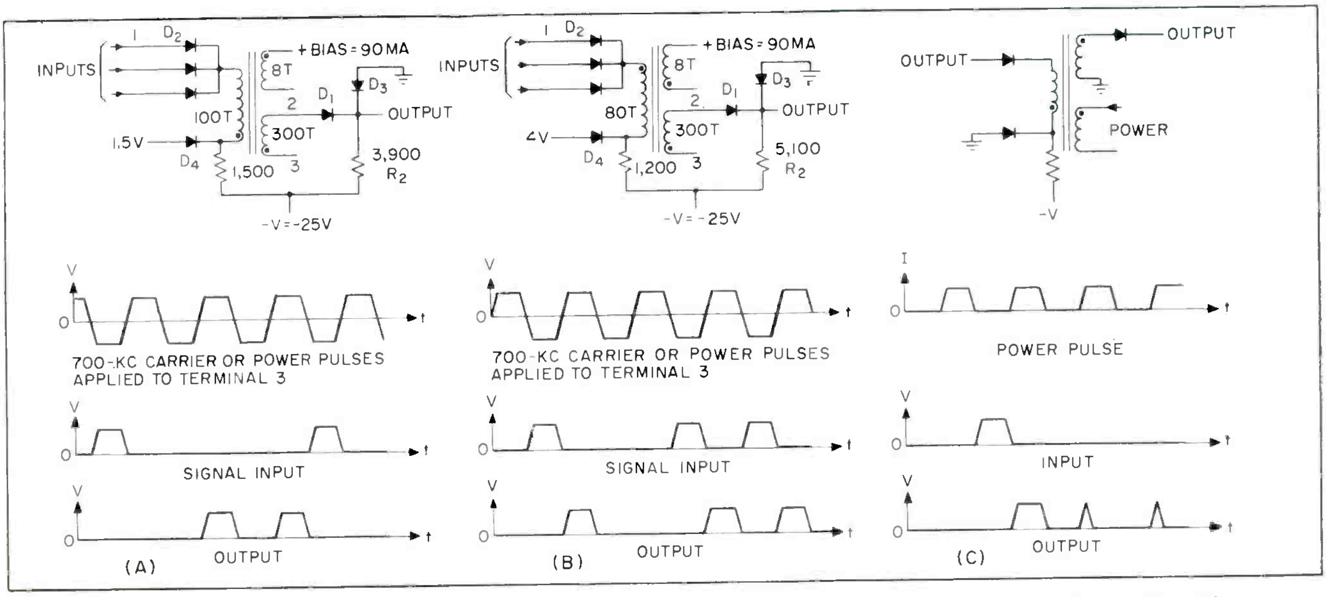


FIG. 1—Series magnetic complementing amplifier (A), series magnetic pulse amplifier (B) and parallel magnetic amplifier (C)

HAS HIGH SPEED

sink capable of absorbing the no-output current of the amplifier. The current which flows in R_2 is just equal to this no-output current. During a no-output period that current will be supplied through D_1 instead of D_3.

The complete suppression of the no-output signal makes it possible to interconnect a large number of these amplifiers without danger of small or partial outputs growing into a full output. Furthermore, this circuit makes it possible for the carrier to impress across the core a fixed quantity of volt-seconds independent of the load. This is important in computer circuits where the load varies under logical-condition combinations.

Another constant-current circuit consists of D_4, R_1 and $-V$. This circuit limits the amount of current which can be transferred to the output by transformer action during a no-output period. Current limiting by this circuit is also necessary in the common situation where one amplifier drives a number of others that have parallel input circuits. Should one of the driven amplifiers saturate before the others, it will short-circuit the source and prevent the amplifiers in parallel with it from switching. Current in R_1 is set to be approximately equal to the magnetizing current of the core as seen from the input winding.

Diode Enhancement

A major factor limiting the gain of the amplifier is the enhancement of rectifier D_1. Enhancement is the temporarily lowered back resistance of the diode which occurs immediately after a large forward currrent is carried and is caused by

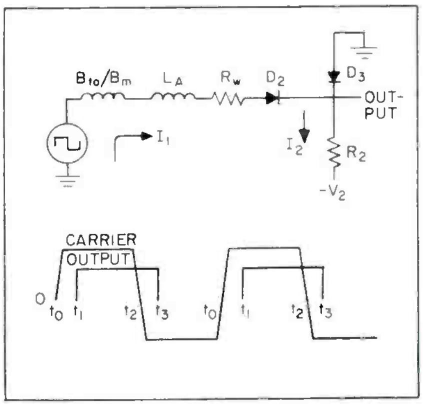
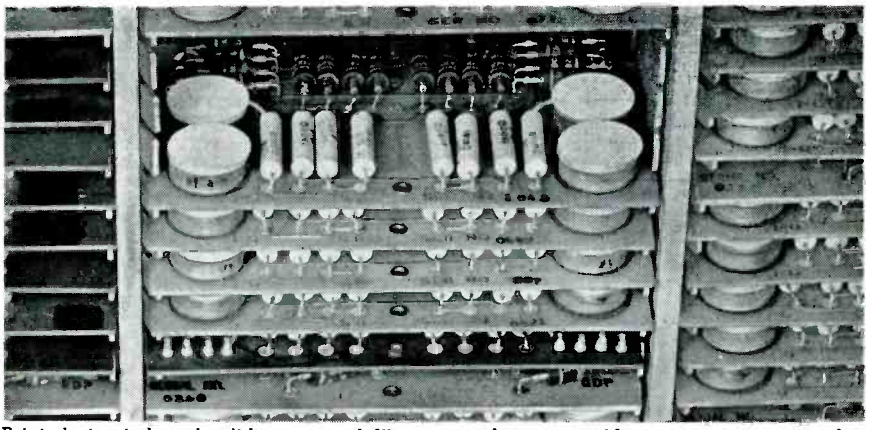


FIG. 2—Equivalent circuit of the series amplifier, including output waveforms. Circuit is used to calculate power gain

the holes injected during the current-carrying period. As an example consider two point-contact diodes with identical d-c characteristics. Both might pass 20 microamperes at 20 volts reverse voltage. Exciting them by a 1-megacycle square wave to carry 100-ma forward current for $\frac{1}{2}$ μsec and then switching to the reverse direction for the succeeding $\frac{1}{2}$ μsec produces an average current flow during the negative half period of $\frac{1}{2}$ ma for low-enhancement diodes and 5 ma for high-enhancement diodes.

The power gain of the magnetic amplifier cannot exceed the ratio of the forward to the back current of the output diode at operating frequency, voltage and current. In the circuit shown in Fig. 1A, the enhancement switches the core from the $+B_r$ position at the end of the output period down the hysteresis loop toward $-B_r$, even if no input has been received. This switching might result in complete or partial cancellation of the following output pulse.

The effects of enhancement are counteracted by the bias winding. Constant direct current flows through this winding to overcome



Printed circuit boards slide into card library as shown, providing compact construction

Table I—Power Gain of Series Magnetic Amplifiers

Freq	Core Gain	Gain with 5% Tolerance
100kc	150	45
250kc	75	20
500kc	42	10
1mc	23	6
2.5mc	10	3

the effects of enhancement and set the core back toward $+B_r$. The winding ampere-turns are equal in magnitude to the worst enhancement ampere-turns to be expected. Bias windings of a number of amplifiers are connected in series in the computer.

Basic Amplifier Circuit

One widely used variation of this circuit is shown in Fig. 1B. This is a series-magnetic noncomplementing or assertive amplifier. A cluster of input diodes used for computing purposes is shown. This circuit uses the same type of power pulses as the circuit shown in Fig. 1A and also makes use of a rectangular-loop magnetic material. However, in this circuit the bias winding and input winding serve different purposes.

The bias winding operates the core to $-B_r$. Therefore, in the absence of a signal no output will be received. The input overcomes the effect of the bias and keeps the core at $+B_r$. Therefore, if an input is received during the following power period, the core is in a low-impedance position and high output results.

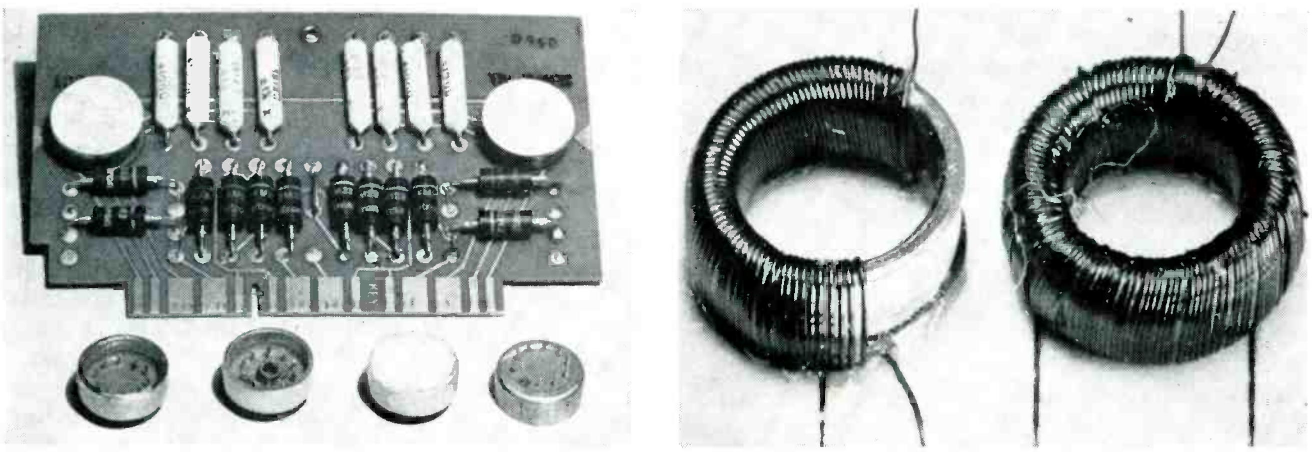
Recently a circuit similar to the parallel magnetic amplifier shown in Fig. 1C has been developed.[2] In this circuit, the power is delivered from a constant-current power source and the output is inductively coupled to the power source through the core. An input places the core on a high-impedance portion of the loop and an output results during the following half period. If no input is received, the core operates from $+B_r$ to $+B_s$ and the output is a spike as shown in the waveform. Speeds up to several hundred kilocycles have been reported with this type of amplifier.

In the Ferractor type of circuitry, the no-output signal is easily suppressed by a constant-current sink on the output. A single power source suffices for all 1,500 cores of the computer and this source provides 375 watts of pulse power at 660 kc.

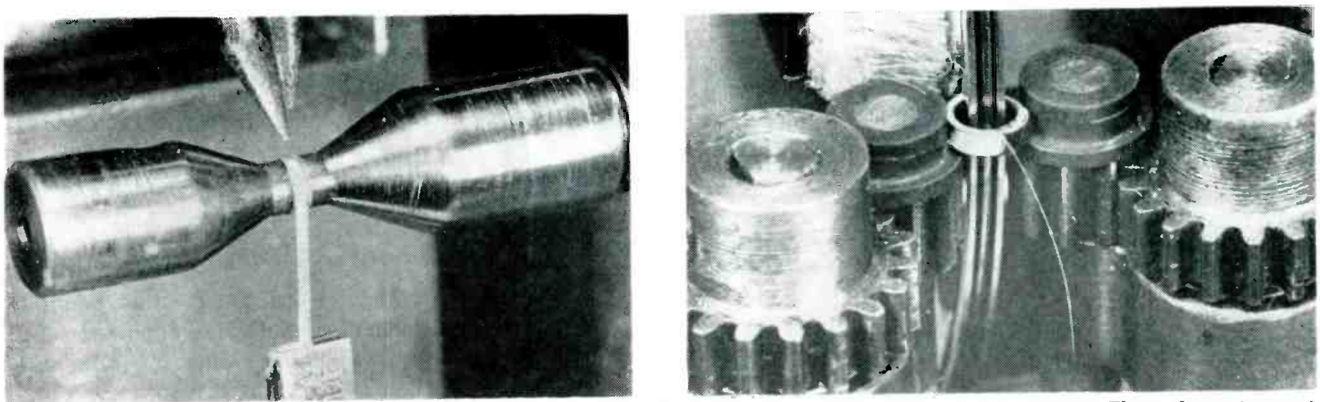
The usual way to drive the constant-carrier circuits is to place a number of power windings in series in the plate circuit of a pentode. This requires approximately 100 pulse sources capable of 375 ma output current, with a total pulse power output of 1,500 watts. The larger amount of power is required because advantage cannot be taken of the load-sharing property of the circuits when using multiple clock sources.

Although the figures show rectangular waveforms, work is being done on sine-wave circuitry. A 2.5-mc demonstration unit uses sine waves for the clock-power waveform.

Since the power pulse divides the operation of the amplifier into two separate periods, it is convenient



Typical printed circuit board (left) gives relative Ferractor size. Headers in various stages of construction are shown in foreground. Close-up (right) shows uniformity of windings obtainable with 0.1-inch-diameter cores using No. 45 wire



Method of winding ⅛-mil, 1/32-inch-wide tape on 0.1-inch bobbins (left). Weight provides tension during winding. Electrodes at top spot-weld tape to bobbin at start and during finishing operations. Bobbins in toroidal winding machine (right) have output winding, in which inductance is critical, put on first. Typical core has 12 wraps of tape on 150-mil diameter bobbin

to calculate the output and input powers separately, then take the ratio to obtain the power gain. Sufficient input power is required to effect the flux change that occurs in the core due to input signal and also to overcome any d-c biases that may be operating on the core. The input voltage is readily obtained from the assumed path on the *B-H* loop during the input period. The switching current is obtained from the measured characteristics of the core.[3]

Output Power

To calculate output power the equivalent circuit shown in Fig. 2 is used. The quantity B_{to}/B_m is a fictitious inductance representing the flux change the core undergoes when starting from flux at t_o and increasing to the maximum flux during the output period, and B_{to} is the flux existing at the start of the output period. The maximum flux is close to the saturation flux density.

The inductance L_A represents the air-core inductance of the output winding, while R_w is d-c resistance and R_2 the output diode. The two inductances absorb volt-seconds from the start of the output wave. This is approximately equivalent to delaying the start of the output voltage from t_0 to t_1. Some of the energy lost during this period is recovered during the period between t_2 and t_3 but it is useless at this time since the input period of the next amplifier is over.

The drops in R_w and D_2 decrease the output voltage amplitude. The principal conclusion to be drawn is that in a practical situation at high frequencies the loss in power gain resulting from the delay between t_0 and t_1 more seriously decreases the power gain than does the decrease in amplitude resulting from the drops in R_w and D_2.

Table I shows the maximum power gain at several different frequencies of the series magnetic amplifier with a 15-volt power pulse, 120 ma maximum output current and a single-level logic circuit. The core gain column shows the gain limited by the B_r/B_s ratio of the core and the inductance of the output winding, while the second column shows the gain with reasonable tolerances on all components and voltages and with commercial diodes.

A power gain of three at 2.5 mc can be obtained. This is comparable to the best that can be achieved with the high-frequency transistors commercially available at present.

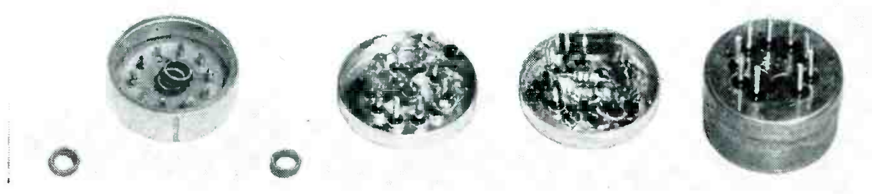
Systems Considerations

Digital data-handling systems require two carrier waveforms of the same frequency and amplitude but 180 degrees out of phase. The output period of the first-phase corresponds to the input period of the second phase and vice versa. Both power pulses can be obtained from a single output transformer with push-pull output windings.

Because of the low-impedance level, it is possible to use a large quantity of distributed wiring ca-

Table II—Figure of Merit for Various Core Materials

Material	Size	60-Cycle B-H Data				Dynamic Magnetizing Force					Merit Figure
						Current Flip				Voltage Flip	
		B_s Gauss	B_m/B_s	B_r/B_s	H_c Oersteds	¼μs	½μs	1μs	2μs	½μs	
S-1	0.051D	1,880	0.90	0.86	1.48	3.62	2.55	1.81	....	4.36	203
S-3	0.051D	2,040	0.90	0.78	0.59	3.61	2.42	1.58	1.14	3.50	198
4-79 Permalloy	⅛mil	8,300	0.90	0.81	0.14	0.62	0.96	0.58	0.35	1.06	2,160
4-79 Permalloy	¼mil	8,450	0.90	0.72	0.17	2.43	1.21	0.66	....	1.68	1,440
Orthonik	⅛mil	14,900	0.90	0.85	0.76	....	3.84	....	....	....	1,040
Supermalloy	⅛mil	8,030	0.90	0.76	0.10	....	1.11	....	....	....	1,620
Moly-perminvar	⅛mil	16,000	0.90	0.86	0.40	....	3.49	....	....	....	1,260
74.8 Permalloy	⅛mil	9,720	0.90	0.75	0.24	....	1.33	....	....	....	1,610



Packaging of Ferractor headers and other circuit components. Header at left shows how two cores, representing independent amplifiers, fit into hermetically sealed unit

pacitance. In the Univac magnetic computer, over 300 $\mu\mu$f of capacitance are allowed on the output and 40 $\mu\mu$f on the input of a magnetic amplifier with a negligible decrease in gain. Since the magnetic amplifiers respond to the integral of the signals applied to them over the input period and output period, they are insensitive to noise and ringing on input signals and power pulses. The combination D_3 and R_2 in Fig. 1A and Fig. 1B serves also to act as a current bias threshold analogous to the grid bias threshold used in electron-tube circuitry to suppress noise.

In the construction of a large system, design procedures are standardized as much as possible. A standard unit of maximum output power is fixed, based on that conveniently handled by the germanium diode. This unit may be on the order of 125 ma and 15 volts, representing the maximum allowable output load on an amplifier with a single output diode. A standard amplifier and complementing amplifier are then designed to yield maximum gain for this maximum output.

Where a larger number of drives is required, a double-power core is used. The double-power cores have twice the output of the single-power cores but require less than twice the input power of a single-power core.

Core Material

Successful operation of the magnetic amplifier circuits depends in part on the use of optimal material and core design. The figure of merit for the core and magnetic material is

$$0.185\ \frac{B_s}{H_m}\ \frac{\left(2\frac{B_r}{B_s}+\frac{B_m}{B_s}-1\right)^2}{\frac{B_r}{B_s}+\frac{B_m}{B_s}}\ \frac{A_m}{A_w}$$

Figure of merit is defined as the power gain of a series magnetic amplifier with ideal diodes, zero resistance in the output windings and all voltages, currents and resistors on value with zero tolerances. In this equation the effects of the material can be separated from those of the winding. The figure of merit is proportional to the saturation B dividend by H_m, where H_m is the H required to switch the core at the given speed of operation. Evaluation of the terms that contain B_r/B_s and B_m/B_s shows that power gain is roughly proportional to B_r/B_s. These terms account for the effects of the material. The figure of merit is directly proportional to A_m, the area of the magnetic material, divided by A_w, the area of the winding.

Material Choice

To choose the best material, all commercially available alloys and ferrites were tested and a number of specially prepared ferrites and alloys were checked. Table II shows a comparison of some of the more promising materials. Note that ⅛-mil 4-79 molybdenum Permalloy has the highest figure of merit when evaluated for ½-microsecond pulses.[4] This figure of merit assumes unity for A_m/A_w. In fact, ⅛-mil 4-79 molybdenum Permalloy has the lowest H_m of any material tested for switching time between one μsec and 0.1 μsec. Furthermore, it has the highest value of B_s/H_m of any material tested. The high B_s/H_m more than compensates for the low B_r/B_s. The low value of B_s/H_m was expected in evaluating ferrites for memory use.

The quantity B_s is an intrinsic property of the material, while B_r is the remanence when the core is switched over a hysteresis loop of a type that B_m/B_s equals 0.9. This ratio corresponds closely to normal amplifier operation.

The values of the figures of merit are for the core material only and do not include the factor A_m/A_w. However, when these factors are entered the relative status is not altered.

Bobbin Design

The ⅛-mil 4-79 molybdenum Permalloy must be supported on a bobbin during annealing and subsequent winding because it is extremely fragile and sensitive to strain. Because of the great dependence of the figure of merit on the ratio of the material cross-section to the winding cross-section, an attempt was made to make the bobbin walls as thin as possible. It was soon found that when the wall of the ceramic bobbin was made less than approximately 10 to 15 mils thick, the bobbins became extremely fragile.

Instead of the relatively bulky ceramic bobbin, a metal bobbin was used to support the ⅛-mil Permalloy. Metal bobbins can readily be made with walls only three or four mils thick and still have sufficient strength to withstand the annealing cycle and subsequent winding.

At a frequency of 1 mc, the power-gain bandwidth achieved by use of the stainless steel bobbin is about four times that of the optimal ceramic bobbin. Since the power gains obtained at 1 mc are on the order of five to seven, the stainless steel bobbin makes magnetic amplifier circuits for computers operating at this frequency practical.

This work was supported in part by the AF Cambridge Research Center under Contracts AF 30 (602)-1055 and AF 19 (604)-1376. The contributions of J. P. Eckert, Jr. and Robert D. Torrey are gratefully acknowledged.

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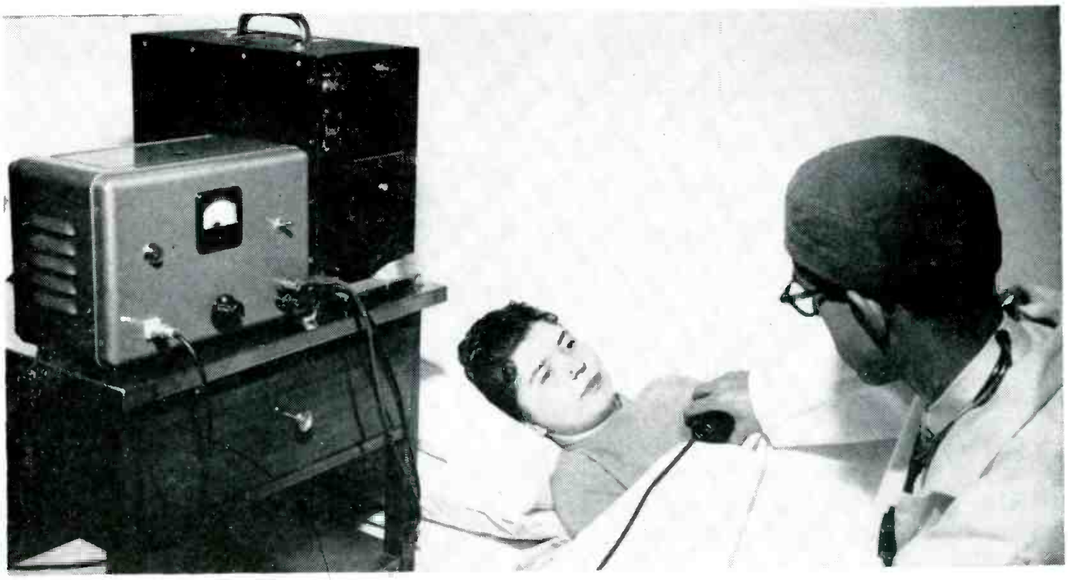

Compact transistorized heartbeat recording system can be operated from either battery or a-c line

Transistor Amplifier for Medical Recording

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Ottawa, Canada

SUMMARY —— Pen recorder amplifier provides transformerless system for recording 3-cps heart signals. Modification of feedback circuit gives audio amplifier with up to 5-watt output flat within 0.2 db from 20 cps to 20 kc

RESEARCH WORK in medical electronics often requires an amplifier to couple a heart-beat microphone to a pen recorder. Microphone output is 1 mv at 10,000 ohms and required frequency response of the amplifier is 3 db down at 3 cps and 2 kc. Recorder input impedance is 17 ohms, with 4 volts needed for full-scale deflection.

These impedances, power levels and frequencies suggest the application of transistors and a complementary-symmetry in the output stage to avoid an output transformer. The amplifier shown in Fig. 1 met these performance specifications satisfactorily. With slight modifications, it has also been used as an audio amplifier to feed a loudspeaker at a level of 1 or 2 watts, with low distortion and flat response to 20 kc.

Recorder Amplifier

The overall voltage gain of the amplifier is about 4,000 with the feedback loop. The minimum input impedance is about 10,000 ohms and 1 mv produces 4 volts rms output across a 10-ohm load, hence the overall power gain is approximately 100 db. Direct-current feedback loops in the preamplifier stages ensure a high degree of temperature stabilization. Emitter degeneration is employed in the first stage to raise the input impedance to the desired level.

The driver-output stages have 100-percent internal voltage feedback, with slightly less than unity voltage gain, but there is still a trace of crossover distortion unless the feedback loop to the base of the last preamplifier transistor is in place. Degeneration introduced by this loop is 16 db. The 220-$\mu\mu$f bypass capacitor across the 22,000-ohm resistor in this loop is essential when working with a purely resistive load, otherwise high-frequency transients can cause the power transistors to run away.

The solid curve in Fig. 2, shows the frequency response curve of the amplifier working into a 15-ohm resistive load, with feedback network *A*. The 3-db points are at 2 cps and 9 kc. The slight increase in

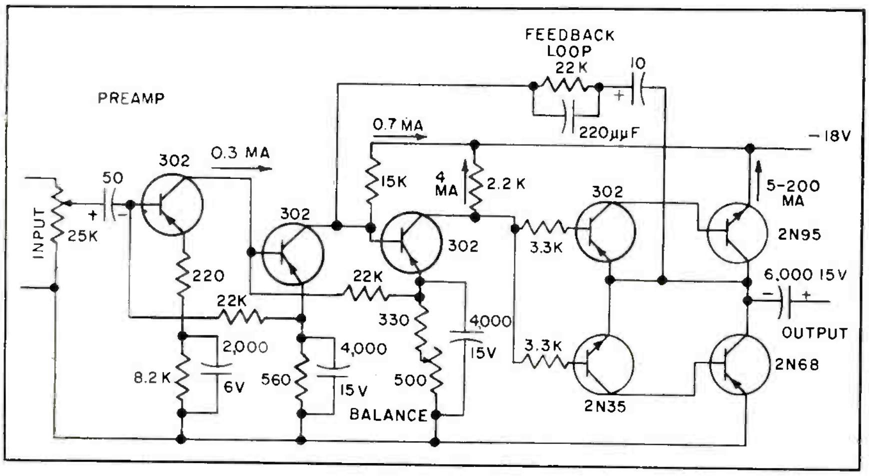


FIG. 1—Transformerless amplifier uses complementary symmetry output stage to match 15-ohm load input impedance of cardiograph pen recorder

response at 5 cps can be removed by selection of the series feedback capacitor and the emitter bypass capacitor, but in practice this bass boost compensates for the fall-off in microphone response at these frequencies.

Figure 3A shows the performance of the amplifier as the load resistance is varied. The maximum undistorted output (1-kc sine wave just below clipping level) is about 1 watt for a 30-ohm load and 2.5 watts for a 6-ohm load.

The efficiency is defined as the ratio of a-c output power to the product of the d-c supply voltage and current to the combined driver-output stage. Curves of total rms harmonic distortion are shown in Fig. 3B for constant output levels of 0.5, 1 and 2 watts.

In Fig. 3C, the solid curve shows the total rms harmonic distortion; and the dashed curve shows the intermodulation distortion, as the input power level is varied. The output signal power, measured here across a 15-ohm load, is directly proportional to input power up to the clipping level. Once this level is reached the distortion increases rapidly.

Clipping

Operating level of the amplifier should be set so clipping does not occur on the peaks when using a loudspeaker load. The pen recorder is an effective peak limiter. Since the undistorted voltage swing of the amplifier is well in excess of the recorder range, harmonic distortion is no problem with the recorder. At reasonable operating levels the harmonic distortion is less than 0.5 percent and the intermodulation distortion still smaller, which meets the requirements of a fairly good audio amplifier.

Noise

With a source impedance of 10,000 ohms and an assumed effective bandwidth of 10 kc (using network *A* of Fig. 2) the measured noise output at full gain is 12 millivolts, which is 52 db below the maximum rms signal voltage of 5.2 volts across a 15-ohm load. This is quite satisfactory since the dynamic range of the recorder is less than 40 db. Noise factor of the amplifier is about 7 db. If low-frequency response is not required the noise factor might be improved by redesigning the first stage to eliminate the electrolytic condensers, and by using a low-noise transistor.

The 500-ohm balance control in Fig. 1 is adjusted initially to bring the collector potential of the last preamplifier stage to half the supply voltage. Alternatively, it may be set so a strong sine-wave signal input is clipped equally on positive and negative peaks at the output. Once set, it needs no further attention since the d-c feedback maintains a constant current in this stage over a wide temperature range.

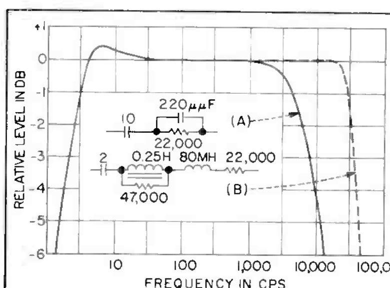


FIG. 2—Response curves of transistor amplifier using two feedback networks

No special selection of transistors is necessary, even for the push-pull driver and output stages, provided that the current gains are within the range of tolerance specified by the manufacturers. The 6,000-μf electrolytic capacitor coupling the output to the load may be omitted by returning the load to a center tap on the power supply. This center tap has to be a low impedance point, which can be obtained easily when using batteries. If a-c operation is desired, two power supplies of opposite polarity are needed to obtain the necessary low impedance.

Direct coupling of the load requires careful selection of the output transistors to ensure equal collector currents, with zero d-c in the load. Even with the best available pair of transistors a small d-c unbalance was observed with increasing output amplitude, resulting in a few milliamperes shift in the load current.

Loudspeaker Amplifier

The only essential change required in the circuit of Fig. 1, to make it useful for driving a loudspeaker, is to modify the feedback loop as shown at (*B*) in Fig. 2. In this network the distributed capacitance of the 0.25-henry choke was excessive, so the 80-millihenry air-core choke was added in series to reduce feedback at the highest frequencies.

The frequency response of the amplifier driving a 15-ohm loudspeaker is shown as the dashed curve in Fig. 2. It is flat to ± 0.2 db from 20 cps to 20 kc, falling off 3 db at 30 kc. Low-frequency response is less important in this application therefore the values of coupling and bypass capacitors may be reduced by a factor of 10 or so, to bring the lower 3 db point up to about 20 cps. The amplifier will also drive a 7-ohm speaker quite satisfactorily, at levels up to 2.5 watts.

The amplifier is well suited to

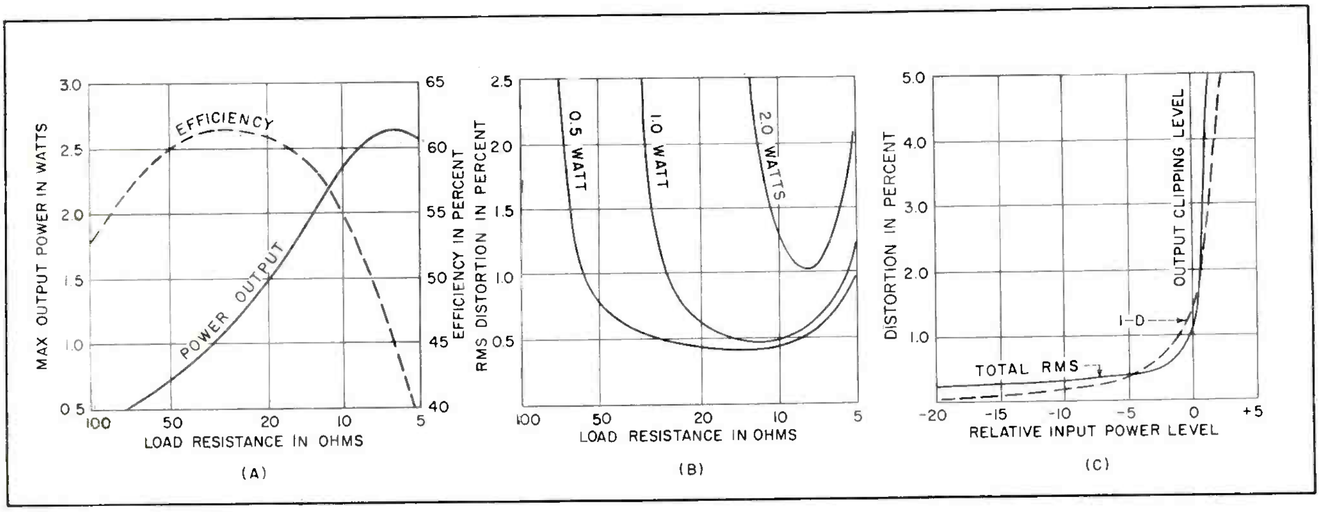


FIG. 3—Power and efficiency (A) rms distortion (B), and rms and intermodulation distortion compared to input power level (C) for transformerless transistor amplifier used to record heart signals at frequencies down to 3 cps

portable operation, using three 6-volt batteries. Over one watt output with 0.5-percent distortion can be supplied to a 15-ohm speaker, with excellent battery economy. Under these conditions the normal overall idling current to all stages is 10 to 15 ma, which increases to 165 ma on peaks. With a 7-ohm loudspeaker the peak current is about 280 ma for 2.5-watts output.

The output transistors work well below their normal ratings and power outputs up to 4 or 5 watts can be obtained by increasing the supply voltage. At still higher levels, the driver stage is the limiting factor, as these transistors can no longer supply adequate base currents to the output transistors.

The 302-2N35 drivers can be replaced by a pair with higher ratings, such as a 2N68-TN95 pair, to yield 10 watts or more of output power on peaks. However, the input impedance of the 2N68-2N95 drivers is considerably lower than that of the 302-2N35 pair, which necessitates a redesign of the previous stage. Furthermore, with the same supply voltage, the idling current of the modified power stages is increased four or five times over the idling current of the original circuit, which may be a serious drawback with battery operation.

Power Supplies

Because of the class-B operation, batteries will give good service in portable applications. Where 110-volt 60-cycle power is readily available, the simplest forms of transistor-regulated power supply are very satisfactory, since the main function of the regulating action is to suppress the ripple voltage. A conventional transformer-rectifier supply, with silicon diodes, is used to furnish full-wave rectified power at 40 to 45 volts to the regulators shown in Fig. 4.

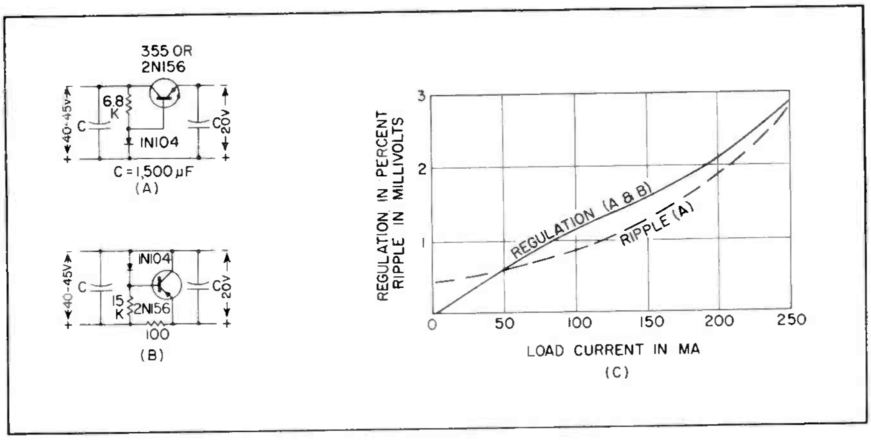


FIG. 4—Series (A) and shunt (B) regulators provide regulation (C) for a-c operation

Series Regulation

With constant load the output voltage of the series regulator, Fig. 4A changes by 1 percent as the line voltage is varied from 90 to 130 volts. Output voltage variation is 2 percent for a load change of 0 to 200 ma. Maximum ripple voltage is reduced to about 2 mv in 20 volts, as compared to 150 mv in 20 volts for the same power supply and filter without the transistor. Ripple voltage of the series regulator decreases as the load drops. The output voltage is fixed at slightly less than the breakdown voltage of the Zener diode, 1N104, which is preselected in the desired voltage range.

The shunt arrangement of the same transistor and diode, shown in Fig. 4B, has a load regulation curve that is almost identical to that shown for the series regulator. The output voltage now is slightly greater than the voltage across the Zener diode. The ripple voltage remains constant at about 2 mv, independent of load. The shunt-regulated supply is a constant-power device, and the total power consumed, including the loss in the 100-ohm series resistor, is greater than for the series regulator, except when the latter is operated continually at maximum load current. On the other hand, an accidental short-circuit across the output of the shunt regulator does no harm, whereas a short across a series regulator usually destroys the transistor.

SUMMARY — New type of crossed-field microwave tube resembles magnetron but has no resonant circuit. Operating frequency is determined externally, either as broadband amplifier or frequency-stabilized self-excited oscillator giving over 60-percent efficiency at output of 2 megawatts. In amplifier operation, radar beam can be scanned without mechanically moving reflector or radar can be shifted rapidly to new frequency to avoid r-f interference or enemy jamming signals

By WILLIAM C. BROWN
Raytheon Manufacturing Co.
Waltham, Mass.

Platinotron Increases

THE PLATINOTRON is a new microwave tube which combines high power output, high efficiency, broadband amplification, low d-c input impedance level, low pushing figure and simple, compact mechanical construction. Power output in the L band is nearly 2 megawatts with over 60-percent efficiency at this level. A bandwidth of 10 percent is easily achieved without dropping below 50 percent in efficiency.

The platinotron derives its high power and efficiency from the magnetron principle of interaction. The bulk of the d-c energy delivered by the power supply is converted directly into r-f energy. In addition to having many of the desirable properties of the conventional magnetron oscillator, the new tube has an entirely new and highly desirable performance characteristic—broadband amplification. The chief physical difference from a conventional magnetron is the use of two external couplings for transmission lines rather than one.

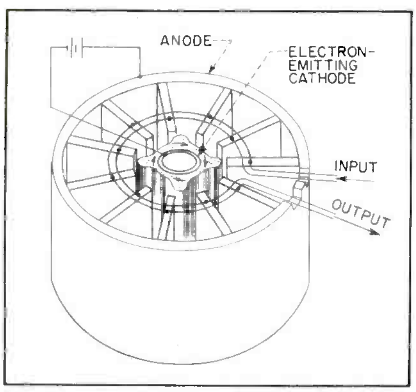


FIG. 1—Mode of operation of platinotron is complex, utilizing crossed electric and magnetic fields and a reentrant slipping-stream electron beam to give backward-wave behavior

How It Works

The mode of operation is shown in Fig. 1. First an r-f signal is injected into the device. This traverses the r-f circuit and proceeds to the output with little loss because the insertion loss is kept low, usually below 0.5 db. A d-c potential is then placed between the cathode and anode as indicated. As the potential is raised, a cloud of electrons forms around the cathode in the shape of a concentric ring and rotates with an angular velocity dependent upon the applied potential.

As the potential is further increased, a critical value is finally reached where the angular velocity of the outermost electrons becomes synchronous with the velocity of a wave traveling on the circuit. At that point the ring transforms into a hub with spokes of space charge or electrons projecting from it. The electrons in these spokes deliver energy to the r-f circuit, surrendering their potential energy (which is a maximum when they are at the cathode) to the r-f field as they move radially to the anode and are collected. Interaction between the spokes of electrons and the energy traveling on the circuit can occur over a wide band of frequencies, without any adjustment of the tube.

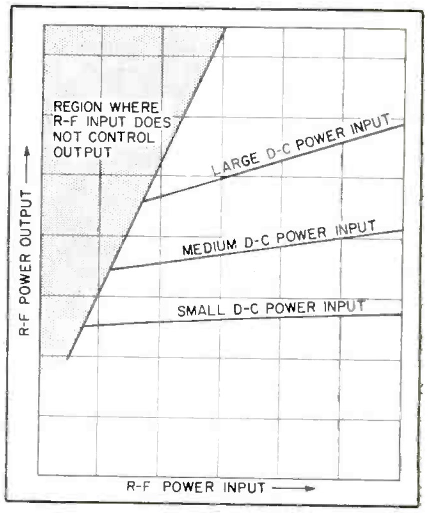
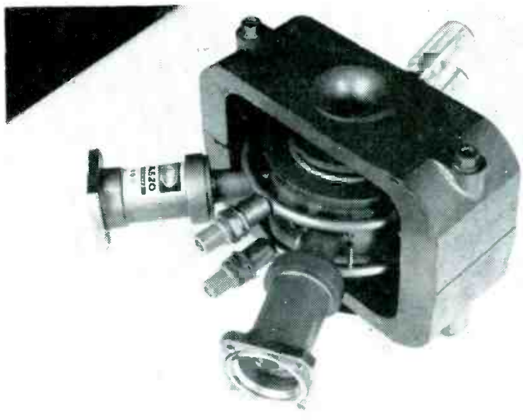


FIG. 2—Power output increases only slightly with r-f power input, but increases rapidly with d-c power input

As voltage is increased, electrons

FRONT COVER—Basic platinotron, with magnet and one cover removed to show 11-vane construction surrounding central 0.75-inch-diameter cathode. Glass-insulated heater leads are at right



Typical permanent magnet construction. Unlike magnetron, new tube has two external couplings instead of one, with vacuum fittings located between input and output

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in the spokes move more rapidly to the anode and create more current flow. The angular velocity remains the same.

Amplifier Operation

The platinotron behaves as a saturated amplifier rather than as a linear amplifier. The magnitude of the r-f output is independent of r-f input but dependent on d-c input. If the r-f drive for a given level of d-c input is reduced to too low a value, the device ceases to be an amplifier.

Applications of the device are limited to those of a saturated amplifier. This is not a large restriction since pulsed radar applications use amplifiers under saturated conditions and most frequency-modulated devices can make use of a saturated amplifier.

Characteristics of the r-f output as a function of the r-f input are given in Fig. 2. The output does increase somewhat with r-f input, because efficiency increases slightly at higher r-f drive. Also, the r-f drive reappears unattenuated at the output and adds to the r-f power generated by the platinotron itself.

A test setup for amplifier operation is shown in Fig. 3. The resistive isolation pad reduces the output power level from the platinotron oscillator to a suitable driving level and presents a reasonable match to any power which might flow in the reverse direction from the platinotron amplifier toward the input. If re-reflected rather than absorbed, this power would interfere with the measurements being made. In practical applications a ferrite isolator with directional attenuation properties is used in place of resistive pad.

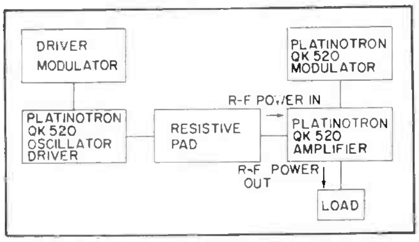


FIG. 3—Testing platinotron as amplifier

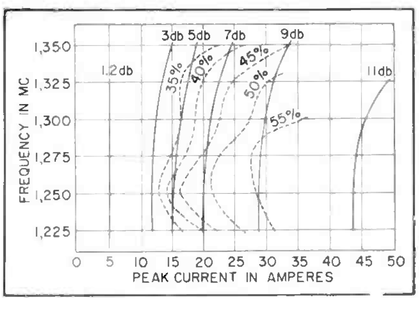


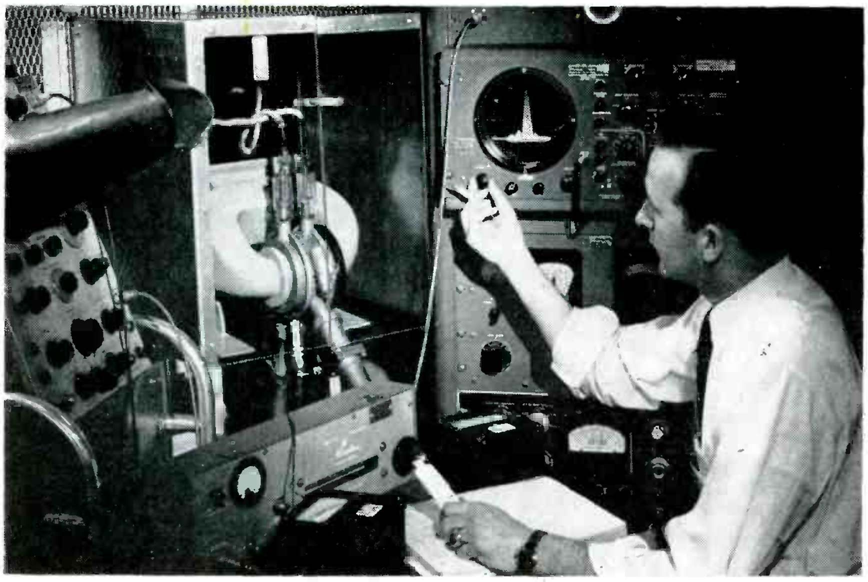
FIG. 4—Contours of constant gain and efficiency, obtained by feeding in a nearly theoretical 5-microsecond r-f input spectrum and varying such parameters as anode potential, anode current, magnetic field, frequency and load

With a 5-microsecond input pulse, the output spectrum was observed at anode current increments of 5 amperes up to 50 amperes and frequency increments of 25 mc from 1,225 mc to 1,350 mc. At no point was there a degradation of the quality of the spectrum. Even at the higher current levels, the efficiency was well over 50 percent, with gain of about 10 db.

Efficiency is here defined conservatively as r-f power output minus r-f power input, divided by d-c power input. The test data is replotted in Fig. 4 to give contours of constant gain and efficiency.

The relationships between anode voltage, anode current, magnetic field and power output and efficiency are shown in Fig. 5. The magnetic field usually represents a compromise between magnet weight and the higher efficiency which can be obtained at higher values of magnetic field. Once the magnetic field is selected, it determines the relationship between anode voltage and current. The curves closely follow those for magnetrons.

Under variable load conditions



Test setup for amplifier operation of platinotron, with pulse output spectrum showing on screen of scope at right of tube

the quality of the output spectrum remains unperturbed regardless of phase position of output mismatch and vswr up to a value of 2.5.

Oscillator Operation

The directional behavior and broadband characteristics of the platinotron make stabilized oscillator operation possible over a relatively broad band of frequencies without changing the tube in any way. Table I compares a platinotron oscillator with a comparable magnetron widely used in radar systems.

The method of using a platinotron in conjunction with other circuit elements to form a highly frequency stabilized oscillator is shown in Fig. 6. Where tuning is not required, the line stretcher is omitted. A portion of the output power is reflected from the reference plane ll'. This reflected power travels back through the platinotron anode with little or no attenuation or reflection and out to reference plane rr'. Here most of it is again reflected, the phase of the reflection depending upon the frequency of the incident power and the resonant frequency of the stabilizing cavity. This re-reflected power is then amplified by the backward wave principle and arrives at the reference plane ll' at full output level.

Steady oscillations can occur only if the loop phase shift from plane ll' to plane rr' and return is an integral multiple of 360 degrees. The phase shift vs frequency characteristic of the stabilizing cavity has a slope many times greater than that of any other element in the circuit. A slight change in frequency will thus permit the cavity to correct for a substantial phase shift which might be introduced by such factors as a change in the antenna load or frequency pushing of the electron stream.

The four phase-shift components which add up to give the total loop phase shift θ_a of the system are shown in Fig. 7. Expressed in radians, these are θ_t, the two-way phase shift along the coaxial transmission lines which connect planes ll' and rr' to the platinotron; θ_p, the two-way phase shift which takes place in the platinotron itself; θ_r, the phase shift which takes place at reference plane rr' of the stabilizing cavity system; θ_l, the phase shift which appears at reference plane ll' of the output reflection.

The system will oscillate at a frequency where the total loop phase shift θ_a is an integral multiple of 2π radians. The phase shift vs frequency characteristic of the stabilizing cavity in the region of cavity resonance has a slope many times greater than that of any other element in the circuit. The tube oscillates in this region

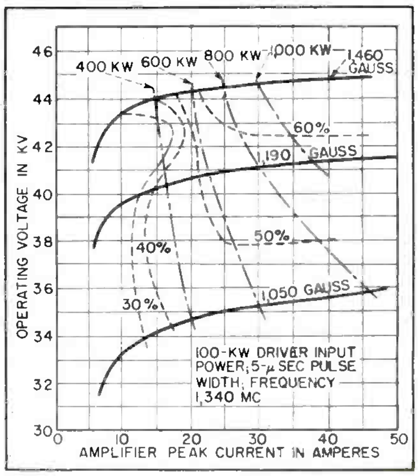


FIG. 5—Typical performance chart for L-band platinotron amplifier

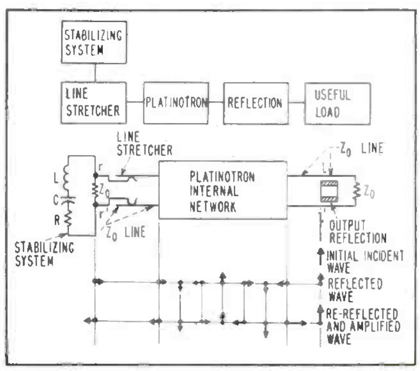


FIG. 6—Method of operating platinotron as frequency-stabilized oscillator

Table I—Comparison of Characteristics as Oscillators

	5J26 Magnetron	QK520 Platinotron
Pulling Figure in mc per sec	2.0–2.5	0.4–0.6
Pushing Figure in kc per sec per amp	50–100	1–4
Peak Operating Current in amperes	46	40
Operating Magnetic Field in gauss	1,400	1,150
Operating Voltage in kv	28.2	36.0
Typical Efficiency in per cent	42	52
Peak Power Output in kw	550	750
Spectrum Sensitivity to Heater Power	Sensitive	Not Sensitive
Tuning Range in mc per sec	1,220–1,350	1,260–1,350

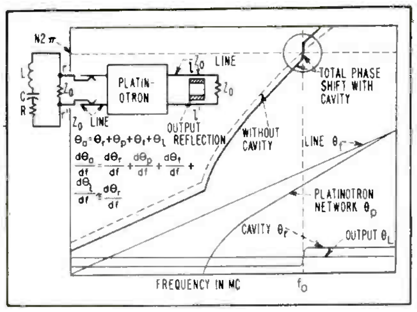


FIG. 7—Components contributing to total phase characteristic of stabilized oscillator. Intersection of dotted lines determines frequency of operation

of steep slope, corresponding to $N2\pi$ loop phase shift, because damping resistor Z_o effectively absorbs all incident energy unless it be at a frequency close to that of the resonant frequency of the cavity. There is then no reflected signal for excitation of the platinotron at frequencies and loop phase shift corresponding to other integral multiples of 2π radians.

Oscillator Stability

It is the steep slope of the phase shift characteristic of the cavity which gives the system its high degree of frequency stability. The region of this steep slope is enlarged in Fig. 8. Any increment of phase shift $\Delta\theta$ added to the total loop phase shift of the stabilized system changes the total value of the loop phase shift and causes the phase-shift curve to intersect the phase shift value $N2\pi$, required for oscillation of the system, at a different frequency.

The heavy dashed line in Fig. 8 represents the phase-shift characteristic of an unstabilized system before an incremental phase change $\Delta\theta$ has been added. The light dashed line represents this same characteristic after the addition of the $\Delta\theta$ increment. The change in operating frequency of the system caused by the $\Delta\theta$ increment is seen to be Δf_u.

The heavy solid line represents the phase-shift characteristic of a stabilized system before $\Delta\theta$ has been added, and the light solid line represents the same characteristic after the addition of $\Delta\theta$. In the stabilized case the resulting frequency change Δf_s caused by the $\Delta\theta$ increment of phase is much less than the frequency change Δf_u in the unstabilized case.

Assuming that the cavity is the only significant stabilizing element in the circuit, the degree of stabilization S is

$$S = \left(\frac{df}{d\theta_p}\right)\left(\frac{2\,Q_L}{f_o}\right) \qquad (1)$$

where Q_L is the loaded Q of the cavity, f_o is the resonant frequency of the cavity and $df/d\theta_p$ is the slope of the platinotron phase-shift characteristic.

The stabilization factor S, which may easily be in the range of 50 to 100, is the ratio of frequency stability in the cavity-stabilized platinotron to the frequency stability of the unstabilized platinotron run as an oscillator. This factor S also represents the improvement in frequency stability over a conventional unstabilized magnetron for those frequency instabilities associated with changes in the internal circuit, such as temperature change, vibration, deposition of material on vanes, electronic loading and barometric effects.

Oscillator Efficiency

Large stabilizations can be obtained by relatively low values of loaded Q of the cavity. Since the unloaded Q of the cavity can be made at least 20 times as great, and since the stabilizing cavity is placed at the input side of the platinotron and therefore has only a fraction of the output power incident upon it, the overall circuit efficiency can be held well over 95 percent.

Figure 9 gives the value of the

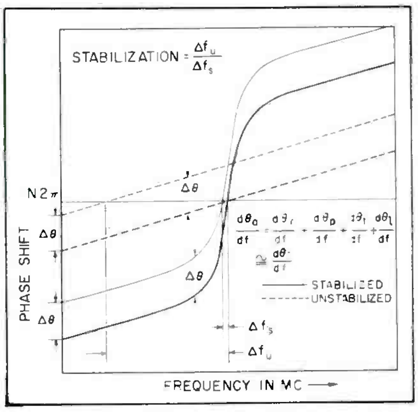


FIG. 8—Expansion of encircled area in Fig. 7, showing stabilizing action of cavity

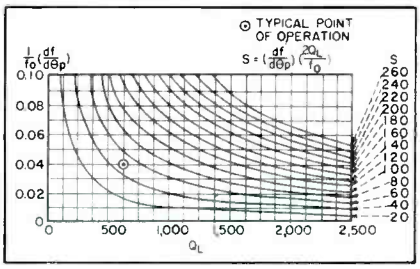
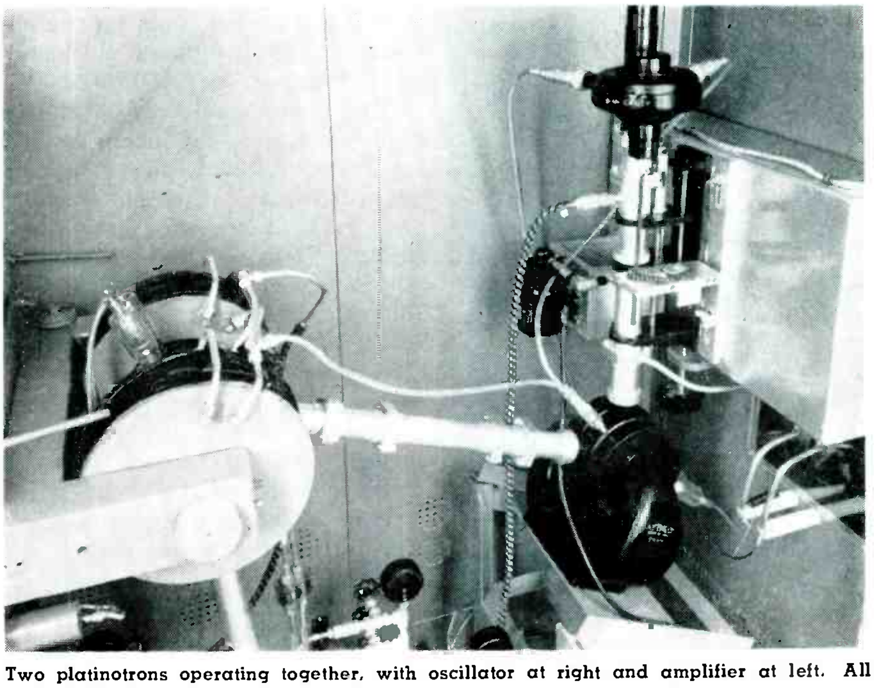


FIG. 9—Variation of stabilization factor S with Q of cavity and slope of platinotron phase-shift characteristic



Two platinotrons operating together, with oscillator at right and amplifier at left. All oscillator tuning is achieved by mechanical drives acting on external cavity

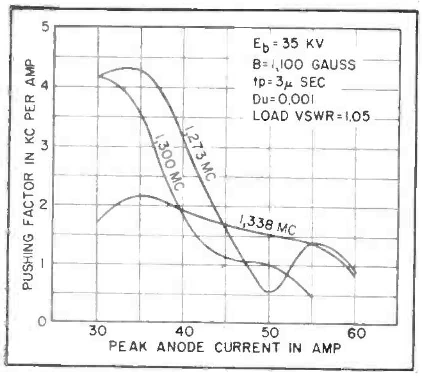


FIG. 10—Dynamic pushing characteristic of L-band stabilized oscillator as function of frequency and anode current. Stabilization factor S is approximately 70 here

stabilization factor S for various combinations of cavity-loaded Q and slope of the platinotron phase-shift characteristic.

Pulling Figure

For a number of reasons $|r_l|$ is usually chosen to be 0.6. Then a practical expression for the pulling figure, which is generally recognized as a measure of the effect which a change in external loading has upon the frequency of the oscillator, is

$$\Delta f = 0.225 f_o / Q_L \qquad (2)$$

where f_o is the operating frequency of the system and Q_L is the loaded Q of the stabilizing cavity system. This equation gives pulling figures which represent a reduction of from 5 to 20 times those normally associated with magnetrons.

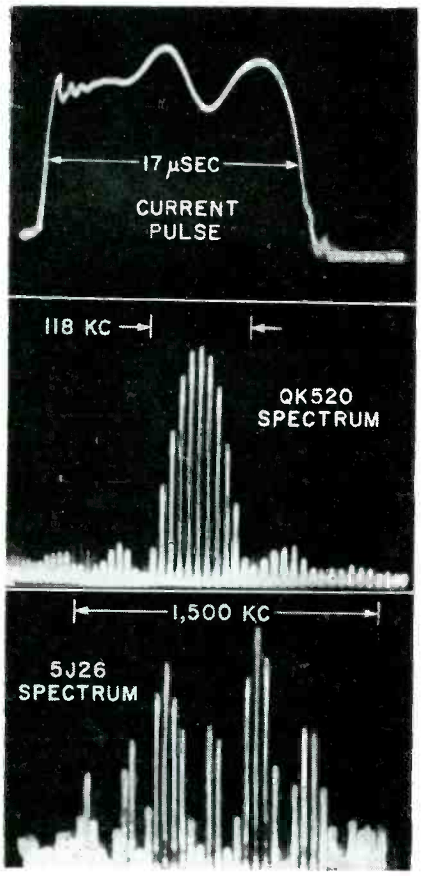


FIG. 11—Comparison of output spectra of QK520 platinotron and 5J26 magnetron for 17-microsecond current pulse

Stabilization Factor

Effects of variations in anode current are reduced in the ratio of the stabilization factor S. The dynamic pushing figures that may be expected are shown in Fig. 10. The pushing figure is defined as the slope of the curve of frequency vs anode current. The drastic reduction in frequency pushing figure means that excellent spectra can be obtained, even with poorly shaped current pulses. Figure 11 compares frequency spectra resulting from a poorly shaped long-duration (17-microsecond) current pulse in an L-band platinotron oscillator and in a 5J26 L-band magnetron. With the platinotron a nearly theoretical spectrum is obtained, while for the 5J26 the spectrum is more than ten times theoretical.

Discontinuities

With stabilized oscillator operation of the platinotron there are no regions of anode current or cathode temperature where the effect of the rotating electron beam on the circuit becomes partly or completely discontinuous, as is the case in magnetrons. Such discontinuities can be avoided by using magnetrons only for short-pulse-width applications. As longer pulse widths are used, it becomes increasingly difficult to avoid trouble from this source, which evidences itself by a discrete jump in frequency of the order of a fraction of a megacycle. Since the platinotron does not experience this phenomena, long pulse widths may be used and a broad range of cathode temperatures may be permitted without adversely affecting the near-theoretical quality of the spectrum.

Oscillator Performance

Behavior over a 100-mc tuning range as an oscillator is shown in Fig. 12. Anode potential, efficiency and power output vary only slightly over the 100-mc range.

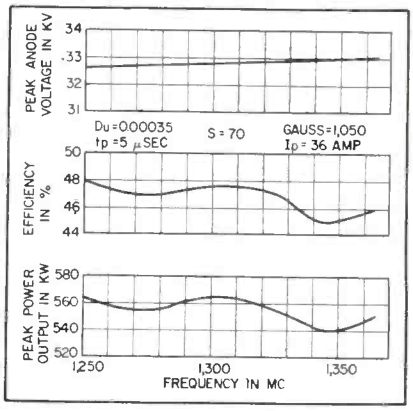


FIG. 12—Platinotron oscillator performance as function of frequency with matched load and fixed values of magnetic field and anode current

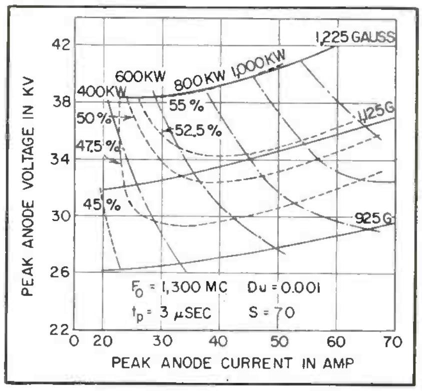
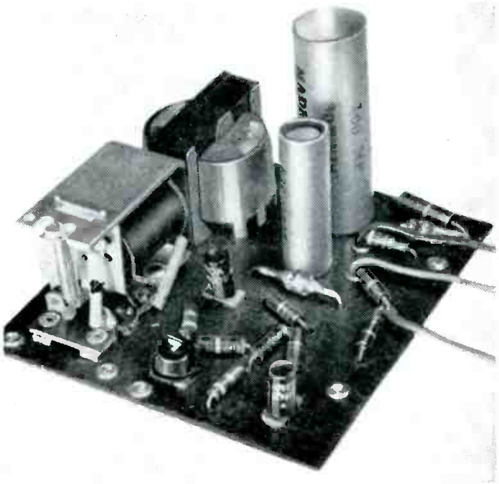


FIG. 13—Platinotron oscillator performance as function of anode current, anode setup and magnetic field at 1,300 mc

Variation of peak power with anode current and magnetic field used is shown in Fig. 13. As the magnetic field level is increased, the anode potential must also be increased to maintain a constant value of anode current. As the magnetic field is increased, the efficiency first increases rapidly and then more slowly. In practice a magnetic field is selected which is the best compromise between efficiency of operation and size of magnet, which is usually a permanent magnet.

The power output that can be obtained depends primarily upon the life expectancy to be specified. Life at an operating point of 36 kv, 40 peak amperes and 0.0024 duty cycle is in excess of 500 hours.

The early and continued support of Evans Signal Laboratory in developing this tube for military use is gratefully acknowledged.



Equipment side of printed chassis

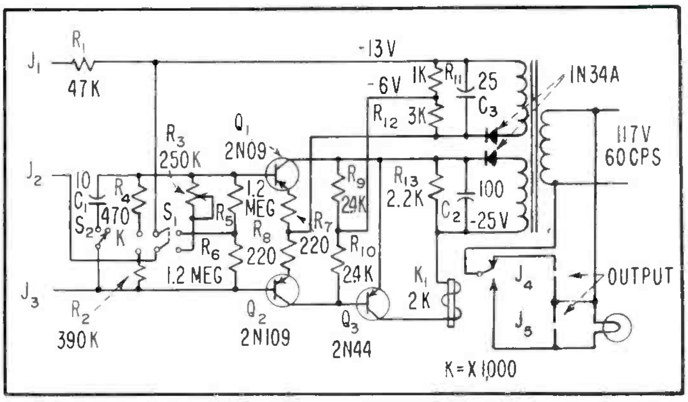


FIG. 1—Circuit diagram of the three-transistor control device

Transistorized Lab Relay

SUMMARY —— Control device with almost indefinite life operated from socket power is mounted on printed-circuit board. Semiconductor diodes and transistors permit miniaturization with size determined only by a-c output fixtures, transformer and relay. Controlled circuits can be normally on or off

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ADVANTAGE of inherent long-life characteristics of transistors is exploited in the design of a new transistorized relay. Two matched 2N109 transistors are used in balanced input and one 2N44 in the relay coil circuit.

Balanced input compensates for ambient temperature changes; it also permits greater versatility in the control circuits. The relay can be energized by a normally open or normally closed contact, by illumination on a cadmium-sulfide cell or photocell and by a control current of 12 microamperes more or less. With the current input feature, a photovoltaic cell, for example, can be used to control the opening and closing of the relay.

The schematic circuit diagram is shown in Fig. 1. With S_1 in normally open position and no input signal, the bias currents of Q_1 and Q_2 are equal. The voltage drops across R_9 and R_{10} are also equal and opposite; therefore, the resultant voltage at the base of Q_3 is zero.

If J_1 and J_2 are shorted with a resistance up to 400,000 ohms, the increased bias on Q_1 upsets the balance of voltage on R_9 and R_{10}, producing a negative voltage at the base of Q_3. Sufficient collector current then flows through Q_3 to energize relay K_1.

With S_1 in the normally closed position and J_1, J_2 open, the collector currents through Q_1 and Q_2 are unbalanced to the point where Q_3 conducts sufficiently to energize K_1. Shorting J_1 and J_2 balances the collector currents again and K_1 opens.

If a photocell of the cadmium-sulfide type is connected across J_1 and J_2, changes in illumination will cause the cell resistance to vary, thus producing the same effect as opening and closing the circuit across J_1 and J_2.

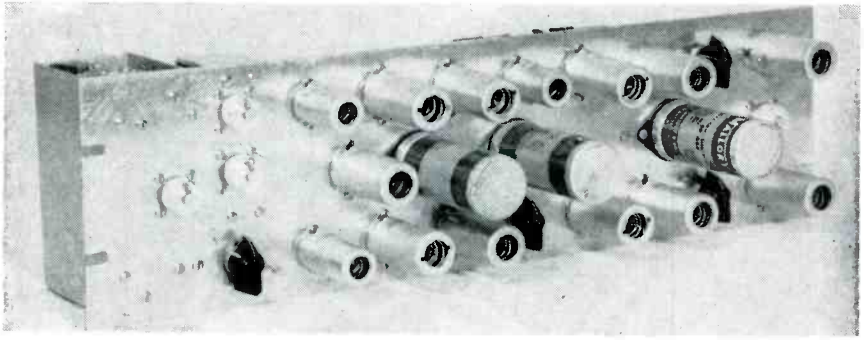
Reverse Operation

It is sometimes more convenient to actuate the relay by opening a contact rather than closing it. Using the normally-closed control option permits this to be accomplished and yet if the relay fails, it will fail safe, shutting off the load.

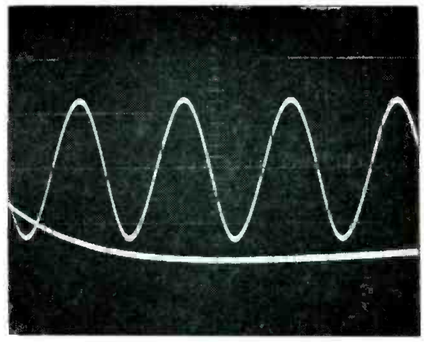
If it is desired to operate the relay from a source of low current, such as a photovoltaic cell, the terminals of the cell are connected to J_2 and J_3 with the positive terminal on J_3; S_1 must be on normally open. The action is now push-pull; the Q_1 collector current is increased while Q_2 collector is decreased. The resulting voltage across R_9 and R_{10} causes the relay to energize.

A slight delay in opening and closing the relay is obtained by closing S_2. The delay time varies depending on the resistance of the input circuit but it is intended primarily only to prevent relay chatter when a slowly moving, light contact is being made or broken.

Sensitivity control R_3 provides a convenient means of limiting the input current if, for instance, it is desired to reduce the output of a photovoltaic cell because of high ambient light.



Rack-mounted low-frequency divider chassis achieves phase stability in countdown by using pulse sampling



Thirty-minute-exposure waveforms of 2.47-mc (top) and 7.35-kc (bottom) outputs

SYNC GENERATOR FOR

PHASE STABILITY is important in NTSC color television to reduce degradation of the brightness signal caused by the color signal. A phase shift of 0.8 degree at 15 kc in the horizontal synchronizing pulse during the 1/30 second between successive scans would reinforce rather than cancel the dot pattern.

The synchronizing generator to be described was developed for use in a dot-interlace system.

Sampling Divider

When a stable high-frequency crystal reference is used, the problem of phase stability becomes one of maintaining the output of the divider chain in time coincidence with every *p*th cycle of the crystal reference frequency. This may be accomplished by using the output of the divider chain to sample the peak of this cycle of the reference frequency. The sampled output is shaped to form the synchronizing pulse.

The method of sampling used depends upon the frequencies involved. At low frequencies, the square wave outputs from multivibrator dividers may be used to control a gate. At frequencies above 50 kc, sinusoidal dividers are usually used. The outputs of these dividers may be added and clipped to achieve an imperfect type of sampling.[1]

A highly stable pulse can be obtained from a pulse-dividing chain by adding the outputs of the various divider stages and using them to sample the input pulse as illustrated in Fig. 1. Astable multivibrator dividers were used in this particular chain, although the principle is applicable to bistable multivibrators and phantastron dividers.

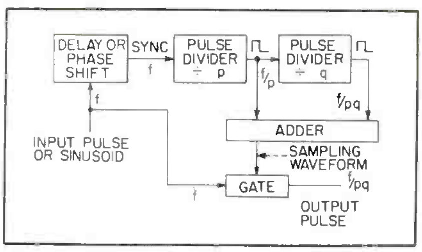


FIG. 1—Basic pulse dividing chain with sampling

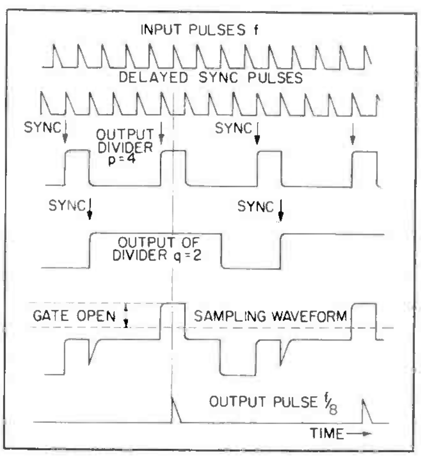


FIG. 2—Pulse relationships in sampling dividing chain

Figure 2 illustrates how the positive pulse duration of each divider is selected so as to select one of the *p* pulses that it divides by. The relative phase of these square pulses is chosen to insure that the output pulse is sampled by the flat portion of the square-wave top. The peak square pulse allows one of the input pulses to pass through the gate insuring that the output is in phase with the input.

Jitter in the firing time of the chain multivibrators has no effect on the phase of the output pulse as long as the counting ratio remains constant and the pulse is sampled by the flat portion of the square pulse peaks.

Experimental Equipment

The high-frequency divider shown in Fig. 3 and 4 was built as a part of a dot-interlace bandwidth-reduction television system.

Crystal oscillator V_1 feeds a 2.47-mc reference signal to buffer V_2. A link coupled to the buffer stage provides a 2.47-mc sinusoidal output signal.

The first locked-oscillator divider, V_3, is self-oscillating at 412 kc. The 2.47-mc signal coupled to its grid through the 0.5-$\mu\mu$f capacitor reacts with the harmonics of the 412-kc signal causing the oscillator to pull in. The oscillator is tuned with the 50-$\mu\mu$f variable-plate capacitor

SUMMARY — Accurately phased horizontal and vertical synchronization pulses are obtained by sampling pulses from frequency divided chains to obtain output corresponding in phase to half-cycle of high-frequency signal. Though design is for 14.7-kc line and 60-cps field frequencies, with 2.47-mc reference frequency, technique is directly applicable to NTSC color systems

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DOT-INTERLACE TV

until pull-in is achieved.

An oscilloscope connected to point A detects lock-in. The 412-kc output of V_3 is used to lock in V_4 at 58.8 kc in a similar manner. The output of V_4 is rectified by the IN34A diode to provide negative pulses which correspond to each negative half cycle of the 58.8-kc output sinusoid of V_4. This pulse which corresponds to the delayed sync pulse of Fig. 2 is amplified and shaped in V_5 and synchronizes multivibrator V_6.

The 14.7-kc output of V_6, which corresponds to divider $p = 4$ of Fig. 2 is applied to cathode follower V_{7A}. The output from the plate of V_{7A} is differentiated by the 100-$\mu\mu$f 82,000-ohm network and applied to the grid of V_{7B} where it is clipped to provide a negative 14.7-kc pulse to the low-frequency divider.

This negative pulse also synchronizes multivibrator V_8 whose 7,350-cycle output corresponds to divider $q = 2$ of Fig. 2. This output is applied to cathode follower V_9. The outputs of V_{7A} and V_9 add in their common cathode resistor to provide the sampling waveform of Fig. 2. The IN34A diode associated with V_{11} clamps the top of this waveform at ground potential.

Sampling Portions

The outputs of V_2, V_3 and V_4 are added and applied to the grid of V_{10}. The 75,000-ohm resistor shifts the phase of the sinusoids with respect to each other so the peaks add in phase.

The output of cathode follower V_{10} is shown in Fig. 5. This waveform which has a peak-to-peak amplitude of approximately 20 v is applied to the grid of V_{11} where the positive peak of the waveform is clamped at ground potential by the grid diode action.

Grid cutoff is held at a fraction of a volt by dropping plate and screen potentials to approximately 45 v. Only the uppermost peak of the waveform draws cathode current.

The repetition rate of this sharp current pulse is 58.8 kc. This clipping action completes the high-frequency sampling.

Low-frequency pulse sampling is achieved by the sampling waveform of Fig. 2 which is applied to the suppressor grid of V_{11}. The suppressor allows electrons to reach the plate on every eighth cathode current pulse. The other pulses draw screen current.

The pulse of cathode current occurs at a time corresponding to the center of the sampling waveform peak as illustrated in Fig. 2 because the negative half cycle of V_4 synchronizes the countdown multivibrators.

The 7,350-cps narrow plate pulse of V_{11} is inverted and amplified by V_{12} and applied to cathode follower V_{13A}. The output charges the 100-$\mu\mu$f capacitor through the IN48 diode. The charge leaks off through the 270,000-ohm resistor in parallel with the condenser providing a much wider pulse that is applied to output cathode follower V_{13B}. The output of V_{13B}, shown in Fig. 6, acts as the horizontal synchronizing pulse. The leading edge of this pulse is in phase with the peak of

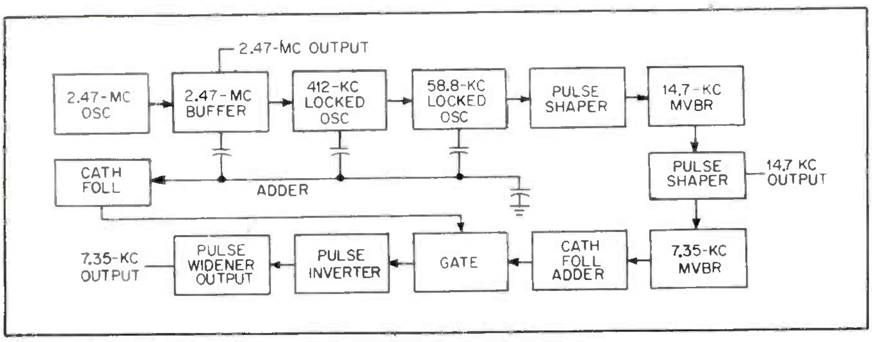

FIG. 3—Block diagram of high-frequency divider used in dot-interlace television system

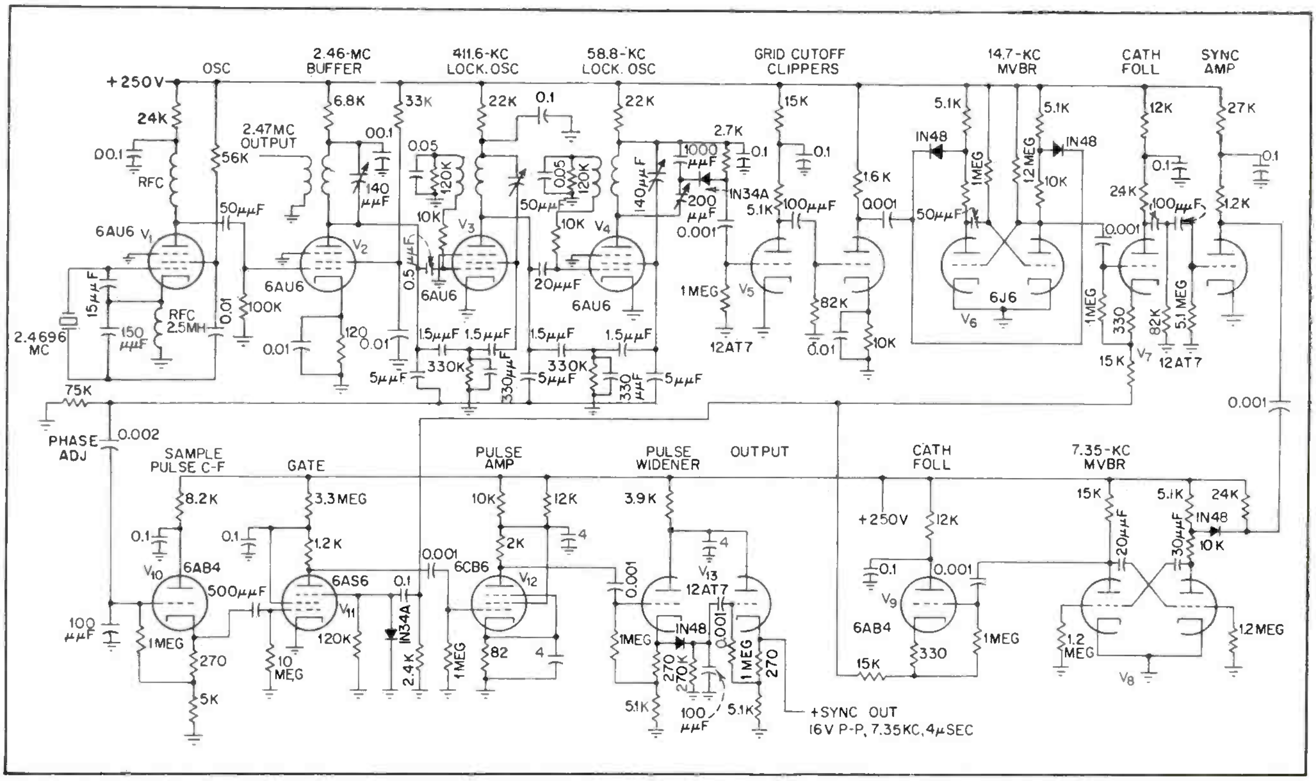

FIG. 4—High-frequency divider counts down 2.47-mc reference frequency to 14.7-kc horizontal line frequency

corresponding cycles of the 2.47-mc output.

Low-Frequency Divider

The low-frequency divider is shown in Fig. 7 and 8. The 14,700-cps output of the high-frequency divider is applied to the input of this divider through the 14-μsec delay line in the cathode of V_{1A}. This pulse is amplified by V_2 and used to synchronize multivibrator V_3 which has an output frequency of 2,100 cps.

The output of V_3, which is applied to cathode follower V_{4A}, consists of a positive pulse similar to divider output p of Fig. 2. The width of this pulse is approximately 1/14,700 second corresponding to $p = 7$.

The opposite polarity output of V_3 is differentiated and clipped by V_{4B} to provide a synchronizing pulse for multivibrator V_5, which provides a pulse to cathode follower V_{6A} at a frequency of 300 cps and a synchronizing pulse to clipper V_{6B} that synchronizes V_7. Multivibrator V_7 provides an output pulse to cathode follower V_{8A} at 60 cps and a 60-cps test output signal.

The cathode follower outputs are added in the 8,200-ohm common cathode resistor to provide the waveform shown in Fig. 9. The peak of this waveform is clamped at ground potential by V_{1B} which acts as a diode. This waveform is applied to the suppressor of V_{12} where it acts as the gating waveform.

Signal Path

Following the path of the input signal through the sampling portion of the divider, the input signal is inverted by V_{11A} and applied to to the grid of gate V_{12}, which is controlled by the gating waveform.

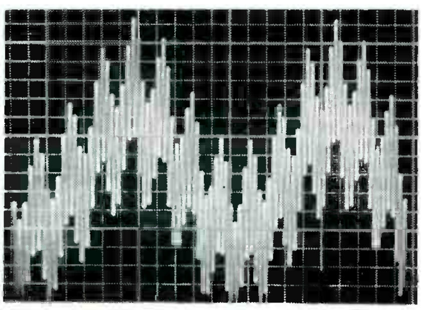

FIG. 5—Composite sampling waveform before clamping and clipping

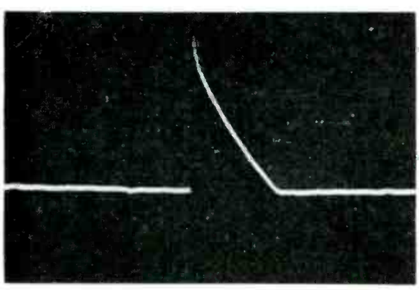

FIG. 6—Horizontal sync pulse has leading edge in phase with peak of corresponding cycles of 2.47-mc reference signal

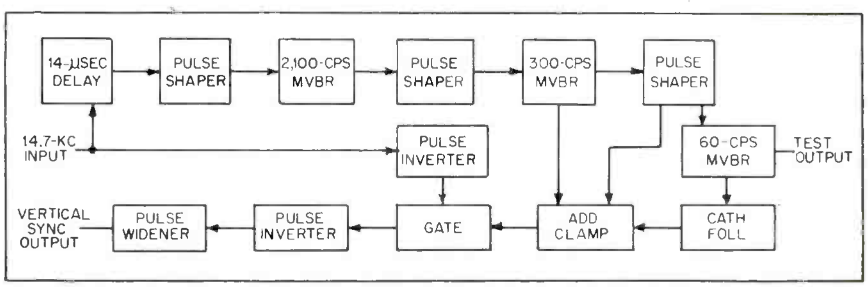

FIG. 7—Low-frequency divider uses pulse-sampling technique to achieve phase stability in counting down 14.7 kc to 60-cps vertical field rate. Vertical sync pulses are in exact phase with every 245th input pulse

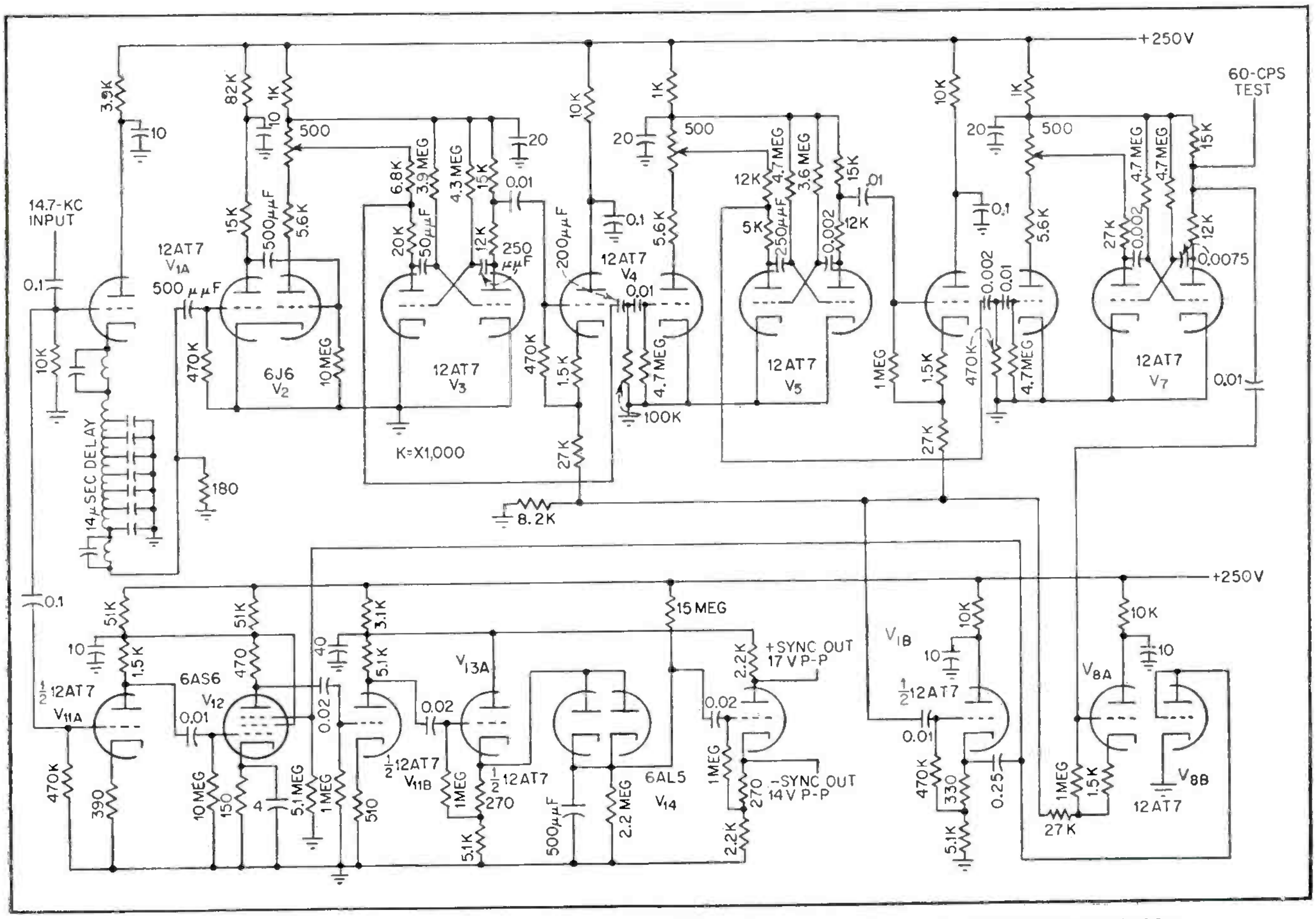

FIG. 8—Sixty-cps output pulses are exactly in phase with every 245th 14.7-kc input pulse to the low-frequency divider

The input pulses only draw plate current on the extreme peaks of the gating waveform. This waveform allows every 245th pulse to be amplified by V_{12}. This selected pulse, which has a 60-cycle repetition rate, is inverted by V_{11B} and applied to cathode follower tube V_{13A}.

The 500-$\mu\mu$f capacitor is charged by V_{13A} through diode V_{14}. The capacitor charge leaks off through the 2.2-megohm resistor providing a pulse similar to that of Fig. 6 but occurring at a 60-cps rate. This pulse is fed to phase splitter V_{13B} to provide positive and negative vertical synchronizing pulses which are in phase with every 245th input pulse to the low-frequency divider.

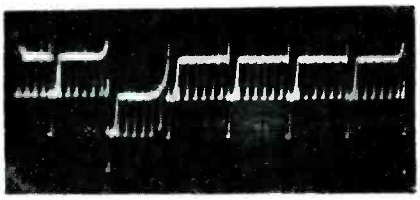

FIG. 9—Gating waveform in low-frequency divider

A simple experiment was performed to illustrate the improvement of phase stability obtainable by sampling. The B+ voltage of the low-frequency divider was slowly varied from 200 to 300 v while time exposures of the 14.7-kc input pulse were made.

In Fig. 10A, the time sweep was synchronized by the 60-cps sampled output pulse. In Fig. 10B, the time sweep was synchronized by a pulse obtained from the 60-cps multivibrator. The pulse from this multivibrator represents the output of a conventional divider chain. The relative phase stability of the input and output pulses using sampling and conventional techniques is thus clearly illustrated.

Potential Applications

The methods of sampling described are applicable to most divider chains and should prove particularly valuable in color television, multiplex systems, facsimile systems and interval timers requiring a high degree of accuracy.

The author thanks P. O. Raygor and G. F. Gannon for their assistance in constructing and testing the equipment.

FIG. 10—Horizontal-rate input pulse with time sweep synchronized by 60-cps sampled output (A) and pulse from 60-cps multivibrator (B) shows advantage of sampling

REFERENCE

(1) P. M. G. Toulon, U. S. Patent 2, 565, 102, Aug. 1951.

Measuring Parameters

By ROY W. HENDRICK, Jr.
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SUMMARY — Instrument measures dynamic ground-emitter characteristics of *pnp* or *npn* transistors at any static collector current from 0.15 to 15 ma. Integral transistor stage reduces effective impedance of test meter to approximate short circuit in beta measurement. Addition of batteries and simple oscillator will make unit portable

ALTHOUGH transistor quality may be roughly evaluated by its base-to-collector leakage current and base-to-collector gain, temporarily baffling results may be faced in dealing with the transistor circuits if these are the only data available. For instance, a two-stage amplifier with an expected gain of 5,000 produced a meager 40 until the static transistor currents were increased. The large increase in input resistance due to lower collector currents had shunted the signals away from the transistor bases, dropping the overall gain.

This experience prompted the development of a test unit which measures all the hybrid parameters of a junction transistor. The instrument can measure the following characteristics at any static collector current from 0.15 to 15 ma: collector leakage with the emitter open, I_{co}; collector current with base open, $I_c(I_B=0)$; base-to-collector current gain, β; input impedance r_i; output impedance with the base at a high impedance to the signal r_o; output impedance with the base terminated in 1,000 ohms, r_o'. The resistances designated are for the grounded-emitter connection.

Except for leakage measurements, the tester determines dynamic characteristics using a 60-cps test signal. Little difference has been encountered between parameters measured with this frequency or the usually specified 1,000-cps test frequency.

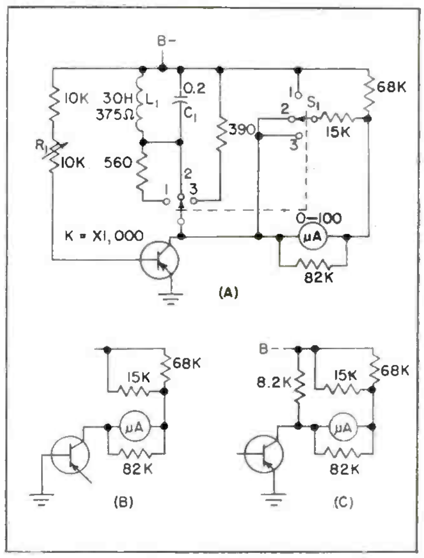

FIG. 2—Collector-current monitoring circuit (A), collector-leakage monitoring system for open emitter (B) and open base (C)

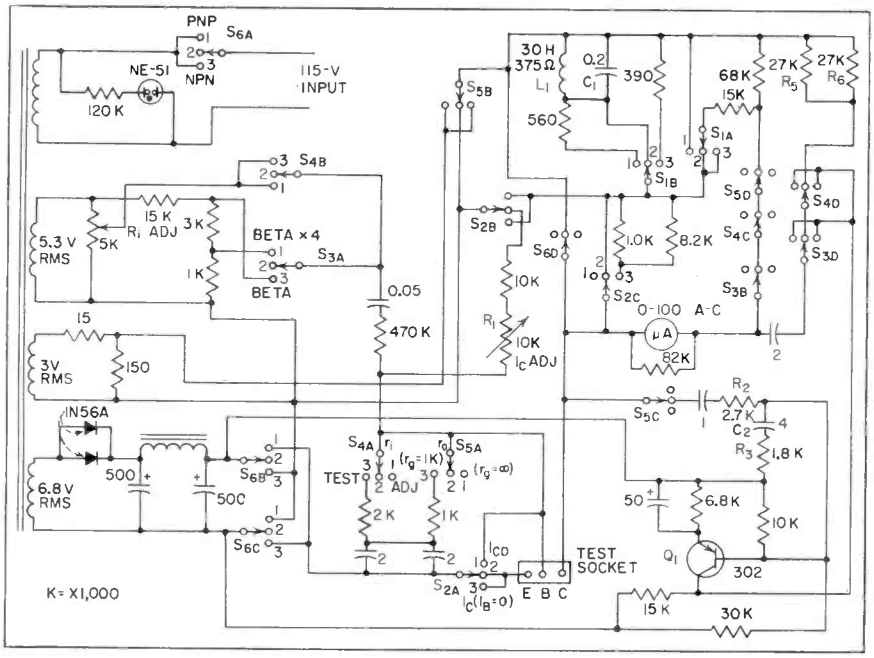

FIG. 1—Tester uses 60-cps signal to determine four common-emitter hybrid parameters

The input resistance r_i is h_{11}, β is h_{21} or h_{cb} and the reciprocal of the open-base output resistance $1/r_o$ is h_{22} or h_c. The inverse feedback ratio h_{12} is difficult to measure directly but is easily calculated from

$$h_{12} = [(R+r_i)/\beta]\,[(1/r_o)-(1/r_o')]$$

where R is the 1,000-ohm resistance terminating the base when measuring r_o'.

Circuit

Figure 1 is the complete schematic diagram of the tester. Its operation is easily understood by considering how it is used to measure each individual transistor parameter.

A series of five lever switches each having three positions determines the particular transistor

# of Junction Transistors

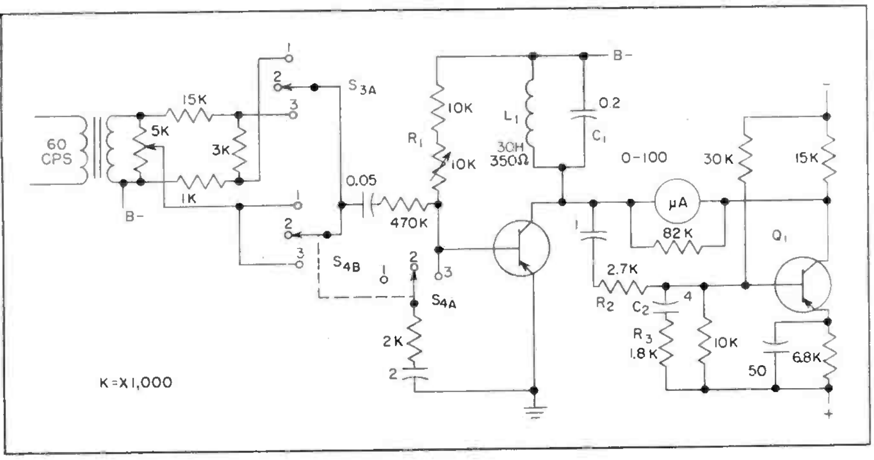

FIG. 3—Circuit used for measuring transistor beta and input impedance

Transistor is attached to tester with spring clips (at right)

characteristic being measured. One switch turns the meter on and chooses power supply polarity for *npn* or *pnp* types.

With the other switches in their neutral positions the tester monitors static collector current as shown in Figure 2A. Current may be adjusted with R_1 to test transistors at currents from 0.15 to 15 ma with full-scale deflections of 2 and 20 ma.

The full-wave rectifier a-c meter responds equally well to d-c currents of either polarity, hence requires no lead reversal with change in transistor type. Collector-current range switch S_1 alters the meter shunt and adds a voltage divider. This arrangement provides a constant driving impedance for the meter so the scale nonlinearity will be identical on low and high-current ranges. In position 3, it also places a purely resistive load on the transistor so auxiliary tests of cut-off frequency may be carried out using the tester as a device for furnishing power and controlling the operating point of the transistor.

Collector Leakage

The emitter-open transistor leakage, I_{co}, is measured with S_2 in Fig. 1 in position 1. The meter is placed in series with the transistor with only a high-impedance shunt, as shown in Fig. 2B. The shunt in Fig. 2C was chosen to adjust the a-c meter to read 100 μa d-c full scale.

Base-open leakage I_o ($I_B = 0$) is measured similarly, but S_2 in position 3 adds a shunt across the meter to reduce full scale sensitivity to 2 ma.

Current Gain

To measure current gain a known a-c is fed in the transistor base and the output current measured. Output current is then proportional to β and the meter can be calibrated directly in terms of gain.

Two precautions are necessary to insure reliable readings.

To operate the transistors properly at large collector currents a low-impedance d-c load must be used; this load must not shunt the a-c signal away from the meter circuit. To meet these conditions, shunt choke L_1 in Fig. 3 was chosen. The choke drops only 5 v d-c due to a static current of 15 ma and yet conducts only a small portion of the a-c signal. Nevertheless, this alternating current conduction is important (particularly at small output indications where the meter impedance rises to more than 10,000 ohms) in accurate measurements because the inductance varies with static current and thus the fraction of the signal shunted may be a function of the current in the choke.

Capacitor C_1 minimizes the variation in signal shunting by tuning the inductor below the 60-cps signal frequency. Thus, as the inductor current increases, the inductance drops but the resonant frequency increases closer to the signal frequency. In this way, signal impedance can be maintained nearly constant.

Beta is defined as the base-to-collector current gain with the collector shorted to ground. Shorted means that the impedance must be smaller than the transistor output impedance r_o. This criterion is not automatically met for an a-c rectifier meter and a moderate power transistor; it is not uncommon to find output impedances of the order of a few thousand ohms which is less than the impedance of a 100-microampere a-c meter to a 25-microampere signal.

To remedy this situation a one-stage transistor amplifier comprising Q_1 was added to reduce the effective impedance of the meter. If the potential at the collector of the transistor under test rises, for instance, the change is amplified and inverted in phase by Q_1. The current which flows back through the meter to the collector of the test transistor due to this inverted signal is nearly the opposite of the

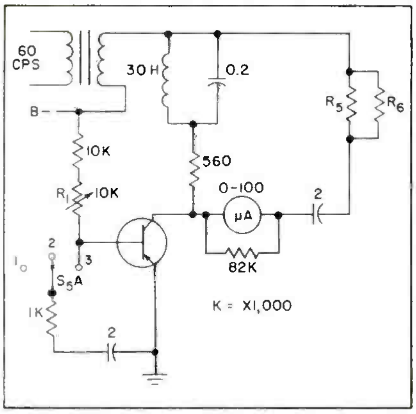

FIG. 4—Output resistance measurement ohmmeter circuit

collector current of the tested unit. Hence, little net unbalanced current results at the collector terminal.

The detector-unit impedance is approximately the total resistance in the base circuit Q_1 divided by its current gain. For the circuit in this tester the effective impedance is about 100 ohms, much less than most transistor output impedances. Resistors R_2, R_3 and capacitor C_2 in the base circuit of Q_1 form a phase-shift correcting network to prevent self oscillation of this feedback amplifier.

The base-collector current gain is measured by injecting a known 60-cps current from a high-impedance source into the base and reading the output current. Two choices of input current are available by switch S_{3A}, roughly $\frac{1}{2}$ or 2 μa. These correspond to full-scale current-gain indications of 200 or 50.

Input Resistance

Transistor input resistance r_i is measured with a circuit arrangement similar to that used in determining β. An unknown base signal current is adjusted to make the output meter read full scale and then a portion of this base current is shunted away from the base through resistor R_4 in Fig. 3 by S_{4A}. The fraction of current still entering the base is

$$i/i_o = R_4/(R_4+r_i) = (1+r_i/R_4)^{-1}$$

from which the input resistance scale may be calibrated. For example, since R_4 is 2,000 ohms, a half-scale reading after adjustment and shunting means the input resistance is 2,000 ohms, a two-thirds full-scale reading means 1,000 ohms and a one-third, 4,000 ohms.

An a-c operated ohmmeter is used for measuring the output impedance with the base at a high signal level impedance (r_o) or at 1,000 ohms (r_o'). Figure 4 illustrates how the meter is placed in series with an alternating potential, a fixed resistance and the transistor being tested. The meter current, neglecting the choke shunt, is

$$i_m = e_s/(R_5+R_m+r_o)$$
$$= \frac{e_s}{(R_5+R_m)}\left[1+\frac{r_o}{R_5+R_m}\right]^{-1}$$

where e_s is the applied potential, R_5 is the series resistance, R_m is the meter resistance and r_o is the measured transistor resistance. Metered output current i_m changes with output resistance r_o in the same manner as shown above for the input resistance. Consequently, the same scale divisions can be used. Proper choice of e_s and R_5 multiply the resistance scale by 10 to ensure that the scale center corresponds to a typical output resistance value. Because the meter impedance changes with applied current the given expression is not precise, but if the series resistor and the applied potential are experimentally fixed with R_5 so zero resistance is full scale and 20,000 ohms is half scale, adequate accuracy is available for all but the most precise applications.

Construction Features

The relative position of the power transformer and load inductor can result in an induced potential in the inductor and a spurious bias in the meter reading. The positions used were chosen empericaly by connecting the meter across the inductor and moving the transformer to various places until a point was found which produced negligible pickup.

The power transformer used to operate the transistors and furnish the a-c test signal is a modified Stancor 6134 filament transformer. The high-current secondary was removed and in its place a 6.8-v power winding and 5.3 and 3.0-v signal windings were wound. It is not necessary that the two signal windings be separate, a 3-v tap on the 5.3-v secondary would be satisfactory.

Regulation of the transistor power supply will be a little better if a full-wave rectifier is used with a center-tapped 13.6-v winding. This would also aid the filtering possibly circumventing the use of a choke filter element—and increasing the ripple frequency well above the signal frequency.

The inductive kick of the transistor-load choke when the current is abruptly changed with 15-ma flowing in the choke produces over a 100-v pulse, enough to ruin the majority of transistor types. Because of this pulse, a transistor should never be pulled from the socket with the power on. Switch S_{6A}, a section of the power switch, shorts the inductor as the power is turned off, safeguarding the transistor.

When the meter is switched to read leakage current, the d-c collector current is rapidly interrupted, making control of the switch opening sequence important if the resultant inductive pulse is not to ruin all transistors tested. Switch S_{2B} shorts the inductor and going from position 2 to 1 it closes before S_{2A} grounds the transistor base interrupting collector current.

It is also important that S_{2B} break contact going from position 2 to 3 and cut off the base current to the transistor before S_{2C} removes the low-impedance meter shunt or else the meter will be an a sensitive current scale while still carrying the full static collector current. To insure these contact sequences, S_2 must be modified.

Battery Operation

In instances where self-contained operation would be an advantage, battery life would be excellent since instrument warm-up is not required and current is not drawn except when actually testing. A Burgess B5 battery should furnish 500 to 1,000 hours of testing under normal circumstances.

This modification necessitates an internal oscillator that could be a neon-bulb type operating from $67\frac{1}{2}$-v battery or a transistor audio oscillator. A reduction in size of the transistor load choke and coupling capacitors can be achieved by running the oscillator at a higher operating frequency.

Plug-in unit fits into the standard nine-pin noval socket. Base is hermetic-seal structure 7/8 x 1 1/16 in., with overall height 2 5/8 in.

Three Oscillator Designs Standardize Circuitry

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SUMMARY —— Thirty-nine existing crystal oscillator circuits shrink into three basic designs using MIL-approved crystals and subminiature tubes. Up to 2.5 octaves within range of 0.8 to 75 mc are covered by unit occupying less than 2.5 cu in. Below 16 mc, untuned circuits afford frequency stability of 5 to 10 ppm. Plug-in package design may be varied physically for special applications without sacrificing any of the specified performance features

ANALYSIS of present crystal oscillator circuitry including four generic types and a few special-application designs, has been made to determine requirements for a series of standardized, packaged units. Data obtained for each of 39 circuits includes type of crystal, operating frequency, stability, output voltage, crystal drive level and operating conditions peculiar to each circuit. As a result of this survey, three basic oscillators, a Colpitts, electron-coupled Colpitts and cathode-coupled were designed.

The Colpitts and electron-coupled Colpitts have untuned circuits with plug-in crystals or any number of external crystals in a switching network. The high-frequency cathode-coupled types require adjusting tuned circuits when changing frequency. If many crystals are used, tuning is done externally. These circuits provide highest output voltage consistent with stability and drive level requirements. Design criteria developed previously[1] and additional experimental work produced circuits covering the 0.8 to 16-mc range.

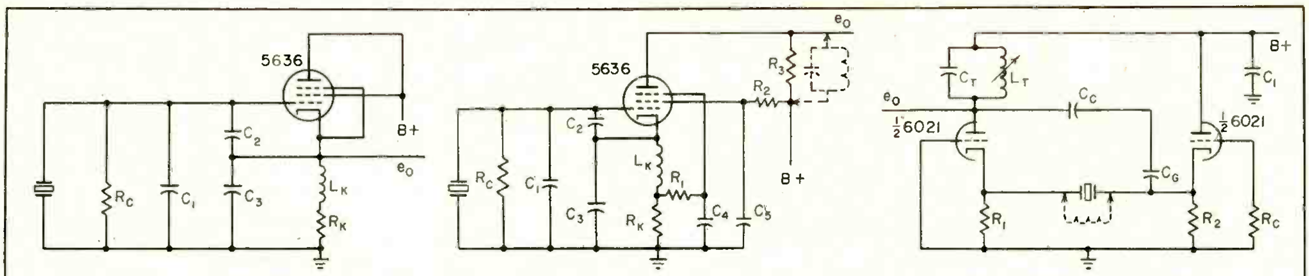
Colpitts Oscillator

The Colpitts circuit is shown in Fig. 1A with component values for each of the three ranges. The 5636 ruggedized subminiature pentode is triode-connected. The correct crystal load capacitance of 32 $\mu\mu$f and the proper ratio of C_3/C_2 occurs when the oscillator couples to a circuit having an input capacitance of 15 $\mu\mu$f.

Current requirement is about 4 ma at operating voltage. Frequency change is from 0.5 to 1 ppm for a 10-percent change in supply voltage, with the operating frequency dependent on the load capacitance. Using commercially-available 5-percent capacitors all circuits operate within 5 to 10 ppm of the crystal antiresonant frequency.

Operating Characteristics

Output voltage and crystal drive level are shown in Fig. 2A. The range of values was obtained using production CR-18/U crystals. Any military type designed to operate at antiresonance into a 32-$\mu\mu$f load



FREQ RANGE	R_C X1,000	C_1 μμF	C_2 μμF	C_3 μμF
0.8-5mc	1,000	15	10	47
3-11mc	100	15	10	47
5-16mc	47	15	10	36
	R_K X1,000	L_K μμF	B+ VOLTS	
0.8-5mc	3.9	7.0	75	
3-11mc	2.0	0.8	100	
5-16mc	1.5	0.3	100	

(A)

FREQ RANGE	R_C X1,000	C_1 μμF	C_2 μμF	C_3 μμF	R_K X1,000	L_K mh
0.8-5mc	1,000	15	10	130	3.9	7.0
3-11mc	100	15	10	62	2.0	0.8
5-16mc	47	15	10	51	1.5	0.3
	B+ VOLTS	R_1 X1,000	R_2 X1,000	R_3 X1,000	C_4 μμF	C_5 μμF
0.8-5mc	125	100	30	10	1,000	1,000
3-11mc	150	100	30	10	1,000	1,000
5-16mc	150	100	30	10	1,000	1,000

(B)

FREQ RANGE	R_1 OHMS	R_2 OHMS	R_C X1,000	C_1 μμF
10-20mc	1,000	1,000	10	470
20-40mc	1,000	560	10	470
40-75mc	1,000	270	10	470
	C_C μμF	C_G μμF	C_T μμF	B+ VOLTS
10-20mc	100	4.7	15	100
20-40mc	100	4.7	15	100
40-75mc	100	1.5	15	100

(C)

FIG. 1—Circuits and component values of Colpitts (A) electron-coupled Colpitts (B) and cathode-coupled (C) crystal oscillators

in the range 0.8 to 16 mc may be used. This includes the CR-18/U, CR-27/U and CR-36/U.

As shown in Fig. 2A the factor limiting output voltage is the crystal drive level. Since the ratio of crystal drive voltage to output voltage is constant for given operating conditions, the crystal drive power level increases as the square of the voltage. Thus there is little increased output for much greater crystal dissipation.

Low-frequency, high-resistance crystals are difficult to start in a circuit which drives at high power levels. This is caused by high initial circuit gain. With fixed crystal parameters, reducing the tube transconductance when not oscillating can lower the initial gain. Oscillations then stabilize at lower amplitude with reduced output and crystal drive level.

Electron-Coupled Colpitts Oscillator

Electron-coupled crystal oscillators offer advantages of ease of frequency multiplication, high ratio of output voltage to crystal drive and control frequencies independent of load-impedance variations. The Colpitts circuit adapts to electron coupling since the plate operates at a-c ground. This allows use of a tetrode or pentode, with the screen grid acting as the oscillator plate. The circuit of the electron-coupled oscillator is similar to the Colpitts, with the addition of a plate load circuit. Resistor R_2 reduces the screen voltage to less than the plate voltage.

The electron-coupled circuit is shown in Fig. 1B. Components in the oscillator portion are nearly identical to those of the Colpitts, but in the middle and high bands C_3 is 15 $\mu\mu$f larger. This yields the same feedback ratio as the Colpitts operating into a 15-$\mu\mu$f load. In the low-band circuit C_3 is much larger. This reduces the amplitude and allows plate current flow for more of the cycle. Otherwise the output at the plate load would be small due to cutoff.

The Colpitts circuit tube type is also used in the electron-coupled arrangement, with decoupled biasing in the suppressor-grid circuit. A 10,000-ohm resistance provides a fixed load and d-c path for plate current. Two sets of output voltage curves under two plate load conditions, are shown in the upper graph of Fig. 2B. The lower curves represent output when the 10,000-ohm load is used alone. The upper curves represent rms output when a circuit tuned to the crystal fundamental is added as shown in Fig. 1B.

The harmonic output obtainable is a function of the load impedance at the desired frequency and the harmonic content of the plate current. The lower graph of Fig. 2B shows peak-to-peak plate current in the three circuits. This was determined by measuring voltage across a 100-ohm load, thus minimizing the effect of stray capacitance on the wave shape. The curves can be used to compute the output at any load impedance.

Plate current waveforms at three frequencies are shown in Fig. 3. Measurements were made using plate supplies of 100 and 150 volts, with the values of R_2 chosen to maintain 75 volts at the screen. The peak-to-peak current at 100 volts is slightly less than the 150-volt values with the waveform nearly unchanged, indicating that operation is independent of plate voltage. Measurements at higher frequency show waveforms similar to those at 5 mc with plate current values of Fig. 2B.

Waveform Analysis

A Fourier analysis of the waveform produced by a 1-mc, 240-ohm crystal in this circuit is approximated by the broken line of Fig. 3. The result can be expressed in terms of the peak amplitudes by $C_n = I_{pp}/(n\pi + 1)$ where C is the Fourier coefficient at the nth harmonic.

Using this equation the designer may predict the output voltage of the electron-coupled oscillator when the impedance at the desired harmonic frequency is known. As an example, the fundamental and second harmonic output of a typical 1-mc crystal unit with a plate impedance of 5,000 ohms at both frequencies is calculated as shown. From Fig. 2B the peak-to-peak current at 1 mc is 10 ma. Then $C_1 = 10/4.14 = 2.42$ ma p-p $= 0.865$ ma rms; and $C_2 = 10/7.28 = 1.37$ ma p-p $= 0.49$ ma rms.

The output voltages at each harmonic are then: $e_{o1} = i_{rms1} Z_L =$

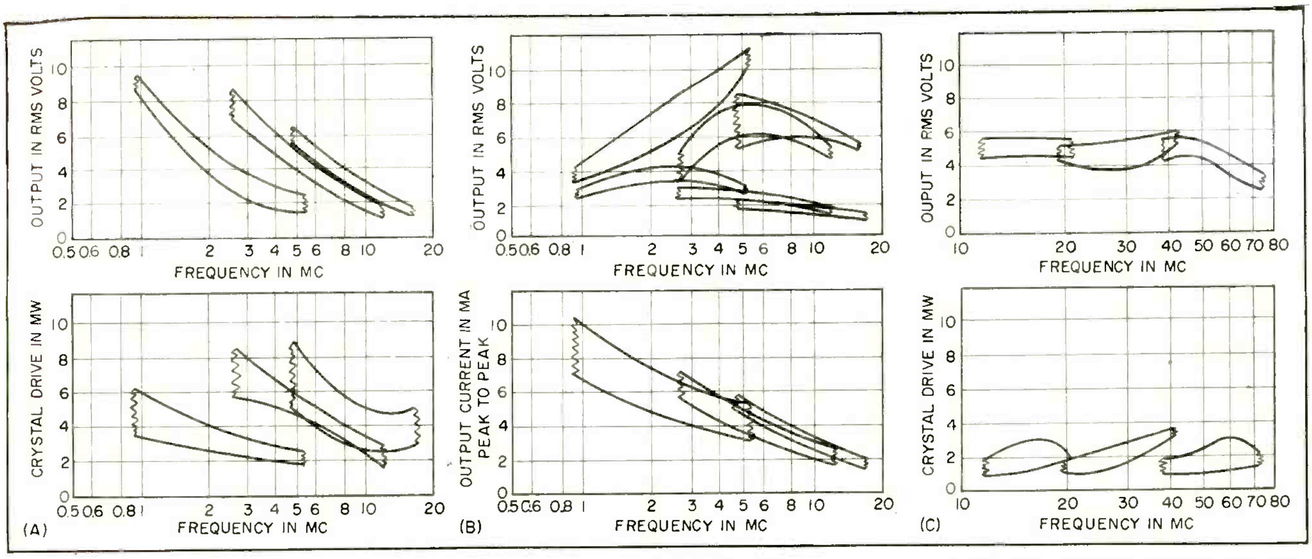


FIG. 2—Measured performance characteristics in three ranges of Colpitts (A), electron-coupled (B) and cathode-coupled (C) units

$0.865 \times 10^{-3} \times 5{,}000 = 4.3$ volts (fundamental); and $e_{o2} = i_{rms2} Z_L = 0.49 \times 10^{-3} \times 5{,}000 = 2.44$ volts (2nd harmonic).

These circuits also require about 4 ma of current at the specified plate voltage. Frequency change for a 10-percent variation in supply voltage is from 0.5 to 1 ppm, and as the plate load circuit is tuned through resonance at the fundamental the change is 3 to 4 ppm. The operating frequency, as for the Colpitts circuit, is within 5 to 10 ppm of the crystal antiresonant point. Military crystals CR-18/U, CR-27/U, and CR-36/U may be used.

Cathode Coupled Oscillator

The cathode-coupled oscillator covers from 10 to 75 mc. A dual triode is used, one section as a grounded-grid amplifier, the other as a cathode follower. Feedback is between the two cathodes through the low-impedance path of the crystal at series resonance. Crystal operation at exactly series resonance requires zero phase shift around the circuit loop. The various stray capacitances must therefore be compensated by the circuitry. This cathode follower is free of phase shift over a wide frequency range due to the small grid-to-cathode capacitor shown in Fig. 1C.

The input capacitance of the grounded-grid stage is resonated at a given frequency. Then the cathode follower load is the crystal resistance in series with the amplifier input impedance, plus the effect of the cathode resistors. With the plate tank tuned to resonance, oscillation will occur at the series-resonant frequency of the crystal.

When the tank circuit is tuned for maximum output voltage or grid current, the operating frequency varies directly with Q and plate tank impedance and inversely with capacitive phase shift in the cathode circuits. Tuning the cathode circuit over a band of frequencies is not recommended. The operating frequency of the oscillator will be above series-resonance of the crystal at the low end of the band and below it at the high end. The range is 10 to 20 ppm due to variation in crystal Q and the repeatability of tuning.

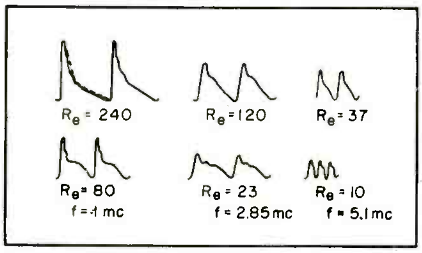


FIG. 3—Electron-coupled plate current waveforms. Broken line approximates Fourier analysis of the 1-mc crystal unit

Circuit Variations

Three variations of the basic circuit of Fig. 1C cover the 10 to 75-mc frequency range. The tank circuit components resonate at each frequency. A variable inductance resonates with the total circuit capacitance of about 15 $\mu\mu$f. Preferred military crystal types include CR-32/U, CR-52/U, CR-54/U, CR-55/U, and CR-56/U.

At 40 mc and higher, uncontrolled oscillations may occur due to feedback through the crystal capacitance when the plate tank is detuned from the crystal frequency. These can be eliminated by resonating the capacitance with a low-Q inductor which operates over a wide frequency band. The network impedance prevents oscillation throughout the tuning range of the plate tank. The required turns of wire wound on a 1/2-watt, 1,500 to 2,200-ohm resistor work well. The inductance value is chosen to tune the crystal shunt capacitance to the center of the operating band.

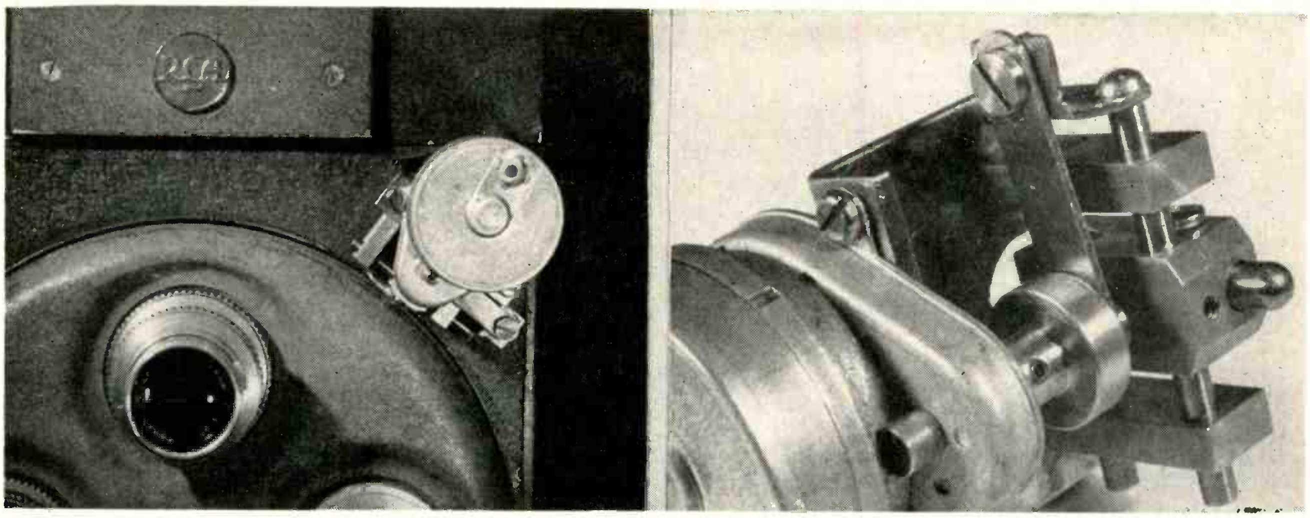
Typical Performance

Performance data for the three cathode-coupled circuits are shown in Fig. 2C. The lower graph shows that drive levels with typical crystals are centered about 1 mw.

The author acknowledges the help of E. H. Borgelt of Wright Air Development Center in his design recommendations and of J. S. Kurinsky of Armour Research Foundation who constructed and tested the units.

REFERENCE

(1) H. E. Gruen, How to Design Colpitts Crystal Oscillators, ELECTRONICS, 30, p 146, Jan. 1957.



Mounting position of antiburn device that oscillates tv camera lens board (left) and mechanical details of device showing cam-operated detent (right). Work is now progressing on device to move lens board in circular orbit for even better burn-in immunity

Motion Minimizes Image

SUMMARY —— By oscillating lens board of tv camera at slow rate, image orthicon burn-in is reduced as much as 90 percent. Horizontal centering circuit in camera is modified to cancel resultant horizontal motion. Details of circuit modification and results of tests on discarded tube are given

EXPENSIVE IMAGE - ORTHICON tubes used in television cameras often have to be discarded simply because of an inherent weakness in which the image orthicon retains a previous camera shot. Experience at WBAL-TV and WISN-TV has shown that about 25 percent of the tubes so discarded resulted from this weakness, sometimes known as burn-in or stickiness. Especially exasperating are the times when some of the best image orthicons have to be discarded when other characteristics such as tonal composition, flatness of field, noise level and freedom from blemishes are especially good.

Causes

Burn-in is caused by two separate and distinct forms of operation. The first is the burn-in on the photo-sensitive surface behind the front plate of the tube itself which results when the camera is focused on a bright object. This occurs whether or not the camera is on,

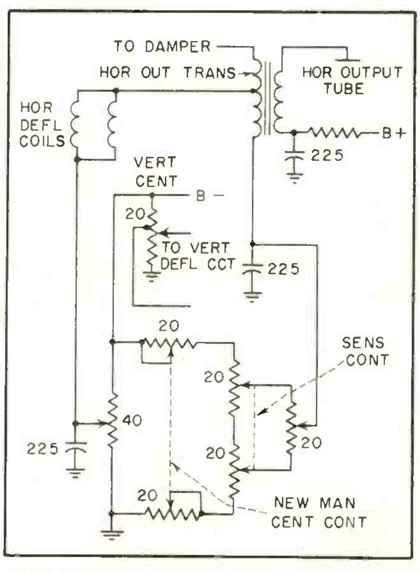


FIG. 1—Horizontal circuit modification required in RCA TK-30 field camera to produce stationary image while lens board is oscillating horizontally

hence the importance of capping the lense when the camera is not in use.

Second, and more important, is burn-in on the target itself. This occurs only when operating potentials are present on the tube.

Correction

The method by which the latter may be corrected consists of slightly moving the focused scene on the image-orthicon tube. Two problems had to be overcome to do this. The first problem was that of interference of the detent mechanism on the camera. This problem is resolved by immobilizing the normal detent of the camera and fabricating a new detent arrangement on the lens turret. This detent consists of a rounded steel pin engaging four recesses, each corresponding to one of the lenses. The detent pin, mounted on a carriage, is slowly moved back and forth by

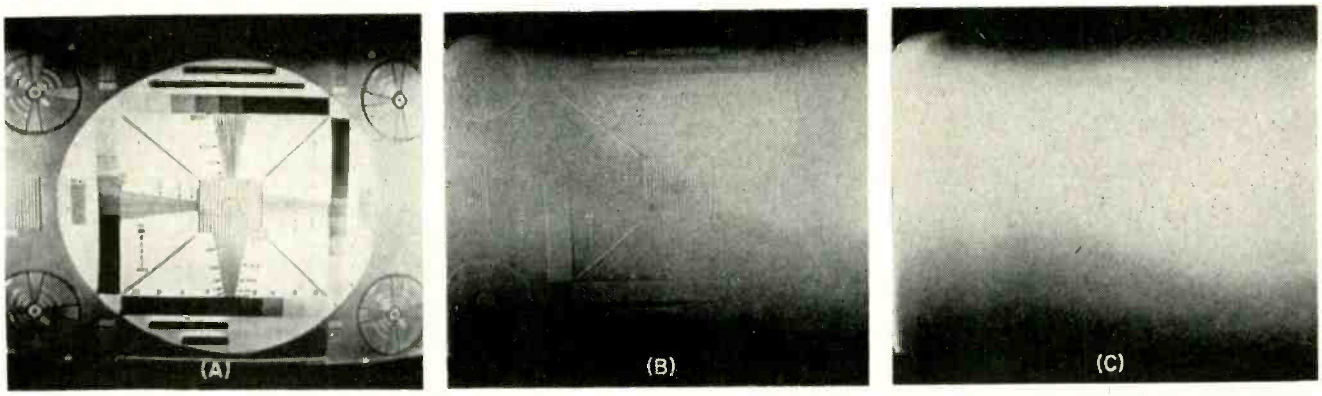


FIG. 2—Effects of burn-in are graphically demonstrated by comparing normal test pattern on master monitor (A) with monitor appearance after tv camera is panned to white card (B). Monitor appearance under same conditions but with antiburn device on (c)

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Orthicon Burn-in

a heavy-duty clock motor.

The second problem was the physical motion of the television picture on the television receiving sets and monitors. This turned out to be minor since most television shots are usually of short duration and during actual on-the-air experiences it was found that this motion was not objectionable.

However, there are times when no motion can be tolerated. Because of this, electrical horizontal cancellation of the motion is used. For nontelevision use, the horizontal physical motion of the picture is of no consequence and no means of cancellation is required. The rate at which the motion takes place is about one revolution in about two minutes.

Figure 1 shows one method of electrical cancellation of horizontal motion. This potentiometer arrangement is connected into the horizontal centering circuit of the television camera and electrically centers the picture opposite to that of the mechanical movement. The manual horizontal centering adjustment is still available for normal requirements. A carbon potentiometer allows smooth centering movement.

Results

Figure 2A shows a typical RETMA test pattern that was photographed directly from a master monitor. The illumination on the test pattern was 150 foot-candles. The tv camera lens opening was f11 The photographing camera lens opening was f2.8 and the exposure was one-tenth of a second. All subsequent tests were photographed using the same camera settings.

The test pattern was focused by the tv camera and exposed for one minute. The image orthicon used for all of these pictures was one which had been discarded because of excessive burn-in. This tube had been in operation for 460 hours, against an average of 850 hours.

The television camera, with the antiburn mechanism turned off, was then horizontally panned to a white card having the same illumination after one-minute exposure on the test pattern. Figure 2B shows the effect of the test pattern burn-in. Figure 2C was taken under conditions identical to Fig. 2B except that the antiburn mechanism was turned on. Figure 3A shows the camera focused on identification card with the antiburn mechanism turned off. The burn-in is clearly visible. Figure 3B shows the same result with the antiburn device working.

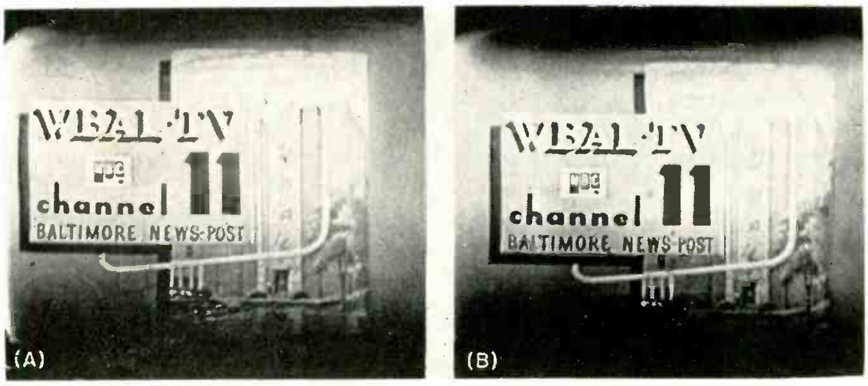
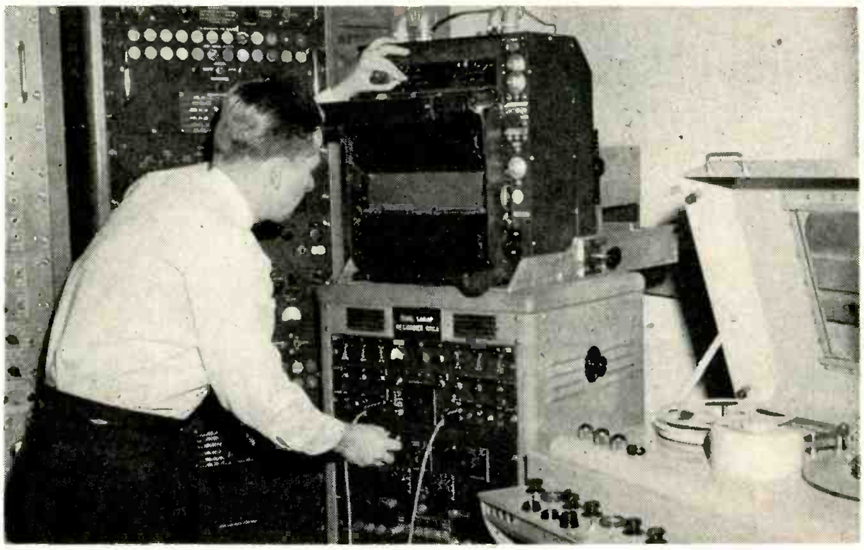


FIG. 3—Burn-in effects without the antiburn device (A) and with the device (B)

By H. B. RIBLET
Applied Physics Laboratory
The Johns Hopkins University
Silver Spring, Maryland



Operator lines up one channel of dual channel data plotter. Tape playback unit at right feeds telemetered data to discriminators mounted in rack behind operator

Automatic Data Plotter

SUMMARY —— Need for manually reading and replotting telemetered data is eliminated by device that automatically plots data as function versus real time and effects 60-to-one saving in man-hours. Recording characteristics can be made to conform with transfer function of telemetering system, relating data values and corresponding displacements, whether linear or nonlinear, with prescribed scale factor

MOST TELEMETERING SYSTEMS and in particular f-m/f-m telemetering systems that are used in many guided-missile programs, employ standard photographic recording oscillographs and complex manual operations to obtain the final plots of function versus real time.

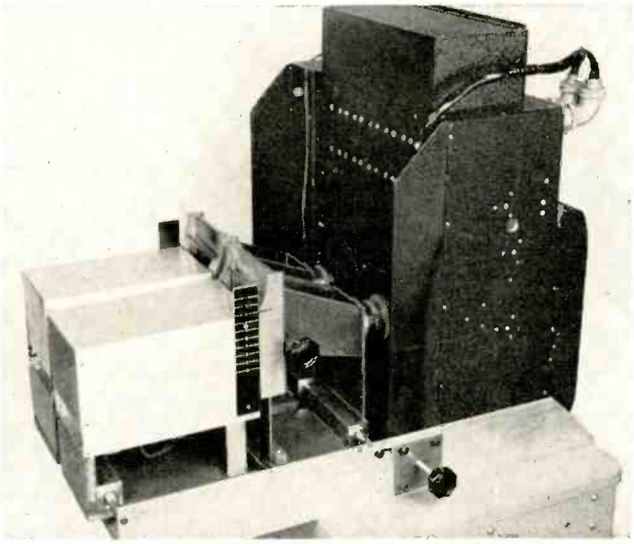
During the past few years, a number of systems have been proposed and built to speed the process of data reduction and to eliminate a number of these complex steps. The simplified automatic data plotter to be described performs many of these steps automatically and provides a direct plot of function versus real time with a great saving of time. This system provides a method of photographically printing a calibrated scale grid and a time grid simultaneously with the data trace.

Figure 1 shows a block diagram of the SADAP. The usual frequency discriminator and calibrator, together with the optical galvanometer, are supplemented with a scale grid projector and time-grid strobe-flash tube.

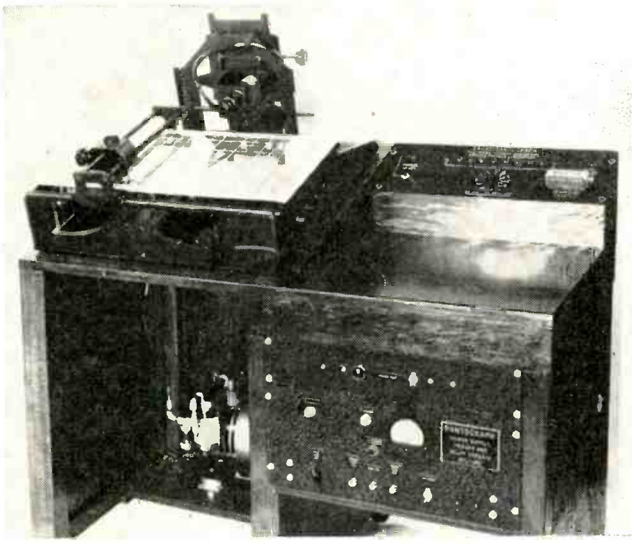
The scale grid template is constructed directly from the frequency-function calibration curve in a separate pantograph device and has the same characteristics as the function scale card which is used to read the data manually. However, in this case, the scale grid is photographed continuously along with the data trace, making it unnecesary to tabulate and replot the data. The time grid is also photographed simultaneously and can be synchronized with the real field time values.

The calibration procedure of the recorder thus becomes a simple operation of inserting particular frequencies corresponding to specific function values as read from the function - frequency calibration curve. These specific frequencies are inserted into the recorder from the frequency calibrator and the sensitivity and zero of the galvanometer are adjusted so the recording sensitivity agrees with the function scale.

The function grid may be made to correspond to any transfer characteristic desired, as indicated in Fig. 1, where the scale grid is shown as a nonlinear function. This system therefore has a distinct advantage over a preprinted



Rear view of dual-channel automatic data plotter shows scale-grid projectors mounted on rear of galvanometer recorders



Calibration curve pantograph assembly on top of cabinet has strobe-tube circuits installed in cabinet

for F-M/F-M Telemetering

grid system or a photographic system which has no function-grid lines at all. At the same time it maintains a high-frequency response of better than 1,000 cps by use of an optical writing system.

System Description

The plotting system consists of three main parts, a galvanometer recorder, a time-pulse generator and a scale-grid pantograph.

The galvanometer recorder is a standard unit which has been modified to provide the optical elements necessary for the superimposition of the function-scale grid, the time grid and the data trace. The standard 30-cm optical lever arm is preserved, but the standard timing system is replaced by a gas-discharge strobe tube which can be triggered from a pulse-generating circuit.

Galvanometer Recorder

Figure 2 illustrates the recorder proper. The blocks at the top of the diagram indicate a source of data, that originates from telemetering data stored on magnetic tape. A system of subcarrier discriminators and low-pass filters is necessary for conversion of the f-m data into an electrical current to stimulate the magnetic galvanometer.

The galvanometer light source consists of an incandescent-lamp line filament which is projected onto the galvanometer mirror, thence to the half-silvered mirror directly under the collimator lens and film plane.

The function-scale-grid film or template is an opaque film with transparent slits that represent the scale-grid lines to be photographed on the film. The image of this template is projected by a standard optical projection lens through the half-silvered mirror and the collimator lens directly onto the film plane. The strobe-flash tube which generates the time grid is contained in a light seal with a slit window whose image is projected onto the film plane in a path parallel to and coincident with the optical path from the galvanometer mirror.

Thus, this optical system superimposes three images: one from the galvanometer mirror; one from the scale-grid template and one from the strobe-flash tube which generates the time grid. As the film is driven past the exposure window, the function-grid lines are photographed as horizontal lines for the full length of the record; the time grid is photographed as vertical lines sequentially along the record and the galvanometer produces a continuous data trace on this

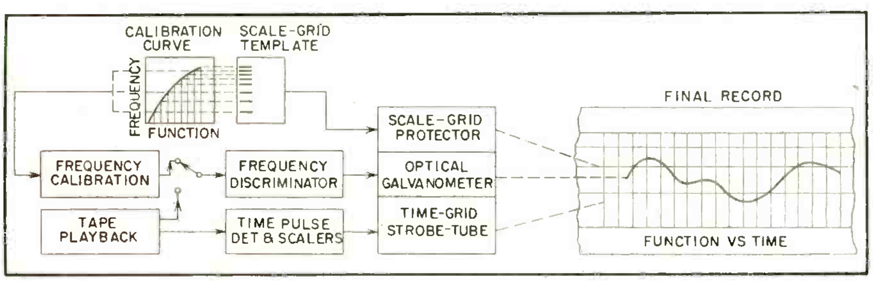


FIG. 1—Block representation of simplified automatic data plotter or SADAP

time and function grid system.

Though Fig. 2 shows a one-channel system, more than one channel can be recorded, depending on the design of the photographic unit.

Time-Grid Generator

Figure 3 shows a simplified diagram of the time-grid generator. This system controls the light intensity of the flash tube that illuminates the timing grid.

A train of pulses, representing actual field time as recorded on the magnetic tape and detected during playback, are fed into the *A* scaler. Here the pulses are increased in magnitude and given a sharp leading edge suitable for triggering a standard bistable - multivibrator scaler stage.

The preset scaler, shown in Fig. 4, incorporates four GE 4SN1A3 binary stages to count the pulse train and provide an output pulse at any predetermined number of input pulses. The binary units (Fig. 5) have a 6J6 reset-pulse amplifier connected to each triode through selector switch S_1. This switch allows a selected reset configuration, which can give a predetermined ratio of input pulses to output pulses. Thus, each group of four binary stages is reset to a particular configuration each time an output pulse occurs.

Scaler Operation

Initially assume that the reset button has been depressed and that the scaler selector switch is set to 1. When the reset button is depressed, there is a higher voltage applied to the grid of the first section of each binary scaler causing

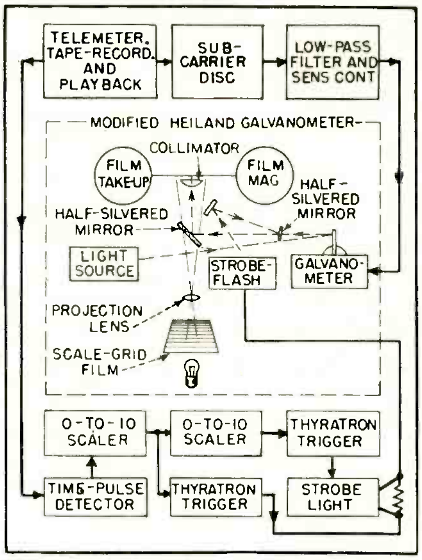


FIG. 2—Block diagram of recorder proper

conduction. When the first scaler flips the second section conducts, producing a negative-going pulse which is transmitted to the second binary scaler. This causes the second scaler to flip and so on until all four binary scalers have flipped.

The negative-going pulse at the output of the last scaler is differentiated and applied to the tuned circuit connected to the grid of the 6J6 feedback tube, producing a damped oscillation at the grid. Since the tube is normally cut off, the first negative swing of the oscillation has no effect. When the oscillation goes sufficiently positive, the tube conducts and the plate voltage drops.

The plate load for this tube consists of the parallel combination of four 6,800-ohm resistors, which are wired to the four decks of the selector switch. The negative-going signal at the plate is transmitted through the diodes to the grid of the conducting section of all the binary scalers resetting to the original condition wherein all the first sections of the scalers are conducting.

With the scaler selector switch set at 1, there will be a negative-going signal at the output of the last scaler for each input pulse.

Schmitt Trigger

At the same time the reset is taking place, the negative-going signal at the output of the last scaler is applied to the input of the Schmitt trigger and cathode follower as shown in Fig. 3.

The Schmitt trigger, shown in Fig. 6, provides an output of uniform amplitude and duration. Since the grid of the first section of the trigger is held at a higher potential than the grid of the second section, the potential of the common cathode follows that of the grid with the higher potential. With no signal applied to the input, the first section conducts heavily and the second section is cut off.

When a negative-going signal is applied to the input of the trigger, the plate potential of the first section increases, the cathode potential decreases and the second section starts to conduct. The regeneration continues until the first section is cut off and the second section is conducting heavily.

The trigger remains in this condition as long as the grid of the first section is held negative by the input. Once the input goes sufficiently in the positive direction, the first section starts to conduct, the regenerative cycle reverses and the first section is then conducting and the second cut off.

Since the input signal is differentiated, the signal applied to the input grid is a short negative pulse. The output, taken from the plate of the second section, is therefore a short negative pulse which is fed to a dual cathode follower providing identical outputs. One output is fed to the next scaler and the other is fed to the strobe trigger.

Strobe Trigger

Figure 7 shows the strobe thyratron trigger.

A minor time line is produced

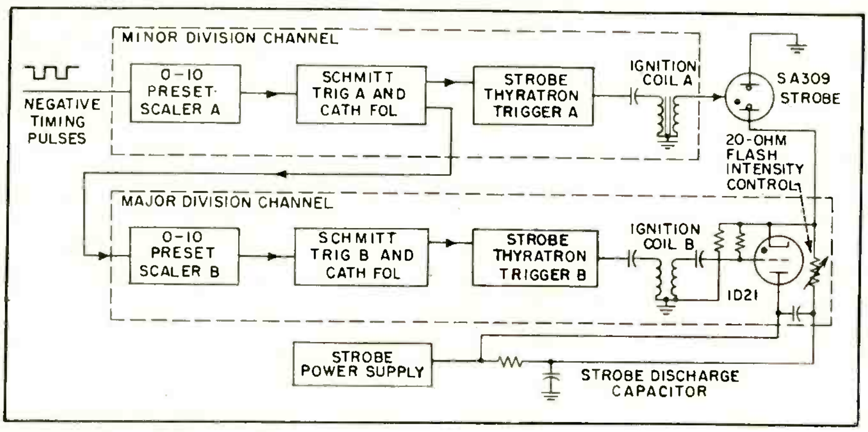


FIG. 3—Time-grid generator and strobe tube circuits utilize standard circuit elements

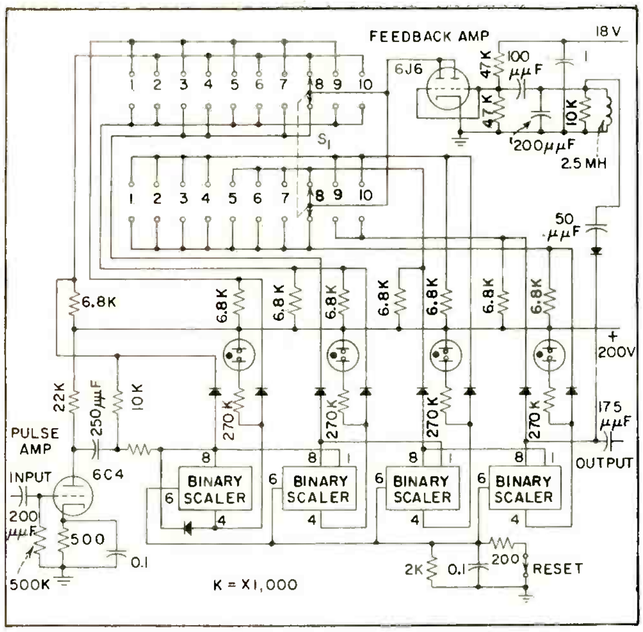


FIG. 4—Zero-to-10 preset scaler counts input train and provides output pulse at predetermined number of input pulses

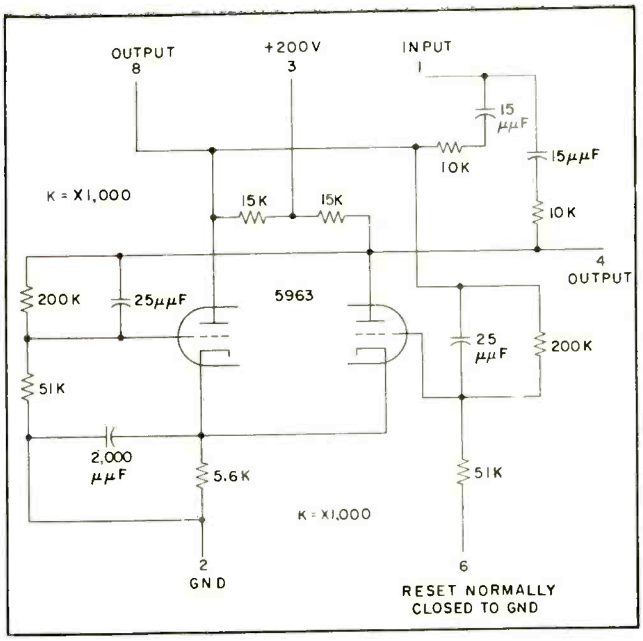


FIG. 5—One of four binary-scaler stages represented by blocks in present counter shown in Fig. 4

for each pulse from the *A* trigger in Fig. 3; a major time line is produced for each pulse from the *B* trigger.

If the *B* scaler selector switch is set at 10, there will be an output pulse from the *B* trigger on pulses 1, 11, 21, etc. These are applied to the *B* ignition coil whose output is fed to the grid of the 1D21 thyratron. Unless there is also an *A* trigger pulse, the strobe will not fire.

The pulse from the *A* scalers operates the *B* scalers and in turn produces the *B* trigger. Therefore the *A* trigger pulse will occur a short but finite time earlier than the *B* trigger pulse. When the *A* trigger fires the strobe-tube, current will flow through the intensity control.

When the *B* trigger pulse is applied to the 1D21 thyratron, the plate-to-cathode voltage allows the tube to conduct, providing a shunt for the 20-ohm control. More exactly, it is the series combination of the capacitor and the tube which shunts the resistor permitting more current to flow through the strobe and producing a brighter flash. This flash will be recorded as a major time line.

Assuming that it is desired to record minor timing lines on the SADAP record for each timing pulse, except each tenth pulse for which a major line is desired, the pulse from *A* trigger in Fig. 3 is fed to the input of the *A* strobe thyratron trigger. After a single stage of amplification, the signal is applied to the grid of a 2D21 thyratron through a cathode follower. A capacitor connected between the plate of the thyratron and ground charges to the plate voltage between firings of the tube. When a positive pulse is applied to the grid, a large negative-going pulse is applied to the *A* ignition coil. This provides a positive pulse of several thousand volts which fires the strobe-tube. The flash is recorded on the record as a minor time line.

By setting the *A* scaler selector switch at any desired position, it is possible to obtain a minor time line for every one to ten input pulses.

It is also possible to select the number of minor time lines for each major time line on the recording. Since the output of the *A* scaler feeds the input to the *B* scaler through the Schmitt trigger and the *A* and *B* scalers are identical, it is possible through appropriate setting of the *B* scaler selector switch to obtain an output pulse from the *B* scaler for every one to ten pulses from the *A* scaler. Thus, it is possible to obtain a

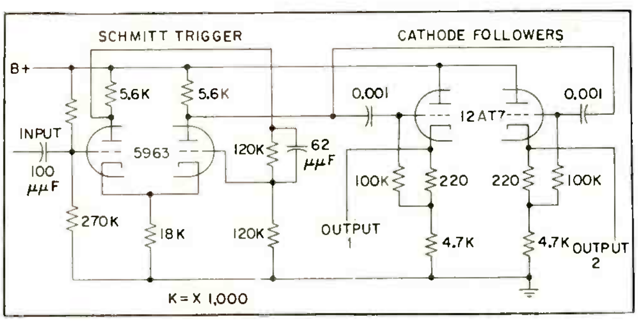


FIG. 6—Trigger provides short negative pulses of uniform amplitude and duration to cathode followers for two identical outputs

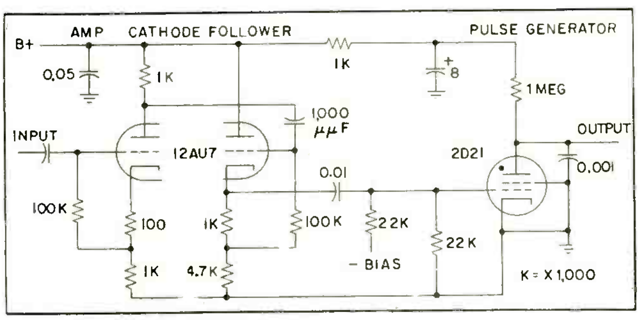


FIG. 7—Strobe-tube trigger provides negative-going pulse to primary of high-voltage ignition coil

major time line starting with the first pulse from the A scaler for every one to ten minor time lines.

Template Pantograph

Figure 8 shows a schematic diagram of the optical-mechanical pantograph developed to provide function-scale-grid templates for the data plotter. The mechanical connection between the crosshair cursor and the lens assembly for photographing an image of a slit on the film plane is shown in simplified form.

Mechanical arm A is pivoted at point B to allow the crosshair cursor to travel from one end of the calibration curve to the other and the lens assembly to travel between mechanical stops. Pivot point B is adjustable to accommodate a variety of dimensions in calibration curves.

In the operation of the pantograph, the crosshair cursor is centered upon predetermined intersections of function values and the curve. At each intersection the strobe tube which illuminates the image of a slit is energized, thus photographing a line on the photographic film located at C.

The completed function-scale-grid template shown in Fig. 9 has a series of closely spaced lines photographed on the film which represents the function values desired. The incremental spacing of these function-grid lines corresponds to the curvature of the calibration curve as shown in Fig. 10.

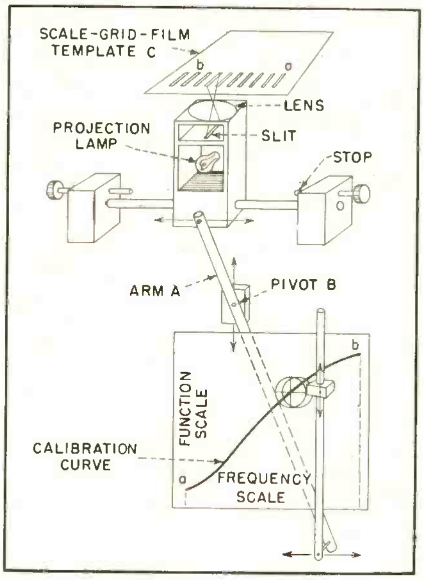


FIG. 8—Schematic diagram of pantograph used in data plotter

The scale-grid lines are constructed from the intersection of the function values and the curve.

Note that in Fig. 9 ten different scales are photographed on one film since only a small vertical image of the template is needed in the recording process. Thus, as many as ten functions can be made available by a simple mechanical detent arrangement in the film holder.

Major and minor divisions are produced on the function-scale template by the same system that was used for producing major and minor timing divisions.

A mechanical counting system of stepping switches is interlocked in such a way that the operator can preset the number of major and minor divisions to be used. The operator then pushes one button each time a function line is to be photographed and the machine automatically produces a minor grid or major grid line as required.

Calibration

The calibration procedure used in plotting data from an f-m/f-m telemetering system will be described as a detailed example. In this system, the function values are transmitted by a f-m subcarrier and the function amplitude is proportional to the frequency of the carrier transmitted.

A calibration curve simlar to the one in Fig. 9 is plotted, giving the function to be measured as one coordinate and the frequency as the other coordinate. This calibration curve can include a combination of the transfer characteristics of all of the components in the system. In the particular system being described, the transmitted data are stored on a magnetic tape as the subcarrier frequency. Therefore, the instantaneous frequency at any given time represents a particular function value.

During calibration, a specific frequency is recorded onto the calibration tape. Two or three different values of frequency may be used to give a two or three-point calibration. Each calibrating frequency can be related to a specific function value from the calibration curve; therefore the calibration point becomes a frequency analog

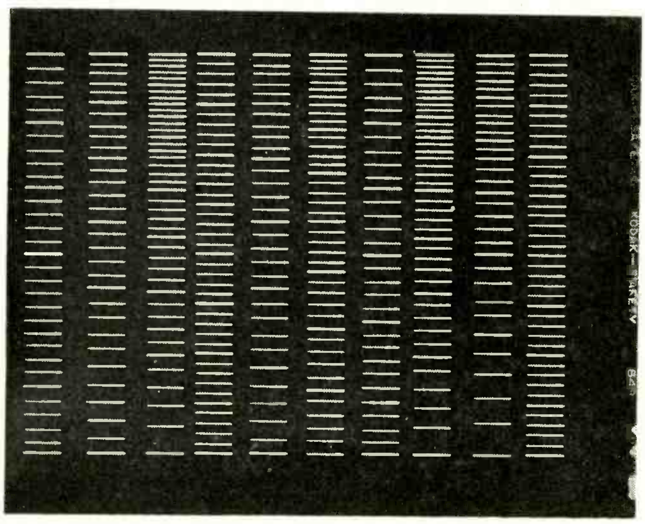


FIG. 9—Typical function-scale-grid template has ten different scale grids on same piece of film

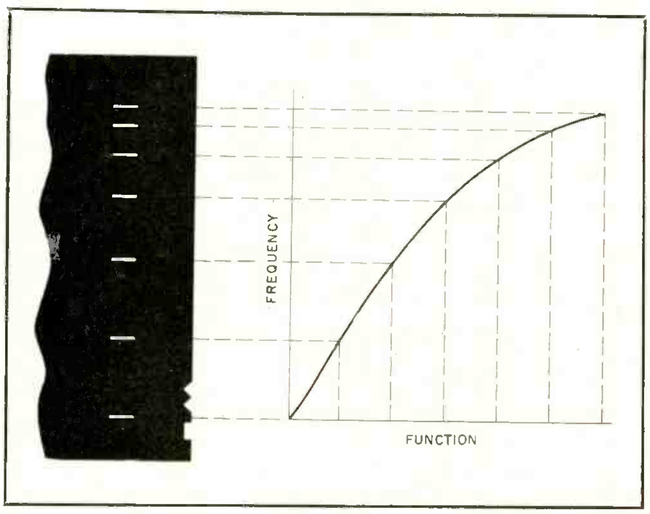


FIG. 10—Calibration curve (right) illustrates construction of scale-grid template (left)

of the function value to be calibrated.

In the case of a voltage-controlled, f-m subcarrier oscillator, this calibration frequency can be considered as an analog of the input voltage and again related to a specific function value in cases where the transducer output is a voltage. These calibration frequencies are played back from the magnetic-tape storage through the playback demodulation equipment which is connected to the recording galvanometer.

Calibration points are of sufficient length to allow adequate time for the sensitivty and zero adjustments.

Pantograph Operation

The operation of the calibration-curve pantograph is simple and straightforward. The calibration curves are prepared on standard 8½ by 11 or 10 by 15-inch graph paper. Ozalid copies of original curves may also be used. The function values to be transferred to the calibration-curve templates are determined and indicated on the curve so they can be easily recognized under the crosshair cursor.

The ratio between major and minor divisions is decided upon and programmed onto the counting circuits; the center line between the extreme ends of the calibration curve is marked to enable accurate placement of the curve on the plotting table. The operator then checks to see that the crosshair cursor will traverse the curve from one end to the other accurately while the lens assembly moves from one mechanical stop to the other.

After the film has been loaded into the camera, the operator starts at one end of the calibration curve and intersects each function point to be transferred to the film. At each point the strobe-flash tube is energized to photograph the function-grid line at that point.

Since as many as ten functions may be placed on one film, an adequate identification system must be used. One simple method is to identify the film itself and also to identify the number of the function-grid position with the particular function used in the calibration curve. The detent positions in the film holder are numbered for this purpose.

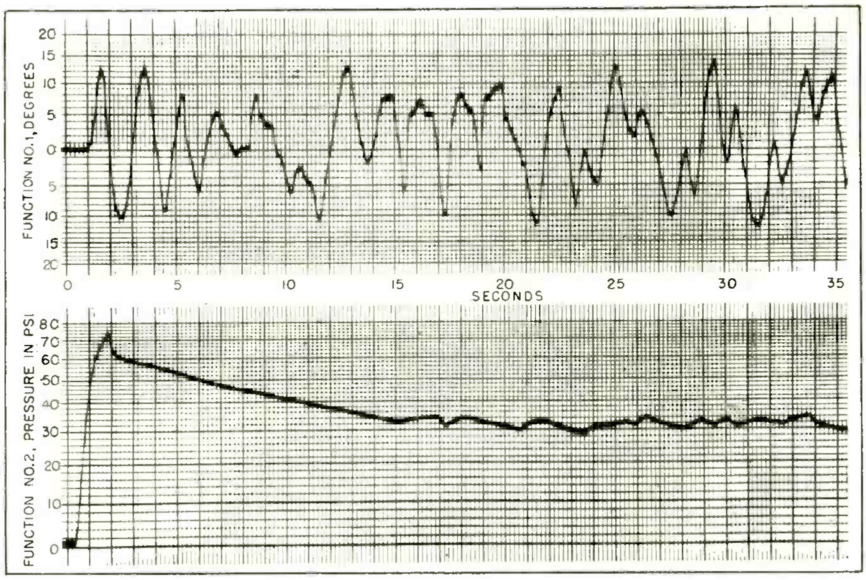


FIG. 11—Typical data plots made simultaneously on SADAP show degrees (top) and pressure in psi (bottom). Horizontal time scale is in seconds

A system to identify the film itself for a particular group of functions has been worked out, involving the use of a standard ink pen with India ink. In the darkroom the title is written with India ink directly on the emulsion side of the film. The area immediately around the writing is then exposed to a small amount of light. This identification is done prior to its insertion in the film holder. During subsequent photographic processing, the ink washes off, leaving its image in the silver emulsion.

After the film has been properly exposed in the calibration curve pantograph, the film is processed in a photographic reversal bath to obtain an opaque background with transparent grid lines.

Evaluation

To complete the manual data reduction for a single missile flight in a reasonable time, approximately one week, it is most efficient for a large number of people to coordinate their efforts in some sort of a production-line effort. As a typical example, it takes approximately 15 to 20 people, working an 8-hour day, approximately one week to complete the data reduction of 20 to 25 telemetered functions. This involves 600 to 800 man-hours for a typical flight-length time of about 120 seconds.

The simplified automatic data plotter yields a complete set of data, involving approximately twenty functions plotted as function against time, in approximately 10 hours. This time includes making the scale grid templates, photographic processing and annotation.

Experience has shown that one man can efficiently operate this equipment. Thus, a ratio of 1:60 is obtained in manpower saving and a significant improvement is obtained in the time required.

Application

In f-m/f-m systems there are often a number of transducers, such as inductance gages and other electro-mechanical coupling devices, which have a nonlinear transfer characteristic. The simplified automatic data plotter is particularly useful in plotting such data, utilizing the feature of the nonlinear scale grid.

Figure 11 shows a typical data plot produced by the plotter. Even when the transfer characteristic is linear, the ability to change from one scale grid to another, thus obtaining different relations between minor and major divisions, is an extremely useful feature. In addition, this device provides an easy method for applying a scale grid to photographic film, thereby utilizing the high writing speeds of an optical galvanometer.

Amplifier Selectivity Curves

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SUMMARY —— Curves and nomograph determine relative attenuation at points on response curve relative to gain and midband response. Design parameters for amplifier having specified response can be determined

IN THE DESIGN of flat-staggered multiple-stage bandpass amplifiers, it is often necessary to determine the relative attenuation of points in the amplitude-frequency response with respect to unity gain at midband. Conversely, it is often desired to find the design parameters of a flat-staggered bandpass circuit having a prescribed attenuation or gain at specific frequencies.

The curves shown here are useful for obtaining rapid, graphical solutions to many such problems. The nomograph in Fig. 1 is useful for quickly computing the parameter X used in the curves. It is also useful for finding the frequencies corresponding to a given attenuation once X and the circuit Q have been determined. Cascaded N-uple stages are presumed here to have the same f_o. It should be noted that $X = 1$ at the half-

(continued on p. 190)

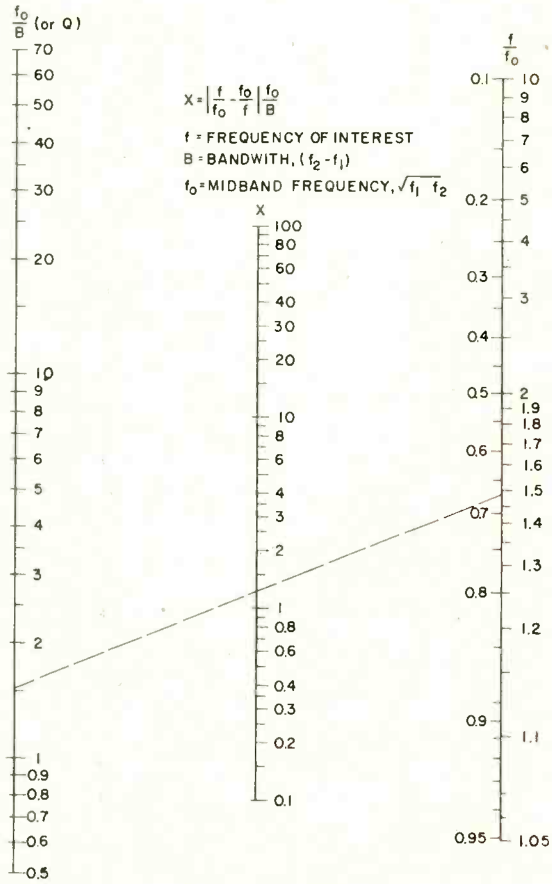

FIG. 1—Nomograph for determining value of X

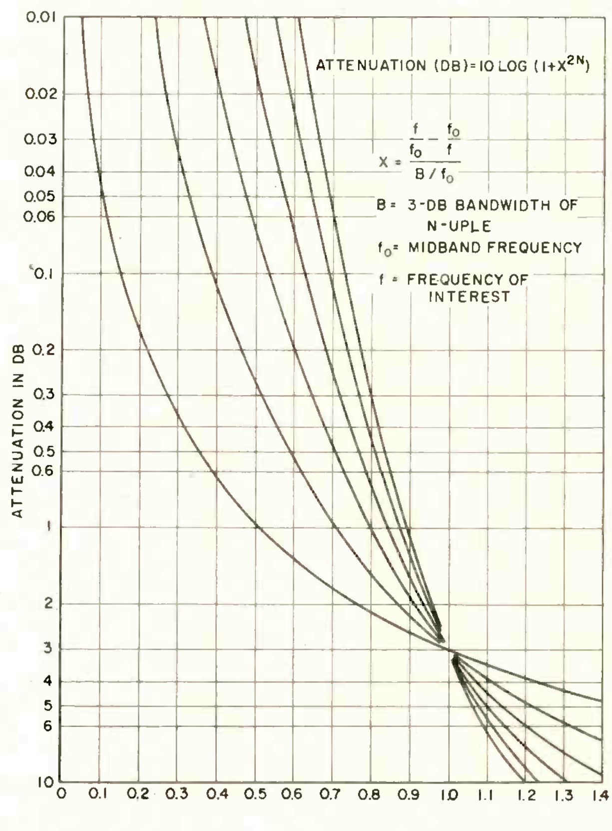

FIG. 3—Selectivity curves for values of X from 1 to 100

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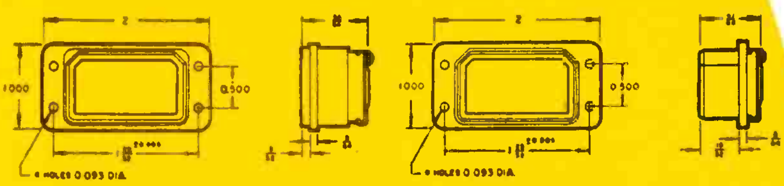

DPX 23-34P

DPX 23-33S

DPX CONNECTORS:

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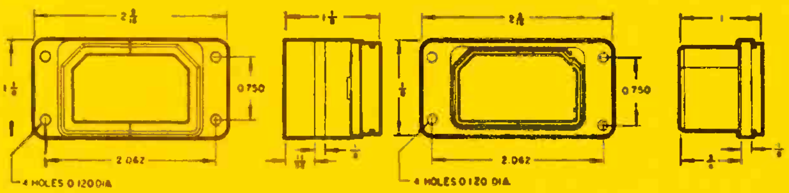

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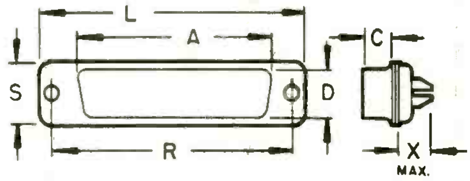

size	A	C	D	L	R	S	X	weight
DA-15P	1 1/64	15/64	23/64	1 17/32	1.312	31/64	5/16	.013
DA-15S	1 3/32	15/64	5/16	1 17/32	1.312	31/64	5/16	.014
DB-25P	1 9/16	15/64	23/64	2 5/64	1.852	31/64	5/16	.023
DB-25S	1 33/64	15/64	5/16	2 5/64	1.852	31/64	5/16	.031
DC-37P	2 13/64	15/64	23/64	2 23/32	2.500	31/64	5/16	.035
DC-37S	2 11/64	15/64	5/16	2 23/32	2.500	31/64	5/16	.035
DD-50P	2 7/64	15/64	15/32	2 5/8	2.406	39/64	5/16	.035
DD-50S	2 5/64	15/64	27/64	2 5/8	2.406	39/64	5/16	.040
DE-9P	45/64	15/64	23/64	1 13/64	.984	31/64	5/16	.011
DE-9S	41/64	15/64	5/16	1 13/64	.984	31/64	5/16	.012

FRACTIONS ±1/64 Tolerance DECIMALS ±0.005 Tolerance

D SUB-MINIATURE SPECIFICATIONS:

Shell, including flange — steel or brass; Finish — Cadmium plate or Irridite. Contacts — No. 20, 5 ampere rating — Copper base alloy, gold plate finish.

Insert arrangements — 5 plus coaxials in 9, 15, 25, 37 and 50 contacts.

Insulation material — Zytel 101 or DIALL.

Polarization — Keystone cornered shell.

Operating temperature —67° to +310°F.

Send for illustrated Catalog No. 157 with details of "D" Sub-Miniature, "DPA" and "DPX" Series.

Cinch ELECTRONIC COMPONENTS

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1026 South Homan Ave., Chicago 24, Illinois
Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

(continued from p 188)

power frequencies, f_2 and f_1.

For cases where the deviation of the frequency of interest f from the midband frequency of an amplifier, f_o, is small compared to f_o, X may be determined from $X \approx |f - f_o| / (B/2)$.

Examples

An amplifier is to be designed having a midband frequency, f_o, of 40 mc. Its overall bandwidth, B_o, is to be 26 mc. What is the lowest order N-uple that can be used if it is desired to attenuate a 26.9-mc signal by 8 db with respect to f_o?

Overall Q of the amplifier is $Q_o = f_o/B_o = 40/26 = 1.54$. At the frequency of interest, 26.9 mc, $f/f_o = 26.9/40 = 0.672$. From Fig. 1, find $X = 1.26$, corresponding to $Q_o = 1.54$ and $f/f_o = 0.672$.

From the Fig. 2, opposite $X = 1.26$, find an attenuation of 7 db for $N = 3$ and 8.7 db for $N = 4$. Therefore, a quadruple must be used.

An amplifier consists of three identical, flat-staggered pairs in cascade. If each pair has a bandwidth B_2 of 10 mc, what is the overall bandwidth B_o of the amplifier; what are its upper and lower half-power frequencies, f_2 and f_1, respectively and what is the total attenuation of a signal at 60 mc with respect to a signal at $f_o = 40$ mc?

At the half-power frequencies of the amplifier, each pair contributes one-third of 3 db or 1-db attenuation. From the curves for a pair $N = 2$ and an attenuation of 1 db, $X = 0.71$. The value of X so determined, for cascaded identical N-uples is numerically equal to the bandwidth shrinkage factor of the amplifier. Hence, the overall bandwidth is, $B_o = XB_2 = (0.71)$ (10 mc) = 7.1 mc. Next determine overall $Q_o = f_o/B_o = 40/7.1 = 5.63$. From the nomograph, corresponding to $Q_o = 5.63$ and $X = 1$, find $f/f_o = 1.093$ and 0.914. Since $f_o = 40$ mc, it follows that $f_2 = (40)\ (1.093) = 43.7$ mc and $f_1 = (40)\ (0.914) = 36.6$ mc.

Determine Q_2 (Q of a pair); $Q_2 = f_o/B_2 = 40/10 = 4$. At the frequency of interest, 60 mc, $f/f_o = 60/40 = 1.50$. From the nomograph, corresponding to $Q_2 = 4.0$ and $f/f_o = 1.50$, find $X = 3.33$. From the curves, find the attenuation per pair ($N = 2$), corresponding to $X = 3.33$. It is equal to 21.1 db.

An amplifier is to be designed using a flat-staggered quintuple ($N = 5$) cascaded with a synchronously tuned stage ($N = 1$). The overall bandwidth, B_o, must be 20 mc. If the quintuple has a bandwidth, B_5, of 22 mc, what is the bandwidth B_1 required of the synchronously tuned stage and at what frequencies will the attenuation of a signal be 40-db below that of $f_o = 40$ mc?

Determine Q_o (overall Q) of the amplifier $= f_o/B_o = 40/20 = 2$. From the nomograph, find one of the normalized overall, amplifier half-power frequencies, say f_2/f_o, corresponding to $Q_o = 2$ and $X = 1$, $f_2/f_o = 1.282$.

Determine Q_5 (Q of the quintuple) $= f_o/B_5 = 40/22 = 1.82$. From the nomograph, find X_5 (X for the quintuple) $= 0.91$, corresponding to $f_2/f_o = 1.282$ and $Q_5 = 1.82$. From the curves for a quintuple ($N = 5$), opposite $X_5 = 0.91$, find the attenuation of the quintuple to be 1.4 db.

At the half-power frequencies of the composite amplifier, the attenuation contributed by both the synchronous and the quintuple) $= f_o/B_5 = 40/22 = 1.82$. db. Hence, the attenuation at those frequencies due to the synchronously tuned stage alone must be equal to 3.0 db − 1.4 db = 1.6 db.

From the curves, find X_1 (X for the synchronous stage) $= 0.67$, corresponding to an attenuation of 1.6 db in the synchronously tuned stage ($N = 1$).

From the nomograph, find Q_1 (Q of the synchronous stage) to be equal to 1.33, corresponding to $X_1 = 0.67$ and $f_2/f_o = 1.282$. The bandwidth of synchronously tuned stage B_1 may then be determined to be $B_1 = f_o/Q_1 = 40/1.33 = 30$ mc.

From the nomograph, choose a value of f/f_o and find X_1 and X_5 corresponding to Q_1 and Q_5 above. From the curves and these X's, find the attenuation of each amplifier separately. When added, the sum of these attenuations in db is the overall attenuation of a signal at the chosen frequency relative to one at f_o. Find, by trial and error, that when $f/f_o = 1.78$ and 0.562, the attenuation of a signal at those frequencies is 40-db below a signal at f_o. The corresponding frequencies are thus $f = (40)\ (1.78) = 71.2$ mc and $(40)\ (0.562) = 22.5$ mc.

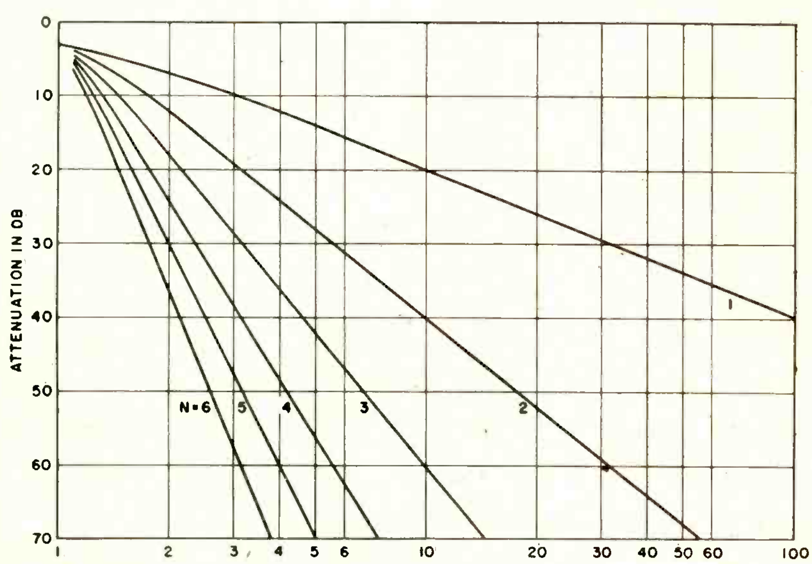
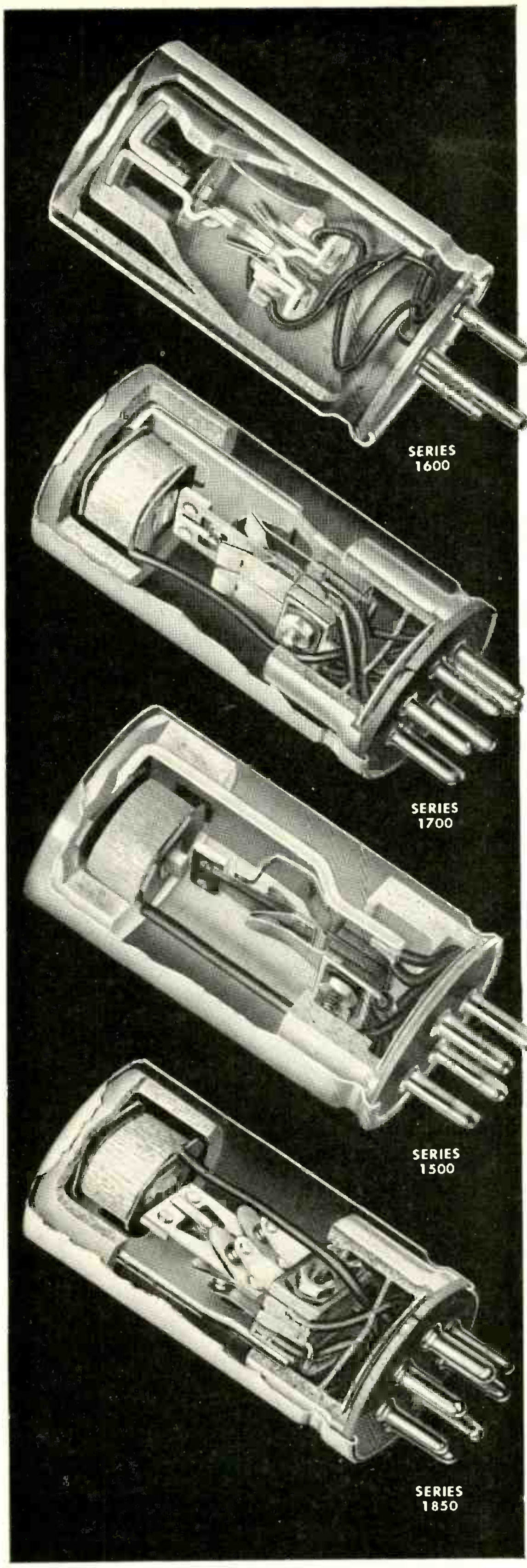


FIG. 3—Selectivity curves for values of X from 0 to 1.4



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Self-rectifying types	1800	nominal duty, shunt drive	electronic equipment—for high efficiency, small space
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Electrons At Work

Edited by DAVID A. FINDLAY

Magnetic-Optical Sound Recording

MAGNETIC sound tracks on film have been discovered to be partially transparent to infrared light. This makes it possible to place a magnetic stripe over the photographic sound track on motion picture films and reproduce the magnetic and optical recordings simultaneously and independently.

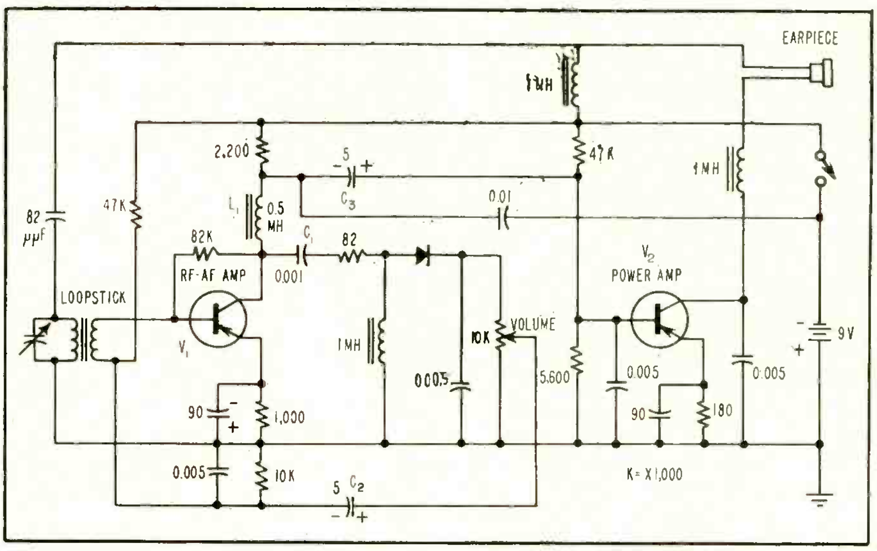
To obtain dual sound tracks, it has always been necessary to use a half-width magnetic stripe covering only half of the photographic track, since the conventional caesium cell used in most motion picture projectors does not respond to infra-red light. This results in loss of signal-to-noise ratio in both sound tracks. In addition, applying the narrow stripe to more than half of the photographic track results in serious distortion. Using a full width stripe, application is much simpler and high quality magnetic sound is achieved. By replacing the caesium cell with the infrared sensitive lead-sulfide cell, high-quality reproduction of the covered photographic sound track is also obtained.

There is a peak of transmission through present magnetic stripes at 2.7 microns. At this wavelength, present lead-sulfide photoconductive cells have about 50 percent of maximum sensitivity, while presently used tungsten exciter lamps have approximately 20 percent of peak radiation. This combination results in about 30 percent transmission compared to an unstriped photographic track. The resulting loss of approximately 10 db is offset by the greater sensitivity of the lead-sulfide cell over the caesium cell.

Further improvement in the output of the photographic sound track should result when photocell and exciter lamp are both modified to peak at 2.7 microns.

Dual sound tracks have many applications in motion pictures, such as recording a foreign version on the magnetic track while retaining the original language on the photographic track. Other applications are stereophonic recording on 16

Reflex Transistor Radio



Two transistor receiver circuit using reflex r-f and a-f amplifier. The r-f signal is amplified by V_1 and coupled through C_1 to crystal detector. The detected audio is then returned to transistor V_1 through C_2 for amplification. Audio output of V_1 is coupled to power amplifier V_2 through L_1 and C_3. Circuit is used in kit made by Allied Radio Corp.

Engineer adjusts receiver of meteor reflection link at Stanford

Radio Link Uses Meteor Trails

BY REFLECTING radio signals from meteor trails, transmission distances up to 1,500 miles have been obtained. An experimental system in the 30 to 100 mc range, is now in operation between the Stanford Research Institute, California, and Montana State College, Bozeman, Montana, a distance of about 800 miles.

The meteors which constantly bombard the earth's atmosphere, create trails of ionized air about 60 miles above the earth's surface. These trails may be used advantageously as reflectors for radio communications.

Since properly oriented meteor trails are not always present, transmission of messages is intermittent. The Stanford equipment has been designed, therefore, for high-speed communications, to make maximum use of the available time. Messages are sent at 600 words per minute, ten times the standard teletype rate.

Using reflections from meteor trails allows effective operation with transmitters of lower power than usually needed for forward-scatter circuits.

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1.5 Amp. KR SERIES

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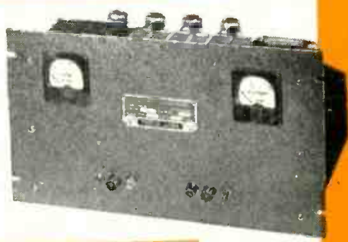
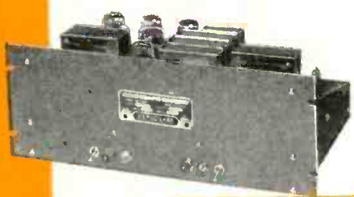
0-150	Each supply	KR16	19"	12¼"	17"	$625
100-200	has two	KR17	19"	12¼"	17"	$625
195-325	15 Amp.	KR18	19"	12¼"	17"	$695
295-450	outputs	KR19	19"	12¼"	17"	$695

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



MODEL KR-4

300 ma. KR SERIES

OUTPUT VOLTS DC	6.3V AC	Model	Rack Mount W	H	D	Price
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.
To Include Dust Cover and Handles for Table Mounting, Add C to Model number (e.g. KR16-C) and Add $10.00 to the Price.
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- Voltage range continuously variable without switching.
- Either positive or negative may be grounded.
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mm with better signal-to-noise ratio than would be obtained using two half-tracks; and combination magnetic and photographic prints for 35-mm theatrical release so that the same prints can be used whether or not a given theatre is equipped for magnetic sound. At present this can be accomplished only by sacrificing some of the picture area to make room for the photographic sound track. Conceivably, it would be possible to have just as many photographic tracks as magnetic tracks without increasing space requirements.

George Lewin, Chief of Pictorial Engineering at the Army Pictorial Center, described the work outlined above at a recent New York panel discussion on sound recording co-sponsored by the SMPTE.

Spot Wobble Cuts TV Screen Lines

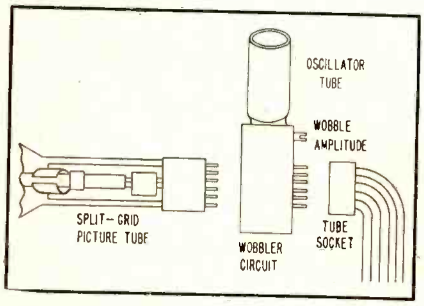
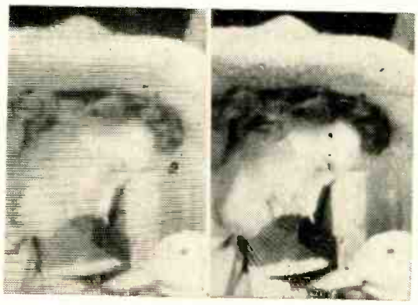


FIG. 1—Wobble oscillator mounts conveniently at base of crt. Short leads minimize stray r-f radiation



Photos of the same crt screen without spot wobble (left) and with proper wobble adjustment (right).

AVERAGE tv viewing distance is the point at which the viewer just fails to distinguish individual horizontal lines. With a 24 in. picture tube, this distance is about eleven feet. This normal viewing distance can be reduced to six feet through the use of spot wobbling.

Spot wobbling, in effect, lengthens the beam vertically so that adjacent lines are just tangent. The horizontal dimension of the beam, on which the resolution depends, is left unchanged. The spot must be wobbled at a frequency sufficiently high that individual cycles of wobble are not visible.

SPLIT GRID—A new crt, developed by Westinghouse, allows wobbling without the extra deflection coils required by a system developed in Britain. The electron gun is a low-voltage electrostatic type with the cylindrical focus electrode cut in half along a horizontal plane.

The oscillator used to produce the wobble is mounted at the base of the crt where all operating voltages are available, as shown in Fig. 1. The oscillator circuit of Fig. 2 drives the split grid at about 25 mc. The low capacitance of the split grid allows high wobble frequencies to be easily obtained. The oscillator coil consists of 11 turns of No. 17 wire on a $\frac{3}{4}$-in. diameter form.

The oscillator-split grid combination has a high Q, minimizing driving power and reducing oscillator harmonics. The mounting keeps leads short preventing r-f radiation. No interference effects due to oscillator harmonics have been noted.

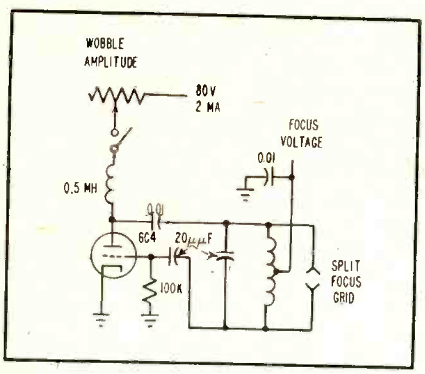


FIG. 2—Oscillator drives split focus grid at 25 mc, causing the beam to widen vertically

Magnetic Core Coincidence Circuit

By A. L. FREEDMAN
Ericsson Telephones Ltd.
Beeston, Nottingham
England

A MAGNETIC CORE coincidence circuit is obtained by connecting the output windings of two square loop cores in parallel, as shown in Fig. 1. With both cores initially saturated in the same sense, a current pulse applied to the input winding of one of the cores will not cause the core to change state because its output winding is short circuited by the output winding of the other core. If input pulses are applied to both cores, both will switch, generating an output signal on the common output winding. An output signal is also obtained when the cores are simultaneously switched back to the initial state by a pulse applied to a reset winding on each core.

Circuits based on this principle have been investigated using 3 mm Mullard D cores which require one ampere-turn to change state. In the coincidence circuit, however, an input signal as large as 1.85 ampere-turns can safely be applied to either core without causing switching, so that the circuit operates correctly for input signals in the range 1 to 1.85 ampere-turns.

The way in which this tolerance arises is as follows: Assume that an input current is applied to core *A* in Fig. 1, both cores being in the zero state. Current generated in the output windings of core *A* is in such a direction as to tend to switch core *B* into the one state. As long as the ampere-turns applied to core *A* are less than twice the minimum switching ampere-turns, the excess current passed by core *A* to core *B* is not enough to switch core *B*. The latter remains on the horizontal part of its hysteresis loop, short-circuits core *A* and prevents it from switching. When an input current generating at least twice the minimum switching ampere-turns is applied to the input winding of core *A*, both cores switch and the circuit no longer acts as a coincidence circuit.

This analysis is confirmed by

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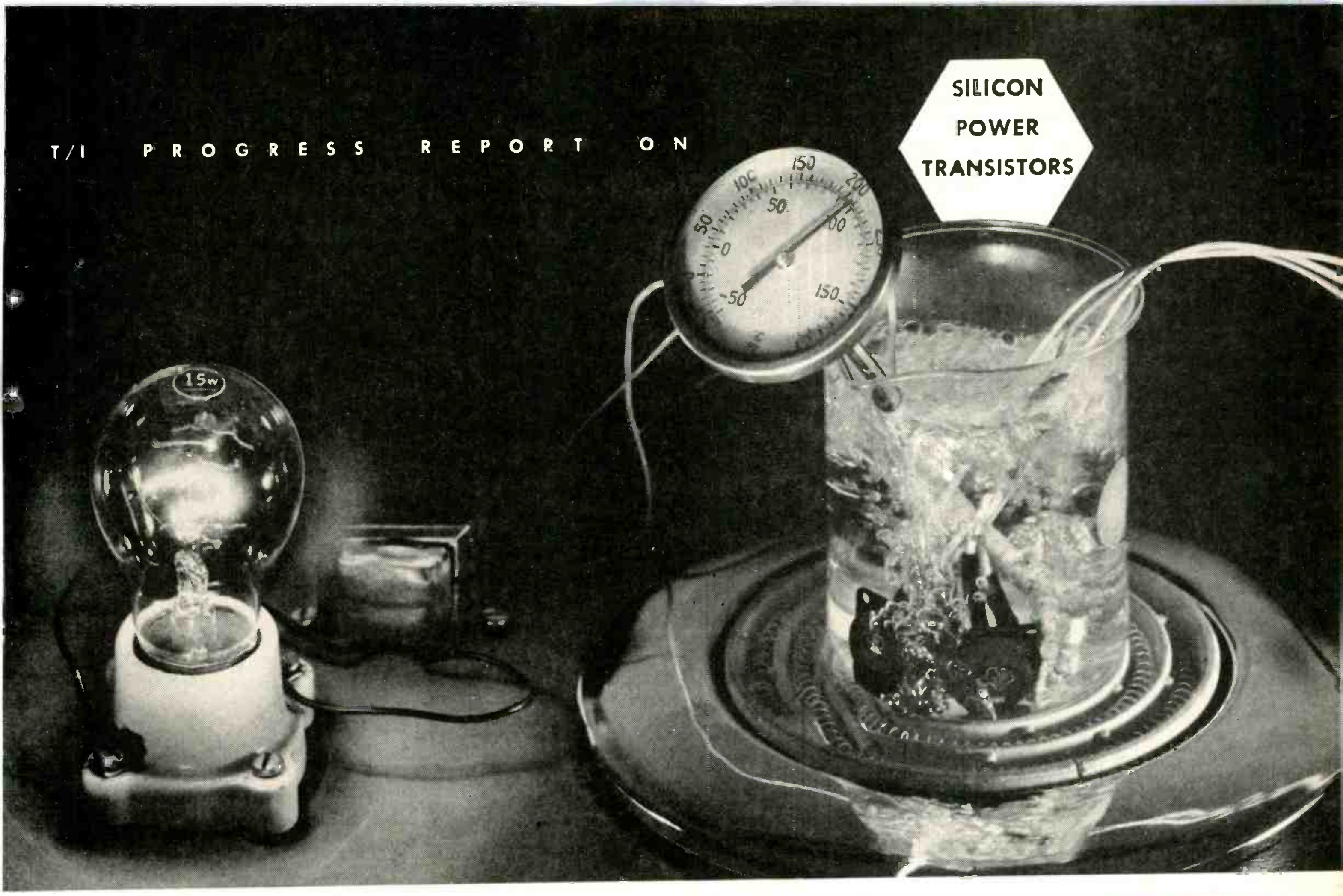

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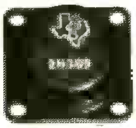

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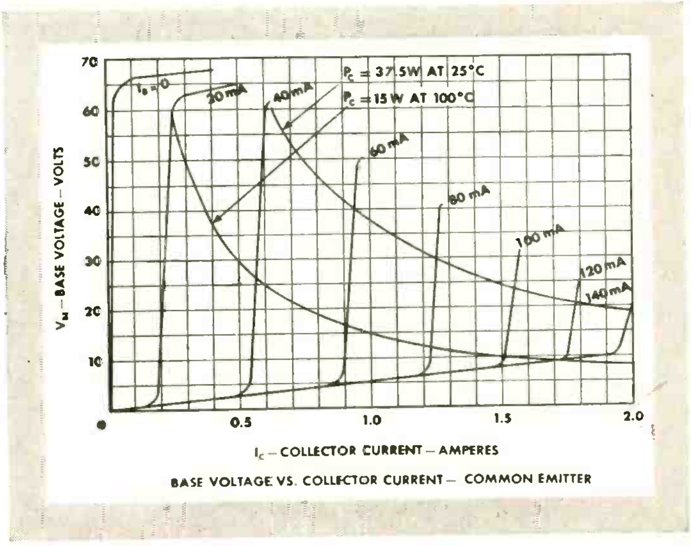

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Power Dissipation at 100°C	15	Watts
25°C	37.5	Watts
Collector to Emitter Voltage	+60	Volts
Base to Emitter Voltage	–2	Volts
Collector Current	2	Amperes
Saturation Resistance	6	Ohms
Base Current	0.5	Ampere
Storage Temperature	–65 to +150°	C

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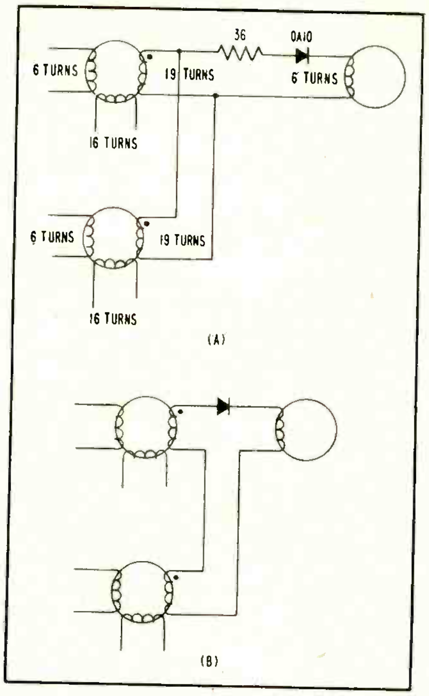
the fact that a three-core, three-input coincidence gate was found to operate correctly for input pulses 1 to 1.4 times the minimum switching ampere-turns.

The coincidence circuit can, of course, be used as an and-gate for simultaneous inputs. Such an and-gate, is shown in Fig. 2A. The 36-ohm resistor is used to reduce the output generated when both cores switch to that obtained when transferring from a single core. When compared with the or-gate of Fig. 2B it is seen that while in the latter the output windings are connected in series, in the and-gate they are connected in parallel. This is the dual of relays.

The author acknowledges the permission of the Controller of Research of Ericsson Telephones Ltd. to publish this material.



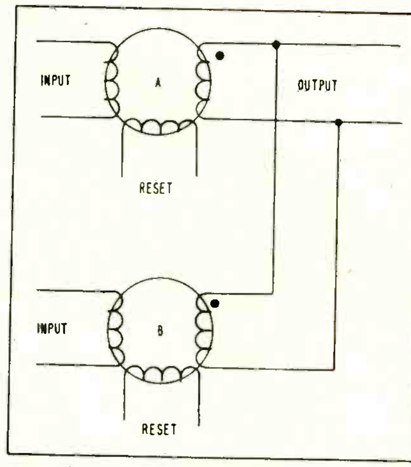


FIG. 1—Basic coincidence circuit using two magnetic cores generates signal on common output when inputs are excited

FIG. 2—Coincidence circuit used as an and gate (A) and as an or gate (B) has output parallel and series

Silicon Diodes as Logarithmic Elements

Y. GOLAHNY
Raytheon Manufacturing Co.
Waltham, Mass.

LOGARITHMIC converters are useful in instrumentation associated with signals of a wide dynamic range, in mathematical computation, and in automatic gain control systems such as used for signal compression and expansion.

Linear-to-logarithmic scale conversion may be obtained by many techniques including thermionic diodes with negative anodes, variable-mu tubes and application of feedback in amplifiers, contact rectifiers, special potentiometers and photomultiplier tubes. Practical shortcomings of these devices include range and accuracy limitations, input and output coupling difficulty and cost.

An inexpensive linear-to-logarithm converter with reasonable range and accuracy, utilizing available stock diodes, may have an advantage over these devices.

A diode will approximate logarithmic characteristics in the lower range of its volt-ampere characteristic curve. As the current through the diode increases, the logarithmic approximation improves, until the current is large enough to cause a significant deviation from the logarithmic current-voltage relation. The upper limit of the logarithmic range was found to be approximately 1 ma.

The logarithmic characteristics of some diodes were explored by measuring their current-voltage relation in ranges from 0.5, 1.0 and 2 ma to 5, 10, and 20 uua. An accurate analysis was obtained by comparing the voltage increments for each diode. Table I summarizes

Table I—Diode Logarithmic Conversion Characteristics

Type	No. tested	Number of Decades 2	3	4	5	6	7	Temp C	Direction
IN300	2			2				25	Forward
IN300A	23		1	6	6	5	4	25	Forward
	6		1	2	2	1		75	Forward
	2							25	Reverse
	6							75	Reverse
IN305	5							75	Forward
	6							75	Reverse
IN432	5		2		3			75	Forward
	5							75	Reverse
Exp 7	30	1	3	7	11	4	3	25	Forward
	15		7	3	1	2		25	Reverse
Exp 8	25	3	7	7	7	1		25	Forward
	24		2	13	7	1		40	Forward
	24	6	9	2				40	Reverse
IN460	5			2	3			75	Forward
	5							75	Reverse
CK840	10			6	3			25	Forward

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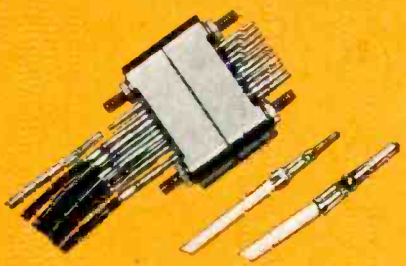

TAPER PINS

The A-MP Miniature Taper Pin Receptacle eliminates tedious and costly operations of soldering leads to miniature connectors. This solderless, quick-disconnect terminal is applied to the lead by means of A-MP Automachine and A-MP Certi-Crimp Tooling . . . then capped over other type connectors, modified to receive the A-MP 37 Series Miniature Taper Pin Receptacle.

Other A-MP Taper Pins are available (Series 53 and 88) for wire sizes 24 - 12 AWG and a wide range of insulation sizes. Insulation piercing Taper Pins are available for small stranded wires and popular size tinsel cords.

TAPER TAB RECEPTACLES

A-MP Taper Tab Receptacles are a recent development for flat tabs employing the taper key principle. They are available for wire sizes 24 - 18 AWG, in gold, silver and tin plated finishes.

The tapered section of these receptacles is standardized to fit the same size tapered tab. Insulation piercing Taper Tab Receptacles are available for small wire sizes and tinsel cords.

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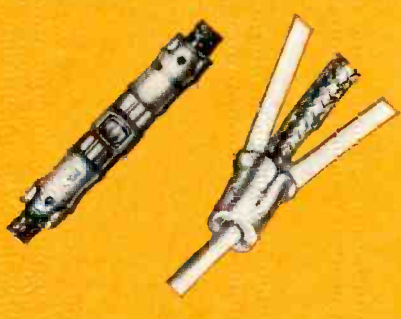

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Further information on these products is available on request.

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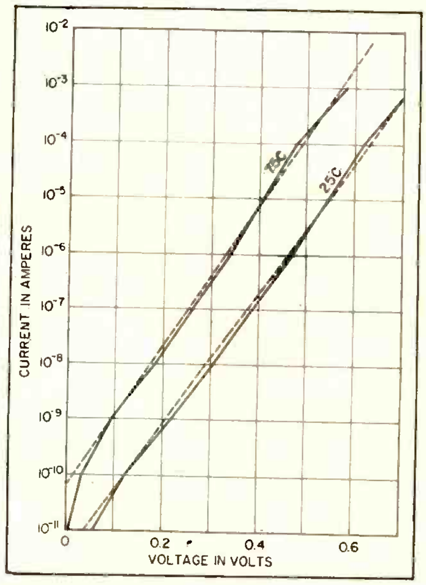
the logarithmic conversion characteristics for the diodes investigated. Maximum variation of the current-voltage relationship was specified as 2 db. Conversion factors were 0.08 v per decade in the forward direction and 1.6 v per decade in the reverse direction. A 10-percent voltage tolerance includes measurement errors, electrometer drift and noise.

Diodes IN300A, Exp-7 and Exp-8 yield a substantial proportion of units with good logarithmic conversion characteristics over a range of 7 decades in the forward direction with a conversion factor of 0.08 volts per decade. Thirty Exp-7 type diodes, for example, yielded 3 units with 7 decades, 4 with 6 decades, 11 with 5 decades, 7 with 4 decades, 3 with 3 decades, 1 with 2 decades, and 2 with no decades of logarithmic current voltage relation within 2 db.

An increase in ambient temperature results in a decreased logarithmic range and affects the linear to logarithmic conversion factor. In the reverse direction, the conversion factor of 1.6 v per decade is quite high but the logarithmic range, tolerance and consistency are considerably poorer than in the forward direction.

Diodes such as IN300A, Exp-7 and Exp-8 can be used directly as logarithmic elements. Appropriate circuits, such as a bridge network containing more than 1 diode, and



Characteristic of 1N300A diode at 25 C and 75 C compared to true logarithmic function (dashed line)

the connection of a number of diodes in series should extend the range of useful logarithmic conversion and increased volts per decade output. The graph illustrates the current voltage characteristics in the forward direction of a IN300A diode, chosen at random, and compared with a true logarithmic function at 25 C and 75 C.

The adverse temperature effects may be reduced by compensating circuits or the enclosure of the diodes in a constant temperature oven similar to the type used for communication crystals.

Galactic Noise Effects TV Receivers

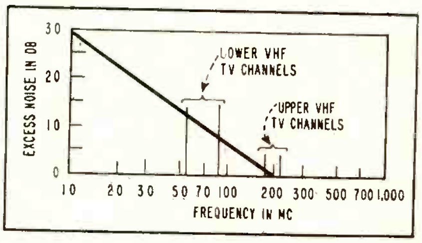
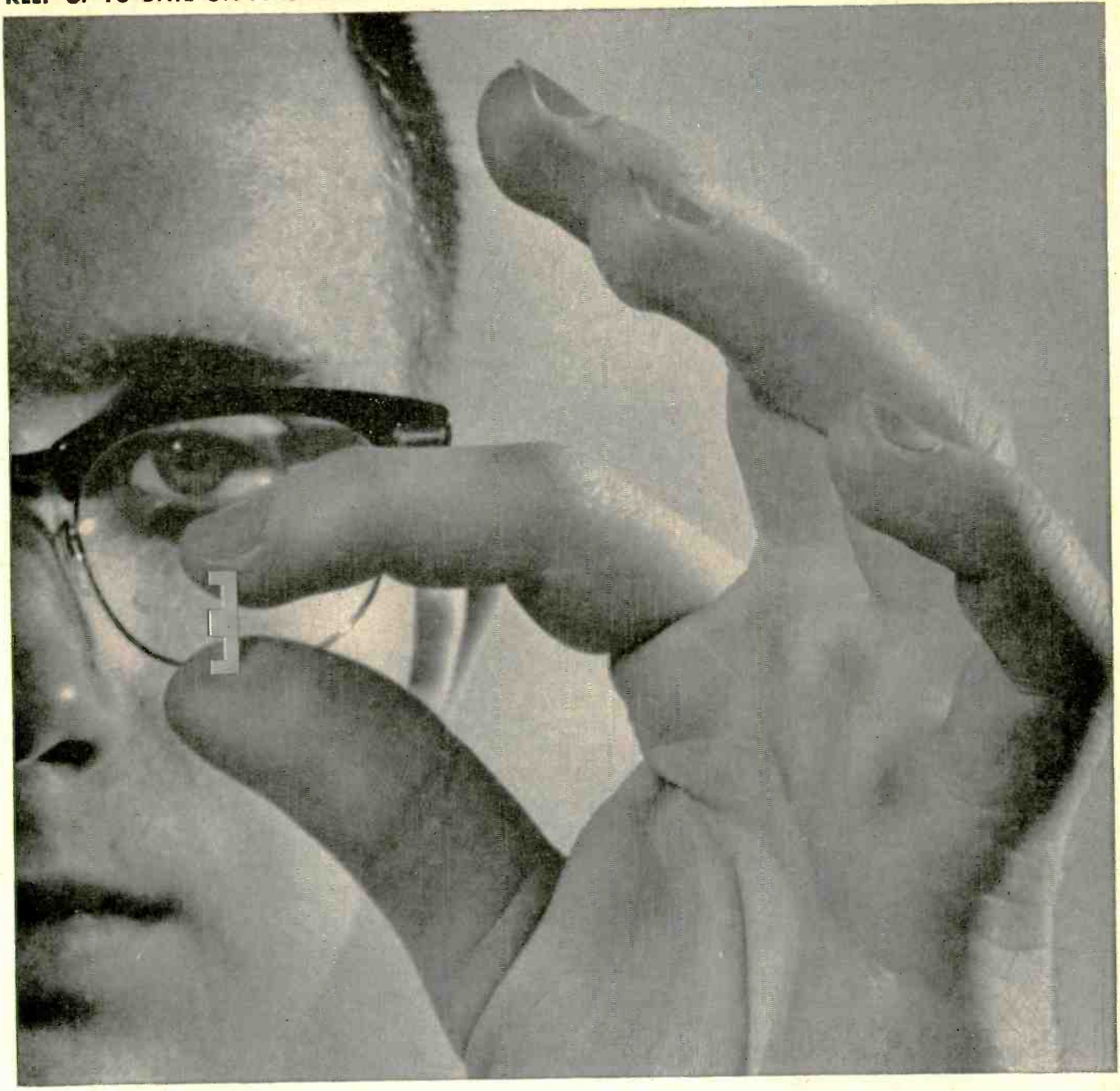


FIG. 1—Galactic noise in excess of thermal equivalent noise as measured by the Bureau of Standards using a vertically polarized dipole

TELEVISION RECEIVER noise factors measured in the laboratory differ from noise factors encountered in actual use since the laboratory measurements fail to take into account the many external influences affecting the receiver connected to an actual antenna. A more accurate measure of the noise present in a tv system is the effective system noise factor. This takes into account the noise of the antenna, transmission line and the noise from external sources in addition to the receiver noise itself.

In the vhf region, from channels 2 to 6, the predominant external noise is galactic noise. As shown in Fig. 1, it decreases with rising frequency at approximately 7 db per octave.

Figure 2, shows the variation of effective system noise with changes in receiver noise factor, assuming



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no antenna and transmission line losses. If these losses are to be considered, they may be added directly to the receiver noise factor. The y intercepts are the contribution of galactic noise.

These curves are of significance in tv tuner design, since they show the overall system improvement brought about by any reduction in receiver noise. For example, reducing the receiver noise factor from 4 db to 1 db at channel 4 produces only about 0.5 db improvement in the entire system noise factor. A one-to-one improvement ratio is found only at the higher vhf channels.

The above information is drawn from the paper, "Galactic Noise—An Important Design Consideration of VHF Television Tuners" by D. Carson of the RCA Victor Television Division—N.H.

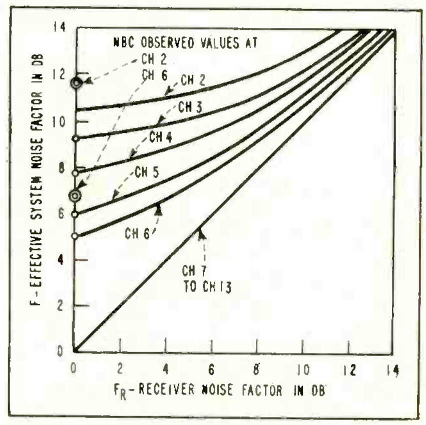


FIG. 2—Effect of galactic noise on effective system noise factor. Discrepancies between these measurements and the Bureau of Standards data are within the normal variations of galactic noise

Preamplifier for Ceramic Pickups

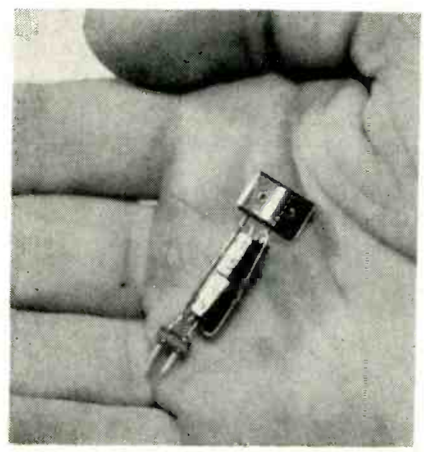
By William Newitt
Senior Engineer
Electro-Voice, Inc.
Buchanan, Mich.

It is desirable that ceramic phono pickups have low source impedance, with an output voltage comparable to that of a magnetic pickup. Some power gain should also be provided so that the ceramic unit may compare favorably with the high power sensitivity of a magnetic pickup.

Power gain may be provided by a transistor amplifier. By placing the amplifier close to the pickup, minimum hum and noise pickup as well as minimum loss due to shunt capacitance can be obtained.

The highest input impedance obtainable from a transistor may be realized from the common-collector configuration. Since the input impedance depends also to a considerable extent on the output load of such a circuit, satisfactory results have been obtained by a tandem type of circuit. Two transistors are used in a cascade-common-collector configuration with the input impedance of one stage comprising the load of the preceding stage.

An experimental circuit, shown in Fig. 1, utilizing 2N184 transistors can handle two volts rms input without introducing distortion. With simulated ceramic pickup,



Complete preamplifier can be housed in tubing 5/16 in. wide and ¾ in. long

having 500 $\mu\mu$f internal capacitance, coupled to the input, open-circuit output response is within ½ db from 35 to 40,000 cycles. Output impedance is 120 ohms at 1,000 cycles.

The transistor assembly was built into a small phenolic tube $\frac{5}{16}$-inch in diameter and ¾-inch long. Plugs fitted at each end permit attachment directly to the pickup. Actual performance verified the results obtained with the simulated ceramic pickup. Total loss in gain resulting from insertion of the transistor unit was ½ db.

At 1,000 cycles, the impedance of the 500 $\mu\mu$f pickup would be about

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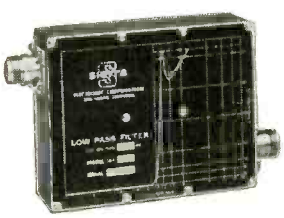
SPECIFICATIONS

Model	Power*	Connectors	VSWR
160-1F	1 watt	Type N fem.	Less than 1.06, dc to 2 KMC;
160-1M	1 watt	Type N male	less than 1.08, dc to 4 KMC.
160-5F	5 watts	Type N fem.	Less than 1.08, dc to 4 KMC.
160-5M	5 watts	Type N male	
160-20F	20 watts	Type N fem.	Less than 1.08, dc to 1 KMC;
160-20M	20 watts	Type N male	less than 1.15, dc to 4 KMC.
160-100F	100 watts	Type N fem.	Less than 1.2, dc to 3300 MC.
160-500F	500 watts	Type N fem.	

*Up to 40° C ambient.



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Coupling Factor: (in db ± 1 db)

Model	10 kc	3 mc	10 mc	30 mc	100 mc	300 mc	1000 mc	2000 mc
137, 137A				73	63	53	43	37
138, 138A				59	49	39	29	
145		52	42	32	22	12		
150				53	43	33	23	
139	50	50						

Directivity: 12 db ± 3 db greater than coupling factor at each frequency.

Impedance: Models 137 and 138 are 51.5 ohms. Models 137A, 138A, 145 and 150 are 50.0 ohms. Model 139 may be matched to most impedances.

Power: Usable to 1000 watts throughout frequency range.

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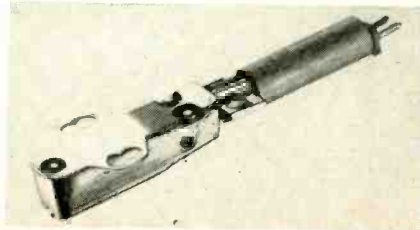


Transistor preamplifier unit installed on phono cartridge can be mounted in phonograph pickup arm

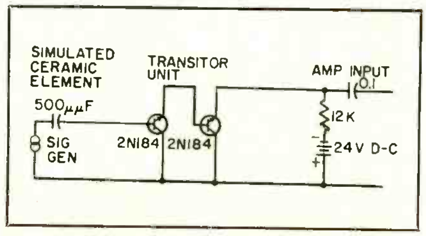


FIG. 1—Simple transistor amplifier can be built into phono pickup arm with power supply installed in amplifier

32,000 ohms. Increase in power sensitivity of the pickup with the attached transistor unit is about 300 times. Thus, a power gain of about 25 db has been provided, and the ceramic phono pickup is capable of driving low load impedances.

The only change required in the existing equipment is the addition of a low-current d-c supply and two components to the preamplifier unit.

Simple Transistor Sweep Generator

By H. L. Armstrong

*National Research Council
Ontario, Canada*

Transistor multivibrators can be operated either as triggered or free-running sweep generators.

The circuit of a triggered sweep generator is shown in Fig. 1. Initially, Q_2 is conducting rather heavily while R_2 provides enough bias current to almost bottom the collector of Q_2. Transistor Q_1 is near cut off. A positive trigger cuts Q_2 off and its collector voltage instantly rises in absolute value. This rise, which causes the initial step in the waveform of Fig. 2 is coupled to Q_1, turning it on. Then the signal at the collector of Q_1 is fed back to Q_2, cutting it off.

The current drawn by Q_1 through R_1 makes the voltage available at point A for Q_2 less, in absolute value, than it would otherwise be. This voltage begins to charge capacitor C, and the charging current keeps Q_1 turned on. As C becomes charged, the rate of charge, (slope of the sweep), tends to decrease. This causes Q_1 to draw less current. Thus the voltage at point A increases in absolute value, tending to maintain the sweep rate. This feedback improves the linearity of the sweep.

At the end of the sweep, Q_2 begins to conduct. The change which this produces at the collector is coupled to Q_1, cutting it off.

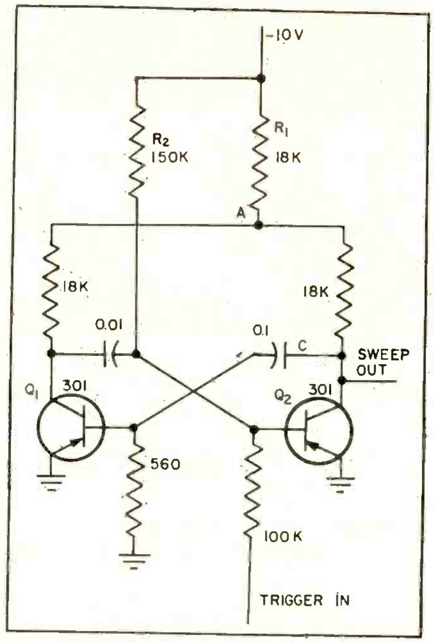
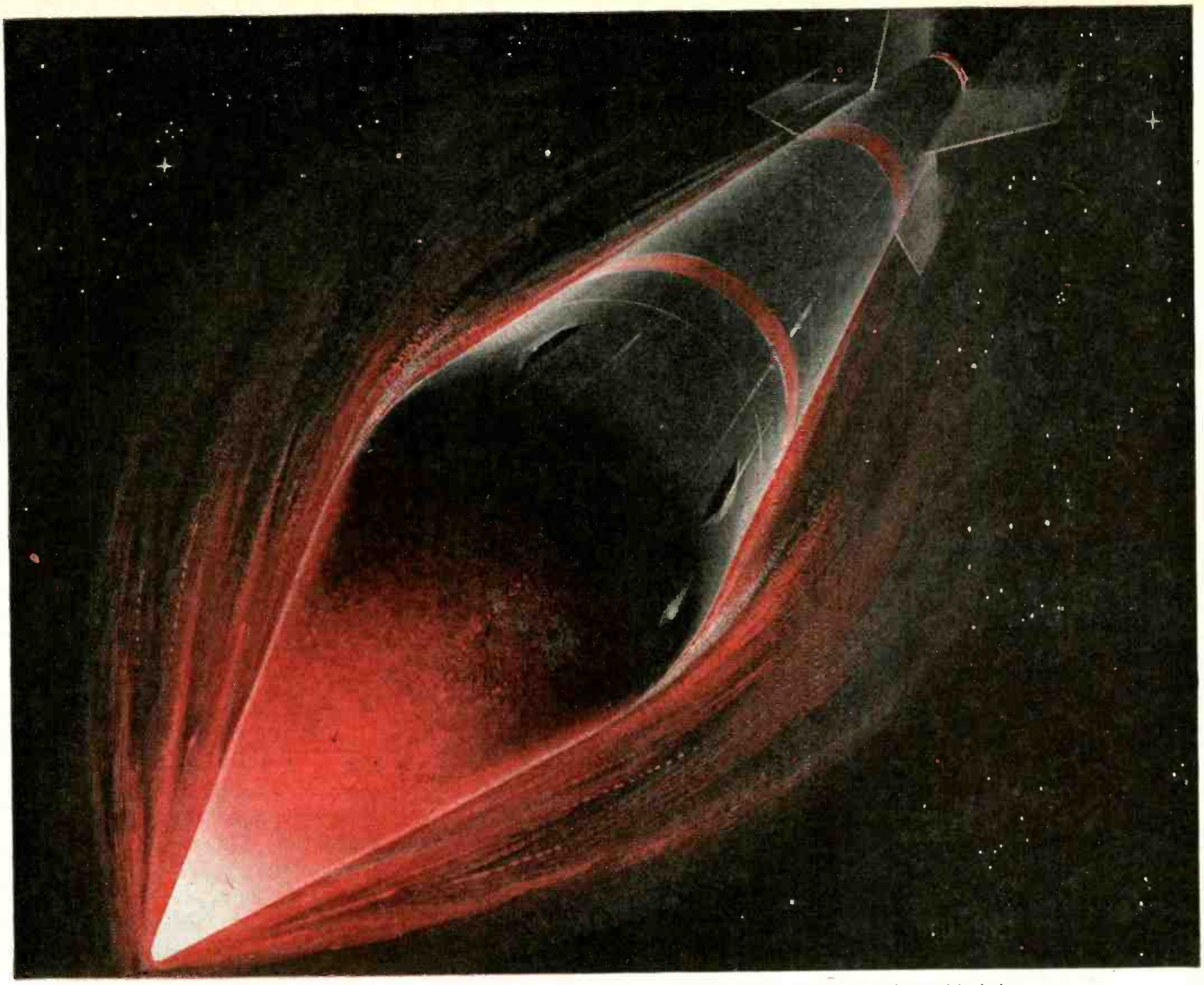


FIG. 1—Triggered sweep generator can be made free-running by increasing value of resistance R_2

This feeds back a signal to Q_2, causing it to conduct very heavily discharging C. Thus the flyback is achieved at the end of the sweep.

If *npn* transistors were used all polarities would be reversed, thus obtaining a positive sweep. The circuit can be made to free-run by altering R_2 to larger values. Waveforms obtained are similar to those for triggered operation.

Figure 2 shows a typical waveform for triggered operation. The trigger, shown on the lower trace, represents about 80 microamperes



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peak signal. Duration is not critical. The output sweep waveform is shown in the upper trace. Its linear part represents about 0.5 volt, and duration is about two milliseconds.

The output of the multivibrator

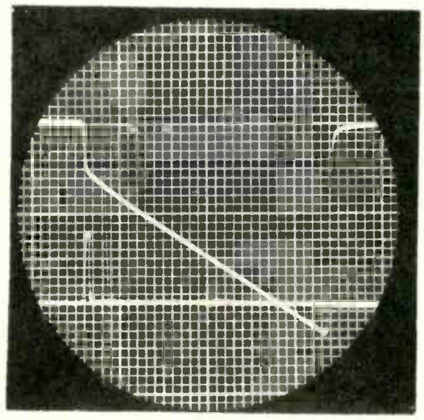

FIG. 2—Trigger pulse and sweep waveform for simple transistor sweep generator

can be loaded heavily enough to drive an ordinary grounded-emitter transistor amplfier stage. In one application it was possible to connect the output directly to the base of the amplifier stage through a 10,000-ohm resistor without harming the waveform.

Low-Mu Triodes Control Power

By John Degelman
Dept. of Biology
Boston University
Boston, Mass.

Valve solenoids and similar electromechanical devices can be controlled by 6AS7 or 6336 low-μ triodes when difficulties, due principally to the low μ of these triodes, are overcome.

The 6AS7 will pass 125 milliamperes per section and the 6336 nearly 400 per section, whereas a comparable beam-power tetrode handling no more than half the current of the 6AS7, demands a plate potential of nearly double the 150 volts required by the 6AS7 and is more critical as to plate load matching. Further, the plate load resistance of the 6AS7 may be as little as 300 ohms, that of the 6336 but 200 ohms.

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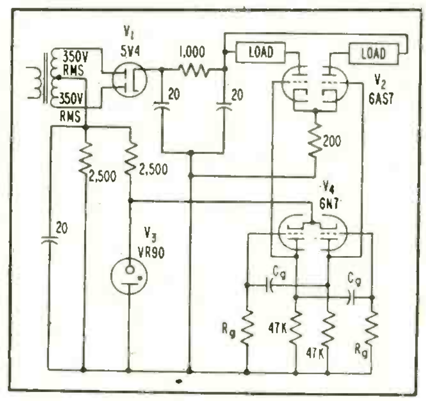
grid of one triode section must be made −75 v with respect to its cathode to cut off plate current. Also, it is not possible to cut off one triode section by a cathode resistor common to both triode sections with but one section passing full plate current.

In overcoming control difficulties to make use of the unique characteristics of the 6AS7, the circuit shown was devised for the operation of a laboratory respirator.[1] In the plate load circuits of the 6AS7 are solenoids used to pull a slide-fitting air-valve piston to and fro in a cylinder.

In the circuit shown, owing to the operation of a free-running multivibrator, the solenoids act alternately, one being supplied with 100 ma while the opposite solenoid is cut off and passes less than 0.25 ma.



Circuit of the solenoid-actuating device, using direct-coupled tubes

The 6AS7 is controlled by a low-frequency astable multivibrator V_4, which is operated with −90 v supplied to the cathode in a manner previously described.[2] For other applications, V_4 may be arranged as a bistable or monostable multivibrator.[3] With the high voltage applied to V_4 as a negative potential at the cathode, the anode potentials of V_4 become negative with respect to ground. This makes possible a direct coupling from the plates of the controlling tube to the grids of the controlled tube.

The grids of the multivibrator, although connected to ground via the two grid resistors R_g, are also returned to the point of highest positive potential. Early examples

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b. Provides frequency response for small signal testing to 1.0 megacycle.

c. Sweep circuit provides 270 volts, 10 amperes, or 20 watts.

d. Input current available to ±110 milliamperes.

e. Operates at a precision level accuracy of ±2%.

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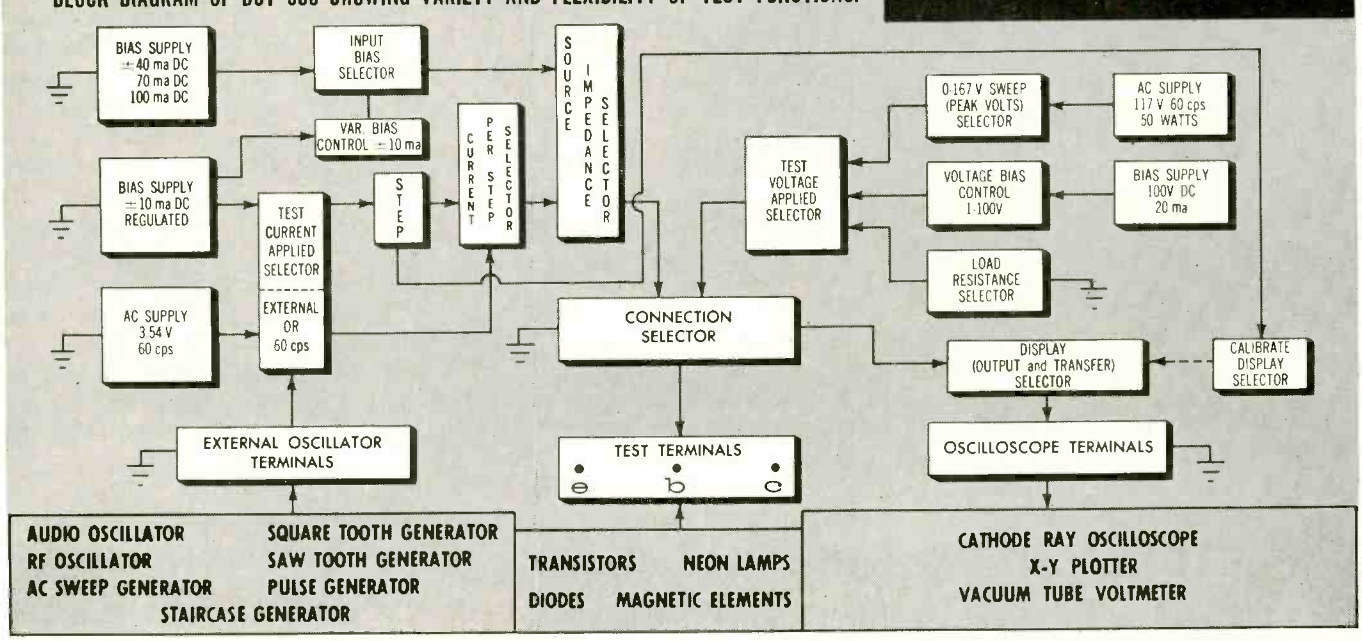
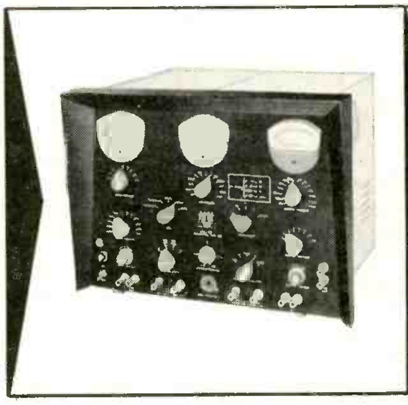
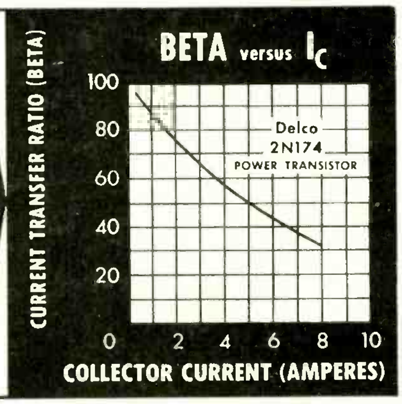


Wide Range Parameter Testing

BTS-400

1. Provides direct meter reading of all hybrid parameters in grounded base or grounded emitter configuration.
2. DC bias settings are continuously adjustable, and metered with maximum ratings of 6 amperes, 150 volts, or 60 watts.
3. Current transfer ratio parameter range of 1/10 to 1,000 covers all commercially available transistors.
4. This is the only test unit made with an input impedance parameter range of 10 to 100,000 ohms.
5. Precision parameter measurement to within ±2% provides the highest accuracy of any commercial unit.





The curve shown above on the 55 watt Delco 2N174 was obtained with Norden-Ketay BTS-400 Test Set.

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Write for Bulletins containing full data on these transistor measuring devices to: Norden-Ketay Corporation, Instrument & Systems Division, Wiley St., Milford, Conn.

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Table I—Characteristics of Twin Power Triodes

Type	μ	r_p in ohms	g_m	i_p in ma	plate diss in w
6AS7	2	280	7,000	125	13
5998	5	300	11,000	135	15
6080	ruggedized version of 6AS7				
6336	2	250	11,000	400	30
6394	same as 6336 with 26.5-v heater				

fied by the manufacturers as allowable for the 6AS7.

The low plate supply voltage required for the 6AS7 allows the rectified and filtered power supply to be divided into a positive potential supply and a regulated negative potential supply for operation of the multivibrator, without an overly high initial supply voltage. The total available voltage from the filtered power supply does not exceed 300.

Power rectifier V_1 is a type 5V4 with an indirectly heated cathode. Full power-supply voltage is not delivered by the 5V4 until after a time lapse of more than 15 seconds following heater and high voltage a-c application to the 5V4. This time delay is considered enough to protect the cathodes of the 6AS7 plates before the tube's cathodes have come up to operating temperature.

The alternative to this design is to provide a time-delay relay. The cathodes of these low-μ power triodes are subject to severe damage or ruin if full power-supply voltage is applied to their plates before the cathodes have come up to operating temperature.

A tabulation of the characteristics of twin power triodes useful in the described applications are shown in Table I.

REFERENCES

(1) J. K. Merlis, & J. Degelman, An Improved Animal Respirator For Laboratory Use, *Science*, **144**, No. 2,974, 1951.
(2) J. Degelman, Phototube Operated Trigger Circuit, ELECTRONICS, p. 134, Jan. 1948.
(2) J. Degelman, Phototube operated Nichol, D. Sayre and F. C. Williams, "Waveforms," Rad. Lab. Series, **19**, McGraw-Hill Co., New York, N. Y., 1949.

Electro-optical Amplifier

IN CONJUNCTION with a photoconductor, an electroluminescent cell can be used as an electrical power amplifier and also as a bistable trigger device. Such a device has

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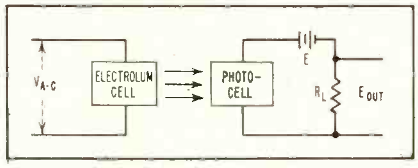
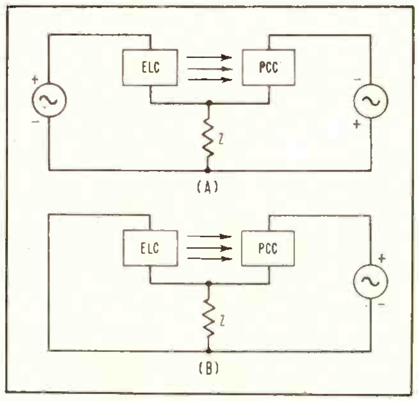


Electro-optical power amplifier



Common impedance develops regeneration (A) or bistability (B)

been used experimentally and found to have a power gain of 50 db. Frequency response of existing devices is poor.

Primary advantages of this type of trigger circuit are the inherently low cost of components and flexibility of the circuit. Triggering is accomplished by mechanical, electrical or optical means. Output can be either optical or electrical.

In the experimental circuit, the electroluminescent cell used a-c responsive copper-activated zinc sulfide. The photocell employed cadmium sulfide, thus putting the spectral response at peaks in the green region.

Power gain was increased by the use of regeneration, achieved through use of a suitably phased a-c source and a common impedance illustrated. Proper choice of the common impedance and the voltage sources produces a bistable circuit.

This information has been furnished by General Electric Co., Syracuse, N. Y.

Transistor Beta Tester

By John D. Harmer

Raytheon Manufacturing Co.
Waltham, Mass.

COMPACT instrumentation used in conjunction with an oscilloscope with d-c amplifiers makes it possible to trace out the beta-curve (relationship between base current

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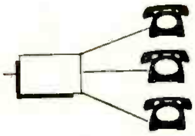
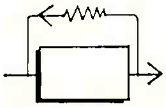
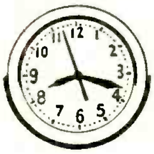
Electronic amplifier. First high-vacuum electronic amplifier. Made possible long distance telephony and then opened the way to radio broadcasting.



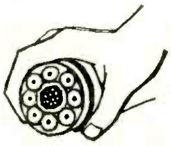
Wave filter. Precisely separates bands of frequencies. Provided major key to economical sharing of the same wires by many voices or radio programs. Indispensable control tool in radio, television and radar.



Negative feedback amplifier. Provides distortionless and stable amplification. Made possible the enormous, precisely controlled amplification needed in long distance telephone calls. The principle is now basic in high-quality amplifiers for radio, TV and high-fidelity reproduction.



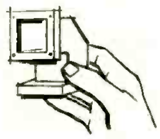
Quartz crystal. Standard super-accurate quartz crystal oscillator developed for frequency controls in radio telephony. Has also become the standard control for clocks in world's astronomical laboratories.



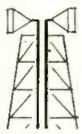
Coaxial cable system. Hollow tube with a central conductor was developed to transmit hundreds of voices simultaneously. Now also provides long distance carrier for TV in partnership with microwave beams.

Transistor. Tiny solid-state device uses extremely small amounts of power to amplify signals. Makes possible electronic telephone switching and much smaller hearing aids, radios, TV sets and electronic computers.

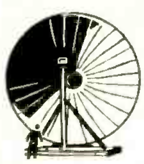
Dial system "brain and memory." Takes over your call and sees that you are connected in the best and quickest way. Newest example: Direct Distance Dialing from home telephones to any part of the nation.



Waveguide. Hollow conductor transmits high-frequency waves. From this came the "pipe" circuits that are essential to radar and very short-wave radio communications.



Microwaves. Bell Laboratories developed long distance microwave transmission. It operates by focusing radio beams from station to station, carries cross-country telephony and TV.



Radio astronomy. This great new science began in the study of radio interference at Bell Laboratories . . . with the tremendous discovery that radio waves emanate from the stars.

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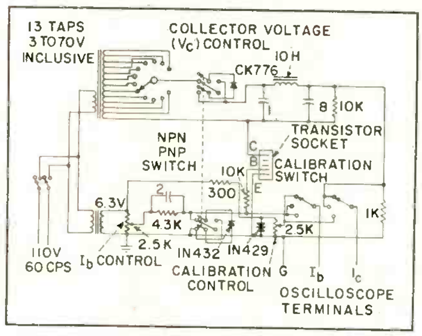
i_b and collector current i_c) of any junction transistor. The instrument operates from a 60-cycle supply and the curve is swept at this frequency. A single switch reverses all polarities so either *npn* or *pnp* transistors can be measured. The collector bias is adjustable in 12 steps between 2 and 60 volts. A calibration device is included that enables the scale of collector and base currents in the display to be determined.

The transistor to be tested is inserted in the subminiature socket. Terminals G, I_b and I_c are connected to the oscilloscope common and X and Y plate terminals respectively. The collector bias voltage is produced across a 10-kilohm resistor by a half-wave rectifying circuit and a smoothing filter.



Circuit diagram of the transistor beta curve tracer showing connections to be made to a cro

This voltage is adjusted by switching to various taps on the transformer secondary. Collector current circulates through a 1,000-ohm resistor to ground and from there through the emitter to the collector and back to the power supply. The voltage across the 1,000-ohm resistor indicates instantaneous collector current.

The transistor base is fed via a 10-kilohm resistor from a 2.5-kilohm potentiometer across a 6.3-v transformer secondary. Ideally, the base current should sweep from zero to a maximum and then back to zero only, without reversal of polarity, as transistor action occurs only in one current direction.

An automatic d-c biasing circuit is therefore included in the base supply, which comprises a 4.3-

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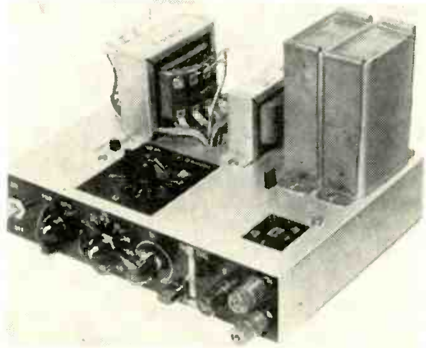


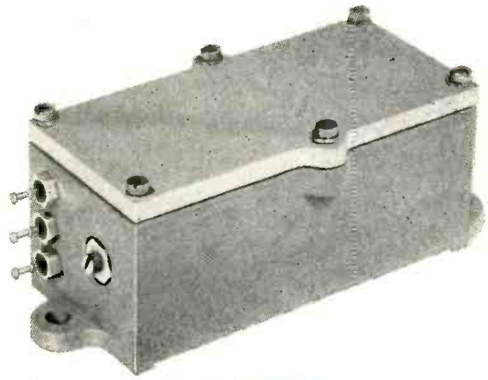
Photograph of the curve tracer shows layout of parts

kilohm resistor shunted by a 2-μf smoothing capacitor in series with the base current supply, and followed by a 1N432 shunt-rectifying diode. The required polarity of this diode and of the collector supply rectifying diode depends upon whether the transistor is *npn* or *pnp*. A four-pole two-position reversing switch is set according to the type of transistor to be tested.

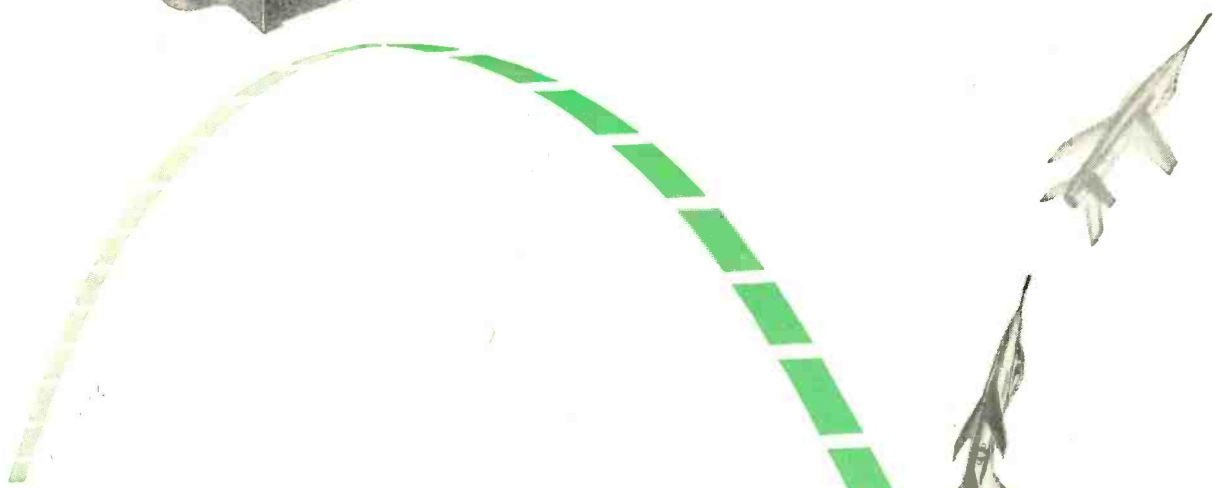
Setting of the 2.5-kilohm potentiometer controls the amplitude of swing of the bias current. The voltage across the 10,000-ohm resistor and base-emitter resistance of the transistor indicates instantaneous base current.

▶**Calibration**—A calibration switch is so arranged that the terminals leading to the oscilloscope are normally connected to the 1,000-ohm resistor in the collector circuit and the 10,000-ohm resistor in the base circuit. The oscilloscope spot then traces out the $i_c - i_b$ curve. When the switch is depressed and calibration control is set to zero, the I_c terminal is connected to ground. The oscilloscope spot then traces out the X-axis. When the switch is raised, I_b is connected to ground and the spot traces out the Y-axis.

A reference voltage for calibration is produced across a symmetrical type 1N429 Zener diode by applying a 6.3-v sine wave to it through a 300-ohm resistor. The diode limits at plus and minus 6 volts, so a squared sine wave appears across it having a regulated amplitude of 12 volts. This voltage is applied across a 2.5-kilohm potentiometer that feeds to the calibration switch. The potentiometer is scaled for both I_c and I_b. When



A line of accelerometers has been announced by the Components Division of Fairchild Controls Corporation. The unit shown—designated Type 940—is now being built for a toss bombing control system for the U.S. Air Force. These accelerometers have been developed with the same exceptional accuracy and reliability found in the complete Fairchild line of precision components: pressure transducers; linear and non-linear, single and multi-turn potentiometers; FilmPots® and trimmers.



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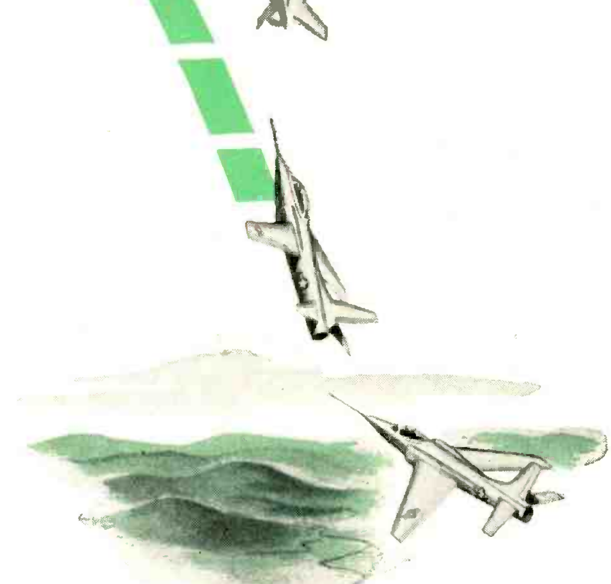

Fairchild's new line of accelerometers will accurately measure a wide range of static or uniformly-varying types of acceleration. Applications include flight testing, air-borne telemetering and computing, and measurement of maneuvering accelerations of missiles and aircraft. Variations of conformation, G-range, natural frequency and damping can be developed to meet special customer requirements. Damping is accomplished by the viscous shear action of the mass in an oil medium.

Over-all accuracy, including linearity, hysteresis and repeatability, is better than 1.5%. The Type 940 (shown above) will operate under ambient temperatures of –55°C to 100°C and will withstand vibration in the order of 10-55cps .030″ double amplitude and 55-500cps at 5G in each of the three axes. Whatever your precision component requirements, whether potentiometers, pressure transducers or accelerometers, you can rely on Fairchild's complete line and advanced engineering for the best answer. For information, write to: Dept. 140-87A, Fairchild Controls Corporation, Components Division.

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the calibration switch is depressed or raised and the calibration control is set to other than zero, the X or Y axis line appearing on the oscilloscope is broadened into a cyclic trace, the vertical or horizontal limits of which are displaced by precisely the amounts indicated on the calibration control.

The curve tracer in its present compact form is useful for comparing the current gain factors of different transistors or of various transistors in a batch of the same type. The change of current gain with operating point is immediately observable. The a-c value for β is the slope of the tangent to the trace, while the d-c value for β is determined from the co-ordinates of the trace point with respect to the origin.

Provided only curve shape is required, and fixing of the origin is not required, an oscilloscope with a-c amplifiers can be used.

Absolute accuracy of the calibration can be no better than 10 percent. Input resistances to the transistor base will vary with operating point and between transistors and comprise an unknown resistance (in the order of 1,500 ohms) in series with the 10-kilohm resistance upon which the current calibration is dependent. The resulting error will be greatest at very low values of I_b.

The stability factor of the testing circuit is not low and was designed this way for simplicity. For this reason it can be expected that the value of I_{co} will be augmented β times in its effect upon collector current. This effect is not likely to cause instability in the transistor except at extremely high operating powers or in high ambient temperatures.

Pulse Attenuators for CRO Displays

By H. Bruce McFarlane

*Radiation Laboratory
University of California
Livermore, Calif.*

SIGNALS of wide voltage range and high frequency require development of a new technique of pulse measurement. It is desired to obtain

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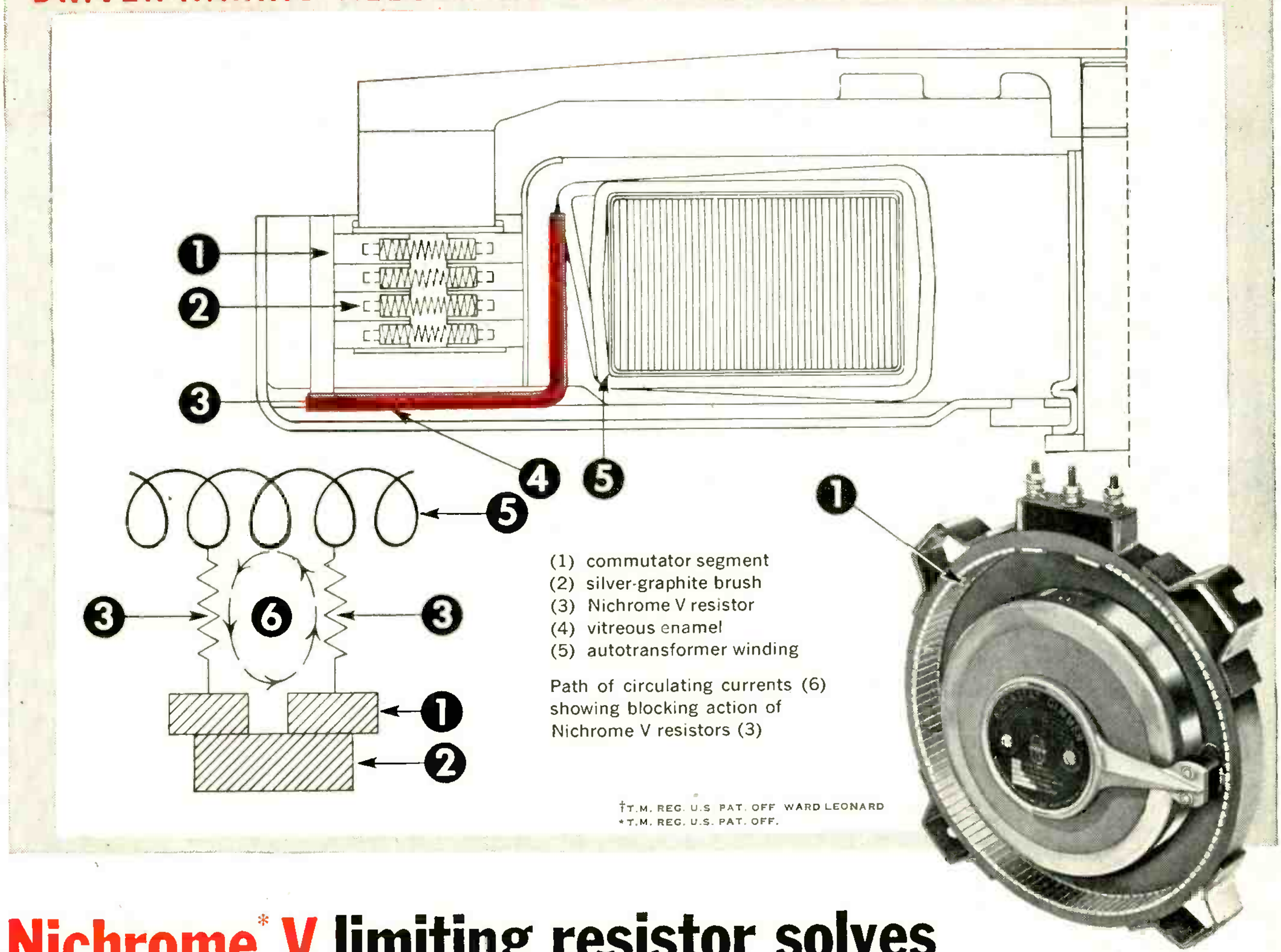

Nichrome* V limiting resistor solves age old brush problem in Ward Leonard Dimmers

This Ward Leonard 6.6 KW Radiastat† Dimmer is essentially a specially designed core type autotransformer whose output voltage is linear, furnishing smooth, stepless control from maximum to zero. Other notable features are: Highest rating in smallest size and longer, maintenance-free life.

Nearly all adjustable autotransformers depend upon carbon brushes to limit the short-circuiting current which occurs whenever the brush straddles two segments. However, in the Radiastat Dimmer, circulating currents are kept to a minimum in a unique way, permitting use of self-cleaning, self-lubricating, low resistance silver-graphite brushes.

In the Radiastat, each segment is electrically connected to its respective turn of the winding through a Nichrome V current limiting resistor. During commutation, the main winding is protected against burnout from high short-circuiting currents, thereby eliminating external resistors or high resistance brushes.

These all important resistors (one for each segment) connect to the segments beneath the vitreous enamel and run out and up to connect with the winding. They protect every step of the Radiastat, regardless of the contact arm position—drop a penny or a nail across adjacent segments—there's no pouff! no burnout! The Nichrome V circulating current resistors completely safeguard the unit.

Nichrome V is used because it supplies a specified ohmage in a #10 wire 3$\frac{5}{16}$" long; bonds well with the vitreous enamel; is highly resistant to heat and corrosion, and easily withstands severe current surges.

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MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES information from a single pulse in regions from 10^{-4} to 10^{3} volts by means of cathode-ray tube displays. The signal-level range in which a cathode-ray tube can satisfactorily operate is from 5 to 100 volts. It is evident that a large number of presentations would be necessary to display the signal over such a wide dynamic range. To reduce the number of oscilloscopes, tests were made to determine if a nonlinear attenuator could be built that would attenuate the high voltages more than the low voltages, thereby essentially compressing the signal.

This report deals with the design and performance of a termination,

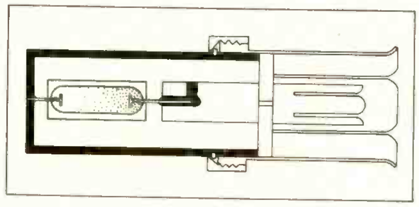


FIG. 1—Coaxial terminating resistor

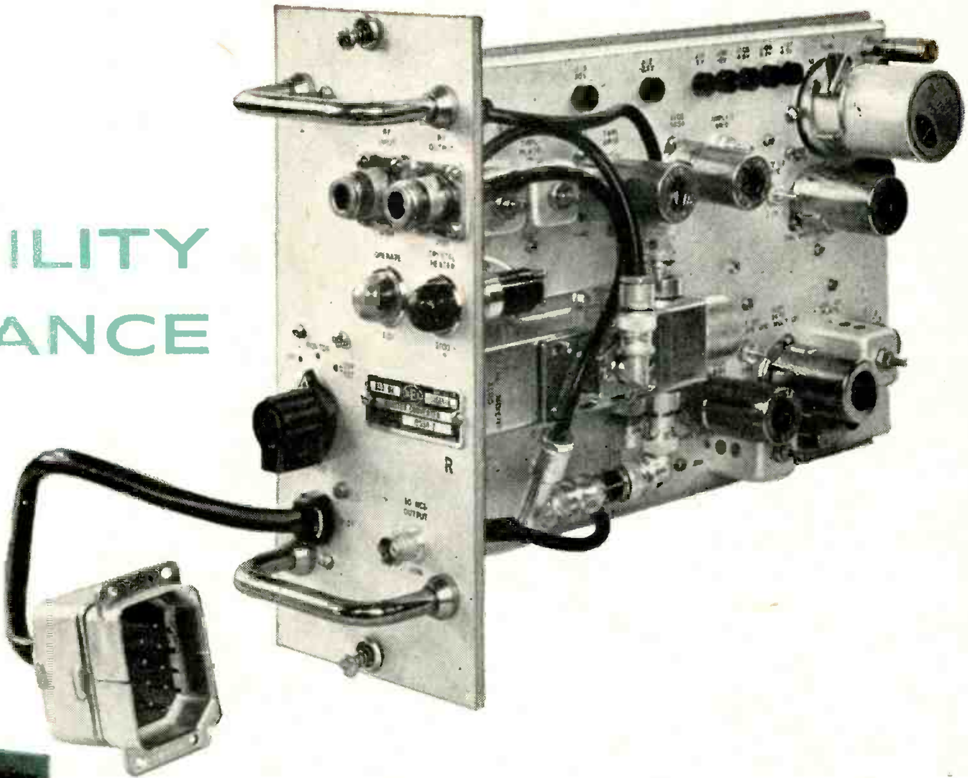
a linear attenuator and a nonlinear attenuator.

A terminating resistor for pulse lines must be capable of withstanding repeated application of pulses having amplitudes of 1,000 volts and durations of 1 μsec, without change in its electrical characteristics.

The impedance should be a nominal 50 ohms. The vswr should not exceed 1.04 from d-c to 300 megacycles. The length of the termination should be no more than 3 inches and its diameter not more than 1 inch.

Film-type resistors, although good from a frequency standpoint, will not stand the high pulse voltage. The Allen-Bradley 2-watt molded-carbon resistor has been used in the past without any special geometry of shielding and is able to hold voltage. The General Radio type 874 coaxial connector was used because of its ease of connection, the fact that it is a hermaphroditic connector and because of a vswr of less than 1.01 up to 1,000 mc. Figure 1 shows a cross-sectional drawing of the termination.

Considerable difficulty has been experienced in soldering molded-



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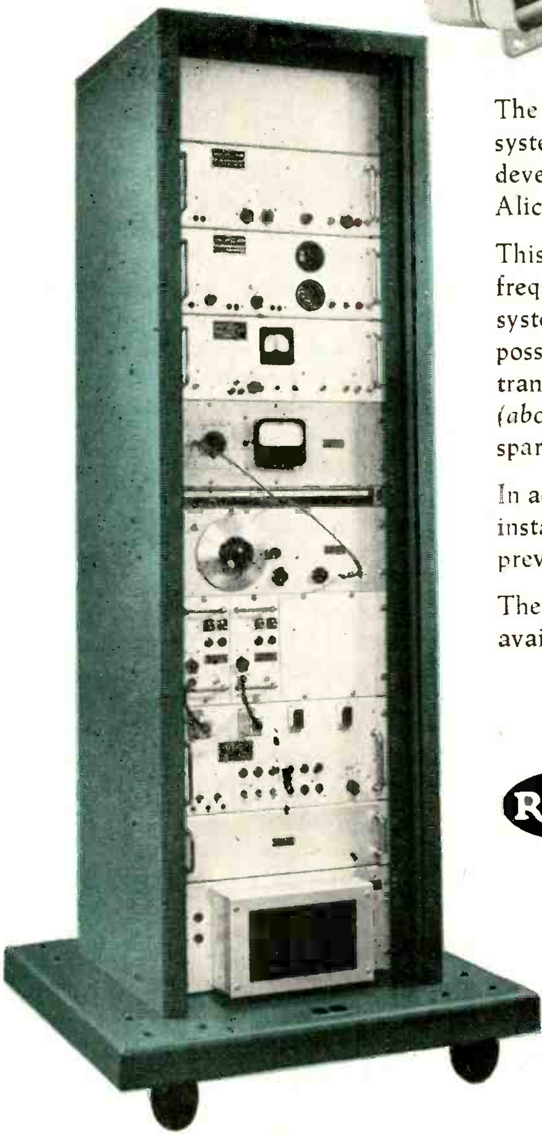

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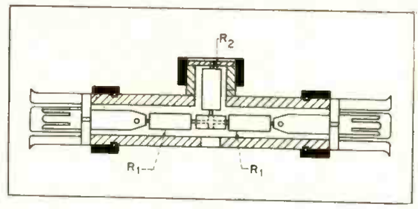


FIG. 2—Housing for linear attenuator

carbon resistors with short leads. Empirical data on the behavior of these resistors with temperature changes has been difficult to compile because of erratic behavior. In general, however, it can be stated that molded-carbon resistors of the type used are characterized by a resistance change with change in temperature as follows:

(1) As the temperature is increased the resistance increases.

(2) As temperature increase is halted resistance increase halts.

(3) As temperature is decreased to initial value, resistance decreases to a value that is higher than the initial value of the resistance.

(4) Further increases in temperature that do not exceed the previous highest temperature reached by the resistor (as in (2)), allow the resistance upon cooling to return to the value noted in (3).

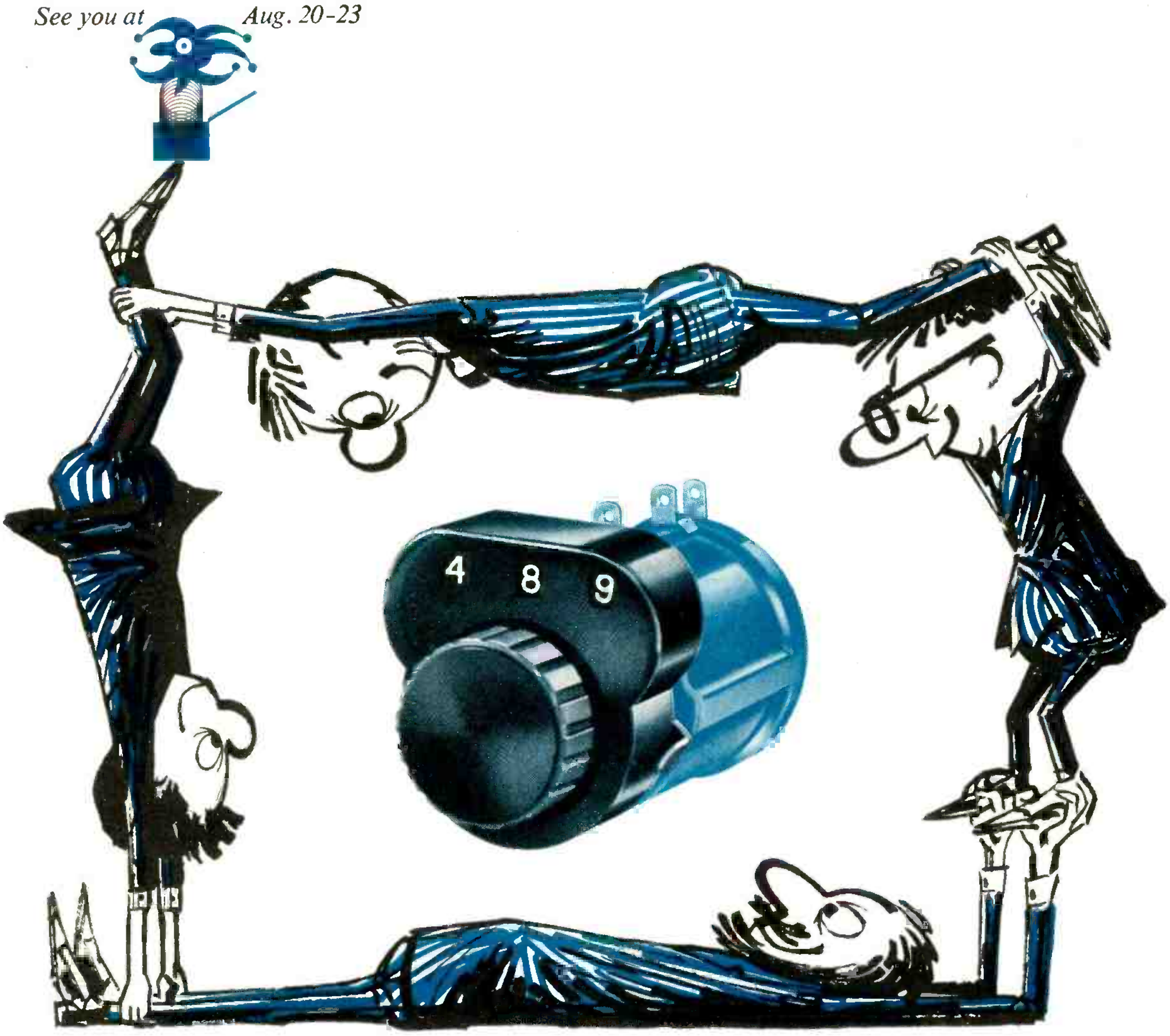
(5) Further temperature rises, wherein the temperature exceeds the previous highest value reached in (2), cause the resistance upon cooling to be greater than that in (3).

Exceptions to the above have been noted in that an occasional resistor will display erratic changes of resistance with increase in temperature. It has been possible to utilize this behavior of molded-carbon resistors in the construction of all three devices mentioned in this report. Inasmuch as leads on the resistors, if left long, contribute an excessive amount of inductance to the devices, it has been found necessary to curtail the length of the leads to somewhere in the neighborhood of 0.1 inch.

To ascertain that the resistors which are to be soldered into the termination do not fall outside the tolerances established, it is necessary to specify to the supplier that the resistors come from the 0.95 to 0.99 sides of the nominal 47-ohm range. Upon heating as they are

Wescon

See you at *Aug. 20-23*



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soldered into place, they usually fall within the 48- to 52-ohm limit required.

The linear attenuator must attenuate pulses having an amplitude of 1,000 volts and durations of 1 μsec and input impedance should be 50 ohms when the attenuator is terminated in 50 ohms. Size should not exceed 1 in. diameter by 6 in. in length.

The 50-ohm attenuator is made using the same type of molded-carbon resistor. The electrical circuit used is that of a balanced tee attenuator. For accurate calibration, however, the attenuator is marked as input on one end and tested to determine its exact attenuation.

It can be shown that the values of resistors required in the two arms and the leg of a tee attenuator are represented by the following formulas:

$$R_1 = Z_0 \frac{K-1}{K+1} \qquad R_2 = Z_0 \frac{2K}{K^2-1}$$

where

$$K = \frac{\text{current in load resistor without attenuator}}{\text{current in load resistor with attenuator}}$$

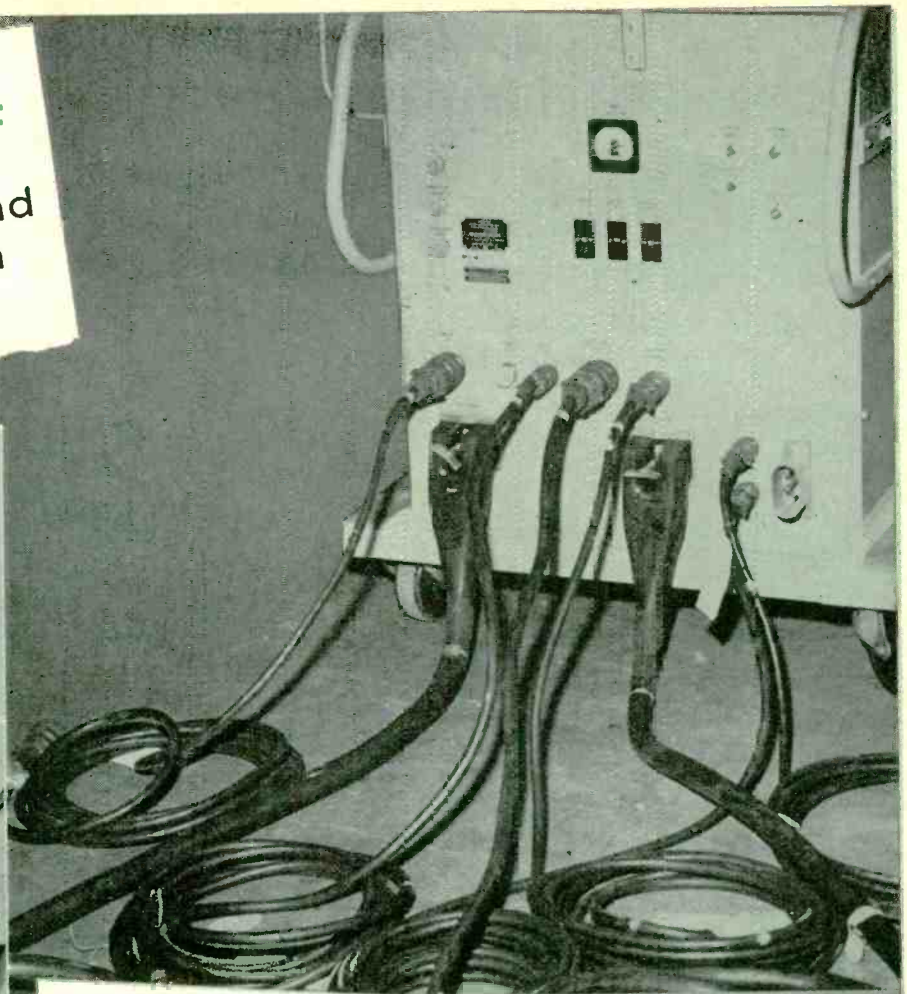
Z_0 = characteristic impedance of line
R_1 = resistance of each of the two arms of the tee
R_2 = resistance of leg of the tee

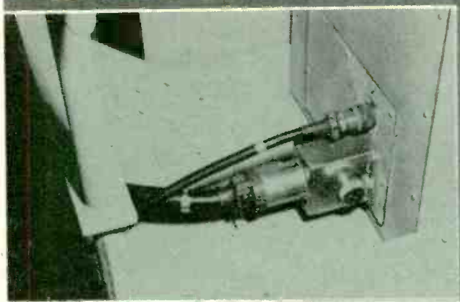
Table I shows the theoretical resistance values required for the attenuators as well as the nominal 5 percent resistor values actually used. These resistance values are automatically adjusted by the heat used in soldering them into place.

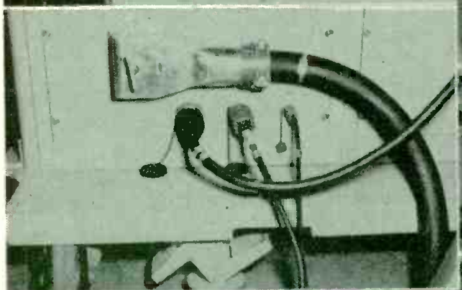
Measurements of Z and θ were made on a vhf bridge with the attenuator terminated in 50 ohms. Using the bridge measurements as a guide, attenuator housings having a variety of configurations were constructed and tested. A cross section of the housing having the most favorable characteristics is shown in Fig. 2. Field tests have

Table 1. Resistance when Z_0 is 50 ohms

Approximate attenuation in db		Ultimate value after heating		Nominal value	Nominal value
	K	R_1	R_2	R_1	R_2
10	3	25	37	24	26
14	5	33	21	33	20
20	10	41	10	39	10







shown that these attenuators are rugged and stand up well under both severe mechanical and severe electrical usage. For reliable operation, the average power dissipation should not exceed 1 watt.

The nonlinear attenuator must show attenuation to a 1,000-volt signal of 20 db, while attenuation to a 10-volt signal should be approximately 6 db. The attenuator should pass signals having a rise time of 10^{-8} seconds and attenuation should be the same for signals of opposite polarity. Input impedance with 1,000 volts input should be 50 ohms.

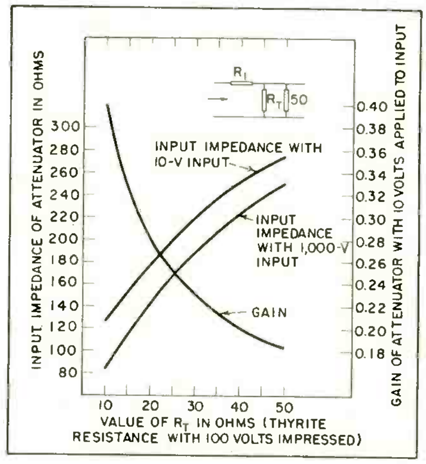


FIG. 3—Thyrite characteristics under varying conditions

Initial experiments on a suitable nonlinear material to be used centered around silicon carbide marketed by the General Electric Company under the trade name of Thyrite. This material is sold in various cylindrical sizes. The type ultimately chosen has a diameter of 0.5 inch and a thickness of approximately 0.06 inch. Thyrite has a negative resistance characteristic. Its resistance can be expressed by the following relation:

$$R_t = \frac{1}{K E^n}$$

where
R_t = resistance of Thyrite at voltage E
E = applied voltage
K = a constant (amperes at one volt)
n = an exponent

The values of both K and n depend upon the dimensions and resistivity of the material used in the particular resistor in question. No two samples of Thyrite have identi-

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These diodes make possible advanced, higher speed circuits in which recovery from a forward pulse must be achieved in a minimum of time. Their low forward voltage drop combined with the fast recovery make them ideal for transistorized computer circuits and similar applications.

SPECIFICATIONS AT 25° C

Type	Forward Voltage Drop @ 10mA	Maximum Reverse Current @ −50V	WIV	Forward Current @ +1V
HD-2762	0.80V	50μA	80V	20mA
HD-2763	0.80V	100μA	80V	20mA
HD-2764	0.67V	50μA	80V	50mA
HD-2765	0.67V	100μA	80V	50mA

All types recover to 100 Kohms in 1 μsec when switched from 30 mA forward to −35V reverse in the modified IBM "Y" test circuit.

If you plan to be in San Francisco for the Wescon show, please visit our booths (#2910-11 and #2912-13). Perhaps we can discuss the new diodes there and determine how to use them most effectively in your circuits. Or, if you prefer, ask for a visit from one of our sales engineers. Please write:

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cal characteristics although all resistors of a given classification fall within a specified range. Both K and n vary from sample to sample.

Assuming a simple L-type attenuator, it can be seen that the nonlinear element must fall in the shunt-leg rather than in the series leg to produce the desired characteristics. Since it is required that the upper limit of output voltage be 100 volts, the Thyrite resistors are measured at this voltage.

Dissipation in the Thyrite resistor will exceed the continuous power rating of 0.1 watt if direct current is applied.

Actual measurements with a simple pulser showed that most samples were within the range of from 10 to 50 ohms with 100 volts applied. A simple attenuator consists of a series resistor leg and a shunt Thyrite leg. The output is shunted by the 50-ohm transmission line or terminating resistor. The three curves of Fig. 3 show the Thyrite resistance with 100 volts applied versus: gain of attenuator with 10 volts input, input impedance with 10 volts input and input impedance with 1,000 volts input.

The curves show that even if all the Thyrite units are selected in

Ultrasonic Surgery

Transducer heads for ultrasonic unit being perfected for brain surgery are inspected by William J. Fry of the bioacoustics laboratory at the University of Illinois. Conditions previously considered inoperable can be treated by focussed ultrasonic beams

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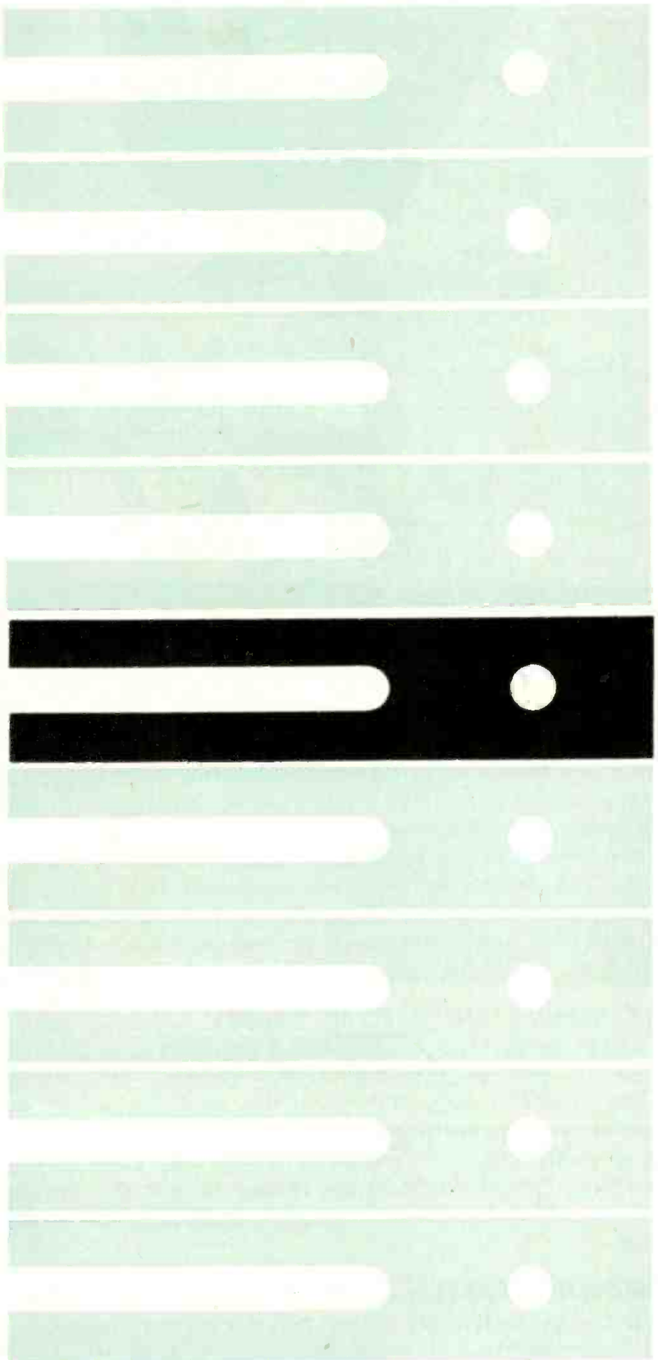

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the range of 10 ohms, the attenuator still has a wide range of input impedance (83 to 125 ohms). Also, the output at 10 volts input is down 8 decibels.

An attenuator with better characteristics can be built if two stages are used instead of one. Since the mismatch criterion is actual volts reflected into the system rather than vswr at any particular voltage, it is evident that a better matching characteristic is desirable with 1,000 volts applied than with 10 volts applied.

The development work on the coaxial linear attenuator was done in collaboration with R. H. Rector. This work was performed under the auspices of the U. S. Atomic Energy Commission.

Determining Grounded-Grid Operation

By Frank Agresti

Applications Engineer
Amperex Electronic Corp.
Hicksville, N. Y.

Equipment designers are often required to determine grounded-grid operating conditions for which the method of calculation is not described in the popular reference books.

A simple method of making the necessary calculations is described here. The determination is easily made from any set of the usual grounded-filament typical operating conditions and the characteristic curves published by the manufacturer.

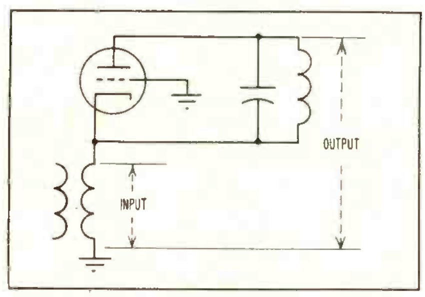

FIG. 1—Basic grounded-grid circuit

This method may also be used to determine the grounded-grid con-

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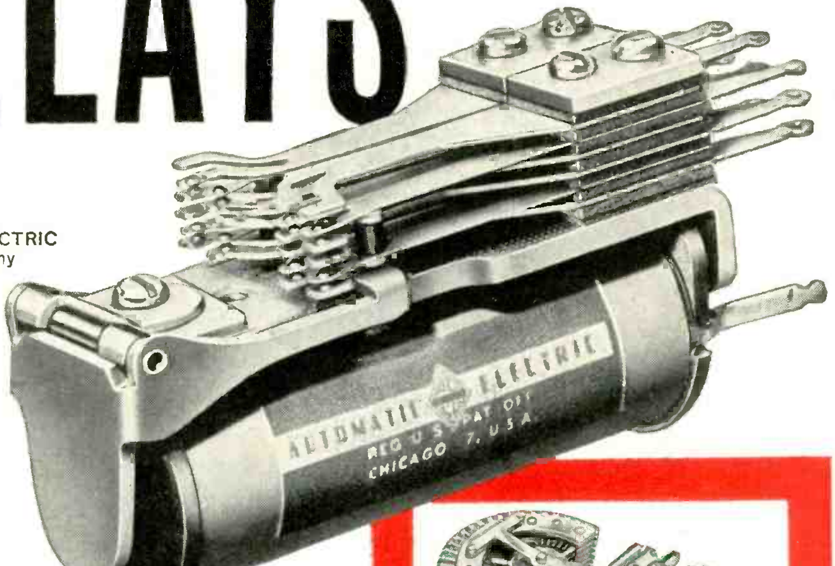

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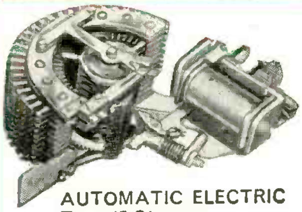

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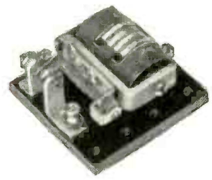

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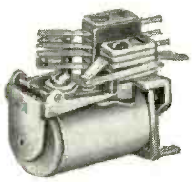

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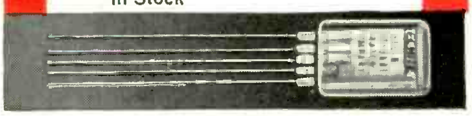

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Table I—Values of *K* For Plate Angle

Angle of flow in degrees	Multiplying factor K
90	6.10
100	5.50
110	5.00
120	4.60
130	4.25
140	4.00
150	3.75
160	3.50
170	3.32
180	3.14

ditions whenever grounded-filament conditions are calculated by any of the standard methods.

The following typical constant-current characteristic curves, together with the associated grounded-filament operating data, were selected from a tube handbook as an example.

The tube used is a type 5868 as r-f power amplifier or oscillator in class-C telegraphy. Typical operation in grounded-filament circuits is shown below. The values shown are for continuous commercial service (CCS).

frequency	100 mc
d-c plate voltage	4,000 v
d-c grid voltage	−350 v
peak r-f grid voltage	580 v
d-c plate current	535 ma
d-c grid current (approx)	115 ma
driving power	60 w
power input	2,140 w
power output (approx)	1,690 w
plate dissipation	450 w

The following steps are used to determine the grounded-grid operating conditions from the above data:

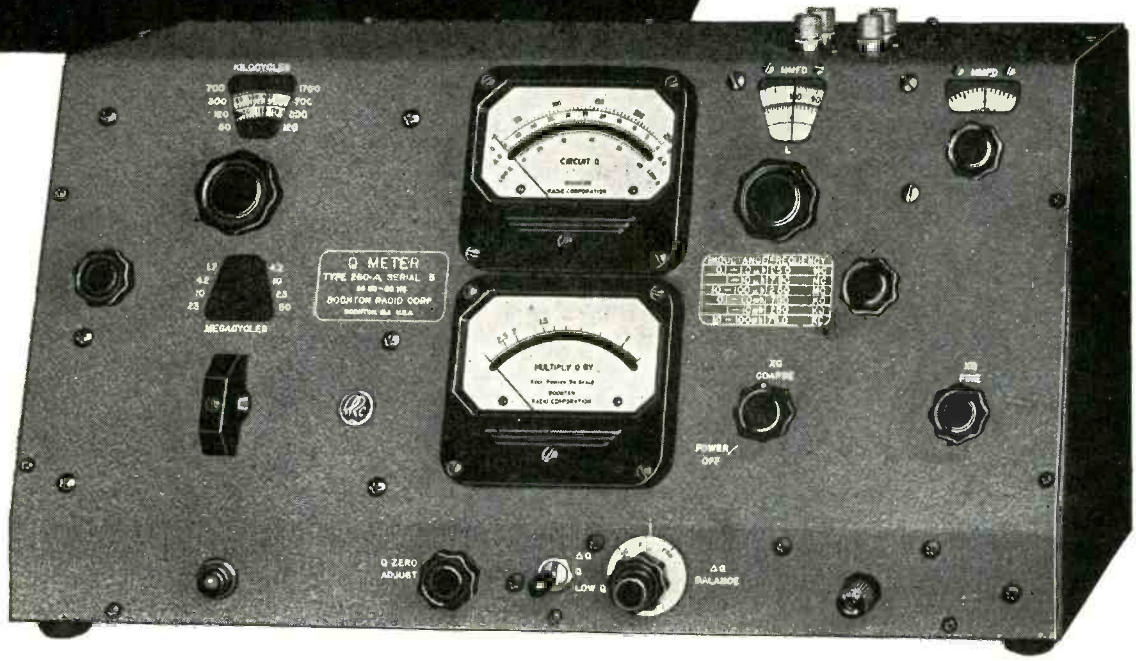
(1.) Construct the load line AB on the constant current curve. Locate point A from operating conditions. Locate B from operating conditions.
(2.) Determine the total r-f plate voltage swing ($a'A$).
(3.) Determine the total r-f grid voltage swing ($a'B$).
(4.) Calculate the power output for grounded-grid operation.

$$\text{Power output} = \frac{a'A + a'B}{a'A} \times$$

grounded-filament power output

(5.) Determine the drive power for grounded-grid operation.
Drive power = drive power grounded-

"FIGURE OF MERIT" MEASUREMENTS



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SPECIFICATIONS

FREQUENCY RANGE: 50 Kc to 50 Mc continuously variable in eight ranges.

FREQUENCY ACCURACY: Approx. ± 1%.

RANGE OF Q MEASUREMENTS: 10 to 625

RANGE OF DIFFERENCE Q MEASUREMENTS: 0 to 125.

INTERNAL RESONATING CAPACITANCE RANGE:
MAIN TUNING DIAL: 30 to 450 mmf. (direct reading) calibrated in 1.0 mmf. increments from 30 to 100 mmf: 5.0 mmf. increments from 100 to 450 mmf.
VERNIER: –3.0 to +3.0 mmf. (direct reading) calibrated to 0.1 mmf. increments.

ACCURACY OF RESONATING CAPACITOR:
MAIN TUNING DIAL: Approximately ± 1% or 1.0 mmf, whichever is the greater.
VERNIER: ± 0.1 mmf.

PRICE: $775.00 F. O. B. Factory

filament + difference between power output for grounded-grid and grounded-filament operation.

For example, refer to the typical operating conditions and constant-current curves for the type 5868/AX9902 triode.

(1.) Locate point A ($E_b = 4{,}000$, $E_c = -350$) and point B
Peak plate current is determined by multiplying average d-c plate current by the proper factor, K. For class-C operation use a factor of 4 and for class-B and class-AB operation a factor of 3.14.
$i_{b\max} = I_b \times K = 0.535 \times 4 = 2.14$ a
$e_{c\max} = E_g + E_c = 580 - 350 = +230$ v
point B ($i_{b\max} = 2.14$, $e_{c\max} = +230$)
(2.) $a'A = 4{,}000 - 300 = 3{,}700$ volts
(3.) $a'B = 580$ volts
(4.) Grounded-grid power output =

$$\frac{3{,}700 + 580}{3{,}700} \times 1{,}690 = 1{,}950 \text{ w}$$

(5.) Grounded-grid drive power = $60 + (1{,}950 - 1{,}690) = 320$ w

The typical operating conditions for grounded-grid are: driving power approximately 320 w, power output approximately 1,950 w.

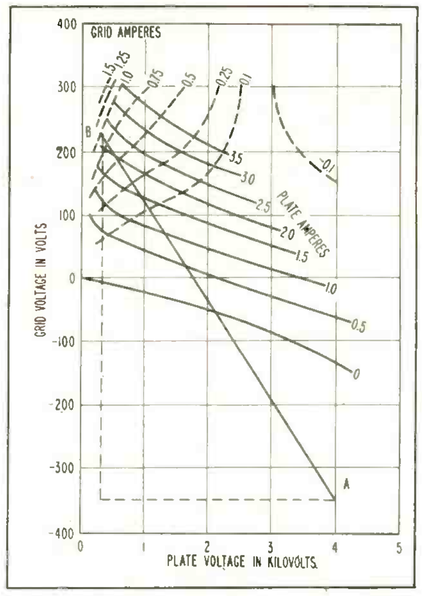

FIG. 2—Constant-current characteristics of type 5868 tube

All other conditions are the same as for grounded-filament operation.

The results are approximate since they depend on the accuracy of the grounded-filament data. They also do not provide for the greater circuit and tube losses inherent at the higher frequencies used in grounded-grid operation.

The method outlined above assumes an angle of plate current flow of 140 deg for class-C operation and 180 deg for class-B and

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class-AB operation. For other angles of plate current flow the factor K must be adjusted as shown in the table.

Large Shielded Enclosure

BY RICHARD J. COSTELLO and BRYCE D. MCMICHAEL
General Laboratories Dept.
Bell Aircraft Corp.
Buffalo, N. Y.

A LARGE shielded room, 40 ft long by 35 feet wide by 18 ft high, has been designed to accommodate complete aircraft and missile systems. The system is isolated within the area and sufficient electrical and hydraulic power is available to operate that system, thus checking operation for electrical noise interference.

The single-walled room is constructed of galvannealed iron panels bolted to steel channels and tensioners making up the supporting framework. The room closely approximates a standard copper shielded enclosure in design except for the materials used. The inside wall is covered with a painted wallboard.

▶ **Access** — Two personnel doors are located, one in each end and one large sliding door is set in a 40-ft wall section. This equipment door clears 16½ ft high by 21 ft wide and is supported on a track and column arrangement completely external to the room itself. The doors open in two sections. They are motor operated and air-bladder-sealed when closed.

Copper and brass have been used on all door closures to insure effective electrical contacts. The room is air-conditioned to maintain uniform temperatures during all testing operations.

Twenty-six power line entrances are provided for the enclosure, each line being filtered by Tobe-Deutsch-

Table I — Attenuation of Large Shielded Enclosure

Frequency	Attenuation in db	Type Filed
150 kc	71	Magnetic
200 kc	106+	Electric
1.0 mc	106+	Electric
18.0 mc	104	Electric
400 mc	84	Plane Wave

Looking through the large equipment door into the shielded room

man line filters 1650-1 and 1753. These filters were chosen because of their rated attenuation of 100 db over the frequency range from 14 kc to 15,000 mc. With these filters, the total power capacity of the room is 300 amperes at 28-v d-c and 35 kva of either 60 or 400-cycle a-c. Five hydraulic oil entrances are provided through the wall of the room to enable servo system operation of an aircraft or missile during the test.

Ace Engineering & Machine Co. designed the room and Bell Aircraft personnel together with Electro-Search, Inc. and International Electronics Engineering, Inc., conducted tests. The first test was conducted on a similarly constructed room of much smaller dimensions.

A second test was then performed upon the large room in accordance with the military specification. The results of this test are presented in Table I.

At the higher test frequencies (400 mc) no adequate and satisfactory explanation of the different results obtained for the large (84 db) and small (110 db) rooms could be found. A definite signal leakage through the large room existed, but there was no single major source for this leakage.

Owing to the 2,500 linear feet of seams in the room, there might be sufficient leakage per foot to account for the discrepancy. Ambient temperature could affect results by varying leakage and resistance of the joints between panel seams. It was noted that results varied from day to day and from season to season.

Oxidation of door-contact surfaces, or air-bladder pressure extremes might also affect leakage.

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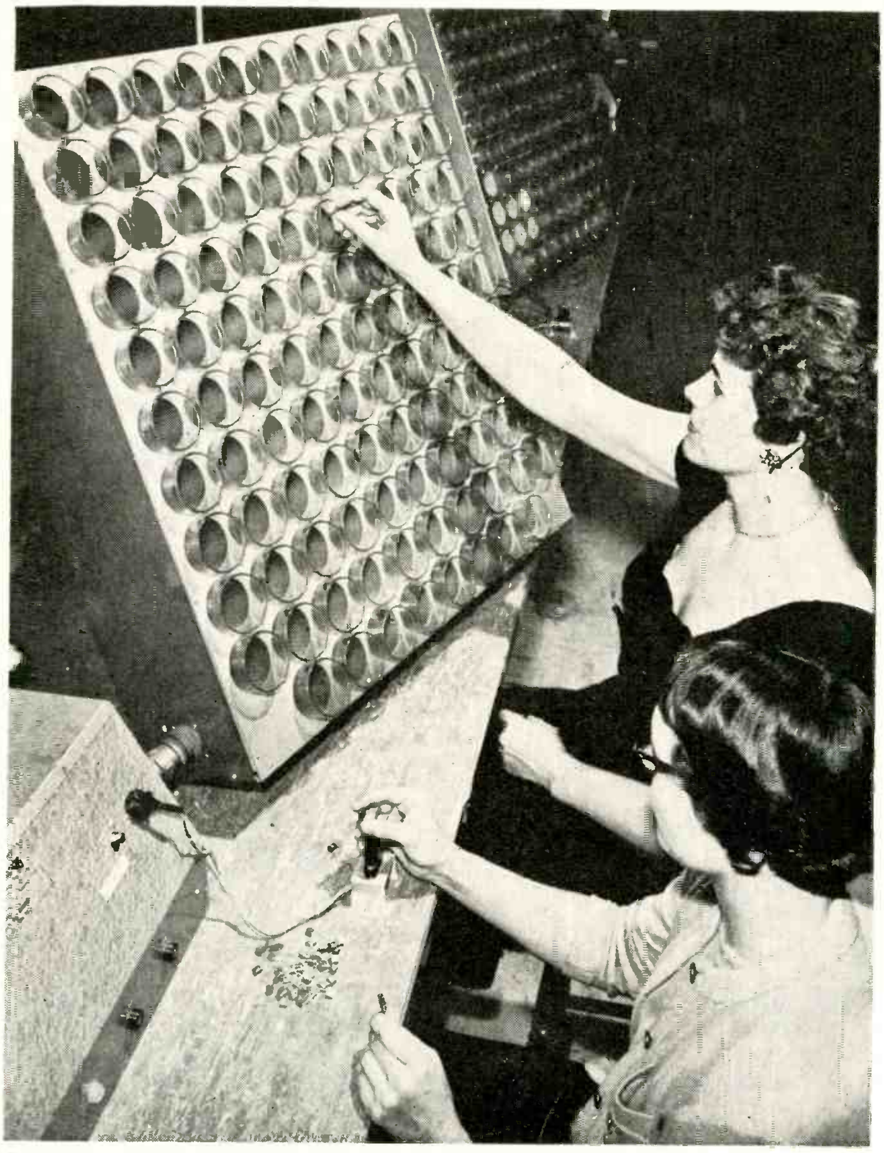
Production Techniques

Edited by JOHN MARKUS

Juke-Box Transistor Tester Lights Up Sorting Glasses



Juke-box tester for matching germanium audio transistors for use in push-pull class B operation. After checking five parameters, tester lights pilot lamp under correct plastic glass in frame, to guide operator at rear who does actual sorting

TRANSISTORS for matched audio applications are automatically given five different tests in less than one second, after which the correct sorting bin for that particular transistor is indicated by a pilot lamp, in the Dallas plant of Texas Instruments Incorporated. This permits accurate sorting into 108 different categories, for precision matching. Two of these bins are for units which do not qualify as audio devices but are still useful as small-signal general-purpose transistors.

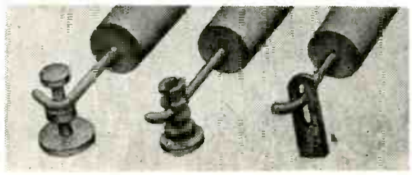
Plastic 8-ounce drinking glasses serve here as sorting bins. A clear 6-watt, 115-volt pilot lamp behind each glass creates an edge-lighting effect at the rim, to indicate clearly to the operator the correct sorting receptacle for that transistor.

Time studies showed that two operators more than doubled the number of transistors which could be measured and sorted by one operator. One loads the transistors into the test socket and removes them. The other, seated directly in front of the sorting frame, picks up the tested transistor and places it in the illuminated glass. All transistors in a given glass are perfectly matched in beta value, for use in class B push-pull operation.

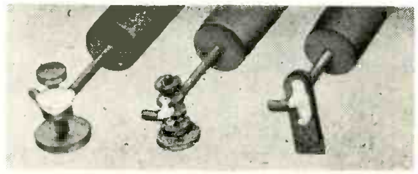
The characteristics checked are collector cutoff current with base and emitter grounded, punch-through characteristics between collector and emitter, 100-ma beta check, 50-ma beta test and 5-ma beta test.

Wrapping of Leads Cuts Quality of Soldered Joints at Terminals

WRAPPING OF LEADS around terminals prior to soldering is now an obsolete manufacturing procedure, according to J. Roy Smith of U. S. Navy Electronics Laboratory in San Diego. Those solder-soaked knotted joints are unnecessary and make parts replacement extremely difficult. Simple soldered connections are adequate and more reliable for all environments provided large parts and wiring harnesses are clamped down to prevent the relative motion which fatigues wires and causes failure.

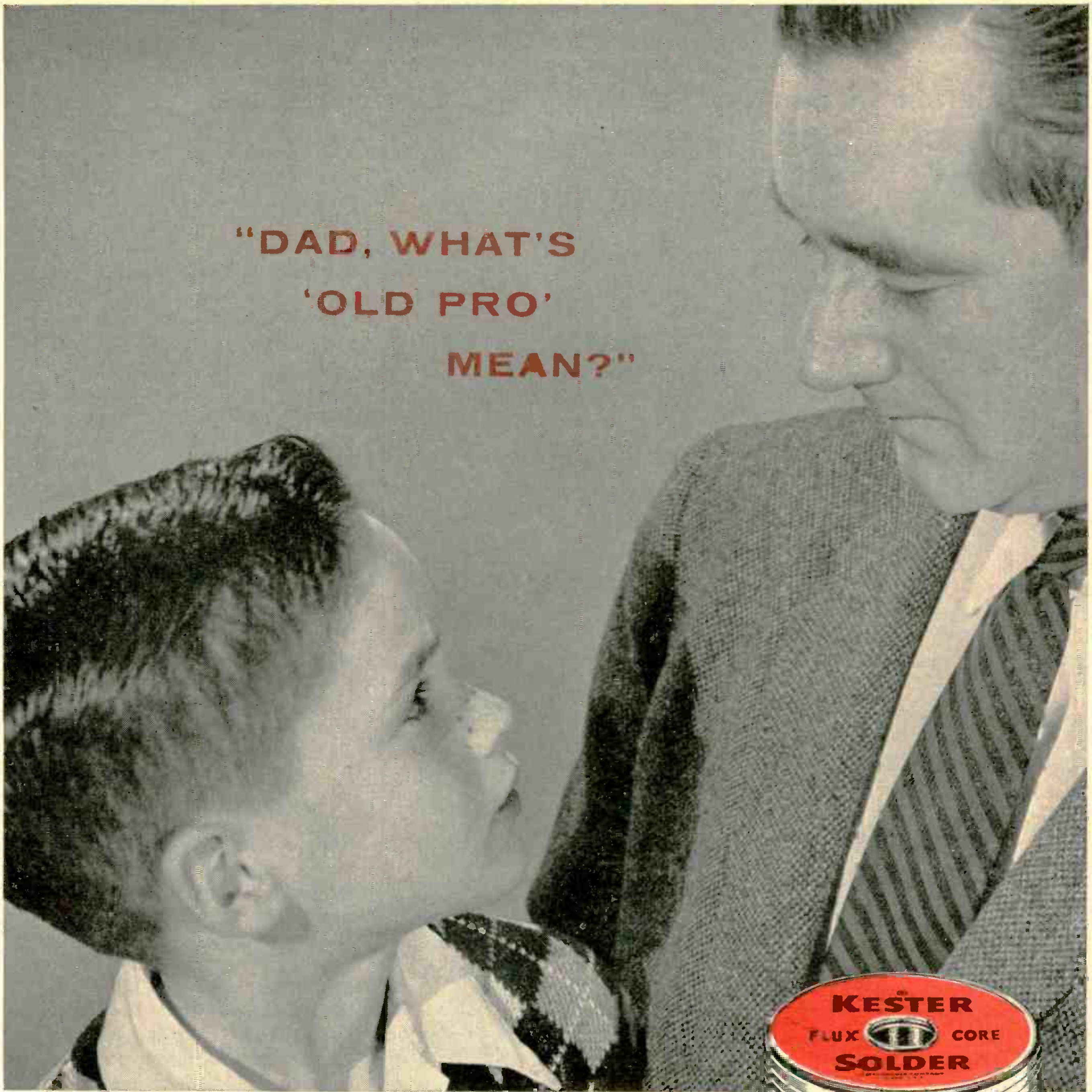


Bends of about 120 deg. as shown here, are now considered adequate



Unwrapped joints give better visibility for inspection of soldering

►**Recommended Joints**—In chassis wiring, when using stud terminals the recommended procedure is to



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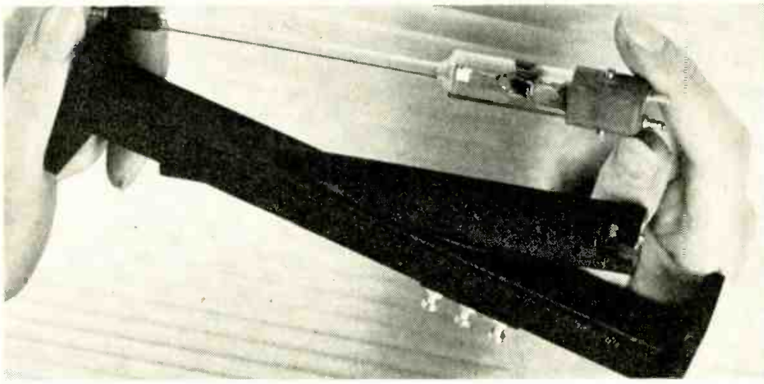
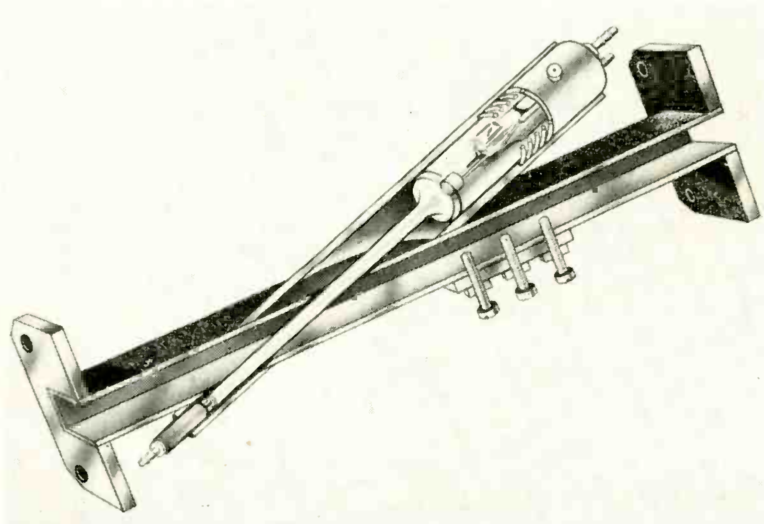
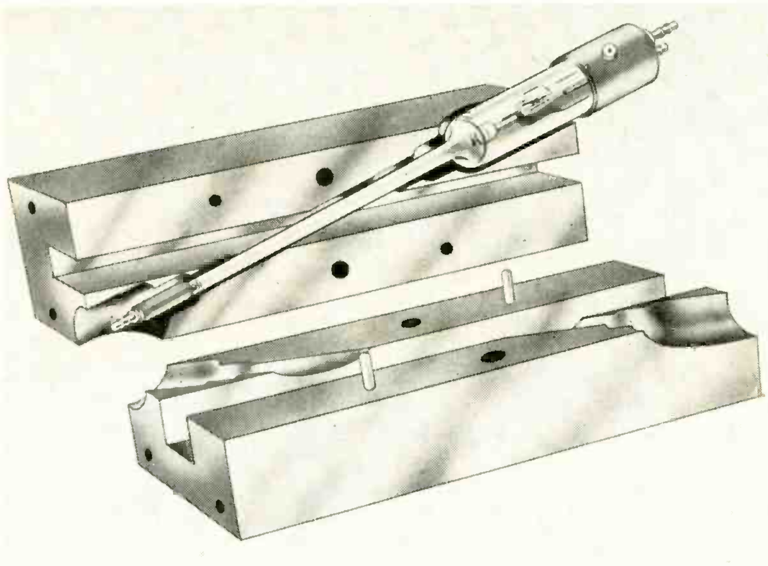
Design of the Month: NOISE TUBE







Waveguide mount only 7¾ inches long holds Ferranti TE10 X-band noise tube at 15-deg angle. Three screws enable user to tune from 8,500 mc to 10,500 mc, for generating constant noise output of 15.25 db for testing noise factor of microwave superheterodyne receivers. Alternative milled-block construction uses mated channels. Division down center lines of major dimension does not affect electrical performance yet simplifies construction, allows internal inspection of waveguide and facilitates inspection of components. Construction time is about one-third of that required to make conventional waveguide assembly. Distributed by Ferranti Electric Inc., 30 Rockefeller Plaza, New York City

bend pigtails around the terminals a little more than a right angle (say 120 degrees).

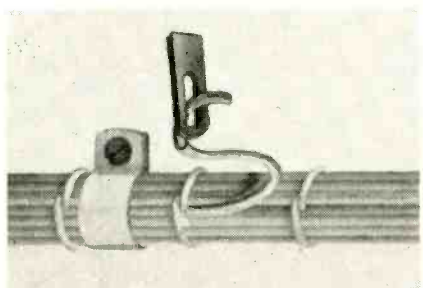
For slotted terminals the pigtails are placed in the slots and the ends of the leads bent aside to lock the part in place.

For eyelet terminals the pigtails are placed in the holes and the ends of the leads also are bent aside to prevent the part from falling out. These are hand operations without pliers. The surplus ends of the pigtails should be cut off with hand cutters, leaving about $\frac{1}{16}$ inch extension on the leads after the bend. This extension holds the part in place until soldered.

► **Harness Joints** — Connecting wires and cables in completed equipment must be clamped down at intervals to prevent fatigue under environmental motion. Cable harnesses should be clamped down before soldering. If this is done the same joints can be used as for hookup wires. However, the lead extensions should be bent in the direction of the tendency of the wire to move, to hold the wire in place until soldered.

► **Inspection**—Absence of the old multi-wrap technique before soldering leaves the terminal clear for a much closer inspection. The quality of the soldered connection is readily determined by inspection. If it can be seen that the solder has wetted the surface of both the terminal and the wire lead and that solder has flowed tangentially to form a concave fillet between the two parts, then a continuous soldered connection is assured.

► **Repair**—Replacement of parts is greatly simplified by these pro-



Cable lead should be bent in direction shown here, just enough so it cannot fall out before soldering *from* PSI . . .

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8 typical diodes in PSI's high conductance series

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		@ 100ma	@ 200ma	@ 25°C	@ 150°C	Test Voltage	@ 25°C	@ 150°C
PS 606	80	1.1		.250	30	– 70	125	50
PS 611	80		1.0	.025	5	– 70	200	100
PS 618	200	1.1		.250	30	– 180	125	50
PS 623	200		1.0	.025	5	– 180	200	100
PS 630	330	1.1		.250	50	– 300	125	50
PS 633	330		1.0	.100	25	– 300	200	100
PS 634	420	1.1		.250	50	– 380	125	50
PS 637	420		1.0	.100	25	– 380	200	100

PSI offers a complete line of high-reliability silicon products for a broad range of applications.

The High Conductance series includes 38 types consisting of useful combinations of d.c. inverse voltages, forward conductance, and inverse leakage limits. Most requirements can be filled by one of these types.

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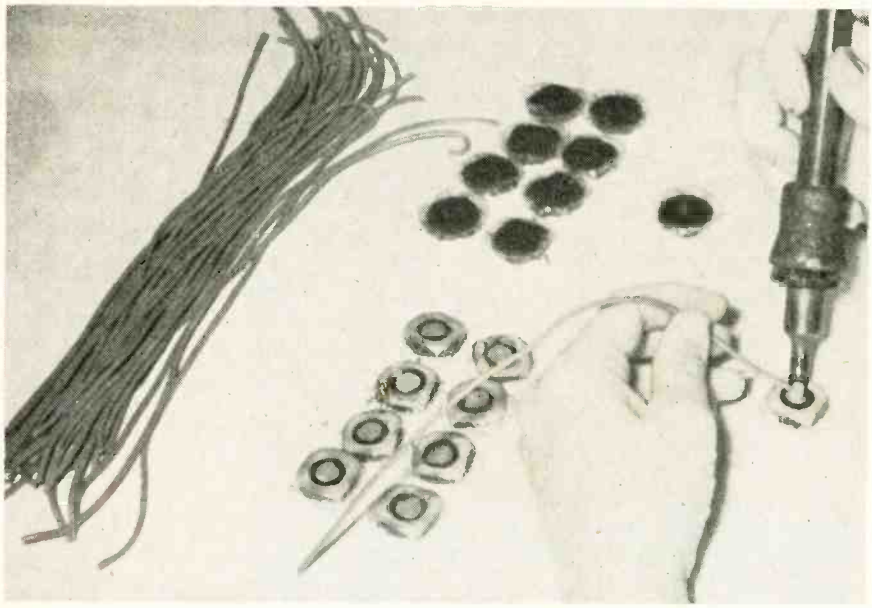
Circle 141 Readers Service Card

cedures. Damaging forces formerly applied to terminals and tube sockets when removing wrapped joints during parts replacement are eliminated. The lead extension may be merely untwisted from a stud terminal without heating the joint excessively.

Conductive Wax Makes Battery Connections



Using low-temperature pencil-type soldering iron to apply wax to zinc side of wafer cell. The wax is similarly applied to graphite side, as on cells shown at rear

SERIES CONNECTIONS between individual wafer-type cells of dry batteries are made automatically by stacking, after a new Burgess conductive wax is applied to the sides of the cells. The wax adheres to a wide variety of materials, including zinc, aluminum, magnesium, graphite and copper, making possible many other types of electrical connections as well. The new wax is available from Burgess Battery Company, Freeport, Ill.

Heating to about 170 F converts the wax to its liquid form, for easy application. At room temperature the material becomes a solid. It consists of a high-quality wax and a finely divided metallic powder such as silver, mixed in a critical ratio. If the wax content is too high, the particles of metal tend to become islands and resistance goes up. If the wax content is too low, the material looses its fluidity at high temperatures. A typical resistance value for the material is 0.005 ohm-cm, but this can be varied within rather wide limits.

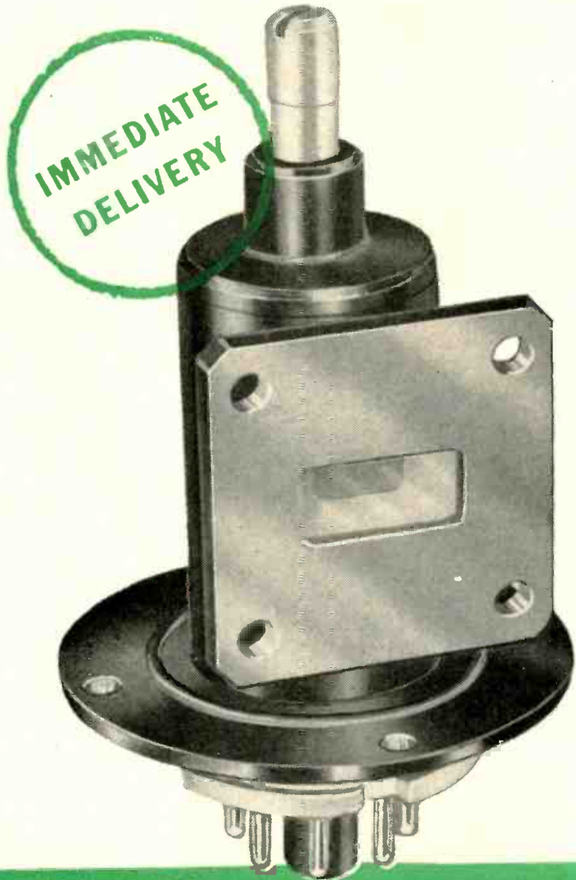
▶ **Applying Wax**— Although the wax can be readily heated in a glass beaker and poured, many other methods are possible. One method involves extruding the material at room temperature into strings about 0.1 inch in diameter, much like ordinary solder. In this form the wax can easily be applied to the desired surface by hand, using a low-temperature soldering iron for melting the wax.

In mechanized production, the wax can be melted and applied by a printing setup. Alternatively, a small amount of solid conductive wax can be placed between the two surfaces to be joined, and the objects then heated until the wax melts and bonds to the surface. Since the cold wax is conductive, an electric current can be sent through the wax to produce the necessary heat.

▶ **Conductive Tape**—Work is now in progress on the production of a conductive wax tape. With this, two conductors can be connected by

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 $3\frac{13}{32}$" high and $1\frac{5}{16}$" 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

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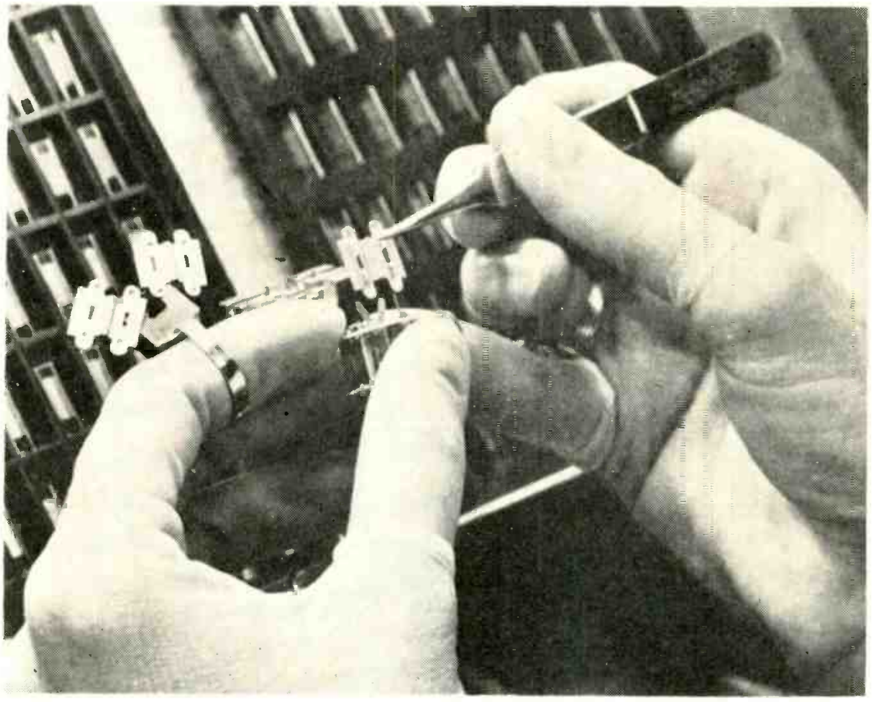
simply taping them together. It is also possible to incorporate the silver powder in adhesives or glues which can be used to join conductors mechanically as well as electrically.

Magnetic Rings Hold Tiny Tube Parts



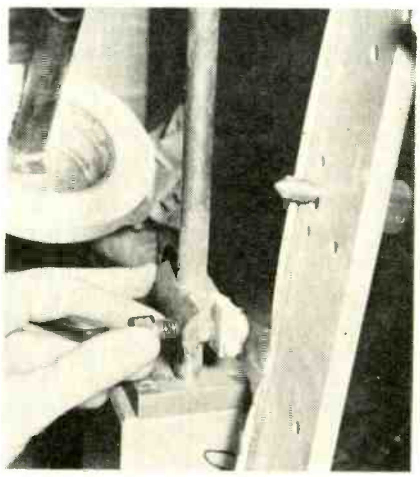
Method of using permanent-magnet ring to hold tiny parts during assembly of electrode structure for high-reliability tubes. Operator now picks up all parts before starting

A SMALL PERMANENT MAGNET worn as a ring simplifies the assembly of tiny parts for electronic tubes in the Owensboro, Kentucky plant of General Electric Co. Motion studies indicated that use of the U-shaped Alnico 5 magnets stepped up this tweezer-type assembly operation 12 percent. Formerly, time was lost in making the extra motions needed to pick up the tiny parts individually from their bins as they were needed during the assembly.

Turntable Speeds Assembly of Panels

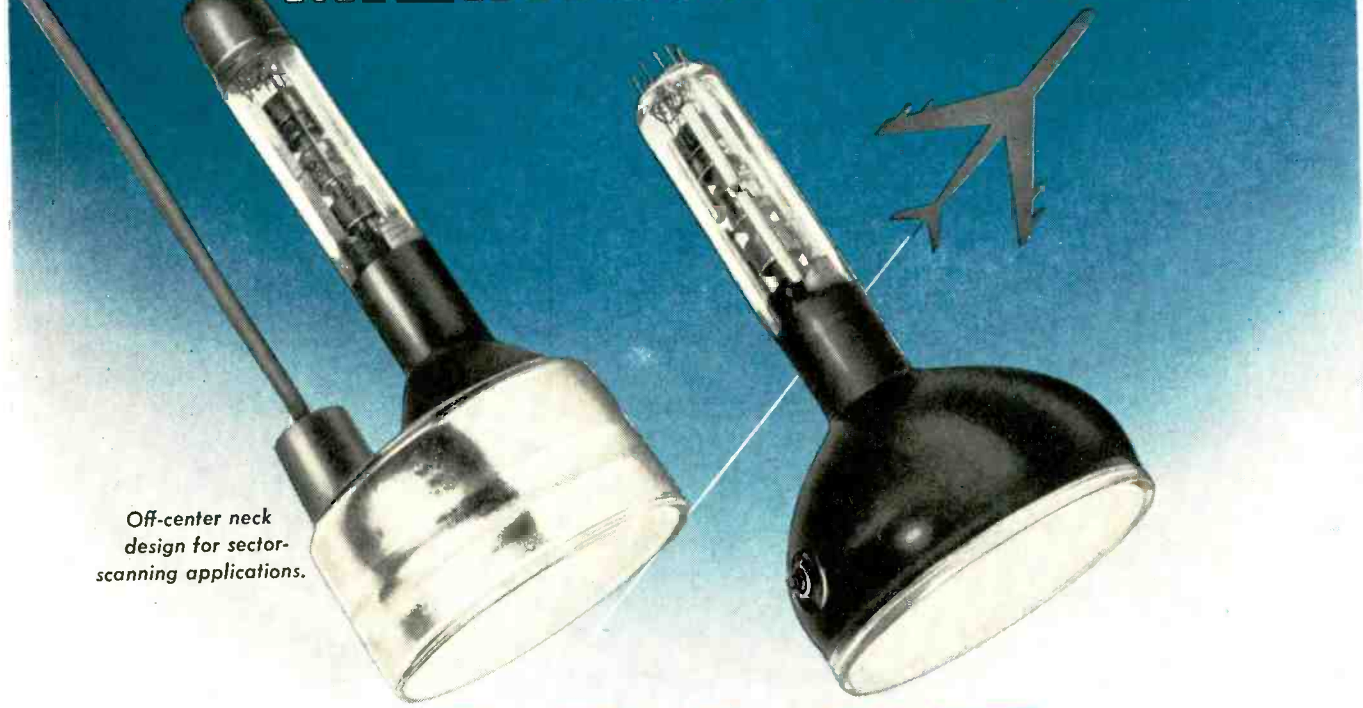
A SIMPLE PLYWOOD turntable having felt-padded wood and metal fixtures for holding seven large power supply panels upright at one time contributes to production efficiency on short runs of special equipment in the Clifton, N. J. plant of Federal Telephone and Radio Co., a Division of IT&T. The operator installs components in convenient groups on each panel in turn without changing her working position. As an example, the two meters are mounted as a group, since they call for the same screwdriver and socket wrench.

A grooved wood strip positions each panel radially. An adjustable



Simple clamp with knurled lock screw holds each panel upright during assembly

SHORT LENGTH- SMALL NECK DIAMETER- MINIATURE BASING-



Off-center neck design for sector-scanning applications.

SAVE SPACE AND WEIGHT IN AIRBORNE RADAR

Miniaturized 3″ to 12″ diameter radar tubes save space and weight in military and commercial installations. Ideal for use in airborne radar or *any* installation requiring high performance with miniaturization.
Du Mont miniaturized radar tubes feature short overall length and small neck diameter. Nine-pin miniature design saves base and socket weight. Reasonable power requirements aid in reduction of associated circuitry size and weight.

Detailed specifications upon request . . .

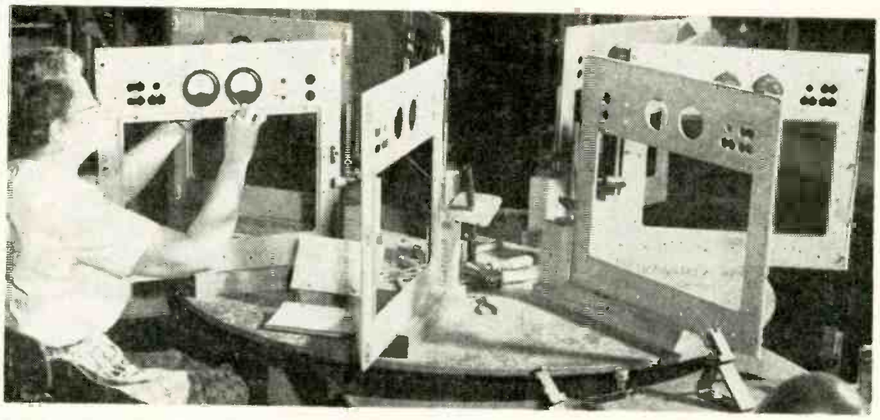
DU MONT RADAR TUBES

TABLE OF IMPORTANT SPECIFICATIONS

Type	Diameter	Length	Focus	Deflection	Neck Diameter	Voltage	Deflection Angle	Screen
B1173	3″	5⅛″	Elect.	Mag.	⅞″	7KV	70°	Alum.
K1517	3″	6⅜″	Elect.	Mag.	⅞″	8KV	Off Center Neck	Alum.
5BCP—	5″	7″	Mag.	Mag.	⅞″	8KV	70°	Reg.
B1174	5″	6 5/16″	Elect.	Mag.	⅞″	8KV	70°	Alum.
B1142	7″	8½″	Mag.	Mag.	⅞″	8KV	70°	Reg.
B1175	7″	7 13/16″	Elect.	Mag.	⅞″	10KV	70°	Alum.
B1191	10″	10 5/16″	Elect.	Mag.	⅞″	10KV	70°	Alum.
B1132	10″	12½″	Elect.	Mag.	1 7/16″	10KV	78°	Reg.

Industrial Tube Sales, Allen B. Du Mont Laboratories, Inc., 2 Main Ave., Passaic, N. J., U.S.A.

Circle 145 Readers Service Card



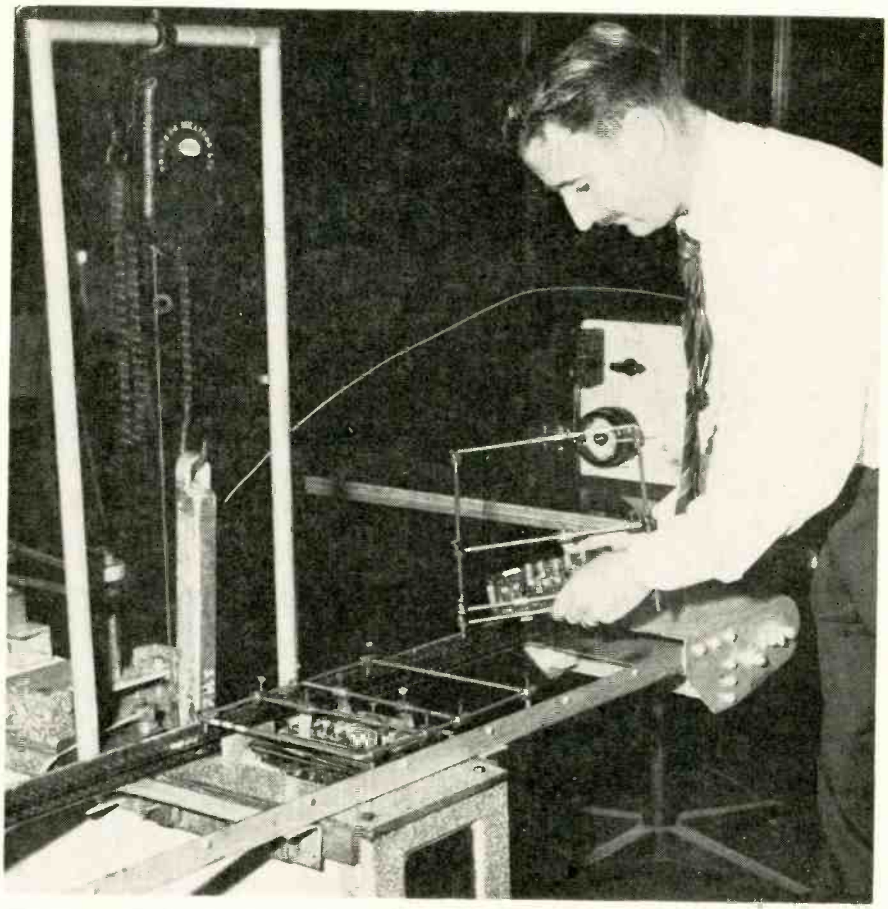
Method of using turntable to expedite installation of parts on seven power supply panels at a time. Holding clamps are padded with masking tape to protect finished front surface of panel

clamp on a vertical rod provides vertical support for each panel, permitting use of the table for a wide range of panel heights in standard rack width.

The turntable is readily turned by hand as required to move the next work position in front of the operator. Flip-up cards indicate parts to be installed.

Solder Wave in Pot Replaces Dip Soldering

SOLDERING TIME and temperature are reduced to a minimum in a new dip-soldering machine which lifts the molten solder up to the board in the form of a linear wave. Only a 2-inch-wide strip of the board is in contact with the molten solder at any given time, so that warping



Demonstration of new soldering machine, in which simple motor-driven bicycle-chain conveyor is used to move board-holding pallets smoothly across top of solder wave

Having your
ups
and downs?

... if they involve Wire Wound Resistors

DALOHM has the answer!

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

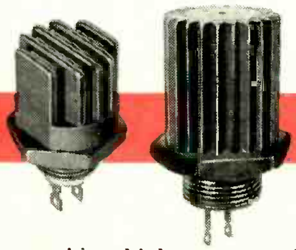
Outstanding examples of the Dalohm line are these miniature, silicone-sealed, wire wound resistors.

You Can Depend On

DALOHM Ω ®

FOR THOSE TIGHT SPECIFICATIONS

TYPE PH

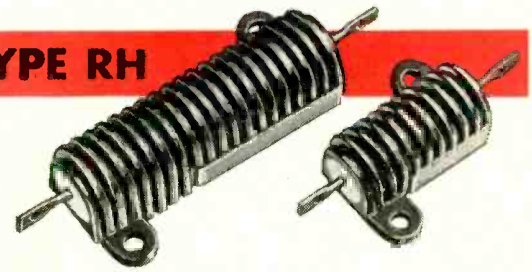


These Dalohm resistors combine high power rating with sub-miniature design. High heat dissipation and protective covering are achieved with vertical-finned black anodized aluminum housings. Vertical single hole panel mounting is provided by integral threaded base and lock nut. Ruggedized construction assures dependability under the most extreme conditions.

- Completely welded construction from terminal to terminal
- Silicone sealed for absolute protection against moisture, shock and salt spray
- Three wattages and sizes: PH-25, 25 watts; PH-50, 50 watts; PH-100, 100 watts
- Resistance values from 0.1 ohm to 60K ohms, depending on type
- Tolerances from 0.05% to 3%

Ask for Bulletin R-33

TYPE RH



Another Dalohm resistor that resolves power and space problems in tight specifications. Black anodized finned housing provides protection and maximum heat dissipation. Mounting lugs provided for horizontal mounting.

- Completely welded construction from terminal to terminal
- Silicone sealed for absolute protection against moisture, shock and salt spray
- Three wattages and sizes: RH-25, 25 watts; RH-50, 50 watts; RH-250, 250 watts
- Resistance values from 0.1 ohm to 100K ohms, depending on type
- Tolerances from 0.05% to 3%

Ask for Bulletin R-21C

JUST ASK US

You are invited to write for the complete catalog of Dalohm precision resistors, potentiometers and collet-fitting knobs.

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

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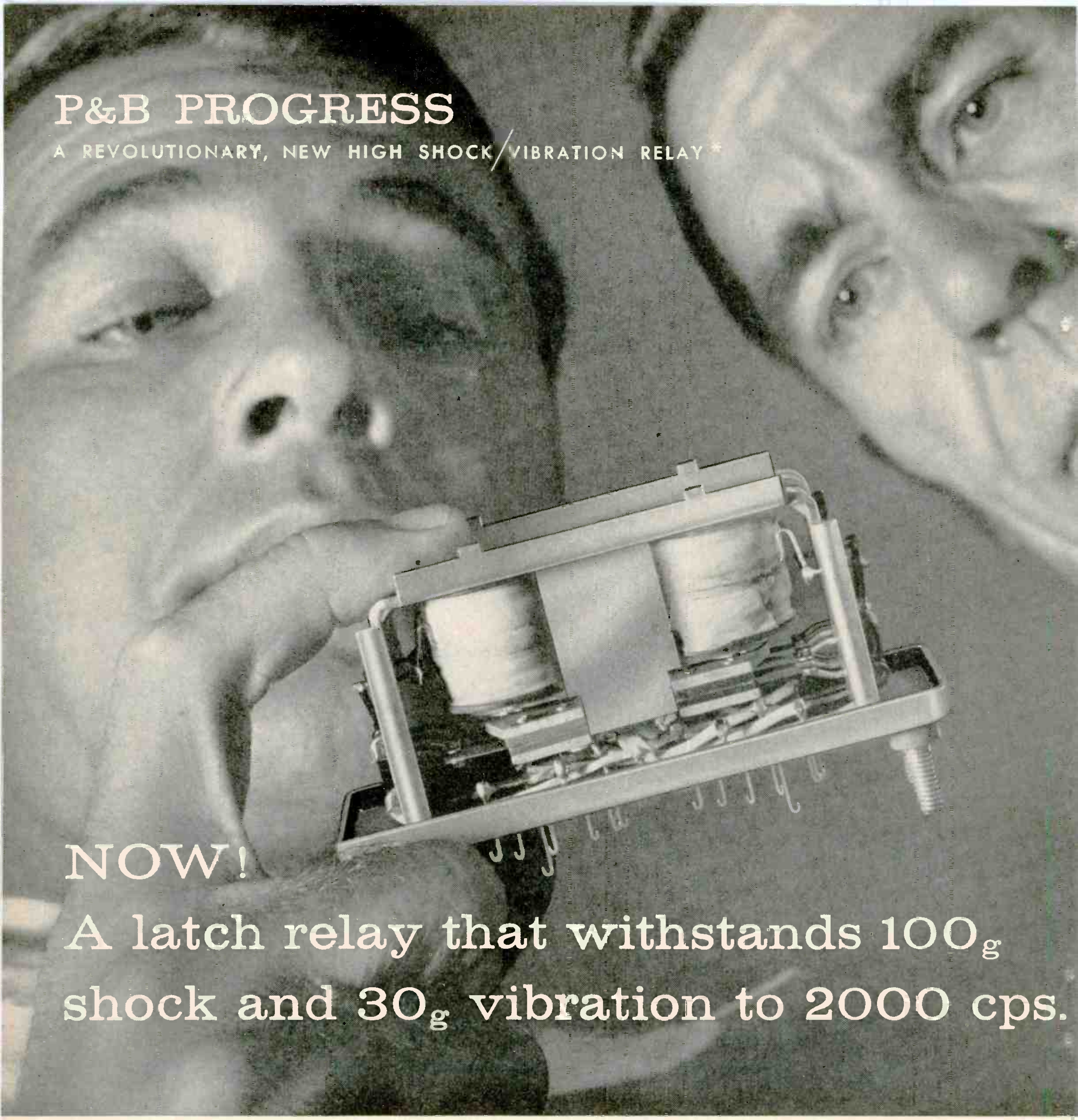


*KG RELAY (Pat. Pending)

ONLY 2.0 WATTS AT NOMINAL VOLTAGE FOR 12 MILLISECONDS EFFECTS ARMATURE TRANSFER

NEW POTTER & BRUMFIELD KG SERIES RELAY

The new KG magnetic latch relay was designed by P&B engineers at the insistence of leading aircraft and missile manufacturers and their suppliers of control systems. A permanent magnet which locks the armature into position is the secret of the KG's dramatically high resistance to shock and vibration.

In addition to withstanding 30g vibration from 6 to 2000 cps, tests show the contacts will open for no more than 80 microseconds during 100g shock.

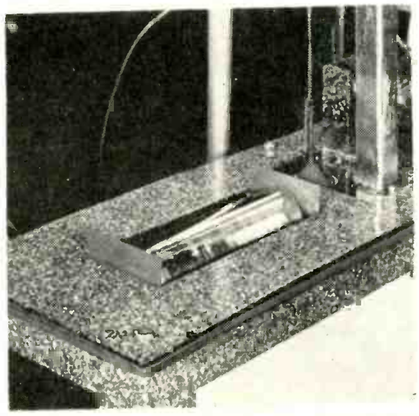
Armature transfer from one set of the 6PDT contacts to another can be made in approximately 12 milliseconds with only 2.0 watts at nominal voltage. The KG is rated for ambient temperatures from −65°C to +125°C.

The KG, together with other relays in the P&B "Star Series", has vastly increased the realm of relay reliability for critical applications demanding positive action of all components. Write or wire today for complete technical data.

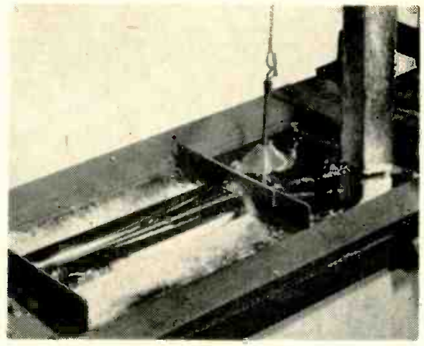
POTTER & BRUMFIELD, INC., PRINCETON, INDIANA—SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY and heat damage to components are minimized. The new machine was developed by Fry's Metal Foundries Ltd. of London, England and is being made available here by Electrovert Inc., 489 Fifth Avenue, New York, N. Y.

▶ **How It Works**—The solder pot holds approximately 500 lb of solder, held at 480F by thermostatic control of electrical heating units. The solder wave is produced by forcing molten solder through a U-shaped horn having a circular inlet in which is mounted a motor-driven impeller pump. The output end of the horn is an 8-inch long rectangle projecting about ¾ inch above the surface of the solder. With the impeller blade rotating in the circular input load which is well below the surface of the pot, solder is forced smoothly through the horn to emerge in the form of a rounded 8-inch-long wave that is always free from oxide. The wiring board is moved through the crest of this wave of molten solder by a simple conveyor mechanism at a speed of 4 feet per minute, to give practically perfect soldering of joints on every part of the board.

Height of the solder wave is controlled by changing the speed of the impeller. The drive motor for this is mounted on a lead screw, so that the motor position can be changed by turning a crank. This changes the tension of the V-belt which couples the output shaft of the motor gear box to the vertical shaft of the impeller blade. As ten-



Closeup view of solder wave formed by pumping molten solder up through rectangular opening



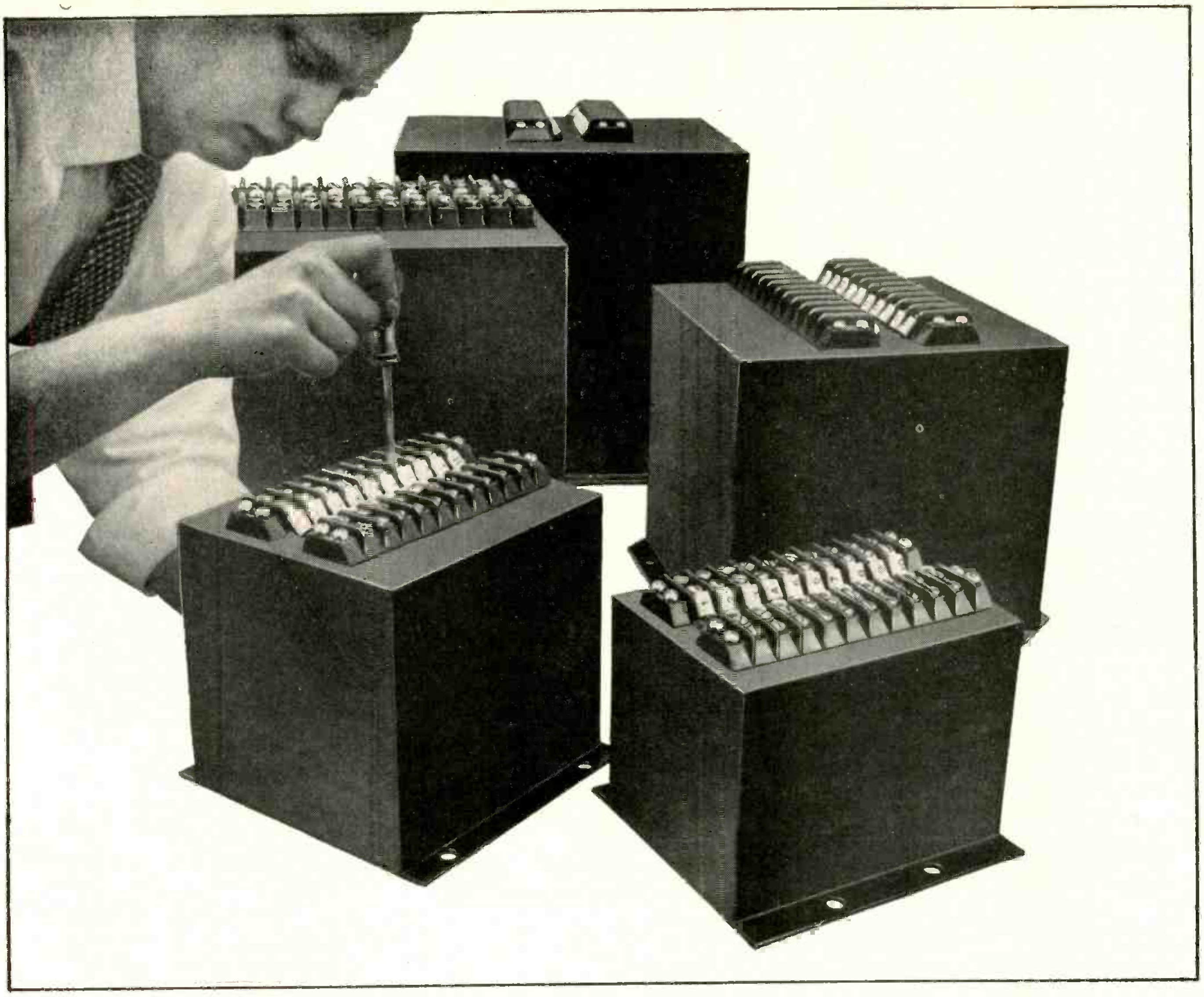
Top of machine with cover removed, showing level of molten solder in pot. At right rear is stainless steel float suspended by chain going to gear-brake arrangement controlling feed of solder ingot next to float

sion changes, a Hi-Lo automatic variable-speed spring-loaded split pulley (made by Equipment Engineering Co., 2853 Columbus Ave., Minneapolis, Minn.) on one of the shafts changes correspondingly in diameter to give the desired change in pump speed.

▶Solder—Solder level is not critical in the pot, since the pump determines the height of the solder wave. The level is automatically maintained within ¼ inch by a simple automatic gravity feed arrangement. A 12-lb ingot of solder 21 inches long is suspended over the pot by a bicycle chain which passes over a sprocket wheel on the large output gear of a six-gear train. On the shaft of the small input gear is a smooth drum against which a brake pad is held by spring tension. A stainless steel float in the solder pot counteracts the tension of the brake spring. When the solder level drops, the float works against the spring to release the brake, allowing the solder ingot to drop into the pot until the level is restored again.

A special Flowsolder alloy is used, with tin content slightly over the eutectic value of 63 percent and with extremely low aluminum and zinc impurity content to give high wetting properties and minimum pickup of contaminating material from the board being soldered. When this solder is applied by means of a solder wave, solder consumption is about 27 percent lower from the board being soldered.

▶Controls—The electrical control



Now--CONTROL offers you standardized saturable reactors

If you're a design engineer who would be delighted with industrial components which are sensitive and, under normal operation, last virtually forever with no maintenance or servicing, then you'll welcome CONTROL's *standard* lines of saturable reactors.

With CONTROL reactor assemblies and magnetic amplifiers, you know complete physical and operating characteristics —a copy of our Catalog R-10 awaits your request. And, delivery is fast because sub-assemblies of these units are stocked, awaiting your control-winding specifications.

CONTROL reactors are available for both 120- and 240-volt 60-cycle operation. There are eleven standard sizes in each voltage range. They have extremely high gain. Six ampere-turns control nearly 2,000 watts in the largest size. Power outputs range from 50 to 2000 watts, with only 2 ampere-turns required for control of the smallest units.

In addition to higher gain, smaller exciting current, and fewer ampere-turn characteristics, CONTROL reactors have a 40 to 1 cut-off ratio. They are totally enclosed so that the high performance toroidal cores used are protected, and the entire assembly has the ruggedness required for long life.

CONTROL offers the same convenience of standardization in use of high permeability magnetic devices that you've enjoyed with other components. Add to this convenience ruggedness and freedom from maintenance which is unmatched, and you'll welcome CONTROL to your design picture. Write for complete details and literature today. *CONTROL, Dept. E-36, Butler, Pennsylvania.*

Reliability begins with CONTROL

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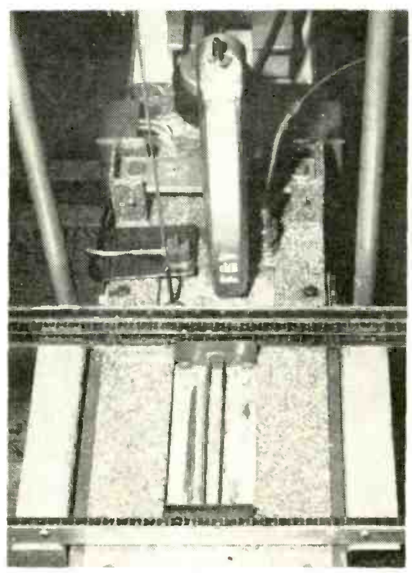
system for the machine, made by Deselectro Co. of New York, provides four separate heating elements in the solder pot. Three of these are connected to the three phases of a 220-volt power line. The fourth is a spare which can be substituted for any of the others without shutting down the machine, merely by changing plugs. An audible alarm and pilot lamps indicate failure of a heater element and tell which one has burned out.

A 10-watt thermostat immersed in the bath is preset and sealed for the desired temperature, to prevent tampering. This controls the heating elements through contactors. A second thermostat is used to prevent starting of the impeller motor before solder is molten. A synchronous motor is used for the impeller to give constant speed regardless of voltage changes which occur as the heating elements are switched on and off by the thermostat.

▶ **Flux**—Special fluxes have been developed for use with the dipping unit. By adjusting the viscosity of the molten resin it has been found possible to formulate a flux which remains on the circuit panel after its passage through the solder wave while being mobile enough to allow the molten solder complete access to the printed wiring and the joints to be soldered. Because of its presence on the exit side of the solder



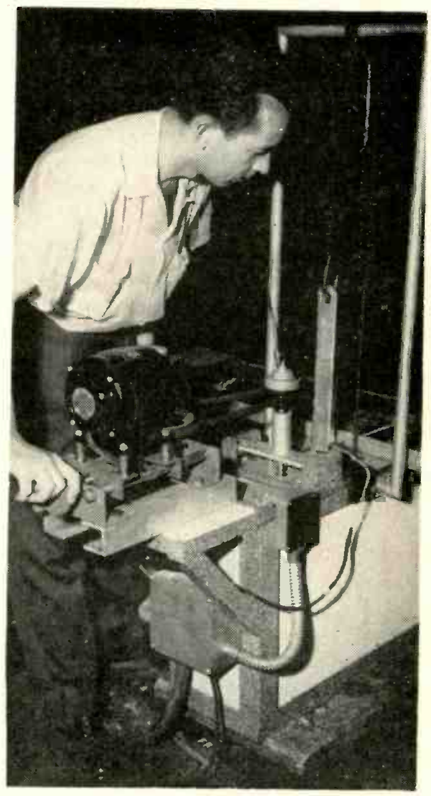
Appearance of rectangular output end of solder horn when impeller is turned off

wave, it effectively prevents the formation of icicles and bridging. The dipped panel is covered with a thin layer of solid resin which is dry and hard, eliminating need for protective varnish.

Where a flux residue is undesirable, or inadmissible, another flux is available which is removed during the passage of the panel through the solder wave. To avoid excess solder pickup on the exit side, vibration of the panel during its passage through the solder wave is recommended with this flux.

▶ **Advantages**—The shape of the solder wave inherently provides angled entry and exit of the board. This feature, combined with the washing action of the moving solder, prevents trapping of flux or air at a joint. The solder wave does not interfere with normal capillary action; solder flows up through the holes around the leads to give a desired neat fillet on the top side of the board.

The constant flow of solder in-



Method of changing height of solder wave. Turning crank moves motor along feed screw, changing tension of drive belt and thereby changing diameter of spring-loaded variable-speed pulley on vertical shaft of impeller running in solder bath

sures uniform solder bath temperature regardless of the amount of heat-absorbing metal on a board. With no sudden drop in surface temperature of the solder when the board touches it, dipping time is reduced yet all joints are made at a well-defined controlled temperature. Surplus solder drains back into the pot at this same temperature, so there is no formation of icicles or bridges between adjacent conductors.

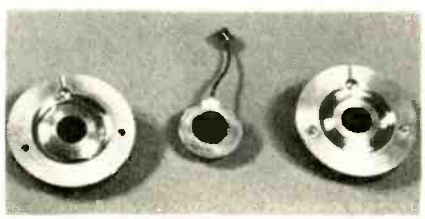
Any simple conveying system can be used to bring the prefluxed boards across the solder wave. Since the boards move along a straight path without stopping, the soldering machine is readily introduced into a completely mechanized production line. For wider boards, a 10-inch-wide nozzle can be used in the solder pot.

Since the molten solder is drawn from well below the surface, it is always clean and free from oxide or dross. Skimming of the surface is therefore unnecessary.

Coated-Filler Resin Speeds Encapsulation

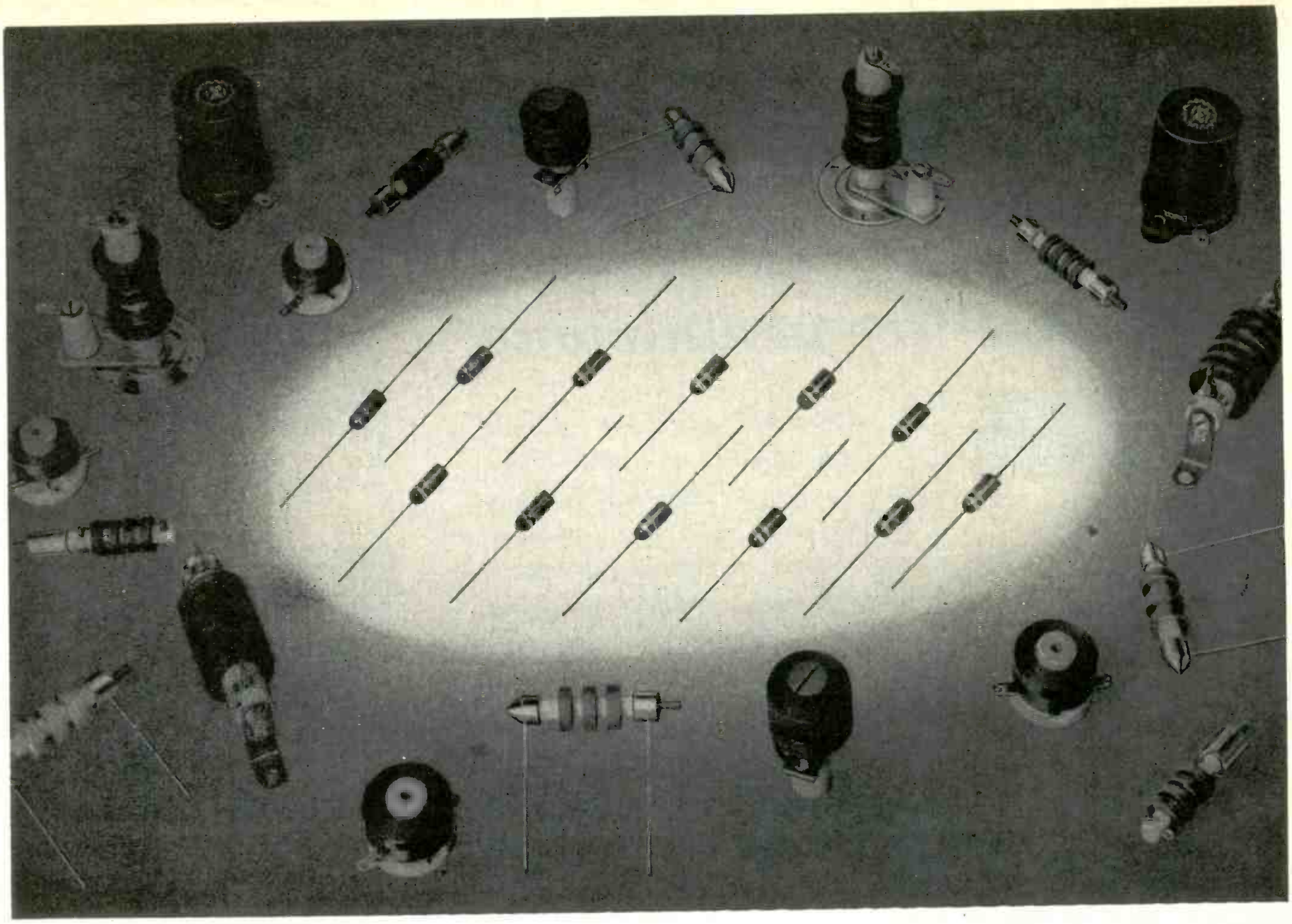
By R. Herr and J. S. Casement
Electrical Products Laboratory
Minnesota Mining and Manufacturing Co.
St. Paul, Minnesota

A NEW resin-applying technique eliminates the mixing operation heretofore required when encapsulating, molding or impregnating electronic components with two-part polymerizable liquid resins. Other advantages include indefinitely long pot life, elimination of the air bubble problem, boosting of filler content, reduction of time in mold and elimination of vacuum requirements during impregnation.



STEP 1. Coil is prepared for insertion in two-part mold

The new resin system developed



Encapsulated Inductances

Millen DESIGNED for APPLICATION encapsulated coils provide another advance in the r-f inductor field. Modern application requires miniature, heat and cold resistant, hermetically sealed, and abrasion resistant r-f inductor assemblies. The James Millen Manufacturing Company has pioneered many advances in the r-f inductor field, including the now standard 4 pi r-f choke, the axial lead r-f choke, and the miniature r-f choke. Developments have now made possible another advance, the No. 34301 and No. J301 encapsulated inductors—hermetically sealed—miniature size. Ambient temperature minus 55 degrees to plus 100 degrees C.

NO. J301 MINIATURE ENCAPSULATED INDUCTANCES

DESIGNED for APPLICATION miniature inductances are: extremely small (see table at right)—hermetically sealed—wound on axial lead Carbonyl cores—color coded. Coils are available in RETMA standard values plus 25, 50, 150, 250, 350, 500, and 2500 microhenries. Coils are three layer solenoids up to 350 microhenries. From 360 to 2500 microhenries coils are pi-wound. Current rating 50 to 600 milliamperes depending on coil size. Inductance ± 5%. Special coils on order.

NO. 34301 STANDARD ENCAPSULATED INDUCTANCES

Encapsulated DESIGNED for APPLICATION axial lead phenolic form r-f inductances. Hermetically sealed—heat resistant—abrasion proof—color coded. 1 to 350 microhenries available in RETMA standard values plus 25, 50, 150, 250, and 350 microhenries. Inductance ± 5%. Values available in same progression as J301 coils listed in the table at the right. Solenoid winding for 1 to 15 microhenries. Universal pi winding from 20 microhenries to 350 microhenries. Current rating 250 to 1500 milliamperes, depending on coil size. Ambient temperature range—minus 55 degrees to plus 100 degrees Centigrade. Size: 3/8 inches diameter × 7/8 inches long. Special coils on order.

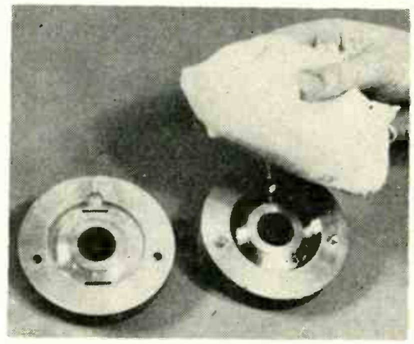
COIL NUMBER	INDUCTANCE MICROHENRIES	DIAMETER INCHES	LENGTH INCHES
J301-25	25	3/16	9/16
J301-33	33	3/16	9/16
J301-47	47	3/16	9/16
J301-50	50	3/16	9/16
J301-82	82	3/16	9/16
J301-100	100	3/16	9/16
J301-120	120	3/16	9/16
J301-150	150	3/16	9/16
J301-200	200	3/16	9/16
J301-220	220	3/16	9/16
J301-250	250	3/16	9/16
J301-300	300	3/16	9/16
J301-330	330	3/16	9/16
J301-350	350	3/16	9/16
J301-360	360	7/32	5/8
J301-390	390	7/32	5/8
J301-430	430	7/32	5/8
J301-470	470	1/4	11/16
J301-500	500	1/4	11/16
J301-510	510	1/4	11/16
J301-560	560	1/4	11/16
J301-620	620	1/4	11/16
J301-680	680	9/32	3/4
J301-750	750	9/32	3/4
J301-820	820	9/32	3/4
J301-910	910	9/32	3/4
J301-1000	1000	9/32	3/4
J301-1200	1200	5/16	13/16
J301-1300	1300	5/16	13/16
J301-1500	1500	5/16	13/16
J301-1800	1800	5/16	13/16
J301-2000	2000	3/8	7/8
J301-2200	2200	3/8	7/8
J301-2400	2400	3/8	7/8
J301-2500	2500	3/8	7/8

JAMES MILLEN MFG. CO., INC.

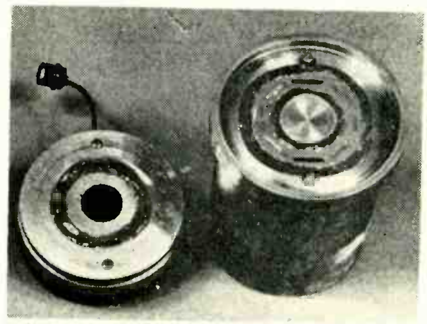
MAIN OFFICE AND FACTORY

MALDEN, MASSACHUSETTS, U.S.A.

Circle 154 Readers Service Card



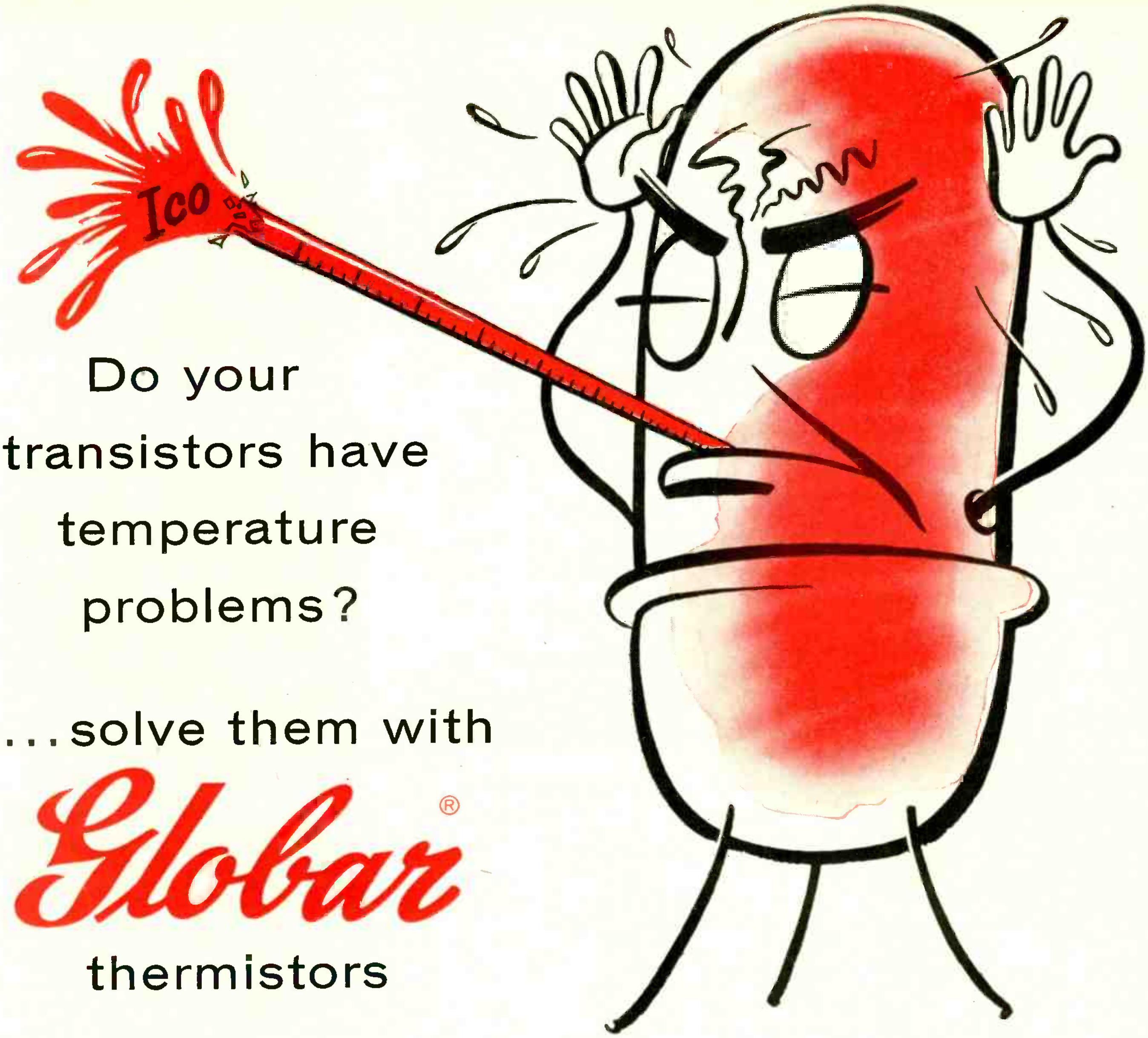
STEP 2. Applying powdered walnut shells as mold release



STEP 3. Coil in mold (left) and can (right) used for applying filler to mold

by 3M uses two parts, but they do not need to be mixed in the usual sense. The part used first is what is normally called the filler, consisting of inert particles. These particles are precoated with a layer of chemical which under heat or drying will bond particle to particle. The coating also is (or contains) the catalyst for the subsequent resin cure. The other component is the resin itself. This is used just as received, by allowing it to fill the interstices of the filler.

▶**Example of Use**—A typical electronic application, using a low-viscosity liquid epoxy resin to form an insulating covering or tire on a television flyback coil, is currently in production at Motorola. The two parts of the mold are first dusted with a release agent such as powdered walnut shells. The coil is then enclosed in the mold and the assembly is inverted in a can having two opening slots which match those on the coil mold. The can is then filled with the bondable catalyzing filler. First a momentary blast of compressed air blows the required amount of filler into a cavity surrounding the coil. This



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operation is a routine step in foundry practice as in the manufacture of sand cores. It is practically an instantaneous operation. Following this, hot, dry air is blown through the coil cavity for about 1 minute. This bonds the filler particles together so that the covered coil may be removed from the mold.

The next step is the introduction of the resin itself. The coil with its porous granular coating is merely set in a bath of the resin. The resin flows upward largely

STEP 4. Can in position over mold to serve as funnel for applying filler

through the forces of surface tension. When this process is complete the resin may be cured by an appropriate oven cycle, such as 2 hours at 135 C or a longer time at room temperature.

▶ **Variations in Method** — In another type of application the coated filler can be much wetter, as by the addition of water, so that it forms a thick paste. This paste is pressed or molded into place around the part to be encapsulated, then dried to form the same type of hard, porous mass. This shell is then impregnated as before.

This alternative processing procedure has the advantage of not requiring any fancy mold or blowing technique, but is not so easily mechanized. It takes more time to dry and set the wet filler because

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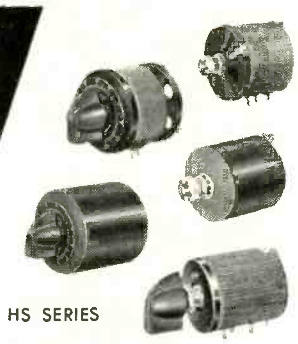

HS SERIES

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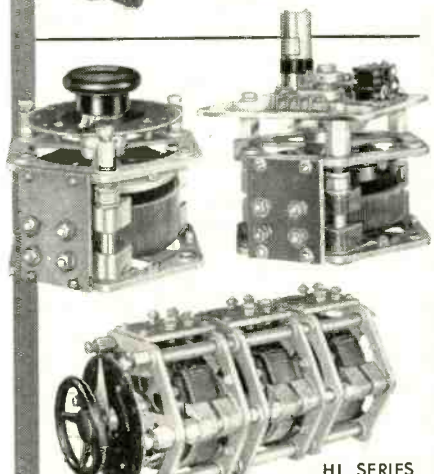
HM SERIES

INPUT		OUTPUT				MANUALLY-OPERATED MODELS				MOTOR-DRIVEN MODELS				
VOLTS	FREQUENCY CYCLES PER SECOND	VOLTS	MAXIMUM AMPERES	MAXIMUM KVA	TYPE OF CONSTRUCTION	TYPE	METHOD OF TURNING	APPROX. WEIGHT (POUNDS) NET	APPROX. WEIGHT (POUNDS) SHIPPING	TYPE	STANDARD MOTOR-DRIVES	SPEED OF TRAVEL IN SECONDS	APPROX. WEIGHT (POUNDS) NET	APPROX. WEIGHT (POUNDS) SHIPPING
SINGLE PHASE														
28	400/800	0–28	2.0	.056	Open	3HS02UK	Knob	0.5	0.9					
28	400/800	0–28	4.0	.112	Open	3HS04UK	Knob	0.8	1.2					
120	400/800	0–120 or 0-140	1.0	.14	Open	1HS01UK	Knob	0.9	1.3					
120	400/800	0–28	2.6	.073	Open	1RHS03UK	Knob	0.6	1.0					
120	400/800	0–120 or 0–140	3.0	.42	Open Square Frame	1HMS03UK	Knob	2.4	2.8	DM1HMS03U	28 Volt D-C	60	4.5	5.1
										AM1HMS03U	120 Volt A-C, 400 Cycles	60	4.5	5.1
120	400/800	0–120 or 0–140	7.5	1.0	Open Square Frame	1HMS07UK	Knob	3.4	3.8	DM1HMS07U	28 Volt D-C	60	5.5	6.1
										AM1HMS07U	120 Volt A-C, 400 Cycles	60	5.5	6.1
120	400/800	0–120 or 0–140	15.0	2.1	Open	1HL15UK	Knob	11.4	14.0	DM1HL15U	28 Volt D-C	60	13.2	16.2
										AM1HL15U	120 Volt A-C, 400 Cycles	60	13.2	16.2
240	400/800	0–240 or 0–280	3.0	.84	Open Square Frame	2HMS03UK	Knob	3.4	3.8	DM2HMS03U	28 Volt D-C	60	5.5	6.1
										AM2HMS03U	120 Volt A-C, 400 Cycles	60	5.5	6.1
240	400/800	0–240 or 0–280	9.0	2.5	Open	2HL09UK	Knob	12.8	15.4	DM2HL09U	28 Volt D-C	60	14.6	17.6
										AM2HL09U	120 Volt A-C, 400 Cycles	60	14.6	17.6
THREE PHASE														
240	400/800	0–240 or 0–280	3.0	1.5	Open	2HMS03UK-3Y	Knob	7.6	8.5	DM2HMS03U-3Y	28 Volt D-C	60	9.3	10.5
										AM2HMS03U-3Y	120 Volt A-C, 400 Cycles	60	9.3	10.5
240	400/800	0–240 or 0–280	7.5	3.6	Open	2HMS07UK-3Y	Knob	10.6	11.6	DM2HMS07U-3Y	28 Volt D-C	60	12.3	13.6
										AM2HMS07U-3Y	120 Volt A-C, 400 Cycles	60	12.3	13.6
240	400/800	0–240 or 0–280	15.0	7.3	Open	2HL15UK-3Y	Knob	34.5	41.0	DM2HL15U-3Y	28 Volt D-C	60	38.0	45.0
										AM2HL15U-3Y	120 Volt A-C, 400 Cycles	60	38.0	45.0
480	400/800	0–480 or 0–560	3.0	2.9	Open	4HMS03UK-3Y	Knob	10.6	11.6	DM4HMS03U-3Y	28 Volt D-C	60	12.3	13.6
										AM4HMS03U-3Y	120 Volt A-C, 400 Cycles	60	12.3	13.6
480	400/800	0–480 or 0–560	9.0	8.7	Open	4HL09UK-3Y	Knob	39.0	45.5	DM4HL09U-3Y	28 Volt D-C	60	42.5	49.5
										AM4HL09U-3Y	120 Volt A-C, 400 Cycles	60	42.5	49.5



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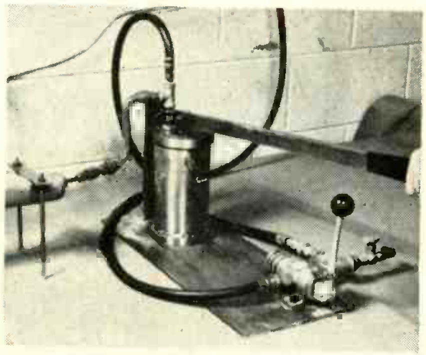
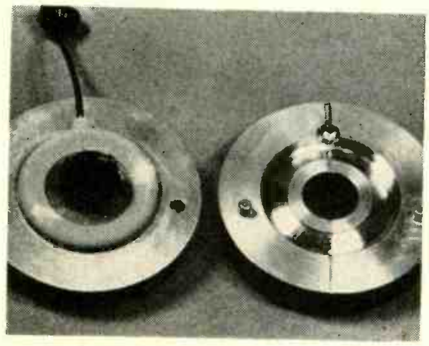


STEP 5. Setup for blowing filler into mold, followed by hot, dry air



STEP 6. Coil ready to be removed from mold after bonding filler

of the larger volatile content. The paste filler is recommended where complex geometry of windings and laminations is involved yet only a liquid resin can adequately penetrate the irregular voids. After the paste is dried, final shaping can be completed and excess paste removed from the inner surfaces of laminations. When the liquid resin is allowed to impregnate and cure, the job is completed without the use of any mold at all.

In still another type of application the object is to fill a can or other container which holds the part. Here no mold is required nor is any useful purpose served by preliminary bonding of the filler particles. The filler is poured dry into the space to be filled. The resin is then allowed to impregnate, preferably from the bottom up so as to avoid air entrapment. This still gives the advantages of associating the catalyst with the filler rather than having it mixed with the resin phase.

► **Fillers** — A high filler content can be achieved by this method. In the coil example, the filler content is 82 percent by weight and ap-

STEP 7. Coil resting in small dish absorbs resin quickly

proximately 65 percent by volume which is appreciably higher than can be obtained by ordinary mixing procedures without obtaining a very thick paste that is useless for most purposes. An inexpensive organic filler here gives obvious advantages in raw material economy, as well as in a lowered thermal coefficient of expansion. For the examples shown the coefficient is about 20 parts per million per deg C, so that the cracking common with other rigid organics surrounding metal parts may be avoided.

Other advantages of higher filler content are higher thermal conductivity and very low shrinkage of the resin on cure. The high filler content is also favorable for reducing moisture absorption, weight loss on heat aging and flammability.

With the coated filler technique a mold is required at most for only a few minutes in the production of each part. This is especially important with inexpensive components made in large quantities.

▶ **Impregnating** — When resin is introduced to coated fillers for impregnation by capillary action no vacuum is required, yet dielectric strength and corona starting levels

NEW SERVO-RATIO MULTIMETER

Combines all the functions of an AC-DC voltmeter, ohmmeter and AC-DC ratiometer in one compact portable unit

Here is a new, highly accurate test instrument designed to make life easier for those who work with computers and other electronic and electrical devices. It measures AC-DC ratios, absolute AC-DC voltages and resistance. You can also measure the gain of operational amplifiers using the 0° phase output provided.

The Servo-Ratio Multimeter computes voltage ratios by dividing the voltage to be measured by the reference voltage obtained from the computer. It is a high-impedance instrument and utilizes a motor-driven, position-type servo mechanism. Average time to obtain a reading is three seconds. Simplification and reliability are obtained through the use of printed circuits.

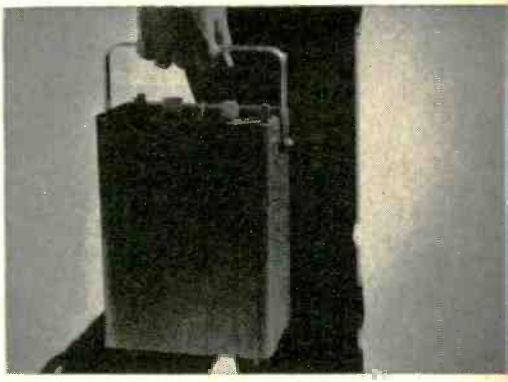
The front panel contains a four-digit illuminated drum counter for readout, phase or polarity indicating lights, function switch, ON-OFF switch, range switch, 0° phase ratio selector, input terminals and 0° phase output terminals.

The Servo-Ratio Multimeter is compact and easy to handle. It has an aluminum case and weighs only 10 pounds. The instrument can be operated in a horizontal or vertical position and has a unique carrying handle that serves as a tilt-stand when the unit is used horizontally. Write for Product Description 2005.

SPECIFICATIONS

Power Consumption: 50 Watts, 110 Volts, 60 cps.
Reference Voltage: DC or 60 cps AC; ± 10 Volts to ± 100 Volts across 8.7K Ohms Load.

Functions	Range
Ratio, AC	0.001 to 1.000 ± 0.1% in 1 range
Ratio, DC	0.001 to 1.000 ± 0.1% in 1 range
60 cps AC Voltage	1 Volt to 1000 Volts full scale ± 1.0% in 4 ranges
DC Voltage	1 Volt to 1000 Volts full scale ± 1.0% in 4 ranges
Ohms	10K Ohms to 10 Megohms full scale ± 1.0% in 4 ranges
Gain	0.01 to 1000 in 4 ranges



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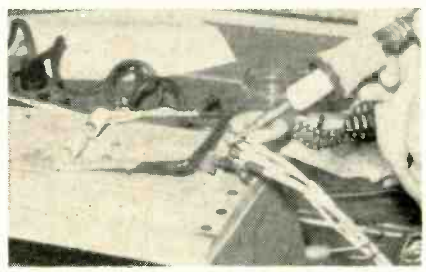
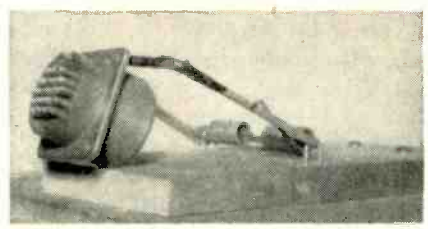
have been better than could be accomplished by vacuum impregnation. There are some impregnation applications which obviously cannot be solved by this method, however. Since the resin is catalyzed in the cure primarily by contact with the bonded filler, the filler must be present nearly everywhere that resin is expected to enter and cure. Resin which merely passes through the bonded filler and further impregnates internal voids will cure satisfactorily within limits, but a large coil could not be fully impregnated by this approach if it had on the outside only a thin skin of the catalyzing bonded filler.

Rat Trap Holds Plugs

AN ORDINARY rat trap with trigger and pan removed serves as an ideal universal holding fixture for all sizes of AN connectors at Transdyne Corp., Maspeth, N. Y. The jaw of the trap is wrapped with



Taped jaw of trap holds flat connector for soldering leads



Large circular AN connector is held firmly even when square mounting flange is not resting on base of trap

electrical tape to minimize slippage and prevent scratching of connectors while they are being held for cabling and soldering operations. Details of this simple technique were furnished by J. A. Simms, production engineer of the firm.

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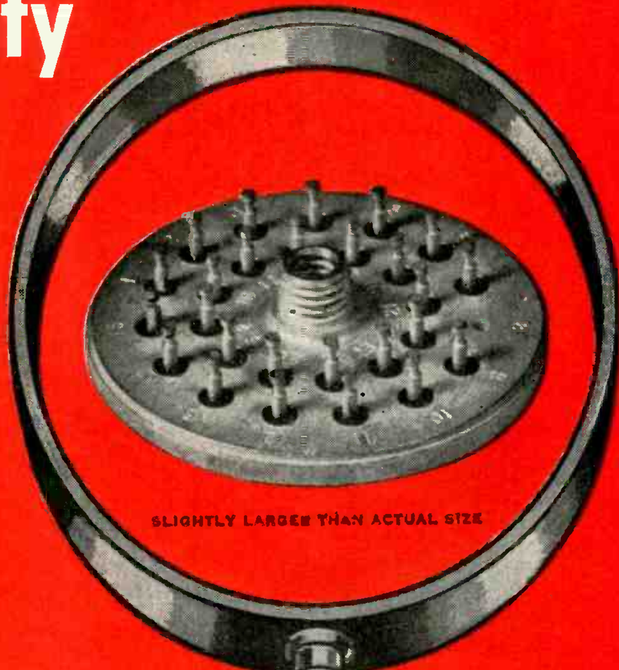
special sealing techniques *Insure* quality



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Inspection and quality control are of prime importance at Constantin, too . . . six, separate check points are maintained for the critical evaluation of each and every seal that comes down the production line.

Experience counts . . . and Constantin's long experience in the design and fabrication of both standard and specialized all-in-one assemblies, end seals, transistor mounts, unit headers, crystal covers, and connectors has set the norm for quality in the glass-to-metal industry. This versatility of manufacture and experience can be yours. Write today for more information.

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New Products

Edited by WILLIAM P. O'BRIEN

67 New Products and 41 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

NONDESTRUCTIVE TESTER

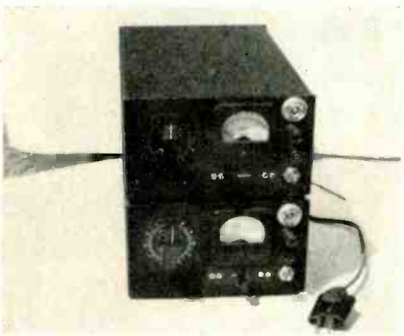
checks coating thickness

UNIT PROCESS ASSEMBLIES, INC., 61 E. 4th St., N. Y. C., New York. Dermitron model D-2 nondestructive coating thickness tester is a portable instrument for both laboratory and production use. It gives fast, accurate and direct readings of virtually any coating on any base, including: metal coatings (such as plating) on metal base; nonmetallic coatings (such as paint, anodizing, porcelain) on metal base; and metal films on nonmetallic base (plastics, ceramics).

Dermitron D-2 comes with four measuring probes for extra wide thickness ranges from thin to thick deposits, and requires only ⅛ in. circle-area for measurement. It can be used for sorting and matching of metals and alloys. **Circle 401 inside back cover.**

LAB POWER SUPPLY

for work with transistor circuits



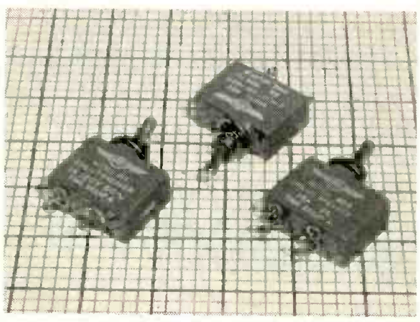
VECTOR ASSOCIATES, 1007 Atlantic Avenue, Brooklyn, N. Y., announces their Model L974 variable power supply especially designed for laboratory work with transistor circuits. The unit offers three continuously variable ranges, 0 −7.5 v, 0 −37.5 v and 0 −75 v, all at 1.5 amperes.

A Superior Electric Powerstat allows voltage control of the input to a full-wave rectifier utilizing GE germanium diodes. Filtering is provided by a swinging choke and a 1,000 μfd filter capacitor. A 2½ in. Simpson meter indicates the output voltage. Low output impedance is maintained throughout each range, never exceeding a value of five ohms.

Physically the units are well shielded and designed to allow stacking. Dimensions are: 4 in. high, 7 in. wide, 12 in. deep. In quantities of one to ten, the price is \$140. **Circle 402 inside back cover.**

CIRCUIT BREAKERS

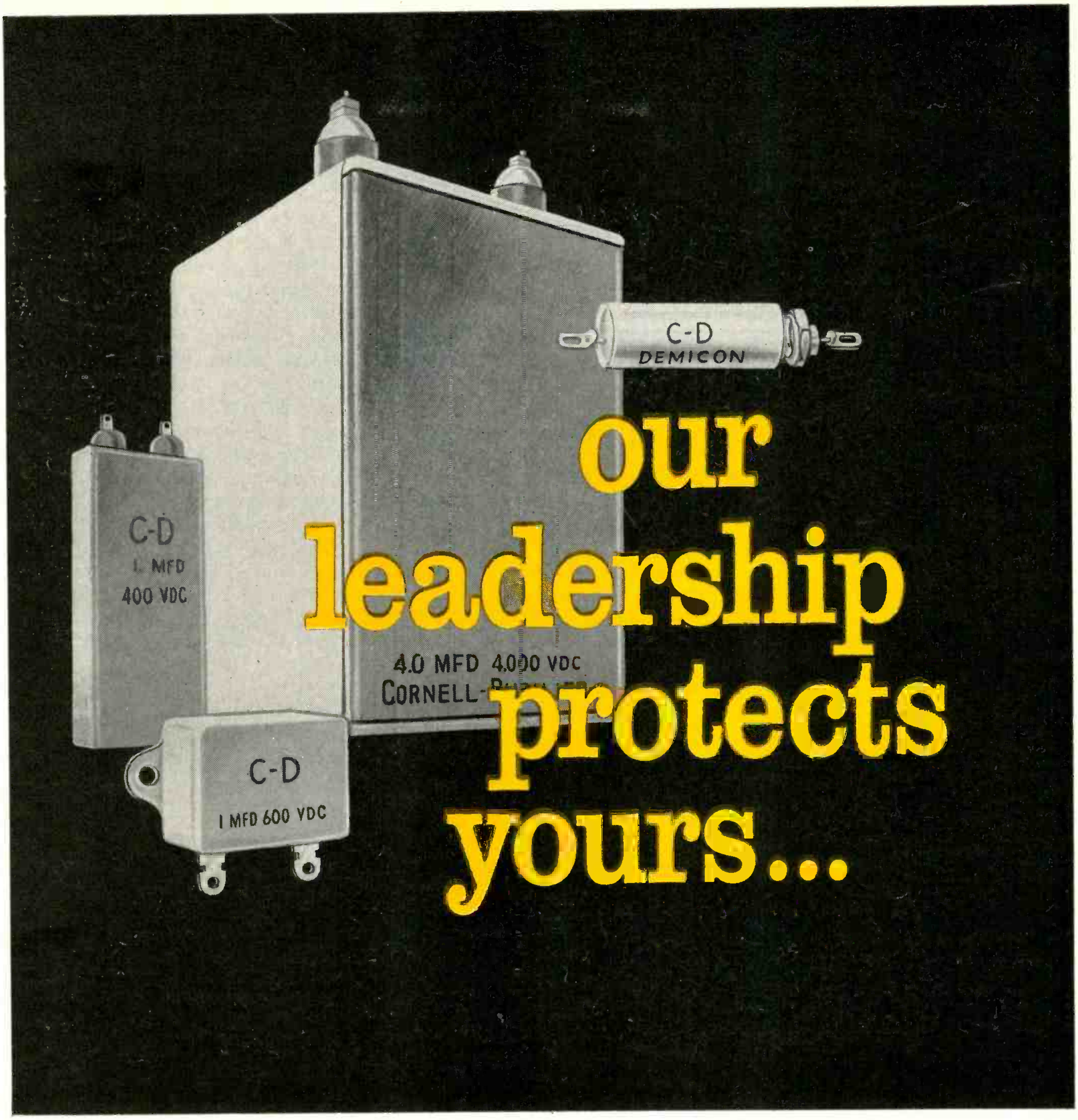
shunt and relay style



AIRPAX PRODUCTS CO., Ft. Lauderdale, Florida, has available shunt and relay style circuit breakers. They use the same magnetic time-delay trip mechanism as the series style breakers. Trip level is independent of temperature in all three styles.

In series style breakers, the release coil is in series with the contacts and operates when the load current exceeds 135 percent of normal rating. In shunt style breakers the release coil can be shunted externally; for example, by a rheostat to adjust trip level. In relay style breakers, the release coil is entirely independent of the contacts. Thus, for example, the release coil can be actuated by the d-c output of a power supply and the contacts can control the a-c input to the supply.

Release mechanism is actuated reliably by as little as 50 ma. Units are available with standard ratings to 10 amperes. When a breaker opens, the toggle returns to its OFF position giving trip indication. The action is trip free



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Circle 164 Readers Service Card

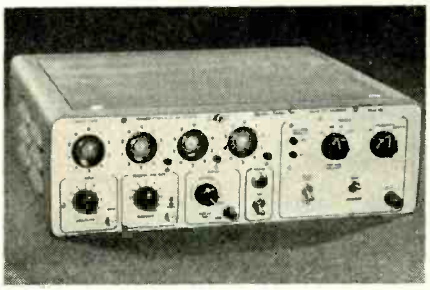
(contacts cannot be held closed manually in presence of overload). Time delays permit normal starting inrushes, operating surges and sequencing transients to pass without ripping the breaker. Two standard delays are available for protecting electronic equipment or equipment with blowers and small motors; faster action is available if needed.

These hermetically sealed breakers withstand 50 g shock, vibrations of 10 g to 1,000 cps and operate from −55 to +100 C (−67 to +212 F). Contacts are rated for 50 v d-c or 120 v rms at 60 or 400 cps. **Circle 403 inside cover.**

FREQUENCY INDICATOR

and printing recorder

ELECTRO-PULSE, INC., 11861 Teale St., Culver City, Calif. Model 7341B frequency indicator, with its associated desk model printer, is a low price range instrument for the measurement of frequency, velocity, rpm and the like, with continuous monitoring and printed readings.



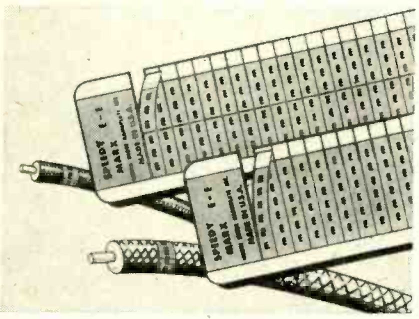
Set-up and operation by nontechnical personnel is feasible due to the instrument's simplified controls and high reliability. With the input signal source connected, the unit counts events during the 0.1 sec, 1 sec or 10 sec time bases available, at rates up to 100,000 per sec. The measurement is then displayed on the glow transfer counting tubes and may be recorded on the standard printer tape. Automatic recycle or single reading modes of operation are available.

A self-test for checking time bases and counters is provided and the unit may be used with an external time base. Input sensitivity is 50 mv, allowing operation directly from common transducers.

Modular printed circuit construction, relay rack panel adaptability, and complete internal accessibility are additional features. **Circle 404 inside back cover.**

WIRE MARKERS

aluminum foil type



NORTH SHORE NAMEPLATES, INC., 214-27 Northern Blvd., Bayside 61, N. Y. A new line of aluminum foil wire markers has been added to the group of self-sticking products marketed under the trade name Speedy Marx. Aluminum markers are furnished on quick-release dispensing cards which have been pre-cut for easy handling, and can be applied instantly without tools.

Flexible aluminum markers offer users double sticking action. A thermosetting adhesive retains its bonding action up to temperatures of 350 F, and the mechanical action of the aluminum as it wraps around wiring will remain unaffected by solvents, grease or coolants. Even large diameter wire and cable, or pipe and tube, can be coded with aluminum markers.

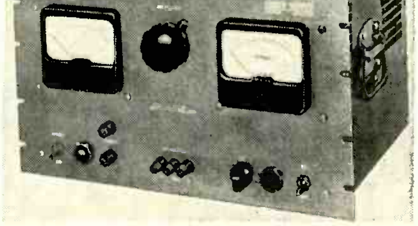
A transparent plastic coating is applied to marker surfaces after imprinting to protect symbols against abrasion, water or dirt. Symbols or markings may be specified as required, or conventional markings ordered from stock. Two sizes are available: 1½ in. markers for wires over ¼ in. o-d, ¾ in. markers for wires under ¼ in. o-d. Special sizes, shapes and colors can also be furnished. **Circle 405 inside back cover.**

POWER SUPPLY

magnetic amplifier type

KEPCO LABORATORIES, INC., 131-38 Sanford Ave., Flushing 55, N. Y., has introduced the first in a series of new tubeless magnetic amplifier voltage-regulated power supplies. Model KM236-15 is a 2-36 volt, 0-15 ampere continuous duty d-c supply.

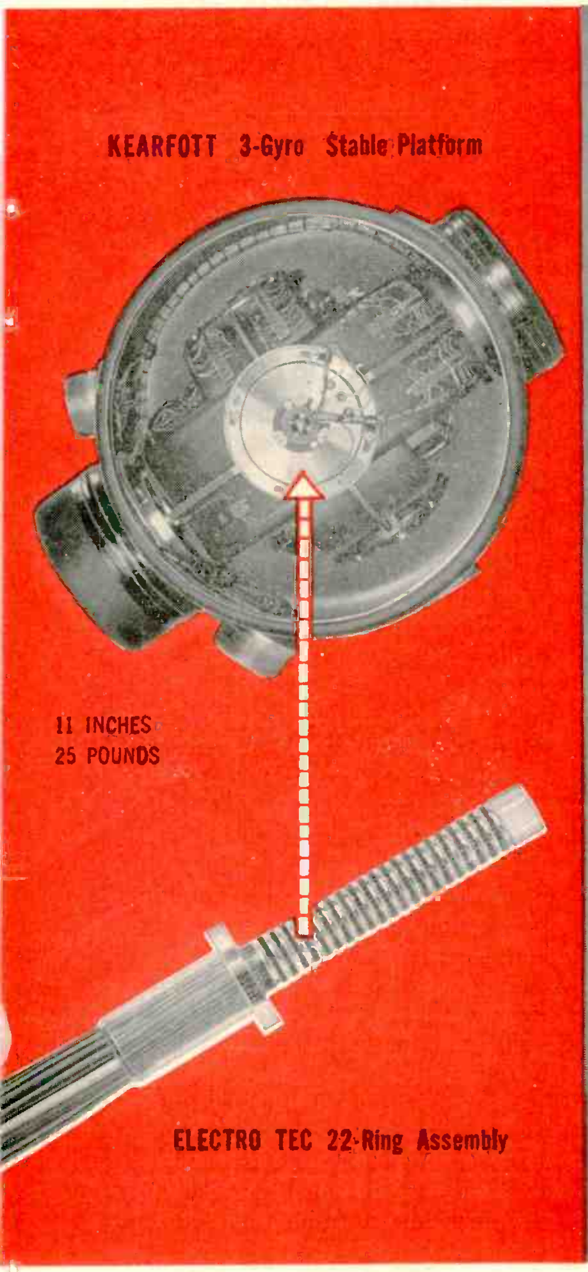
In the 2-36 v range, the output voltage variation is less than 0.5 percent for line fluctuation from 105-125 v, and less than 0.5 percent or 25 mv, whichever is greater, for load variations from minimum to maximum current. Ripple is less than 0.5 percent or 25 mv rms.



Other features are: (1) a short circuit will not damage the supply; (2) full current may be drawn at any voltage from 2-36 v; (3) the unit will operate in the 57-63 cps frequency range.

Height of the unit is 12¼ in.; width, 19 in.; depth, 17 in. This

Pioneers in ULTRA-RELIABILITY ... No. 1 of a Series



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Slip Ring Assemblies.... by Electro Tec

BY KEARFOTT: Smallest 3-gyro stable platform ever produced . . . Housed in an *11 inch sphere* . . . Total weight: *25 pounds.* Capable of providing vertical outputs with a *maximum error of 7 minutes* under all dynamic flight conditions. *Sustaining* such accuracy for *thousands of hours* of operation in United States Navy and Air Force aircraft.

BY ELECTRO TEC: 5 Slip Ring Assemblies, having as many as *22 contact rings* on a *small* diameter . . . Keep torque friction to minimum . . . Concentration of *many* rings in *minimum* space permits further miniaturization of related components . . . Aids overall size and weight reduction . . . *Optimum electrical performance* achieved by ring contact material of 24k. fine gold (approximate hardness, 120 Brinell) . . . These characteristics help Kearfott — and others — attain *ultra-reliability* — and make possible the "impossible"!

For further information write for fully illustrated brochure to

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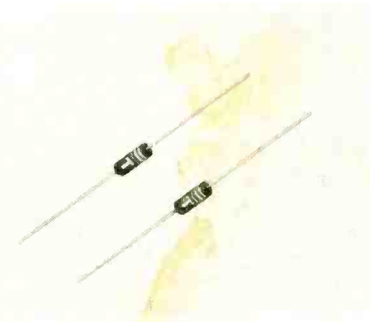
FOR. PATS. PEND.

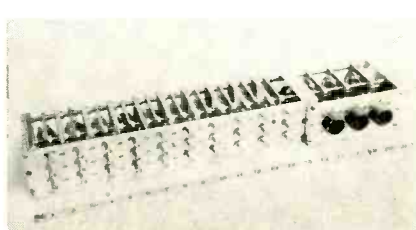
supply is also available in 30 and 50 ampere versions. **Circle 406 inside back cover.**



SILICON DIODES
for computer applications

TRANSITRON ELECTRONIC CORP., Melrose 76, Mass., has available a new line of silicon diodes which are particularly useful in military computers where high temperatures are encountered. Operating voltages extend to 200 v, and no derating is necessary up to their maximum temperature of 150 C. With switching times as fast as 0.3 μsec or less, these diodes can often directly replace germanium or vacuum types. High inverse resistance and forward conductance, combined with their fast switching and high temperature properties, allow maximum flexibility in design.

Manufactured using Transitron's subminiature glass package, the fast switching diodes can be used under the most severe environmental conditions. All units are subjected to temperature cycling and storage to insure reliable performance. Bulletin TE-1350 provides complete engineering specifications. **Circle 407 inside back cover.**



ROTARY SWITCH
for video and pulse use

THE DAVEN CO., Livingston, N. J., has available a new wide band

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

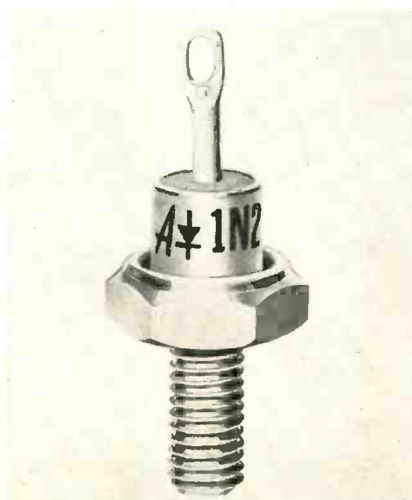
PALO ALTO 1, CALIFORNIA

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 166 Readers Service Card

video and pulse switch, No. 5583. It is designed for use at frequencies up to 4.5 mc. The electrical characteristics of this switch call for dpdt operation of 10 separate circuits with very strict isolation requirements. The 10 rear decks of the switch are all completely isolated from each other by the use of sectional shielding and r-f grounding fingers. Each of these 10 decks was also designed to eliminate capacitive or inductive coupling effects within each deck.

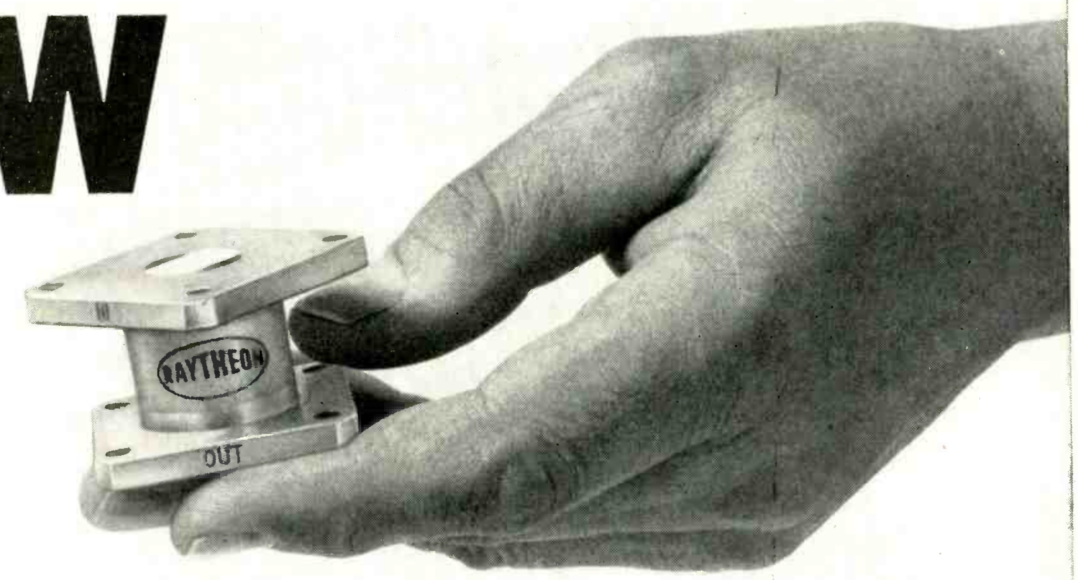
The three front decks of this unit are designed for the purpose of switching filament voltages, line voltages and B+ voltages and the like. The entire switch is silver plated to provide excellent r-f characteristics and all contacts and wipers are of coin-silver to minimize contact resistances. Overall dimensions are 4½ in. by 3 in. by 22 in. in depth. **Circle 408 inside back cover.**



SILICON RECTIFIERS
operate from —55 C to +150 C

General Instrument Corp., Automatic Mfg. Division, 65 Gouverneur St., Newark 4, N. J. Designed and manufactured to the extremely rigid requirements of MIL-E-1, four JAN types of silicon rectifiers (1N253, 1N254, 1N255 and 1N256) are now in large-scale production. The new rectifiers, which cover the range of 100 to 600 v peak inverse, are of alloyed junction construction with all-welded hermetic seal. Developed for use in all types of

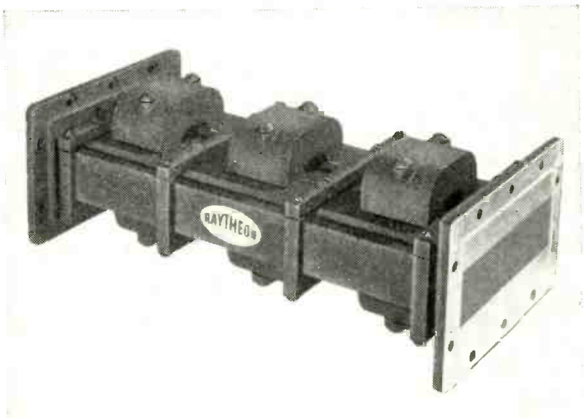
NEW



MINIATURIZED MICROWAVE ISOLATORS such as this new Raytheon X band unit weigh as little as 6 ozs.

MICROWAVE FERRITE ISOLATORS

—New designs now available for several bands

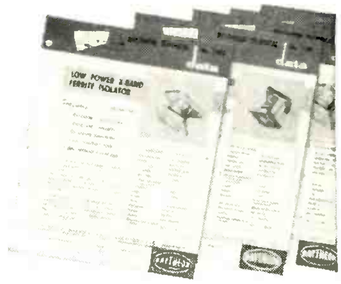


NEW HIGH POWER L-BAND ISOLATOR, first of its kind, typifies Raytheon leadership in microwave ferrite materials and devices.

You'll want to learn more about Raytheon's new full line of microwave ferrite load isolators as well as other devices now available commercially for the first time. Included in the line is a completely new L-band isolator, the first of its kind ever built. There are also units for S, C, X, K_E, and K_U bands.

RAYTHEON'S TYPE R-151 FERRITE MATERIAL is available for Faraday rotation devices in X and K band frequencies and for resonant-type isolators in S through K bands. Other compositions are available for various applications.

WRITE TODAY for technical data sheets on standard Raytheon microwave ferrite devices and material. Please state your specific requirements for more complete data. Write to W. C. Plouffe at address below.



RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

SPECIAL MICROWAVE DEVICE GROUP
28 SEYON STREET, WALTHAM 54, MASS.

See the Raytheon ferrite exhibit at Wescon.

Circle 168 Readers Service Card

military equipment where the basic limitations of selenium, germanium and vacuum tube rectifiers must be overcome, these units are designed for high reliability under the most severe environmental conditions of moisture, vibration fatigue, high acceleration vibration, centrifuging, shock and temperature cycling. They have been successfully operated at temperatures ranging from −55 C to +150 C and they can be stored to temperatures ranging from −65 C to +180 C. **Circle 409 inside back cover.**

DIGITAL VOLTMETER
various models available

ELECTRONIC COMPUTER CO., 6191 Ridge Ave., Phildelphia 28, Pa., has available various models of an all electronic analog to digital converter for data reduction systems and general voltage measurement applications. The unit pictured is model 100A with 0.1-percent accuracy or ±1 count and readings as high as 70 per sec. Input is 0 to 130 v. The unit supplies power for an external scale changing amplifier. It can be used as a counter, timer or an events per unit time instrument. It contains a decimal point locater and both decimal and binary coded output (1-2-2-4). Four-digit 0.01-percent accuracy models are also available. **Circle 410 inside back cover.**

MICROWAVE ANTENNA
for the 100-500 mc band

AINSLIE CORP., 312 Quincy Ave., Quincy, Mass., is offering a newly developed model CF-121M 12-ft diameter microwave antenna for the 100 to 500-mc band, with a

dipole exciter. Its gain is 23 db or better at 500 mc, with minimum side lobes and cross polarization of 20 db or better. It features low vswr at any frequency in the band accomplished through a unique readjusting balun and reflector assembly.

The antenna is of rugged, lightweight, all aluminum mesh construction, fully weatherized and corrosive resistant. It is available in both the 12-ft diameter model CF-121M, and a 14-ft diameter model CF-141M. **Circle 411 inside back cover.**

SILICON CRYSTALS
grown to required type

THERMOSEN, INC., 361 W. Main St., Stamford, Conn., announces the availability of oriented single crystal silicon ingots grown to customers' required type and resistivity. Crystals average 60 grams in weight, but smaller crystals can be supplied when desired.

Production is currently on a limited basis and priority will be given to customers requiring one or two crystals for research or small-scale production. Typical applications are rectifiers, transistors and infrared lenses. **Circle 412 inside back cover.**

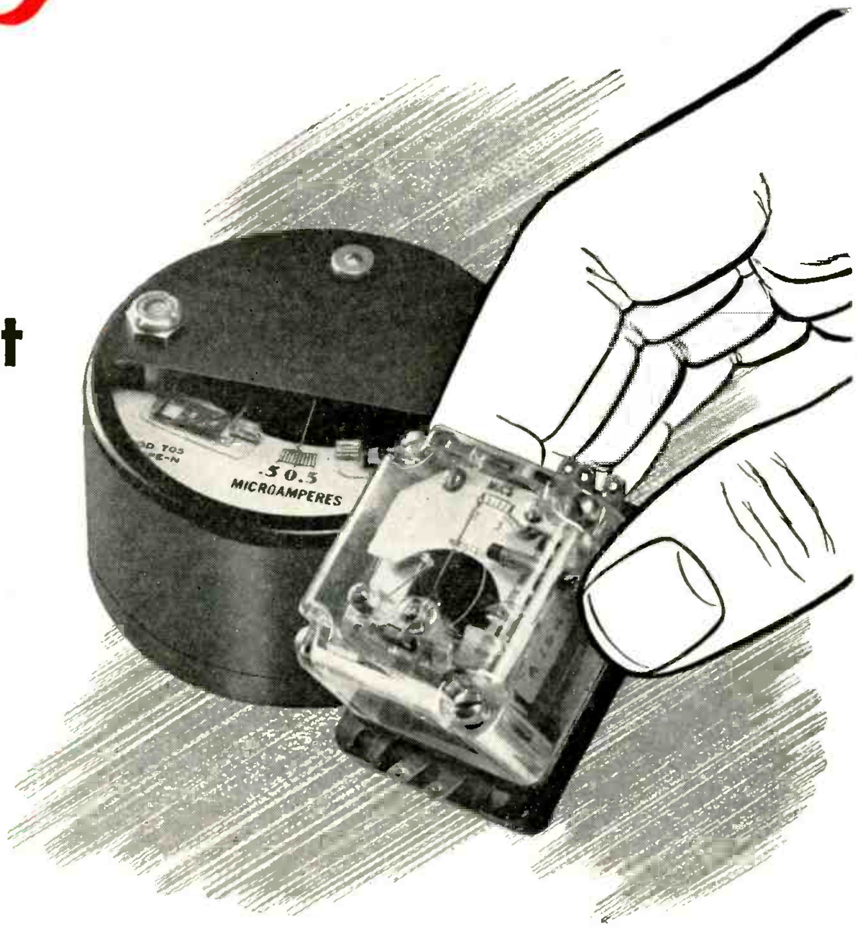
CERAMIC SWITCH
with up to eight decks

THE DAVEN CO., Livingston, N. J. has available a new ceramic switch which can be ganged with up to eight decks. One, two or three poles per deck may be obtained as standard.

Occupying less than 1½ sq in. of panel space, this rugged miniature ceramic switch contains up to 18 positions on a single wafer. Solid silver-alloy contacts, rotors

Forget the Amplifier

If your design utilizes an amplifier to boost a minute signal for relay operation – or, if you have 'shelved' some new product idea because the cost, space requirement and other drawbacks of amplifiers made the design impractical – *Sensitrol relays are for you.* For these tiny, ultra-sensitive relays, which operate direct on input signals as slight as *1 millivolt* or *½ microampere,* and handle substantial wattage at *110 volts,* entirely replace amplifiers, vacuum tubes and auxiliary power supplies. They are available with single or double contacts, fixed or adjustable, manual or solenoid reset. For engineering assistance in adapting Sensitrol relays to present products, or new problems you have in mind, call your nearest Weston representative, or write for the Sensitrol bulletin B-25-B . . . *Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.*



Boost feeble input signals with compact

Sensitrol® relays

WESTON Instruments

A DAYSTROM UNIT

Circle 171 Readers Service Card

The Magic Mirror One-Ten° Aluminized Picture Tube

The Magic Mirror **One-Ten°**, the brand-new 110° deflection picture tube, is designed by Tung-Sol to meet the most exacting specifications and performance requirements of manufacturers of portable and light-weight cabinet and table TV sets.

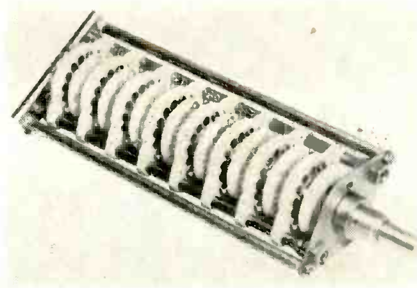
The Magic Mirror **One-Ten°** is being produced in types 17BZP4 and 21DAP4. The 17BZP4 is 12 9/16 inches long (three inches shorter than standard 90° tubes), possesses a 155 square-inch viewing area and weighs but 10 pounds. The 21DAP4 is 14 11/16 inches long, has a 262 square-inch area and weighs 20 pounds.

The Magic Mirror **One-Ten°** needs no ion-trap magnet. It is aluminized by the same unique method that has earned for all Tung-Sol picture tubes their reputation among set manufacturers for pictures of outstanding quality.

TUNG-SOL®

ELECTRON TUBES
SEMICONDUCTORS

TUNG-SOL ELECTRIC INC., NEWARK 4, N. J.



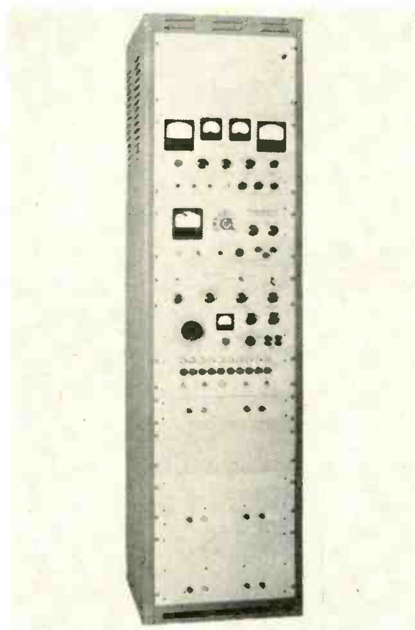
and slip rings provide low and uniform contact resistance. Ceramic parts are silicone impregnated to function under extreme humidity. Sturdy solder terminals are supplied for wiring. This miniature switch meets and exceeds the electrical and environmental requirements of MIL-Spec S-3786. Flashover voltage at 60 cycles is 1,000 v peak; current carrying capacity is 2 amperes.

These switches find a variety of applications on guided missiles, airborne radar equipment and portable and mobile ground equipment. **Circle 413 inside back cover.**

SINGLE-TURN POT meets military specs

Spectrol Electronics Div. of Carrier Corp., 1704 South Del Mar Ave., San Gabriel, Calif., has announced a precision $1\frac{1}{16}$ in. diameter single-turn potentiometer, the model 130. It meets military specifications NAS-710 environmental humidity requirements, and will operate in a temperature range of -55 C to $+85$ C. Standard linearity tolerance is ± 0.5 percent, however special linearity tolerances are available upon request.

The unit has a standard resistance range from 10 ohms to 30,000 ohms, with a standard tolerance of ±3 percent. Model 130 has a life exceeding 1,000,000 revolutions. Multiple taps can also be requested with as many as 11 additional taps being supplied to meet nearly all specific location requirements within 26 deg of each other, on the rear of the unit. Further information is available from the company. **Circle 414 inside back cover.**



TRANSISTOR ANALYZER
with extended power range

POLYPHASE INSTRUMENT CO., East Fourth St., Bridgeport, Pa. The extended power range of Polyphase model TA-13 transistor analyzer is sufficient to analyze the most important characteristics of all transistors. The collector sweep power supply, rated at 20 amperes and 150 v, is more than adequate for testing of transistors currently available. Transistors with power ratings ranging from 10 mw to 100 w may be tested. Tracing of seven characteristic family curves is presented on any conventional oscilloscope.

Electronically generated and swept, 10 constant-current input current steps are individually adjustable and metered to 50 ma per step or 450-ma total current. A built-in calibration axis generator

is used for accurate oscilloscope calibration. Accurate meter measurement of small signal alpha and beta, d-c beta and d-c collector leakage current is conveniently performed. **Circle 415 inside back cover.**

FLUTTER METER
features superior limiting

D & R, LTD., 402 E. Gutierrez St., Santa Barbara, Calif. Model FL-3D flutter and wow meter is designed to be used as a general purpose test instrument meeting the requirements for measuring flutter content in recording and reproducing systems as established by the IRE, ASA and SMPTE.

Superior limiting, extended bandwidth, selectable wow and flutter filters, and rms calibration are outstanding features. Full-scale sensitivities of 2.0 percent and 0.5 percent are available with accuracies better than 10 percent. An output terminal is included to provide a d-c to 250 cps signal for graphic recording purposes. A regulated power supply insures stable operation of internal 3,000-cps carrier oscillator over wide excursions of the input line voltage. The FL-3D measures 7 in. by 12 in. by 6 in. and weighs only 10½ lb. **Circle 416 inside back cover.**

VOLTAGE REGULATORS
corona type instruments

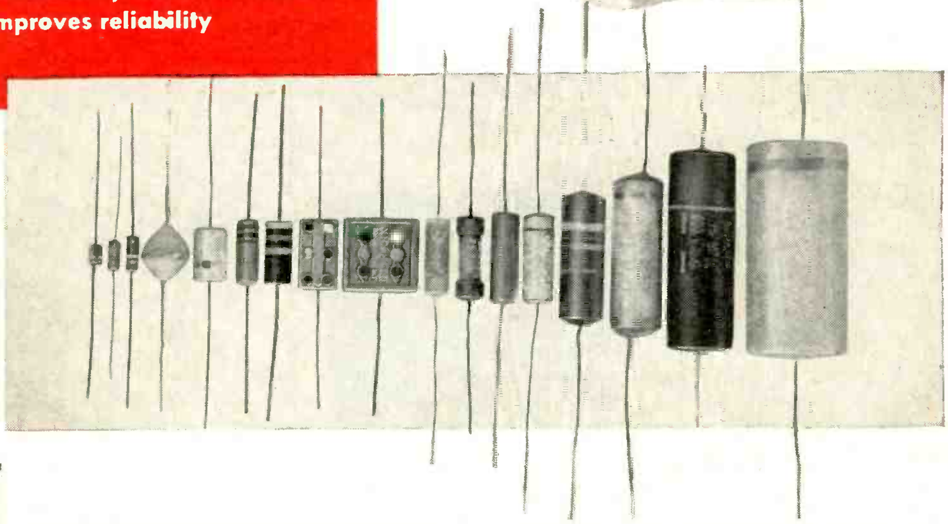
THE VICTOREEN INSTRUMENT CO., 5806 Hough Ave., Cleveland 3, Ohio, announces the development of corona type regulators with current ratings up to 4 ma. They are produced for MIL and other

The new

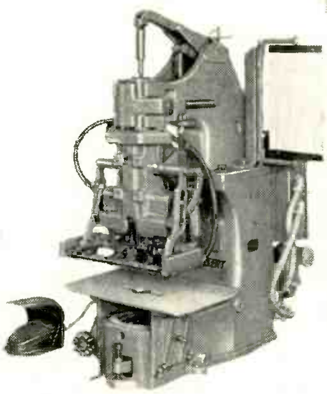
DYNASERT

#3 Component Inserting Machine

- ☆ Takes axial lead components in broad range of sizes and shapes
- ☆ Handles bent or off-center leads
- ☆ Cuts assembly time and costs — improves reliability



Machine cuts component leads, forms them into a staple shape, inserts them into holes in your wiring boards and clinches in one operation. Up to 700 insertions per hour can be made on average size board.



Here's a brand new machine for inserting components in printed wiring boards. It's so advanced in adaptability and performance reliability that it gives new meaning to mechanized assembly.

This machine eliminates normal requirements for straight or centered leads, special packaging or preparation. It is economical for use on short runs; new set-ups are quickly made by simple adjustments or slip-in tooling.

Available either for individual bench operation or as a unit in fully automatic conveyorized assembly lines. For full information write:

INDUSTRIAL SALES DIVISION

United

SHOE MACHINERY CORPORATION

140 FEDERAL STREET, BOSTON, MASS.

PRODUCTION EQUIPMENT FOR ELECTRONICS

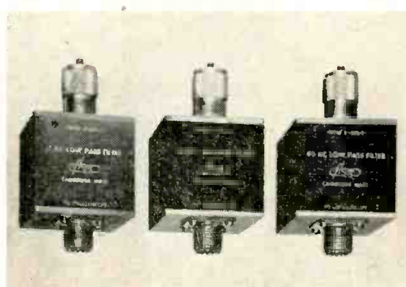
Circle 176 Readers Service Card

applications in T6½ and T9 envelopes in voltage ranges below 3,500 v.

This simple form of high voltage regulation can be used in many applications formerly requiring the more complex multitube systems. Suggested applications for high current corona type voltage regulators include klystron power supply, high beam current synchroscopes, laboratory oscilloscopes, radar display units and magnetron oscillators. **Circle 417 inside back cover.**

R-F PREAMPLIFIER
high-gain type

RADIATION, INC., P. O. Box 37, Melbourne, Florida. This preamplifier combines extremely high gain with a low noise figure and relatively wide bandwidth. The model 1 provides a gain of 35 db at band center and the model 2, 50 db, both with a maximum noise figure of 3.5 db. Frequency response is within 3 db over the band of 215-247 mc. The unit occupies a volume of ⅓ cu ft and weighs less than 3½ lb. **Circle 418 inside back cover.**



LOW-PASS FILTERS
remove undesired h-f signals

FLOW CORPORATION, 85 Mystic St., Arlington 74, Mass., announces a

DOW CORNING CORPORATION

Silicone Dielectrics

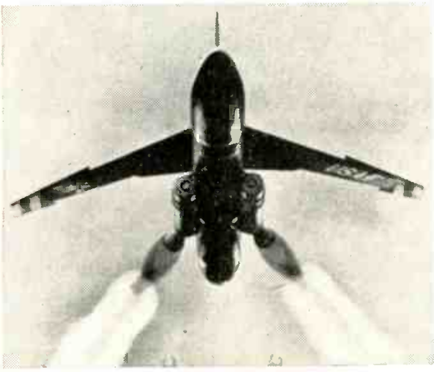
ELECTRICAL AND ELECTRONIC NEWS No. 13

Reliability of Snark Instruments Assured with Silicone Rubber

Engineers at Northrop Aviation take no chances on the performance of intricate high impedance circuits in the "Snark" guided missile, the F-89 Interceptor and other Northrop projects. They virtually "seal in" top performance by completely encapsulating the brains of these units in Silastic* RTV.

A new, easy-to-apply silicone dielectric that vulcanizes into a rubbery solid at room temperatures, Silastic RTV provides positive protection for even the most delicate electronic components. All panels containing resistors, capacitors, transistors and other recording and transmitting gear are embedded in this Dow Corning silicone rubber. According to Northrop engineers, a single coating—

- provides an effective cushion against vibration
- assures maximum moisture resistance
- improves electrical properties, especially surface resistivity
- protects assemblies against rough handling
- may be applied with a caulking gun

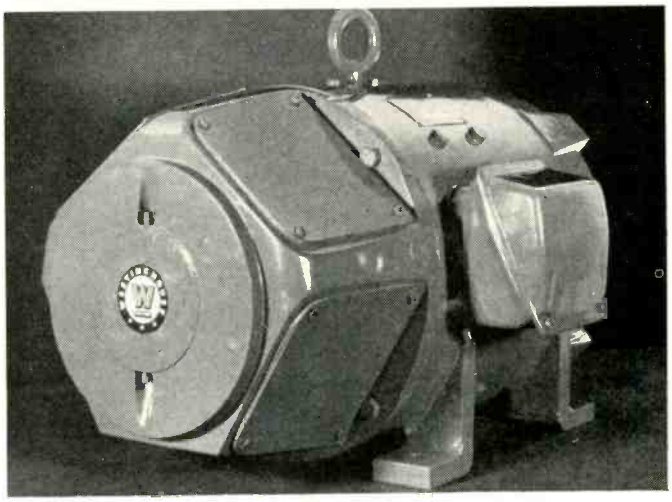


Another important advantage of using Silastic RTV in this application is the ease of inspecting or replacing individual components after assembly. The silicone rubber "skin" is simply slit open to expose the component. Such openings are easily patched with more Silastic RTV.

Silastic RTV ranges from a heavy putty to a fluid-like consistency. It attains optimum physical and dielectric properties in 4 to 7 days. *No. 51*

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

Westinghouse Introduces Silicone Insulated D-C Motors



While most leading manufacturers of electrical equipment build silicone insulated units for special purposes, now for the first time Westinghouse's new Life Line "H" series offers the advantages of silicone insulation in standard "off the shelf" d-c motors and generators.

Dow Corning silicones have been used in combining a high temperature insulating system with complements of copper and iron equal to those used in conventional Class B machines. As a result, these new motors and generators rated at Class B temperatures have at least 10 times longer insulation life.

In addition, Dow Corning silicones help provide extra protection against emergency overloads and abnormal ambients to reduce motor maintenance. Insulation is no longer a limiting factor to motor life. Already in production, the new dc motors span ratings from 1 to 150 hp: the dc generators are rated from ¾ to 100 kilowatts.

Life Line "H" equipment is designed to be especially useful for automated processing where insulation failure in one unit may shut down an entire assembly line throwing production schedules and costs way out of line.

The extra overload capacity provided by the silicone insulation system makes these motors ideal for conveyor, pump, blower and processing motors in mines; for drive motors in the glass, machine tool, paper and metals industries; for conveyor drive motors in material handling and many other processing industries. *No. 50*

Silicone Glass Coil Insulators Reduce Small Motor Assembly Costs

By insulating the coils of their ⅕ hp, 14,000 rpm afterburner ignition actuator motors with silicone-glass laminates, Lear, Inc., have cut costs a substantial $1.50 per unit

Located next to jet engines where ambient temperatures soar to 400 F and higher, these motors have always been silicone protected. Lear originally tape-wrapped the coils by hand, but they recently eliminated this time-consuming job by switching to pre-formed glass laminates bonded with a Dow Corning silicone resin.

By reducing assembly time to an absolute minimum, the laminated insulators save Lear $1.50 per motor while still providing the maximum in insulating efficiency. The coil insulators are pre-formed in two sections by Stevens Products of East Orange, New Jersey. *No. 52*

Send Coupon for More Information

DOW CORNING CORPORATION · Dept. 4820
Midland, Michigan
Please send me 50 51 52

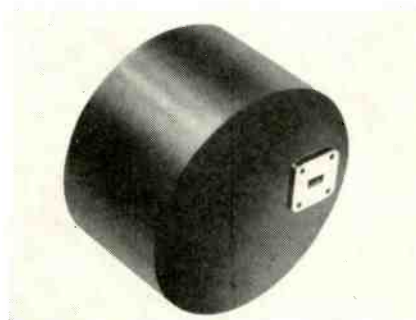
NAME __________
TITLE __________
COMPANY __________
STREET __________
CITY ______ ZONE ____ STATE ______

ATLANTA • BOSTON • CHICAGO • CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEW YORK • WASHINGTON, D. C.

Canada: Dow Corning Silicones Ltd., Toronto; **Great Britain:** Midland Silicones Ltd., London; **France:** St. Gobain, Paris new series of audio low-pass filters for use in any system whose a-c resolution in the a-f range suffers from stray noise at frequencies above the range of interest.

These new series F sharp-cutoff low pass filters remove undesired h-f signals such as amplifier noise in the amplified output signals from hot wire anemometers, strain gages, vibration pickups, acoustic pickups and the like.

Standard values available from stock are 7, 20 and 40-kc cutoff. Attenuation is zero at low frequency, 1 db at cutoff frequency and 12 db per octave above cutoff. Connectors are standard AN PL-259 coaxial input and SO-239 coaxial output. Input impedance is 500 ohms; output impedance, 4,000 ohms. Size is 2 by 2 by 2 in. Shells are extruded aluminum, distinctively color coded and marked. **Circle 419 inside back cover.**



MINIATURE ISOLATOR for Ka-band use

AIRTRON, INC., 1101 W. Elizabeth Ave., Linden, N. J., announces a new 100-kw resonant absorption Ka-band miniature isolator weighing less than 3 lb. Designed to operate over a frequency range of 34.5 to 35.9 kmc, it insures optimum magnetron spectrum and power output by furnishing isolation between magnetron and r-f energy reflected from line mismatches.

Because of its extremely compact shape, the isolator affords retrofitting easily and simply; consequently, redesigning of existing systems is simplified or unnecessary.

Since the ferrite is mounted di-

FIRST IN SERVICE

CNI

ELECTRONICS PACKAGE

NOW IN FULL PRODUCTION

The AN/ASQ-17 CNI package, developed and built by Packard Bell Electronics, marks the first successful integration of communications, navigation and identification in one compact unit. It has been accepted for service use by the U.S. Navy in the Douglas A4D "Skyhawk" and the Chance-Vought F8U "Crusader." It has been in quantity production for several months. Hundreds are now in operation.

ENGINEERING BEYOND THE EXPECTED

Mutual interference between IFF and UHF is normally inevitable, even when the units are encased separately and spaced several feet apart. In the AN/ASQ-17 these two units are packaged together, *a fraction of an inch* apart. Yet in official trials *mutual interference was not noticeable or measurable.* This achievement "beyond the expected" resulted from coordinated efforts of Douglas, Chance-Vought and Packard Bell Electronics engineers.

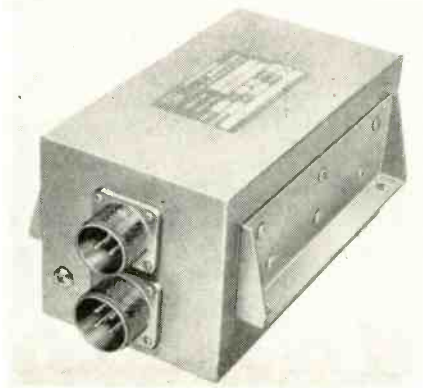
AN/ASQ-17 will be featured at Booths 609-610, WESCON, *San Francisco Cow Palace, Aug. 20-23.*

PACKARD BELL ELECTRONICS
TECHNICAL PRODUCTS DIVISION
12333 W. Olympic Boulevard
Los Angeles 64, Calif., BRadshaw 2-2171

Circle 180 Readers Service Card

rectly on the waveguide wall, heat is conducted away from it quite rapidly, allowing operation at high power levels without forced air cooling.

Optimum electrical characteristics include an isolation of 20 db minimum and an insertion loss of 1 db maximum. It operates over a temperature range of −55C to +100 C. These operating characteristics are guaranteed under vibration specification MIL-E-5272A. **Circle 420 inside back cover.**



POWER SUPPLIES
low voltage a-c, d-c type

ENGINEERED MAGNETICS DIVISION, Gulton Industries, Inc., Metuchen, N. J., announces a new line of Glennite low voltage a-c, d-c power supplies. Engineered to deliver precise plate voltages to aircraft electronic systems, the Glennite telemeter and strain gage power supplies are designed for 400-cycle operation, but are also available for 60-cycle circuits. Hermetically sealed, the tubeless power supplies have no moving parts.

Characteristics include a regulation of ±0.2 percent, ripple of 1 percent rms, recovery time of 0.5 sec and a variety of outputs. These power supplies will retain accuracy under extreme airborne conditions of shock and vibration. **Circle 421 inside back cover.**

SCREEN RESIST
for printed circuits

TECHNIQUES INC., 52 Jackson Ave., Hackensack, N. J., has announced

Coffee-break Reading—

IF you are responsible for (or are engaged in) the design, development, purchase or production of systems requiring precision timing, you realize the distinct advantage of knowing about the companies from which you buy. The background, experience, reputation of these suppliers and the application of their products can, as you know, act as a valuable guide in saving time and money, — not to say the avoidance of regret and disappointment.

● So, over your coffee cup, know ye that: —

● Our products consist basically of frequency standards and precision, electronic forks, (50 to 3000 cycles, accuracy to 1 part in 100,000 or better if required). These are available separately for integration with units of your own manufacture or as parts of instruments made by us.

● Several of our executives have engaged in the engineering of these frequency standards and precision forks for more than 20 years; a few more are at the 15-year mark. During this time we have learned much regarding the subtle idiosyncracies of materials and the mischievous capers of delicate processes. Each of our completed production units undergo 85 measurements. A single transistorized standard contains copper, steel, nylon, silicone rubber, glass, carbon, teflon wire, mylar capacitors, silicon diodes and a fork alloy containing 15 elements. So what? Accuracy, dependability, stability . . . superiority.

● In miniaturization, our staff has produced units which, in a 5-ounce, 6-cubic inch volume have proved more rugged and possess efficiency superior to 60-pound, 3-cubic foot units in general use some years ago.

● Our company has been in the frequency standard business for 20 years. Instruments of our manufacture have met the rigid inspection and exacting tests imposed by governments, the armed forces and industry for widely varied, high-precision timing applications. Continuing reorders and our consequent growth attest the satisfaction of our products.

REPRESENTATIVE FIELDS OF APPLICATION

Aviation, Navigation
Ordnance, Ballistics
High-speed Photography
Viscosity Measurement
Fluid Flow
Nuclear Physics
Telemetering
Chemical Reaction
Radiation Counting
Computers
Facsimile
Fire Control
Accurate Speed Control
School and Indl. Research Labs.

American Time Products, Inc.
580 Fifth Avenue, New York 36, N.Y.

Supracote Blacktop No. 3. This material is a superior screen resist formulation for printed circuits. It is designed to withstand the action of alkaline cleaning and plating baths without lifting, pitting or undercutting. Excellent results are obtained either with ferric chloride or sulfuric chromic etchants. Sharpness and detail of pattern laid down compare extremely favorably with direct photographic process. **Circle 422 inside back cover.**

MEGOHMMETER
both resistance, conductance

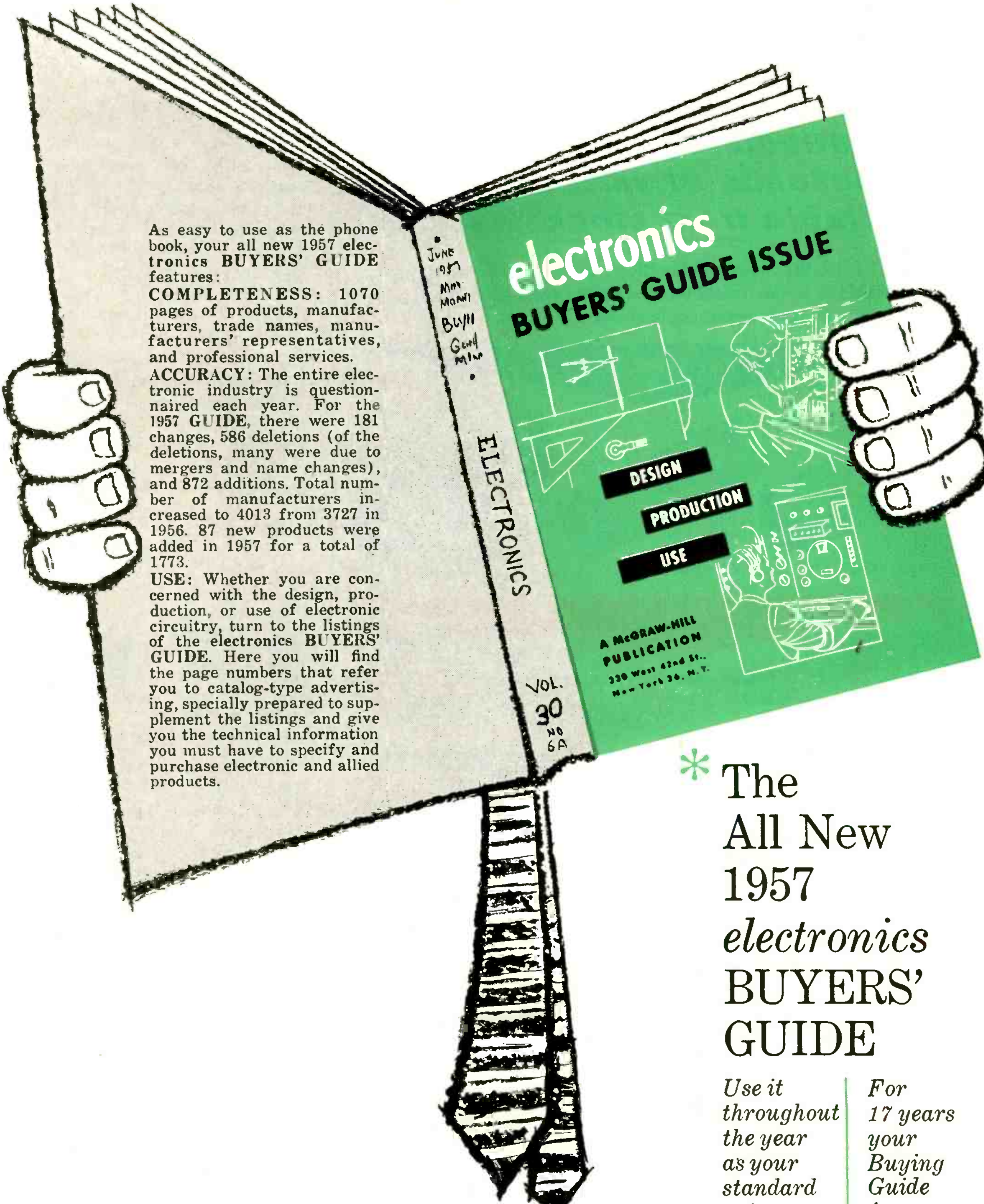
THE HERMAN H. STICHT CO., INC., 27 Park Place, New York 7, N. Y. Model 35A high resistance MYRIA megohmmeter is of Britsh manufacture. It not only covers a very wide range of resistances from 50,000 ohms to 200,000 megohms over 10 ranges, with 2 fixed test potentials, but it has a scale reading also in conductance. The instrument is calibrated in conductance as well as in resistance.

The instrument is $13\frac{1}{4}$ in. by 11 in. by $8\frac{1}{2}$ in., weighs only 22 lb and is equally suitable for use in workshop, field, or laboratory. **Circle 423 inside back cover.**

RELAY
for military and industry

RADIO CORP. OF AMERICA, Camden, N. J., recently developed type 204W1 high-temperature airborne-electronic relay. It features an active getter for absorption of residual gas and organic vapors. Inclusion of the getter assures dependable operation over an ambient range of −65 to +125 C,

*now in your hands . . .



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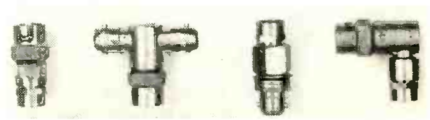
electronics A McGraw-Hill Publication 330 West 42nd Street New York 36, N.Y.

and under low-current, low-voltage as well as full load conditions.

A 6pdt, miniaturized-type, hermetically sealed relay, the 204W1 utilizes palladium contacts and is compactly constructed to meet the electrical and mechanical requirements of U.S. military relay specification MIL-R-5757. This rugged relay is built to withstand severe conditions of shock, vibration, humidity and altitude.

Design features include a unique one-piece extruded can with two integral mounting flanges safeguarding against h-f vibration, shock and salt spray. In production, the 204W1 is evacuated, filled with gas, and hermetically sealed to prevent coil and contact damage from dust, moisture and corrosion.

Rigorous testing throughout the entire manufacturing process insures peak operating performance. Overall height is 1¾ in. Its diameter is 1 3/16 in. and it weighs less than 3 oz. **Circle 424 inside back cover.**

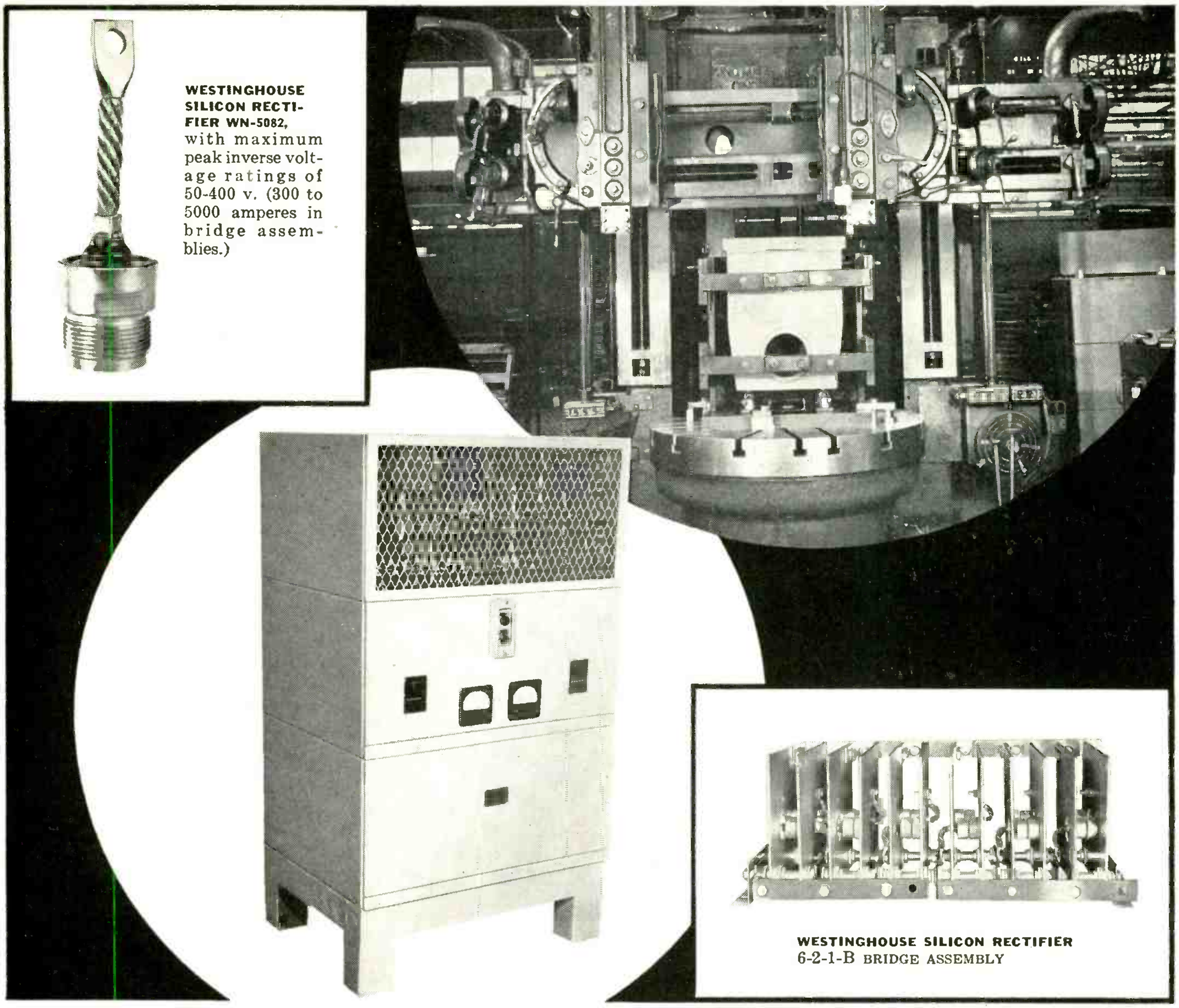


CONNECTORS
miniature and subminiature

KINGS ELECTRONICS CO., INC., 40 Marbledale Road, Tuckahoe, N. Y., introduces the KM series of small, lightweight miniature and subminiature connectors. This series is used with RG-59/U, RG-62/U and RG-71/U cables. These connectors have a peak voltage of 500 v and operating temperatures from 350 to 450 F. From left to right are: plug (KM-51-01), tee adapter (KM-91-02), panel jack (KM-11-01) and angle plug (KM-51-02). **Circle 425 inside back cover.**

JACK PANEL
double row type

AUDIO DEVELOPMENT CO., 2833 13th Ave. South, Minneapolis 7, Minn., has available the new PJ-340 double row jack panel. The new



WESTINGHOUSE SILICON RECTIFIER WN-5082, with maximum peak inverse voltage ratings of 50-400 v. (300 to 5000 amperes in bridge assemblies.)

WESTINGHOUSE SILICON RECTIFIER 6-2-1-B BRIDGE ASSEMBLY

Westinghouse SILICON(Si) RECTIFIERS put more muscle in DC power converter!

Successfully proven in rigorous welding, aircraft and guided missile applications, Westinghouse Silicon Power Rectifiers offer many advantages for power supplies.

Used in the Westinghouse 50KW Power Converter to drive the boring mill above, the WN-5082 bridge assembly supplies greater power and higher efficiency in less space. The 3-phase 60-cycle 440 v. power supply operates with a full load efficiency of 90% and an even higher half load efficiency. Regulation is approximately 8% from no load to full load with a Power Factor of 96 to 97.

Especially rugged for varying duty cycles, the WN-5082 withstands heavy loads of constant on-off operation, high-voltage transients, alternate heating and cooling.

YOU CAN BE SURE... IF IT'S

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Westinghouse can supply single diodes or complete bridge assemblies built to your specifications. For full information on how Westinghouse Silicon Rectifiers can bring new efficiency and economy to your applications, mail the coupon today.

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Please send me data on the new Westinghouse WN-5082 Silicon Rectifier.

Please send me data on other Westinghouse Silicon Rectifiers. (Describe types or applications)________

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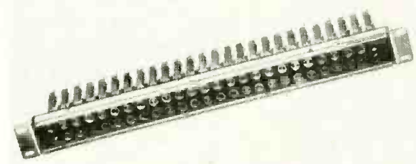
CITY________ ZONE________ STATE________

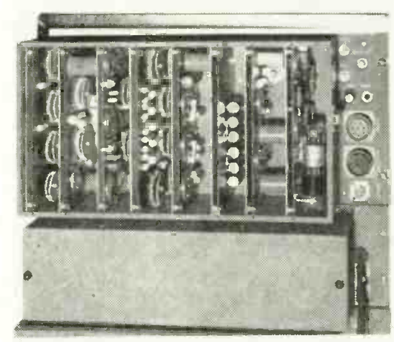
Circle 186 Readers Service Card



panel provides for 52 jacks mounted on ⅝ in. centers. It is constructed of molded black phenolic plastic reinforced with steel for maximum rigidity. It is 1¾ in. wide and fits a standard 19 in. relay rack.

The PJ-340 comes complete with 52 ADC type PJ-318 normally closed circuit jacks. Mounting brackets, designation strips, and jacks are plated to withstand a 50 hr salt spray test.

This jack panel is equivalent to the Western Electric 230 A. It is also available without jacks as ADC type PJ-30. **Circle 426 inside back cover.**



SSB TRANSCEIVER
completely transistorized

ERCO RADIO LABORATORIES, INC., Garden City, New York. Type 464-TR carrier frequency ssb transceiver will provide reliable voice communication channels over existing telephone or power lines where additional talking facilities are required. It can be used on any frequency between 5 kc and 200 kc where the total attenuation does not exceed 80 db with each voice channel occupying a bandwidth of 3,000 cps.

Plug-in modular construction together with printed circuitry is employed and the complete trans-

AVOID PROTOTYPE DELAYS!
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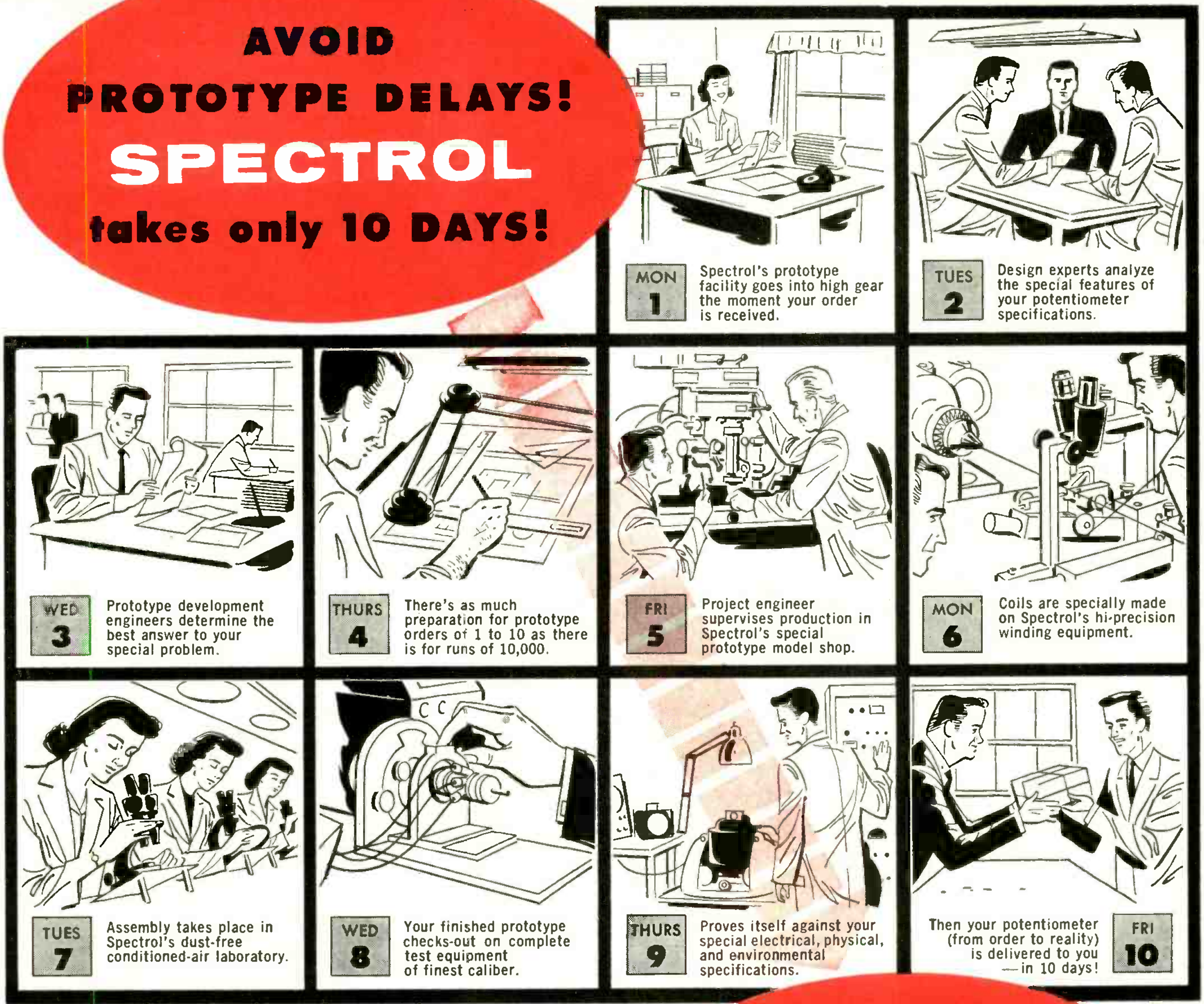

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That means, with Spectrol you can actually be in production long before you would receive your first prototype elsewhere. Remember Spectrol—for any of your potentiometer requirements—standard or special!

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D. R. Bittan Company
VALLEY STREAM, L. I., NEW YORK
Locust 12444

Samuel K. Macdonald, Inc.
WASHINGTON, D. C.
COLUMBIA 53938

Uni-Office, Ltd.
ROTTERDAM, HOLLAND

Circle 65 Readers Service Card

ceiver is mounted on a standard $8\frac{3}{4}$ by 19 in. panel. When transmitting, +15 dbm carrier is used for selective calling and receiver avc. At full modulation, the sideband power is +26 dbm or 400 mw peak envelope power. Because the transceiver is completely transistorized, the total battery drain from a 24 v d-c source is only 400 mw when receiving and 4 w when transmitting. Selective calling components are mounted on an adjacent panel.

The equipment is applicable to any service where physical circuits are limited by line noise or overloading and will provide additional talking circuits at a fraction of the cost of installing additional physical circuits. **Circle 427 inside back cover.**

STEP INPUT UNIT
for use with X-Y recorder

F. L. MOSELEY CO., 409 N. Fair Oaks Ave., Pasadena, Calif. Data plotting at any number of preset increments up to 999 steps along one axis is possible with the new model 51 step input unit. Designed for use with the Autograf X-Y recorder, the unit provides means for producing bar-type graphs to any scale on standard or nonstandard graph paper. Completely self-contained, the model 51 visually displays by means of illuminated numbers the content of the mechanism at any point in a test series thus facilitating start and stop operations without losing track of position at any time. Calibration to any scale factor is possible by adjusting both size and number of steps to conform to the data being plotted. Zero may be set at any point. Use of the unit does not require modification of a

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MILITARY TYPE

AUTOMATIC silicon rectifiers

JAN TYPES

1N253

1N254

1N255

1N256

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The reliability demanded by the rigid electrical, mechanical and environmental specifications of MIL-E-1 is now assured with **Automatic's** JAN TYPE silicon rectifiers . . . offered in production quantities at prices reflecting volume output.

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TYPICAL VALUES FOR AUTOMATIC MILITARY TYPE SILICON RECTIFIERS

Type No.	Peak Reverse Voltage	DC Output Current AY*	Maximum Reverse Current* **	Mounting	MIL-E-1 Technical Spec. Sheet No.
	(VOC)	(MA)	(MA)		
1N253	100	1000	0.1	Stud-Mount	1024
1N254	200	400	0.1	Stud-Mount	989A
1N255	400	400	0.15	Stud-Mount	990A
1N256	600	200	0.25	Stud-Mount	991A

*CASE TEMPERATURE 135°C.

**AVERAGED OVER 1 CYCLE FOR INDUCTIVE OR RESISTIVE LOAD WITH RECTIFIER OPERATING AT FULL RATED CURRENT.

Available JAN TYPES: 1N253, 1N254, 1N255, 1N256

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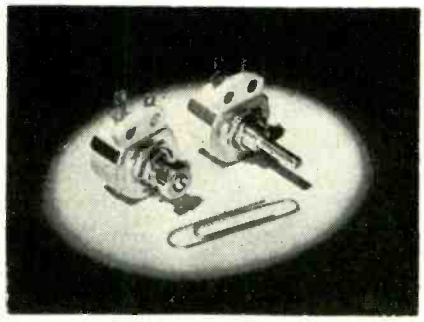
MASS PRODUCERS OF ELECTRONIC COMPONENTS

AUTOMATIC MANUFACTURING
DIVISION OF GENERAL INSTRUMENT CORPORATION
65 GOUVERNEUR ST.
NEWARK 4, N. J.

standard recorder. **Circle 428 inside back cover.**



MINIATURIZED POTS
use new molding material

CLAROSTAT MFG. CO., INC., Dover, N. H. Further refinement of the series 49M miniaturized wire-wound potentiometer, by way of still higher dielectric strength, has been announced.

A new molding material, green in color, is now used in these potentiometers. This feature, together with design refinements, results in exceptionally low electrical leakage in operation. Tests indicate complete compliance with the high performance standards set for miniaturized components in the most critical applications.

Series 49 M pots are $\frac{3}{4}$ in. in diameter by $\frac{1}{2}$ in. deep; 1.5 w; 4 ohms to 20,000 ohms resistance. **Circle 429 inside back cover.**

TUBE SHIELDS
large in diameter, length

INTERNATIONAL ELECTRONIC RESEARCH CORP., 145 West Magnolia Blvd., Burbank, Calif. The NW type shield (NW6-6528) was designed especially for the Bendix 6094 tube and tubes of the same bulb size. These tubes are larger in diameter and length than the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ONLY PRECISION MACHINED ROTARY RELAY
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BURTON BROWNE/New York

usual 9 pin noval tube. The NW shield assembly consists of an aluminum shell, a phosphor bronze compression spring and an inner beryllium copper spring finger liner. This assembly locks into a brass MIL type B base T6-1001. The spring finger liner grasps the glass bulb and dissipates the heat by conduction, radiation, and convection. This shield will lower the bare bulb temperature of a 6094 tube operating at 16 w filament and plate dissipation by more than 60 C. The shield assembly and base retain the tube under extreme shock and vibration conditions. This type shield is also available to fit all standard sizes of 7 and 9 pin miniature tubes.

For retrofitting equipment having old style JAN bases, a TR shield is available to fit the 6094 tube. In this assembly (TR6-6027-1) attachment to the base is accomplished by a snap-on type lock which offers superior retention of the tube under shock and vibration environments. The reduction of the bare bulb temperature afforded by this shield is 35 C under conditions described for the NW type shield. The TR type shield is also available to fit all standard size 7 and 9 pin miniature tubes. **Circle 430 inside back cover.**

TINY CAPACITORS
for high temperature use

DEARBORN ELECTRONIC LABORATORIES, 1421 North Wells St., Chicago 10, Ill. Deltaply 165 capacitors offer a new low in volume and a new high in reliability over the temperature range −65 C to +165 C. As an example of the size, a 1.0 μf, 200 v unit requires 3.8 cu in. The same unit in Teflon requires 6.4 cu in. Capacitance change over the full temperature range will amount

NEW DC-to-10MC OSCILLOSCOPE requires only 7 inches of rack height

A new 3" rack-mounting oscilloscope, the Tektronix Type RM16, combines high performance with small size to help ease the space problem in rack installations. It measures only 7" high, 19" wide, 16¾" rack depth, 19¼" overall depth. For servicing convenience, the RM16 can be tilted vertically on its modern slide-out mounting.

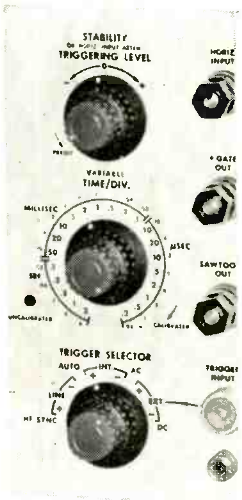
DC-COUPLED VERTICAL AMPLIFIER

Main Amplifier passband is dc to 10 mc, risetime 0.035 μsec. Vertical deflection is calibrated in steps of 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, and 50 v/div. An ac-coupled preamplifier provides three additional steps of 0.01, 0.02, and 0.05 v/div at a frequency response of 2 cycles to 9 mc, risetime 0.04 μsec. Calibration accuracy is within 3% of the panel reading. A vernier (uncalibrated) control provides for continuously-variable adjustment from 0.01 v/div to 125 v/div. Balanced network provides 0.25-μsec signal delay. Input capacitance is 38 μμf direct, 13 μμf with probe.

WIDE-RANGE SWEEP CIRCUIT

A single knob is used to select any of 22 calibrated sweep rates from 0.2 μsec/div to 2 sec/div. Calibration accuracy is typically within 1% of full scale, and in all cases within 3%. A vernier (uncalibrated) control provides for continuously-variable adjustment from 0.2 μsec/div to 6 sec/div. The unblanking waveform is dc-coupled to the crt grid, assuring uniform bias for all sweep and repetition rates.

A sweep magnifier expands the normal sweep to 50 divisions, any 10 of which can be positioned on the screen, increasing the calibrated sweep range to 0.04 μsec/div. The magnified sweep rate is read directly from the panel. Calibration accuracy is within 5% of the displayed portion of the magnified sweep.



FOUR-WAY TRIGGERING

1. Amplitude-Level Selection—adjustable amplitude-level and stability controls for triggering at a selected level on external, internal, and line signals—either polarity—ac or dc-coupled.
2. Preset Stability—same as above, except stability is preset at the optimum triggering point and requires no readjustment.
3. Automatic Triggering—automatic level-seeking trigger circuit provides dependable triggering for most applications, even on very small signals, through wide changes in amplitude, frequency, and shape of the triggering signal. Provides a reference trace on the screen when no trigger signal is present.
4. High-Frequency Sync—assures a steady display of sine-wave signals up to approximately 20 mc.

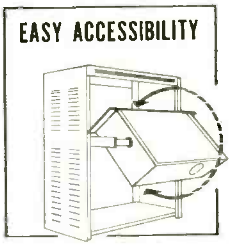
OTHER CHARACTERISTICS

Voltage calibrator has 11 fixed peak-to-peak outputs from 0.05 to 100 volts. Accuracy is within 3%. Square-wave frequency is approximately 1 kc.

New 3" Tektronix cathode-ray tube, Type T31P2, is used. Optional phosphors are P1, P7 and P11. Accelerating potential is 1.85 kv.

Horizontal amplifier can be driven by an external signal. Deflection factor is approximately 1.4 v/div, frequency response dc to 500 kc.

Power supplies are electronically regulated. Type RM16 operates on 105 to 125 v or 210 to 250 v, 50 to 60 cycles, 260 watts. Type RM16-S1 operates on 50 to 800 cycles, uses dc fan motor.

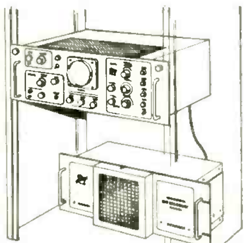


Type RM16
(50 to 60 cycle supply)
$795.00

Type RM16-S1
(50 to 800 cycle supply)
$830.00

Prices f.o.b. Portland, Oregon

The Type RM16 will also be available with power supply separated from indicator unit for racks with limited depth. Dimensions are: Indicator Unit—7" high, 19" wide, 11⅜" deep . . . Power Supply—7" high, 19" wide, 5½" deep.



First shipments of the Type RM16 are expected to be made during November 1957. Please keep in touch with your Tektronix Field Engineer or Representative for current details.

See the Type RM16 and other new Tektronix instruments at WESCON, booths 1701, 1702.

Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon
Phone CYpress 2-2611 • TWX-PD 265 • Cable: TEKTRONIX

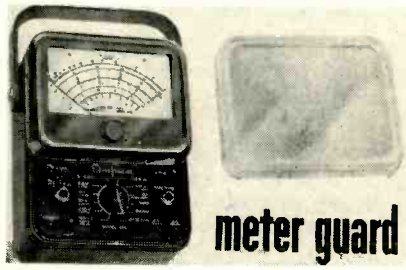
ENGINEERS—interested in furthering the advancement of the oscilloscope? We have openings for men with creative design ability. Please write Richard Ropiequet, Vice President, Engineering.

Circle 192 Readers Service Card

to less than 9 percent.

Insulation resistance in megohms × microfarads varies from 200,000 at 25 C. The self-healing, metallized, plastic film provides unusually long life at 165 C with no voltage derating.

Capacitance values from 0.001 to 10.0 μf, may be obtained in hermetically sealed metal tubes or double-lock seal tubular cans. The smaller sizes are also available uncased. Standard voltage ratings are 200, 400 and 600. **Circle 431 inside back cover.**



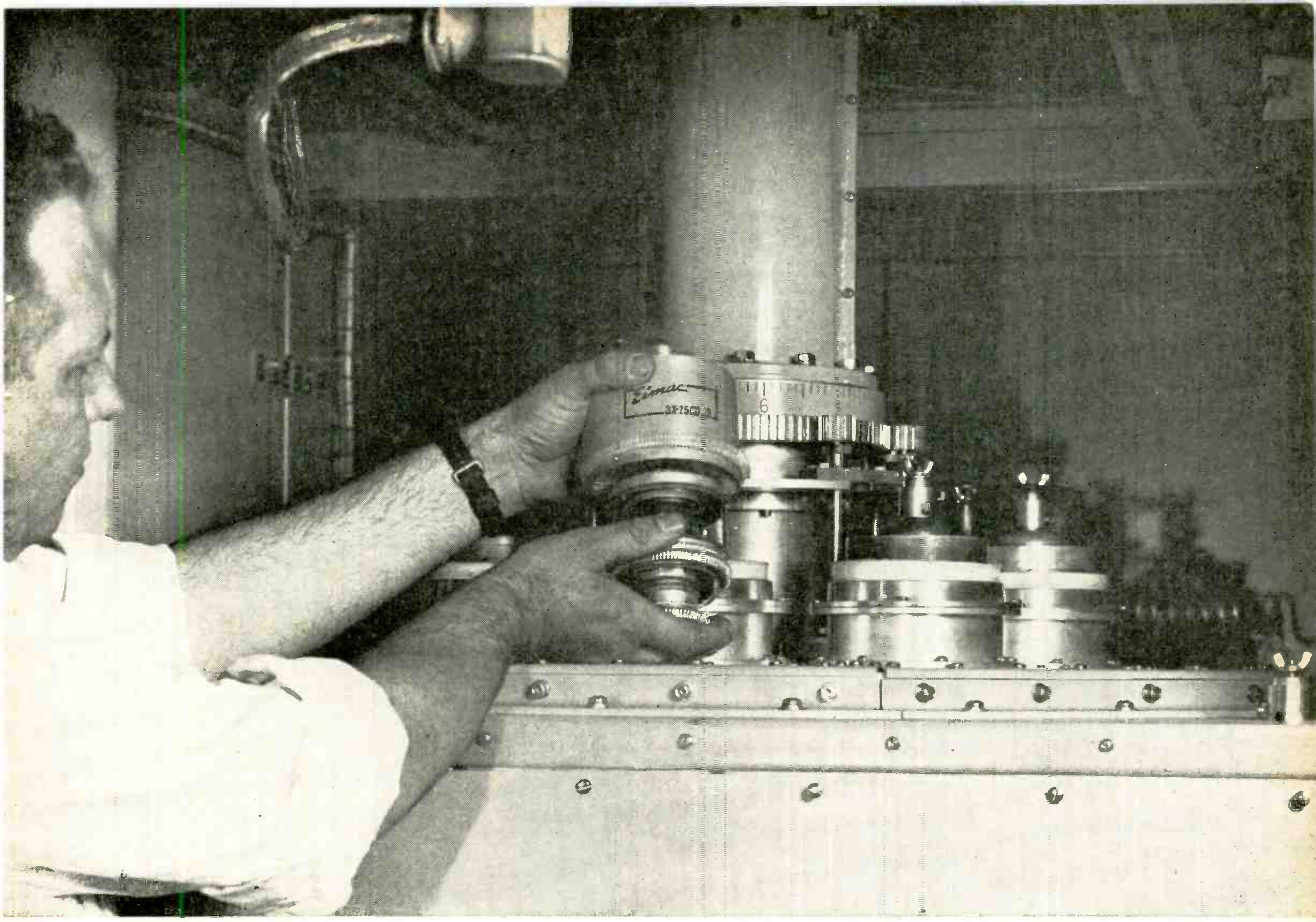
METER COVER
prevents costly damage

ELECTRONIC DEVELOPMENT LABORATORIES, 71 Nassau St., New York 38, N. Y. Meter Guard is a transparent protective meter cover for Simpson instruments, models 260, 303, 276 and 880. Made of Super-Strong Involex this invisible shield slips on over the Bakelite meter case to constantly protect against dropped tools and other hazards. The Meter-Guard works while the instrument is in use or in transit, thereby preventing costly and annoying damage to meter glass, case and movement. It is unconditionally guaranteed. **Circle 432 inside back cover.**

DIGITAL CODER
transistorized 10-bit unit

RADIATION, INC., P. O. Box 37, Melbourne, Fla., has developed a completely transistorized 10-bit digital coder. Constructed entirely on printed wiring boards, the unit is extremely compact and resistant to high shock and vibration conditions.

The coder uses the "half-split" sampling technique and operates



Final Amplifier Stage, model TX-264,
developed by Rixon Electronics, Silver Spring, Maryland.

Rixon uses 8 Eimac triodes in final amplifier to get 60 KW of ionospheric scatter power

Eight Eimac 3X2500A3 triodes in parallel make up the tube complement of this co-axial power amplifier in the new 60 KW Rixon ionospheric scatter transmitter. A total of 11 Eimac 3X2500A3's are used in the RF circuitry, which eliminates need for a complex stock of replacements.

In the modern Rixon transmitter, a hundred watt exciter drives a 2KW first stage, utilizing one Eimac 3X2500A3. This stage delivers up to 2 KW to the second stage which uses two Eimac 3X2500A3's. This stage can be connected to the antenna to deliver ten KW power or used to excite the final co-axial amplifier occupying five cubic feet and using *eight* 3X2500A3's. This unusual final amplifier will deliver up to 60 KW of useful power. Rixon engineers indicate a final amplifier apparent efficiency of 85 per cent at 60 MC, while the overall efficiency to all three amplifier stages is a remarkable 67.5 per cent!

Discriminating Rixon engineers bore several important factors in mind when they selected the Eimac 3X2500A3 for this transmitter:

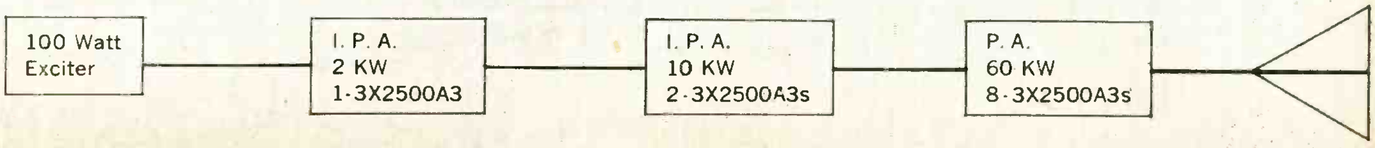
1. Its small size (9 by 4.16 inches) simplifying storage and shipping problems.
2. Its moderate cost.
3. Its rugged, sturdy space-saving construction.
4. Its delivery of a full 7.5 KW output up to 110 MC.

Ever since "the big signal" on 50 MC Eimac has been the leader in providing the tubes for ionospheric scatter.

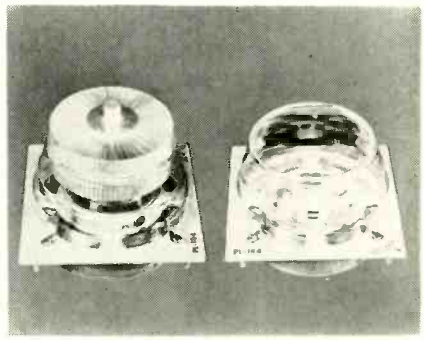
EITEL-McCULLOUGH, INC.
SAN BRUNO · CALIFORNIA
Eimac First **with power for ionospheric scatter**

Eimac

See Eimac Tubes That Can Take It at WESCON, San Francisco Cow Palace, August 20-23, booths number 1706 and 1727-28.



at 24,000 samples per sec with a bit rate of 264 kc. It accepts voltage inputs between ±5.12 v with an input impedance of 1 megohm. The unit will digitize one channel of analog voltage with a frequency response of 12 kc. It will digitize any number of channels in conjunction with a multiplexer. The output is either serial binary or parallel binary code as desired. **Circle 433 inside back cover.**



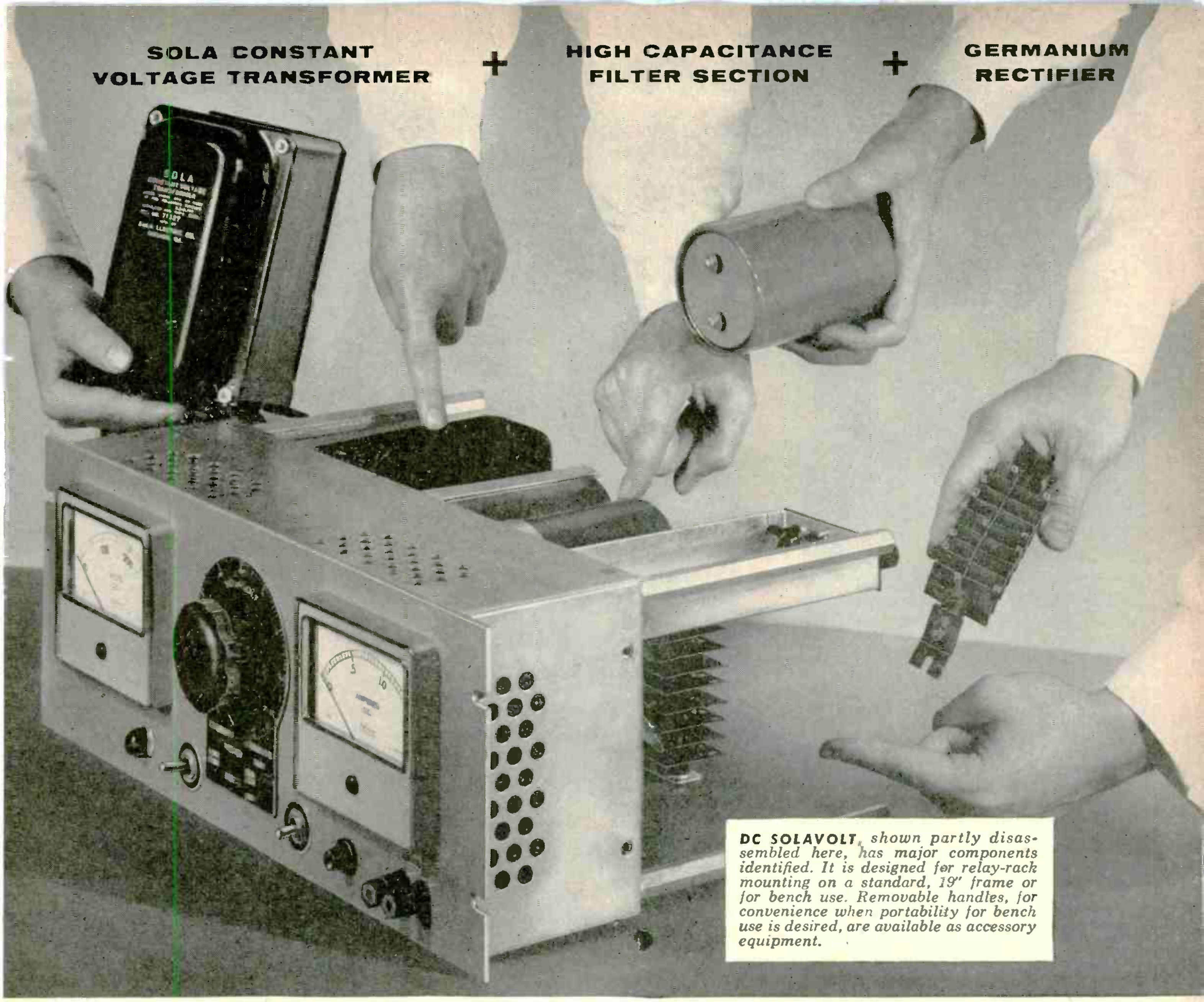
TUBE SOCKET
for 1,000-w beam pentode

PENTA LABORATORIES, INC., Santa Barbara, Calif., has announced the availability of a socket designed especially for its PL-172, 1,000-w beam pentode tube. The new type socket, PL-184, provides connections for all tube terminals, including the suppressor-grid and screen-grid rings, and also includes air-flow directing means for proper cooling of the anode and seals. Capacitors built into the socket provide low-inductance r-f by-passing for the suppressor grid and screen grid of the PL-172. **Circle 434 inside back cover.**

PRECISION SWITCHES
miniaturized units

HAYDON SWITCH, INC., Waterbury, Conn., has developed plastic body precision switches, so small that nine could fit into one cu in. of space.

The No. 5300 series switches measure only $\frac{25}{32}$ in. by $\frac{17}{32}$ in. by $\frac{1}{4}$ in. Two No. 5302 switches can be mounted, activator to activator and operated in a 1-in. diameter tube. These subminiature precision



DC SOLAVOLT, *shown partly disassembled here, has major components identified. It is designed for relay-rack mounting on a standard, 19" frame or for bench use. Removable handles, for convenience when portability for bench use is desired, are available as accessory equipment.*

Unique combination of components in adjustable "DC Solavolt" regulated power supply reduces conventional size, weight, and cost

Compact size, low weight, high efficiency, and moderate price distinguish the new "DC Solavolt" from conventionally-designed, regulated, adjustable dc power supplies. These outstanding advantages have been secured by using a unique assembly of components (shown above) that occupy only 7" of height and 12¼" of depth on a standard, 19" relay rack frame.

Along with design simplicity, the "DC Solavolt" provides laboratory standards of performance:

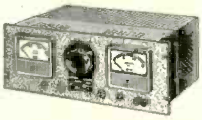
OUTPUT VOLTAGE REGULATED WITHIN ±1% at full load with supply voltage variations up to ±15%. (Regulation within ±1.5% at 50% load and lowest voltage setting.)

RIPPLE VOLTAGE HELD WITHIN 0.10% (rms) at full load and nominal input voltage.

An important feature of this adjustable dc power supply is its ability to handle transient or "pulse" loads of up to twice the full load rating of the supply. The "DC Solavolt" has no tubes to replace, requires no "compensating" or "zero" adjustments, and needs no maintenance.

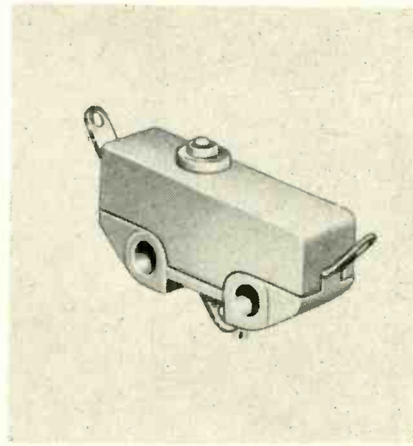
Six stock models provide outputs *adjustable in voltage ranges between 5 and 400 volts and load currents up to 7 amperes.* Your local electronic distributor now has the "DC Solavolt" in stock. He will be happy to give you further, technical information.

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



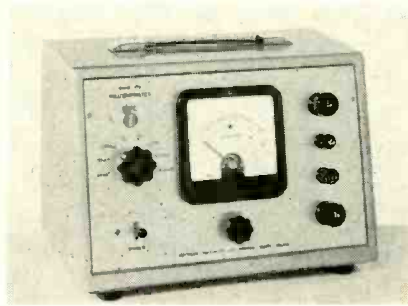
Write for Bulletin 7H-DC-245
See this equipment at WESCON, Sola Booth 2610

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



switches can be ganged together in infinite numbers to perform multiple switching functions in confined areas.

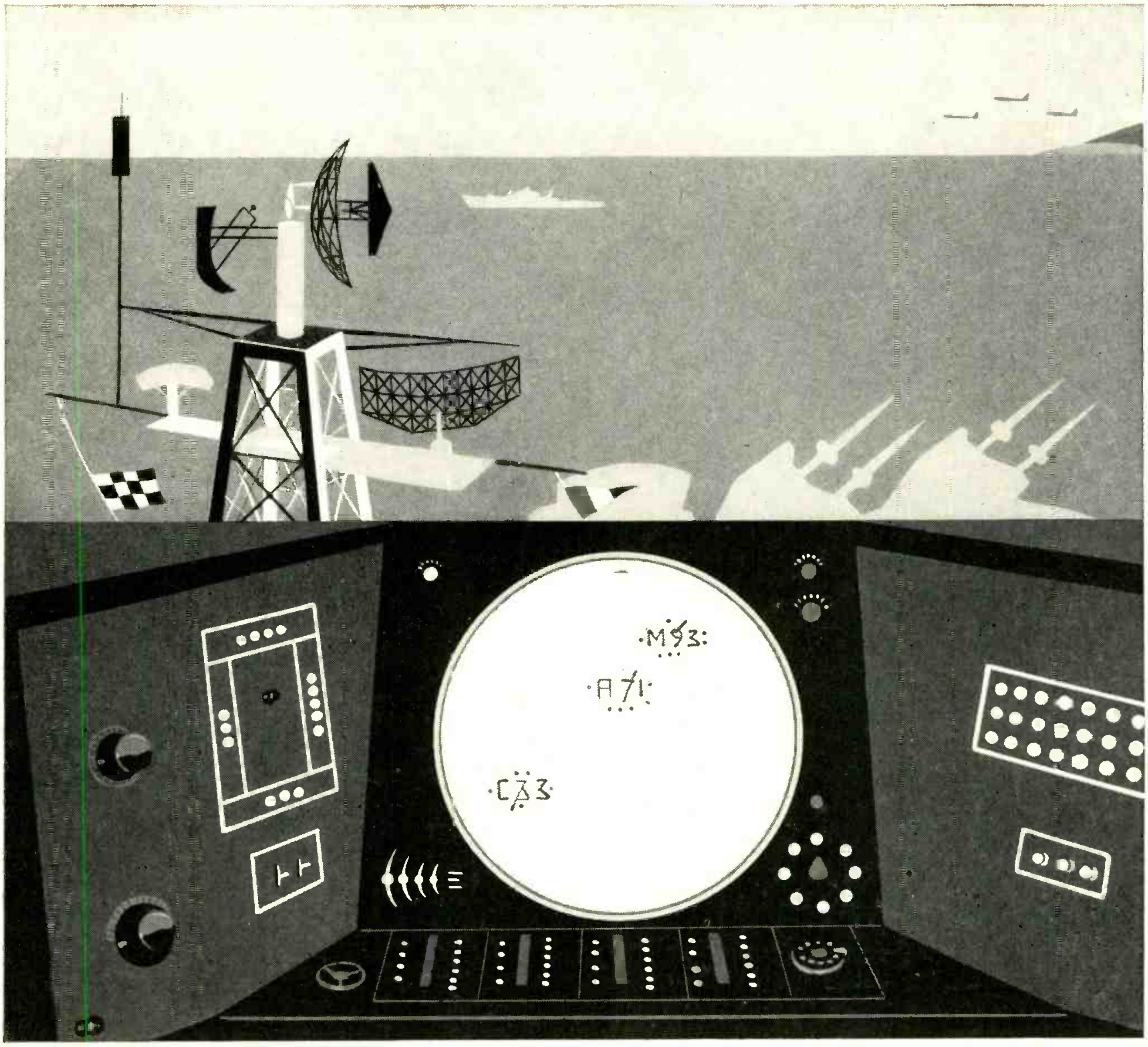
Each switch in the 5000 series is available according to specifications as SPNO, SPNC or SPDT. The characteristics are 5 amperes resistive at 28 v d-c; and the same at 115 v a-c. They will operate satisfactorily at −65 deg as well as +250 deg. **Circle 435 inside back cover.**



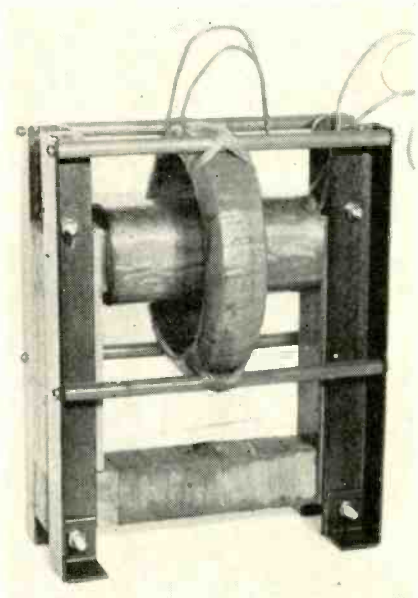
MILLIOHMMETER
measures low resistances

THE HERMAN H. STICHT CO., INC., 27 Park Place, New York 7, N. Y., announces the model 47A milliohmmeter, designed for the measurement of low and very low resistances, covering a range from 20 micro-ohms to 1,200 ohms over seven decades. It is a portable, direct reading instrument, line operated with no batteries being required. It employs a-c test currents at line voltage frequency. This overcomes the risk of overheating test equipment under test. With the model 47A, the power dissipated in the test specimen is very small, less than ⅛ of a watt in the worst case.

The instrument uses the four



terminal principle. It incorporates a self-calibration circuit which allows the accuracy of the instrument to be checked at any time in a matter of seconds. Accuracy of the instrument is generally better than ±2 percent of full scale. **Circle 436 inside back cover.**



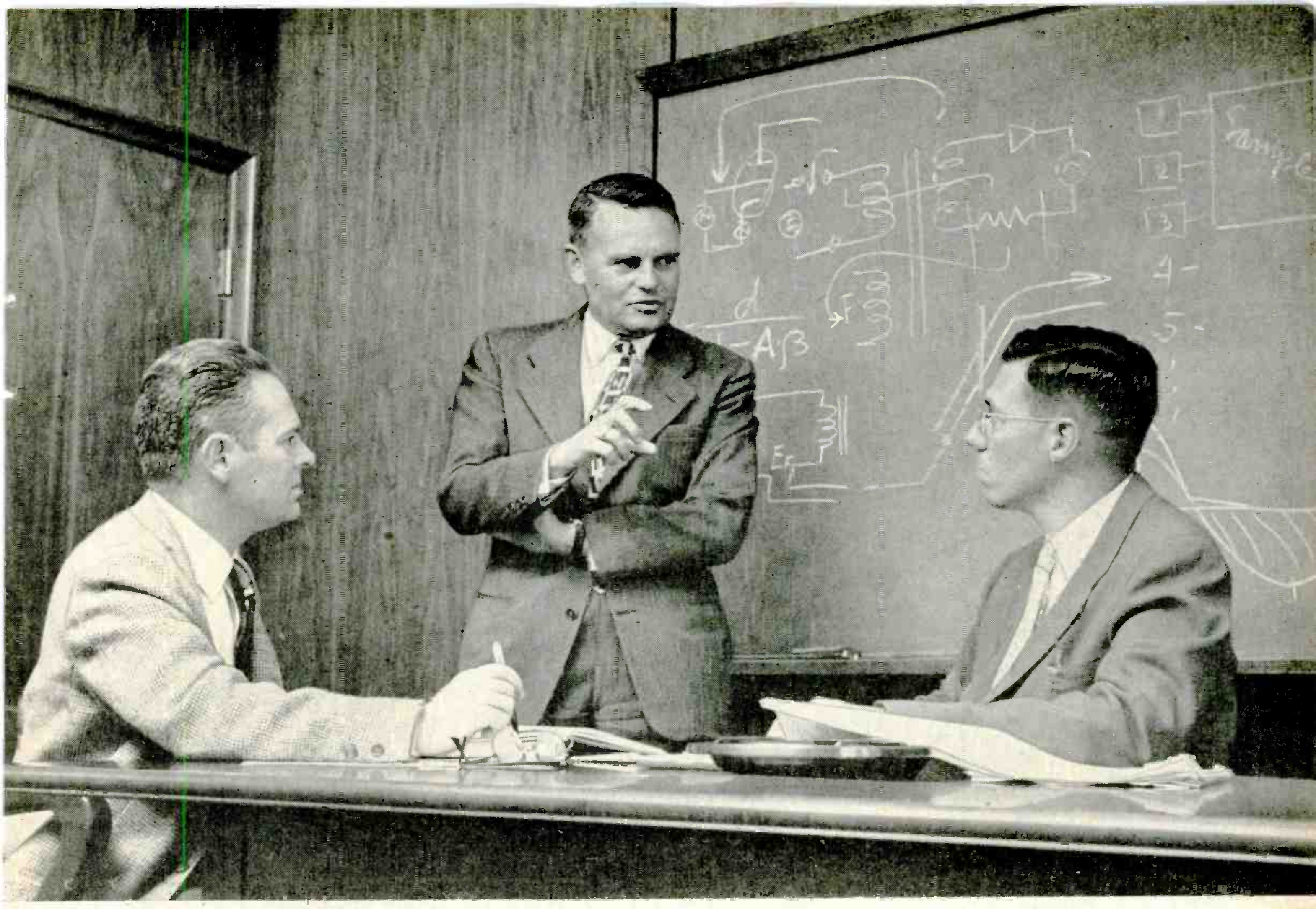
FILAMENT TRANSFORMER
featuring low capacitance

DEL ELECTRONICS CORP., 39-41 North MacQuesten Parkway, Mt. Vernon, N. Y. Illustrated is a typical low capacitance filament transformer designed and manufactured by the company. This particular one is insulated for 50 kv and is rated at 115 v/10v, 10 amperes. Capacitance between secondary and frame is 20 $\mu\mu$f.

Other designs with voltage insulation range up to 75 kv, and capacitance range from 10 to 50 $\mu\mu$f to suit special requirements are available. **Circle 437 inside back cover.**

PLUGS & JACKS
made to military specs

KINGS ELECTRONICS CO., INC., 40 Marbledale Road, Tuckahoe, N. Y., is in production on telephone plugs and jacks made according to military specifications, MIL-P-642A and MIL-J-641A. Every plug and jack has undergone exten-



Staff Scientist Dr. J. W. Muehlner (center) discusses an advanced PDM telemetering system for missile application with K. T. Larkin (left), Telecommunications Department manager, and J. R. Dawley, Telecommunications Systems Section head.

MISSILE SYSTEMS TELECOMMUNICATIONS

Weapon systems programs at Lockheed Missile Systems demand advances far exceeding the current state of telecommunications. Positions are open on the Palo Alto, Sunnyvale and Van Nuys staffs for scientists and engineers possessing a high level of ability and interest in:

TELEMETRY – Research in various areas of physics and electronics related to advanced telemetering projects; theoretical analysis of advanced FM, PDM, PCM System concepts; design integration of all phases of telemetry with weapon systems requirements; conception and development of original high-capacity and high-accuracy systems; development and package design of airborne telemetering equipment capable of operating under extreme environmental conditions, including transducers, subminiaturized subcarrier oscillators, crystal controlled FM transmitters, solid state commutators, PDM keyers, digital storage and conversion devices; development and prototype design of ground telemetry equipment to include devices such as high-efficiency decommutators, calibrators, digital encoders.

COMMUNICATIONS – Application of information theory concepts to challenging communication link problems; analysis and design of microwave communication link components to be utilized in most advanced weapon systems; development and test of television links for special projects.

Address the Research and Development Staff at Sunnyvale 18, or Van Nuys 22, California.

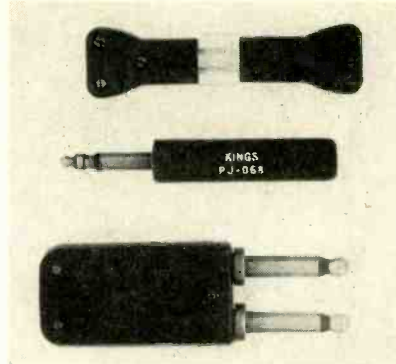
Lockheed

MISSILE SYSTEMS DIVISION

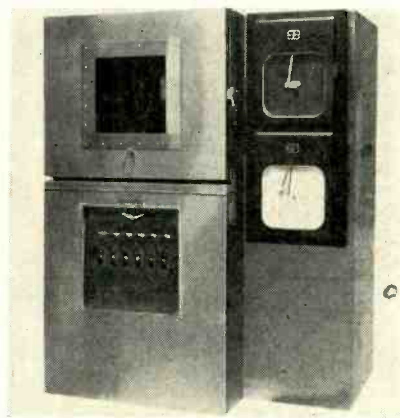
LOCKHEED AIRCRAFT CORPORATION

PALO ALTO · SUNNYVALE · VAN NUYS

CALIFORNIA



sive life and humidity tests and has received full government approvals. The items illustrated are: top, PJ-292, JJ-055; center, PJ-068; bottom, PJ-327. **Circle 438 inside back cover.**



HUMIDITY TEST CHAMBER
has test volume of 8 cu ft

ENVIRONMENTAL EQUIPMENT CO., 369 Linden St., Brooklyn 27, N. Y. Model H8 humidity test chamber simulates environmental conditions throughout the temperature range of 0 deg F to +200 F and 5 percent to 98 percent relative humidity. Controls include 12 in. diameter wet and dry bulb recorder, controller, programmer. Better than ±2 F control tolerance is maintained. Interior dimenisons are 30 in. wide by 20 in. deep by 24 in. high. Low air velocities are maintained throughout the test space. **Circle 439 inside back cover.**

D-C AMPLIFIER
features floating input

NEFF INSTRUMENT CORP., 2211 E. Foothill Blvd., Pasadena, Calif. A

HYCOR precision components

WAVE FILTERS

Low, high and band-pass types with high "Q" toroid elements. Ranges up to 100 kc., up to 10,000 ohms impedance. Stock types. Also designed for special circuitry or miniaturization.

send for bulletin F-P

TOROID COILS

High "Q" factor, excellent current and temperature stability. Encapsulated, fully protected from shock and environmental conditions. Also in encapsulated and metal cased types.

send for bulletin STP

MAGNETIC AMPLIFIERS

Toroid construction. Standard types with 10,000 or 50,000 power gain. Also designed for specified power, impedance, and response requirements. Cased per military specs.

send for bulletin MA

RATIO TRANSFORMERS

0.1% accurate even with wide changes in load, frequency, ambient temperature. Up to 1000:1 ratio. Special accuracies to .005%. Miniature encapsulated and hermetically sealed MIL-T-27 types.

send for bulletin RT

TELEMETERING FILTERS

Low and band-pass filters. Negligible hum pickup in low level circuits. Excellent phase linearity and attenuation accuracy. Standard and sub-miniature sizes.

send for bulletin TF

RESISTORS

Encapsulated, for 0.1 watt to 4 watts. Standard tolerance ±0.1%. Fully protected. Exceed

MIL-R-93A spec. With axial or radial leads, lugs, or leads for printed circuitry.

send for bulletin PH

DECADE INDUCTOR UNITS

Accurate, stable inductance values for design or experimental work at 150 to 20,000 cps. Four types: .001, .01, .1 or 1 Henry per step. 2% accuracy per step.

send for bulletin D-2

POWER TRANSFORMERS

Miniature encapsulated types rated 14 V.A. Precise regulation—no external fields. 375 to 525 cps, primary voltage 115, 28 or 12.6 V. Multiple secondaries. Specials supplied.

send for bulletin WT

PROGRAM EQUALIZER

Bridged T constant impedance type, low and high selectors. Impedance: 500/600 ohms in-out. 14 db insertion loss. Pad compensation with key in "out" position.

send for bulletin E

MAGNETIC CLUTCHES

Only 1" o.d., but deliver torque of 15 oz. in. on 2 watts. 5 millisecond response. Gear, cable or direct-in-line drives. Economical for multiple clutching assemblies.

send for bulletin C-2

IRC

HYCOR

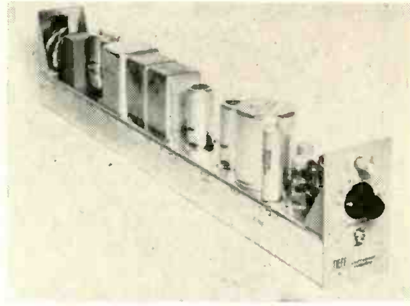
VARIABLE FILTER

Low-pass, high-pass with negligible hum pickup, distortion and aging. Same eight cutoff frequencies, about 16 db attenuation per octave on both high and low.

send for bulletin S-1

DIVISION OF INTERNATIONAL RESISTANCE CO.

12970 BRADLEY AVENUE, SYLMAR 1, CALIFORNIA



unique d-c amplifier featuring a true floating input is offered for amplification of low-level signals from thermocouples, strain-gage bridges, and resistance-bridge transducers. In the type 1-100C, input and output are isolated from each other and from ground. The amplifier, basically a carrier type, utilizes a 400-cycle chopper modulator.

The gain of this amplifier is continuously variable from 5 to 100 by means of a seven-position attenuator and a gain potentiometer. Linearity is 0.05 percent of full scale. Long-term stability is ± 0.2 percent of full scale, and long-term drift is less than ± 5 μv referred to the input. Input impedance is greater than 1.5 megohms, and output impedance is 60 ohms. Noise level is less than 5μv peak-to-peak referred to the input. **Circle 440 inside back cover.**

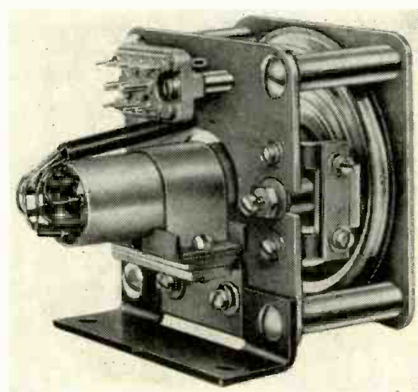
TRACER
displays transistor curves

TEKTRONIX, INC., P. O. Box 831, Portland 7, Ore. This new precision instrument traces characteristic curves for both *pnp* and *npn* transistors on the face of a crt. It has a 10-ampere collector supply and a 2.4-ampere base supply. It displays 4 to 12 curves per family, with input current from 1 μa-per-step to 200 ma-per-step, or input voltage from 0.01 to 0.2 volts-per-step.

Vertical deflection is calibrated in collector current, base voltage, base current and base source voltage. Horizontal deflection is calibrated in collector voltage, base voltage, base current, and base source voltage.

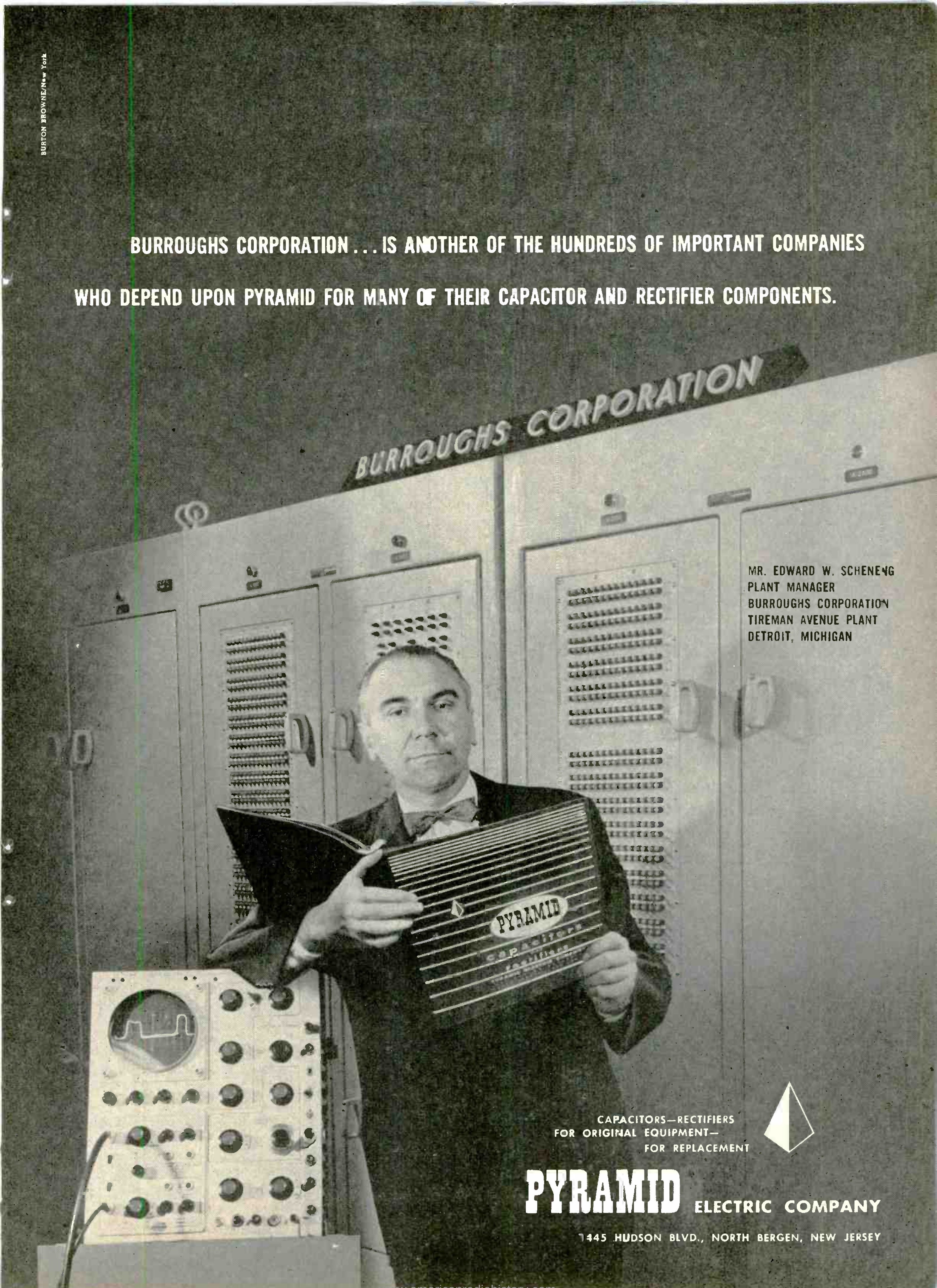
Seven different transistor characteristics are accurately plotted

for examination and measurement. Sixteen dissipation-limiting resistances and 24 driving resistances are available. Single-family or repetitive display can be selected. Transistor characteristics can be displayed in either the common-emitter or common-base configuration. Price is $925. **Circle 441 inside back cover.**



PRESSURE TRANSDUCER
for data reduction systems

FISCHER & PORTER CO., 93 Jacksonville Rd., Hatboro, Pa., has developed a pressure transducer for use in data reduction systems. The device converts a 3-15 psi signal to a-c millivolts directly proportional to the pneumatic input. When pressure is applied to the sensing element of the transducer, the resulting movement of an expandable capsule displaces an armature which induces opposing voltages in twin secondary coils. This voltage is linearly proportional to the pressure input. The output may be used to po-


BURTON BROWNE/New York
BURROUGHS CORPORATION . . . IS ANOTHER OF THE HUNDREDS OF IMPORTANT COMPANIES WHO DEPEND UPON PYRAMID FOR MANY OF THEIR CAPACITOR AND RECTIFIER COMPONENTS.
BURROUGHS CORPORATION
MR. EDWARD W. SCHENENG
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TIREMAN AVENUE PLANT
DETROIT, MICHIGAN
PYRAMID
capacitors
CAPACITORS—RECTIFIERS
FOR ORIGINAL EQUIPMENT—
FOR REPLACEMENT
PYRAMID ELECTRIC COMPANY
1445 HUDSON BLVD., NORTH BERGEN, NEW JERSEY

sition an indicator, recorder or control device.

Accuracy of the F & P pressure transducer is high: 0.25 percent of the full scale. Additional information is available. **Circle 442 inside back cover.**

SMALL POWER SUPPLY
photomultiplier type

THE NJE CORP., 345 Carnegie Ave., Kenilworth, N. J., announces the availability of a new improved, miniaturized version of their photomultiplier power supply.

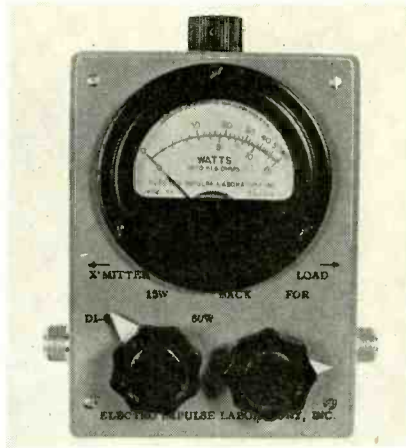
Printed-circuit techniques and completely redesigned circuitry have yielded the smallest, widest-range, best regulated supply currently available.

Designated the model CS-324XA, the unit supplies 800 to 2,000 v at 0 to 5 ma, regulated to ±0.005 percent, against ±10 percent line changes, with a load regulation of 0.035 v no-load to full-load, ripple less than 25 mv rms and excellent short-term stability. The new design occupies only 5¼ in. of panel height on standard equipment. Model CS-324XA is reversible in polarity. It supersedes all the older photomultiplier power supplies formerly manufactured by the company. **Circle 443 inside back cover.**

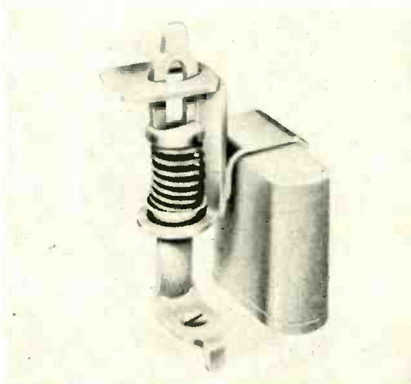
R-F POWER MONITOR
feed-through type

ELECTRO IMPULSE LABORATORY, 208 River St., Red Bank, N. J. This new feed-through r-f power monitor measures incident power between 2 and 500 mc; reflected power and vswr between 10 and 500 mc, in one compact instrument without any accessories. The instrument can be calibrated and

Circle 201 Readers Service Card

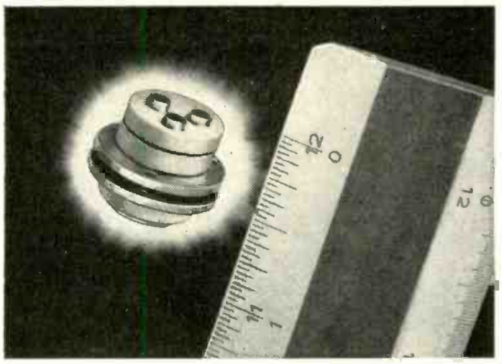


the calibration can be checked frequently at 60 cps with the help of an accurate 60 cps wattmeter. The power measuring range is 0 to 15 w, and 0 to 60 w. Similar instruments with higher power measuring ranges are also available. **Circle 444 inside back cover.**

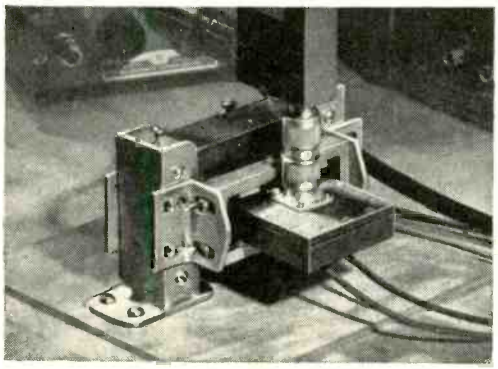


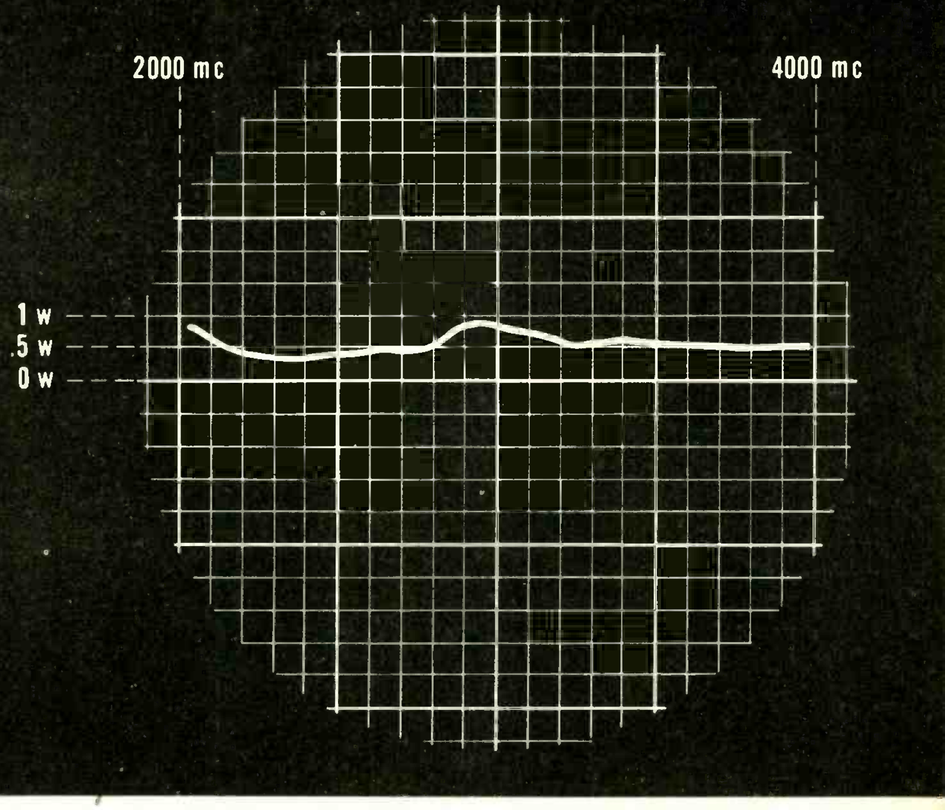
CRYSTAL CLIP
is easily chassis mounted

THE BIRTCHER CORP., 4371 Valley Blvd., Los Angeles 32, Calif., has developed and produced a new line of crystal retainers. They are made from type 302 stainless steel and are designed to hold nearly all popularly used crystals, semiconductors and other miniature components having similar configuration securely in place under severe shock and vibration. Chassis mounting is accomplished through one screw or rivet and a drilled hole for a positioning tab. Removal of the crystal is effected through slight upward pressure on the spring-loaded retaining flange which swings completely out of the way to provide easy



ABOVE: the GL-6917 voltage-tunable magnetron is extremely small and compact—only ⅝″ high and less than ¾″ in diameter. **BELOW:** complete cavity and magnet assembly for the GL-6917 has been developed to assist equipment manufacturers.





▲ Observe from the scope presentation above (actual photograph made with a production GL-6917 on test) how power over the entire 2000-mc tuning range is substantially constant, varying only .5 w. Because tube frequency, with voltage-tunable magnetrons, is a linear function of anode voltage, an r-f signal can be tuned at will to any frequency in a wide spectrum.

New GL-6917 voltage-tunable magnetron combines wide-range tuning, steady output, dependability!

General Electric's GL-6917 voltage-tunable magnetron—first of a new series in development—offers to designers of military and other microwave equipment a simple, efficient means of changing output frequency rapidly with no important reduction in signal power.

The tube is a major breakthrough in circumventing enemy radar-jamming and in other counter-measure work. Also, the GL-6917 finds direct application in missile tracking and other telemetering ..... in air navigation ..... broadband test equipment .... microwave communications generally.

Construction is extra-rugged. Fundamentally compact and sturdy, the GL-6917 is a hard-solder type and is metal-ceramic for even greater strength. The tube is designed to operate unpressurized up to 60,000 feet altitude.

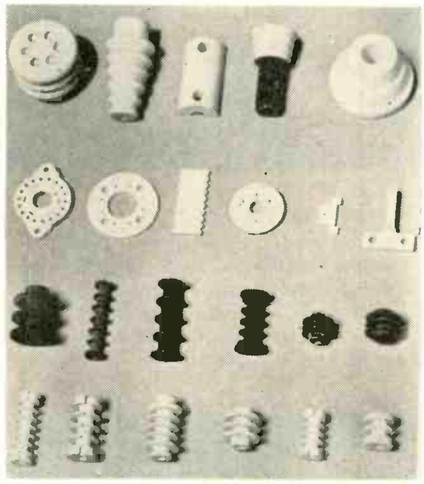
General Electric has developed a special cavity and magnet assembly for the GL-6917, to assist designers in applying the tube to equipment on the boards. For full information on Type GL-6917 and accessories, call your regional G-E power-tube representative! *Power Tube Department, General Electric Company, Schenectady 5, New York.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

9545-8481-1

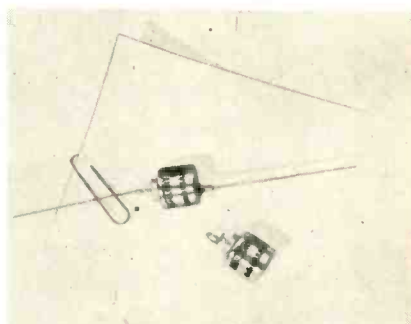
access for service even in extremely crowded chassis. **Circle 445 inside back cover.**



BOBBIN LINE
custom fabricated

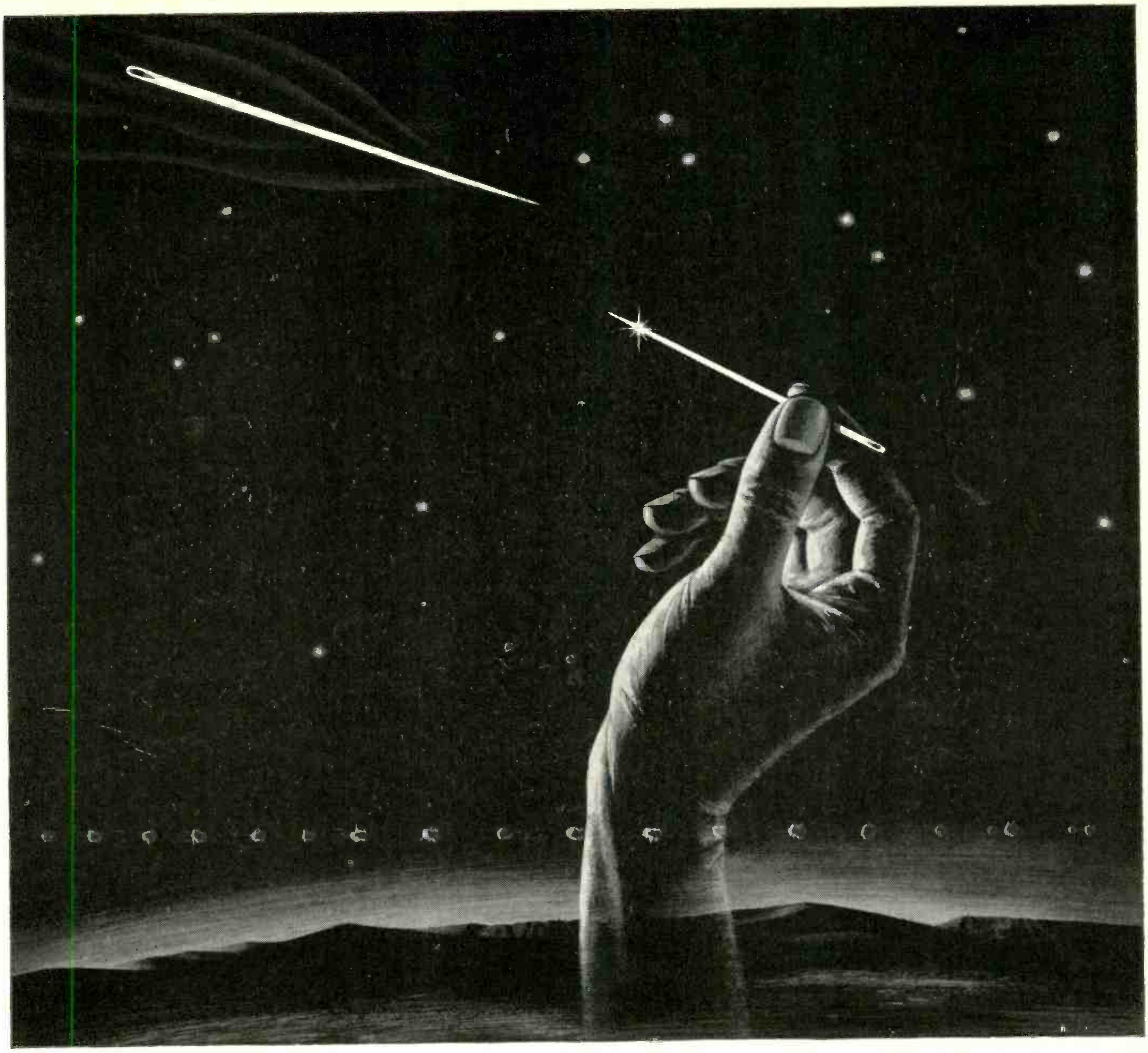
THOR CERAMICS, INC., 225 Belleville Ave., Bloomfield, N. J., offers a complete line of custom-fabricated winding forms, coil forms and bobbins. These bobbins, in addition to an unlimited variety of other shapes and sizes, can be made of epoxy, ceramics, nylon, polyesters, fluorocarbons, teflon, polystyrenes and other materials.

A large variety of standard or custom sizes and shapes of steatite, either pressed or machined, are also available to meet both JAN-1-10 and commercial specifications. Additional data is available. **Circle 446 inside back cover.**



TANTALUM CAPACITORS
designed for 175 C service

P. R. MALLORY & CO., INC., Indianapolis, Ind., has developed the XTM line of minature tantalum electrolytics designed for 175 C



Sending a needle to intercept a needle...

THROW a needle high into the air. Then try to hit the needle by throwing another needle at it. You'll know how hard a task it is to intercept a deadly enemy "needle" rushing towards you from the sky at hypersonic speeds.

Engineers and scientists of Sylvania's Electronic Systems Division are working to answer the threat of enemy ballistic missiles. Accepting complete responsibility, from idea to production, they are creating an integrated weapons system . . . a ground-to-air ballistic missile intercept system.

Whether your project requires management or technical experience for complex integrated systems, sub-systems, equipments or special components, from initial concept through mass production—Sylvania engineers will be glad to discuss methods of solving your specific problems.

SYLVANIA ELECTRIC PRODUCTS INC.
Electronic Systems Division
100 First Avenue, Waltham, Mass.

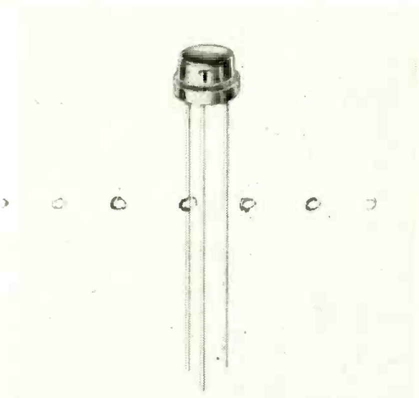
SYLVANIA

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

Circle 204 Readers Service Card

service. They are intended for compact equipment where maximum conditions of temperature, humidity and mechanical shock are encountered.

The units are being manufactured in six capacitances, from 4 to 40 μf, at nominal working ratings from 40 to 360 v. Of tantalum construction, these capacitors are designed for operation over a temperature range from −55 to 175 C. The body diameter of the metal case (all capacitances) is only $\frac{3}{8}$ in., with case lengths from $\frac{9}{16}$ in. to $1\frac{3}{32}$ in. All capacitances employ a true metal-to-glass hermetic seal—offer a choice of $2\frac{1}{4}$ in. axial leads or solder-tab terminals. **Circle 447 inside back cover.**



SILICON TRANSISTORS

a new line of h-f type

TRANSITRON ELECTRONIC CORP., Melrose 76, Mass., has available a new line of high-frequency silicon transistors. Eleven types are included which provide a range of current gains up to 60, and collector voltage ratings to 45 v. Rated for operation to 175 C, these units feature low collector cutoff currents. All types are specified for a maximum of 0.5 μa at their maximum collector voltage rating. Types ST13 and ST33 have a typical cutoff frequency of 17 mc.

Manufactured by the diffusion process, close control is maintained on all characteristics to achieve uniformity and interchangeability. All units are subjected to temperature cycling and storage, and other severe environmental tests to insure reliable per-

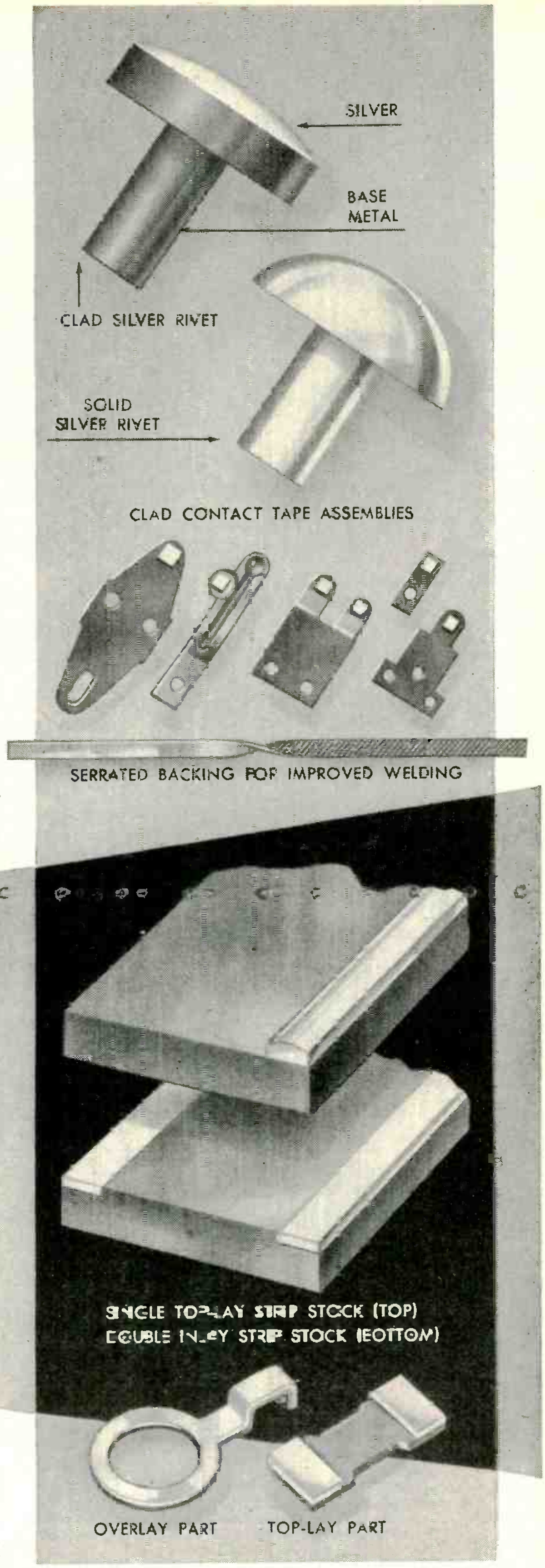
For Leadership
in Electrical Contacts Look to

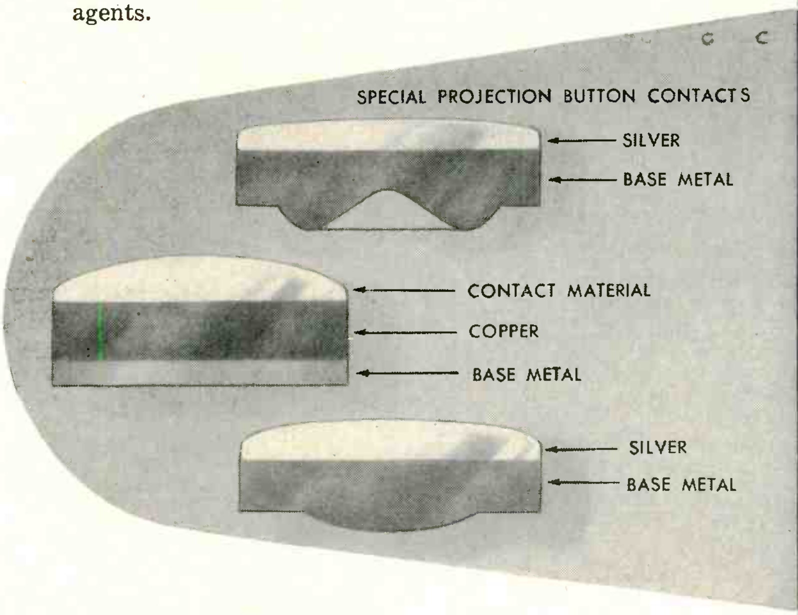
GENERAL PLATE

Extensive new facilities are now completed and in operation at General Plate, offering customers a single source for an almost infinite selection of new and useful types and sizes of electrical contacts.

Here are but a few of the new ideas in contacts that have been developed commercially at General Plate.

- **Clad Electrical Contact Tapes** — designed for high speed mechanized assembly — ideal for miniaturization — give increased performance at reduced cost.
- **New Metal Bonding Processes** — offer improved contact materials — include silver cadmium oxides, refractory metal mixtures and platinum group metals, as well as all regular silver materials.
- **Trimetal Clad Projection Welding Contacts** — a copper conductor between contact face and backing — provides higher specific heat with lower surface temperatures — gives greater contact capacity and longer life at lower cost.
- **New Clad Button Projections** — designed and produced to meet your specific application requirements — facilitate easier welding, provide better conductivity.
- **New Silver Clad Rivets** — put silver where it is needed, with lower cost backing materials for better fastening properties.
- **Single and Double Inlay-Overlay-Top-lay** — made by G.P.'s new exclusive P.T. cladding process — achieves permanent bonding of preferred contact metals to practically any malleable base metal without intermediate bonding agents.





With 41 years of General Plate metal cladding experience behind the emphasis now being put on G.P. electrical contacts, it will pay you to investigate. Technical data bulletins are available on request — just let us know what types of contacts you are interested in.

You can profit by using General Plate metals

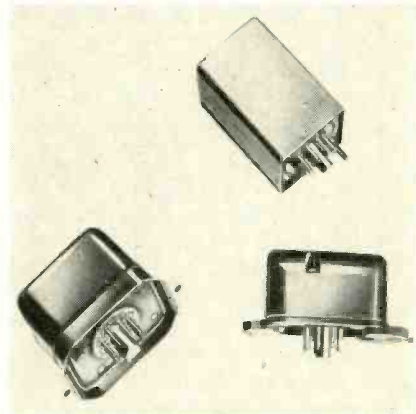
METALS & CONTROLS CORPORATION

General Plate Division 1308 Forest Street, Attleboro, Mass.

FIELD OFFICES: NEW YORK, CHICAGO, DETROIT, MILWAUKEE, LOS ANGELES

Circle 206 Readers Service Card

formance in military applications. Bulletin TE-1353 provides complete specifications and ratings. **Circle 448 inside back cover.**

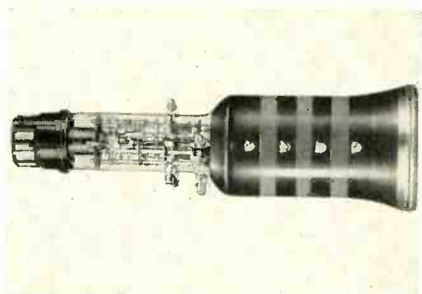


D-C POLAR RELAY
transistorized unit

BARBER-COLMAN CO., 1400 Rock St., Rockeford, Ill. The MYZA transistorized d-c polar relay is an adaptation of the company's Micropositioner with a built-in transistor preamplifier, requiring greatly reduced input power to operate the contacts.

MYZA units are available with three types of contact operation: form K or null-seeking calibration; form M, known as memory type calibration; and form C, snap-acting calibration. Three types of enclosures can be supplied.

These relays are useful in many positioning, variable leg Wheatstone bridge, and speed regulation circuits. They are designed to individual applications. **Circle 449 inside back cover.**



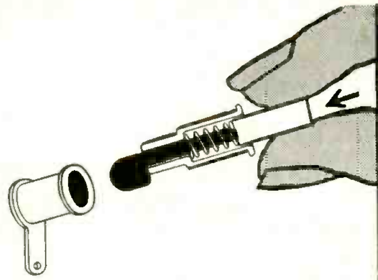
DOUBLE-GUN CRT
high deflection sensitivity

20TH CENTURY ELECTRONICS LTD., King Henry's Drive, New Adding-

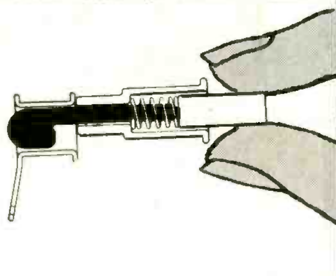
Now—from AVNET

the new HUBBELL *Interlock* SELF-LOCKING CONNECTOR

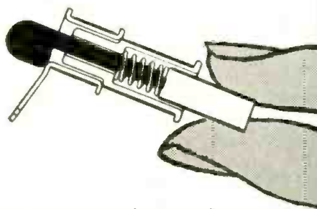
TRADE-MARK



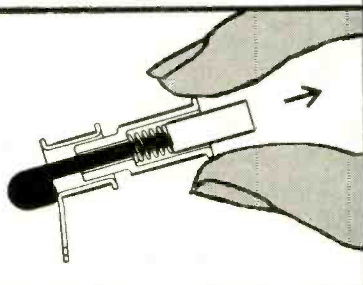
Grip male Plug at extreme terminal end and push Plug straight into Jack.



Contact head enters Jack.
Sleeve is pushed back.



Contact head passes Jack tube and moves into offset position which allows front part of sleeve to center, snap in, and lock. Spring presses contact head against underside of Jack contact.



Pull on flanged sleeve lifts sleeve from tube and releases contact head. Plug then snaps out.

The HUBBELL INTERLOCK CONNECTOR is revolutionizing the Industry. The savings in time and in labor costs are almost unbelievable. Avnet Applications Engineers will give you more specific details. Phone, wire or write Avnet, East or West. See Avnet at the Wescon Show, Booth 107.

HUBBELL REG. U.S. PAT. OFF.

INTERLOCK SYSTEM MODREY PATENTS REG. U.S. PAT. OFF.

Hubbell / Avnet

AVNET EASTERN SALES:
36 N. Moore St., N. Y. 13, N. Y.
BEekman 3-5780

AVNET WESTERN SALES:
8966 National Blvd., L.A. 34, Cal
TExas 0-6141

Bendix • Sylvania • Thordarson • Sprague • Hubbell

	Fahnestock clip	Plug (banana)	Crimp	Wire Nut	Screw	HUBBELL INTERLOCK
1 Lg. Contact Area			✓	✓	✓	✓
2 High Contact force			✓	✓	✓	✓
3 Long life			✓	✓	✓	✓
4 Small size		✓	✓			✓
5 Mech. stability			✓		✓	✓
6 Quick disconnect	✓	✓		✓	✓	✓
7 Low assembly cost						✓
8 Self-burnishing						✓
9 Self-locking						✓

Circle 208 Readers Service Card

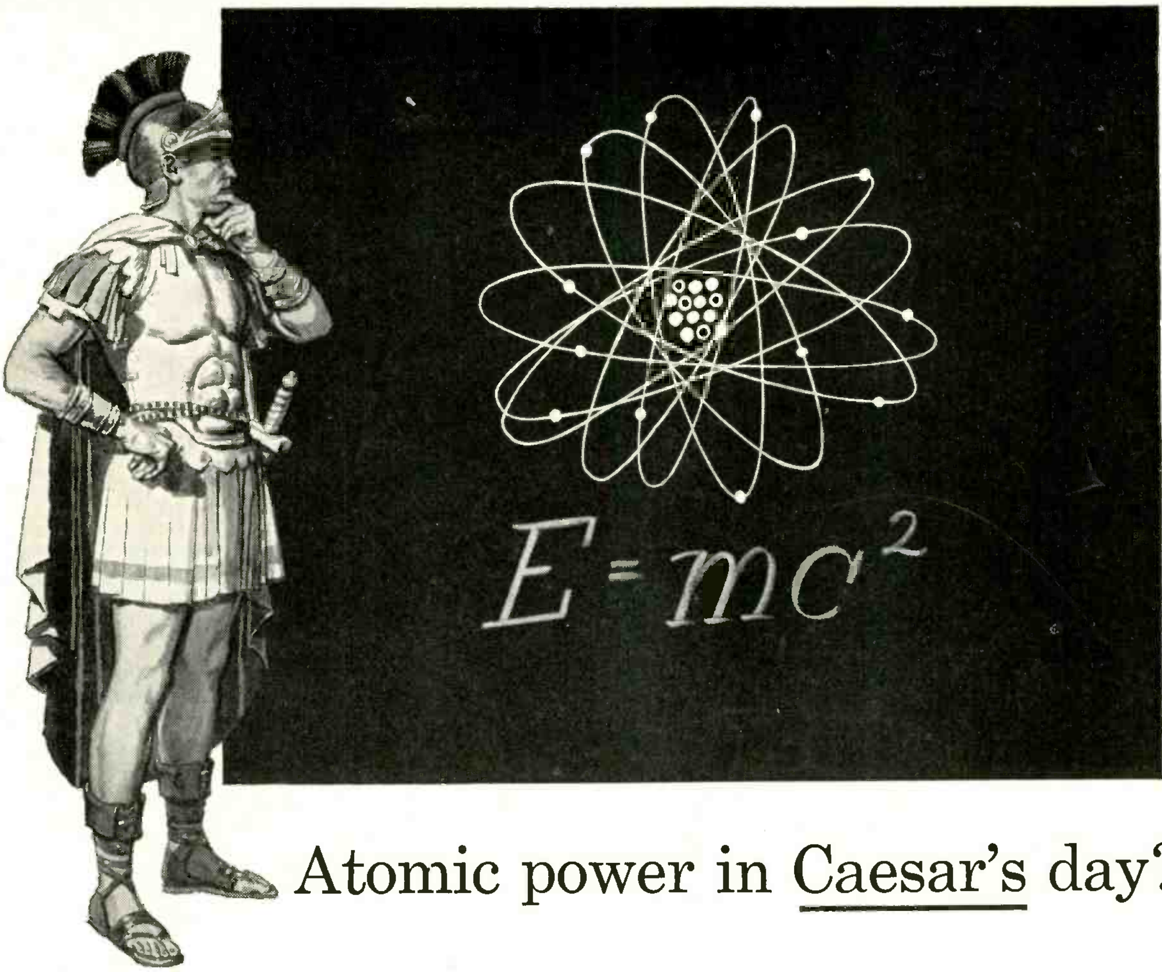
ton, Croydon, Surrey, England. Type D6AB/240 is a double-gun tube with a post deflection accelerating system suitable for operation at high ratios of screen to anode voltage. The gun itself is identical in characteristics to that used in the D6 series of tube, maintaining the features of high precision and high beam current. The configuration of the accelerating electrode minimizes the distortions associated with P.D.A. systems in a double-gun tube and allows the tube to be operated with a ratio of screen to gun voltage of 5 to 1, while keeping deflection nonlinearity to less than 3 percent. Deflector sensitivities at an overall voltage of 10 kv are 0.25 mm per v, giving a deflection sensitivity of one volt per spot width with a spot diameter of 0.25 mm.

The tube has a 6½ in. diameter, ground and polished flat face and is 19 in. long overall. For operation in the region of 10 to 20 kv aluminized screens are provided. **Circle 450 inside back cover.**

TINY POWER SUPPLY
is all transistorized

KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J., has introduced the Transiply which provides all the characteristics of an infinite life battery, and in addition, incorporates the flexibility of a continuously variable output voltage.

Special features include a stable metered output, continuously variable output, low impedance, no ripple, high current and avail-



Atomic power in Caesar's day?

Certainly!

It was there, in the ground, in the air and water. It always had been. There are no more "raw materials" today than there were when Rome ruled the world.

The only thing new is knowledge . . . knowledge of how to get at and rearrange raw materials. Every invention of modern times was "available" to Rameses, Caesar, Charlemagne.

In this sense, then, we have available *today* in existing raw materials the inventions that can make our lives longer, happier, and inconceivably easier. We need only *knowledge* to bring them into reality.

Could there possibly be a better argument for the strengthening of our *sources* of knowledge—our colleges and universities? Can we possibly deny that the welfare, progress—indeed the very *fate*—of our nation depends on the quality of knowledge generated and transmitted by these institutions of higher learning?

It is almost unbelievable that a society such as ours, which has profited so vastly from an accelerated accumulation of knowledge, should allow anything to threaten the wellsprings of our learning.

Yet this is the case

The crisis that confronts our colleges today threatens to weaken seriously their ability to produce the kind of graduates who can assimilate and carry forward our rich heritage of learning.

The crisis is composed of several elements: a salary scale that is driving away from teaching the kind of mind *most qualified* to teach; overcrowded classrooms; and a mounting pressure for enrollment that will *double* by 1967.

In a very real sense our personal and national progress depends on our colleges. They *must* have our aid.

Help the colleges or universities of your choice. Help them plan for stronger faculties and expansion. The returns will be greater than you think.

If you want to know what the college crisis means to you, write for a free booklet to: HIGHER EDUCATION, Box 36, Times Square Station, New York 36, New York.

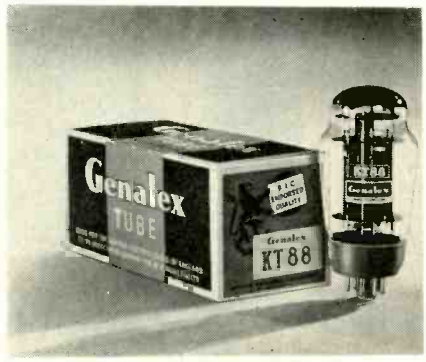
HIGHER EDUCATION
KEEP IT BRIGHT

PUBLIC SERVICE ADVERTISING COUNCIL

Sponsored as a public service, in cooperation with the Council for Financial Aid to Education ability of positive or negative bias. Other features include small size, light weight, low heat loss, low noise, no hum, high conversion efficiency and elimination of warm-up time.

The unit may be used as a power supply for transistor circuitry, power supply to regulate filament and bias currents and as an infinite life battery.

Full specifications and prices are available from the company. **Circle 451 inside back cover.**



AUDIO AMPLIFIER TUBE
high power, low distortion

BRITISH INDUSTRIES CORP., 80 Shore Road, Port Washington, N. Y. The Genalex KT88 audio amplifier tube may be regarded essentially as a more powerful version of the KT66, with up to twice the output and even lower distortion. Yet it is considerably smaller than the KT66.

With fixed bias, an output of 100 w may be obtained from a pair of KT88 tubes with a plate supply of 560 v. The KT88 has the same pin connections as the 6L6 and KT66. It has an increased plate dissipation of 35 w, together with a higher mutual conductance based upon a cathode of more generous size. Its internal construction permits the use of a higher plate voltage. The KT88 fits the standard octal socket. **Circle 452 inside back cover.**

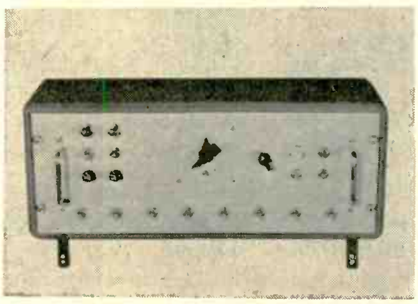
VARIABLE RESISTOR
for higher temperature

ALLEN-BRADLEY CO., 136 West Greenfield Ave., Milwaukee 4, Wisc. A new hot molded composition variable resistor, especially designed to withstand ambient temperatures up to 150 C, has been added to the company's line.

Approximately one inch in diameter, the resistor is conservatively rated at 2 w under 100 C ambient operating conditions, and will provide reliable performance at a temperature of 150 C under "no load" conditions. Type K variable resistor has a conservative rating of 3 w for operation in 70 C ambient temperature.

The new control has the solid composition resistor element, terminals, insulation, faceplate, and threaded bushing all hot molded in a one-piece plastic body. This eliminates riveted, soldered and welded connections, which are potential sources of noise. After molding, the resistor is practically impervious to the effects of heat, cold, moisture and aging.

The resistors can be furnished in single, dual and triple units, with plain bushings or lock bushings. Shafts can be had plain, flatted or slotted in increments of ⅛ in. up to 6 in. maximum. **Circle 453 inside back cover.**

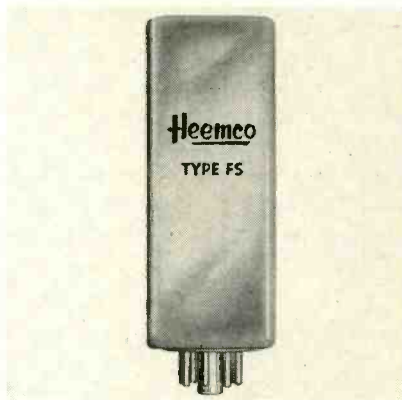


PROGRAMMER
for computer read-out

SANBORN Co., 175 Wyman St., Waltham 54, Mass. Operation of the company's six- and eight-channel oscillographic recording systems for analog computer read-out can now be automatically programmed, with a new device developed expressly for this purpose. Joint operation of the 156- or 158-5490 console system and the model 183 programmer occurs automatically in the following sequence (unless manually terminated)—step 1: recorder turned on; steps 2 to 16: calibration signal voltages of 0, 100, 20, 10, 5, 1, 0.2, 0, −0.2, −1, −5, −10, −20,

—100 and 0 fed to all channels; steps 17 and 18: d-c levels of computer read; step 19: computer output recorded for predetermined chart length, or as controlled by computer; step 20: recorder turned off, programmer reset for another cycle.

Cycle, initiated by a pushbutton, can be stopped and the programmer reset for another cycle at any time. Provision is also made for remote starting or stopping cycle. Length of record can be preset to any length up to 700 mm, or operated manually. Switches are provided for reversing the polarity of each individual input. **Circle 454 inside back cover.**



PACKAGED SOURCES
for plug-in operation

HILL ELECTRONIC ENGINEERING AND MFG. CO., INC., New Kingstown, Pa. Shipped ready for plug-in operation on aircraft and missiles, these new small-size oscillators are designed for use without special shock mounting. They use quartz crystals for precise frequency control and are available in a range of from 400 cps to 150 kc.

This compact packaged source will maintain frequency stability and operation through vibration frequency of 0 to 2,000 cps at 10 g. A frequency stability of ±0.025 percent can be maintained without oven over a range of —65 to 105 C and accuracies of ±0.002 percent can be achieved over smaller temperature excursions. Use of an oven to control temperature will provide frequency stability of ±0.001 percent from —65 C to 95C under dynamic conditions of shock and vibration as given above with greater stability at lower temperatures.

It will meet specifications MIL-E-5272A, MIL-E-5400 and MIL-7-5422 for shock and vibration. **Circle 455 inside back cover.**

FREQUENCY CONVERTER
weighs only 3½ lb

THE LIQUIDOMETER CORP., Skillman Ave., 36th & 37th Sts., Long Island City 1, N. Y., has announced a new frequency converter that makes 400-cycle power available at any 60-cycle electrical outlet. Overall dimensions are 8⅜ by 5 in. and weight is 3½ lb. The long-life design and sturdy construction of the converter make it practical for continuous use in the small shop or laboratory, or as a secondary 400-cycle power source in the larger instrument shop.

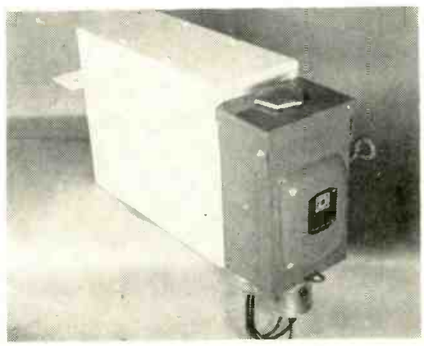
The frequency converter has no moving parts, is quiet in operation and supplies up to 20 w power output. Bulletin number 629 supplies complete information. **Circle 456 inside back cover.**

BALLISTIC COMPUTER
displays seven parameters

ALLEGANY INSTRUMENT CO., INC., 1091 Wills Mountain, Cumberland, Md. Type K-1 ballistic computer is used in the development of guided missiles. It contains all necessary amplifiers, programing circuitry and balance equipment for direct hookup to the thrust and pressure transducers, and automatically displays such

parameters as ignition delay, action time, integrals of thrust and pressure as well as peak values.

The K-1 can be supplied either for printout on paper tape by a Clary printer or on cards by IBM summary card punch. It is also available as the type K-2 which contains special tape recording equipment and a highly refined play-back analyzer section for detailed examination of isolated portions of a record. **Circle 457 inside back cover.**



BROADBAND PREAMPS with low noise

A R & T ELECTRONICS, INC., P. O. Box 370, North Little Rock, Arkansas has available a line of low-noise preamps with frequency ranges from 53 mc to 470 mc. A typical preamp, model A 195-42, has a 3 db bandwidth of 163 mc to 227 mc, midband gain of 12 db and midband noise-figure of 2.0 db.

These fixed-tuned broadband preamps are designed for continuous unattended operation mounted at the antenna and connected to the receiver by low-loss coaxial cable. Rack mounting models are available.

Power consumption is 15 w at 110 v, 60 cps. A fused switch box with pellet-type lightning arrestor is provided.

The preamps are designed for input and output impedances of 50 ohms. The input circuits are mismatched for optimum noise figures. Preamps for other impedances are available on special order.

One W.E. 416B planar triode and two selenium rectifiers are used. The rectifiers are on a separate chassis with plug-in interconnections.

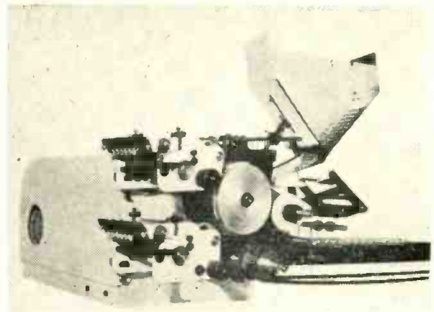
The metal case is 10 in. high by 16 in. wide by 5 in. deep and mounts by means of two right angle mounting brackets. Weight is 23 lbs. **Circle 458 inside back cover.**

AUDIO PREAMPLIFIER
with high-speed agc

ELECTRONIC SYSTEMS ENGINEERING Co., 903 Cravens Bldg., Oklahoma City, Okla., announces the Limpander (limiter-expander) model LE-2, audio preamplifier with new high speed, non-feedback, automatic gain control that incorporates a unique background noise squelching system. High impedance input, and outputs at low level as well as 600 ohms (high level), facilitates easy incorporation in existing installations. Limiter portion of the amplifier has a time constant of 50 μsec on attack and 20 millisec on release. Consonant amplification is accomplished without the excessive distortion of clipper circuits.

Model LE-2 is especially useful as a consonant amplifying preamplifier for plant paging systems. The noise penetrating characteristics of consonant amplified sound makes a paging system more effective.

Audio monitoring for plant protection is greatly facilitated by the high speed squelch of the limpander, model LE-2. It provides an effective means of eliminating the normal background noise of any large room such as a warehouse, yet will transmit at high gain all transient sounds. **Circle 459 inside back cover.**



MARKING MACHINES
two new models

POPPER & SONS, INC., 300 Fourth Ave., New York, N. Y. Two marking machines entirely new in design and performance have been added to the line of Rejafix marking equipment. These machines can be used to mark resistors, capacitors, tubes and the like.

One is the fully automatic model 555 (illustrated) which will print in one or two colors onto cylindrical items of limited diameter size at a speed of about 6,000 to 9,000 pieces. It prints directly or by offset.

The other machine is the semiautomatic model Four Square which will print in one or more colors onto products of many shapes, including flat and tubular ones. **Circle 460 inside back cover.**

AXIAL FLOW FANS
feature Venturi ring mounts

ASHLAND ELECTRIC PRODUCTS, INC., 32-02 Queens Blvd., Long Island City 1, N. Y., has available a new series of 4-in., 8-in. and 10-in. axial flow fans. These propellor fans come complete with Venturi rings facilitating direct mounting against enclosures, cabinet walls or dust filter boxes without the additional cost and bother of further rings and brackets.

These fans are available for 50, 60 or 400 cycle operation, or for variable power supply frequencies; and for all voltages and phases. Designed for military or commercial requirements, the precision-engineered fans are powered by the company's 24-slot motors, and are supplied in models to meet various conditions of altitude or ambient temperatures. Fans and motors are matched for static pressure conditions as required.

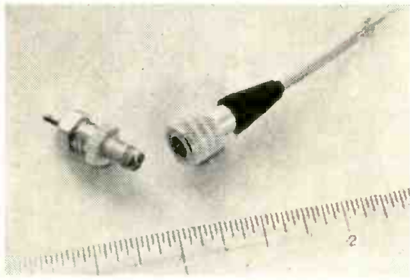
The eight-in. fan illustrated operates on 115 v, 60-cps a-c, single phase. **Circle 461 inside back cover.**

SILICON MODULATOR
replaces choppers

BRADLEY LABORATORIES, INC., New Haven, Conn. A silicon modulator for converting low-level d-c voltages (0 to 500 mv) to a-c signal voltages is announced. Designated the S-1 and developed primarily to replace choppers, the new unit incorporates two silicon diodes with closely matched resistors within a hermetically sealed metal container.

General specifications are: temperature range of −55 C to +85 C; input resistance of 2,700 ohms; output of 0 to 1.6 v a-c linear; balance of 10 mv maximum at room temperature and 15 mv over the temperature range.

Among the advantages which can be listed for the S-1 and other semiconductor modulators are: suppression of side band and carrier frequencies; equally good transmission in either direction; low input and output impedance; no need for filament power or B-plus supply; unusual stability and long life; controlled degree of balance; and assembly of all essential components within a small compact container. **Circle 462 inside back cover.**



COAX CONNECTOR
subminiature, snap-lock

AUTOMATION - ENGINEERING CORP., 723 Sonora Ave., Glendale 1, Calif., announces a subminiature snap-lock coaxial cable connector and mating receptacle available in 50, 75 and 95 ohm sizes. This design of coaxial cable plug is spring loaded and snaps into position to engage its special receptacle firmly. The plug cannot be removed by pulling on the cable, or by vibration, but only by sliding the knurled sleeve toward the cable end.

These connectors will withstand a temperature range of −70 F to +550 F and shock of 100 g on any axis; vibration at 5 g from 10 to 20,000 cycles.

Other design configurations are available—angle feedthrough, hermetic sealed, and the like, as well as engineering facilities for special application. **Circle 463 inside back cover.**

VOLTAGE REGULATOR
for high frequency use

THE SUPERIOR ELECTRIC CO., 83 Laurel St., Bristol, Conn. Stabiline automatic voltage regulator type IEH5101 for 400 cycle, single phase service gives instantaneous correction of line voltage variations with only 0.25 v bandwidth for line voltage variations and 0.35 v bandwidth for load current and load power factor changes. It is completely electronic with no moving parts.

Ruggedly constructed for long trouble-free life, it is especially well adapted for aircraft (built to meet MIL-E-5400) marine or industrial applications which may be exposed to vibration problems. It is also ideally suited for use in laboratory, inspection and test lines and as a component for other equipment where exacting voltage control is necessary. Input is 95-130 v for nominal output voltage; output: 115 v nominal, adjustable from 110-120 v; load: 1.0 kva; waveform distortion: 3.5 percent maximum at 400 cps; power factor: 0.7 lagging to 1.0 size: 7¾ in. by 5 in. by 14⅜ in. including front panel handles. **Circle 464 inside back cover.**

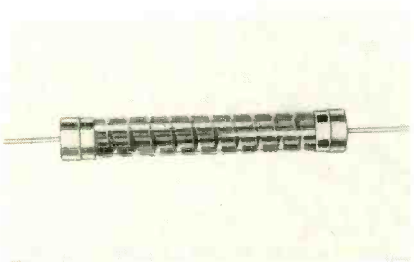
FREQUENCY METER
a transistorized unit

TELETRONICS LABORATORY, INC., 54 Kinkel St., Westbury, L. I., N. Y., has added to its line of modular instruments a transistorized frequency meter. It is designed to measure frequency in the range from 10 cps to 100 kc with an accuracy of 2 percent regardless of wave shape down to a 1 percent duty cycle.

To insure easy, accurate readability seven full scale ranges of 100, 300, 1 kc, 3 kc, 10 kc, 30 kc and 100 kc are provided. Minimum input voltage is 0.1 v rms and maximum 120 v.

The instrument measures 8¾ in. by 5¾ in. by 4 in. and represents a ⅓ size module in the TLI modular system. Thus, it will occupy

⅓ of the panel area of the modular system rack panel adapter or stack pedestal. Price is $125. **Circle 465 inside back cover.**



METAL FILM RESISTORS
hermetically sealed

THE DAVEN CO., Livingston, N. J., announces that their new line of Davohm series 850 hermetically sealed metal film resistors are now available and in mass production. This series offers the lowest noise level available (no more measurable noise than on precision wirewounds); low resistance values (as low as 2 ohms in ½ w size); excellent h-f characteristics (very low reactive impedance component, no plastics to add dielectric losses, no semiconductor effect); temperature range from −65 C to 150 C; the same positive temperature coefficient for all resistors from 2 ohms to 4 megohms.

The resistors are completely hermetically sealed in three sizes in ohmic ranges from 2 ohms to 4 megohms in accuracies of ±½, ±1, ±2 and ± 5 percent. They will never short out or burn up since there are no organic compounds which might carbonize or burn. **Circle 466 inside back cover.**

LINE REGULATOR
magnetic amplifier type

MCHENRY CONTROL CORP., P. O. Box 604, Norwalk, Conn. Featuring high transient overload capacity and adjustable output voltage, a new low-priced tubeless regulator is insensitive to frequency changes. A new magnetic circuit reduces weight of the 1 kva unit to 40 lb. Output voltage is regulated from an input of 95 to 130 v, no load to full load. **Circle 467 inside back cover.**

New Literature

Phase Meters, Delay Lines, Counters. Advance Electronics Lab., Inc., 249-259 Terhune Ave., Passaic, N. J. Features and specifications, as well as illustrations, for a full line of phase meters, delay lines and counters, are given in literature now available. **Circle 501 inside back cover.**

D-C Standard and Null Voltmeter. KIN TEL (Formerly Kay Lab), 5725 Kearny Villa Road, San Diego, Calif. Model 301 d-c voltage standard and null meter is illustrated and described in bulletin 15-3. The unit discussed has stability locked in with chopper amplifiers. A circuit description, applications and specifications are given in the loose-leaf perforated catalog sheet. **Circle 502 inside back cover.**

Servomotor-Rate Generator. Beckman/Helipot Corp., Newport Beach, Calif. Data sheet 869 covers the model 18 MG 490/460, a size 18, 115 v, 400-cycle motor generator. Complete specifications, electrical characteristics, torque-speed curve, 2-view drawing and schematic make this a valuable data sheet for servomechanism designers. **Circle 503 inside back cover.**

Matched Transistor Pairs. General Transistor Corp., 91-27 138th Place, Jamaica 35, N. Y. Specially selected matched pairs of *pnp* and *npn* transistors for use in complementary symmetry circuits are described in a recent data sheet. The pairs discussed (SMP series) are matched in five contiguous beta categories and have a wide variety of applications, especially in transformerless class B push-pull output stages, d-c coupled amplifiers and balanced modulators. **Circle 504 inside back cover.**

Waveguide Pressure Winder. Microwave Associates, Inc., Burlington, Mass, Brochure 57-W describes waveguide pressure windows and their uses. Performance curves, outline dimensions and drawings, and complete electrical and mechanical data are given in the new brochure for each window type. Helpful installation instructions are also included.

Broad bandwidth, high power, cover-flange-mounted windows for direct mounting between standard flanges in the frequency range from 2.5 kmc to 75 kmc are listed. Solderable windows for sealing reference cavities, filters and so forth, in the frequency range from 2.5 kmc to 16 kmc are also included. **Circle 505 inside back cover.**

Multiconductor Cable. Pacific Automation Products, Inc., 1000 Air Way, Glendale 1, Calif., offers "Design Engineering Specification PAP-C-101" to designers, engineers and purchasing agents.

This comprehensive engineering manual describes materials, construction, design criteria, specification conformance, performance, identification, reproducibility and other important features for determining the correct electronic cable for specific applications. **Circle 506 inside back cover.**

Microwave Components. Microwave Development Laboratories, Inc., 92 Broad St., Babson Park, Wellesley 57, Mass. A new 12-page catalog C457 describes, illustrates and gives simplified ordering information on a full line of hybrid junctions, flanges and adapters which, with appropriate TR tubes, will form microwave duplexers to meet a wide variety of requirements. **Circle 507 inside back cover.**

Ferrite Magnetic Materials. General Ceramics Corp., Keasbey, N. J. An eight-page illustrated bulletin entitled "Ferramics for General Applications up to 200 Megacycles" is available. Fully described is the nature of Ferrites, their advantages and limitations and method of production. Also included is a detailed comparison of Ferramic bodies and their specific applications to the electrical and electronics industries. **Circle 508 inside back cover.**

Tape Noise. Minnesota Mining and Mfg. Co., 900 Bush St., St. Paul 6, Minn. The problem of noise in magnetic tape recordings is discussed in *Sound Talk* bulletin No. 34 now available upon request.

The five-page technical bulletin, illustrated with graphs and line drawings, tells what tape noise is and how it is diagnosed on a tape recorder. Among the considerations covered in the paper are frequency modulation noise, drop-out noise, modulation noise causes, and erasure problems. **Circle 509 inside back cover.**

Aircraft Type Relay. Phillips Control Corp., 59 W. Washington St., Joliet, Ill. A single-page bulletin covers the type 57 relay, a rugged, compact, medium-power aircraft type relay, designed to meet the severe environmental conditions imposed by military applications. Illustrations, dimensions and characteristics are included. **Circle 510 inside back cover.**

Servo System Analyzer. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y. Five models of the Servoscope servo analyzer, including the new model F, are described in a new data sheet.

The model F discussed was developed in response to requests for a model that would accurately measure frequencies as high as 100 cps, yet still afford low end coverage at 0.005 cps. It provides sine, modulated sine and square wave signals as well as the linear sweep and reference carrier on four ranges from 0.005 to 100 cps. For further information, request TDS 1100. **Circle 511 inside back cover.**

Instrument Translator. Crescent Engineering & Research Co., 5440 N. Peck Rd., El Monte, Calif., has available a brochure describing the instrument translator, a 10-oz temperature-compensated control system encapsulated in duralum-inum case. The unit discussed operates from any power source, a-c or d-c, and integrates a-c or d-c sensors with a-c or d-c control mechanisms. **Circle 512 inside back cover.**

Multiheaders and Plugs. Hermetic Seal Corp., 29 South 6th St., Newark 7, N. J. Comprehensive information on hermetic seal Vac-Tite compression multiheaders and plugs is offered in a 16-page catalog condensing over 10,000 different types of hermetic seals manufactured by the company. Parts are carefully grouped to provide essential information, part numbers are simplified, and dimensioning standardized for quick, easy reference. Drawings and illustrations are included. Research and engineering facilities are available to solve special hermetic seal design problems. **Circle 513 inside back cover.**

Microminiature Relay. Schweber Electronics, 122 Herricks Road, Mineola, L. I., N. Y. An eight-page bulletin features new microminiature sealed relays in high temperature range. It discusses tiny relays with rugged construction, specifically designed for computers and airborne instruments. Specifications and dimensional diagrams are included. **Circle 514 inside back cover.**

Phototube Catalog. Continental Electric Co., 6 No. Michigan Ave., Chicago 2, Ill., has published an illustrated eight-page catalog (No. 257) on phototubes and semiconductor lead sulfide photoconductive cells. The new brochure provides full information, including charts and mechanical specifications, on the firm's Cetron-Taylor line. **Circle 515 inside back cover.**

Delay-Line Flat. Columbia Technical Corp., 61-02 Thirty-First Ave., Woodside, N. Y. Details and descriptive information on the new Delay-Line Flat are found in bulletin No. 9-56.

The flats discussed have a unique, radically new design—the new elliptical core, which permits the same 5 in. long core to be used in any impedance range from 75 to 7,500 ohms. Maximum delays range from 0.05 μsec at 75 to 125 ohms to 2.0 μsec at 2,500 ohms and higher impedances. The standardized physical size facilitates layout problems and provides easy interchangeability of types. **Circle 516 inside back cover.**

Universal Control System. Crescent Engineering & Research Co., 5440 N. Peck Rd., El Monte, Calif. The type 67, a 10-lb, single channel control system or carrier amplifier, is covered in a recent four-page folder. The instrument described has modular construction, allowing independent use of regulated power supply, oscillator and amplifier, and provides choice of six excitation frequencies for operation of most types of transducers. **Circle 517 inside back cover.**

Magnetics Data. Avion Division, ACF Industries Inc., 11 Park Place, Paramus, N. J. A single-sheet bulletin covers PQ magnetics. Features listed are: (1) magnetics to meet your requirements; (2) minimum size and weight; (3) rugged premium construction; (4) quality production; and (5) reliable performance. The bulletin announces a new and complete magnetic component service which was born of necessity to meet Avion's own requirements for both standard and specially designed units. Types of components, characteristics and advantages are given. **Circle 518 inside back cover.**

Semiconductor Products. General Electric Co., Syracuse, N. Y., has available a monthly Newsletter on its semiconductor products. It will be mailed regularly to those who request it. **Circle 519 inside back cover.**

Automatic Wave Analysis. Minneapolis-Honeywell Reg. Co., Davis Laboratories Div., 10721 Hanna St., Beltsville, Md. How automatic wave analyzers can speed reduction of analog data and increase statistical reliability provides the subject matter for bulletin 9001. The bulletin points out the advantages of analog reduction of analog data in eliminating such tedious and time consuming steps as manual fairing, measuring or sampling, or analog-digital conversions.

Bulletin 9001 concludes with a rundown of the general specifications of two of the company's analyzers that perform all reductions from the original recorded data to a permanent printed plot of amplitude vs frequency or power vs frequency automatically. **Circle 520 inside back cover.**

Dual-Purpose Antenna. Aircraft Radio Corp., Boonton, N. J. Standing-wave ratios and radiation pattern diagrams and descriptions of the type A-13B vhf navigational antenna are contained in a new brochure. Type A-13B discussed incorporates two broadbanded antennas, one for use with VOR and runway localizer receivers and one for use with glide-path receivers. It is designed for use on all types of aircraft. **Circle 521 inside back cover.**

Teflon Wire and Cable. American Super-Temperature Wires, Inc., West Canal St., Winooski, Vt., has published a 30-page catalog on Teflon insulated wires and cables. Complete specifications and prices are presented on Teflon and silicone insulated magnet wires, lead wires, lacing cords, sleeving, tubing and shielded and jacketed miniature cables. Helpful information on applications is also included. **Circle 522 inside back cover.**

Long-Life Capacitors. Industrial Condenser Corp., 3243-65 N. California Ave., Chicago 18, Ill. A new 12-page catalog 1165 presents data not previously available on electrolytic capacitors and describes the new Royaltic long-life capacitor which eliminates such problems as short operating life, excessive leakage currents and rapid shelf aging of conventional electrolytic units. **Circle 523 inside side back cover.**

Power Rectifiers. Sarkes Tarzian, Inc., Rectifier Division, 415 N. College Ave., Bloomington, Ind., has available fly sheets numbers 16, 17, 18 and 19 dealing with different types of silicon rectifiers. Specifications, characteristics and dimensions are shown. **Circle 524 inside back cover.**

Electromechanical Breadboard Parts. Beckman/Helipot Corp., Newport Beach, Calif., has published a catalog offering complete descriptions of all parts necessary for the easy assembly of complicated gear trains and servomechanisms. The 24-page book also includes typical schematics which are representative of basic synchro transmitter and receiver systems, potentiometer transmitter and receiver systems, and a mechanical resolver system.

Each component is described in detail in the approximate order in which it would be used while setting up a typical system. All necessary information is in one place, including pictures, specifications, outline drawings and complete ordering instructions. **Circle 525 inside back cover.**

Electronic Components. Onandaga Pottery Co., Syracuse 1, N. Y. A 32-page booklet includes a discussion and listing of general characteristics of printed electronic circuits. Radio receiver and television receiver components are covered and circuits are illustrated. **Circle 526 inside back cover.**

Ceramic Capacitors. Automation Components, Inc., 875 Hickory St., Peckville, Pa. A four-page catalog sheet covers a line of by-pass disk capacitors, temperature compensating disk capacitors, and high voltage tubular and disk capacitors. Specifications are included. **Circle 527 inside back cover.**

Frequency Period & Time Interval Meter. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif. A single-page bulletin describes model 7550B frequency, period and time interval meter which measures from 0.1 to 100 kc and 100 μsec to 1.2 days with 200-mv input sensitivity. The instrument discussed is designed for flow measurement, filter characteristic determination, accurate frequency determination, oscillator calibration, rpm monitoring and timing of physical events. **Circle 528 inside back cover.**

Pulse Programming Equipment. Navigation Computer Corp., 1621 Snyder Ave., Phladelphia 45, Pa., has released a new brochure describing the technical features of its transistorized pulse programming equipment. It offers descriptions, specifications and illustrations of the individual units as input and output waveforms. The brochure has an index tab as an aid to filing and allows for the later insertion of additional specifications sheets. **Circle 529 inside back cover.**

Laboratory Power Supplies. Burroughs Corp., Electronic Instruments Division, 1209 Vine St., Philadelphia 7, Pa., has published a new brochure illustrating and describing three power supplies in the laboratory instrument line.

The units discussed in the four-page brochure—types 9001, 9102 and 9202—provide up to eight standard voltage outputs both positive and negative from +400 v d-c to −400 v d-c and cover a range of current capacities from 2 ma to 6 amperes. Regulation on each of the supplies discussed is maintained at better than ±5 percent for all output voltages. Ripple voltage is kept to a minimum of less than 0.5 percent rms. **Circle 530 inside back cover.**

Ultrasonic Gaging. Branson Instruments, Inc., 37 Brown House Road, Stamford, Conn., has announced a new eight-page technical bulletin on the Vidigage, an ultrasonic resonance instrument used for fast, nondestructive testing. Bulletin V-200 gives complete data on the time-saving advantages of using the instrument to measure thickness of metal, glass and plastic from one side and to find corrosion, laminar discontinuities or other flaws. **Circle 531 inside back cover.**

Component Bulletin. Richards Electrocraft, Inc., 3739 N. Kedzie Ave., Chicago, Ill. A new eight-page bulletin gives complete information on the company's products including plugs, jacks, connectors, adapters and push-button switches in both standard and miniature sizes. Parts are completely illustrated; drawings show construction details and tables list sizes and types available. **Circle 532 inside back cover.**

Quick Reference Catalog. Eitel-McCullough, Inc., San Bruno, Calif., has published a new 16-page 3-color quick reference catalog.

Summarized electrical and physical data are given in handy tabulated form for each of the company's line of triodes, tetrodes, pentodes, klystrons, high vacuum and mercury vapor rectifiers, vacuum capacitors, vacuum switches, ionization gage, contact finger stock, heat dissipating connectors, air system sockets and chimneys. **Circle 533 inside back cover.**

Microwave Components. Microwave Associates, Inc., 22 Cummington St., Boston 15, Mass. An attractively illustrated four-page short-form brochure describes microwave waveguide components and test equipment in the 2.63 to 75-kmc frequency range.

The components are listed both in numerical order by model number, including frequency ranges and prices, and separately by function and waveguide size. More than 200 instruments are listed, including coaxial and cartridge-type bolometers (barreters and thermistors), branch guide and sidewall directional couplers, antenna rear feeds, crystal mounts and balanced mixers, precision variable attenuators, tunable thermistor mounts, fixed attenuator pads, matched and unmatched hybrid tees, bends, twists and transitions. **Circle 534 inside back cover.**

Relay Catalog. Magnecraft Electric Co., 3350B W. Grand Ave., Chicago 51, Ill. A handy engineering catalog describes printed circuit relays, miniature and subminiature, 6pdt and power relays, snap action relays, 400-cps relays, and rectified relays for quiet operation and increased reliability on a-c. It also includes a wide selection of relays with hermetically sealed and dust-tight enclosures; with removable dust covers; and with dust-tight observation window enclosures. **Circle 535 inside back cover.**

Recent Electron Tube Developments. Eitel-McCullough, Inc., San Bruno, Calif. "What's New With The Electron . . . 1957" is a 20-page, 2-color brochure on recently developed Eimac products.

Basic electrical data are supplied on many new tube types, with emphasis on new developments in ceramic tube design. Information is included on klystrons, power tetrodes, triodes, ceramic receiving tubes, beam switch tubes and beam rectifiers, high vacuum rectifiers, air system sockets and klystron amplifier circuit components. **Circle 536 inside back cover**

Current Governor. North Hills Electric Co., Inc., 402 Sagamore Ave., Mineola, N. Y. A single-page bulletin illustrates and describes the model CG-1 current governor, a two terminal current stabilizer modulator and programmable electronic load. Applications and specifications are listed. **Circle 537 inside back cover.**

Corona Type Voltage Regulators. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio, announces availability of an engineering paper on corona type voltage regulators.

The eight-page paper describes how corona regulators can solve voltage regulation problems without the use of multitube circuits. It is illustrated with performance curves, graphic analysis of corona regulator operation and gives typical schematic diagrams for use in cascade regulators, circuits for increasing current rating, cathode follower regulator circuit and other applications. **Circle 538 inside back cover.**

Seismic Data Processing Equipment. Texas Instruments Inc., 6,000 Lemmon Ave., Dallas 9, Texas. Descriptions of "seisMAC", the only all electronic seismic data processing computer on the market, and its related equipment for central office processing, are contained in a new eight-page brochure.

In addition to detailing the economic and technical advantages of the TI-Central office processing system, the bulletin contains descriptions of such other components of the system as "magne DISC", disk-type magnetic recorder; the 7000B all-purpose amplifier, and the T-Z (time-depth) camera. Write for Seismation bulletin No. S-318. **Circle 539 inside back cover.**

Electrochemical Assembly Kits. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y. A new instruction book containing tables of common gear ratios and moments of inertia has been prepared for Servoboard electromechanical assembly kits. The eight-page booklet spells out instructions for installing components in hangers, installing hangers and gears, gear alignment and gear selection. **Circle 540 inside back cover.**

Audio Frequency Equalizers. Cinema Engineering Division Aerovox Corp., Burbank, Calif. A 16-page catalog, "Audio Frequency Equalizers," contains product illustrations and two dozen charts showing response characteristics, dialog and variable equalizer diagrams.

The units described provide standard networks which, in simplified and flexible arrangements, may be used to build up almost any type of audio frequency response characteristic.

Principle use of the items discussed is in the fields of: industrial and scientific research, telecommunications, tv and broadcasting, sound recording and motion pictures.

A deviation from the usual catalog style is the inclusion of eight case studies—problems and solutions from experience in actual usage. **Circle 541 inside back cover.**

Plants and People

Edited by WILLIAM P. O'BRIEN

Electronics manufacturers expand plants and facilities by acquisition, leases or new construction. Top engineers and executives in the industry are promoted and move to new responsibilities. MIT Opens $4,000,000 Laboratory

Burroughs' Electro Data Completes Computer Facility

COMPLETION of a sixfold enlargement of its Pasadena plant, now totaling 250,000 sq ft, was recently announced by the Electro Data Division of Burroughs Corp. The $4-million plant is the West's largest engineering and production facility for electronic computers.

A chief feature of the building is the integrated electronic data processing center, where a quarter-million dollar Datatron system is installed for contract computation.

In addition to manufacturing Datatron electronic data processing systems, Electro Data markets the E101 desk-size computer and the series G high-speed printing, tabulating and punch-card equipment.

Electro Data's new computer facility in Pasadena, Calif.

RCA to Establish Major Lab in Boston Area

CONSTRUCTION of a 132,000-sq ft, single-story major electronics laboratory for military airborne equipment and systems is now under way in the greater Boston area. It is scheduled for completion by June, 1958, according to present plans.

The new lab will be erected on a 35-acre tract near the intersection of Routes 128 and 3, between Burlington and Bedford, Mass. It will provides engineering space and developmental facilities for approximately 300 electronic engineers and scientists and an equal number of supporting personnel.

The Boston Laboratory will be equipped with the latest in electronic test equipment and computing devices, and will feature a modern model shop and one of the nation's most extensive installations of flight simulation facilities. The simulation facilities provide computers, a replica of a jet aircraft complete with operating controls, and other devices to enable RCA engineers to forecast with electronic precision the nature of airborne systems needed to meet specific aeronautical goals. Simulation makes possible performance evaluation of such systems while under development, and with important reductions in time-and-cost consuming flight tests.

Bendix Expanding for Missile Work

PACIFIC DIVISION of Bendix Aviation Corp. is constructing a 12,000 sq ft addition to its manufacturing facilities in North Hollywood, Calif., to provide necessary space for the division's missile programs.

The new building area is required primarily for the assembly and testing of hydraulic components being produced under contract by the division for the Atlas, Titan, Nike, Terrier, Talos, Sparrow and other missiles slated for future production.

Sperry Rand Builds In Florida

CONSTRUCTION of a $2,000,000 electronics facility for development of advanced radar instrumentation by Sperry Rand Corp., in Clearwater, Fla., began in June. The newly organized electronics division will consist of an initial 75,000 sq-ft air-conditioned laboratory structure. First operations of the new division will employ approximately

Good-ALL capacitors

The 600 UE

A MYLAR* dielectric capacitor MOLDED IN EPOXY

The superior moisture resistance of EPOXY gives far better humidity protection than commonly used molding materials. High dielectric strength is also an attractive property of this tough, dense plastic.

Exclusive Good-All molding technique eliminates all possibility of deforming or otherwise damaging windings during the molding process. Uniform wall thickness is carefully maintained.

600-UE

600-UPE

The same quality features illustrated in the cut-away drawing are available in *Pin Types* for use in upright mounting.

Leads are securely bonded in the EPOXY molding compound. This extremely tight bond prevents moisture from entering the capacitor at this point.

The dark maroon capacitor body is exceptionally durable as well as attractive. Since overall dimensions are held within close tolerances, this capacitor type is ideal for automatic machine insertion.

TYPICAL APPLICATIONS

Electronic Organs . . .Test Equipment . . . Communication's Systems . . . TV Receivers

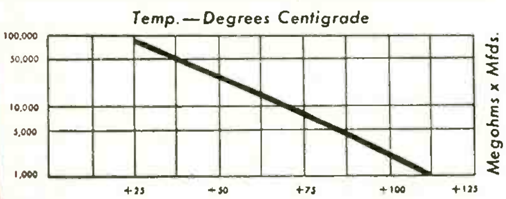
The outstanding combination of a space-saving Mylar winding sealed in moisture resistant EPOXY provides you with premium performance in a rugged compact design. This new capacitor incorporates these valuable properties of Mylar dielectric . . . HIGH IR, STABILITY WITH LIFE and LOW POWER FACTOR. Good-All Types 600-UE and 600-UPE (for upright mounting) are priced to encourage widespread use in both consumer products and industrial equipment.

*DU PONT'S TRADEMARK FOR POLYESTER FILM

SPECIFICATIONS

Insulation Resistance . . . Greater than 75,000 Megohm-Mfd. at 25°C (See curve below for higher temperatures)
Power Factor . . . Less than 0.6% from +25°C to +85°C
Temperature Range . . . May be operated at rated voltage from −65°C to +85°C and to +125°C with derating
Humidity Resistance . . . Far surpasses requirements of RETMA Spec. REC-118-A
Voltage Range . . . 100, 200, 400 and 600 Volts D.C.

INSULATION RESISTANCE vs. TEMPERATURE



DIMENSIONS OF TYPE 600-UE, 100 VOLTS D.C.

CAP.	SIZE	CAP.	SIZE
.015	.312 x 15/16	.15	.500 x 1 3/16
.047	.375 x 1 1/16	.22	.500 x 1 9/16
.1	.438 x 1 3/16	.47	.562 x 1 15/16

Our engineers are ready to work with you on special applications. Write or wire for specifications and quotations.

GOOD-ALL ELECTRIC MFG. CO. • OGALLALA, NEBRASKA

A leading manufacturer of Tubular and Ceramic Disc Capacitors

150 scientific and technical personnel.

The company plans to utilize the new facility to expand its development and testing of new microwave and electronic instruments designed to control and monitor various functions in aircraft and missile systems, industrial processes, and other new types of electronic systems. Over $1,000,000 in scientific instruments, special machine equipment, and test facilities will be installed before operations begin late this year.

Largest Magnetic Tape Plant Opened In Minnesota

Minnesota Mining and Mfg.'s new magnetic tape plant

A PLANT estimated to be capable of meeting the recording demands of the entire world for the next 10 years, was recently put into 24 hour-a-day production by Minnesota Mining & Mfg. Co., St. Paul, Minn. It is a factory built and maintained to achieve near-sterile conditions required to produce essentially perfect magnetic tapes necessary for such critical applications as video tape recording, electronic computers and instrumentation recording.

Dr. W. W. Wetzel, general manager of the firm's Magnetic Products division, said that the 78,000 sq-ft unit, located at Hutchinson, Minn., incorporates the ultimate in tape-making technology based on a half century's experience in applying precision coatings, and more than a decade of pioneering in the production of highly specialized tapes for magnetic recording.

Consolidated Avionics Announces Two Appointments

HARRY GLIXON, president of Consolidated Avionics Corp., recently announced that Edward Foodim has been appointed assistant to the president, and Ira L. Kasindorf has succeeded E. Foodim as chief engineer.

Foodim is a specialist in design and production of large scale data reduction instrumentation systems.

Kasindorf comes to Con Avionics from Servomechanisms, Inc., where he was chief engineer of the Components Division at Westbury, L. I. Before joining Servomechanisms, Kasindorf was a project engineer with Airborne Instruments Laboratories, Inc., and prior to that was on the National Advisory Council Committee for Aeronautics, Moffet Field, Calif.

Consolidated Avionics is a subsidiary of Consolidated Diesel Electric Corp., Stamford, Conn., manufacturer of aircraft ground support, power and test equipment for industry.

Edward Foodim

Ira L. Kasindorf

Ivans Named V-P At Kin Tel

APPOINTMENT of William S. Ivans, Jr., as vice president in charge of engineering for Kin Tel, a division of Cohu Electronics, Inc., has been announced.

Ivans was formerly chief electronics engineer of Convair, and is outstanding in the field of electronic instrumentation.

He joined Convair as project engineer in 1946. Initially, he directed the development of a complex radar homing and flight control system for Navy missile proj-

the pioneer
is the leader

PANORAMIC introduces...

Quick accurate visual analysis of measurement problems made possible by Panoramic instruments has speeded research and development projects . . . cleared production test bottlenecks. Their broad range panoramic displays eliminate tedious, complicated point by point measurements . . . present an easily read, graphic "picture", simple to analyze. Panoramic's wide variety of spectrum analyzers, unique response curve tracing systems and telemetering test instruments have made them pioneers and leaders in the field.

Time-saving and precedent-setting, these new instruments open up completely new areas of measurement through visual analysis.

new ways in new instruments that rapidly solve measurement and analysis problems

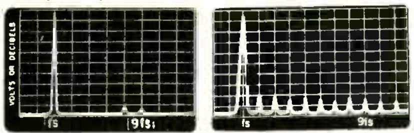
Model TDC-5, Panoramic Telemetering Simultaneous 5-Point Calibrator and Dynamic Checker

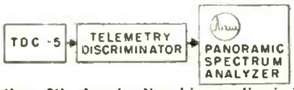
For the FM/FM telemetry field, the new TDC-5 offers two important new facilities: A simultaneous five-point calibrator for discriminator linearity measurements in all of the 18 RDB subcarrier channels and the 5 optional 30% channels. A dynamic checker which converts any phase distortion in the discriminator package into harmonic distortion for sensitive determination and analysis on the screen of a Panoramic Spectrum Analyzer.

Packaged in modular form with individual chassis and interchangeable crystal assemblies for each channel, a common simultaneous output terminal and function control is provided in a master unit.

In its first function, the TDC-5 furnishes five deviation frequencies for each channel—for example, +7.5%, +3.75%, 0%, −3.75%, −7.5%. Other deviation frequencies can be set if desired. Each frequency is crystal controlled and precise to within ±0.02%. Operation may be automatic, semi-automatic or manual. On automatic, frequencies are stepped sequentially for all channels included in system.

As a dynamic checker, a stepped FM wave is generated for each subcarrier discriminator. As the stepping rate is increased beyond the permissible information rate, significant distortion of the FM envelope is detected as harmonic distortion of the stepping frequency on the screen of the Panoramic Spectrum Analyzer. By simply adjusting the cycling rate of the TDC-5 (continuously variable from 2 to 2,000 cps), maximum capacities of each channel may be established easily by visual analysis. New and valuable information for all FM/FM telemetering systems obtained quickly and easily on Panoramic's new TDC-5.





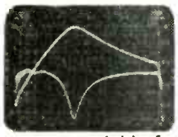
I. Linear discriminator spectrum II. Harmonic from 2nd thru 8th due to Non-Linear discriminator. Spectrum analysis of discriminator staircase output. Fundamental Frequency (f) = Staircase Repetition phase distortion

Model PA-1, Panoramic Sonic Phase and Amplitude Response Analyzer

A unique dual purpose instrument, the PA-1 permits rapid tracing of *both* the amplitude and phase shift characteristics of audio band networks. Each characteristic is displayed as a single line curve . . . on the identical frequency scale . . . on the 5" CRT screen of Panoramic's companion Model LP-1a Sonic Analyzer. Function selection is accomplished through a single front panel switch.

Phase angle is read on the vertical linear scale calibrated up to 180° at full scale. A fewer number of degrees may be expanded to full scale for greater reading accuracy of small phase shifts with higher sensitivity settings. Lag and lead sense are determined by an internal circuit.

Amplitude scales are linear and two decade log. The PA-1 may be used without performance degradation even at attenuations greatly exceeding 100 db . . . enhancing even more the versatility of Panoramic's Selective Frequency Response System.



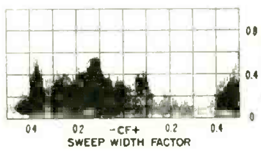
Amplitude and phase angle vs. frequency curves of parallel resonant RLC network —traced with model PA-1—phase angle goes from 0° to 90° at either side of resonance

Frequency scales are 40 cps to 20 kc logarithmically or any 200, 1000, or 5000 cps linear segment within a 20 cps to 22.5 kc range. Scanning rates are 1 cps internally . . . variable from 0.05 to 60 when used in conjunction with Panoramic's Model TW-1 Triangular Wave Generator.

Model PDA-1, Panoramic Spectral Power Density Analyzer

Specifically designed to provide an accurate analysis of the relative spectral energy distributions of random waveforms, typical of complex vibrations and noise data, the PDA-1 offers an excellent *quantitative* solution to the problem of adequately sampling a non-discrete function. Used with the appropriate automatically scanning Panoramic Spectrum Analyzer, it will cover any frequency range from subsonic through microwave.

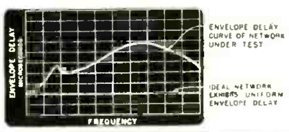
Operation is simple and automatic. The PDA-1 sums up all signal contributions at each small frequency band (as determined by the resolution capabilities of the companion analyzer) and reads out at a figure equal to the total energy content. The integration process is repeated at the adjacent band, and so on, throughout the spectrum of interest. When the input data is presented from a looped tape recording, the sampling interval is synchronized with the loop period thus intercepting all segments. Total scan time is adjustable up to 60 minutes, integration intervals 1-30 seconds.



Spectral density analysis of random vibration data. PDA-1 read-out through LP-1a Sonic Analyzer on companion recorder, Model RC-3.

Model DD-1, Panoramic Ultrasonic Delay Distortion Indicator

This instrument makes possible automatically the detection of minute time delay variations of ultrasonic networks as a function of frequency. In many types of networks (such as, bandpass filters and video amplifiers) the relative uniformity of delay over a band of interest is much more important than total transmission time between input and output terminals. The DD-1 is the answer . . . it gives an extremely sensitive measure of incremental delay *distortion* defined by the variation in slope of the phase angle vs. frequency curve . . . traces out a horizontal plot for networks with uniform delay in a band. Frequency ranges from 8 to 300 kc.

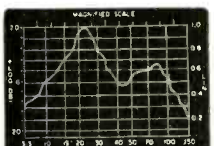


Model SF-1, Panoramic Synchronous Frequency Analyzer

A receiver which monitors the vibrations of mechanical devices at the frequency equal to the instantaneous rotating or reciprocating speed, the SF-1 automatically tracks machine speed as it is varied under test. Thus, a complete characteristic of the relative vibration levels vs. frequency is obtained throughout the entire speed range. All other vibration frequency components, harmonics, noise, etc., are severely attenuated. If desired the SF-1 may be locked onto one of the several harmonics of the rotating speed.

Frequency ranges are a broad band scale on the calibrated H axis . . . any 10% segment may be magnified to full scale width for detailed examination. Amplitude scales are linear and two decade log. Readout is on a 5" CRT or an external X-Y recorder.

This form of fundamental component study with the SF-1 is an invaluable aid in dynamic balancing and in pinpointing resonant conditions.



▲ Amplitudes of fundamental vibrations at the frequencies of rotation automatically traced by Model SF-1.

see us at the Wescon Show Booth 814

If you can't be there, write, wire or phone NOW for complete information on these new instruments.

A Panoramic Applications Engineer is always available to discuss specific problems.

PANORAMIC RADIO PRODUCTS, Inc.

New Address: 522 South Fulton Avenue, Mount Vernon, N. Y.
Phone: MOunt Vernon 4-3970 • Cables: Panoramic, Mount Vernon, N. Y. State

This is our new home. Modern, up-to-the-minute, it will double engineering and production facilities . . . provide greater efficiency.

William S. Ivans, Jr.

ects. Subsequently, he supervised a number of new developments, including airborne mapping radar systems, long-range missile tracking and guidance, antennas, and radomes. He also gained extensive experience in research on basic aircraft and missile instrumentation systems and automatic equipment.

Compton Labs Building Opens

MIT's $4 MILLION new Compton Laboratories building is open. Equipment includes the IBM 704 computer, worth $2.7 million and largest in any U. S. educational center.

The five-story structure adds 125,000 sq ft of floor space to MIT. It houses the Research Laboratory of Electronics, Laboratory for Nuclear Science, and Computation Laboratory.

Atop the building is a huge penthouse. There will be facilities for study of cosmic rays and radio waves. The computer fills a 46 by 70-ft room. A blackboard 48-ft wide is in the lecture hall. The building is named after Karl Taylor Compton, former MIT president and chairman.

Two Engineers Join ECS Staff

DAVID BARNES and Martin Bondar have joined the engineering staff of Electronic Control Systems, Inc., Los Angeles, Calif. ECS is affiliated with Stromberg-Carlson and is a subsidiary of General Dynamics Corp.

David Barnes was formerly with Electronic Corp. of America, and while attending MIT, worked with Philco Corp. in their co-op program. He is assigned to the Data Processing Section.

Martin Bondar has been associated with Hughes Aircraft and Hoffman Laboratories. Prior to joining ECS he was working at the Allen B. DuMont Laboratories. He is presently assigned to the Equipment Engineering Section.

Sam F. Arn

Gertsch Appoints Arn To Sales Post

IN A general expansion at management level, president Elmer P. Gertsch has announced appointment of Sam F. Arn as general sales manager of Gertsch Products, Inc.

Arn, a senior member of IRE, and formerly in sales with the Lear Cal Division of Lear, Inc., will direct the national sales efforts of Gertsch representatives, and will set up a West Coast direct sales organization for the company. The company manufactures a broad line of precision electronic instruments and ratio transformers.

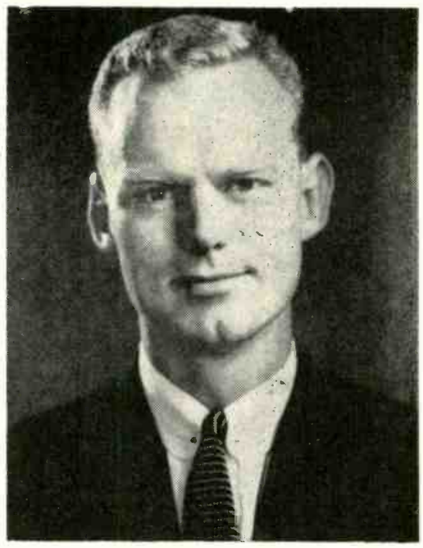
Convair Advances Chief Design Engineer

CHARLES S. AMES, chief design engineer of Convair's intercontinental ballistic missile program since its beginning in 1946, has been named chief project engineer for the Atlas ICBM at Convair-Astronautics.

Ames currently is on special assignment at the Air Force Missile Test Center, Patrick Air Force Base, Florida. He will be replaced by Lloyd Munson, a design engineer at Convair-Fort Worth. Munson has aided in the design of the Convair B36 intercontinental bomber, the B58 Hustler and other heavy aircraft.

Metals & Controls Opens West Coast Facility

To EXPAND technical service to the aircraft and guided missile industries, Metals & Controls Corp. of Attleboro, Mass., has opened a West Coast design engineering facility. Its work will be to engineer supplementary actuating systems for KLIXON miniature precision switches in aeronautical and electronic applications.



William Jones

William Jones will head the Los Angeles laboratory and office staff as project engineer.

Andersen Labs Moves To New Quarters

A NEW, modern building at 501 New Park Ave., West Hartford, Conn., now houses Andersen Laboratories, Inc. The location provides additional facilities for manufacturing ultrasonic delay lines and for increased research in the electronic field.

Andersen Laboratories have pioneered in ultrasonic and special electronic equipment for six years. Particular emphasis has been centered on components for the radar, computer and airborne control field.

Chief Engineer Named at L&K Ltd.

Ray Clinton

LEWIS AND KAUFMAN, LTD., Division of International Glass Corp., has appointed Walter Raymond Clinton chief engineer in charge of research, design, and development relating to Los Gatos brand electron tubes.

In 1953 he joined Penta Laboratories in Santa Barbara, Calif., with responsibilities in v-t and twt development. Later he was affiliated with the GE Microwave Laboratory as a design engineer on twt development.

GPL Opens New Test Lab

A 23,200-SQ FT environmental test building was recently opened by General Precision Laboratory on its 69-acre property at Pleasantville, N. Y.

Under construction since April, 1956, the $450,000 structure increases the company's testing facilities for military and commercial electronic equipment by two and one-half times the former area.

The new lab houses additional apparatus to simulate extremes of temperature, altitude, humidity, acceleration, vibration and shock. Subjected to these and other environmental conditions encountered in world-wide operational use are GPL-developed automatic airborne navigation systems and components, and special ruggedized television equipments.

Physicist Joins Philco Computer Group

Dr. Morris Rubinoff

DR. MORRIS RUBINOFF, associate professor in electrical engineering at the University of Pennsylvania, has joined the Government & Industrial Division, Philco Corp., as manager of digital computer engineering. His duties will include future research and development of TRANSAC, Philco's new completely transistorized large scale data processing system.

Daystrom Hires Otis As Systems Engineer

MANNY OTIS, formerly with the USAF Cambridge Research Center's Computer Laboratory, has become associated with the Systems Division of Daystrom, Inc., La Jolla, Calif., as a systems engineer.

While at Cambridge, Otis worked on magnetic-core memory devices, logic and equipment for a radar data-processing digital device, and

Manny Otis

the improvement of digital computer components. At Daystrom he is specializing in logical design of individual systems utilizing magnetic and transistor components, and the development of digital circuits.

New Loral Plant Marks Company Growth

LEON ALPERT, president of Loral Electronics Corp., announces completion of its new 1½ million dollar plant building consisting of 100,000 sq ft of single-story floor space on 5 acres of land. The new plant is located at 825 Bronx River Ave., Bronx, N. Y.

SMPTE Has New Staff Engineer

THE APPOINTMENT of J. Howard Schumacher, Jr. to the post of staff engineer for the Society of Motion Picture and Television Engineers has been announced. His present position is laboratory technician for NBC Development. He has been associated with NBC for 12 years.

Airpax Locates in Florida

CENTRAL ENGINEERING DIVISION of Airpax Products Co., Baltimore, Md., is now located in Fort Lauderdale, Fla. The new air-conditioned building includes 14,000 sq ft of laboratory and production space, as well as offices.

In moving to Florida, the division is expanding its production facilities to meet the growing market for special missile components. Additional engineering and technical personnel are being recruited to undertake further component and equipment development.

RCA Encourages Science Teachers

A DEFINITE shortage of qualified teachers in science and mathematics, particularly in high schools situated in grass-roots areas, has been revealed in surveys conducted by RCA. Based on its findings, selection was made of 20 colleges and universities for new company scholarships to encourage students entering the science teaching profession. In all, 30 such scholarships, involving $22,000, will be financed by RCA for the academic year 1957-58.

Farley Named Chief Electronics Engineer at Canoga

Edward J. Farley

CANOGA CORP., Van Nuys, Calif, has appointed Edward J. Farley as chief electronics engineer. Employed by Canoga for the past two years, he formerly held the position of special projects engineer for electronics.

Prior to joining Canoga, he was

project engineer on MSQ 1-A Air Force ground guidance radar MSQ 1-2.

Rehler Named to New Post

KENNETH M. REHLER has been appointed manager of the Data Processing Section at Electronic Control Systems, Inc., the West Los Angeles affiliate of Stromberg-Carlson and a subsidiary of General Dynamics Corp. He will be responsible for analysis design and development of special purpose analog and digital computers for commercial and military data processing applications.

Rehler has been in the computer field since graduating from MIT. Formerly with Raytheon, he was later vice-president of Computer Control Co., Inc.

Beckman Promotes Del Duca

Anthony Del Duca

APPOINTMENT of Anthony Del Duca as chief electronics engineer for the Process Instruments Division of Beckman Instruments, Inc., has been announced. Formerly a senior engineer, he will direct the design of electronic circuitry for a variety of instrumentation developed for the monitoring and control of industrial processes, ranging from chemical and petroleum operations to atomic power facilities.

Del Duca was previously employed by Noth American Aviation in the design and development of fire control radar circuitry. His experience also includes development of guided missile circuitry for the Convair Division of General Dynamics Corp.

Freeman Joins General Ceramics

GENERAL CERAMICS CORP., Keasbey, N. J., manufacturers of industrial ceramics for the electrical and electronics industries, announce the appointment of James Robert Freeman to the engineering staff of the company's memory core products division. Freeman, formerly a staff member of MIT's Lincoln Laboratory, will act as a technical consultant to better serve customers on the West Coast.

Government Honors Colson Engineer

Melvin Martins

MELVIN MARTINS, an electronics engineer at the Colson Corp., Elyria, Ohio, has been cited by the U. S. Department of Commerce for his part in the development of a new instrument for the Census Bureau. A gold medal for exceptional service was awarded to Martins by Secretary of Commerce Sinclair Weeks.

The instrument he developed transcribes census data brought in from the field into language that can be fed to Univac, the electronic brain. Martins is a member of the engineering and design staff of Colson's Electronic Hospital Equipment Division.

GE Names Johnson To New Post

M. R. Johnson

APPOINTMENT of M. R. Johnson as manager of the newly established Armament & Control Section of the Light Military Electronic Equipment Dept. has been announced. In his new post Johnson will have responsibility for manufacturing operations of the new Section located at Johnson City, N. Y., and its engineering facilities at Schenectady, N. Y.

Prior to his present appointment, he was manager-engineering of the Light Military Electronic Equipment Dept., a position he had held since 1952.

Mullard Increases Transistor Capacity

THE first stage of the Mullard Ltd. factory designed solely for the manufacture of semiconductors has been completed at Millbrook Trading Estate, Southampton, England.

Occupying 75,000 sq ft, this first section is only one-third of the total plant. The plant eventually will employ 1,500 to 2,000, with a planned annual output of several million semiconductor devices by 1958.

The new factory is a self-contained center containing research, development and application laboratories as well as manufacturing facilities, although basic research into transistor problems will still be carried out at the central Mullard Research Laboratories located elsewhere in the south of England.

Del Electronics Names New Executive

Hugo J. Di Giovanni

HUGO J. DI GIOVANNI has joined Del Electronics Corp., Mt. Vernon, N. Y., in the capacity of vice-president and chief engineer. He was formerly director of the Technical Liaison Division of the New York Office of the Atomic Energy Commission.

Di Giovanni was chief engineer at the X-Ray Division of North American Philips Co., Inc. At Del Electronics Corp. he will be responsible for the development of new products.

Ram Moves to Larger Quarters

IN RESPONSE to increasing military and industrial demand for engineering and production know-how for inductors of all kinds—as well as greater service industry demand for the company's tv sweep components—Ram Electronics has expanded its engineering and production facilities and has moved to new and larger quarters at 600 Industrial Ave., Paramus, N. J.

The new plant is 22,000 sq ft on one level, on a 3½ acre plot. It accommodates 250 employees and is easily expandable as the necessity arises.

Varo Starts New Division

Fred P. Granger

ESTABLISHMENT of a transformer division with Fred P. Granger as general manager was recently announced by Varo Mfg. Co., Inc., Garland, Texas.

The new division will provide an integrated engineering and manufacturing facility for magnetic components. It is equipped to design and build transformer chokes, saturable reactors and magnetic amplifiers to specific requirements in addition to offering standard designs now in manufacture.

Mr. Granger is in addition vice-president in charge of customer relations for Varo. He has been with the company since 1949.

Universal Transistor Products Takes Larger Plant

A FIVE-HUNDRED percent sales increase in two years has resulted in the acquisition of a new air-conditioned 12,500-sq ft plant for Universal Transistor Products Corp. at 36 Sylvester St., Westbury, L. I., N. Y.

The company manufactures a wide variety of commercial and military transistorized power supplies ranging from low-power consuming units for radios and radiation detectors to high power units for rockets, missiles, microwave stoves and electronic flash units.

Honeywell Appoints Semiconductor Manager

William W. Martenis

APPOINTMENT of William W. Martenis as manager of the semiconductor activities of Minneapolis-Honeywell Regulator Co. has been announced.

For a number of years, Martenis has been manager of Honeywell's new product extension activities. He will continue to handle these duties, in addition to being in charge of engineering, development, production and sales of the company's power-type transistors.

Research Instrument Moves to Larger Quarters

THE RESEARCH INSTRUMENT CO., of Portland, Ore., has moved its operations to new and larger quarters at 7962 S. E. Powell Blvd., Portland 6, Ore. The new facilities provide an increase in working area of 400 percent including space for additional expansion. Plans call for continued expansion as new models of instruments and components are introduced to the field.

The new quarters will also house facilities for production of the new line of series 100 single turn precision potentiometers recently announced.

Ford Instrument Names Two to Key Posts

Edward C. Wagner

Michael A. Moscarello

EDWARD C. WAGNER has been appointed to the new post of assistant to the vice president for engineering at Ford Instrument Co., Division of Sperry Rand Corp.

At the same time, Michael A. Moscarello was named engineering director for marine equipment.

Schaner Joins The Daven Co.

Frederick A. Schaner

RECENTLY announced by The Daven Co., Livingston, N. J., is the appointment of Frederick A. Schaner as chief engineer. Previously employed as manager, receiver engineering, Research and Development Division of Air Associates, Inc., he was responsible for research and development of subminiature, automatically and fixed tuned receivers for aircraft and missile data link systems.

New Rheem Plant Established

RHEEM Electronics Division is now fully established in its new facility at 7777 Industry Ave., Rivera, Calif. The new plant is devoted exclusively to electronics and provides space for research, development and fabrication of test equipment as well as design and production of airborne and laboratory electronic instrumentation units.

Chipp Joins FTL

APPOINTMENT of Rodney D. Chipp as manager of systems engineering for the radio communication laboratory of Federal Telecommunication Laboratories, Nutley,

Rodney D. Chipp

N. J., has been announced.

He will be in charge of advanced planning in the radio communication laboratory, which will require liaison with both military and commercial communication agencies. In addition, he will coordinate the system engineering of the various radio communication projects. He was formerly director of engineering for the manufacturing divisions of Allen B. DuMont Laboratories, Inc.

Kansas Company Incorporates

CAL-OHM Laboratories, manufacturer of precision electronic components, recently announced incorporation of the company under a State of Kansas charter.

The company presently is in production on precision wire-wound resistors, trimming and 10-turn potentiometers, Wheatstone bridges and decade resistance boxes. It also offers research and development for the solving of specific electronic instrumentation problems, or production to specifications of electronic components.

General offices and main plant of the company are in Sterling, Kansas.

Nichols Named Chief Engineer for Taylor Instrument

A FORMER director of research for Taylor Instrument Companies, Rochester, N. Y., has rejoined the organization after an absence of several years. He is Nathaniel B. Nichols, newly appointed to the position of chief engineer. He succeeds Ralph E. Clarridge, who has been appointed to the president's staff as specialist for new product lines.

Nichols left the Rochester company to become professor of electrical engineering at the U. of Minnesota. He subsequently joined Raytheon as assistant v-p and manager of commercial engineering. During the war he worked with MIT.

Mack Electronics Names Director of Engineering

Wendell E. Phillips

APPOINTMENT of Wendell E. Phillips as director of engineering for Mack Electronics Div., Inc., of Plainfield, N. J., has been announced. Before joining Mack Electronics, Phillips served as engineering section manager of Air Associates, Teterboro, N. J., for the past 6 years. Prior to that he held engineering positions with the Lavoie Laboratories and the Federal Television and Radio Corp.

Bendix Computer Div. Doubles Plant Size

THE nation's fourth largest manufacturer of electronic computers, Bendix Computer Div., Bendix Aviation Corp., recently completed doubling the size of its main plant at 5630 Arbor Vitae St., Los Angeles, Calif. The additional provides space for expanded administrative, marketing, engineering and production facilities.

A feature of the new addition will be an enlarged computer center, equipped with two Bendix G-15D general purpose computers and two Bendix DA-1 digital differential analyzers to be available to firms on a rental basis.

Servomechanisms Gets New Components Division

A NEW component division for Servomechanisms, Inc., has been announced. Known as the Vacuum Film Products Division, it is located in El Segundo, Calif., and occupies 5,500 sq ft.

The new division will be responsible for the development and manufacture of electronic components utilizing vacuum deposition techniques. The application of this technique will stress the development of high temperature miniaturized electronic circuit components.

Raytheon Names Division Manager

HARVEY J. FINISON has been appointed manager of Raytheon

Harvey J. Finison

Manufacturing Company's semiconductor division. He will direct division activities at the firm's two plants in Newton and a third in Brighton, Mass. He reports directly to N. B. Krim, vice-president of the firm's receiving and cathode-ray tube operations.

Before joining Raytheon, Finison served as business consultant to the management services division of the Arthur D. Little, Inc., and as director of engineering and executive vice president of the National Pneumatic Co. and Holtzer-Cabot divisions of Boston.

M-H Aero Guidance Engineers Move

MINNEAPOLIS-HONEYWELL has completed the transfer of most of its inertial guidance engineering effort to the firm's new Aeronautical Division facility at St. Petersburg, Fla.

The staff in Florida now numbers more than 300, and is scheduled to reach more than 500 by the end of the year. Construction of the 90,000-sq ft engineering facility was begun last fall. It is the first phase of a proposed $4-million plant that will be devoted solely to design and manufacture of inertial guidance systems and components.

Electromation Co. Names Chief Engineer

APPOINTMENT of Glen E. McClure as chief engineer of Electromation Co., Santa Monica, Calif., was recently announced.

Associated for several years with Hoffman Laboratories, McClure was instrumental in the design of numerous military electronic devices marketed by Hoffman. He is also credited with design of a 250-tube electronic memory device for Standard Coil Products Co., Los Angeles.

McClure won recognition for his design of r-f elements of the TACAN portable beacon simulator for Hoffman Labs. Earlier, he served as chief electrical engineer for Schwein Engineering Co.

New Books

VHF Television Tuners

By D. H. Fisher
Philosophical Library Inc., New York, 1957, 133 *p*, $6.00.

In the young and rapidly advancing field of television tuners, this is the first book ever published which covers design considerations as well as production and servicing problems. Mr. Fisher has put together a coherent and readable account of the theoretical and practical aspects of the subject in a relatively small book.

▶ **Standards**—Although the proposed performance criteria and general specification of vhf television tuners are pertinent to the British standards, they apply equally well to the American standards in a broad sense. As a matter of fact, the basic philosophy of tuner design in Europe, according to this book, has been faithfully following the American practice with only minor deviations.

Mr. Fisher logically divided the tuner into three parts—signal-frequency amplification, frequency converters and oscillators. In connection with signal-frequency amplification, he presents an excellent treatise on shot and thermal noises at very high frequencies.

However, the author fails to emphasize the importance of matching between antenna and signal-frequency amplifier under all signal conditions and at any frequency within the signal passband. This has been a profound design criterion of tuners for use in color television receivers.

▶ **Cosmic Noise**—Furthermore, the problem of cosmic or galactic noise is only superficially mentioned. Its effect on design considerations of recent American vhf television tuners is missing. For instance, at channel 1 of Band I in England or channel 2 in this country, the galactic noise is of such a magnitude, at all times, that the noise factor of the television tuner is relatively unimportant unless it exceeds 10 db. Therefore, the best tuner design at lower vhf is not to secure the lowest noise factor, but rather to maintain a condition of optimum signal transmission from the aerial to the television tuner.

The author's treatment on frequency converters is more or less conventional, aiming at the best conversion gain and noise factor. The critical property of harmonic formation in frequency converters is again missing.

Finally, the discussion on frequency stability of local oscillators is inadequate since analytical approaches to this vital problem have been published in the American literature. These inadequacies, however, are made up quite sufficiently by the systematic and complete description of production and servicing techniques.

The chief criticism of this book, in the reviewer's opinion, is that the references given are insufficient to satisfy most readers.

In general, Mr. Fisher's book is well organized and clearly written. The material is carefully arranged and integrated. The complicated problem of a television tuner is described in simple language with the aid of little mathematics. For these reasons, it is extremely easy to read and is an excellent choice for readers seeking a broad knowledge of vhf television tuners. On the other hand, it will not fulfill the needs of those who are looking for advancements in this field.—Wen Yuan Pan, *RCA Victor TV Division, Cherry Hill, N. J.*

Automation In Business And Industry

By Eugene M. Grabbe
John Wiley & Sons Inc., New York, 1957, 611 *p*, $10.00.

The University of California offered a course in the spring of 1955 which consisted of a series of lectures by prominent engineers and scientists covering the most recent developments in the field of automation and their applications. This volume is the publication of these lectures and represents the efforts of 21 authors.

The usual advantages and disadvantages of a book written by many authors can be found here. For example, the coverage is quite broad; included are such diverse subjects as Nyquist's stability criteria and the social impact of automation. However, there is much repetition of introductory material and the technical level is quite variable throughout.

The large field of coverage and the rather general treatment gives the book the appearance of a handbook on automation; because of this, it should make a very good reference for engineers and managers, especially for those who are contemplating the first giant steps towards the introduction of automation techniques or systems into their particular fields of endeavor.

Very few readers will find the entire volume of interest, but very many readers both from engineering and management should find various sections of the book to be helpful. Which sections will depend upon the reader's technical background and his particular interest in this young but vast subject.

▶ **Past and Future**—The book opens with some historical background and presents the implications of the future introduction of more automation upon our society and our technology. Next follows a series of general definitions of terms used in the field and an introduction to the language of automation. The section on feedback control systems is more technical than the preceding sections and includes a fairly extensive discussion of such topics as various stability criteria, transient response of control systems and examples of automation in industry today.

A very informative presentation of instrumentation controls is contained in Chapter 5 followed by a chapter which introduces analog computers to the reader. The section on digital computers is quite comprehensive and serves to introduce the chapter on data processing which discusses the uses of digital computers as well as the requirements of data processing equipment for various applications.

A section on analog-to-digital conversion units is followed by a brief account of input-output equipment and associated peripheral off-line equipment. The solutions to some large volume information-handling problems using large-scale digital computers are considered in Chapter 11. The application of control systems to the automatic control of flight, the subject matter of Chapter 12, serves as a good illustration of the capabilities of automation techniques. The reader is also introduced to some typical sensing and actuating elements at this point.

The mechanization of the fabrication of electronic assemblies is used to exemplify the potentialities of automation for the fabrication industries. It is pointed out that the fabrication industries have lagged behind the processing industries in applying automation techniques.

After presenting the role of analog computers in industrial control systems and the use of digital control of machine tools, the authors offer additional examples of automatic production systems used in today's manufacturing industries.

▶ **Management Aspects**—In Chapter 17 the reader is led away from the technical aspects of automation by a discussion of some of the problems facing management and engineering due to the introduction of automation. The next chapter is devoted to a discussion of the economics of the application of automation in industry along with a consideration of some of the effects of automation upon management, industry and society in general. Although automatic control methods have been technically developed, some very important factors in our society have retarded the use of automation. Those discussed here include lack of industrial capital, ignorance of the availability of new devices, and plain management inertia. The wise industrialist will examine this presentation carefully.

▶ **Future**—Certainly one of the most interesting and original contributions of this work is its last chapter entitled "The Future of Automation". Here the author quite convincingly shows the superiority of the overall systems approach to the development of automation basing his remarks on an analogy between automation in business and industry and military electronics. He points out the inevitability of the importance of automation in the future of industry and the steps which business and industry must take to gain the major benefits of automation within the next eight to ten years.—D. E. ROSENHEIM, *IBM Watson Laboratory at Columbia University, New York, N. Y.*

Les Semiconducteurs

BY G. GOUDET and C. MEULEAU
Eyrolles, Paris, France, 1957, 436 *p*, 5,720 *fr*.

MUCH has been written about the transistor since its invention in 1948 by Dr. Shockley and his associates at the Bell Telephone Laboratories. It is difficult to conceive of a discovery that has attracted more widespread interest or immediate application.

Development of new types and applications of various semiconductor devices have occurred so rapidly as to make it difficult to follow. The present work satisfies a number of requirements. It is at once a highly theoretical treatment of the solid state physical properties of semiconductors, a well developed exposition of the characteristics of their behavior as determined by their internal and surface chemical constitution and a timely summary of the most recent applications in various circuits and under diverse physical influences.

▶ **Crystal Properties**—The theoretical study of crystal properties, the effects of impurities, the preparation of various combinations of germanium, silicon, selenium, etc., the velocity of surface recombination, crystalization by alloying, fusing or zone melting and by growing, preparation of *pn*, *npn* and other more complex junctions—these are but a few of the aspects of semiconductors treated.

As the title implies the work is truly a study of all forms of semiconductors such as diodes, triodes, tetrodes, varistors, gyrators, thermistors, power meters, infrared-ray modulators, etc. Additionally the development of the equivalent circuit both in grounded-base and grounded-emitter connections is covered.

There is also a very comprehensive bibliography which details on an international scale all publications relating to each chapter. This includes references from an early contribution in 1918 to the first part of 1956.

It is felt that for one desiring a single book in French which covers semiconductor theory and practice this is a worthwhile title.—RALPH C. KENNEDY, *Adjunct Associate Professor of Physics, Hofstra College.*

Modern Mathematics For the Engineer

By EDWIN F. BECKENBACH. *McGraw-Hill Book Co., New York*, 1956, 514 *p*, $7.50.

A SERIES of lectures on various mathematical topics, which have extensive application to engineering, was presented recently by the University of California. Each separate topic was delivered by a person prominent in that field. The resulting lectures have been incorporated into this book.

▶**First Part**—The subjects covered are organized into three parts. The first emphasizes the various techniques for formulating solutions and constructing mathematical models. Thus its subject matter tends to include more of the classical methods of mathematics. In particular, problems involving linear and nonlinear differential equations, ballistics, the calculus of variations and the boundary value problems associated with partial differential equations are discussed.

▶**Statistical Procedures**—The second part is mainly concerned with statistical procedures. Thus this section starts off with a presentation of N. Weiner's theory of prediction. This is followed by the theory of games, the various techniques of operations research and dynamic programming and the Monte Carlo methods.

▶ **Computational Techniques**—The third part deals with the computational techniques that have had such great importance in modern engineering research and development. These include a discussion of matrices, integral transforms, conformal mapping, numerical methods of solving systems of differential equations and finally a description of analogue and digital computing systems.

This book suffers from the same fault that most books do which have a different author for each chapter. That is, it lacks continuity and a unified approach. Some chapters such as the one on dynamic programming by Richard Bellman are quite detailed and represent a comparatively thorough presentation of their subject matter. Other chapters in the book are somewhat cursory having very little development and illustration of the presented theory.

Moreover, the various authors presume different amounts of mathematical preparation on the part of the reader. For instance the first chapter on linear and nonlinear oscillations by Solomon Lefschetz requires no more than a knowledge of the elementary theory of ordinary differential equations. On the other hand, Norbert Weiner presupposes a knowledge of the Lebesgue integral when discussing his theory of prediction. This is very unlikely if the reader is an engineer even though this is the type of person for which the book has ostensibly been written.

▶ **Unidentified Terms** — On page 76, Magnus R. Hestenes in discussing the calculus of variations mentions the positive definite quadratic form without stating just what this is. It is doubtful if the average engineer will have come across such a concept.

There are also instances of repetition in the material presented in different chapters.

Most of these flaws are due simply to the fact that the book has nineteen authors and they are perhaps inevitable.

The book has many well presented sections on the various mathematical topics of interest to the engineer. When taken separately, they represent very good introductions to these topics considering their limited length. This is notably true, for instance, in the excellent chapter on matrices by Louis A. Pipes. His development is more thorough and has more examples than the similar chapter on matrices in his own book on applied mathematics for engineers and physicists. In short, the entire book is not suitable as a textbook for a course on engineering mathematics but it is very good as a reference for introductory material on any particular topic in it.—ARMEN H. ZEMANIAN, *College of Engineering, New York University.*

Photoconductivity Conference

BY R. G. BRECKENRIDGE, B. R. RUSSELL and E. E. HAHN
John Wiley & Sons, Inc., New York, 1956, 653 *p*, $13.50.

THIS book presents the papers delivered at the Photoconductivity Conference at Atlantic City. In addition to the papers, some of the discussions are also included.

As is true of all books of this type, this collection is most valuable for those engaged in research in the field and it is not intended for those unfamiliar or only slightly familiar with the subject. It deals with the fundamental processes involved in photoconductivity and not with applications. There is no doubt in the mind of this reviewer that this book will be as useful to the man who applies photoconductivity to practical ends as to the research scientist, since it not only gives a thorough insight into the processes involved but also an excellent survey of the present state of scientific knowledge in the field and of the problems and materials which are currently in the foreground of interest.

Of course, all topics are not equally well discussed because all branches are not equally well represented at a meeting. This is the more so since the field of photoconductivity has tremendously expanded, as becomes evident upon glancing through this book.

▶ **Major Sections**—The editors have skillfully arranged the subject into five major sections.

The first section gives an introduction into the phenomenological treatment of photoconductivity and a description of the limit of sensitivity and rate of information of photoconductive devices. The second and third parts deal with the optical and electronic elementary processes occurring in photoconductors. Whereas the optical part is mostly concerned with special problems, the electronic part begins with a comprehensive treatment of the basic photoconductivity equation by S. Rittner. The fourth part is devoted to the various photoconductive materials and their properties and the fifth treats special processes and effects.

On reading this book, it becomes quite obvious that photoconductivity has almost developed into a science in itself; thus one finds that many subjects are treated in a very detailed way while others are only treated as a side line or not mentioned at all. One finds, for example, only very short mention of the Zinc Cadmium sulfides as photoconductors, although they certainly belong to one of the outstanding groups of available photoconductors. The original classic material in photoconductivity, selenium, is not mentioned even once. These are natural drawbacks in this type of book, but they are minor considering the tremendous amount of information the book makes available which otherwise could be gathered only from many dispersed sources.—H. KALLMANN, *Professor of Physics, New York University, New York, N. Y.*

Thumbnail Reviews

Transistor Manual. General Electric Co., Semiconductor Products, 1224 W. Genesee St., Syracuse, N. Y., 61 p, $.50. Basic transistor theory, construction techniques and principles of circuit design for technicians, hobbyists and experimenters. Specifications are given for all transistors registered with RETMA as of Dec. 1956.

Numerical Integration of Differential Equations. By A. A. Bennett, Wm. E. Milne, and H. Bateman, Dover Publications, Inc., 1956, 108 p, $1.35. Treatment of several new methods of numerically solving differential equations. Methods dealing with the integration of ordinary differential equations involve interpolation procedures by use of polynomials, successive approximations and step-by-step methods of integration.

Currents, Fields and Particles. By Francis Bitter, John Wiley and Sons, Inc., New York, 1956, 599 p, $8.50. A second year textbook in physics based on atomic physics. Contents include basic electromagnetic field theory, electromagnetic radiation, physical optics, wave mechanics and nuclear physics.

Arcs in Inert Atmospheres and Vacuum. Edited by W. E. Kuhn, John Wiley & Sons, Inc., New York, 1956, 188 p, $7.50. Papers presented at symposium on "The Electric Arc in Inert Atmospheres and Vacuum" held at spring meeting of Electrochemical Society, Inc., in San Francisco.

Printed Circuit Bibliography. Television Society of Great Britain, London, 1956, 79 p. Compilation of published and some unpublished articles on printed circuits and allied techniques.

Arithmetic Operations in Digital Computers. By R. K. Richards, Van Nostrand Co., Inc., Princeton, N. J., 1955, 397 p, $8.00. Introduction to mathematics necessary to understand digital computers including: Boolean Algebra, binary and decimal adding, subtracting, multiplying; decimal-to-binary and binary-to-decimal conversion.

British Broadcasting: Radio and Television in the United Kingdom. By Burton Paulu, University of Minnesota Press, Minneapolis, 1956, 457 p, $6.00. Description and appraisal of nontechnical aspects of British broadcasting.

English-Russion, Russian-English Electronics Dictionary. Dpt. of the Army Technical Manual TM30-545. Superintendent of Documents, Government Printing Office, Washington, D. C., 1956, 944 p, $3.50. Collection of about 22,000 Russian terms and abreviations used in electronics and telecommunications. In addition to sources published in the U. S., U.S.S.R. and U.K., terms obtained from Soviet factories, research institutions and individual scientists are included.

Dictionnaire francais-anglais des termes relatifs à l'électrotechnique et à l'électronique. By H. Piraux, Editions Eyrolles, 61 Boulevard Saint-Germain, Paris, France, 1956, 168 p, 960 fr. English equivalent of approximately 10,000 French technical terms related to electronics and associated fields.

Dictionnaire anglais-francais des termes relatifs à l'électrotechnique et à l'électronique. By H. Piraux, Editions Eyrolles, Paris, France, 1956, 296 p, 1,850 fr. English-French companion volume to French-English dictionary listed above. Included in this volume are conversion tables for units of length, volume, weight, photometry, colorimetry, etc.

Electricity and Magnetism. By J. Newton, Philosophical Library, New York, 1957, 613 p, $10.00. Introductory text for engineering students thoroughly covers basic material. This British text includes material not usually found in American texts on the same level.

Auto Radio Service Manual, Vol. 6. Howard W. Sams & Co., Inc., Indianapolis, Indiana, 1957, 240 p, $3.95. Servicing information on 45 auto-radio chassis produced during 1956 and late 1955.

Essential Characteristics. Electronic Components Division, General Electric, Schenectady, N. Y., 1957, 228 p, $.75. Seventh edition of tube handbook has data on 1,593 tube types. New material includes plate dissipation ratings and page of basic data on loudspeaker enclosure dimensions.

Auto Radio Removal—1955. Howard W. Sams & Co., Inc., Indianapolis, 1957, 104 p, $2.95. Initial manual of series covers instructions for removal of radios, power-supply units and loudspeakers from 1955 automobiles.

Automation: Its Purpose & Future. By Magnus Pyke, Philosophical Library, New York, 1957, 191 p, $10.00. Nontechnical discussion of application of electronic computers in mass-production industries and business. Factors are considered which will effect the rapidity of spread of automatic control in different countries.

Analysis of Bistable Multivibrator Operation: The Ecles Jordan Flip-Flop Circuit. By P. A. Neetson, Philip's Technical Library, Eindhoven, Holland, 1956, 82 p, $2.15. A detailed analysis of the transient behavior of a bistable multivibrator with many simplifying assumptions that was the author's doctorial dissertation at the Technical University of Delft, Holland.

Metallic Rectifiers—Principles and Applications. By Leonard R. Crow, Howard W. Sams & Co., Inc., Indianapolis, 1957, 280 p. $3.00 (paper). Copper-oxide, selenium, magnesium-oxide and silicon rectifiers are covered with respect to characteristics and circuit applications. A glossary of electrical and metallic rectier terminology, a list of sources and a classified bibliography are included as appendices.

Pinpoint TV Troubles in 10 Minutes. By Coyne Electrical Schools, Howard W. Sams & Co., Inc., Indianapolis, 1957, 310 p, $3.00 (paper). A prac-

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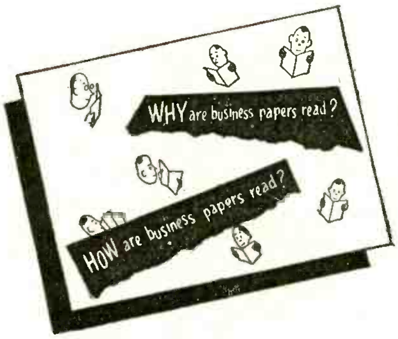

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330 West 42nd St., New York 36, N. Y.

One of a series of advertisements prepared by THE ASSOCIATED BUSINESS PUBLICATIONS tical, quick-answer, tv troubleshooting reference book for service technicians.

Statical Analysis of Stationary Time Series. By U. Grenander and M. Rosenblatt, John Wiley & Sons, Inc, 1957, 300 p, $11.00. A rigorous treatment of the theory of stationary time series that unifies the methods of analysis and presents them on a level suitable for statisticians and physicists.

Scatter Propagation Theory and Practice. By Ira Kamen and George Doundoulakis, Howard W. Sams & Company, Inc., Indianapolis, 1956, 196 p, $3.00. With a minimum of math, this book attempts to familiarize technicians and engineers with the principles and practices involved in installing, operating and maintaining scatter systems. Both ionospheric and tropospheric forms of propagation are discussed and many examples of existing equipment including that in the northern DEW line and other scatter lines are given.

Audio Amplifiers and Associated Equipment (Vol. 8). Howard W. Sams & Co., Inc., Indianapolis, 1957, 226 p, $3.95. This volume covers late 1955 and early 1956 models of audio amplifiers, preamplifiers and a-m f-m custom tuners and is intended for service technicians, audio engineers and experimenters.

Frequency-Modulated Radio. By K. R. Sturley, The Macmillan Co., New York, 1957, 120 p, $3.00. General introduction to principles, theory, design, construction and servicing of f-m equipment for the engineering student, amateur and service technician.

Low-Power Telecasting—A Handbook for Station Owners and Operators. By Harold E. Enne, Howard W. Sams, Inc., Indianapolis, 1957, 106 p, $2.95 (paper). Survey of basic considerations in planning low-power installation. Antennas, propagation, transmitters and vidicon camera chains, both live and film, are also covered.

Symposium on Minimum Property Values of Electrical Insulating Materials. American Society for Testing Materials, 1916 Race St., Philadelphia, 1957, 48 p, $1. Collection of seven papers presented at Feb. 14, 1956 meeting of committee D-9.

Supervision of Scientific and Engineering Personnel. Compiled by John T. Lloyd and Robert D. Gray, Industrial Relations Section, California Institute of Technology, Pasadena, Calif., 1956, 82 p, $8.75. Outline of results of series of conferences and meetings on characteristics and development of professional employees, building and maintaining a good technical team, appraisal of performance, supervisors role in professional development, salary administration policies, benefit plans, complaint and grievance handling, unionization of professional employees, communications, professional work group organization, and what professional workers expect of their supervisors.

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Backtalk

Ultrasonic Control

DEAR SIRS:

I WAS happy to see the article on our Space Command (Ultrasonic Gong Controls TV Sets, p. 156, March 1957) and I have heard some favorable comments about the way you set it up optically, the use of photographs and the general readability.

But there never seem to be any roses without thorns. The caption under Fig. 4 is correct in its first sentence, but the second sentence is a lost sheep which has strayed from Fig. 3.

The caption for Fig. 2 should read as follows:

Single-tune button steps tuner switch in one direction, a skip-stop mechanism provides stopping only on desired channels.

ROBERT ADLER
Research Department
Zenith Radio Corporation
Chicago, Illinois

Visual, Not VHF

DEAR SIRS:

A NUMBER of times I have noticed an error in ELECTRONICS magazine and thought you might not mind being corrected on it.

In the air navigational system commonly called VOR, the letters *VOR* stand for visual omnidirectional range, rather than for vhf omnidirectional range. Reference: Air Force technical orders and other documents covering the system.

CLAUD N. AUSTIN
Austin Motivator Laboratories
Seattle, Washington

3-D Printed Wiring

DEAR SIRS:

WE HAVE received several letters (from as far away as London) from manufacturers interested in the application of techniques described in the article, "Three-Dimensional Printed Wiring," which appeared in your June issue, page 160.

The research reported was supported jointly by the Army, Navy, and Air Force under contract with the Massachusetts Institute of Technology.

F. P. HAZEL
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Massachusetts Institute of Technology
Lexington, Massachusetts

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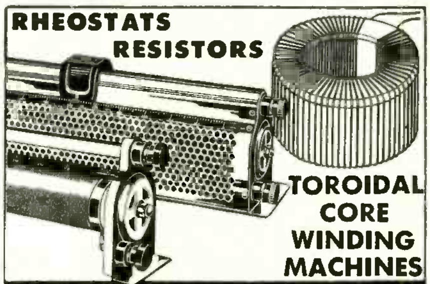

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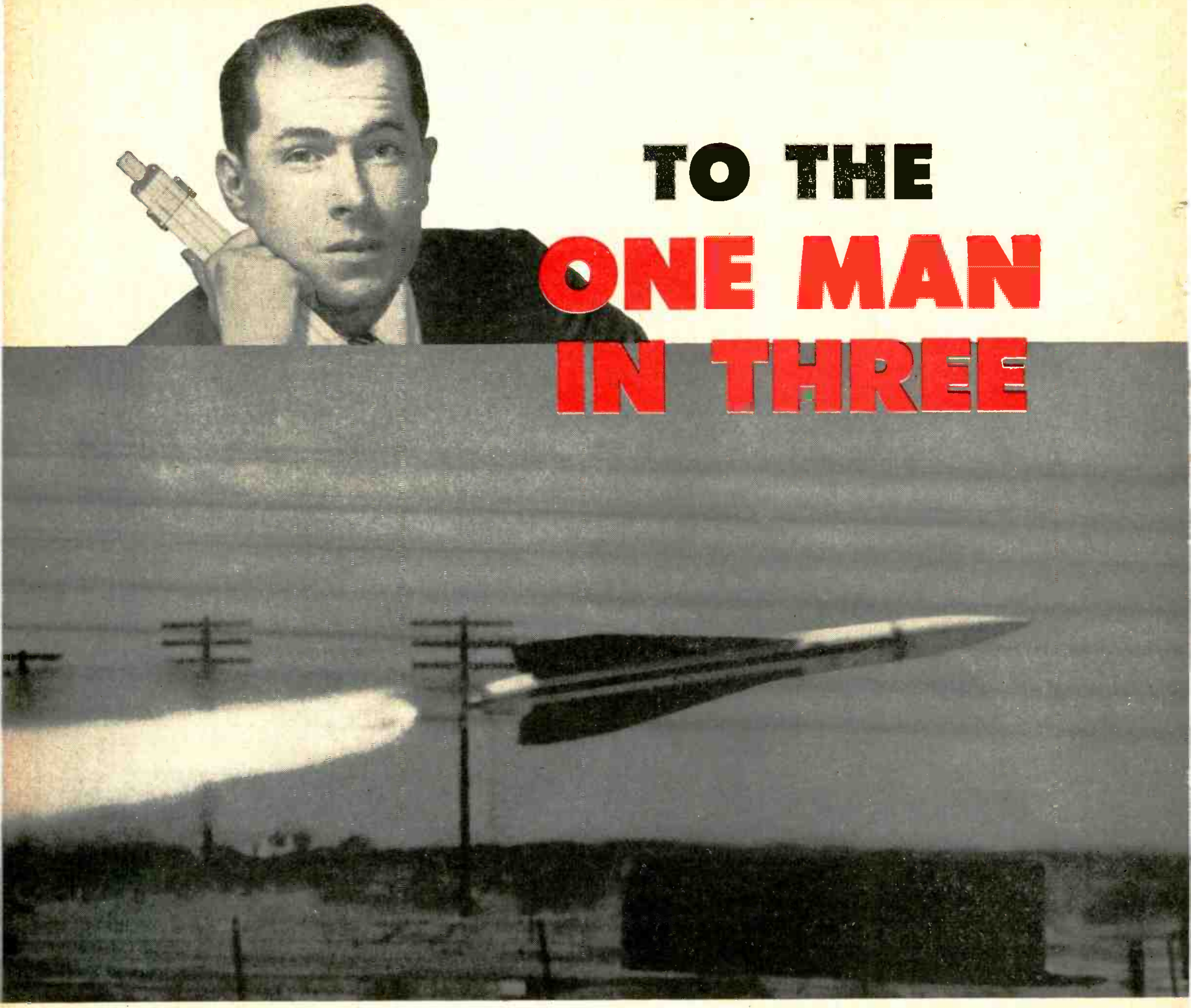

OFFICIAL U. S. ARMY PHOTOGRAPH

TO THE ONE MAN IN THREE

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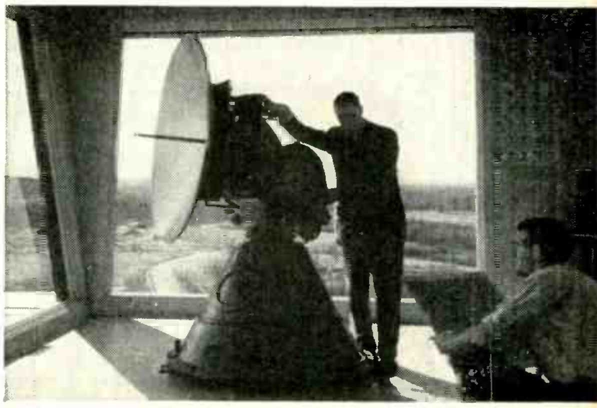
MAYNARD LABORATORY engineers design and flight test airborne navigational and guidance systems.



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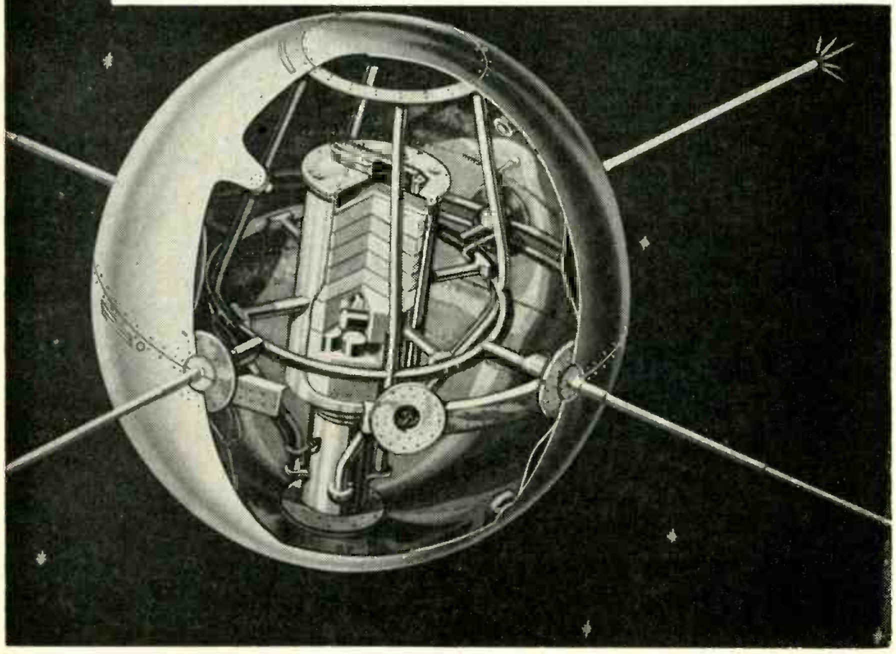

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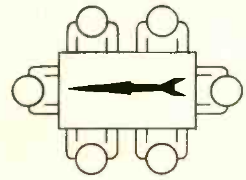

SEE HOW ARMA'S PROJECT TEAM SYSTEM BENEFITS THE INDIVIDUAL ENGINEER AND THE COMPANY

Science and technology are becoming increasingly complex. So also are the solutions to the advanced engineering problems which ARMA is called upon to resolve, such as developmental aspects of the Inertial Guidance System for ICBM Titan and the Fire Control System for B-52 tail defense.

To make sure that each project receives expert guidance at every phase—research, design, development—ARMA entrusts each engineering contract to a group of engineers known as a "Project Team."

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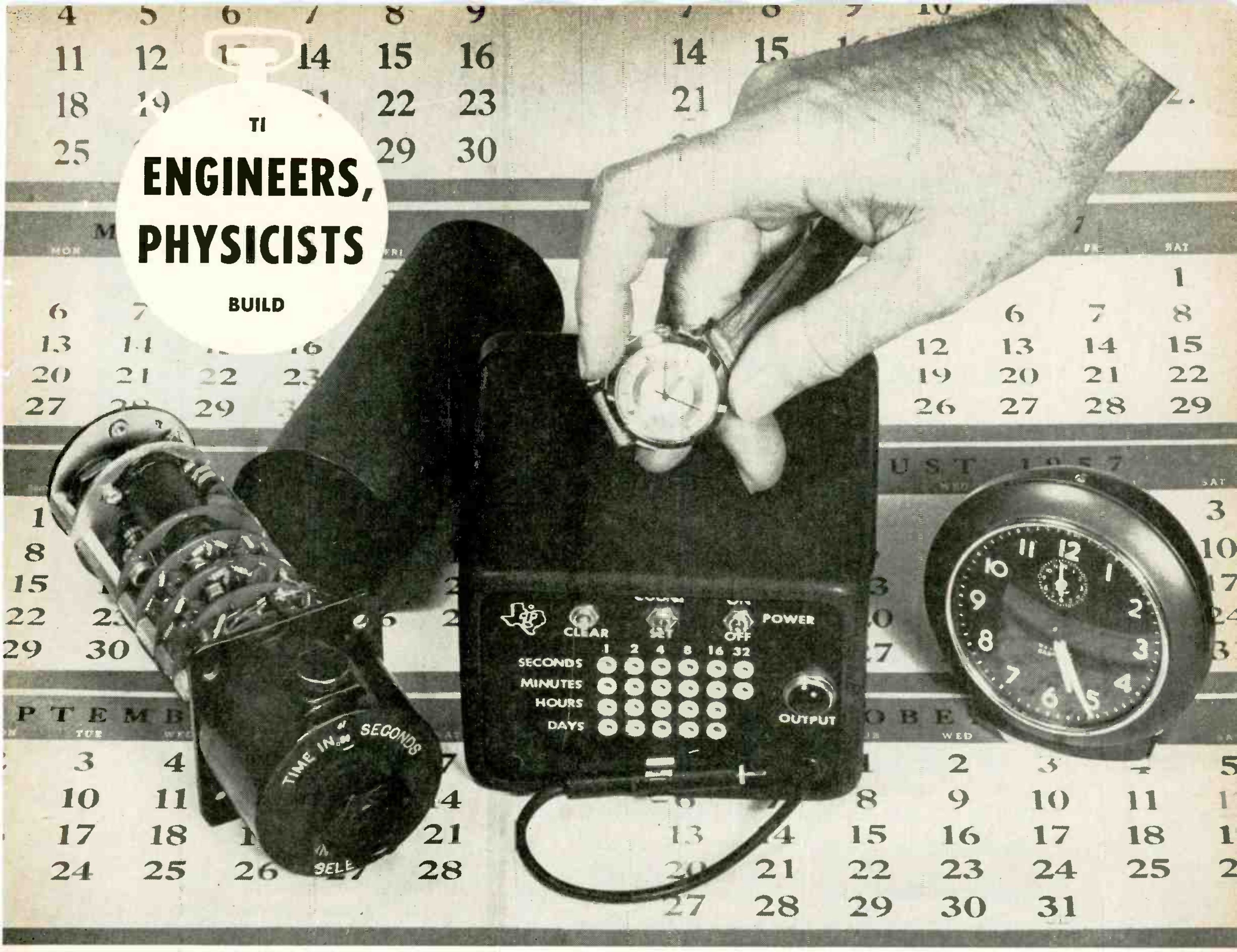

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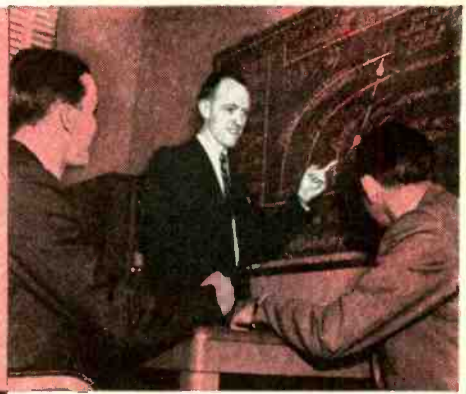
Project Engineer Robert J. Cantwell uses a system of gimbals to describe navigational problem in the analysis of a new system design.



Development Engineer J. Robert Holmes computes, with other systems reliability analysts, the operational worth of a bombing system.

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Staff Engineer William Howard reviews gearing accuracy requirements of test equipment with electronic circuit designers.

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Circuit Development Group Leader Ralph Wolcott considers future changes in computer output unit for bombing-navigational systems.

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Development Engineer John Walsh discusses the use of a recording storage tube at IBM's Airborne Computer Laboratories, Owego, N. Y.

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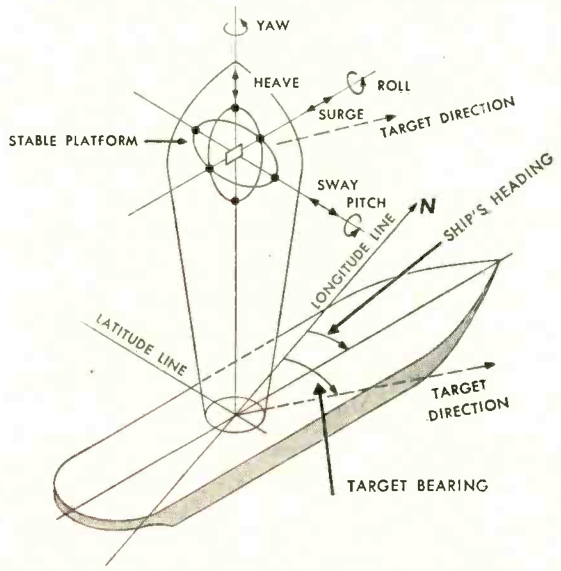
GENERAL ELECTRIC SELECTED TO DEVELOP GUIDANCE AND FIRE CONTROL SYSTEMS FOR NEW NAVY MISSILE, POLARIS

New Group Forming as Missile & Ordnance Systems Department of G.E. Adds Navy Project to Nose Cone Development Program.

POLARIS is the most challenging development undertaken by industry for the Navy since the nuclear propulsion program. It is an Intermediate Range Ballistic Missile, whose specifications call for launching capability from both surface vessels and submarines.

PROBLEMS UNIQUE IN MISSILE TECHNOLOGY

SHIPBOARD LAUNCHING: INITIAL CONDITIONS



The diagram above presents the primary parameters involved in shipboard launching of a ballistic missile in its simplest form.

For Polaris, MOSD must not only surmount these initial conditions but solve fire control problems more complex than heretofore encountered. Pinpoint accuracy in missile guidance is an impressive accomplishment under the most favorable conditions. But how do you achieve it with a missile hurled from a moving platform and aimed at an object approximately 1,500 nautical miles away?

In addition, the Polaris guidance and fire control systems must also operate effectively under the difficult conditions created by submarine launching.

HOW IS MOSD EQUIPPED TO SOLVE THESE PROBLEMS?

As prime contractor for IRBM and ICBM Nose Cone Development, MOSD can draw on a reservoir of top level experience and skill. This G-E department also has a backlog of significant experience in the development and manufacture of Naval Fire Control Equipment, such as range-finders, computers and radar antennas.

NEW OPPORTUNITIES FOR ENGINEERS WITH EXPERIENCE IN THE DEVELOPMENT OF GUIDANCE & FIRE CONTROL SYSTEMS

A new group is now being formed to work on Polaris Missile Sub-Systems at MOSD. It will be located at Pittsfield, Mass. in the heart of the Berkshire resort and vacation area. Openings are at all levels for men with experience in:

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Design, development, fabrication of analog computers for guidance and fire control systems

GUIDANCE & CONTROL SYSTEMS

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Laboratory development, testing, modification of control systems

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OPPORTUNITIES OPEN ON OTHER MISSILE PROGRAMS

Engineers and Scientists with experience in other areas of Electrical Engineering, Aeronautical Engineering, Aerodynamics, Mechanical Engineering, Physics or Mathematics should inquire about positions on other missile programs at Missile and Ordnance Systems Department.

AN INVITATION

If you would like to contribute to any of the advanced missile development programs at MOSD, you are invited to send a resume of your education and experience. Or write us for a convenient application form. All resumes will be carefully reviewed by the MANAGERS of our various technical components. You will be invited to visit our offices and discuss work we are doing directly with the Manager with whom you will be working. Communications will be entirely confidential.

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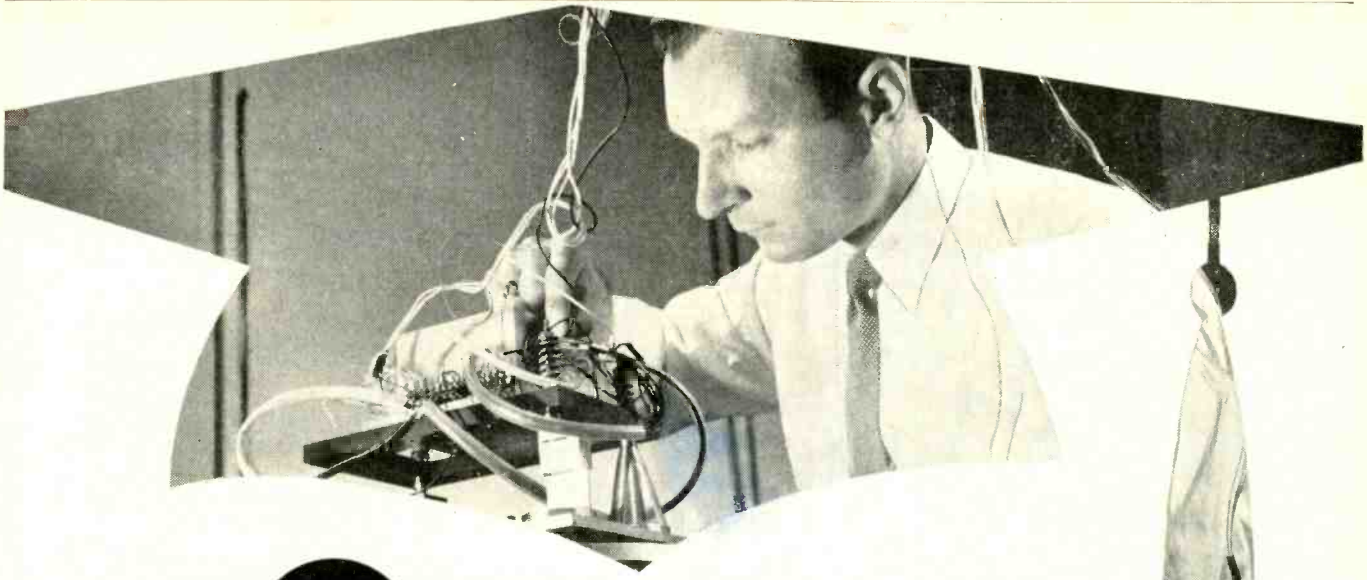

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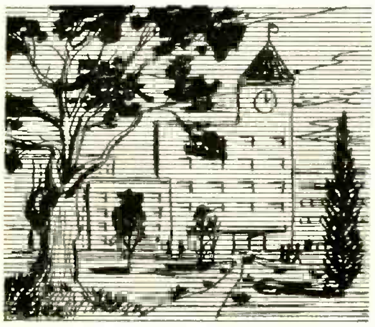

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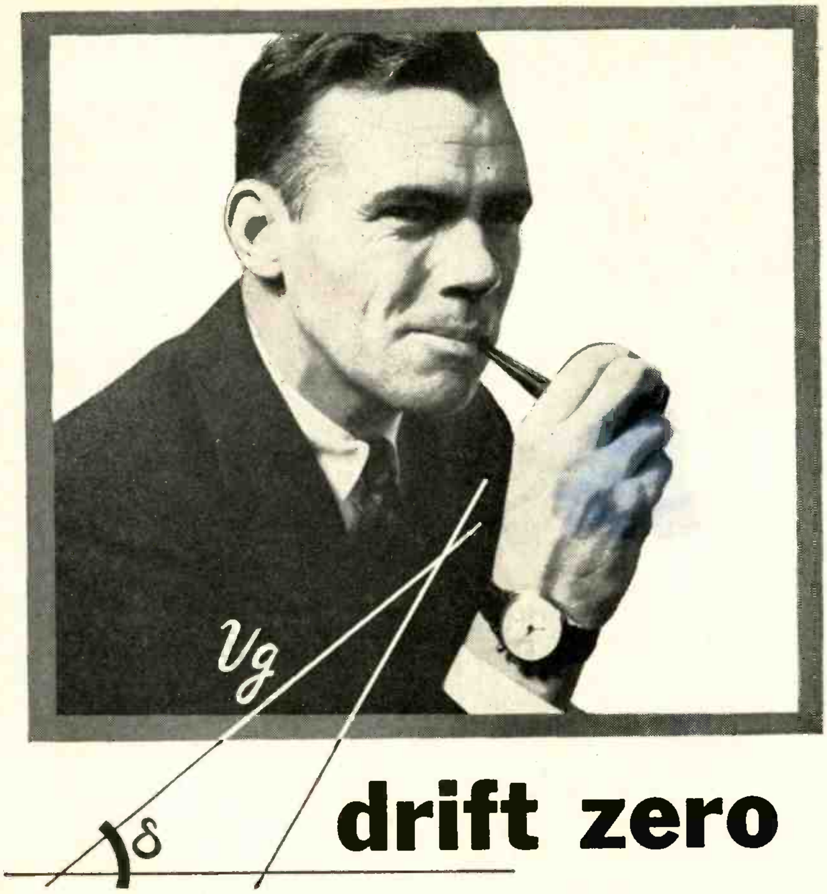

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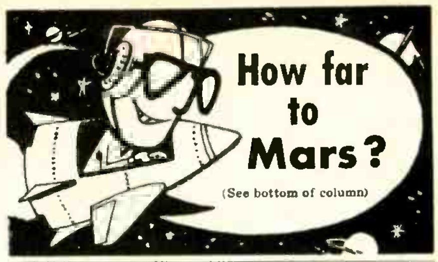

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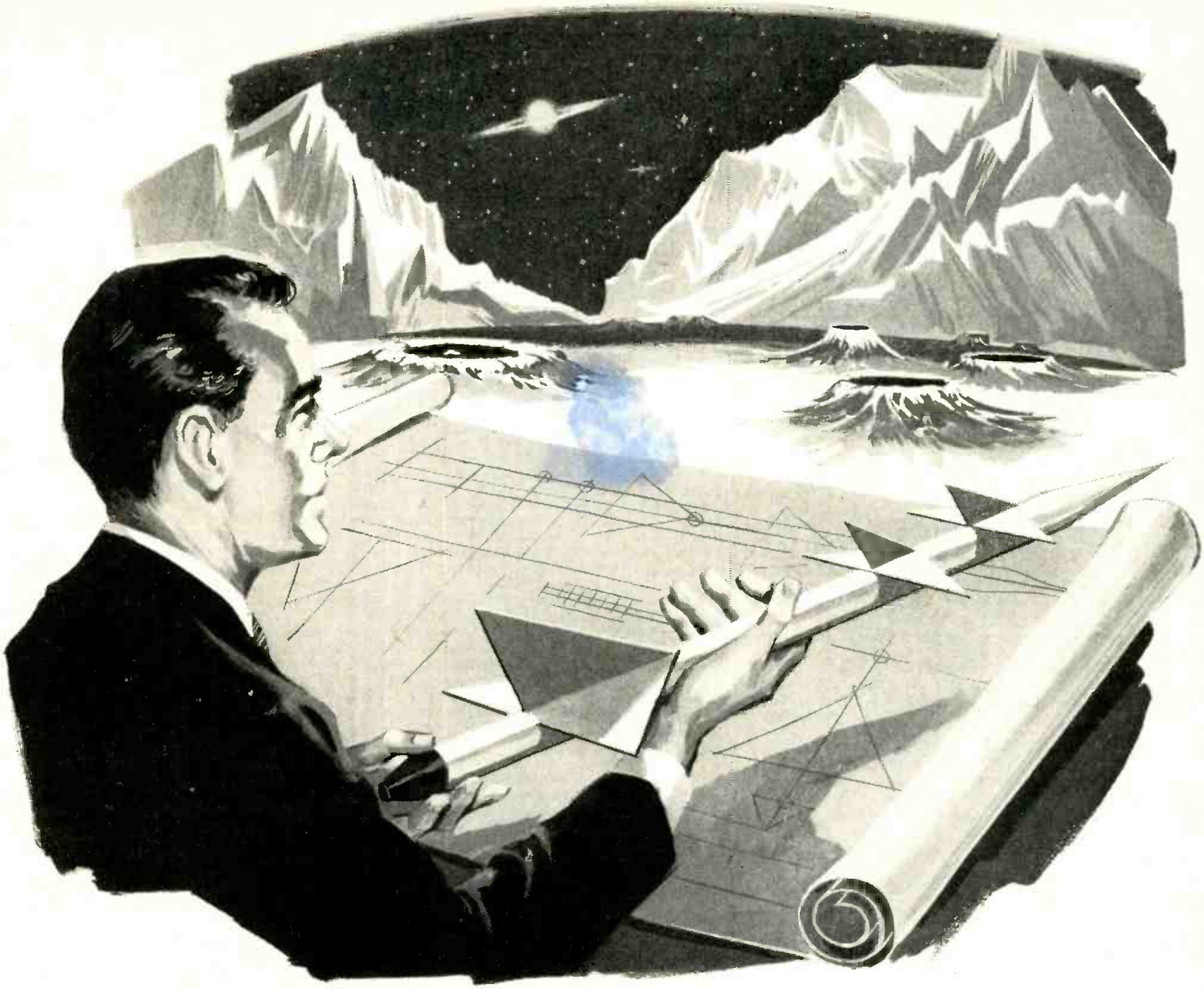

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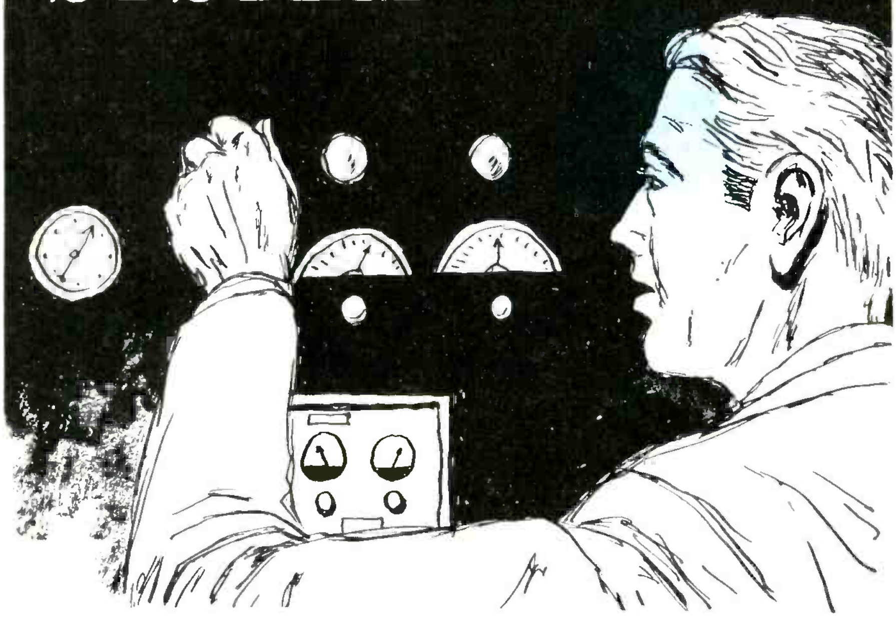

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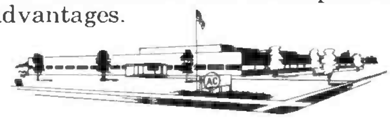

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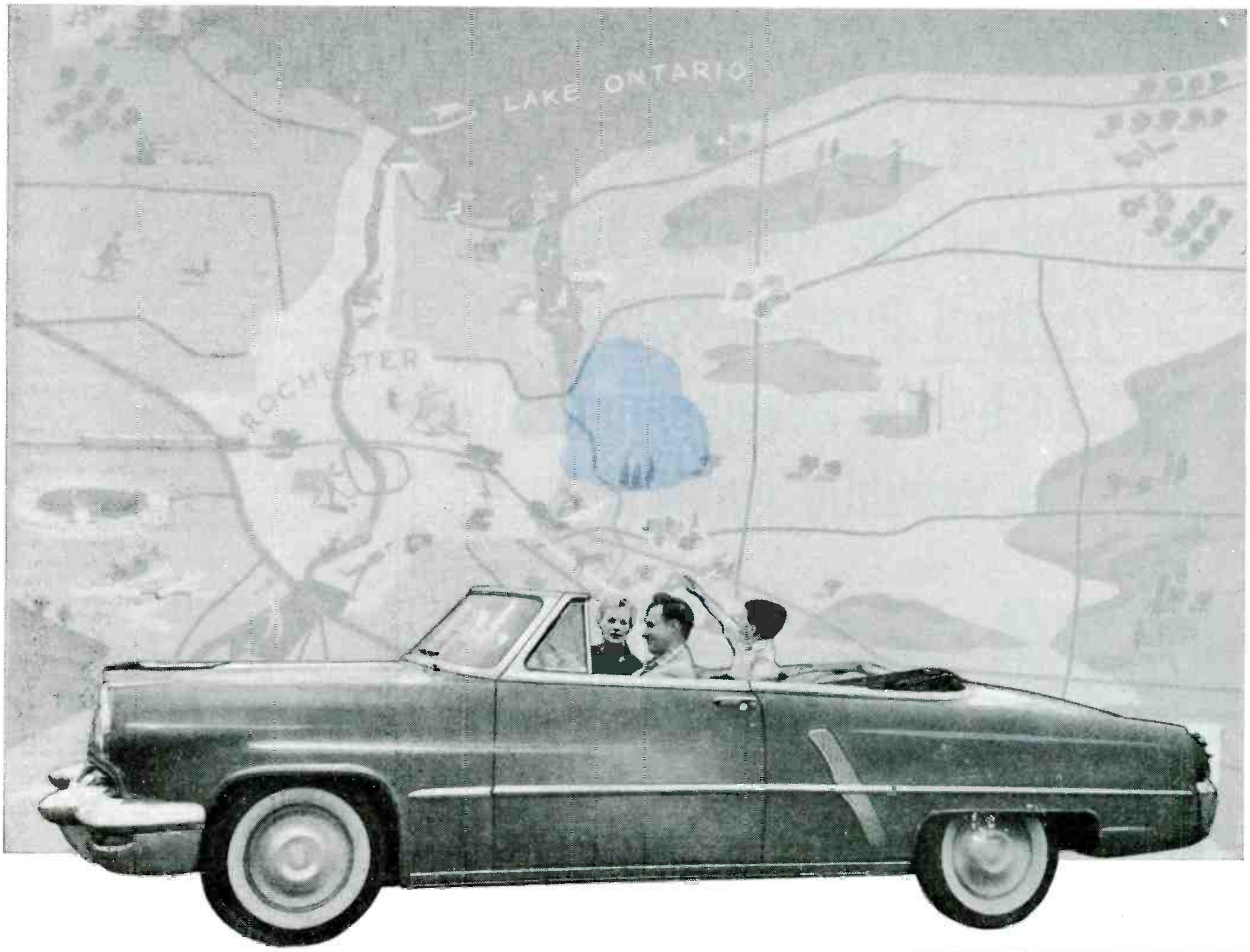

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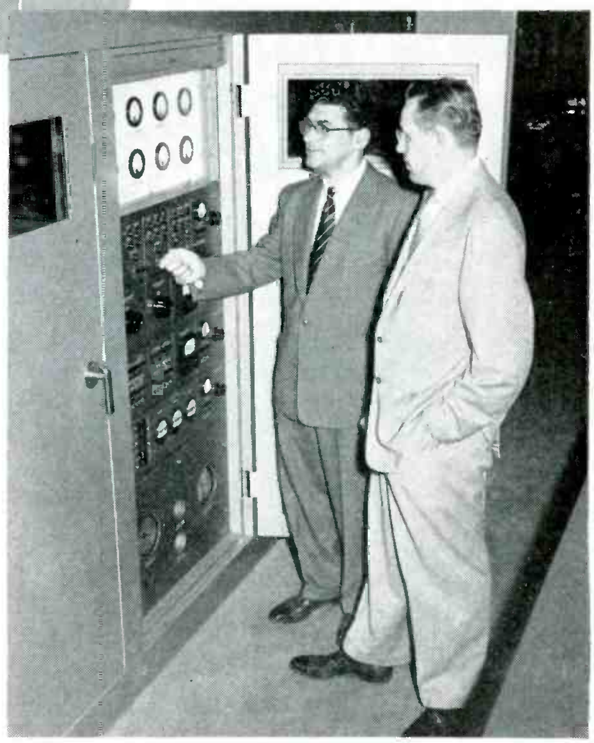

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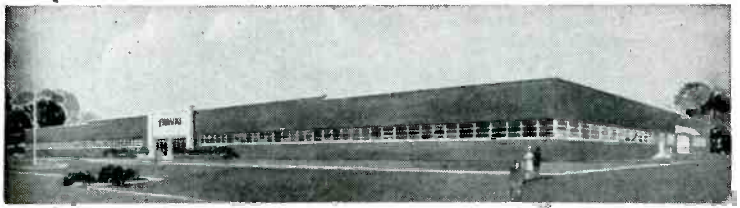

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5744	1.00
5749/6BA6W	1.15
5750	2.25
5751	2.00
5751WA	3.50
5755/420A	6.50
5763	1.00
5779	70.00
5780	150.00
5783	3.95
5783WB	5.25
5785	1.50
CK-5787	4.40
5795	250.00
5814	.65
5814WA	3.00
5825	6.00

5829	.85
5829WA	3.75
5837	50.00
5840	3.00
5840A	4.50
5841	4.25
5842/417A	12.00
5844	1.50
5847/404A	12.00
5851	3.50
5852/TES	6.00
5853	60.00
5855	35.00
5876	5.00
5879	1.25
5893	9.00
5896	3.00
5899	3.50
5902	4.00
5902A	5.50
5902A(CL)	2.50
5903	12.50
5904	8.50
5905	7.75
5906	8.50
5907	8.50
5910	.60
5915	.50
5916	8.50
5932	3.25
5933/807W	1.25
5948/1754	150.00
5956	35.00
5962/BS101	4.00
5964	.80
5965	1.00
5967	10.00
5977A	3.00
5981	50.00
5982	149.50
5987	9.50
5992	9.00
5993/TE-10	9.00
6005/6AQ5W	1.70
6019	300.00
6021	3.00
6021-A	4.50
6029/408A	2.00
6037/QK243	49.00
6038	7.50
6046	.75
CK-6050	2.00
6073	1.50
6074	2.50
6080	3.50
6080WA	6.00
6081/ATR407	22.50
6082	3.00
6088	1.50
6095	2.00
6096	1.30
6097	1.50
6099	1.40
6100/6C4WA	2.00
6101/6J6WA	2.25
6106	9.00
6110	5.50
6111	4.00
6112	4.50
6116	90.00
6117	60.00
6130	5.00
6134	3.50
6136	2.50
6147	3.00
6159	3.00
6161	42.50
6169	Q
6177	75.00
6184	9.00
6186/6AG5WA	2.25
6189/12AU7WA	3.00
6197	1.25
6199	27.50
6201/12AT7WA	3.00
6203	2.75
6205	4.50
6211	1.00
6263	10.00
6264	10.00
VA-6310/V260	75.00
6339	20.00
6363	75.00
6406/QK428	200.00
6533	10.00
6611	12.00
6612	14.00
6788	8.50
6832	12.00
8012	1.00
8025A	2.00
9001	.70
9002	.50
9003	.90
AX9903	16.00
D178461	50.00

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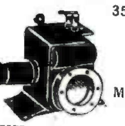
PULSE TRANSFORMERS



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 Biflar; 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

(All Primaries 115V. 400 Cycles)

400 CYCLE TRANSFORMERS

(All Primaries 115V. 400 Cycles)

RA6405-1	800VCT/65MA, 5VCT/3A	$3.69
T-48852	700VCT/806MA, 5V/3A, 6V/1.75A..	4.25
352-7098	2500V/6MA, 300VTC/135MA	5.95
KS9336	110V/50MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 6.3V/.66A, 6.3VTC/21A.	4.25
KS80984	27V/4.3A, 6.3V/2.9A, 1.25V/.02A...	2.95
52C080	650VCT/50MA, 6.3VCT/2A, 5VTC/-2A	3.75
32332	400VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150-0-1150V 2MA	2.75
80G198	6VCT/.00006 KVA	1.75
302433A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5/3.5A	4.85
KS9445	592VCT/118MA, 6.3V/8.1A, 5V/2A..	5.39
KS9685	6.4/7.5A, 6.4V/3.8A, 6.4/2.5A......	4.79
M7474318	2100V/027A	4.95
70G30G1	600VCT/56MA	2.65
352-7069	2-2.5V Wdgs at 2.5A, Each Lo-Cap., 22Kv Test	5.95
352-7096	2.5V/1.79A, 5V/13A, 6.5V/6A, 6.5V/1.2A, D/O BC800........	4.95
352-7099	360VCT/20MA, 1500V/1MA, 2.5V/-1.75A, 6.3V/2.5A, 6.3V/6A, P/O VC929	6.45

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

MITRED 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 figure: 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

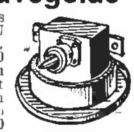
MAGNET AND STABILIZER CAVITY For 2J41 Magnetron $24.50

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 723A/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. Reasonance indicator is 3½ 20 microamp meter. Brand new, in portable wooden carrying case........ **$75.00**

TEST EQUIPMENT

TS 102 Radar Range calibrator. Rep. rates are 400/800/1600/2000 PPS. Operates from 115, 60-1600 cy. Used, exc $95.00

RCA WR 39A TV Calibrator. 20-240mc, with crystal on 2.5 or .25 mc. Used, exc........ $65.00

RCA WR 53A. FM Sweep Generator covers 88-108 mc and 8.5-10.7 mc*........ $49.00

108 mc and 8.5-10.7 mc*........ $49.00

RCA WR 67A. Test oscillator. 100kc-30 mc, internal or external mod.*........ $43.00

RCA 710A Signal Generator, 380-560 mc........ $70.00

Kay Marka-Sweep. Model RF-P. TV alignment generator, channels 1-12, plus LF freq. Markers at pix and audio. Output 0.5v across 70 ohms.*. $125.00

P4E Synchroscope: 4 mc. bandwidth with a gain of 100. 5-inch display, includes 2-stage video amplifier. Writing speeds 0.04/0.166/0.5/2 in. per microsec* $75.00

TS/28/UPM Synchroscope. Uses 5CP1 tube, and may be used as a regular scope with repetitive sweeps. Signal gain is 100 with a bandwidth of 5mc. Triggered sweeps range from 1 to 6 microsec. per inch*........ $135.00

PULSE EQUIPMENT

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

10 CM R.F. HEAD

Complete R.F. Head and Modulator delivers 50 K.W. Peak R.F. at 3000 MC. Pulser delivers 12KV pulse at 12 Amp. to magnetron of .5, 1 or 2 microsec. duration at duty cycle of .001. Unit requires 115V, 400-2400 Cycles, 1 phase @ 8.5A. Also 24-28 VDC @ 2A. External sync. Pulse of 120 V Req'd. Brand New. Complete with magnetron, magnet, plumbing and all tubes $275

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GOVERNMENT ELECTRONICS BULLETIN!

From Disposal Office, Dayton Air Force Depot, Dayton, Ohio

More and more electronics equipment is being received daily at Dayton Air Force Depot. This means that the selection for you, the bidder, is getting better and better.

THE COMPLETE SYSTEM SALES POLICY is shortly going into effect. *This is important to you*, the buyer of electronic equipment! YOU WILL BE ABLE TO PURCHASE COMPLETE SYSTEMS WHENEVER POSSIBLE. As in the past, you may also purchase the separate component parts.

For Example: SCR-274N Radio Set, composed of the following components: Ant. Relay Unit BC-442, 3 Dynamotors DM-32-A, 1 Dynamotor DM-33-A, 1 Modulator Control Unit BC-456-A, 1 Radio Control Box BC-451-A, 1 ea. Radio Receivers BC-453-A, BC-454-A, BC-455-A, and 3 transmitters, BC-457-A, BC-458-A, BC-459-A, plus Racks and Tubes.

NOTE: this SCR-274N is used here only as an illustration of the new sales policy for future sales. When such equipment is available as a complete system, you will be notified by means of "Invitations to Bid" forms, which are mailed out over our bidders list. For complete bidding details, refer to our ad on page 423 of the April 1, 1957 issue of ELECTRONICS.

We are now processing equipment for a large October Sale. Bidders list will receive notification of exact dates.

IF YOU ARE NOT ALREADY ON THE BIDDER'S LIST, WRITE NOW

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GENTILE AIR FORCE STATION

DAYTON 10, OHIO

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1CT	$37.50	5N	$22.50
1DG	37.50	5SDG	12.50
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1F	37.50	5SG	29.50
1G	37.50	6G	34.50
3D	62.50	6DG	27.50
3HCT	62.50	6HG	42.50
5B	22.50	7G	42.50
5CT	34.50	7DG	47.50
5HCT	42.50	23CX6	45.00
5F	34.50	2J1F1	4.95
5G	34.50	2J1G1	3.95

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Hermetically Sealed 200VDCW-500VDCT
0.5 MFD.................... $7.50 Ea.
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MFD by Western Electric....Brand New

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Full Range of Values Available From Stock for Immediate Delivery

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125KC to 20 MC—Heterodyne Freq. Meter—Crystal Calibrated—Accur.—.02% to 2MC; .01% from 2-20 MC—Modulated—Battery Oper.—w/Calibration Books—Exc. Cond.—checked out—Gtd. Ea. $79.50

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G-370D Fixed Attenuator—1" x 2"—20DB	45.00
J-370C Fixed Attenuator ¾ x 1½"—10DB	45.00
J-370D Fixed Attenuator ¾ x 1½"—20DB	45.00
S-370D Fixed Attenuator 1½ x 3"—6DB	52.50
S-370D Fixed Attenuator 1½ x 3"—20DB	52.50
G-870A Slide Screw Tuner 1 x 2" 3.95 to 5.85 KMC	95.00
J-870A Slide Screw Tuner ¾ x 1½" 5.85 to 8.20 KMC	95.00
AC-24 WAVE GUIDE STAND	2.50
S-25 Wave Guide Clamp 3" x 1½"	1.25
G-25 Wave Guide Clamp 2" x 1"	1.25

KOLLSMAN SERVO MOTORS WITH TACH GENERATOR

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GR 419A Wavemeter 20–300 Mc	*75.00
GR 434B Audio Freq. Meter	*95.00
GR 475-BS2 Frequency Monitor AND GR 681-AS2 Frequency Dev. Meter	*300.00
GR 572B 1KC Hummer	7.50
GR 620A Het. Freq. Meter	*345.00
GR 700P1 Voltage Divider	27.50
GR 713B Beat Freq. Osc	*225.00
GR 715AE DC Amplifier	250.00
GR 720A Het. Freq. Meter	275.00
GR 723C VT Fork 1KC	*89.50
GR 724B Precision Wavemeter	160.00
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Boonton 110A QX Checker	*170.00
Boonton 152A FM Signal Gen. 20–28 MC & 1–5 MC w/150R Pwr Supply	*185.00
Dumont 185 Electronic Switch	*57.50
Dumont 208 Oscilloscope	*89.50
Dumont 248 Oscilloscope	*375.00
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Hewlett-Packard 325B Distortion Analyser	*220.00
Hewlett-Packard 337B FM Monitor 25–175 MC	*465.00
Kay Megasweep 50KC–1000MC	*200.00
Lavoie La-239A Oscilloscope	*850.00
Measurements 62 VTVM	99.50
Measurements 78E Std. Signal Gen. 50–75MC	115.00
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Sperry Microline Model 291A Cavity Freq. Meter 2575–3780 MC—Accur. 0.15 MC	*395.00

Victoreen 247 AY "Radiation" Survey Meter 0–2.5/25/250/2500 milliroentgens/hr	$115.00
Weston Model 1 Direct Reading Ohmeter 0–2.5/25/50 ohms ¼%	120.00
Weston 45 DC Voltmeter 0–15V–½% Acc.	*35.00
Weston 695 Power Level Meter	30.00
Weston 785 Industrial Circuit Tester	95.00
Weston 796 Megohmmeter 0-20/200 megohms 500V. Battery Operated	*42.00
AN/UPM-2 Wavemeter 80–1220 Mc Accur. 1 MC	*97.50
AT-48/UP 3 CM Pickup Horn Antenna	9.95
AT-105/AP 'K' Band Pickup Horn Ant.	12.95
BC-221 Frequency Meter 125 KC-20,000 KC-Accur. .05%	*115.00
I-126 Signal Generator 15–25 MC & 195–225 MC-Int. Mod	115.00
I-138A 10CM Signal Generator 2700–2900 MC	*125.00
LAE-1 UHF Signal Generator 510–1300 MC Accur. 1%	*225.00
LAF VHF Signal Generator 90–600 MC. Accur. 1%	*325.00
LHA Audio Oscillator-20–20,000 cy. Mfd. by Hewlett-Packard	*85.00
LP Std. Signal Generator 9.5 KC-50 MC-2V. Output	*375.00
ME-11A/U. R.F. Wattmeter	*80.00
TS-33/AP 3 CM Frequency Meter 8700–9500 MC Accur. .03%	*145.00
TS-34/AP Oscilloscope 30cps-1 Mc Portable	*195.00
TS-46/AP Wave Meter 3000 MC	49.50
TS-100/AP Oscilloscope-A. J. R & X Indication-Freq. video to 3 MC	89.00
TS-174/U Freq. Meter 20–230 MC Accur. .05%	385.00
TS-311A/UP Precision Echo Box 3730 to 8910 MC—Measures frequency, power, spectrum analysis. Incl. Crystal mixer tester	*225.00
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1B32	.25
1B35	3.25
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1B62	2.75
1L24	18.00
1L33	22.00
1N21	.25
1N22	.50
1N23	.50
1N23B	.90
1N38A	.50
1N43	.25
1N70	1.00
1P23	1.75
1P41	2.50
1P42	5.00
2C22	.35
2C26	.25
2C26A	.35
2C27	5.00
2C33	.50
2C34	.25
2C40	6.50
2C43	10.00
2C46	5.00
2C53	10.00
2E22	2.75
2E24	2.25
2E25	2.50
2E25A	2.85
2E36	1.35
2J21	2.50
2J22	2.50
2J29	50.00
2J31	10.00

Type	Price
2J33	20.00
2J34	15.00
2J38	10.00
2J49	25.00
2K26	35.00
2K28	24.00
2K37	100.00
2K48	45.00
2K56	50.00
2X2	.15
EL-3C	3.45
3A5	.50
3B27	3.25
3C37	20.00
3CP1	2.50
3CP1S1	2.00
3DP1S2A	7.50
3D21A	3.00
3E29	8.45
3FP7A	2.50
3GP1	2.00
3HP14	1.75
3J21	50.00
3JP7	3.45
3KP1	7.50
4AP10	4.50
4-125A	23.00
4-250A	33.00
4B22/EL5B	3.75
4J25	25.00
4J26	25.00
4J27	25.00
4J29	50.00
4J30	40.00
4J31	100.00
4J33	75.00
4J51	35.00
4PR60A	25.00
4X150A	20,00
5AP1	2.75

Type	Price
5BP4	2.50
5B21	1.25
5C22	17.50
5CP7	2.50
5D21	5.00
5D23	10.00
5D24	15.00
5JP2	5.00
5MP1	2.75
5R4WGY	2.50
5SP7	45.00
5SP11	45.00
5Y3WGT	1.50
6AC7W	1.00
6AJ5	1.25
6SN7WGT	1.25
6SL7WGT	1.25
7ACP19	100.00
7BP7	3.75
7C29	65.00
7MP7	7.50
9GP7	10.00
12DP7	10.00
12DP7A	20.00
12SP11	45.00
RX21A	9.00

Type	Price
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FG32	3.50
RK34	.50
L040CT	2.000
UH50	5.00
HK54	4.00
Q1C59	100.00
RK59	1.25
RK60	1.25
QK61	20.00
RK72	.25
RK73	.25
CV88	2.00
101D W.E.	2.50
101F W.E.	2.50
VU111S	.75
114B	.50
RX-120	20.00
F-123A	6.75
VT-127	2.50
F127A	15.00
F-128A	7.50
GL-152	10.00
FG-154	10.00
203A	2.00
204A	25.00
AV209	5.00

Type	Price
212E	17.50
215A W.E.	2.00
217C	1.75
220B	90.00
221A	100.00
222A W.E.	100.00
249B	2.65
253A W.E.	2.00
254A W.E.	2.50
259B W.E.	5.00
262B W.E.	5.00
267B W.E.	5.50
274A W.E.	2.50
285A W.E.	5.00
304TH	10.00
304TL	10.00
310A W.E.	3.75
323A	7.50
332A	25.00
348A W.E.	4.75
350B W.E.	2.00
356B W.E.	3.00
359A W.E.	1.75
368A W.E.	2.00
374A W.E.	1.75
375A W.E.	10.00
387A W.E.	3.75

Type	Price
QK389	15.00
394A	2.75
402A W.E.	12.50
404A W.E.	12.50
416B W.E.	Q
417A W.E.	12.50
429A W.E.	6.00
421A W.E.	3.75
422A W.E.	7.50
429A	12.00
446B	1.00
464A	2.00
WL468	12.50
H500	35.00
CK502AX	1.00
CK503AX	1.00
CK505AX	1.25
CK506AX	1.00
CK507AX	1.25
CK522AX	1.25
WL532A	.25
705A W.E.	.65
706AY	15.00
707B	2.50
713A	.25
715A	2.00
717A	.35

Type	Price
718CY	25.00
720BY	35.00
721A	.75
722A	.75
723AB	8.50
724B	.50
725A	5.00
730A	5.00
801A	.25
803	2.00
805	4.50
806	7.50
811	2.65
813	9.50
829B	8.45
832A	7.75
836	1.25
838	.29
841	.29
843	.35
845	4.00
851	6.50
861	10.00
872A	1.00
876	.75
884	1.00
891	55.00
955	.25
991	.30
K-1001 Dumont	50.00
K-1051 Dumont	50.00
1616	.35
1619	.25
1625	.25
1626	.25
1629	.15

Type	Price
1631	1.00
1632	.20
1680	1.00
1846	50.00
5517	1.25
5518	275.00
5528/C6L	5.00
5637	5.00
5650	50.00
5651	1.25
5676	.75
5693	4.50
5703	.90
5718	1.50
5719	1.50
5726	.75
5744	1.00
5803	3.75
5814	1.00
5825	6.25
5827X	5.00
5838	5.00
5933	1.50
6035	10.00
6038	5.00
6073	1.75
6098CT	2.00
6099	1.00
6130	4.75
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8012	1.00
8013A	3.50
9002	.50
D178461 W.E.	75.00

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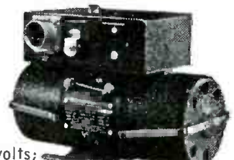
INFRA-RED RECEIVER

(SNOOPERSCOPE) TYPE A1

Contains elaborate optical system with many-coated lenses. Unit is very lightweight complete with carrying case. Receiver is 8½" long with 2½" Schmidt Ultra high speed approximately +0.5 object lens.

$19.95 ea.

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

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

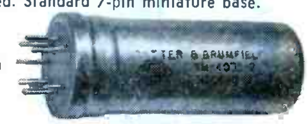
DMF2506M Continental Electric
24-30 volts input; 5.5-45 amps.; cont. duty. Output: 115 volts; .44 amps.; 400 cyc.; 1 phase; pf. 1.0; 50 watts. — $39.50

AN 3499 Eicor, Class "A"
Input: 27.5 volts at 9.2 amps. AC. Output: 115 volts, 400 cycles; 3 phase, 100 voltamp; continuous duty. — Price $39.50 each

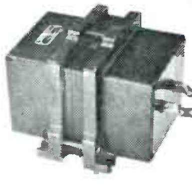
POTTER & BRUMFIELD RELAY

#SM5LS SPDT 8,000 ohm 11/16" dia. x 1 11/16" long. Approx. weight 1 oz. Hermetically sealed. Standard 7-pin miniature base.

Price **$3.00** each



S14940 TRANSFORMER



Mfgd. by Kenyon. Output: 5 volts, 115 amps. Input. 105/125 volts, 60 cycle, single phase. Overall dimensions: 10" x 7" x 6". Approx. weight: 30 lbs.

$15.00

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
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2J1F3 Gen. 115/57.5V 400 cy.	10.00
2J1FA 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
2J5F1 Cont. Trans. 105/55V 60 cy.	17.50
2J5H1 Gen. 115/105V 60 cy.	17.50
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5DG 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
6DG 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. 26/1.8V 400 cy.	15.00
R210-1-A Kearfott Trans. 26/1 8V 400 cy.	20.00
R220-1-A Kearfott Receiver 26/1.8V 400 cy.	20.00
R235-1A Kearfott Resolver 26/1 8V 400 cy.	22.50
C5670 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
C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
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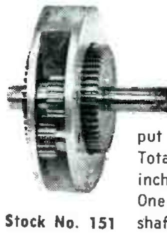
C7933 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 22V 60 cy.	7.50
403 Kollsman Autosyn. Mtr. 32V 60 cy.	7.50
FPE-25-11 Diehl Servo Mfr. 75/15V 60 cy.	19.50
FPE-43-1 Resolver 400 cy.	25.00
FJE-43-9 Resolver 115V 400 cy.	19.50
999-0411 Kollsman 26V 400 cy.	15.00
13770410 Kollsman 26V 400 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



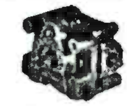
1 to 1 reverse ratio; 48 teeth on input and output gear, 1-1/32 inch diameter. Total outside diameter 1-25/32 inches. Shaft size is ¼ inch. One shaft is 9/16" long; other shaft is 3/16" long.

Stock No. 151 — $5.00

3800 CYCLE INVERTER

Mfgd. by Eclipse-Pioneer #12144-1-A. Input: 24-30 volts DC, 10 amps AC. Output: 115 volts, .95 amps, 3800 cycle, single phase. Approx. weight 2½ lbs. **Priced at $39.95**

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

RADAR

P.P.I. REMOTE REPEATERS

VD 7" Upright
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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.
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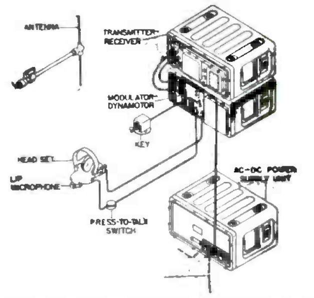
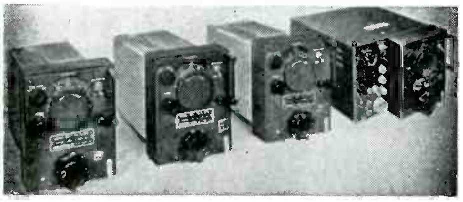


AN/APR-4
38-4000 MC RECEIVER



RDO

NAVY SEARCH RECEIVER

The RDO is a very elaborate radar search receiver greatly improved over the APR-4. The set uses APR-4 tuning units, but is much more versatile, having input metering. D.B. output meter, automatic noise limiter and greater selectivity and sensitivity. The RDO is recommended when only the very best wil do. Input 110v 60 cyc.

AN/ASQ-1 AIRBORNE MAGNETOMETER

This is an airborne chart recording magnetometer. The set consists of an amplifier, oscillator, detector head, chart profile recorder, power supply. The equipment has a sensitivity of 2 gamma. The AN/ASQ-1 records on an Esterline angus recorder disturbance in the earth's magnetic field. An indicator is provided that gives a bearing on a magnetic disturbance. Input is 28v DC. Weight about 130 lbs.

SHORAN

AN/APN-3-AN/CPN-2

The AN/APN-3 and AN-CPN-2 are Precision distance measuring installations. This equipment operates on 225 mc. The range is 250 miles with an accuracy of 25 feet. This equipment is widely used by geological companies for prospecting and mapping. Power input is 110v 400cyc and 28v DC.

AN/GSQ-1 SPEECH SCRAMBLER

This is a unit designed to be attached to either a radio or telephone circuit to scramble speech or code. This equipment utilizes coded cards in each terminal equipment. Unless the properly numbered card is inserted on the receiving end the speech can not be unscrambled. This provides an excellent privacy system. 24 VDC input. Mfg. Western Electric.

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

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 Panadaptor
AN/APQ-5 18-80 MC Receiver Indicator
AN/APQ-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-1 thru 20
AN/SPT-Series
SCR-596 1.5-30 MC Barrage Rec.-Trans.
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.

MAR POINT TO POINT RADIO SET

Portable 225-398 mc point to point 10 chan. crystal controlled voice and mew radio set. This is a very late radio set used for point to point and ground to air communication. The transmitter output is 8 watts on 10 pre-set crystal controlled channels instantly selected by a band switch. The RFC is also crys. controlled on the trans. freq. The set is inclosed in 3 water proof shock proof cabinets that may be set up in a few minutes on location. This equipment is ideal where a reliable radio link easily transported is needed. Power input is either 24 VDC 115/230V AC or DC. Complete sets avail. Write

GROUND INSTRUMENT LANDING SYSTEM

This set consists of an AN/CRN-10 localizer and a AN/CRN-2 glide path ground station. This equipment can be set up at an airport to provide a complete I.L.S. that will operate with the AN/ARN-5 and RC-103 airborne I.L.S. system to provide blind approach facilities. This system can be installed permanently or transported. Each station has complete monitoring facil. Input power is 110V 60 cyc.

AN/TRC-1-3-4

100 MC RADIO-RELAY EQUIPMENT

The AN/TRC series is a mobile portable set for duplex or simplex radio telephone point to point communication. This set will operate with the CF series carrier systems to provide multi channel operation. The TRC operates on 100 MC with an output of 10 50 watts. The set is crystal controlled. Complete sets avail. Input 110v 60 cys.

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 cyc.

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ART-13 Transmitter
BC-348Q Recvr.
R5A/ARN7
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ARC-27 Transcvr. & Parts
APS-15

TEST EQUIPMENT

Hewlett-Packard 624-B Test Set
APR-4 TEST SET. Complete with all tuning units. Spare tuning units also available.

TS-175/U **BC-221** **LM FREQ.**
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100 or more @$1.40 each

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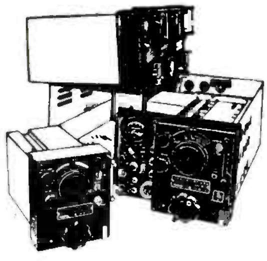
AN/APT-5 TRANSMITTERS

Make excellent power signal generators for the range 300-1625MC., rated at 58 watts CW RF at 500MC. Contains blower-cooled 3C22 in re-entrant cavity with precision cathode, plate and loading controls, plus 6 tube AM MODULATOR and amplifier flat from 50KC to 3MC. (easily converted to audio) with phototube noise generator. 115 volt 60 cycle filament supply. New, in export packing, with matching special plugs, lecher line, alternate feedback assembly, manual, audio conversion instructions and technical data, at $250.00. Limited stock.

AN/APR-4 RECEIVERS

With all five Tuning Units covering 38 to 4,000MC; versatile, accurate and compact, the aristocrat of lab receivers in this range. Complete with wideband discone antenna, wavetraps, 100 page manual, plugs, cables and mobile accessories as required.



The AN/APR-4 has been our specialty for over ten years. Over 40 hours of laboratory time is invested in each complete set immediately prior to shipment, so that we can not only guarantee it to pass A-N specifications, but to have the inevitable mass-production irregularities corrected and the latest improvements added. We maintain a complete stock of spare parts and expect to service our customers' sets indefinitely. Write for data sheet and quotation.

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OA3/VR-75	.90	4C35	14.00	VX-55	6.00	726A	4.00	5687WA	4.00
OA4G	.75	4D32	23.00	FG-57	7.50	726B	9.50	5691	4.25
OA5	3.50	4E27	7.00	RK-61	2.25	726C	7.50	5692	4.50
OB2	.60	4J45	35.00	RK-65/5D23	6.50	750TL	30.00	5693	3.75
OB2WA	2.50	4J46	35.00	FG-67	7.50	802	2.00	5702	1.40
OB3/VR-90	.80	4J52	50.00	HY-69	2.00	804	7.00	5703	.85
OC3/VR-105	.50	4J61	125.00	FG-81A	8.50	805	3.00	5704	1.15
OC3W	2.50	4PR60A	27.50	FG-95	14.00	807	1.10	5719	1.35
OD3/VR-150	.50	4X150A	17.50	100TH	5.00	807W	1.25	5720	15.00
OD3W	2.50	4X500F	42.50	102L	2.50	807WA	5.00	5725	2.00
EL-C1A	6.00	5A6	2.00	121A	2.50	810	10.00	5726	.75
1AD4	.90	5AP1	5.00	122A	2.50	811	3.00	5727	1.25
1AE4	1.00	EL-5B	4.00	123A	2.50	812	2.50	5728	7.50
1AF4	2.50	5BP1	2.50	124A	2.50	813	10.00	5734	12.00
1AG5	2.00	5BP1A	7.50	VT-127A	2.00	814	1.25	5740	50.00
1B24	5.00	5BP2A	3.00	FG-172	15.00	815	1.25	5749	1.15
1B35	3.25	5C22	25.00	FG-190	10.00	816	1.35	5750	2.00
1B35A	7.50	5CP1	2.00	CE-203	5.00	826	.75	5751	2.00
1B63A	15.00	5CP1A	7.50	203A	2.50	828	8.00	5755	6.50
1B83	7.50	5CP7A	8.00	CE-235A	5.00	829B	8.50	5763	1.00
1P21	29.50	5CP12	10.00	FG-235A	55.00	832A	4.85	5771	250.00
1P22	5.00	5FP14	5.00	242C	10.00	835	2.50	5783	3.50
1P25	25.00	5HP1A	7.50	QK-243	40.00	836	1.20	5784	4.50
1P28	7.50	5JP1	7.50	244A	5.00	837	1.25	5787WA	6.00
1Y2	5.00	5JP2A	5.00	245A	6.00	845	2.50	5796	10.00
2AC15	4.50	5JP4	3.50	249B	3.00	850	7.50	5798	15.00
2AP1	2.00	5JP5A	7.50	249C	2.50	866A	1.15	5801	5.00
2AP1A	4.00	5JP11A	7.50	250R	4.00	866 JR	1.35	5803	5.00
2AS15	4.50	5LP1	12.50	251A	42.50	868/PJ-23	1.50	5814	.75
2BP1	3.00	5LP2A	7.50	252A	7.50	869B	50.00	5814A	1.50
2C36	35.00	5R4GY	1.25	253A	2.00	872A	1.00	5814WA	3.00
2C39	5.00	5R4WGY	2.25	254A	2.25	874	.75	5819	25.00
2C39A	10.00	5RP1A	17.50	257A	10.00	884	.95	5827	4.00
2C39B	29.00	5RP11A	75.00	FG-258A	75.00	885	.65	5828	6.00
2C40	6.50	5SP1	40.00	259A	10.00	913	17.50	5829	.85
2C40A	26.00	5SP7	40.00	262B	5.00	917	1.40	5830	85.00
2C42	8.00	5UP7	12.50	FP-265	15.00	918	1.50	5836	93.00
2C43	7.50	5X3	2.00	267B	3.50	920	2.00	5840	3.00
2C44	.25	5XP1	50.00	268A	5.00	922	1.75	5842	12.00
2C46	5.00	5XP11	50.00	271A	5.00	923	1.25	5847	12.00
2C50	6.00	EL-C6J	10.00	272A	6.00	927	1.00	5854	.85
2C52	2.75	EL-C6L	5.00	274B	.50	929	1.00	5876	5.00
2D21	.75	6AC7W	.50	275A	3.50	931A	4.00	5881	3.00
2D21W	.85	WE-6AK5	1.25	276A	10.00	959	1.15	5886	2.75
2E22	2.00	6AK5W	1.00	279A	150.00	CK-1006	2.25	5894	15.00
2E24	2.00	6AL5W	.75	282A	2.00	1237	4.50	5899	3.50
2E26	3.25	6AN5	2.25	282B	3.75	HY-1269	3.00	5902	4.00
2J47	50.00	6AQ5W	1.75	283A	3.25	1274	2.50	5902A	5.00
2J51	150.00	6AR6	1.35	285A	4.50	1619	.50	5915	.50
2J52	50.00	6AR6WA	6.00	286A	3.25	1620	3.50	5932	3.25
2J54	25.00	6AS6	1.25	287A	2.00	1624	1.10	5933	1.25
2J59	50.00	6AS6W	2.00	293A	8.00	1846	50.00	5933WA	5.00
2J61	8.50	6AS7G	2.50	300B	6.00	2050	1.00	5948/1754	100.00
2J62	3.00	6AU6WA	2.00	304TH	10.00	2050W	3.00	5949/1907	75.00
2J64	75.00	6BA6W	1.25	304TL	12.50	ZB-3200	75.00	5962	4.00
2K25	10.00	6BE6W	2.00	310A	3.50	5528	5.00	5963	1.25
2K26	32.50	6BL6	22.50	311A	3.50	5550	30.00	5964	.85
2K28	30.00	6C4W	4.00	313C	2.50	5552	55.00	5975	3.00
2K29	30.00	6C21	15.00	316A	.50	5553	75.00	5977	2.50
2K30	75.00	6F4	2.25	323A	7.50	5556	10.00	5979	7.50
2K33A	50.00	6J4	1.25	323B	5.00	5557	4.00	5980	6.50
2K34	100.00	6J4WA	2.00	328A	3.50	5558	5.50	5981/5650	50.00
2K35	150.00	6J6W	.85	336A	3.50	5559	7.50	5998	4.50
2K41	85.00	6K4	2.00	338A	3.50	5560	14.00	6005	1.75
2K45	30.00	6K4A	2.50	339A	9.50	5584	3.00	6012	3.50
2K48	50.00	6L4	2.00	347A	2.50	5591	2.75	6021A	4.00
2V3G	.85	6L6WGA	3.25	350A	2.50	5610	1.00	6028	2.00
3ABP1	50.00	6L6WGB	3.50	350B	2.00	5633	5.00	6037	50.00
3AP1	2.00	6Q5G	2.25	352A	15.00	5634	5.00	6038	7.50
3AP11A	5.00	6SJ7WGT	2.00	354A	8.50	5635	5.00	6073	1.25
3B24	.75	6SK7W	.85	355A	8.50	5636	2.50	6080	3.50
3B24W	4.50	6SK7WA	2.00	388A	1.00	5636A	3.00	6087	4.00
3B24WA	7.50	6SL7WGT	1.25	393A	3.50	5637	3.50	6098	6.00
3B25	3.50	6SN7WGT	.75	394A	2.50	5638	3.00	6100	2.00
3B26	2.75	6SU7GTY	2.00	403A	1.35	5639	5.00	6130	5.00
3B28	4.00	6X4WA	2.00	403B	2.75	5639A	6.00	6134	3.50
3B29	5.00	6X5WGT	1.00	404A	12.00	5640	5.00	6136	2.00
3BP1	2.00	7F8W	1.50	407A	3.00	5641	4.50	6137	2.00
EL-3C	4.00	7MP7	15.00	408A	2.00	5642	.90	6146	4.40
EL-C3JA	10.00	VX-10	4.00	409A	4.25	5643	4.00	6189	2.50
3C23	3.00	12AT7WA	2.75	417A	12.00	5644	5.75	6199	27.50
3C24	2.00	12AU7WA	2.50	418A	15.00	5645	5.00	6201	2.85
3C33	6.00	12DP7A	25.00	420A	6.50	5646	3.00	6236	185.00
3C45	5.00	FG-17	4.00	421A	4.50	5647	4.00	6263	10.00
3D22	9.50	HK-24	2.00	429A	8.00	5650	50.00	6264	10.00
3E22	4.00	HK-24G	2.00	446A	.50	5651	1.25	6322	8.50
3E29	10.00	26A7GT	3.00	446B	1.00	5651WA	3.00	6328	4.85
3GP1	2.00	26C6	1.10	450TH	38.50	5654	1.25	6626	2.50
3J21	50.00	26D6	1.50	450TL	38.50	5656	4.00	6627	2.50
3J31	35.00	26E6WG	2.25	464A	1.75	5663	.95	6655	35.00
3JP1	7.50	26Z5W	3.00	575A	10.00	5667	100.00	8005	4.50
3JP7	10.00	FG-27A	10.00	631-P1	5.00	5670	2.00	8012A	3.50
3JP12	10.00	FG-32	5.50	701A	1.50	5670WA	4.00	8013A	4.50
3KP1	7.50	FG-33	15.00	707B	2.00	5672	1.00	8020	1.25
3X2500A3	150.00	BX-33A	5.00	715C	10.00	5675	6.85	9001	.75
4-65A	13.50	35T	3.00	719A	10.00	5676	.75	9002	.50
4B31	20.00	35TG	2.50	721A	.50	5678	.75	9003	1.00
4B32	7.50	VX-41	5.00	721B	7.50	5685	10.00	9005	2.00

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Hermetically Sealed

'DIAMOND H' Relays

Mfg. By
HART MANUFACTURING CO.
The "Diamond H" series R Hermetically sealed Relays will match or surpass USAF Spec. MIL-R-5757B.

26.5 V.D.C. Coil Res. 150 ohms 4PDT (4C) Contacts rated 2A @ 30 V.D.C.
Hart #R115BIP-1 Plug-in type Dim. 1-1/16" dia. x 1¾" High. R115BIP-1 **$1.75**

15 Pin SOCKET for above Relay. R101PS Each 25¢

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4PST Norm. open (4A) 28v. D.C. Coil 280 ohm. Will operate on 18v. D.C. Hermetically Sealed . . . Size 2⅛" x 1½" x 2¾". Contacts 10 amp. at 30v. D.C. or 115v. A.C. non-ind.

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#182DXX107

$1.75

Fig. 1 Fig. 2 Fig. 3

STRUTHERS-DUNN Sub-Miniature RELAYS

Size 1¼" dia. X 1¼" high. Mounting centers 1½" except fig. #3⅝" mtg. Studs. 26.5 V.D.C. 150 ohms.

Fig. 1 Dunco #220XCX310 3PDT (3C) R103
Fig. 2 Dunco #220XDX310 4PDT (4C) R104
Fig. 3 Dunco #220XDX301 4PDT (4C) R105

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(7ACP-19)

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DUMONT HIGH VOLTAGE

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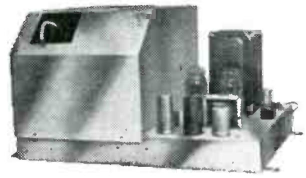

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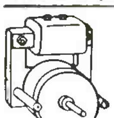

2 RPM ...	$2.90	1 RPM	3.95
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3, 6 RPM .	3.15	1 R.P.12Hr.	3.25
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Laboratory Special 1 of Each Motor $25

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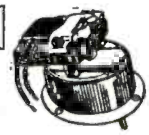

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6 RPM reversible..... 10.00
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(Continued from page 415)

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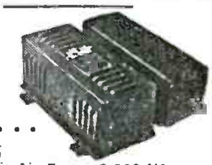

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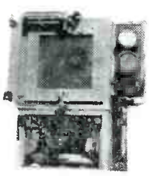

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1B24	5.00	3B29	4.75	FG-27A	8.00	403A/6AK5 (WE)	.90	1635	1.60
1B24A	15.00	3C23	3.95	FG-32	4.25	403B/5591	2.90	1654	2.00
1B32	.25	3C24/24G	1.70	35TG(surp)	2.00	404A/5847	12.50	1850A	Write
1B35	3.35	3C45	6.75	VC50/32 (cap)	8.00	408A	2.75	5517	1.35
1B40	2.00	3E29	8.00	QK60	20.00	412A	3.50	5528/C6L	5.00
1B63A	19.00	3J30	25.00	QK61	21.50	416B	30.00	5559/FG57	8.50
1N21	.10	3K20000LK	Write	RK65/5D23	7.50	417A/5842	12.00	5638	2.75
1N23B	.65	4-65A(Surp)	15.00	FG-81A	3.10	421A/5998	4.00	5639	5.75
1N34	.45	4-125A	30.25	100TH (surp)	6.25	GL434A	5.00	5642	1.00
1N65	.85	4-250A	35.00	100TL (surp)	11.00	UE578	7.00	5721	125.00
1N70	1.50	4B24/EL3C	4.50	FG-105	10.80	Z666/5J30	5.00	5725	1.50
1P23	1.75	4C35	15.00	F-123A	6.75	GL-673	12.50	5726/6AL5W	.65
1P37	3.50	4J21	75.00	F-128A	10.00	726A	5.00	WL5736	110.00
1P41	2.50	4J36	70.00	VXR-130	1.00	726B	14.00	5744	1.00
1Z2	1.25	4J37	70.00	FG-166	12.00	726C	12.00	5787WA	5.00
CE2C	2.00	4PR60A	30.00	FG-172	13.50	750TL (surp)	30.00	5802	4.50
CL-2	10.00	4X150A(surp)	19.00	QK-181	12.50	805	4.00	5812	1.00
2BP1	3.95	4X500A(surp)	45.00	QK202/5721	125.00	807W/5933	1.50	5814	1.00
2C39A	10.00	4X500F	40.00	249B	2.75	809	2.50	5819	23.95
2C43	7.50	EL5B/4B22	5.50	HK253	5.00	814	2.50	5829WA	3.00
2C51/396A	2.75	5BP4	3.00	HK-257B/4E27	7.40	826	.50	5840A	4.50
2C53	9.75	5C22	24.00	287A	2.20	829B	8.00	5876	7.00
2D21W	.95	5CP1A	6.50	304TL	12.50	832A	6.75	5879	1.20
2E24	2.25	5D21	5.50	307A	.60	833A	36.00	5998/421A	4.00
2E25	3.50	5D23/RK65	7.50	311A	5.50	837	1.25	6021	3.00
2E26	2.95	5J30/Z666	4.00	313C	2.50	869B	Write	6096	1.40
2E35	1.80	5JP2	3.50	313CD	2.50	872-A	.90	6100/6C4WA	2.00
2J21A	3.50	5JP5	5.50	QK319	100.00	872-A (GE)	2.75	6130/3C45	4.75
2J22	3.50	5R4WGY	3.00	328A	3.50	902P1	2.00	6187	4.00
2J37	9.00	5Y3WGT	1.50	338A	3.75	918	1.10	6211	1.10
2J54	25.00	6AK5W	1.00	350B	2.35	927	.95	6264	10.00
2K25	13.50	6BA6W/5749	1.25	354A	2.25	954	.10	6278/C5F14	20.00
2K30/410R	115.00	6BM6	30.00	355A	10.00	958/958A	.35	6292 (Dumont)	Write
2K45	35.00	6C4W	4.00	371B/VT166	.75	CK1007	.45	6485	1.30
2V3G	.65	C6L/5528	5.00	375A	10.00	CK1026	2.35	8005	Write
3B24	1.50	6C21/450TL	13.50	393A	4.50	R1130B	10.50	8008/872A	3.25
3B24WA	10.50	6SN7WGT	1.75	396A/2C51	3.00	HY-1269	3.35	8020	1.00
3B25	5.00	8D21	Write			1622	1.60	AX9903/5894	17.50
3B26	3.95								

INDUSTRIAL XFMRS • VERY LARGE QUANTITY BRAND NEW, HIGH QUALITY COMM. TYPES • SPECIAL LOW PRICES • WRITE FOR LATEST LIST, FREE!

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Super gloss red & black, or plain glossy white. Both types with new safety partition that meets U. S. government specifications! Specify white or colored when ordering.

SIZE	FOR TUBE TYPE	Quantity per case	PRICES Per case	PRICES Per 100
Miniature red & black 1" x 1" x 3"	6AU6, 6AL5, etc.	3000	$27.00	$1.00
Miniature glossy white "	" "	3000	27.00	1.00
GT red & black 1¼; x 1¼" x 3⅝"	6SN7GT, 6W4GT, etc.	2000	22.50	1.25
GT glossy white "	" "	2000	22.50	1.25
Large GT red & black 1½"x1½"x4½"	1B3, 6BQ6GT, etc.	1500	20.25	1.50
Large GT white "	" "	1500	20.25	1.50
G red & black 2" x 2" x 6"	5U4G, 6BG6G, etc.	1000	18.00	2.00
G white "	" "	1000	18.00	2.00
Small Jumbo, white 3" x 3" x 7½"	809, 866A, etc.	550	41.25	7.50
Large Jumbo, white 4" x 4" x 10"	813, 872A, etc.	300	27.00	10.00
Ministackers, white (holds 10 mintubes)		1000	13.50	1.50
GT stackers, white (holds 10 GT tubes)		1000	18.00	2.00
		Carton Lot	Per Carton	Each
Lead sheaths for crystal diodes		144	12.90	.10

TERMS: 25% Deposit with Order. Balance C.O.D.—or Send Full Remittance with Order. Well Rated (D&B) Firms, Net 10. All Items Subject to Stock Depletion and Price Variation Without Prior Notice. All Merchandise Fully Guaranteed for Cost of Merchandise Only. Minimum Order $10.00.

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Cadmium or olive drab finish.

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MULTIPOT 25, 100, 300, 2000, 5000, 10000, 20000 Ohms/0.5%/ 10 Turns Equiv. HELIPOT
HELIPOT Also 30K. Each 55.98
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G.R., DeJur, Muter LAB potentiometers
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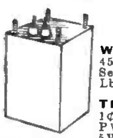
Muter 0214/500 ohm/10 Watt 1.50@
DeJur 20,000 ohm/12Watt 3.00@
TRIMPOT Miniature 2,000 ohms CW 1.50@

60mcs/85DB Gain IF STRIP W.E. Dsgn mfrd. by MOTOROLA contains 8/6AK5 & 1/6AL5 Tubes. Compact 2" W11 L 2 3/8 HGT. $14@. 2 for $25 LESS TUBES $7@.



450 MA CHOKE $3 @ Qtys. 10

W.E. Mfgr for U.S.N. Rated 4Hy 450ma/3KV/27 ohms hermetic Sealed & Cased 4¼x3½x4½"x10 Lbs. #CH1001 SPECIAL $4@. 3for$10, 10for$30

TRANSFORMERS all 115V/60cy/ 1Φ PRIMARYS VAC H'Sealed PWR&FIL/U.S.N. 6V@8A/ 5V@3A&1200VCT @ 200ma. Tapped pri. 5H7L6"W $7@. 5for$30
TP502/5500VCT@650ma/WST/USN $39
TPF52/778VCT@200ma/5V@3A, 6.3VCT@5A $4@, 3for$11, 25for$70
TPF53/270VCT @ 50ma/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/HYPERSIL/OIL $7@ 2for$12, 5for$25
TPF56/900VCT@35ma/2x2.5V @ 2A $3@, 2for$5
TPF57/2500@10ma/2.5V@2A $4@, 3for$10
TPF58/5850, 5400, 5000VCT @ 40ma $8@
TF01/2.5V@2A $1@, TF02/2.5VCT @ 10A/5KV $4@, 2for$7, 10for$29
TF05/7.5VCT/12A/15KV KENYON $7.50@
TF06/2X12V@2A/or 24V@2A $4@ 2for$7
TPHI Isolation 110to220&440VAC/150W $4@.
MIL-T-27 TRANSF Hermetic Sealed

STEVENS ARNOLD PRECISION DC-AC CHOPPER TYPE CH365

SPDT/COIL 26VDC800. Ω IMP 60Cys/830 Ω 400Cys/1100 Ω. Use as Chopper Rectifier, DEMODULATOR, Sq. Wave Generator Reg. $20@ SPECIAL $4@, 3for $11, 20for$55

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COOL THAT TUBE EQUIPMENT or TRANSISTOR. TAPPED for 6&12VAC/60 cy. operates on 400 cys as well. BARBER COLEMAN Mfgr 1.25@, 5for$5 50 for $45
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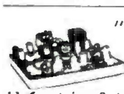
"DUMONT" TV-Hi-Fi-LAB



Hi-Lo-V Power Supply can be used for Radar, Color & Projection TV, Snooperscopes, HiV, Testing. Delivers 20 to 30 KV fully regulated & adjustable contains 3 tube voltage regulator, 3 sens relays & sweep protection ckts. SOLA 3% Regulated Constant Voltage Hi Current Powered; Delivers 420VDC @ 350ma pure DC & 6.3V/6A filament, includes 13 tubes 2/5U4. 2/6SN7 2/6AL5. 2/6BG6G, 3/1B3, OA3, 6W6, 6SJ7 input 117VAC/60cy/1Φ. DUMONT RA119 for 30" TV & Diagram. $200 value: $25@, 2/$45, 5/$100

"TEKAP" REGULATED POWER SUPPLY

LAB & HIFI, Built & ready to work. Uses "SOLA,, constant voltage Filament & Power Xfmr w/rectifier tube. Low Resistance Brute Force Filter. Furnishes 400VDC @ 250 ma from filter system 3% regulated & 12V @ 5A filtered DC for filaments. T400RPS $45

NEW DC "REGOVAC"® HIVOLTAGE

SUPPLY R200: REGULATED OUTPUT 250 450 VDC AT 200MA: REGULATION 1% MIN TO MAX CURRENT RIPPLE LESS THAN 5MV. IMPED 2 OHMS AND ALSO NON-REGULATED 125VDC@ 100MA, 6.3V/12A. COMPLETE CONTROLS FRONT PANEL SWITCHES, PILOT LIGHT BINDING POSTS, FUSES, 4" VOLT & MILLIAMMETER (2% ACCY) RACK 8-3/4H13D19"W OR CABINET.
R200R RACK MOUNTING $135
R200C CABINET $150

"TEKAP"® ONE & 3 PHASE 400 CYS SUPPLIES

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 & Radio Noise Filter; All in One Cabinet.
T4750B Basic Non-Metered $475
T4750M DC & AC & Freq Metered $563

"TEKAP"® 1Φ/400cys/115v/1500 watts Regulated Power Supply Pckg. Operates 115 or 230v/60cy/1Φ input, 28VDC@100 amps Filtered to inbuilt Regulated Inverter .90Pf. Carbon Pile Voltage Regulator, Freq Adj & Radio Noise Filter. All in one Cabinet.
T41500B Basic Non-Metered Supply $650
T41500M DC&AC & Freq Metered $738

"TEKAP"® 1Φ 400 cys/115v/485 watts Power Supply Pckg. Op/ 115v/60 cys
T4485B Basic Non-Metered $299

New "RECOVAC"® 190 VDC PCKG. Regulated 145 to 190VDC @ 35 Ma. Regulation 1% Min to Max. Constant Output for 25% Variation in line & load. Extremely low ripple & recovery time. Input 115VAC. Housed in compact cover grill & Chassis.
R35C19 $24
New "REGOVAC"® 175 VDC PCKG. Regulated 75 to 175 VDC @ 50 ma. Regulation 1% Min to Max. Constant output for 25% variation in line & load. Extremely low ripple & recovery time. Also 6.3VAC @ 3 amp Input 115VAC Housed in compact cover grill & chassis.
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TUBES

"TAB" TESTED *INSPECTED* GUARANTEED!!!

WRITE FOR COMPLETE TUBE LIST

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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	4A1 2.00	548 2.00
6J5 .59	26A7 3.69	250H 19.45	1B27 9.00	2J37 9.00	4A11 2/1.00	571 1.49
6K6 .59	FG27 8.28	250L 19.45	1B29 2.42	2J38 24.00	4B25 15.00	725A 2.50
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 .72	T55 9.00	303A 8.45	1R5 .78	2K33A 39.00	4J51 215.00	814 2.35
6SQ7 .74	RK60 1.17	304H 12.60	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	827R 100.00
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 67.50	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	837 1.35
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	5B 4.00	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 1.20	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	6A 18.00	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 1.20
12SK7 .75	EK90 .99	512X 2.00	2E31 2.00	3C33 6.00	6AD4 3.00	5691 4.70
15E 1.19	EZ90 .79	522X 2.00	2E32 1.22	3C34 6.00	6AD6 1.29	5692 5.00
FG17 3.49	EB91 .81	525X 2.00	2E35 2.00	3C37 19.00	6AD7 1.39	5693 5.00
19BG6 2.15	FG95 16.00	531X 2.00	2E36 2.00	3C39 80.00	6AE5 1.89	WE417A 12.00
19T8 1.16	FG98 14.75	532X 2.00	2E43 1.64	3C45 7.00	6AE6 1.89	5BP1 1.50
T20 5.00	100H 6.39	533X 2.00	2G21 2.26	3D21A 3.00	6AF6 .99	5BP4 3.50

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"TABTRAN" Rectifier Xfmrs

Sec'd Volts (DUAL† 0-9-15-18-&-0-9-15-18 Series Sec'ds 0-3-6-9-12-15-18-21-24-27-30-33-36 Volts

TR4001 @ 1 Amp† ea/sec/w $4.95
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TR4005 @ 12 Amp† ea/sec/w 16.70
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TR4008 @ 100 Amp†* per ea sec wndg. 117.00
18 Volt 2 Amp $1.98; 2 for 3.50
† Wndgs in Series at Ratings shown; Parallel 2X Current, Voltage outpt. 0-9-15-18.
***Dual Pri 115 & 230VAC/60cys INPUT**

120* or 230† VDC AC/Transformer✦ *For Selenium F.W.B. Rectifier* ✦

All Primaries 115 & 230VAC/60cy/1Φ Input
Secondary 0-125, 150, 160, 165,* Nema Specs
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TR4010* @ 10 Amp Continuous Duty $72
Secondary 0-250, 300, 320, 330. Nema Specs
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◆ *Selenium F.W. Bridge Extra!*

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CR6001/ 1 Amp/0.1 HY/1.4 Ohm $3.50
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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

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
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TPA500/500W† 8.25
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**Less Cord, Plug & Receptacle.*

New "TEKSEL"® SELENIUM RECTIFIERS* Engineered for Automation & Industry "TAB" Distributors for "Technical Apparatus Builders" Mfgrs. Industrial Power Rectifiers with "KOOLTAB" Current Collectors & Brackets. Also to Your Specs Any Current. Quick Deliveries! Replacements Our Specialty. *Write for Quantity Prices.* *Specials in 24 hours*

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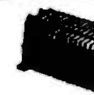
MAX DC AMP	Single Phase Full Wave Bridge 18VAC 14VDC	36VAC 28VDC	54VAC 42VDC	72VAC 54VDC	130VAC 100VDC	266VAC 217VDC	3-Phase Bridge 3-Phase 16VAC 20VDC	3-Phase 30VAC 36VDC	3-Phase 120VAC 150VDC	3-Phase 208VAC 256VDC
1	$1.50	$2.30	$3.75	$5.30	$8.75	$27.90	$3.75	$4.90	$21.45	$39.75
2	2.35	3.35	5.40	6.45	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 VOLTS AC INPUT : CR20R† 10VAC/CT., CR32D†16VAC/CT, BR18R—BR18C*—BN18R*—18VAC.*



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6&12VDC—OUT FAN COOLED
CR20R† $14
6VDC@100AMP
REPLACEMENT OR CONVERSION
6&12VDC 100/50AMP
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BR18R* $24
BR18C* $26
BN18R* $20
6 & 12 VDC 80/40AMP

COMING NEW "SILTAB"® SILICON JUNCTION HITEMP RECTIFIERS. WRITE!

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. Imput 115 VAC/60 cys.**

Stock Number	Continuous Rating	Basic
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B28V/5ACC	5 Amp (1% Ripple)	69
B28V/12A	0-28 VDC at 12 Amp	90
B28V/12ACC	12 Amp (1% Ripple)	135
B28V/24A	0-28 VDC at 24 Amp	139
B28V/24ACC	24 Amp (1% Ripple)	189
B28V/50A*	0-28 VDC at 50 Amp	225
B28V/50ACC*	50 Amp (1% Ripple)	350
B28V/100A*	0-28 VDC at 100 Amp	439
B28V/100ACC*	100 Amp (1% Ripple)	600
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 RELAY 24 VDC SUPPLIES *Cased Filtered Ready to Work*

B24VAR 24VDC @ 1 amp $8
B24VER 24VDC @ 2 amp $11
B24VJR 24VDC @ 5 amp $21

NEW VARIABLE 0 to 6 & 12V. SUPPLIES

50 & 25 Amp FILTERED DC SUPPLY AIR-MARINE-POLICE-POWER SUPPLY DESIGNED FOR COMMUNICATIONS TRANSMIT & RECEIVE. RUGGED DESIGN 4" VOLT & AMP MTR. DESGND FOR CONTINUOUS SERVICE 6 V @ 50 AMPS & 12 V @ 25 Amps FILTERED 2% RIPPLE 115VAC/ 6 CY/1Φ INPUT. ONE YEAR GTD.
T612SNACC 5200

FILTER CAPACITORS

CE156M 6000MFD 15V $2@; 2/$3; 10/$12
CE502M 2000MFD 50V $4 ea, 10 for $30
BRACKET for CE156M or CE502M 25c@, 5/$1
CE 2005M 500mfd@200V $6@, 4/$22, 10/$45
Brackets for Capacitors @ 25c each

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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.**

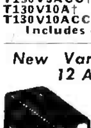
Stock Number	Continuous Rating	With Meters
T28V5A*	0-28 WVDC at 5 Amp	$57
T28V5ACC	5 Amp (1% Ripple)	84
T28V5A2CC	5 Amp 0.1% Ripple	155
T28V12A	0-28 VDC at 12 Amp	138
T28V12ACC	12 Amp (1% Ripple)	168
T28V12A2CC	12 Amp 0.1% Ripple	250
T35V16ACC†	0 to 35V @ 16 Amp/.5% Rip	210
T28V24A†	0-28 VDC at 24 Amp	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
T35V25ACC†	0-35V @ 25 Amp (.1% Rip.)	370
T35V50ACC†	0-35V @ 50 Amp (.1% Rip.)	639
T60V1ACC	0-60 VDC @ 1 Amp/0.1% Rip	108
T60V2ACC	0-60 VDC @ 2 Amp/0.1% Rip	139
T60V5ACC	0-60 VDC @ 5 Amp/0.1% 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

New Variable 0 to 6 & 12 Volt 12 Amp DC Power Supply



Battery Eliminator, Charger, Model RR, Plater, Aircraft, Marine or any DC Reg. Extra Hvy Duty Selenium Rectifier, 2 Meters V. & A. Dsgnd for Cont. Service and up to 20 Amp. Intermittent overload, 10% Ripple. **New Model T612V12AC Special $33.00**
612V12ACC only 0.5% Ripple at 5 Amps $43.00

Isolation and Control Transformers

Indoor Power Circuit Type NEMA CASED Primary 230/460V & Secondary 115/230 V 1Φ 60 cys *NEMA Specs.

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

AIRCONDITIONING BOOSTER Transformers 104 to 115V TPB21/1Kva **$15**, TPB22/2Kva **$20**, 208 to 230V TPB23/1Kva **$16**. TPB24/1.5 Kva **$19**, TPB25/2Kva **$23**, PTB26/2.3Kva **$25**, TPB 3Kva/$29
Also 1-phase & 3-phase Booster Transformers. Discounts to Quantity Users

NEW "TAB" BUILT POWER SUPPLIES

1200VDC @ 200ma. Brute Force filter, oil capacitors, Bleeder, Bridge 866A Rectifiers & Fil 6.3V @ 8A&125VDC Bias **$48**, Kit with chassis **$39**. Built Same Only 600VDC @ 200ma **$36**. Kit **$28** Built 2200VDC@200ma DC Supply **$66**.

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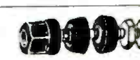

Similar to Superior DF30*, takes plugs, tips' lugs wire. 1/16" to 1/4" panels.
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BP10*, 10 Amp, 18c @ 100/$15
BP60*, 60 Amp, 75c @ 50/$30
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Mfrs. write quantity prices

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 0-27V/7.5A 51.64
Cased 0-270V/9A 81.60
Cased 0-270V/12A 107.10
Cased 0-270V/15A 124.95
Cased 0-270V/30A 154.70
100BU3-3 Φ @ 240/out 0-240/520W/1.2A $36
300BU3-3 Φ @ 230/out 0-230/1.2KVA/3A 50
500BU3-3 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
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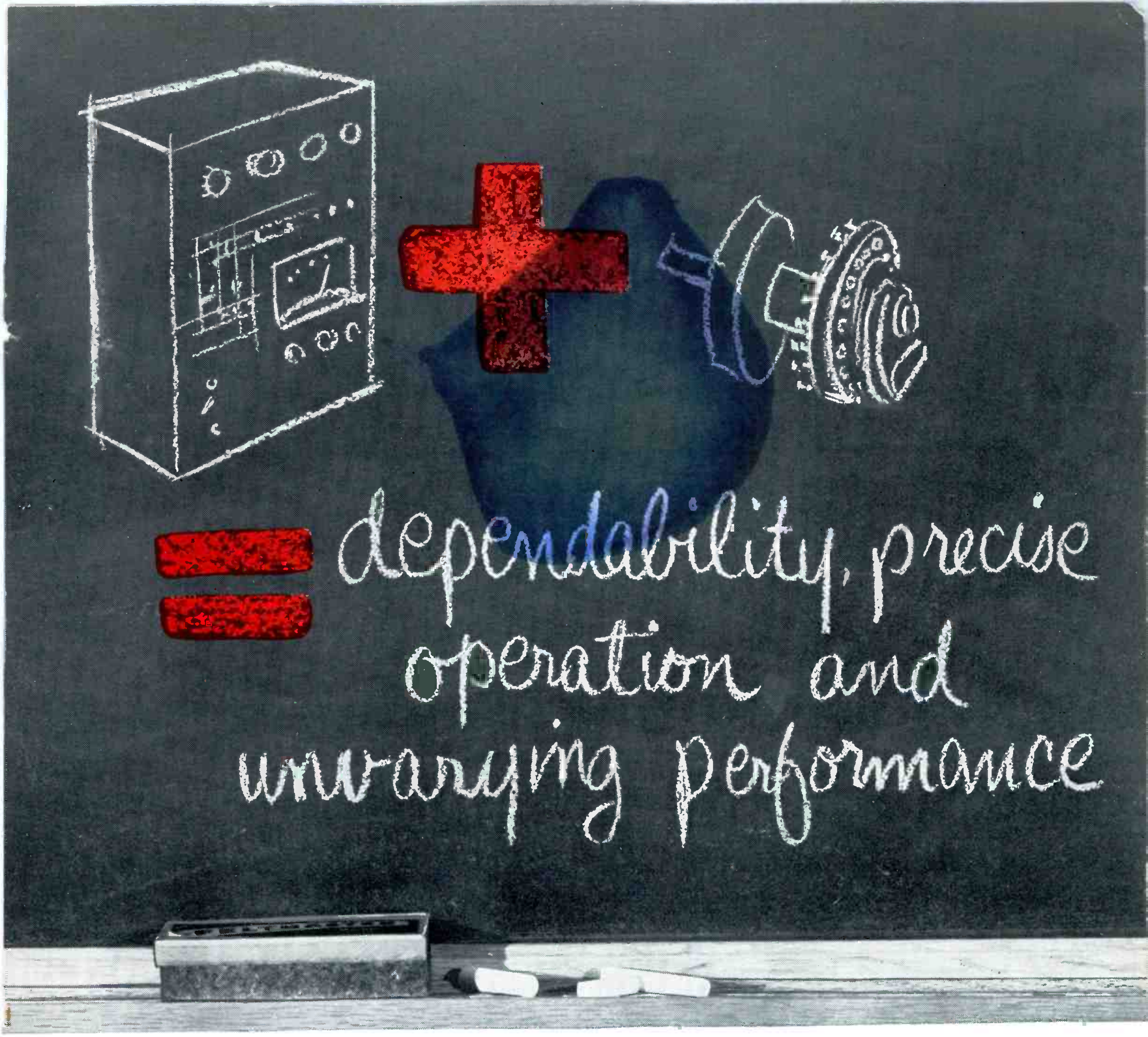

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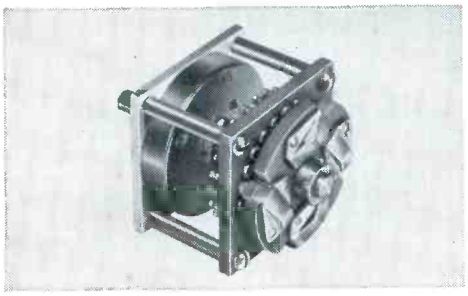

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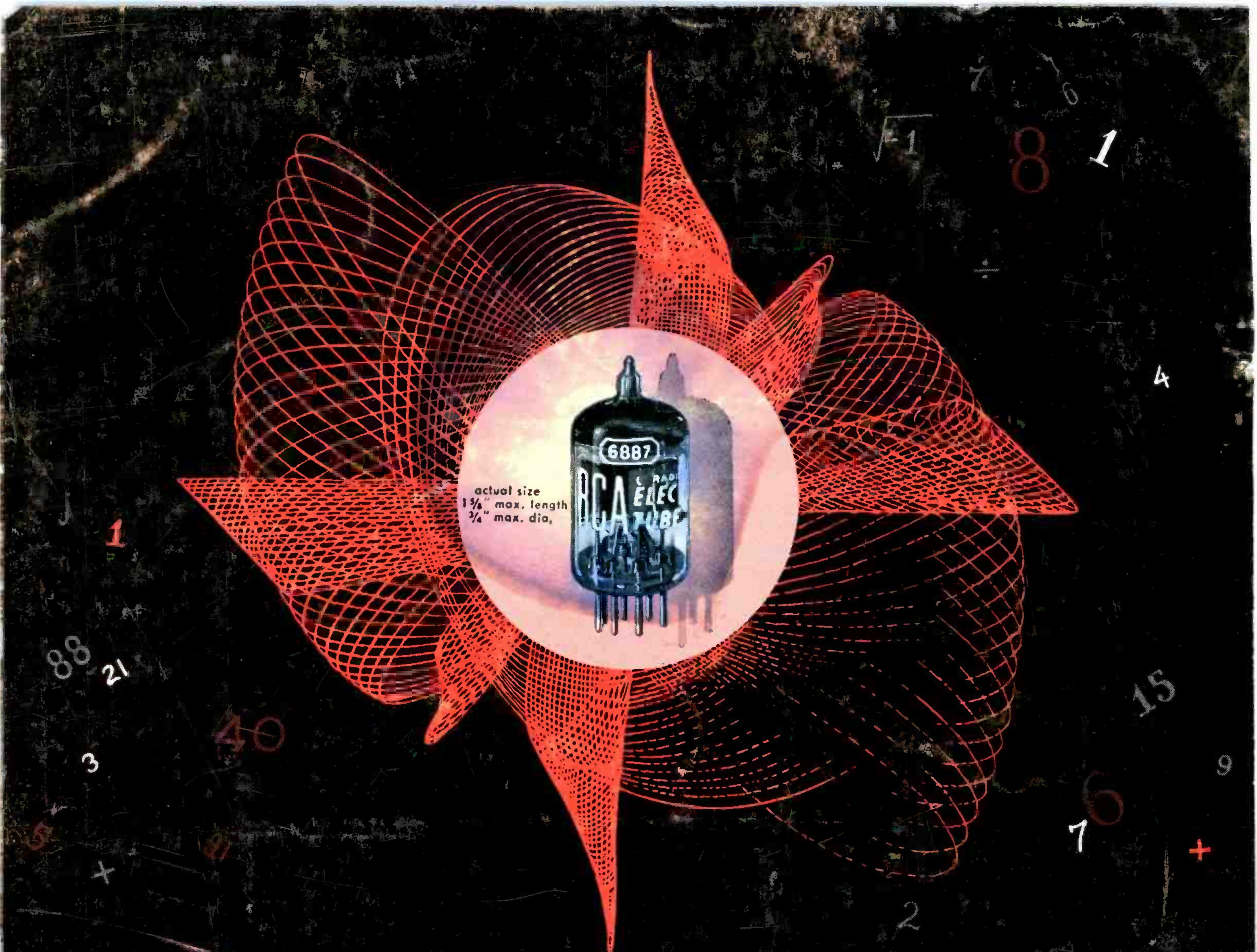

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