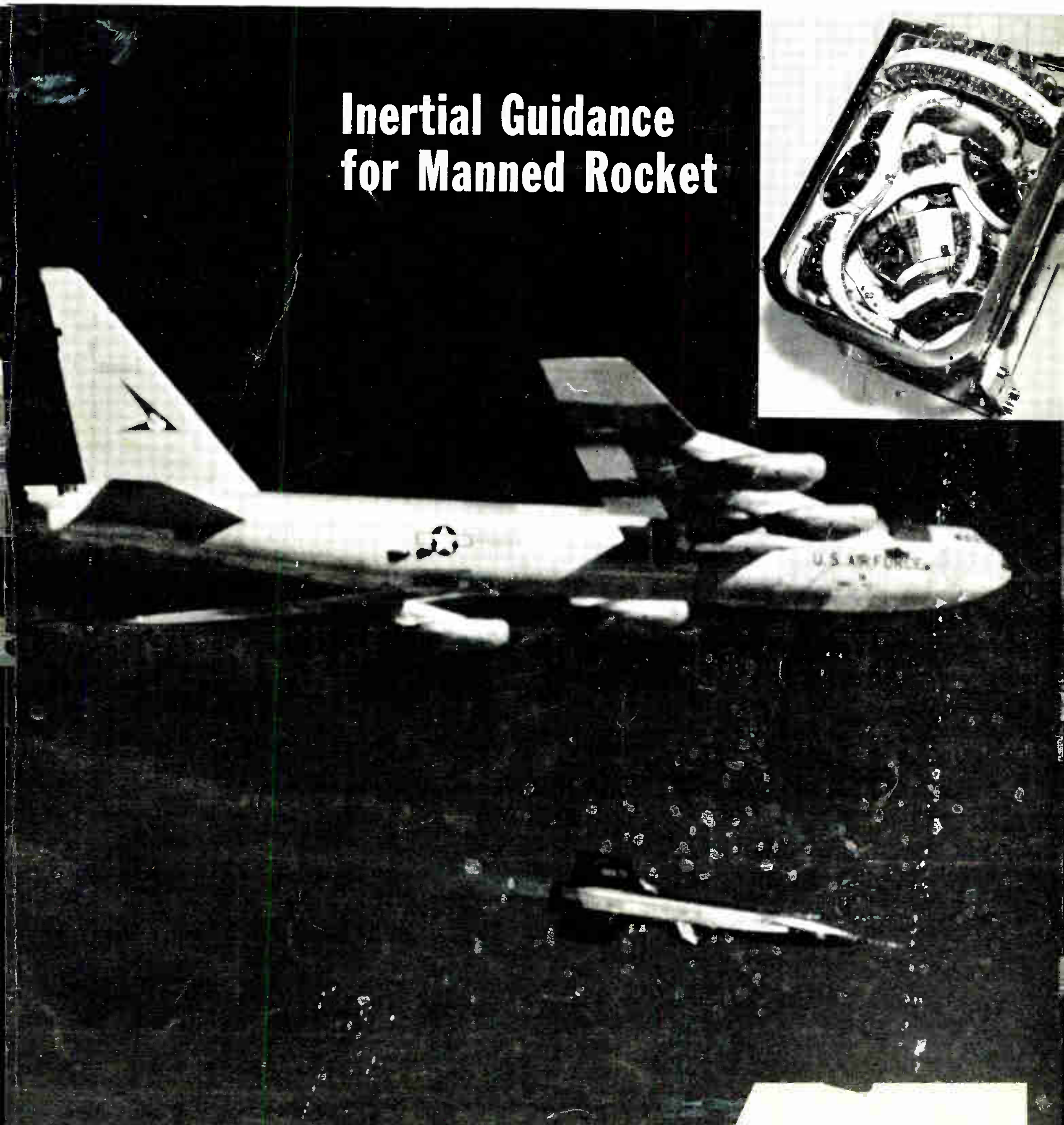
AUGUST 14, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 33 PRICE SEVENTY-FIVE CENTS

Inertial Guidance for Manned Rocket



San Francisco Industry: 50

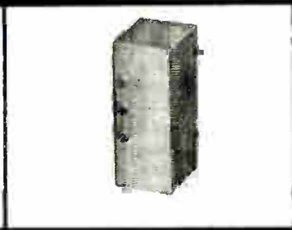
For Your Special Applications

The bulk of UTC production is on special units designed to specific customers' needs. Illustrated below are some typical units and some unusual units as manufactured for special applications. We would be pleased to advise and quote to your special requirements.

FILTERS

All types for frequencies from .1 cycle to 400 MC.

400 ∼ telemetering, 3 db at ± 7.5%, 40 db at 230 and 700 ∼, ⅝ x 1¼ x 2".



15 ∼ BP filter, 20 db at 30 ∼, 45 db at 100 ∼, phase angle at CF less than 3° from —40 to + 100° C.

LP filter within 1 db to 49 KC, stable to .1 db from 0 to 85° C., 45 db at 55 KC.

LP filter less than .1 db 0 to 2.5 KC, 50 db beyond 3 KC.

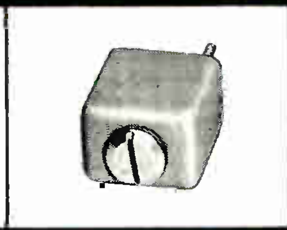
HIGH Q COILS

Toroid, laminated, and cup structures from .1 cycle to 400 MC.

Tuned DO-T servo amplifier transformer, 400 ∼ .5% distortion.

Toroid for printed circuit, Q of 90 at 15 KC.

Dual toroid, Q of 75 at 10 KC, and Q of 120 at 5 KC.



HVC tapped variable inductor for 3 KC oscillator.

SPECIALTIES

Saturable reactors, reference transformers, magnetic amplifiers, combined units.

RF saturable inductor for sweep from 17 MC to 21 MC.

Voltage reference transformer .05% accuracy.

Multi-control magnetic amplifier for airborne servo.

Input, output, two tuned interstages, peaking network, and BP filter, all in one case.

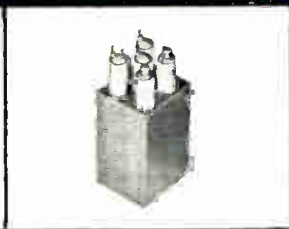
PULSE TRANSFORMERS

From miniature blocking oscillator to 10 megawatt.

Wound core unit 01 microsecond rise time.

Pulse current tansformer 100 Amp.

Pulse output to magnatron, bifilar filament.

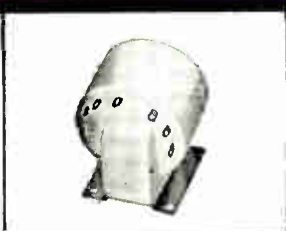


Precise wave shape pulse output, 2500 V. 3 Amps.

POWER COMPONENTS

Standard and high temperature . . . hermetic, molded, and encapsulated.

Multi-winding 140 VA, 6 KC power transformer 1¼ x 1¼ x 1"



200° C. power transformer, 400 ∼, 150 VA.

400 ∼ scope transformer, 20 KV output.

60 ∼ current limiting filament transformer, Sec. 25 Mmfd., 30 KV hipot.

UNITED TRANSFORMER CORPORATION

150 Varick Street, New York 13, N. Y. • EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y., CABLES: "ARLAB"
PACIFIC MFG. DIVISION, 4008 W. Jefferson Blvd., Los Angeles, Cal.

electronics

AUGUST 14, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 33

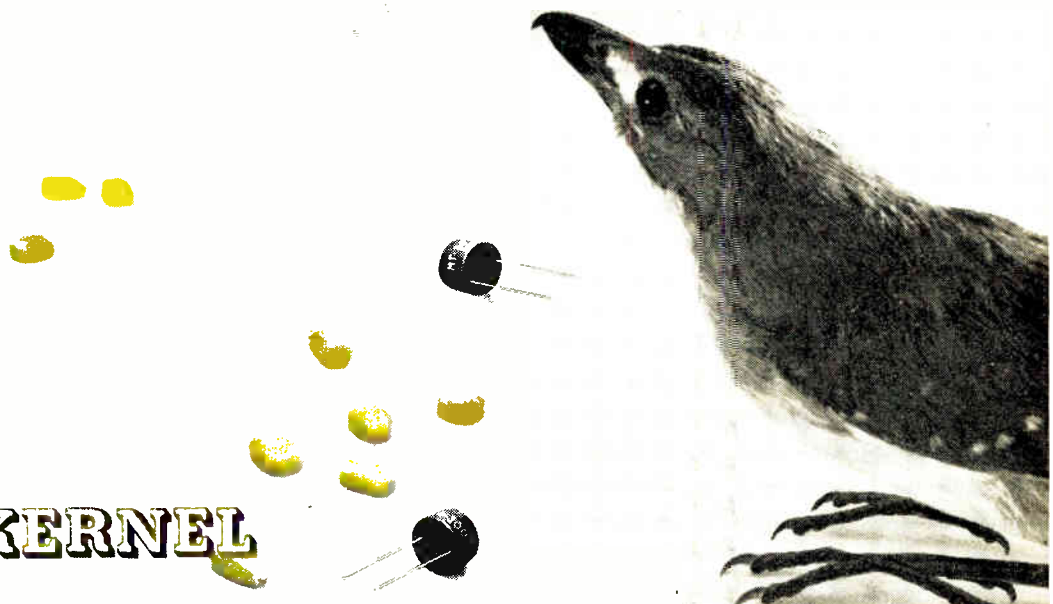
Issue at a Glance

Business

Engineering

Departments

it's for the BIRDS*



THE KERNEL

... A New Microminiaturized Toroidal Inductor

The new Burnell & Co. MT 34 and MT 35 microminiature Kernel toroidal inductors are made to order for the engineer who isn't content with outer husk solutions but gets right to the core of second generation missile communication problems.

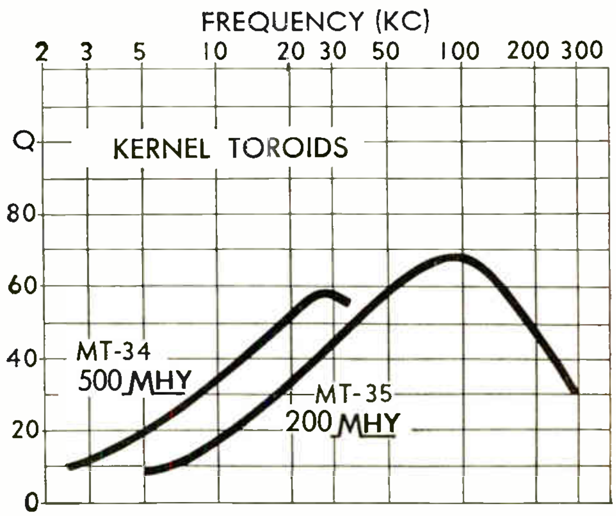
MT 34 microminiature Kernels can be supplied with inductances up to 500 mhys and the Kernel MT 35 is available in inductances up to 200 mhys. MT 34 Kernels are recommended for frequencies to 30 kcs and the MT 35 is applicable to frequencies up to 200 kcs depending on inductance values. Q for the MT 34 is greater than 55 at 25 kc and for the MT 35 more than 60 at 100 kcs.

Size of the MT 34 and MT 35 is .417" OD x .215", spacing between leads .3" x 1" L with a weight of .06 ounces.

The new microminiature Burnell MT 34 and MT 35 Kernels provide maximum reliability as well as considerable economy in printed circuit use. Completely encapsulated, the Kernels will withstand unusually high acceleration, shock and vibration environments.

Write for special filter bulletin MTF to help solve your circuit problems.

*missiles



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Burnell & Co., Inc.

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SHOPTALK . . . editorial

electronics

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HALF CENTURY OF PROGRESS. Our lead business article on p 28 reveals some little known facts that led to the electronics industry's growth on the peninsula south of San Francisco. It provides a quick but fascinating briefing on local industry for readers attending Wescon next week.

We learned a lot from this story. For one thing; how deep go the roots of western electronics. Seems the ball started rolling, broadly speaking, before the beginning of this century. Development of electron devices, in a narrower sense, dates from 1912.

Author of this article is a man intimately associated with peninsula electronics, Emmet G. Cameron. Cameron graduated from University of California at Berkeley with a B.S.E.E. and an impressive list of honors.

He worked for several firms on the West Coast and elsewhere, progressively increasing his executive responsibility. He joined Varian in 1953 as works manager of the tube division and is now vice-president and general manager of the firm.

He is currently a director of Western Electronics Manufacturers Association. This week he writes as a historian about things electronic in and around Palo Alto.

YOUR FUTURE. Continuing growth both of our industry and this magazine has resulted in additional openings on our staff for engineering editors. Helping to write and edit ELECTRONICS magazine can be a deeply satisfying and rewarding experience. It can also be a man-killing job. It depends on what kind of a man you are.

Here's what it takes: A degree in electrical engineering with heavy concentration in electronics, a year or so of experience in our industry, a well-developed bump of curiosity about new circuits, components, systems and materials.

If you fill this bill and are able to write, edit and report technical developments, Editor MacDonald would like to talk to you about your future on our staff—especially if you live within commuting distance of New York City.

Coming In Our August 21 Issue . . .

LOW-NOISE SYSTEMS. Progress in the development of low-noise amplifiers such as masers and paramps has reached the point where these devices are being incorporated into military microwave hardware.

According to New England Editor Maguire, virtually all new government contracts for missile acquisition raders, satellite tracking radars and tropo scatter communications systems now incorporate paramps. In addition, extensive study of diode paramps for tv tuners is reviving the hope once held for uhf-tv.

Maguire's article describes the progress being made in paramps and packaged tunable masers which are in great demand by radio astronomers. In addition you'll learn of other significant developments in the microwave field.

TRANSISTOR MEASUREMENTS. With high-frequency performance of transistors pushing to higher limits all the time, precise measurements of the maximum frequency of oscillation are required to predict the ultimate performance of these devices. J. Lindmayer and R. Zuleeg of Sprague Electric Co., in North Adams, Mass., have devised a technique for measuring this parameter using a coaxial structure. This method extends the range of measurement up to 1,000 mc.

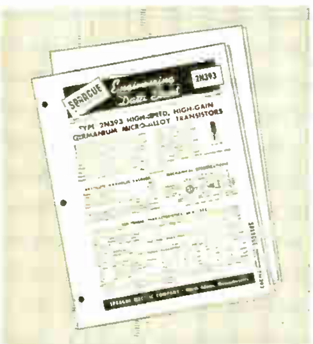
2N393

2 x actual size

2N1122

HIGH-SPEED, HIGH-GAIN MICRO-ALLOY TRANSISTORS for modern computer circuitry

Types 2N393 and 2N1122 Micro-Alloy Transistors combine high gain with excellent high frequency response to meet demands of high-speed computer switching applications in the megacycle range. Low saturation resistance, low hole storage, and exceptionally good life characteristics make these micro-alloy transistors top performers in general high frequency applications and computer circuits.



Made by electrochemical manufacturing techniques, Sprague Micro-Alloy Transistors are uniformly reliable, as well as reasonably priced for transistors with such excellent operating parameters.

All Sprague transistors—micro-alloy, micro-alloy diffused base, and surface barrier types—are now produced in Sprague's completely new spotless semiconductor facility.

For engineering data sheets on the types in which you are interested, write Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

Sprague micro-alloy, micro-alloy diffused base, and surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type numbers are manufactured to the same specifications and are fully interchangeable. You have two sources of supply when you use micro-alloy and surface barrier transistors!

Other popular SPRAGUE transistors

2N128
SB MIL GENERAL PURPOSE (MIL-T-12679A)

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FOR MEDIUM GAIN AMPLIFIERS

2N345/SB102
FOR HIGH GAIN AMPLIFIERS

2N246/SB103
FOR HIGH FREQUENCY OSCILLATORS

2N501
MADT FOR ULTRA-HIGH SPEED SWITCHING

SPRAGUE COMPONENTS:

TRANSISTORS • RESISTORS • MAGNETIC COMPONENTS • CAPACITORS • INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

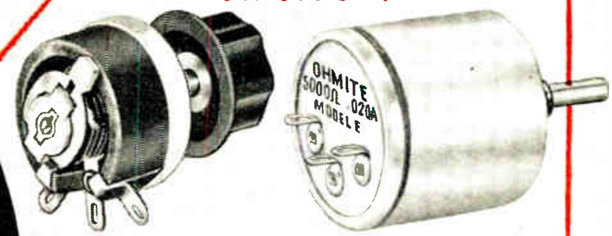
SPRAGUE®
THE MARK OF RELIABILITY

CIRCLE NO. 5 READER SERVICE CARD

Newest addition to industry's most complete line of **Rheostats**

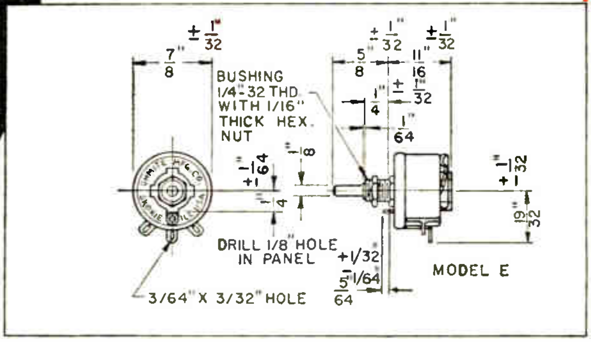
12½-Watt miniature OHMITE® Rheostat In Enclosure

Actual Size



Without enclosure, only ⅞" diam. In enclosure, exclusive of shaft but including terminals, only 1 7/32" long by 1 3/64" diam.

Compact enclosure of Model E Rheostat consisting of lightweight, drawn aluminum housing is dusttight.



Even though Ohmite already has the most complete line of rheostats available to industry, Ohmite continues research and development to *improve and expand* this product line. Newest addition is the 12½-watt miniature Model E Rheostat in enclosure. Ohmite's Model E wire-wound power rheostat will dissipate 12½ watts.* Yet, it is no larger than many 1- or 2-watt potentiometers. Such extraordinary power handling capability is characteristic of Ohmite's time-proven, all-ceramic and metal construction, and exclusive vitreous enamel coating. This tiny unit is designed to operate at a maximum hot spot temperature of 340°C. Derating is linear from full wattage at 40° C to zero watts at 340° C. With its small size, and because it can be used at high ambients, the Model E is applicable to *many military and aircraft uses.*

Special length shafts and bushings, screwdriver shafts, locking type bushing, tandem mountings, enclosures, etc., similar to the variations available on the larger rheostat, can be provided upon specific request.

* *Rating on metal panel*

Smaller than many 1- or 2-watt potentiometers

All-ceramic and metal—vitreous enameled

High dissipation for small size—many military applications

Tandem assemblies consisting of two, three or more units can be supplied made to order.

Resistance range: Up to 5000 ohms with 23 stock values; higher values available with OHMICONE silicone-ceramic coating.

Resistance Tolerance: ± 10%

Weight: 0.52 ounce

11 SIZES
12½ to 1000 Watts

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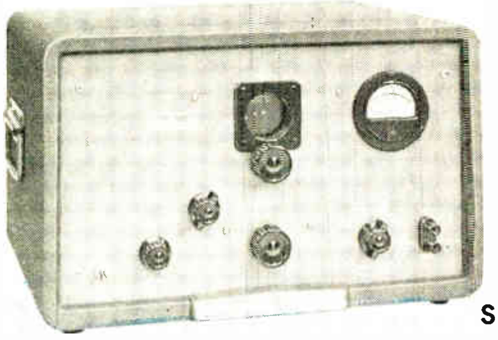
Get several instruments in one! These PRECISION

650A-FLAT WITHIN 1 DB, 10 CPS TO 10 MC!



Many Uses Testing TV amplifiers or wide-band systems, measuring filter transmission characteristics and tuned circuit response, determining receiver alignment, making telephone carrier and bridge measurements.

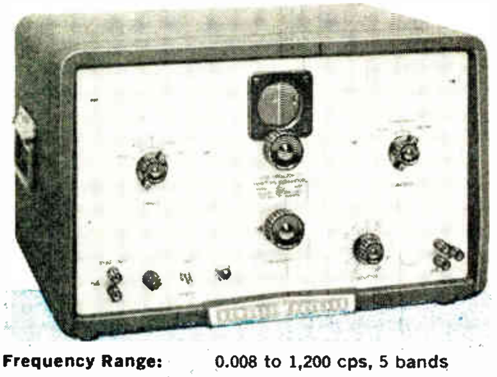
Special Advantages No zero set, extremely wide frequency range, no adjustments during operation, output voltage attenuator, self-contained VTVM, 2% to 3% stability, simplest operation.

650A TEST OSCILLATOR

Specifications

Frequency Range:	10 cps to 10 MC, 6 bands
Stability:	± 2% to 100 KC, ± 3% above
Output:	15 mw or 3 v into 600 ohms; 6 v open circuit
Voltage Range:	0.00003 to 3 v
Frequency Response:	Flat within 1 db full range
Distortion:	Less than 1% to 100 KC, less than 2% to 1 MC, 5% at 10 MC
Output Monitor:	VTVM monitors attenuator input in v or db
Output Attenuator:	50 db attenuation in 10 db steps; output variable continuously from + 12 to — 50 dbm
Hum:	Less than 0.5% full scale
Price:	$490.00 (cabinet) $475.00 (rack mount)

202A-DOWN TO 0.008 CPS; TRANSIENT-FREE!



Many Uses Electrical simulation of mechanical phenomena, vibration studies, servo research and testing, medical research, geophysical problems, subsonic and audio testing.

Special Advantages No transients, continuously variable 0.008 to 1,200 cps, electronically synthesized sine, square or triangular waves, 1% stability, 0.2 db response, less than 1% distortion on all but x 100 range.

202A LOW FREQUENCY FUNCTION GENERATOR

Specifications

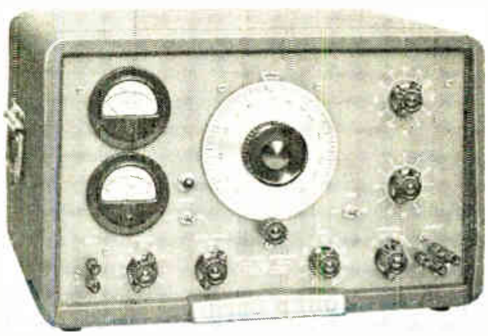
Frequency Range:	0.008 to 1,200 cps, 5 bands
Frequency Stability:	1%, including warm-up
Output Waveforms:	Sine, square, triangular
Output Voltage	30 v peak-to-peak across 4,000 ohms, all waveforms
Internal Impedance:	Approx. 40 ohms full range
Sinewave Distortion:	Less than 1% except 2% on x 100 range
Output System:	Floating; either side may be grounded
Frequency Response:	Constant within 0.2 db
Hum:	Less than 0.05% of max. output
Sync Pulse:	10 v peak neg., less than 5 μsec duration
Price:	$525.00 (cabinet) $510.00 (rack mount)

Call your hp rep for engineering help,

OSCILLATORS

fill so many different needs!

hp 205AG—SIX INSTRUMENTS IN ONE—20 CPS TO 20 KC!



Many Uses Measure amplifier gain and network frequency response, measure broadcast transmitter audio and loudspeaker response, drive bridges, use in production testing or as precision source for voltages; many other laboratory applications.

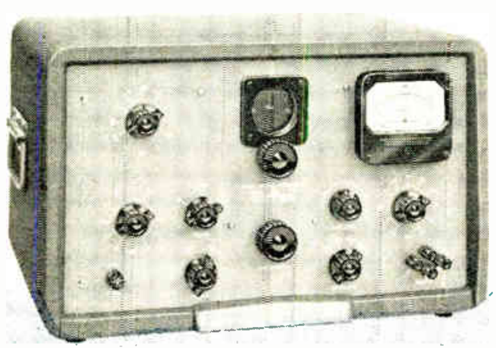
Special Advantages Completely self-contained high power frequency response instrument. No auxiliary equipment needed. 5 watts output, less than 1% distortion, no zero setting. Supplies precisely known voltage, output meter calibrated in v and dbm, separate input meter for gain measurements, wide range of output impedances.

hp 205AG AUDIO SIGNAL GENERATOR

Specifications

Frequency Range:	20 cps to 20 KC, 3 bands	**Distortion:**	Less than 1% above 30 cps
Frequency Stability:	Better than 2% long term	**Hum:**	60 db below output voltage or 90 db below zero level
Output:	5 watts into matched load	**Input, Output Meters:**	Read direct in v or dbm
Frequency Response:	± 1 db full range to + 30 dbm; ± 1.5 db above — 30 dbm	**Input Attenuator:**	Extends meter range to + 48 dbm and 200 v rms, 5 db steps
Output Impedances:	50, 200, 600, 5,000 ohms; circuit is balanced and center-tapped; any terminal may be grounded	**Output Attenuator:**	110 db in 1 db steps
		Price:	$500.00 (cabinet) $485.00 (rack mount)

hp 206A—LESS THAN 0.1% DISTORTION TO 20 KC



Many Uses Precision, convenient audio voltage source, ideal for checking FM transmitter response and distortion; broadcast studio performance, high quality, high fidelity amplifier testing and transmission measurements.

Special Advantages Continuously variable audio frequency voltage, 0.2 db response. Represents the ultimate in voltage output accuracy and low distortion at any level. 2% frequency stability, less than 0.1% distortion. 111 db attenuator with 0.1 db steps.

hp 206A AUDIO SIGNAL GENERATOR

Specifications

Frequency Range:	20 cps to 20 KC, 3 bands	**Frequency Response:**	Better than 0.2 db, 30 cps to 15 KC
Calibration:	Direct in cps, 20 to 200 cps	**Distortion:**	Less than 0.1% above 50 cps
Frequency Stability:	± 2% including warmup drift	**Hum:**	At least 75 db below output or 100 db below zero level
Output:	± 15 dbm into 50, 150 and 600 ohms	**Output Attenuators:**	111 db in 0.1 db steps
Output Impedances:	50, 150 and 600 ohms balanced; 600 ohms single ended	**Price:**	$750.00 (cabinet) $735.00 (rack mount)

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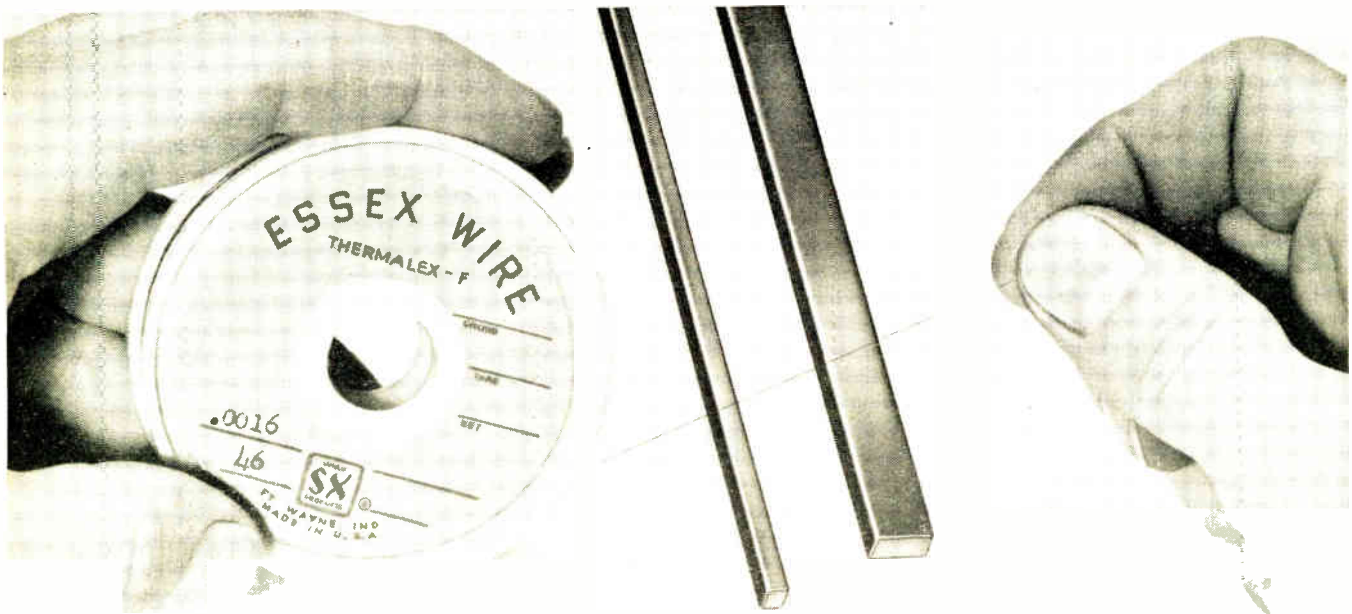
Now...all sizes and shapes of SX Magnet Wire for every "hot spot" application

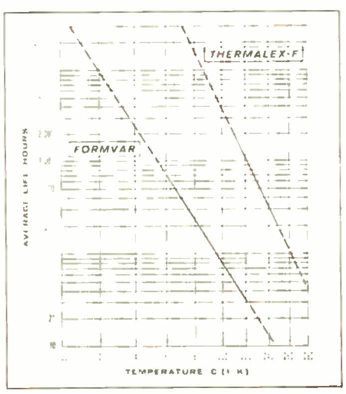
Thermalex F®

MAGNET WIRE *Class F (155°C)*



Rounds, squares and rectangulars also available with single and double glass coverings

VERSATILE GENERAL PURPOSE APPLICATION
Thermalex-F is not a special wire but has properties required for a general purpose application and can be used through the 105 C-155 C temperature range . . . Class A applications as well as Class F . . . eliminating the need for buying more than one type of magnet wire.



OUTSTANDING THERMAL STABILITY
A.I.E.E. #57 "Procedure for Evaluation of the Thermal Stability of Enameled Wire" which is an accepted test, indicates a 30,000 hours life at 170°C for unvarnished specimens.

Thermalex-F, a Class F (155°C) magnet wire insulation developed by Essex, is now available in round wire from 11 to 50 AWG size and all Formvar sizes of square and rectangular. This full size range gives every manufacturer the versatility he needs in one insulation type for his exact application!

SX THE WIRE DESIGNED WITH THE FUTURE IN MIND ®

Magnet Wire Division
ESSEX WIRE CORPORATION
Fort Wayne, Indiana

Manufacturing Plants: Birmingham, Ala.; Anaheim, Cal.; Fort Wayne, Ind.; Hillsdale, Mich.

National network of Warehouses and Sales Offices . . . Call your local "Essex Man."

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throug
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Skills + Experience
Top Quality

Benefit from the experience gained in building 21,000,000 picture tubes...

specify RCA!

In over a decade of experience, RCA has produced more than 21,000,000 picture tubes. What does this experience promise you?

First, it promises *quality*...high standards for checking every tube component every production step. It promises *improvements*...the constant research that has given you the latest developments in picture-tube design. Every improvement in technique, every new design is thoroughly proved-out before release. Further, this "know-how" promises the *dependability* and *availability* you need to meet tight production schedules. Why settle for less'

RCA offers you every active picture-tube type for black-and-white television...types with either low or high grid-No. 2 voltage, either short or long neck, either 90° or 110° deflection, as well as the very latest in color picture tubes. For details, get in touch with the RCA Field Representative at our office nearest you.

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

WASHINGTON OUTLOOK

WASHINGTON—MORE MONEY for ICBM production and for defense against ballistic missiles and submarines. That sums up most major changes in individual electronics-related projects of the fiscal 1960 defense appropriation. The bill has come out of the congressional wringer in final shape after six months of debate, haggling and revision. The total sum is close to the administration's $39.2-billion budget request, not counting an additional $1.6 billion for military construction still in the mill.

ICBM production was jacked up $172 million over the Pentagon's request. A $137-million increase was voted for antisubmarine defense—with $13.2 million extra for the Goodyear Aircraft-Librascope-Kearfott Subroc underwater missile. The Army got a $238-million bonus for general hardware procurement—much of it to be spent on additional communications equipment and ground radar—and an increase of $137 million to speed development of Western Electric's Nike Zeus anti-ICBM missile.

Offsetting the budget hikes were a series of cutbacks: $50 million was knocked out for Air Force radar replacement; procurement funds for the Bomarc, Nike Hercules and Mace missiles were trimmed; the Navy received $35 million to buy long lead-time components for a nuclear aircraft carrier in place of a proposed $260-million conventionally powered vessel.

- **Military contracting officers** will be unable to commit the fiscal 1960 money—which includes some $4.8 billion for electronics—for a couple of months.

  Still to come is the Pentagon's apportionment procedure, conducted jointly with the Budget Bureau, during which individual projects are reviewed once more. The budget plans are still subject to change.

  The military services will be allowed to spend most, if not all, the extra funds tacked on to some of the projects. No firm decision, however, has been made yet on the ICBM increase.

- **Military spending plans** will be even more difficult to anticipate in the future as the result of new congressional action which will require the armed services committees of both houses to okay an authorization bill on missile and aircraft procurement in addition to the money bills voted by the two appropriations committees. This double congressional check is now routine for foreign aid and military construction expenditures.

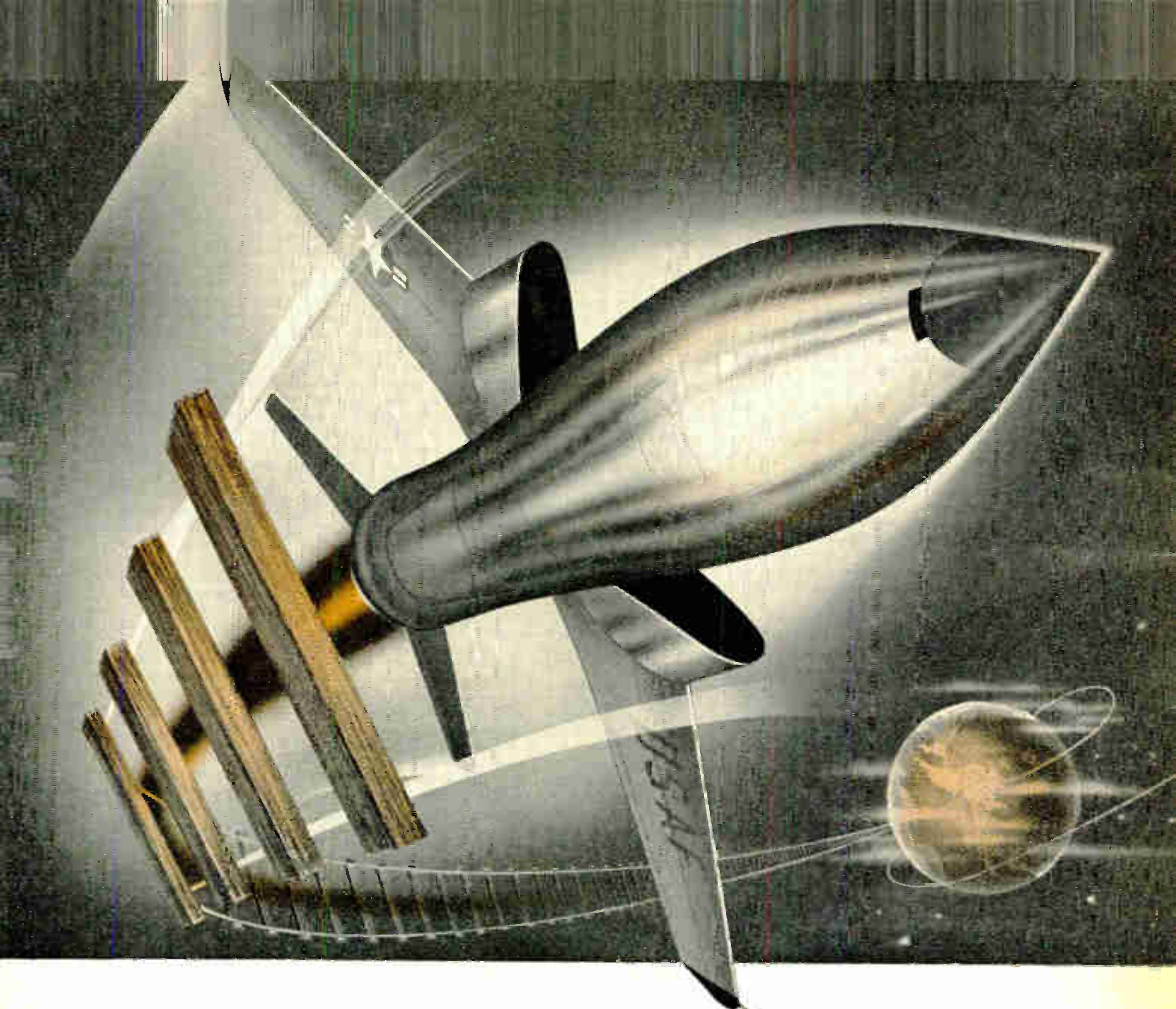
  The new double-check reflects Congress' intent to have a greater voice in decisions related to specific weapon projects. On long-range planning for production runs, missile and aircraft contractors and subs will now have still another obstacle to sweat out.

- **Hearings may be held** this fall on the major current proposal dealing with control over the radio spectrum—the new bill by House Commerce Committee chairman Oren Harris (D., Ark.).

  Rep. Harris feels there has been enough study. Now he wants a specific proposal. He views his bill not as the final answer but a departure point.

  His bill would establish a frequency allocation board to divide the spectrum between government and nongovernment users. The board would consist of three members appointed by the President for nine years. They could be overruled only by the President acting in the interest of national security or foreign relations.

  The FCC would continue to assign whatever frequencies are given over to civilian use. A government frequency administrator, personal assistant to the President, would be the czar over all government uses, assigning frequencies among the various agencies.



Express line to everywhere . . .

Developing over 15,000 lbs. of thrust from its powerful jet engine . . . traveling at nearly twice the speed of sound in its surge through the uncharted vastness of the stratosphere . . . this is the formidable Republic F-105 "Thunderchief" . . . the newest fighter-bomber of the Tactical Air Command. And all the while, the sole occupant of this supersonic arsenal with wings is as sure of his position as the engineer of an express train running on carefully surveyed and mile-posted roadbed!

Thanks to the LFE Doppler Radar Navigator, which the Air Force chose for the F-105, the pilot knows instantly and automatically his course and distance to destination; ground speed and drift angle, over land or sea at all speeds from stationary to nearly Mach 2! The AN/APN-105 is fully automatic, self-contained, lightweight, and free from the effects of shock, vibration, and cloud reflections.

This latest in the LFE series of Radar Navigators is another example of the unparalleled experience in Doppler Radar which has earned LFE its reputation for *Leadership from Experience.*

LFE

Leadership from Experience

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ENGINEERS: LFE offers outstanding employment opportunities in Navigation, Radar and Surveillance, and Computer Systems and Components.

from

DALOHM

better things in smaller packages

NEW

Type MF METAL FILM RESISTORS

These new molded metal film resistors combine the advantages of DALOHM's unique molding techniques with advanced, high vacuum, evaporated metal film procedures to provide the best characteristics of wire wound resistors — including high resistance values — while retaining miniature size.

Inherently stable, DALOHM metal film resistors offer good high frequency characteristics; low noise levels; low and controllable temperature coefficients; and the *ability to withstand rigorous environmental* conditions.

- Rated at 2, 1, ½, ¼ or ⅛ watts, depending on size.
- Resistance range from 100 ohms to 4 Megohms, depending on size.
- Standard tolerance ± 1%.
- Temperature coefficient ± 50 and ± 100 P. P. M., depending on size.
- Completely insulated.
- Provides complete protection from moisture and salt spray
- Endures severe mechanical shock.
- High stability.
- Excellent high frequency characteristics.
- Allows high heat dissipation.
- Long, reliable load life.

SPECIAL PROBLEMS?

You can depend on DALOHM for help in solving any special problem in the realm of development, engineering, design and production. Chances are you can find the answer in our standard line of precision resistors (wire wound, metal film and deposited carbon); trimmer potentiometers; resistor networks; collet-fitting knobs; and hysteresis motors. If not, just outline your specific situation.

DALOHM Ω

DALE PRODUCTS, INC.

Box 136 Columbus, Nebraska

Write for Bulletin R-43

from

DALOHM

better things in smaller packages

NEW

750 and 1000 T-POTS

These two new trimmer potentiometers, in standard and miniature sizes, mark another DALOHM advance in meeting the most stringent requirements. Both surpass the applicable paragraphs of MIL-R-19A, MIL-R-12934A, MIL-E-5272A and MIL-STD-202A.

Ruggedly constructed, with *completely sealed cases,* and inherently stable, DALOHM 750 and 1000 potentiometers perform reliably under extreme conditions of temperature and humidity, shock and vibration.

	750	1000
• Rated at:	2 watts*	2.5 watts*
• Resistance range:	10 ohms-30K ohms	10 ohms-50K ohms
• Standard tolerance:	± 5%	± 5%
• Size:	.180 x .300 x 1.000"	.180 x .300 x 1.25"
• Screw adjustment:	17 ± 2 revolutions	25 ± 2 revolutions
• Weight:	2 grams	2.5 grams
• Volume:	.054 cubic inch	.068 cubic inch

*Mounted per MIL-R-19A

COMPLETELY SEALED
END RESISTANCE: 3% maximum on all values
NOMINAL RESOLUTION: 0.1% to 1.3%
LINEARITY: Below ± 3% on all values
NOISE DURING ADJUSTMENT: Per NAS-710 (100 ohms maximum equivalent noise resistance)
TEMPERATURE COEFFICIENT OF TRIMMER: 50 PPM/° C. maximum
WELDED CONSTRUCTION THROUGHOUT: Assures maximum reliability and precision
VIBRATION: Per MIL-STD-202A, Method 204, Condition B, 15 g. to 2000 cps.
LOAD LIFE: Per MIL-R-19A
SHOCK: Per MIL-STD-202A, Method 202A, 100 g.
ACCELERATION: Per MIL-E-5272A, Procedure II, 100 g.
HUMIDITY: Per MIL-STD-202A, Method 106A

Write for Bulletins R-41 and R-44

DALOHM Ω

DALE PRODUCTS, INC.
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Zack Radio Supply Company
San Francisco, California
Connex Corp.
Oakland 14, California
Manley Electronic Supply
Lancaster, California
Wholesale Electronic Supply
Ventura, California
Shelley Radio Company
Los Angeles, California
Shanks & Wright
San Diego California

COLORADO
Denver Electronic Supply
Denver 4, Colorado

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Washington, D C

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Tampa, Florida
Hammond Electronics, Inc.
Orlando, Florida
Thurow Distributors
Tampa, Florida
Orlando Florida
Pensacola, Florida

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Precision Radio
Honolulu 14, Hawaii

ILLINOIS
Newark Electric Company
Chicago, Illinois

INDIANA
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Fort Wayne, Indiana
Graham Electronic Supply
Indianapolis, Indiana
Radio Distributing Company
South Bend, Indiana

KANSAS
Interstate Electronic Supply
Wichita, Kansas

MARYLAND
Kann-Ellert
Baltimore 3 Maryland
D & H Distributing Co.
Baltimore 30 Maryland

MASSACHUSETTS
A. W. Mayer Company
Boston, Massachusetts

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Radio Tube Merchandising
Flint 3, Michigan
Electronic Supply Corp.
Battle Creek, Michigan
Electronic Supply Corp.
Kalamazoo, Michigan
Radio Electronic Supply
Detroit Michigan

MINNESOTA
Electronic Center, Inc.
Minneapolis, Minnesota
Radio Electronic Supply Co.
Minneapolis, Minnesota
Gopher Electronics
St. Paul, Minnesota

MISSOURI
Electronic Components for Industry Co. St Louis 17, Missouri
Jones Electronic Sales
Kansas City 1, Missouri

NEW JERSEY
General Radio Supply
Camden 2, New Jersey
Federated Purchaser
Mountainside, New Jersey

NEW YORK
Federal Electronics
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Radio Equipment Corporation
Buffalo 3, New York
Electronic Center, Inc.
New York 11, New York
Harrison Radio
New York 7, New York
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Terminal Radio
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Higgins & Sheer
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Morris Distributing Company
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Arrow Electronics
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Valley Electronics Labs
Utica, New York
Milo Electronics
New York 7, N.Y.
E. E. Taylor
Albany 6, N Y

NEW MEXICO
Radio Specialties, Inc.
Alamogordo, New Mexico

NORTH CAROLINA
Dalton-Hege Radio Supply
Winston-Salem, North Carolina

OHIO
Mytronic Company
Cincinnati, Ohio
Pioneer Electronic Supply
Cleveland, Ohio
Srepco, Inc.
Dayton, Ohio
Hughes-Peters, Inc.
Columbus, Ohio

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Radio Supply Company
Oklahoma City, Oklahoma
Oil Capitol Electronics
Tulsa 1, Oklahoma

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WEST VIRGINIA
Chemcity Electronics Dist.
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WISCONSIN
Taylor Electric Company
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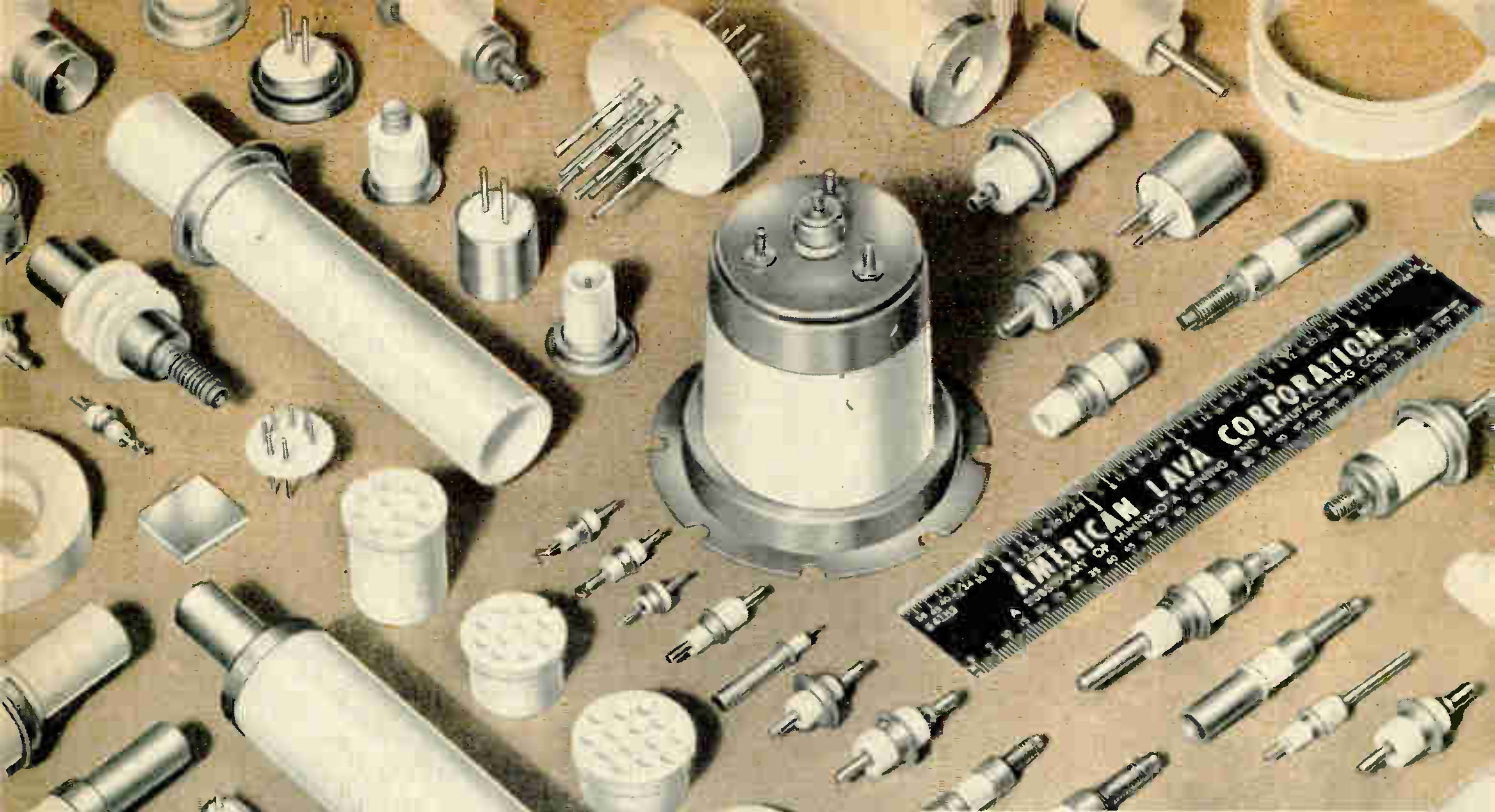

AMERICAN LAVA CORPORATION


AMERICAN LAVA

Plan Eight-Company Merger

LARGE-SCALE CONSOLIDATION and merger activities currently set in motion by **Consolidated Electronics Industries Corp.** and **Philips Industries Inc.** will establish one new company, one wholly-owned subsidiary and absorb eight smaller firms.

The new company will bear the same name as the older firm, Consolidated Electronics Industries Corp. In addition to its older namesake it will include: **Philips Industries Inc., Central Public Utilities Corp.,** St. Louis, Mo., and **Advance Transformer Corp.**

CEIC will establish a wholly-owned subsidiary, **Philips Electronics and Pharmaceuticals Inc.,** which will in turn own **Anchor Serum Co., Philips Electronics Inc., The Islands Gas & Electric Co.** and **Philips Roxane, Inc.**

Both the consolidations and the mergers are subject to the approval of stockholders of the various constituent companies. The present Consolidated Electronics common stock is listed on the New York stock exchange. Application for listing of the new firm will be made immediately upon completion of its formation. The company will begin operations with a net worth of approximately $50 million.

• **AMP Inc. & Pamcor Inc.,** Harrisburg, Pa., reports highest net sales and income in the company's history for the first half of 1959. Net sales amounted to $20,439,931, as compared with $14,832,112 for the same period in 1958. New orders this year totaled $21,920,000 and the backlog of unfilled orders stands at $7,720,000.

• **Ampex Corp.,** Redwood City, Calif., announces plans to establish a subsidiary to be called **Ampex Military Products Co.** The new group will be devoted to major R&D activity for direct government projects as well as for prime contractors. Location of the new facilities is still under study.

• **Crosby Electronics,** Hicksville, N. Y., has acquired rights to the Madison Fielding line of high-fidelity and stereophonic equipment. The acquisition marks the entrance of Crosby Electronics into the consumer manufacturing field. The product line includes receivers, tuners, amplifiers and preamplifiers. Crosby will continue its work in manufacturing electronic test equipment and specialized broadcast gear.

• **Controls Company of America,** Schiller Park, Ill., through a special stockholders meeting has voted to increase the firm's $5 par value common stock from 1 million to 3 million shares. This action paved the way for a 50 percent stock distribution on August 10 to stockholders of record July 24.

25 MOST ACTIVE STOCKS

WEEK ENDING JULY 31

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Sperry Rand	2,093	27½	25⅝	26¼
Lear	908	17½	16¼	17
Emerson	835	17⅜	15¾	17⅛
General Dynamics	757	54½	50⅞	54⅛
Gen Tel & Tel	620	78	74⅝	75⅛
Intl Tel & Tel	573	39	37¼	37⅜
Raytheon	561	53¼	51⅝	52¼
Elec & Mus Ind	548	7⅝	6⅝	7⅜
Univ Control	519	18¾	17⅝	18½
Gen Elec	480	82⅜	80⅜	81¼
Philco	451	28¾	27⅝	28
Avco Corp	422	15⅛	14½	14½
Westinghouse	398	97	94½	95¼
Gen Instr	371	29⅜	25⅜	28⅞
RCA	351	67⅞	65¾	66¼
Burroughs	331	35½	33¾	35
Reeves Soundcft	315	10⅛	9⅛	9½
Admiral	312	23½	20⅜	20⅝
Ampex	279	88¼	82¼	83
Zenith	250	122	116½	119¼
Amer Bosch Arm	239	33½	32⅛	32⅝
Beckman	226	67½	64	65¾
Cons Elect Ind	222	45¼	42⅛	42⅝
Robinson Tech Prod	209	22	14½	21½
Litton Ind	197	137⅞	126¼	128

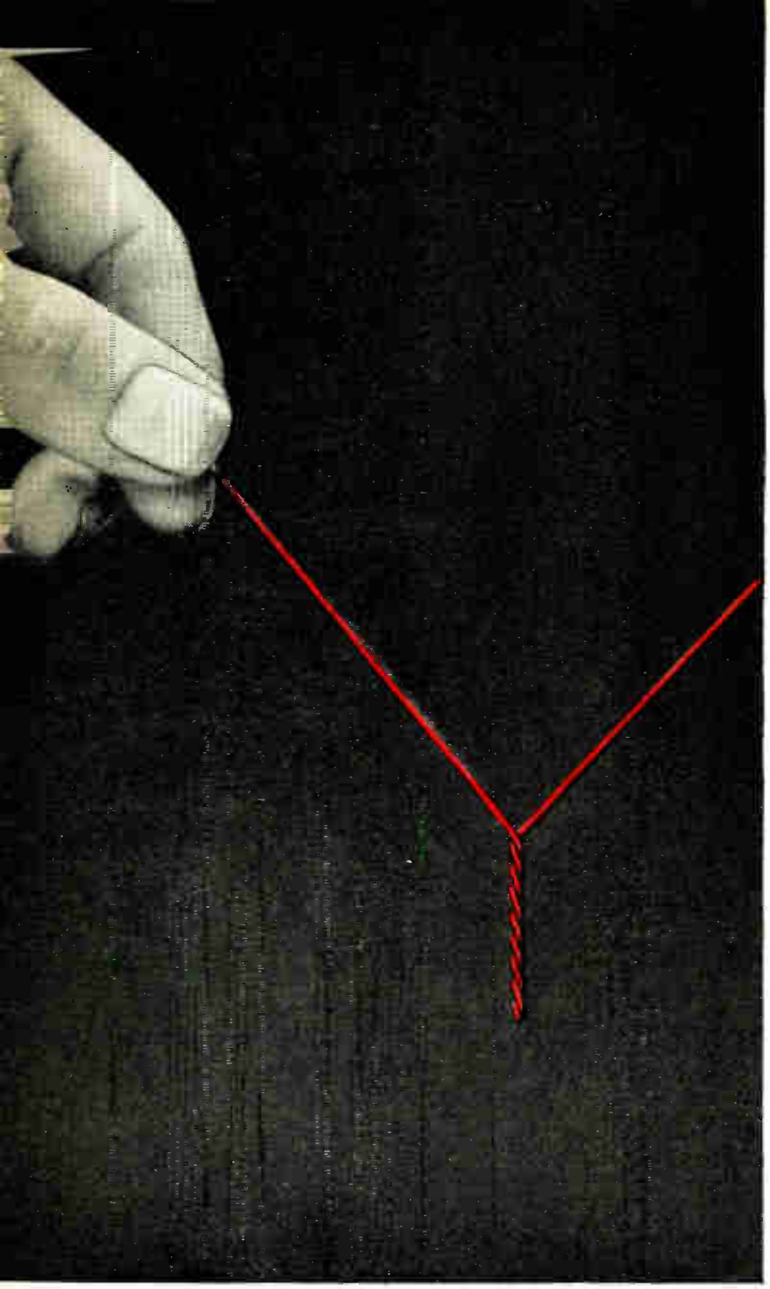
The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co.

NEW PUBLIC ISSUES

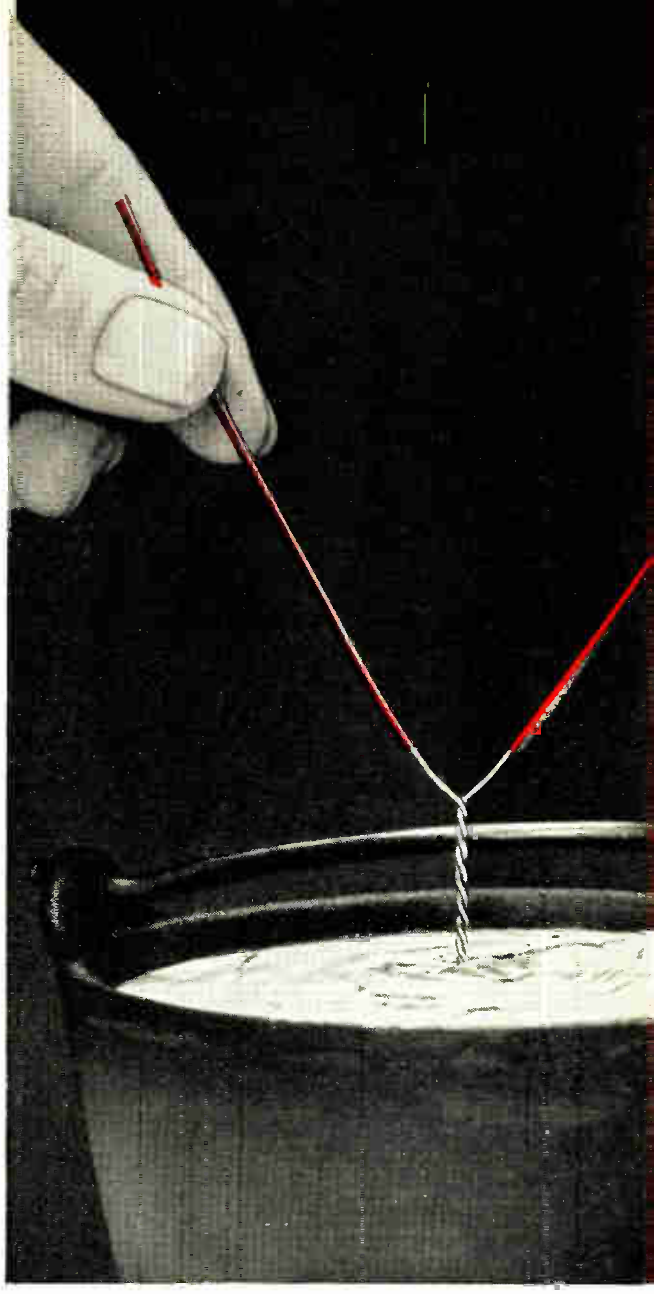
	No. of Shares
Wilcox Electronic Company	318,736
Cubic Corporation	100,000
Controls Company of America	191,703
Television Shares Management Corp.	206,500
Executone Incorporated	136,000

STOCK PRICE AVERAGES

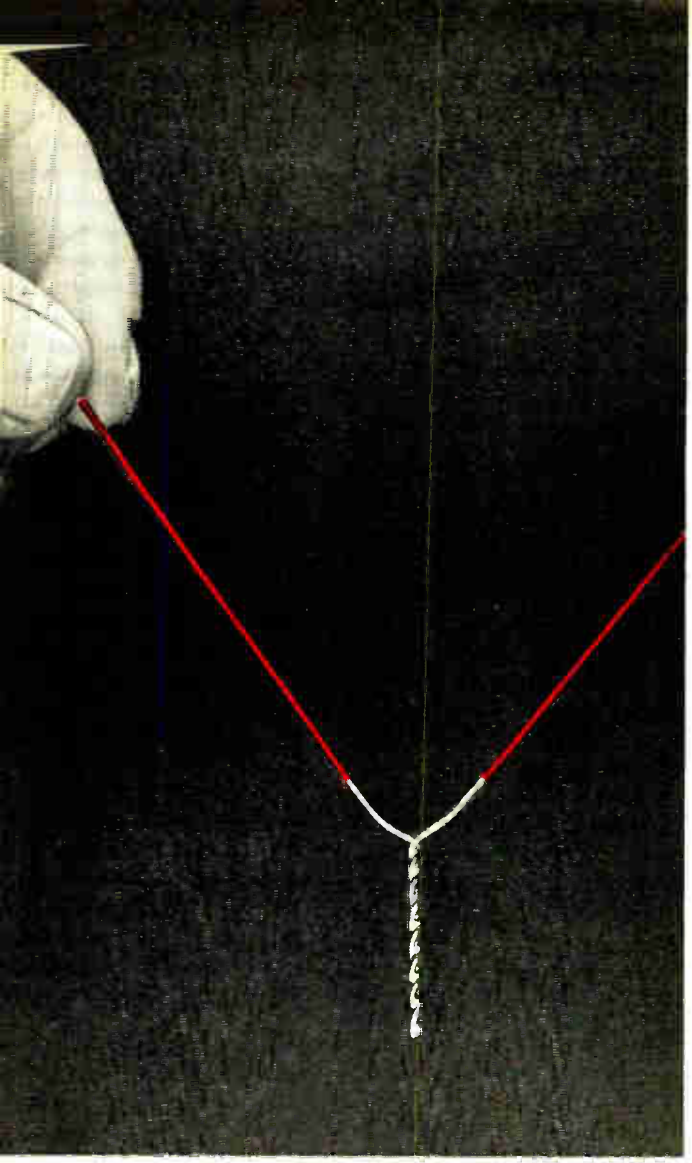
(Standard & Poor's)	July 29, 1959	July 1, 1959	Change From One Year Ago
Electronic mfrs.	98.56	100.02	+75.3%
Radio & tv mfrs.	116.42	115.26	+130.1%
Broadcasters	103.36	104.75	+66.2%



TWIST WIRES . . .



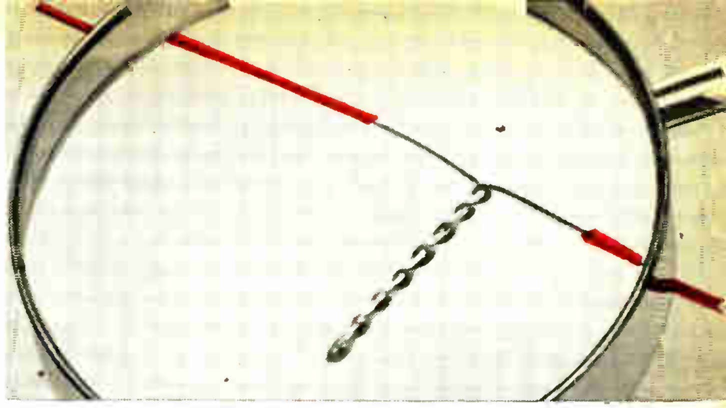
DIP IN SOLDER . . .



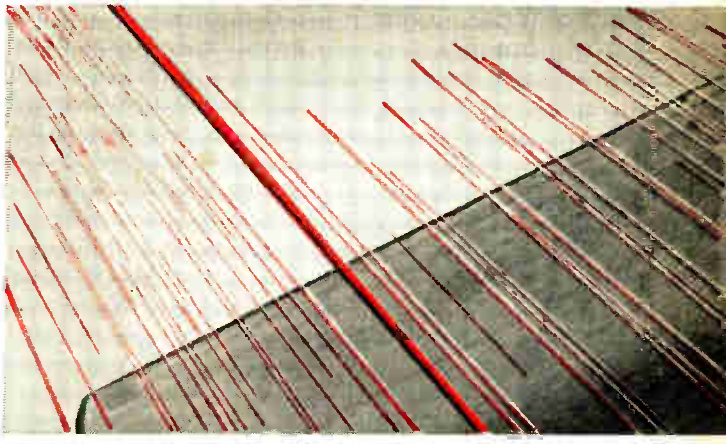
OINT IS COMPLETED WITHOUT TRIPPING WIRE with Analac wire dipped in 50-50 tin-lead solder at 360° C (680° F). The insulation is moved at the temperature of molten solder.

Analac...

:osts for many industries



1. **STRONG JOINTS**—as strong as the same joints made in bare copper wire—are produced. Here in laboratory test, joint holds under high stress.



2. **EXCELLENT ABRASION RESISTANCE** of Analac is shown in this test. It has the same high windability normally associated with Formvar, Plain Enamel.

3. **MOLDED-PLASTIC CASES** — designed and developed by Anaconda—protect spools of Analac from damage during shipping. Result: no breaks due to bent spools.

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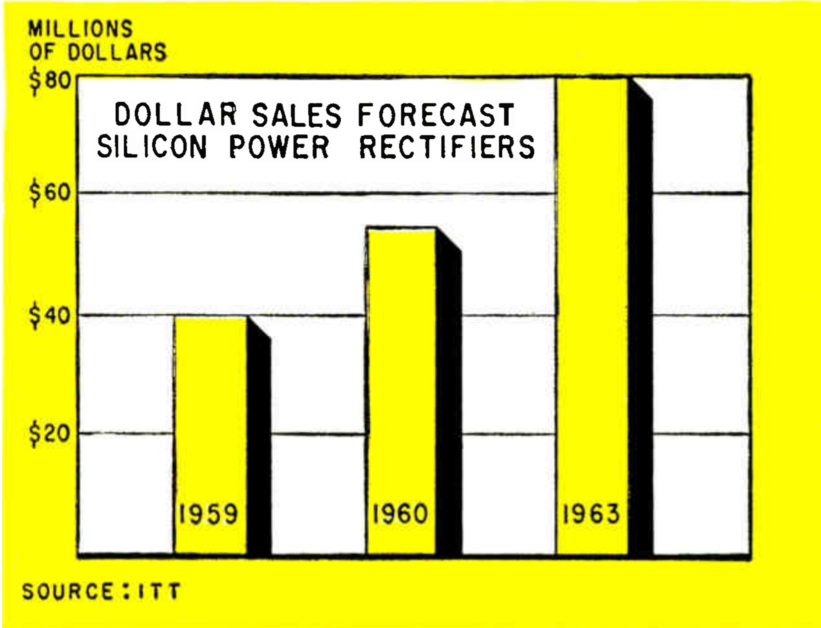


Silicon Rectifier Sales Up 35%

SILICON POWER RECTIFIER sales this year should hit the $40-million sales mark, a gain of 35 to 40 percent over sales of $25 to $26 million in 1958, says Paul Petrack, silicon products manager for ITT Components division.

In units, the volume forecast for 1959 is 15 million, which compares with sales of 8 to 10 million units in 1958.

Estimates include only silicon rectifiers with 100 milliamp ratings or higher. All glass diodes and zener diodes are excluded.

By 1960 dollar sales should rise to $55 million, says Petrack. His rough estimate for 1963 is $80 million. Unit estimates for these years are 25 million in 1960 and 35 million in 1963.

Above forecasts are based on investigations made by ITT. The investigations did not include the big market for silicon power rectifiers which is developing among automobile manufacturers.

It is expected the automobile industry, which has started to shift from d-c generators to alternator-rectifiers for power generation, will buy an additional $3 to $6 million worth of the rectifiers by 1961-1962.

Sales to industrial users take about 50 percent of the dollar market at present, says Petrack. Remainder is divided between military product users—40 percent—and entertainment product users.

Industrial portion of the market should be still larger in next few years, Petrack says.

Growth in use of electric power by industry and greater industrial use of electronic equipment are general factors behind the optimistic industrial business outlook. Among the specific factors are the developments in the automobile industry and trends toward use of d-c motors and electronic machine tools.

Other factors behind Petrack's forecast for rapidly rising silicon power rectifier sales, include the general growth of the electronic industry and the electronic components business, expectation of greater use of the rectifiers by the military for radar and other military equipment, plus expansion of sales to manufacturers of tv and radio sets.

FIGURES OF THE WEEK

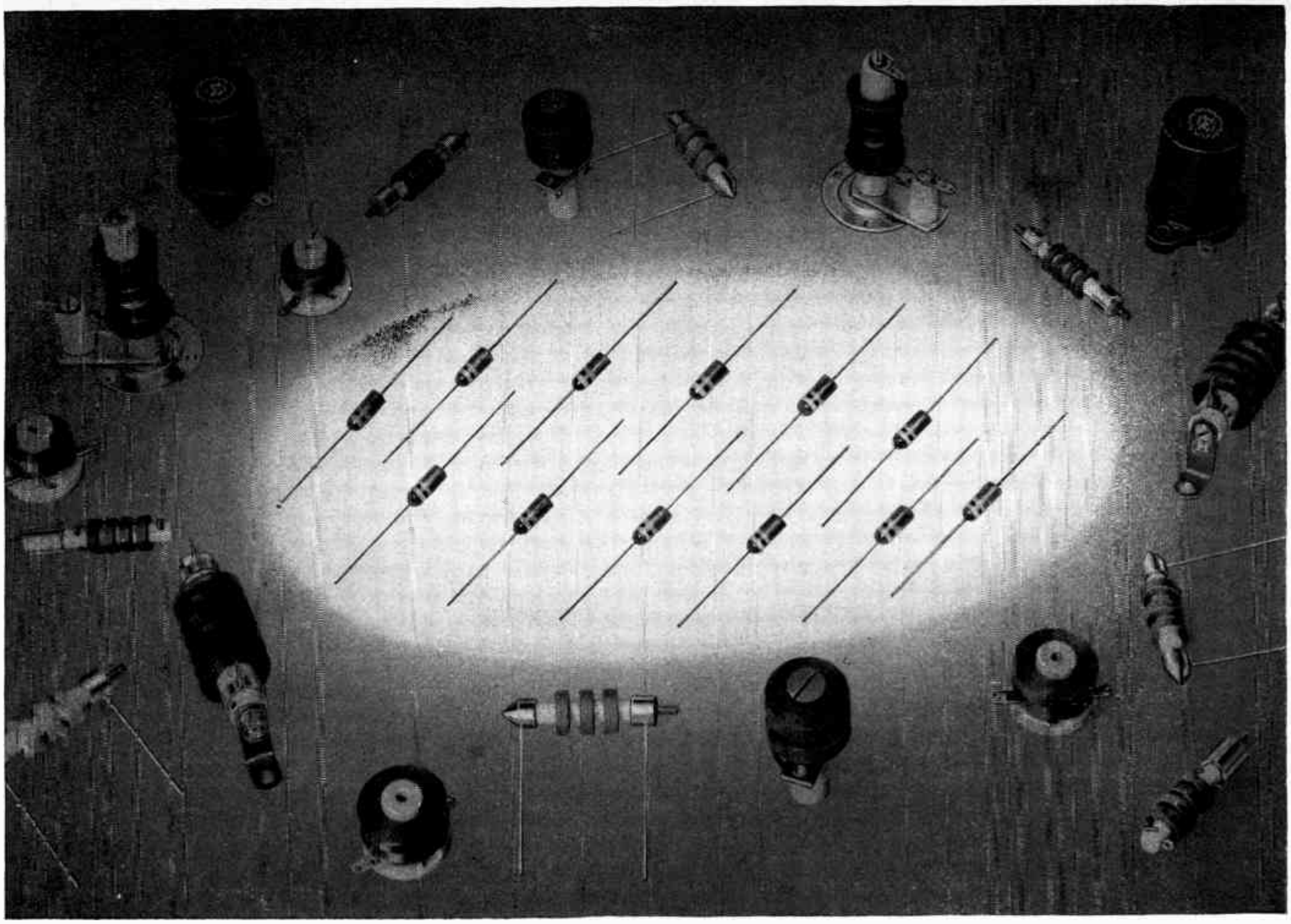
LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	July 24, 1959	June 26, 1959	Change From One Year Ago
Television sets	98,447	110,300	+63.6%
Radio sets, total	240,644	288,041	+39.0%
Auto sets	77,827	126,022	+42.4%

B.F.Goodrich

... and B.F.Goodrich is selling it ... in the form of microwave absorbent. If you're in the business of space, this is the testing material for you. As you know, the specifications and details are complicated. So why not ask for *all* the information? Write for free booklet to The B.F.Goodrich Company, 586 Derby Place, Shelton, Connecticut.

B.F.Goodrich ***microwave absorbents***



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

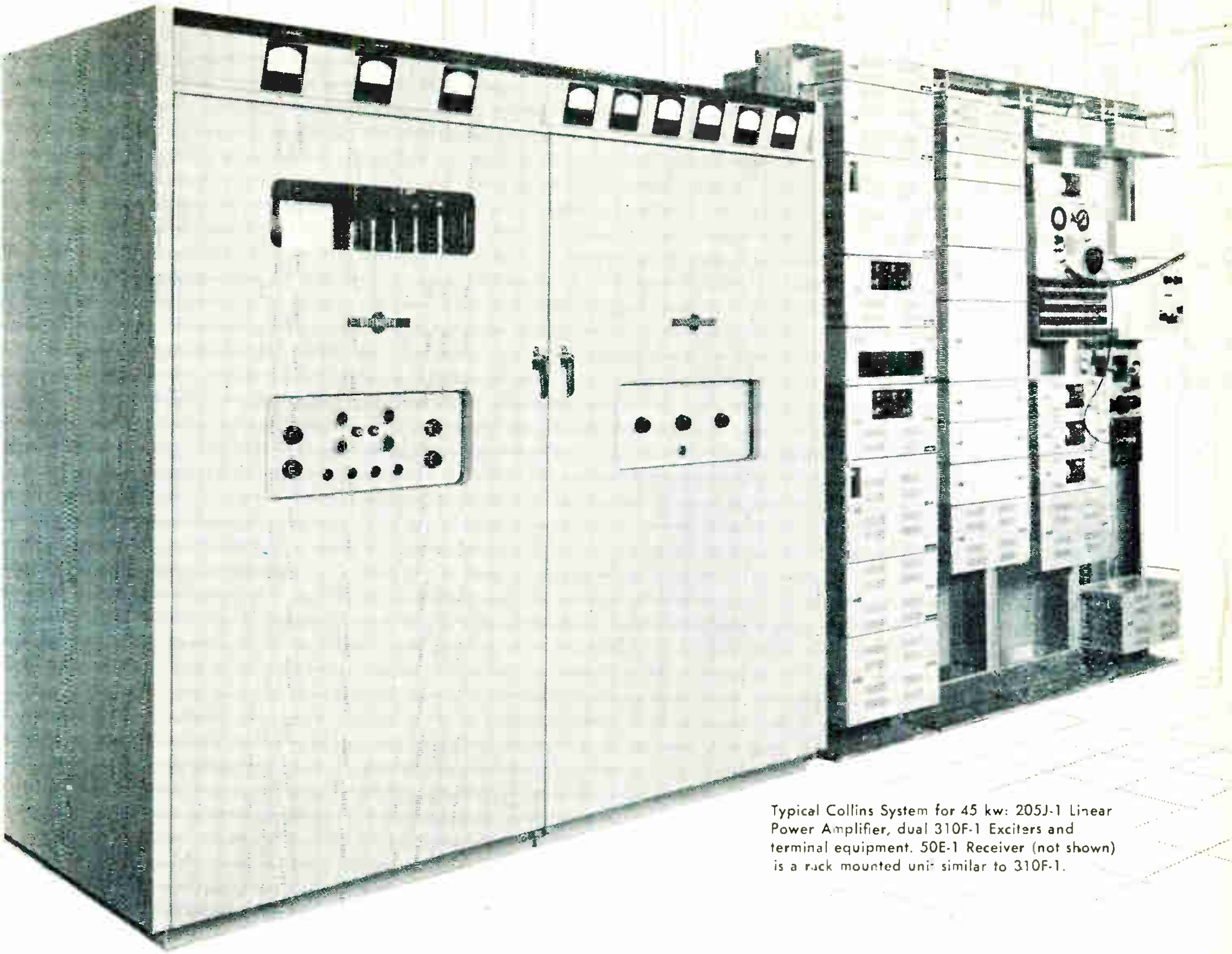
Encapsulated DESIGNED for APPLICATION axial lead phenolic form r-f inductances. Hermetically sealed—heat resistant—abrasion proof—color coded. 1 to 350 microhenries available in RETMA standard values plus 25, 50, 150, 250, and 350 microhenries. Inductance ± 5%. Values available in same progression as 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.



Typical Collins System for 45 kw: 205J-1 Linear Power Amplifier, dual 310F-1 Exciters and terminal equipment. 50E-1 Receiver (not shown) is a rack mounted unit similar to 310F-1.

automatic tuning for 45 kw communication stations COLLINS SSB

Stemming from a common heritage of design concepts and engineering standards, Collins single sideband systems range in function from low power, fixed tuned facilities to this automatic 45 kw station. Any frequency in 1 kc steps in the 2 to 29.999 mc range may be selected on a direct reading counter dial. Switching matrices enable local or remote selection of antennas as well.

Nucleus for this station is the 205J-1, a fully automatic 45 kw PEP linear power amplifier. Tuning is completed automatically by servo systems actuated by an error signal derived from phase comparison of input and output signals.

The automatically tuned 310F-1 Exciter generates the sideband signal with a balanced modulator and Mechanical Filter, heterodynes it to the operating frequency and amplifies it to the desired excitation level, using receiving type tubes throughout.

Closely related to the exciter is the 50E-1 Receiver. It uses a Mechanical Filter for narrow bandwidth and sharp skirt attenuation. Frequencies are synthesized by a stabilized master oscillator which is phase locked to an internal frequency standard imparting a stability of 1 part in 10^9 per month. Frequency standards with a stability of 1 part in 10^8 per day are available.

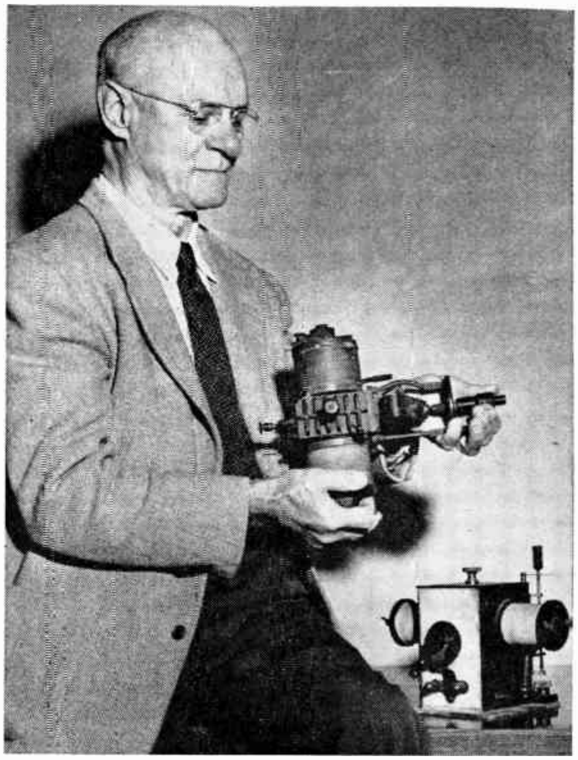
The equipment described is part of the complete Collins line of SSB equipment and accessories. Other equipment can provide from 100 watts to 45 kilowatts output with manual or automatic servo tuning.

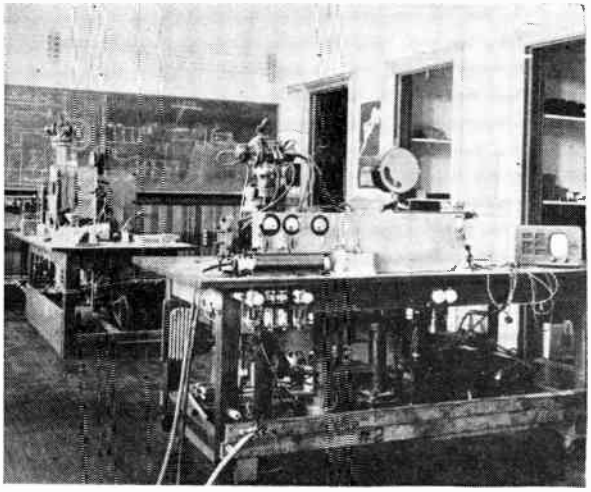
Write for literature or consult your Collins representative for additional technical information.

COLLINS

COLLINS RADIO COMPANY • CEDAR RAPIDS, IOWA • DALLAS, TEXAS • BURBANK, CALIFORNIA

CIRCLE NO. 27 READER SERVICE CARD





Cyril Elwell (left), called founder of electronics industry in San Francisco's peninsula area, holds Poulsen-arc converter he built in Palo Alto 50 years ago. On table: original converter he brought from Denmark in 1909. Photo above: Stanford University lab where Hansen, Ginzton, the Varians and others worked in late '30s

San Francisco's 50-Year Story

By **EMMET G. CAMERON,** Vice President-General Manager, Varian Associates, Palo Alto, Calif.

FIFTY YEARS AGO the San Francisco Peninsula was a pleasant, sleepy area of farms and orchards. Today it is a humming interurban community of half a million people.

A single industry—electronics—forms the backbone of peninsula economics, and has wrought the change. The industry has over 100 manufacturing and research firms in the area, doing an annual business in the neighborhood of $400-million, furnishing the livelihood for about 30,000 of the area's young families.

Three Events

Of the many actions and events in San Francisco's story, three stand out because of their powerful impact.

The first occurred at Palo Alto on Oct. 1, 1891, when Stanford University installed its first president, David Starr Jordan. The policies of this great educator created the atmosphere in which electronics later grew.

Twenty years later, in the summer of 1912, three men named de Forest, Van Etten and Logwood leaned over a table in a house in Palo Alto watching a fly walk across a sheet of paper. They were listening to the fly's footsteps, tremendously amplified. It was the first time anywhere that a vacuum tube amplified a signal, and more than any other event this was the birth of electronics.

In July of 1937, also in Palo Alto, a young physicist named Russell Varian was classifying ideas for a tube to work at centimeter wave lengths. As he worked, the idea came to him for a control principle that fitted none of his categories—the principle of velocity modulation of electrons.

World Leader

David S. Jordan brought to Stanford a group of outstanding teachers, many from Cornell. Among these was Harris Ryan, whose name lives in the Ryan High-Voltage Lab.

The presence of these men attracted outstanding students to Stanford. Their leadership inspired the young men to strike out on their own. Cyril Elwell, one of the early students, was destined to be the actual founder of the industry in the area.

Elwell, an American raised in Australia, came to Palo Alto in 1902 to study at Stanford. In 1908 he was persuaded by Ryan to work on a damped-wave radio system invented by Ignatius McCarty of San Francisco. After a year of work, Elwell saw that only c-w radio would provide adequate quality. He moved to acquire the U. S. rights to the Poulsen arc system, invented in Denmark by Valdemar Poulsen in 1903.

With these rights, Elwell founded the Poulsen Wireless Telephone & Telegraph Co., which became the Federal Telegraph Co., forerunner of Federal Telephone & Radio, now the American manufacturing arm of ITT.

Elwell's new company boomed. In 1912, Elwell hired a group of men almost all of whom are revered today as true pioneers of the industry. These included Lee de Forest, Charles Logwood, Herb Van Etten, Doug Perham, Leonard Fuller, Ed Pridham and Peter Jensen.

Pridham and Jensen left Federal Telegraph to invent the moving-coil loudspeaker and found the Magnavox Company. Later Jensen founded the loudspeaker company which bears his name.

In the early '20s the Stanford labs trained another generation of men destined for industry leadership. Four of these, among many of note, were Fred Terman, Ralph Heintz, Herbert Hoover, Jr., and Charles V. Litton.

Radio Pioneers

After graduation from Stanford, Ralph Heintz founded with Jack Kaufman, a University of California engineer, the firm of Heintz & Kaufman, Ltd., which for many years pioneered in short-wave radio developments. When World War II came he founded, with Bill Jack, the Jack & Heintz Company to manufacture electrical equipment for U. S. aircraft. Ralph Heintz now operates a private research laboratory in Los Gatos.

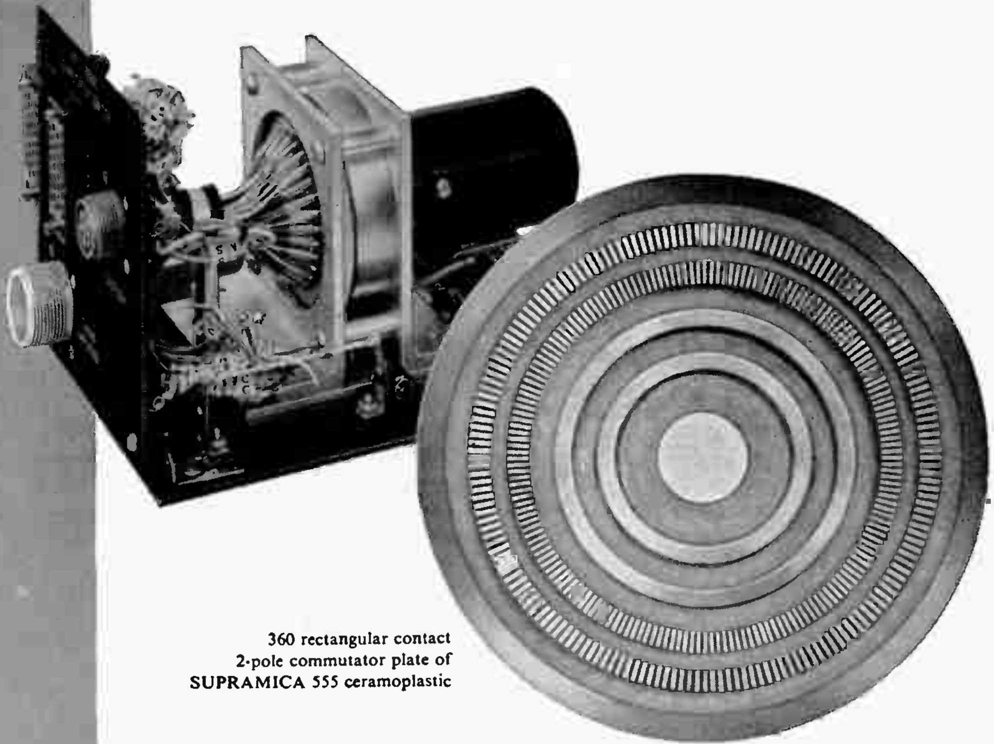
Heintz & Kaufman, Ltd. began the manufacture of large vacuum tubes for radio transmitters in 1931. Two of the men employed in this operation, Bill Eitel and Jack McCullough, left in 1936 to found (in a vacant butcher-shop) their own company. Eitel-McCullough, Inc. (or "Eimac") now has plants in San Bruno and Belmont.

Charles Litton became the leader in the vacuum-tube activities of Federal Telegraph, designing and developing many tubes as well as basic tube-manufacturing processes and equipment which affected the entire industry. When in 1931 Federal Telegraph was moved from Palo Alto to New Jersey, Litton stayed on the Peninsula to found Litton Engineering Laboratories and later Litton Industries. Charles Litton still operates the Laboratories, now in Grass Valley, Calif., while through a series of mergers Litton Industries, now headed by Tex Thornton, has be-

(Continued on p 33)

major advance in miniaturization:

SUPRAMICA® 555 commutator plates



360 rectangular contact
2-pole commutator plate of
SUPRAMICA 555 ceramoplastic

on a 3 inch precision-molded plate ...up to 540 rectangular contacts!

Since 1948 . . . when Mycalex Electronics Corporation pioneered the first *precision-molded* MYCALEX® 410 glass-bonded mica, 180-contact commutator plate . . . MYCALEX switches have introduced a degree of accuracy and dependability never before approached in mechanical switching.

And now, Mycalex offers a *new* ceramoplastic commutator plate design destined to set *even higher* standards for long-life, low-noise-level multiplexing.

Typical of these new plates is the CP 427. Its specifications call for *precision-molded* SUPRAMICA 555 ceramoplastic which delivers total dimensional stability as well as superb thermal endurance (700°F.). The individual contacts of this plate have an exclusive *rectangular* form and embody tolerances within the .0005″ range. They are permanently fixed in place.

An exclusive brush-holder design permits *lower pressures* on the wipers . . . gives *lower contact resistance* with a noise level of *less than 10 microvolts*. Brush bounce is eliminated and life greatly extended. MYCALEX switches using this type of design have been tested satisfactorily for over 1000 hours at 600 RPM without maintenance.

Information on complete MYCALEX switches or matched brush assemblies and plates is available.

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SEE OUR NEWEST PRODUCTS BOOTH 1003-1005 WESCON '59

POWER

handling capacity of the new Westinghouse Silicon

POWER

transistor!

Greater than 99% efficiency when used to handle 1.5 kw of power in a low-frequency DC switch! Power loss is only 10-15 watts when handling 1.5 kw. That's just one of the impressive specifications established by a remarkable new semiconductor device—the Westinghouse Silicon Power Transistor.

This Power Transistor is remarkable in other ways, too . . .

- It is the first power transistor available in voltage ranges above 100 volts.
- It has power dissipation capability of 150 watts made possible by the low thermal resistance of .7°C/watt.
- It can operate at higher temperatures than germanium (150°C., compared to 85°C).
- It has astonishingly low saturation resistance—less than .5 ohms at 5 amperes and .75 ohms at 2 amperes, an achievement made possible through extensive research and development of hyper-pure Siemens-Westinghouse Silicon.
- It is 100% power-tested under actual maximum rated specifications before leaving the plant.
- It is encapsulated in a rugged, all-welded case.

HERE ARE A FEW OF THE APPLICATIONS . . .

• Inverters and converters • Data processing circuits • Servo output circuits • Series regulated power supplies • As a low frequency switch • In class A amplifiers.

Available in 2 and 5 ampere collector ratings in production quantities now. For complete specifications and details, contact your local Westinghouse representative.

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

Westinghouse Electric Corporation, Semiconductor Department Youngwood, Pa.

San Francisco . . .

(Continued from p 29)

come one of the larger electronics companies in the country.

Bill Hewlett and Dave Packard were two products of Stanford's "communications laboratory" in the attic above Dr. Ryan's office on the campus. Under Fred Terman this lab became a center of electronics developments, and one of the inventions accomplished here was Bill Hewlett's resistance-tuned oscillator. This instrument was the first product of the company which Hewlett and Packard founded in 1938.

Gets World Fame

In the late thirties another of the real giants of the industry began his work in Stanford's Physics Laboratories. This was Dr. William Webster Hansen, who in his short lifetime was to collaborate in three major developments.

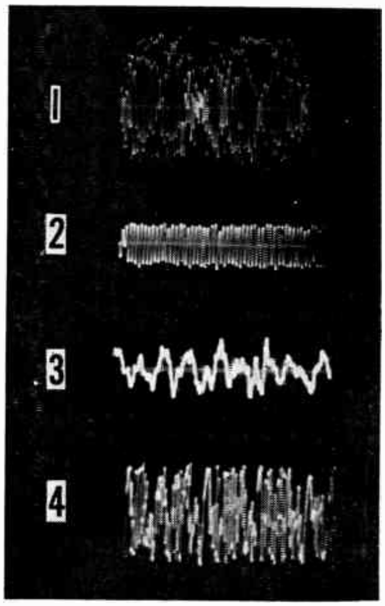
Dr. Hansen worked with the Varian brothers on the invention of the Klystron, was co-inventor with Dr. Felix Bloch of nuclear magnetic resonance apparatus, and in 1947 with Dr. Edward Ginzton developed the first of Stanford's linear accelerators. Peninsula electronics men continue to found new companies which combine technical accomplishment with economic success. In 1948 the Varian brothers founded Varian Associates, now a major area manufacturer.

Many of the electronics companies founded in the area are well-known all over the world. Ampex, famous for its videotape gear, was founded in 1944 by Alexander M. Poniatoff in San Carlos. Lenkurt was founded by Len Erickson and Kurt Apperson to develop and build radio systems for telephone communications, is now part of the General Telephone family. Dalmo-Victor, founded by T. J. Moseley, has become a major manufacturer of airborne antennas.

Besides home-grown companies, the Peninsula has in recent years begun to attract "outposts" from some of the giants of the electronics industry. These firms move West to tap the talent in the Bay area, stay to confirm its phenonenal success story.

New Radar Tells Target's Sex

Army is buying 3 highly-sensitive combat surveillance radars for seeing and hearing at night



Video presentations of moving targets picked up by Hazeltine's new Army combat surveillance radar show (1) a train, (2) automobile, (3) walking man and (4) walking girl. Difference is caused by Doppler effect

RADAR THAT CAN distinguish between a man and a woman a mile away (by the shorter, quicker steps taken by a woman wearing a skirt) is one of three new combat surveillance radar systems soon going to the Army.

Consisting of short, medium and long range units, the three sets together can monitor a battle area up to a distance of 20,000 meters, during darkness or fog.

Improved Version

The short-range, 5,000-meter unit is Sperry's AN/PPS-4, an improved version of the Army's "Silent Sentry." It is being produced for evaluation under a $3.5-million follow-on contract.

Switching from tubes to transistors in the new version reduced by half the set's power requirements, making it possible to use a battery in place of a gasoline generator. The system has no moving parts and no fuel problems. No scope is used with the system. Returned signals are auditory only. Range, azimuth and elevation data are accurate within 25 yards. A moving man can be detected at a half mile.

Army's medium-range, 10,000-meter radar, designated the AN/TPS-21, is under development by Hoffman. Originally developed under a Navy contract, the equipment is being bought by the Army. New sets will provide both video and audio presentations.

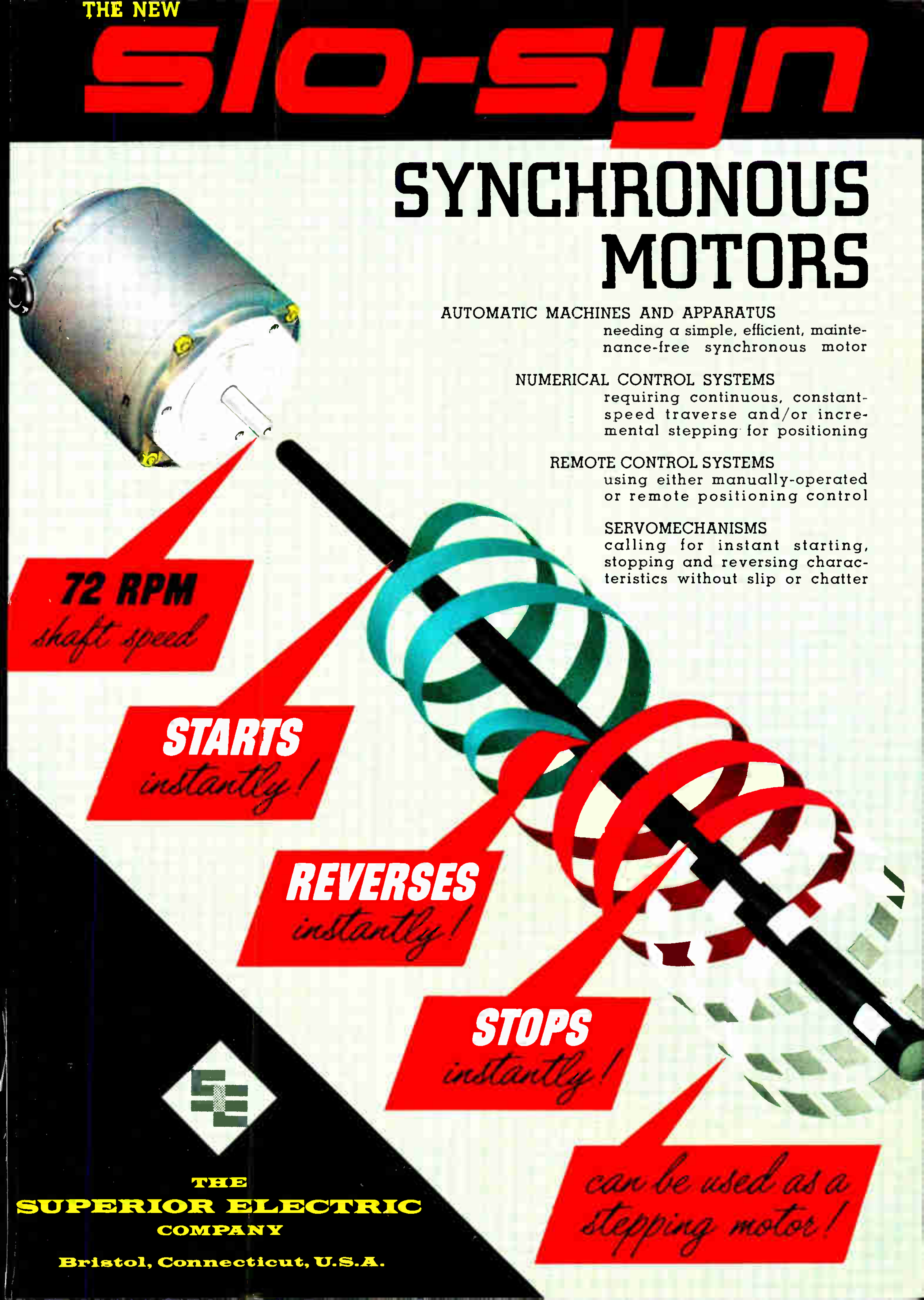
Long-range, 20,000-meter unit, designated the AN/TPS-25, is being produced by Hazeltine under a new $2-million contract. Previous contracts for development and prototypes amounted to $4 million. In addition to distinguishing between a man and a woman at one mile, the unit can make out the difference between a moving man and a moving vehicle at 10,000 meters, and can determine the speed and direction of moving vehicles at 20,000 meters.

Using pulsed radar, presentation of the returned signal is both audio and visual. Because of Doppler effect, the sounds heard through the set's loudspeaker reveal the nature of the target. The steady whining of a moving vehicle is different from the more erratic sound bounced back from the knees of a walking man.

Starts Tracking

Antenna's azimuth during search is ten degrees. Once moving target is picked up, the azimuth is cut down to two degrees for tracking. If range of the object is determined to be 9,000 meters, the field of focus is gated for between 8,500 and 9,500 meters. All objects within this area (2-deg arc and 1,000-meter depth) return signals. Echoes from the moving object stand out against the stationary background clutter due to Doppler effect—there is a 30-cycle difference for every 1 mph of motion.

Sperry's PPS-4 and Hazeltine's TPS-25 were recently displayed for the first time at the Association of the U. S. Army's annual meeting in Washington.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AUTOMATIC MACHINES AND APPARATUS
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requiring continuous, constant-speed traverse and/or incremental stepping for positioning
REMOTE CONTROL SYSTEMS
using either manually-operated or remote positioning control
SERVOMECHANISMS
calling for instant starting, stopping and reversing characteristics without slip or chatter
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STARTS instantly!
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can be used as a stepping motor!
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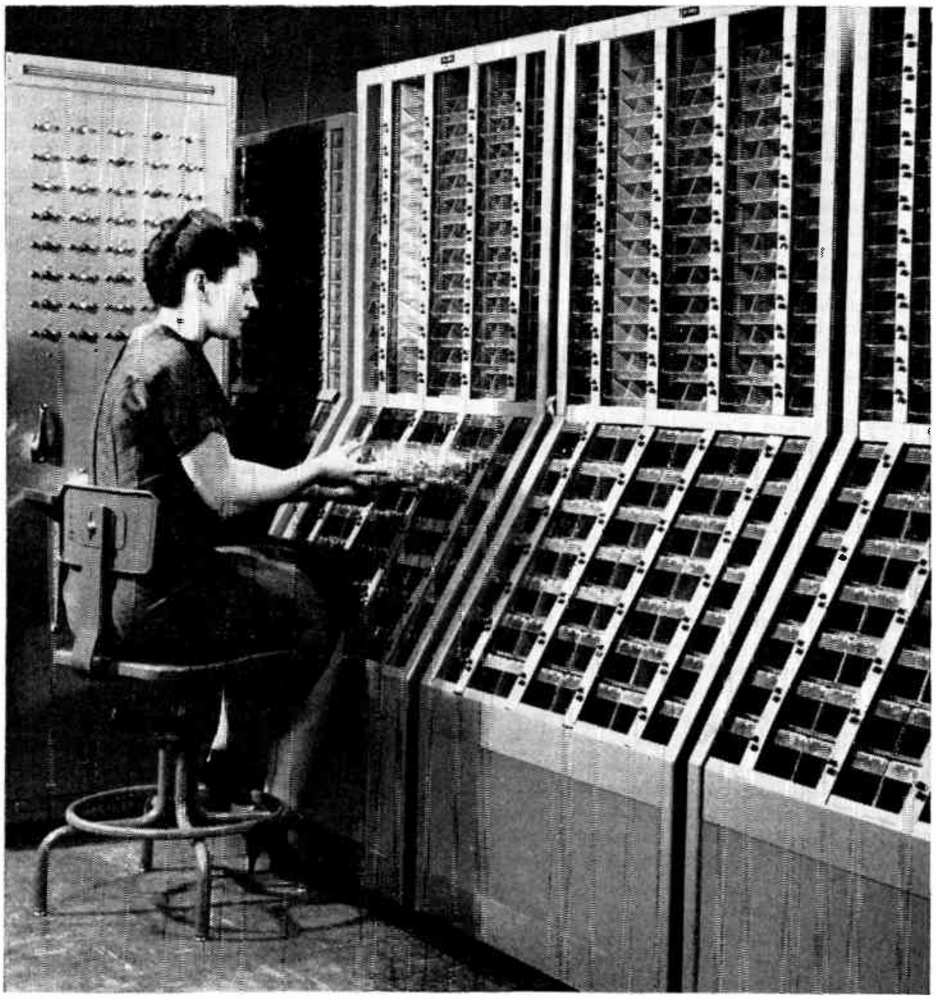

News from Raytheon's Semiconductor Division...

AUTOMATIC TESTING—

The operator is testing Raytheon semiconductor products at one of the new automatic test sets. This equipment, designed by Raytheon engineers, checks and classifies transistors according to the several hundred possible combinations of test parameters —including emitter and collector current cutoff, frequency cutoff, a-c beta, d-c beta, breakdown voltages, input voltage, collector capacitance, extrinsic base resistance and gain.

POSITIONS FOR MEN WHO ARE GROWING FASTER THAN THEIR ASSOCIATES

If you have applicable experience in any of the following areas and want to learn more about Raytheon's semiconductor opportunities, please use the attached coupon.

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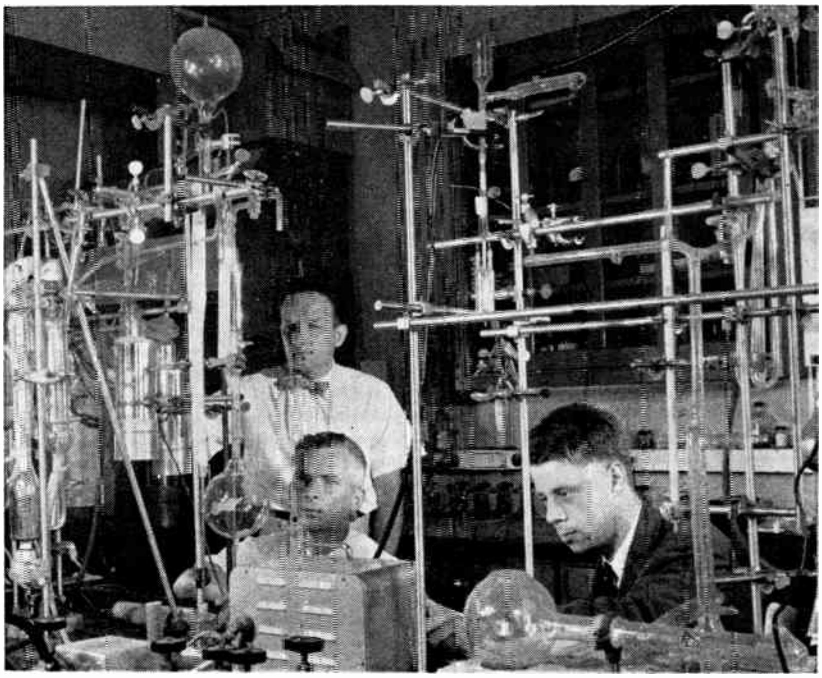
←CIRCLE NO. 36 READER SERVICE CARD



Semiconductor research intrigues skilled men at Bell Telephone Laboratories

What Role for Basic Research?

In our industry basic research need not involve a large program. It can have a limited objective

THE TRANSISTORS, masers and mavars of tomorrow will come out of today's basic research programs.

Who will cash in on these yet undiscovered products of tomorrow? Giant firms employ thousand-man staffs constantly on "fishing" expeditions. Does this cut the smaller firm out of new proprietary products?

Not so, say several industrial research directors. The smaller firm can run an effective basic research program with limited objectives.

The role of basic research among government, industry and university scientists and administrators was highlighted recently by the Symposium on Basic Research at the Rockefeller Institute.

Who's Researching

It's generally conceded that basic research in physical science, as a continuing effort within the electronics industry, is carried on by only the oldest research laboratories associated with the largest corporate enterprises. The others cannot afford to underwrite full-time research that is not clearly related to a practical end.

Peter C. Goldmark, president and director of research of CBS Laboratories, Stamford, Conn., tells ELECTRONICS that basic research today really works for industry in two ways: (1) The by-products of basic work in many government, university and industry labs help the whole industry. (2) A single company's broad objectives may be implemented by a program that includes basic research.

To some, a scientist is not a basic research man unless he is free to ask all of his own questions. But a more liberal definition is sometimes accepted by industry.

This is the concept of a limited objective assigned to a scientist in the form of a fundamental question about nature; the question seems worth asking the scientists on the chance that, if he can answer it, the knowledge can be applied to a broader objective.

In such a case, Goldmark says,

the basic researcher should be completely removed from the practical aspects of the program. The limited objective—to satisfy a curiosity—may involve a hope but not an expectation, of acquiring some knowledge that will be useful.

One Example

Goldmark cites the research connected with the depositing of iron oxides on thin plastic film which culminated in today's magnetic tape. Although the technique was probably accomplished with an object in mind, there must have been more limited objectives that were previously assigned to physicists and chemists.

Even though they may follow the concept of a limited objective for a fundamental scientist many research directors do not think in terms of the label, "basic research." They see fundamental studies and applied research as too intermingled to sort out.

Radioastronomy is an example of a whole science that crossed over from basic to applied research, Goldmark points out. At one time men studied it with no earthly motives; now it's part of applied space research.

Another research director, commenting on the overlapping of basic and applied research in industry, says that applied research is sometimes underrated by both the public and by scientists. This, he attributes to an aura of glamor which has come to surround famous names in basic research.

Critical Questions

He said that trying to understand nature by first asking a critical question of it, and then finding the answer, was essential to scientific progress, but that there are comparatively few scientists today who are mature enough to ask so critical a question that a great discovery will be produced. Of those that have such maturity, he said, there are few to go around in our industry or any other.

For this reason, he says, the electronics industry does not employ many researchers who stake out their own ends and regard practical possibilities as by-products or accidents.

From Technical Breakthrough **to Reliable Production** [redacted]

CARCINOTRONS*®

Backward Wave Oscillators have now attained the full cycle of the capability associated with all CSF products. This cycle, beginning with the pioneering research and development has led to the largest frequency coverage in Carcinotrons, is now completed with the reliable full scale production of these tubes.

Electronically tunable, the Carcinotron tube permits the largest range of uninterrupted tuning ever achieved by a single tube. Latest developments in CSF CW Carcinotrons include:

- ▶ milliwatts at 2 m/m wavelength
- ▶ watt at 4 m/m wavelength
- ▶ 10 watts at 8 m/m wavelength
- ▶ 5 kilowatts at 1 m wavelength

A partial listing is shown below of current CSF production of type "O" Carcinotrons, which have a complete coverage from 1 to 100 kMcs.

CO 515	980 – 2100 Mcs.
CO 521	8000 – 16,000 Mcs.
CO 2012 A	15,500 – 24,000 Mcs.
CO 1308 A	23,500 – 37,500 Mcs.

Current production of "M" type Carcinotrons between 1 and 10.5 kMcs includes:

CM 5200	1200 – 1500 Mcs	500 W Cw min
CM 440	2700 – 3400 Mcs	500 W Cw min
CM 7060A	3200 – 4000 Mcs	200 W Cw min
CM 730	8500 – 10,500 Mcs	80 W Cw min

American Radio welcomes inquiries about special development for particular needs.

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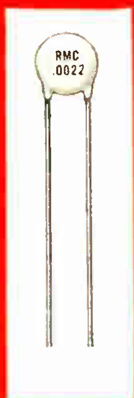
CIRCLE NO. 40 READER SERVICE CARD

Check RMC for your needs in ceramic capacitors

RMC DISCAPS

Type JL

RMC Type JL DISCAPS are engineered for applications requiring a minimum of capacity change as temperature varies between −60°C and +110°C. Over this wide range the capacity change of type JL DISCAPS is only ±7.5% of capacity at 25°C. Standard working voltage is 1000 V.D.C.

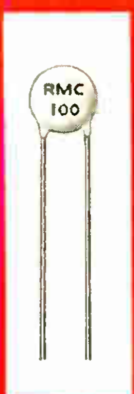


Type B

Designed for by-passing, coupling or filtering applications, Type B DISCAPS meet and exceed all E.I.A. RS198 specifications for Z5U ceramic capacitors. Type B DISCAPS are manufactured in capacities between .00015 MFD and .04 MFD and one rated at 1000 working volts.

Type JF

Type JF DISCAPS exhibit a frequency stability characteristic that is superior to similar types. These DISCAPS show a change of only ±7.5% over the range between +10°C and +85°C. These DISCAPS extend the available capacity range of the E.I.A. Z5F ceramic capacitor between +10°C and +85°C and meet all Y5S specifications between −30°C and +85°C.



Type C

Specifications of E.I.A.-RS198 are met or exceeded by these temperature compensating DISCAPS. Smaller sizes are well suited to designs where space is at a premium. Type C DISCAPS are rated at 1000 working volts providing a higher safety factor.

Type SM

Where space is at a premium, Type SM DISCAPS can be specified with complete assurance of the quality, dependability, and electrical performance built in all RMC DISCAPS. SM DISCAPS show minimum capacity change between +10°C and +65°C.

FIN-LOCK DISCAPS

Designed for holes from .040 to .052 "Fin-Lock" DISCAPS are automatically stopped in holes over .052 by the shoulder design of the leads. "Fin-Lock" leads permit either automatic or hand assembly. "Fin-Lock" leads are available on all DISCAPS of standard voltages, ratings and spacings at no increase in price.

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CIRCLE NO. 41 READER SERVICE CARD

West's Growth Speeds Up

Centers sprout as east, west companies open branches in Arizona, Utah, Colorado, New Mexico

SAN FRANCISCO—Wescon won't be the only topic here next week.

Sure to be discussed plenty are four inland western states, Arizona, Utah, Colorado and New Mexico.

Five years ago electronics was almost nonexistent in them. Today it's spreading faster than sagebrush—and far more profitably.

Companies headquartered along the Pacific, and an increasing number of Eastern firms, are locating branch operations in Arizona, Utah, Colorado, and New Mexico.

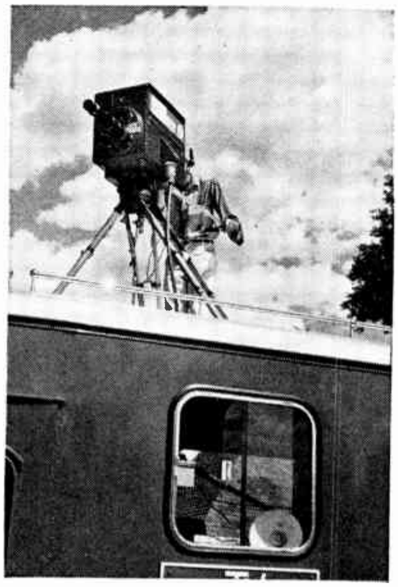
Climate, living conditions, and recreation facilities have attracted many new firms and technical personnel to the West, as have electronic markets springing up in the West. The chance for association with universities and research institutes is another attraction.

The Los Angeles-Orange County area continues to be the largest center of electronics in the West with a gross sales volume of $1.157 billion estimated for 1959. By year's end it is predicted that 84,000 people will be employed.

Second largest center is the San Francisco Bay area with figures slightly less than half those of the southern complex, but with a higher growth rate.

This year's outlook for the Portland-Seattle area is approximately $70 million in business. Tying for fourth place are the San Diego County and Phoenix-Tucson areas, with an estimated $62 million each during '59. The greater Denver area is expected to do close to $42 million.

Tv Tape Goes Mobile



INDICATION of the growing impact of tv tape on station operations is evident in the attention being paid to mobile tape units.

In the photo, a unit belonging to Giantview Tv, Detroit, is shown. First placed in operation last month, the gear is designed for shooting taped commercials and features on location. Expected customers include advertisers, tv stations and film producers.

The van-mounted equipment includes an Ampex recorder, four pickup cameras, camera chain equipment plus power supplies and auxiliary gear.

Earlier this year, Ampex equipped a mobile unit for company use containing two camera chains. The gear in this van can be operated while the vehicle is in motion as well as when it is parked. It can also be tied into tv studio facilities for interior recording. The 35-ft van is 10 ft high, 8 ft wide. It weighs about 10 tons loaded.

In the New York area, a double unit has been outfitted by RCA for Termini Video Tape Services. One van contains the recording gear, while a second holds the camera equipment.

Television station WFLA, Tampa, Fla., has expanded its facilities by purchase of a mobile tape unit. A second station, WPST, Miami, has also announced purchase of a unit.

CIRCLE NO. 45 READER SERVICE CARD→

A VITAL 100 MINUTES!

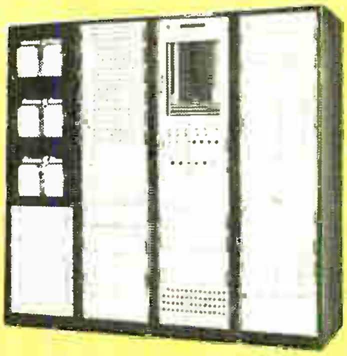
Firing Sequencer with 762 CLARE RELAYS gives automatic control

Automatic control of the countdown at the Air Force's Cape Canaveral Missile Test Center—from X minus 90 minutes to 10 minutes after a missile is fired—is in the hands of a Milgo Model III Sequencer.

The Sequencer, built by Milgo Electronic Corporation, Miami, Fla., automatically controls the myriad operations which must be performed before any missile can be launched. It is preprogrammed to recognize the precise condition that must exist during each of the operations it controls. When any other condition is detected, it will automatically hold fire until the condition is corrected. In a recent instance, it saved a Titan prototype which developed a malfunction after firing but before actual takeoff.

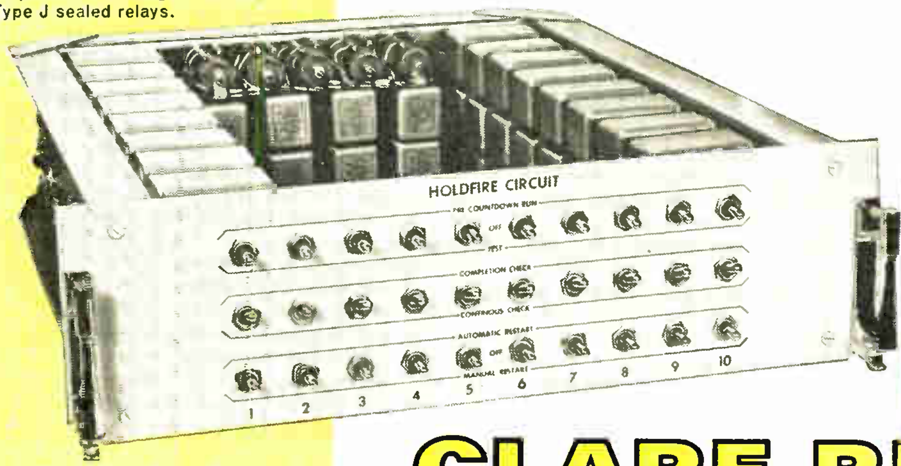
Another of these sequencers is being built by Milgo for installation at the Pacific Missile Range, Vandenberg Air Force Base, Calif.

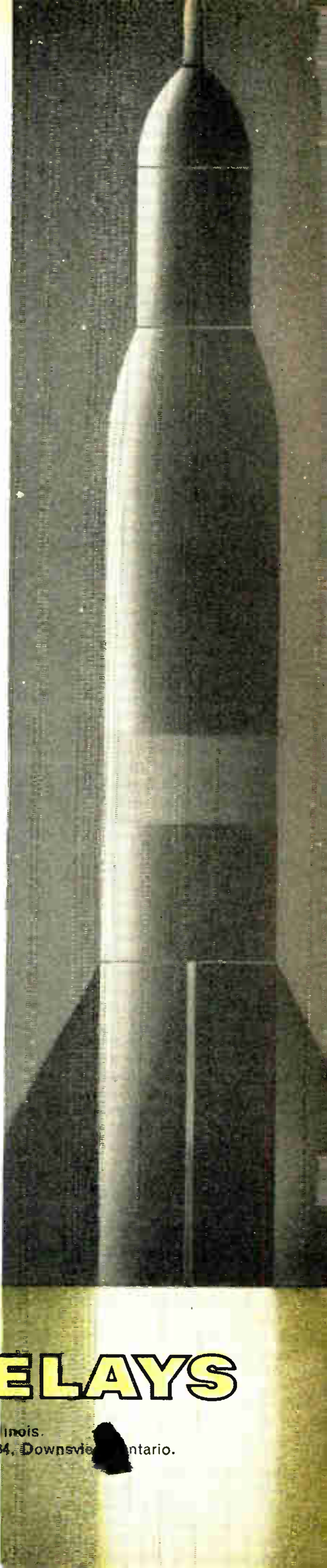
Milgo engineers selected 762 Clare Type J and Type HG Relays for this supremely important device, and not one has ever malfunctioned. Here is convincing proof that, where the safety of personnel and of valuable equipment is at stake and the utmost accuracy is demanded, a designer who rides with Clare relays can rest assured that he has chosen wisely and well,—not necessarily the cheapest relays but certainly the very best.



Front view of Model III Sequencer which uses 762 CLARE Type J Relays and 14 CLARE Type HG Relays. Made by Milgo Electronics Co., Miami, Fla.

View of control rack of Model III Sequencer showing 56 CLARE Type J sealed relays.





CLARE RELAYS

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MEETINGS AHEAD

Aug. 17: Ultrasonics, National Symposium, PGUE of IRE, Stanford Univ., Palo Alto, Calif.

Aug. 18-21: Western Electronics Show and Convention, WESCON, Cow Palace, San Francisco.

Aug. 23-26: Electrical Conf. of the Petroleum Industry, AIEE, Wilton Hotel, Long Beach, Calif.

Aug. 23-Sept. 5: British National Radio & Tv Exhibition, British Radio Industry Council, Earls Court, London.

Aug. 24-26: Gas Dynamics Symposium; Plasma Physics, Magnetogasdynamics; American Rocket Society, Northwestern Univ., Evanston, Ill.

Aug. 24-27: Ballistic Missile and Space Technology, USAF, Space Technology Labs, Inc., Los Angeles.

Aug. 31-Sept. 1: Elemental and Compound Semiconductors, Tech. Conf., AIME, Statler Hotel, Boston.

Aug. 31-Sept. 2: Army-Navy Instrumentation Program, Annual Symposium, Douglas Aircraft and Bell Helicopter, Statler-Hilton, Dallas.

Sept. 1-3: Association for Computing Machinery, National Conf., MIT, Cambridge, Mass.

Sept. 3-6: Air Force Association's National Convention, Exhibition Hall, Miami Beach, Fla.

Sept. 14-16: Quantum Electronics, Resonance Phenomenon, Office of Naval Research, Shawanga Lodge, Bloomingburg, N. Y.

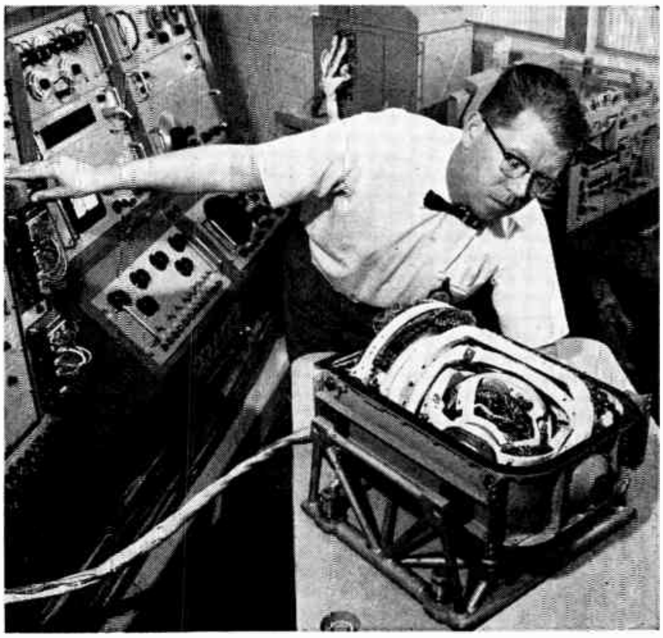
Sept. 17-18: Engineering Writing and Speech, Dual National Symposia, PGEWS of IRE, Sheraton-Plaza, Boston and Ambassador, Los Angeles.

Sept. 21-25: Instrument-Automation Conf. & Exhibit, ISA, International Amphitheater, Chicago.

Oct. 12-15: National Electronics Conference, IRE, AIEE, EIA, SMPTE, Sherman Hotel, Chicago.

Mar. 21-24, 1960: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, N. Y. C.

There's more news in ON the MARKET, PLANTS and PEOPLE, and other departments beginning on p 84.



X-15 instrument panel showing the inertial speed, rate-of-climb and altimeter indicators (grouped at top right of panel)

Checking out the central assembly of the stable platform

Guidance Systems in Manned Space Flight

Conventional reference sensors are impractical at the altitudes and velocities of the planned X-15 flight path. The inertial reference system, including the transistorized integrator amplifier with a gain of a quarter of a million, is described.

By S. T. CAP and N. P. WHITE
Senior Engineer, Engineering Section Head, Sperry Gyroscope Company, Great Neck, N. Y.

MANNED SPACE FLIGHT poses a number of unusual electronics problems. The safe return of the pilot and the X-15 in many ways hinges on the accurate performance of the flight data references. At the altitudes and velocities of the X-15 flight path, conventional reference sensors such as doppler and height radars, machmeters and pressure altimeters are either inaccurate or impractical.

The inertial reference system to be described is completely self-contained requiring no external references or ground links. It consists of a stabilizer, which incorporates a stable platform, a computer and inertial cockpit instrumentation of unique design.

The cockpit instruments include a total velocity indicator, a rate-of-climb indicator and an altitude indicator all giving inertially-derived information. Attitude information from the stabilizer is repeated on the new standard ball indicator of the Air Force integrated flight instrumentation system.

For flight performance evaluation, these data plus all velocity components are supplied to recorders. Information is recorded with a higher degree of ac-

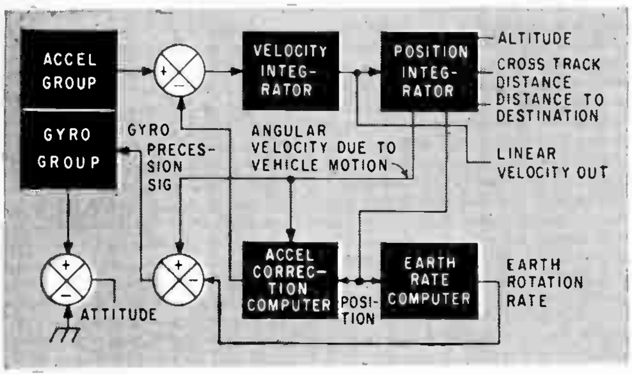


FIG. 1—X-15 inertial system uses two precision accelerometers and two gyroscopes interconnected with precision integrators in a Schuler loop. A third gyro supplies heading reference

curacy than that required for the pilot's display.

In the system shown in Fig. 1, the platform's two precision accelerometers and two gyroscopes are interconnected with precision integrators in a Schuler loop or 84-minute pendulum. This system maintains the vertical direction and provides aircraft velocity outputs. A third gyroscope maintains the heading reference and a third accelerometer provides vertical acceleration information.

INTEGRATORS. The integrators are directly involved in the computations of the output velocities and to a lesser extent in maintaining the vertical directional reference. The accuracy of the accelerometers (0.01 percent of reading) must be preserved by accurate integration.

The integrator shown in Fig. 2, consists of a precision d-c tachometer (.002 percent of reading linearity) driven by a 6-watt a-c servometer which in turn is driven by the integrator amplifier. The amplifier accepts up to eight input signals through a precision (0.005-percent ratio deviation) network and a low-noise chopper modulator.

All computing components have accuracies approaching that of laboratory standards. The integrator amplifier contributes less than 0.01-percent error to the computations.

The integrator amplifier uses ten silicon transistors and has a gain of a quarter of a million. The schematic of the amplifier is shown in Fig. 3. Emitter-follower isolation stage Q_1 is followed by two grounded-emitter, emitter-follower pairs Q_2 through Q_5. Gain stage Q_6 and phase inverting driving stage Q_7 and Q_8 are transformer-coupled to power output transistors Q_9 and Q_{10}. The output transistors are provided with heat sinks.

High amplifier gain produces some problems. For example, if a spurious signal of only microvolt level were picked up at the input, the amplifier would saturate and be rendered inoperative. To avoid such pickup, the input network is shielded by a Mu-metal can grounded to signal ground and an overall steel can grounded to the power ground. A low-noise

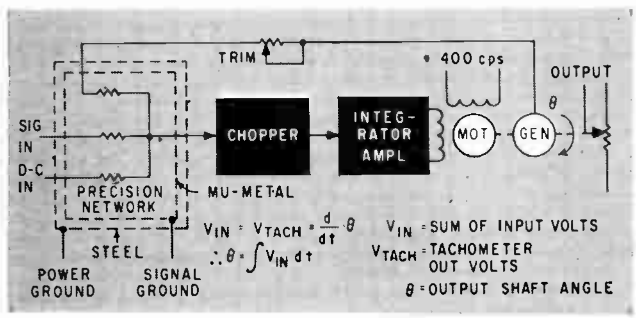


FIG. 2—Precision integrator uses d-c tachometer whose accuracy is 0.002-percent of reading driven by a 6-watt a-c servomotor powered by the integrator amplifier

Schuler Loop

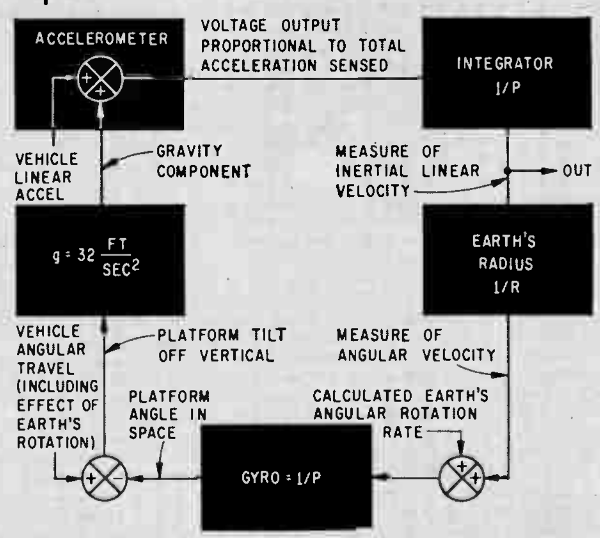
Schuler-tuned pendulum is a term used to describe a system which will maintain a vertical reference direction despite vehicle accelerations with respect to the earth's surface.

In the X-15 inertial reference system, this objective is carried out by precessing the gyros (which determine the platform vertical direction) at an angular rate specified by the integrated accelerometer output. As this rate equals the angular velocity of the vehicle around the earth, the platform vertical direction is thus kept aligned with the true vertical direction.

If an error exists in the pure inertial loop (for example, an erroneous vertical direction or velocity), the error recurs in a cyclic manner with an 84-minute period in the same fashion as a physical pendulum oscillates about the vertical. This gives rise to the name 84-minute pendulum.

The inertial system oscillates when an error is introduced because the gyro-accelerometer combination is a closed feedback loop with two integrations and no damping as illustrated in the attached figure.

The gyro determines the accelerometer angular position and thus cont[illegible]utes to its output since they are both mounted to th[illegible]me structure. The accelerometer responds to both ve[illegible]cceleration and any gravity acceleration component [illegible] due to a tilt from the vertical direction.



The period is 84-minutes because the characteristic equation is $p^2 + g/R = 0$ and the natural period is $2\pi\sqrt{R/g}$ in seconds

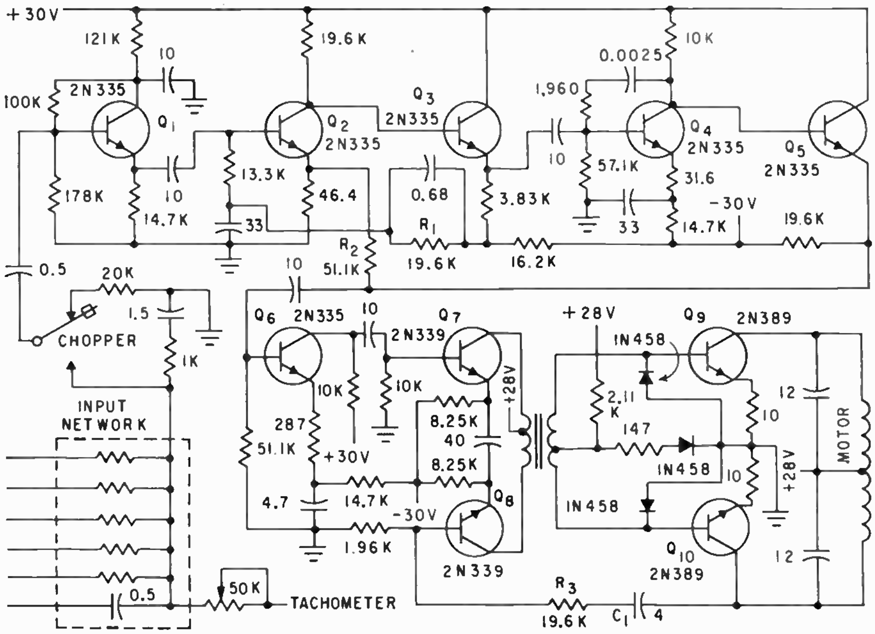


FIG. 3—Integrator amplifier has gain of 250,000 and uses ten silicon transistors in five voltage gain stages

power supply with a ripple of less than 0.01-percent is used.

Transistor bias stabilization is achieved by application of some form of d-c feedback to every stage. All stages have relatively high-impedance emitter resistors bypassed where required. The gain of Q_2 and Q_3 is kept constant by feedback through R_1. The gain of Q_2 through Q_5 is stabilized by feedback from Q_5 to Q_2 through R_2. Feedback through R_3 and C_1 stabilizes the driver-output stage gain. All components are derated at least 2:1. The extremely high loop gain makes the integrator errors due to amplifier gain variation negligible.

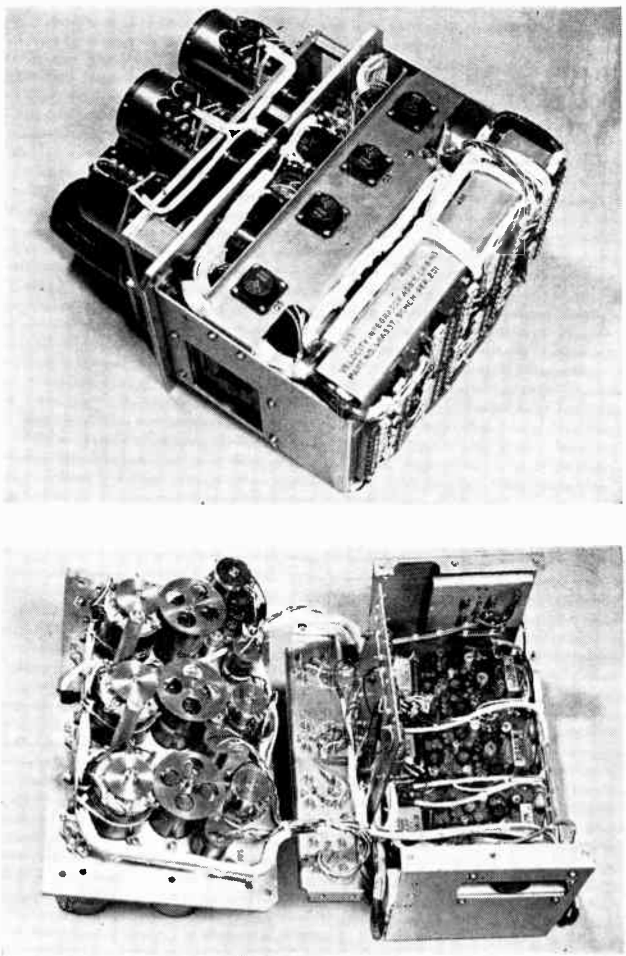


FIG. 4—Assembled integrator package showing wiring arrangement and transistor heat sinks. Three integrators are packaged together

PACKAGING. Components of the amplifier were the smallest available in the tolerances required. The final assembly containing three integrators is shown in Fig. 4. Although component density is high within the integrator, numerous tests points are available.

Components are mounted vertically to conserve space and hand wiring is used throughout, resulting in an amplifier that is appreciably more compact than a printed circuit version. In the final assembly step, a special thermosetting resin was applied to the card assembly forming a high-strength coating that holds the wires and components firmly in place. The completed amplifier is then wired into place on the integrator mechanical assembly to produce the final unitized package.

The amplifiers are only a fraction of the size of the associated electromechanical package so unitized type packaging arrangement is used throughout the entire system. To utilize all available space, amplifiers are designed to fit within the mechanical assemblies. The need for separate space-consuming electronics racks is obviated. Interconnection wiring is at a minimum and many electrical connectors are eliminated. Electrical isolation of computing loops is another feature of this type of packaging.

The authors acknowledge the help of Paul Marcus, designer of the integrator amplifier.

Feedback Design for

Negative feedback lessens the effects of temperature and transistor variations. For a specified current gain, the design method produces maximum available feedback. Alternatively, the equations and the approach may be used to obtain a specified input impedance

By THOMAS R. HOFFMAN, Professor of Electrical Engineering, Union College, Schenectady, New York

NEGATIVE FEEDBACK is known to contribute to amplifier stability and to lessen the effects of transistor variations. But the problem of considering all possible parameter variations over a given temperature range is complex and is best attacked with the aid of a fairly good-sized computer.

Since in many cases this procedure is not possible or economical, the usual design objective is to use as much negative feedback as possible and still obtain the required overall gain. The basic idea is to trade excess gain for stability.

Testing the completed circuit will reveal the extent to which the stability requirements have been met. If the maximum available amount of negative feedback has already been used, and further stability is required, another stage of amplification with feedback may be the solution.

All semiconductor devices, transistors included, are by nature temperature sensitive. Variations of the operating point also affect performance, often appreciably. The variation of parameters in production lot transistors is well known and again, negative feedback helps to minimize the effects of these variations.

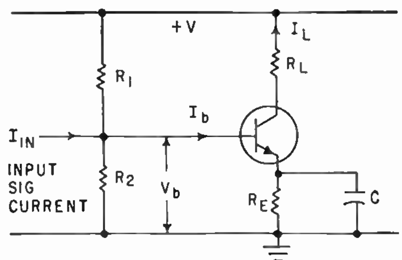


FIG. 1—Typical grounded emitter stage without feedback. The capacitor brings the emitter to a-c signal ground

Table I—Formulas for Feedback Amplifier Design

	Unbypassed R_E (Fig. 2 and 3)	Collector to Base R_F (Fig. 4 and 5)
Current Gain	$K_i = \frac{I_L}{I_b} = \frac{R_E + r_e - r_m}{R_E + R_L + r_e + r_c(1-a)} = \frac{R_E - 2{,}310{,}000}{R_E + 197{,}500}$	$K_i = \frac{I_L}{I_1} = \frac{-aR_F}{R_L + R_F(1 - a + R_L/r_c)} = \frac{-0.925R_F}{0.079R_F + 10{,}000}$
Input Impedance	$R_i = \frac{V_b}{I_b} = r_b + (r_e + R_E)(1 - K_i) = 300 + (R_E + 20)(1 - K_i)$	$R_i = \frac{V_b}{I_1} = [r_e + r_b(1-a)](1 - K_i) - \frac{R_L r_b}{r_c} K_i = 12.5 - 43.7\,K_i$
Overall Current Gain	$\left\lvert \frac{I_L}{I_S} \right\rvert = \lvert K_i \rvert \left[\frac{R_S R_B}{R_i(R_S + R_B) + R_S R_B} \right]$	
Overall Voltage Gain	$\lvert K_V \rvert = \frac{I_L R_L}{E_S} = \lvert K_i \rvert \left[\frac{R_L R_B}{R_i(R_S + R_B) + R_S R_B} \right]$	

Only the grounded emitter stage is considered here since it is the configuration with the highest gain and is the most often used. Negative feedback may be introduced into a grounded emitter stage by adding an unbypassed emitter resistor (R_E) or a feedback resistor (R_F) from collector to base. Although it might be thought that the results would be similar regardless of how the feedback was derived, the two cases produce greatly different input impedances. Thus the unbypassed emitter resistor makes possible a substantial increase in input impedance while the addition of feedback resistor R_F decreases the input impedance. The two cases will be considered separately.

Transistor Amplifier Stages

Figure 1 shows a conventional arrangement for an *npn* grounded emitter amplifier without feedback. Resistors R_1 and R_2 are chosen in conjunction with R_E and V to give the desired d-c emitter current. Capacitor C bypasses R_E so that the emitter is grounded for a-c. The quantities of interest are current gain, $K_i = I_L / I_b$, and input resistance, $R_i = V_b/I_b$. Current I_b is the portion of the input signal current I_{in} that actually reaches the transistor. Note that the overall current gain I_L/I_{in} will depend on the division of I_{in} between the bias resistance (R_1 and R_2 in parallel) and the transistor base lead. If K_i and R_i are known, this ratio may be readily determined.

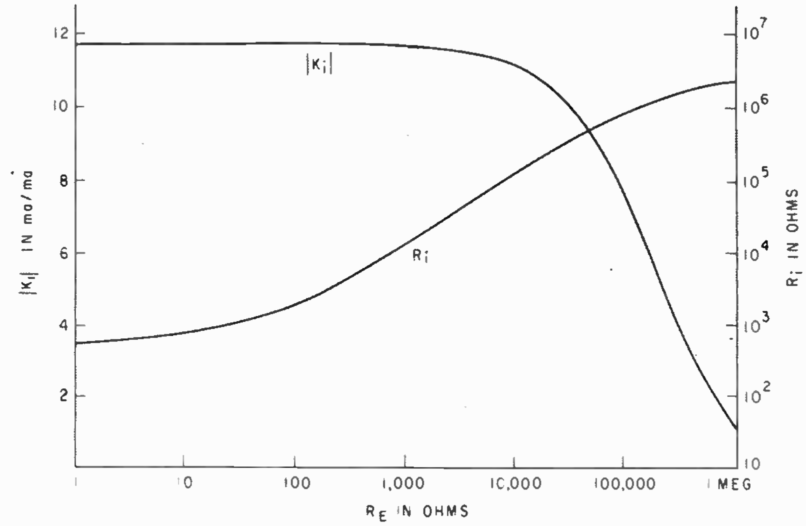


FIG. 3—Current gain K_i and input impedance R_i functions for feedback obtained from an unbypassed emitter resistor. Current gain is little affected until R_E exceeds 10,000 ohms. Curves are for small signals

If C in Fig. 1 is omitted, R_E becomes a factor in the signal behavior of the circuit. This circuit and its a-c equivalent are shown in Fig. 2A and 2B.

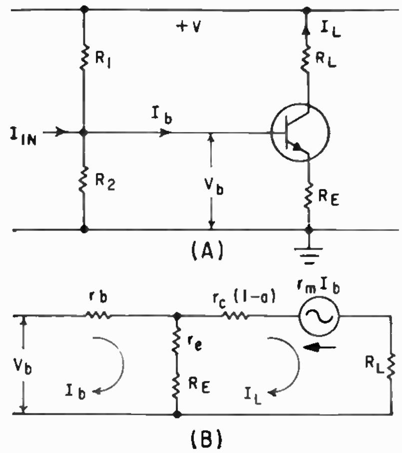


FIG. 2—Removing the emitter bypass capacitor produces negative feedback in transistor stage (A); equivalent circuit for small signals only (B)

The current gain K_i may be expressed in terms of the device parameters. Input resistance R_i can be concisely expressed in terms of K_i. The equations for these two quantities are given in Table I.

Evaluation of the expressions for K_i and R_i is generally difficult because of the large number of parameters involved. At this point the designer must substitute average values of parameters for the transistor he plans to use. To illustrate, typical values for a low-level, silicon junction transistor have been chosen:

r_b = 300 ohms
r_e = 20 ohms
r_c = 2.5 megohms
a = 0.925
$r_m = ar_c$ = 2.31 megohms

In addition, it will be assumed that R_L is 10,000 ohms. This, too, will be a known quantity in a particular design. The expressions for K_i and R_i with the above values substituted are included in the table.

Figure 3 is a plot of current gain and input impedance as a function of unbypassed R_E. Note that R_i starts to increase almost immediately as R_E exceeds zero, while K_i is not affected appreciably until R_E exceeds 10,000 ohms. From a practical viewpoint, it may be concluded that variation of R_E over a range that would still permit proper biasing will have no noticeable effect on K_i but will increase R_i drastically. However, if the input signal source is anything other than an ideal constant current generator, increased R_i will lower the overall current gain by reducing the amount of signal current that reaches the transistor base terminal.

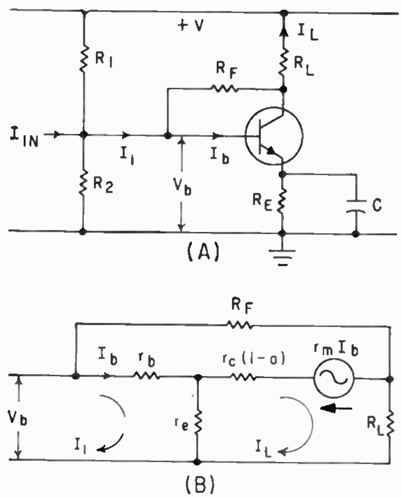


FIG. 4—Negative feedback from collector to base is obtained through resistor R_F (A). Bypassed R_E is not effective in small signal a-c equivalent circuit (B)

For the transistor used, a 10,000-ohm load resistor is small with respect to r_c $(1 - a)$. Current gain K_i and R_i, are therefore relatively insensitive to changes in R_L.

Figure 4A shows the circuit for collector to base feedback and Fig. 4B the equivalent circuit. With the approximation that r_e and r_b are much less than r_c $(1 - a)$, normally true for transistors of all types, equations for K_i and R_i are developed and listed in the table.

be readily obtained from the relationships just presented by including the effect of bias and source impedances. An equivalent circuit which would apply for either feedback arrangement is shown in Fig. 6. The source has been represented by a constant current generator I_S paralleled by the source impedance R_S. This representation is perfectly general since any source can be so shown by applying Norton's theorem.

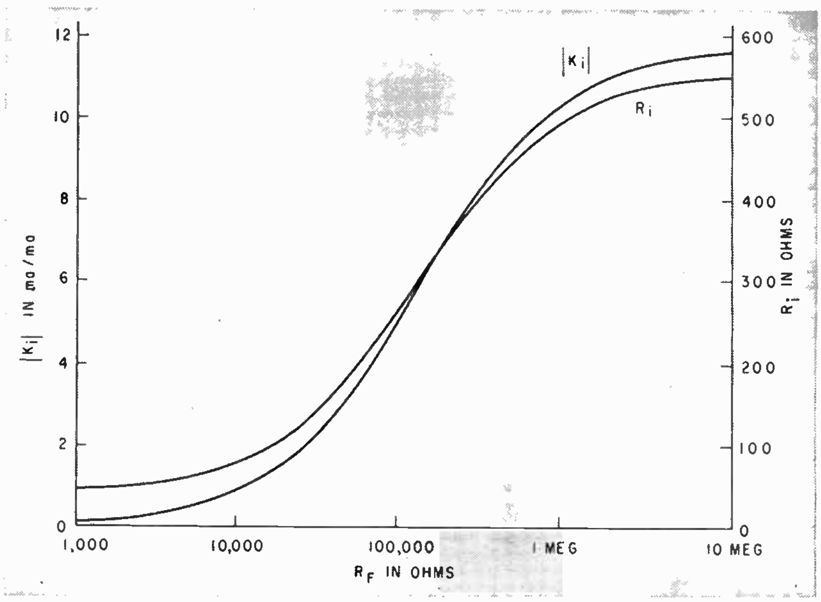


FIG. 5—Current gain K_i and input impedance R_i are shown for negative feedback from collector to base via resistor R_F. The gain and input impedance vary in nearly the same ratio. Curves are for small signals only and should not be extrapolated.

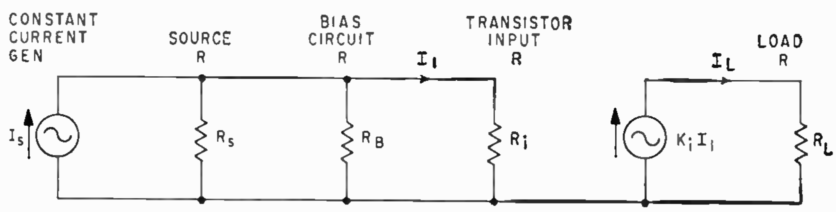


FIG. 6—Equivalent circuit for grounded emitter stage

Presentation of the results of these equations again requires specific values. Using the typical device parameters of the R_E case, the expressions for K_i and R_i are plotted in Fig. 5. Note that K_i and R_i vary together in much the same proportion as R_F decreases. For this case, the magnitude of the load resistance has a greater effect on gain than in the R_E case.

Circuit Design

In a practical problem, the parameter of interest is usually the overall current gain. This may

Since R_i and K_i are known for any value of the feedback resistor (R_E or R_F), overall current gain can be readily predicted with the help of the curves (Fig. 3 or Fig. 5). The relationship is: $I_L/I_S = K_i \{R_S R_B/[R_i\ (R_S + R_B) + R_S R_B]\}$. The factor in brackets is merely the current division ratio between R_i and the parallel combination of source and bias resistances.

If desired, overall voltage gain is also obtainable. The source is represented by its Thevenin equivalent (a constant voltage generator E_S in series with the source impedance R_S), and voltage gain can then be expressed in terms of R_i, K_i, R_S and R_B as follows: $K_V = I_L R_L/E_S = K_i\ \{R_L R_B/[R_i(R_S + R_B) + R_S R_B]\}$. Again, this is readily evaluated for any R_E or R_F with the aid of the curves.

Design Examples

Use of the curves is best illustrated by examples. Assume a transistor with the average small-signal parameters of Figs. 3 and 5 is to be used in an application requiring an overall current gain of 8. The source impedance is 10 K, and the bias circuit impedance (R_1 and R_2 in parallel) is 20 K. Load resistance is 10 K.

For unbypassed R_E feedback, determine R_E to satisfy the requirement. The overall gain is: $|I_L/I_S| = |K_i|\{10^4\ (2 \times 10^4)/[30{,}000R_i + 2 \times 10^8]\} = 8$. From Fig. 3 it is evident that K_i is independent of R_E over a wide range. Thus, assuming K_i to be 11.7 (the no-feedback value), we may solve for R_i equal to 2,107 ohms. This requires an R_E of 122 ohms. (Note that if a d-c R_E larger than 122 ohms is desired for bias stability, the additional resistance can be bypassed by a capacitor. The 122 ohms represents the value of R_E that should be effective in the signal circuit.)

For R_F feedback, determine R_F to satisfy the requirement. The overall gain is: $|I_L/I_S| = |K_i|\ \{2 \times 10^8/[30{,}000R_i + 2 \times 10^8]\} = 8$. Using Fig. 5, a cut and try method is used. When R_F equals 400 K, the curve yields a K_i of 8.88 and an R_i of 430 ohms, which satisfies the above relationship.

For actual design work, the curves for K_i and R_i must be plotted accurately. Furthermore, it must be realized that the curves are for a particular type transistor and normally cannot be used in a design problem requiring other types. In many cases the same curves can be used, with little error, for several types of transistors.

Note that resistance, except for one case, is plotted to a log scale.

Optimizing Antenna Switches and Phasers

Multiple antenna systems for airborne communications equipment are automatically switched or phased for maximum performance rather than simply above a predetermined minimum. Techniques provide signal-to-noise enhancement and increased range without contributing switching transients

By **IRVING DLUGATCH*** Hoffman Laboratories, Inc., Los Angeles, California

MODERN AIRCRAFT seldom provide ideal single antenna locations. It is difficult to make arrangements in aircraft design specifically to fit requirements of communications antennas. Despite extensive research, development and measurement, it is not possible to provide omnidirectional properties.

The problem has been aggravated by using high frequencies (uhf and vhf). There are often nulls or shadows in some directions, sometimes requiring changes in course to maintain communications.

Two antennas on different parts of the aircraft improve omnidirectional characteristics. Directivity patterns of the two antennas are chosen to be complementary. However, simple parallel connections would result in interferences, creating a null. Actually, multiple nulls occur so that with two antennas, uhf performance particularly may show little or no improvement. Hence, a means is required to combine signals received from two or more antennas so that signal addition results in the largest possible output signal.

* Now with Space Technology Laboratories, Los Angeles, Calif.

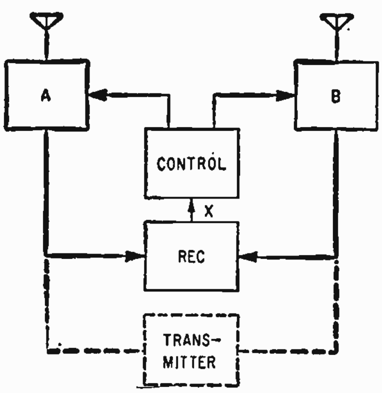


FIG. 1—Control unit switches between antennas or phasing elements until received signal reaches predetermined amplitude

Phasing and Switching

Two general types of solutions are available—antenna phasing and antenna switching. With antenna phasing, an artificial delay is inserted in series with one antenna so that signal addition will occur. In one scheme, this is accomplished by continually and rapidly varying the phase of one antenna about a mean value to eliminate stationary nulls. In a second type phaser, delay is automatically adjusted until signal level exceeds a predetermined threshold for the equipment, at which point the phaser is locked.

Similarly, a switch may cycle continuously to reduce interference or may be stopped when one antenna provides the desired minimum signal.

These methods are compromises, since a much greater signal-to-noise level might be available if phasing or switching in the automatic types could be pursued to their optimums. A chopper or wobbler does not eliminate nulls but merely reduces them and, at the same time, reduces average signal. Also, they introduce new interferences from switching transients and modulations. The technique to be described adds to the automatic phaser or switch a means of optimizing selection of switch position or degree of delay by locking equipment at maximum signal level.

In the basic receiving system in Fig. 1, *A* and *B* are either switching or phasing elements operated by the control unit. Essentially, this unit is a bistable multivibrator triggered by a clock that alternately turns on one antenna and turns off the other until receiver audio output reaches an amplitude large enough to turn off the clock. In some systems, where transmission is required, the transmitter is connected as shown by the dotted lines. The control unit remembers which antenna the receiver was using, and it switches that radiator to the transmitter.

Phasing Control

In the phasing control part of the circuit in Fig. 2, output of the pulse generator triggers a stair generator with capacitor C_1 being charged in small steps. Charging can continue as long as V_2 is conducting. When the receiver thresh-

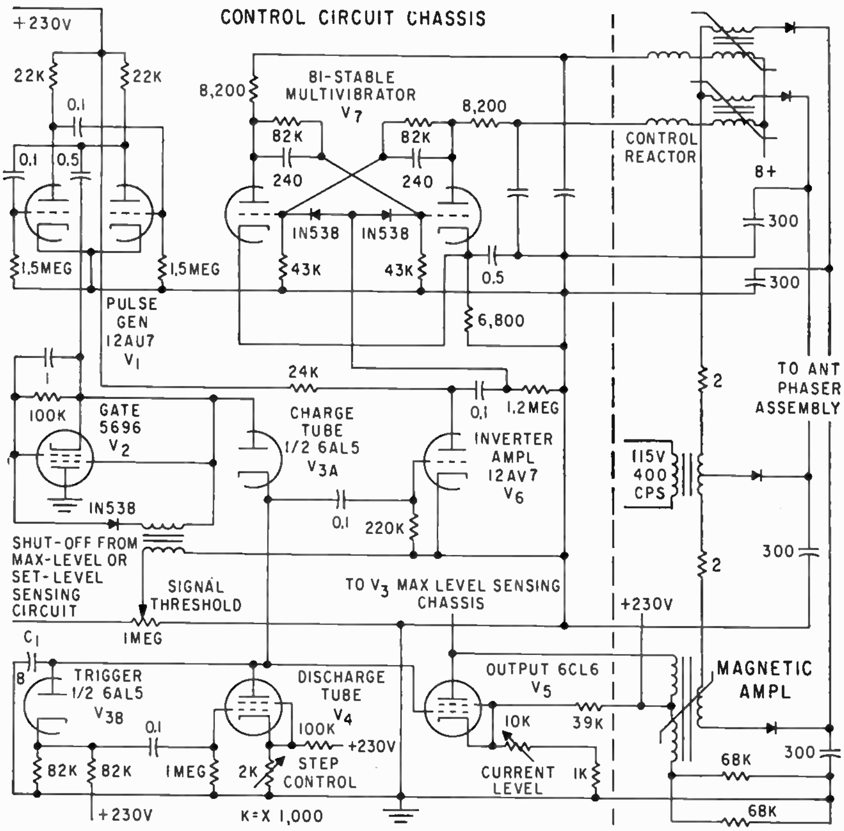


FIG. 2—In complete system, stair generator charges C_1 in steps until receiver threshold cuts off V_2. Charge on C_1 biases V_5 to change magnetization of reactor and thus changes antenna phasing

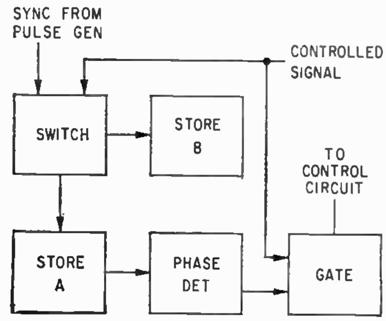


FIG. 3—Switching between two storage units is synchronized with pulse generator to sample result of antenna phase changes

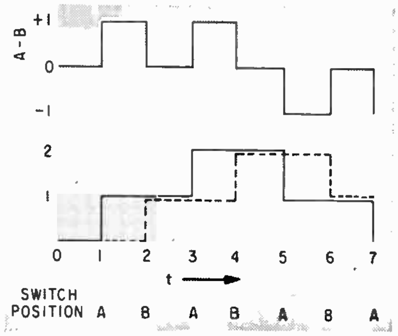


FIG. 4—Storage in A (solid line) and in B (dotted line) show how levels increase until a peak is passed

hold is exceeded, a bias cuts off V_2, stopping the process.

Tubes V_{3B} and V_4 limit the number of steps so that, if a satisfactory signal is not obtained, the count can be started again. At signals too low for reliable communications, the phasing control permits cycling. Capacitor C_1 controls bias on V_5, which operates a saturable reactor to vary current in the coil used to change magnetization of the ferrite phasing element. When the combined signal from both antennas results in a predetermined minimum signal level, the cycle is stopped. The charge on C_1 remains, resulting in constant output current.

Sensing Device

A sensing device at point *X* in Fig. 1 is needed to determine whether phasing could be improved by going to the next increment before releasing the locking pulse, as in Fig. 3. Audio output is switched rapidly between two storage components. Switching is synchronized with the pulse generator so that each storage is sampling the result of a succeeding increment of antenna phase change. Thus the level of each store is alternately increased toward the signal limit. Before saturation is reached, recycling must occur. While amplitudes are increasing, one storage level will either equal or exceed the other. Should the levels start to decrease, as would occur if the signal passed through a peak, the same storage level would become lower and/or equal to the other, as shown in Fig. 4.

If storage *A* is in the first switch position and incremental increases are equal, the plot indicates that *A* leads *B* during a rising amplitude and lags during the fall. This condition is further stressed by the curve for the difference between *A* and *B*.

The phase detector in Fig. 3 senses this change as an indication of a peak and permits the output signal to pass through the gate to the control circuit, where it turns off the control action.

It was assumed that reduction in level would occur with storage *A* first, but the reverse could be true. For example, when *t* equals 4 in Fig. 4, the *B* level may drop to zero or to unity. In the first case, $(A - B)$ will exceed the normal value and an amplitude-sensitive device can be added to stop control action.

In the second case, the unit would not detect the optimum position. However, the system can be arranged so that a limited number of steps are used before recycling occurs. If timing is based on an uncompensated, free-running pulse generator, it is unlikely that the effect of a specific step in one cycle would coincide with that of another, particularly since the received signal is varying at the same time. At worst, the phaser would be operating as a wobbler, but servo operation would be restored as quickly as conditions of transmission change.

Circuit

The circuit in Fig. 5 incorporates this technique. Audio is rectified by V_1. Capacitor C_1 provides a reference of average signal value. The d-c obtained alternately charges C_2 and C_3 at the grids of V_2. Switching is done by V_3, a bistable multivibrator, and is synchronized with the pulse generator so that each switch position corresponds to a change in antenna phasing.

As C_2 and C_3 are charged, plate currents of V_2 increase following the pattern indicated by Fig. 4. Tube V_{4A} functions as a phase detector.

With rising signal amplitude, bias on V_{4A} will be either zero or positive. When the peak is passed and phase reversed, the grid of V_{4A} goes negative. The grid of V_{4B} is therefore made positive, closing relay K_1 and permitting the control signal to pass to the control unit. Relay K_2 opens whenever the difference in the potentials of C_2 and C_3 become excessive, forcing the system to either resume or initiate cycling.

A similar system designed for an antenna switch is shown in Fig. 6. An important difference in operation is that at each position of the switch a different antenna is being used. Otherwise, the phase detector of the sensing unit is essentially the same as that for the phaser.

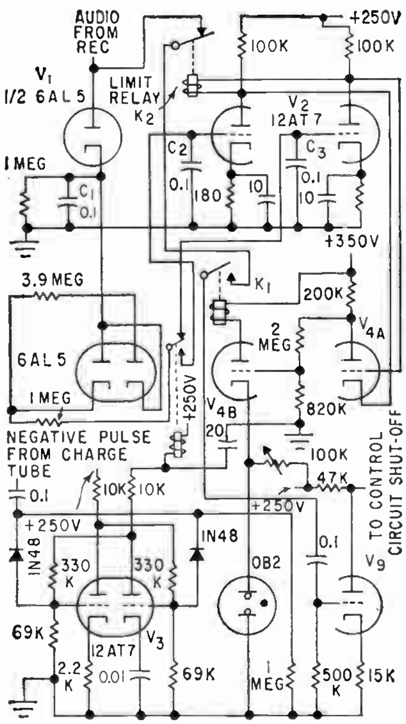


FIG. 5—Rectified audio provides reference voltage which is applied alternately to C_2 and C_3. When peak is passed, relay K_1 permits signal to pass to control unit

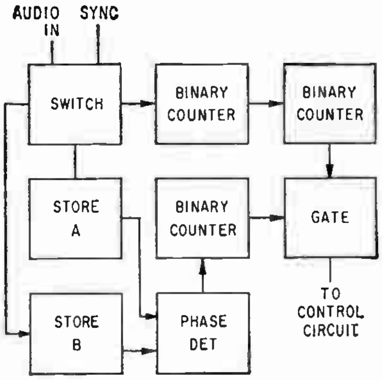


FIG. 6—Antenna switching is accomplished with an arrangement similar to that for antenna phasing

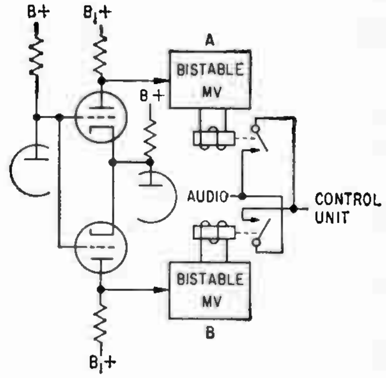


FIG. 7—When a large signal on one antenna sends two pulses to the same counter, a control signal locks the system

Decoding

Details of the decoding method are shown in Fig. 7. When a substantial signal appears on one antenna, one phase detector delivers a pulse to its counter. Two such pulses to the same counter are required to release the control signal to lock the system.

Because each counter is responsive to triggers of one polarity only, it is necessary to have separate phase detectors and counters for each antenna. It is possible that sensing unit sensitivity may not detect a useful signal. To avoid this, the gate is opened on every fourth switch pulse, and, if the preset threshold is exceeded, the system would use antenna *B*.

Performance

The significance of this technique in antenna installations is determined as follows: Assume that amplitudes of signals from each antenna are equal and that either signal alone exceeds the receiver threshold. The control unit without sensing will, in the case of the phaser, lock the system when the phase angle between the two antennas is 120 degrees. At that point, the resultant signal is exactly equal to that of a single antenna. Losses in the system can be ignored since they can be overcome by reducing the phase angle between antennas.

However, with the sensing device, it is possible by optimum phasing to achieve a signal power level twice that of one antenna. This is equivalent to a 3-db decrease in receiver noise figure or an increase in effective range by a factor of 1.41.

Further, insertion losses of the device for improving the antenna system are often such that it is essential to achieve optimum phasing for any improvement over a single antenna.

Switch Advantage

The advantage of the sensing unit with an antenna switch is less obvious. An increase in signal will accrue but is less likely to be in the order of 3 db. The advantage lies in reducing the possibility of locking on a reflection or other undesirable signal. A direct, good-quality signal is more likely to be of greater amplitude than one damaged by propagation delays or distortions. In this sense, an immeasurable noise figure improvement is obtained. Also, switch insertion losses will be compensated by obtaining a larger signal.

Finally, the sensing unit permits replacement of choppers and wobblers in many systems. These types reduce signal power substantially, offsetting benefits of multiple antennas. In addition, they introduce modulations that interfere with signal intelligibility.

A disadvantage of the sensing circuit is its basically slow response. However, a switching time of one second was satisfactory with many types of navigation and communication equipments.

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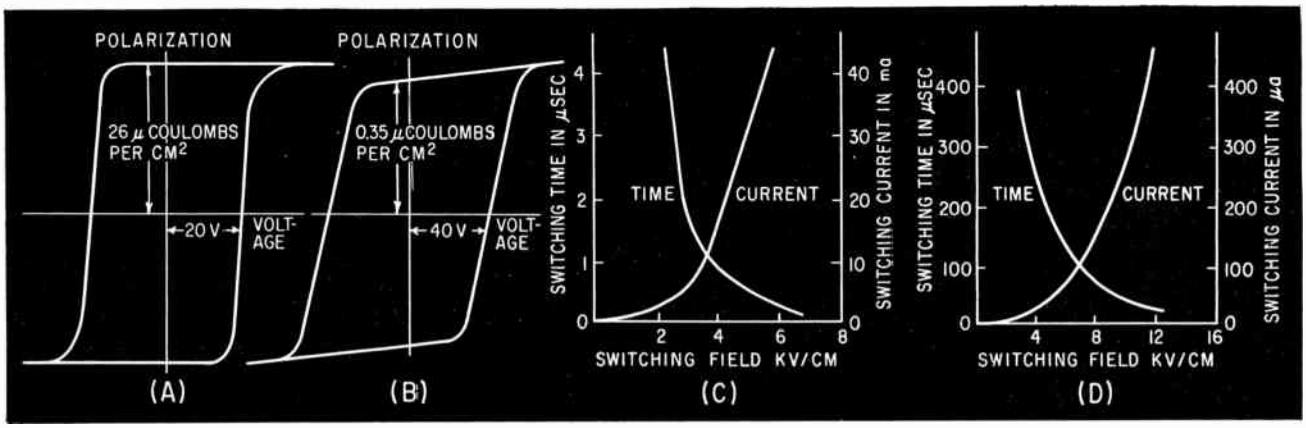

FIG. 1—Charts show hysteresis loops of 0.2-mm thick crystals of barium titanate (A) and guanidine aluminum sulphate hexahydrate (B). Graphs (C) and (D) respectively indicate switching current and switching time for single crystals of each

Ferroelectric Crystals for Switching Applications

Characteristics of nonlinear ferroelectric single crystals indicate they may be used for information storage devices of small size and low power consumption as well as for transducers and phonograph pickups

By M. PRUTTON, Research and Design Division, Electronics Branch, International Computers and Tabulators, Ltd., Stevenage, England

FERROELECTRIC SINGLE CRYSTALS show a hysteresis between their polarization and the electric field strength applied to them, analogous to ferromagnetic materials. They can be polarized completely in one direction and then reversed by a pulse of suitable length. Generally, they possess square hysteresis loops.

COMPUTER USES—Their nonlinear behavior and sometimes high dielectric constants have already led to some applications as high permittivity materials.

Anderson describes a shifting register constructed with barium titanate crystals which can operate at rates up to 2,000 pulses per second with 12-volt output pulses. Such a system may be attractive because of its very small size and low power consumption. However, speeds over 100,000 pulses per second are not likely to be obtained with presently known materials.

Barium titanate is also used in its ceramic form for transducers. Rochelle salt is widely used in crystal phonograph pickups.

CRYSTAL PROPERTIES—Physical properties of single crystals of some ferroelectric materials are given in Table I. Coercivity and switching speed are functions of crystal thickness and applied field strength as noted. The values tabulated are approximate and are intended only as a guide. The hysteresis loops of two well-known crystals, barium titanate and guanidine aluminum sulphate hexahydrate are shown in Fig. 1A and 1B, respectively.

SWITCHING PROCESS—The switching process in all of these materials is given by an exponential relation between switching time t_s, peak current i_s and applied pulse field E. Thus, $i_s = i_o e^{-a/E}$ and $t_s = t_o e^{a/E}$.

In these equations, e is the exponential of mathematics. The quantities i_o and t_o express the switching current and time for an infinitely large field E. The quantity α is called the activation field.

There is not sufficient data available to tabulate i_o, t_o and α. Crystal material, its thickness and electrode area determine the magnitude of i_o and t_o. Typical values for crystals 0.2 mm thick are: guanidine aluminum sulphate hexahydrate, i_o of 15 ma/cm^2 and t_o of 10 μsec; barium titanate, i_o of 2 amp/cm^2 and t_o of 0.4 μsec. Generally, α is of the order of thousands of volts per centimeter.

Plots of the exponential reversal characteristic are shown for typical crystals of these materials in Fig. 1C and 1D.

The exponential switching behavior renders the crystals unsuitable for the direct use of half-voltage matrix selection techniques for digital computer storage. It means that there is no threshold field below which the crystals will not switch.

PRODUCTION—All of these materials are soluble in water except for barium titanate, which is soluble in hydrochloric acid. They can be grown in large single crystal plates or bars weighing from a quarter-pound to four pounds. Barium titanate is grown from a melt, usually as triangular plates about one cm on a side and one mm thick.

The production problems associated with such materials are not severe, as demonstrated by the techniques already well-established for manufacturing Rochelle salt piezoelectric phonograph pickups.

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Table I—Nine Ferroelectric Crystals and Some of Their Physical Properties

Material	Chemical Formula	Crystal Group	Refractive Indices	Curie Temp (deg K)	P_{sat}[a] (microcoulombs/cm)	H_c[b] @ 50 cps (kv/cm)	Switching Speed[b] (μsec)	Dielectric Constant[c]
Rochelle Salt	$NaKC_4H_4O_6 \cdot 4H_2O$	monoclinic	1.49	255 296	0.25 (0 C)	0.1	100	500
Barium Titanate	$BaTiO_3$	tetragonal	about 2.4	393	26	1	1	5,000
Guanidine Aluminum Sulphate Hexahydrate	$CNH(NH_2)_2Al$-$H(SO_4)_2 \cdot 6H_2O$	trigonal	1.45 1.54	about 573	0.35	2	40	6
Guanidine Gallium Sulphate Hexahydrate	$CNH(NH_2)_2GaH$-$(SO_4)_2 \cdot 6H_2O$	trigonal	......	about 573	0.36	4	60	6
Potassium Dihydrogen Phosphate	KH_2PO_4	orthorhombic	1.47 1.51	123	4.5 (110 K)	6	......	1,500 (75 K)
Potassium Dihydrogen Arsenate	KH_2AsO_4	orthorhombic	1.52 1.57	92	5 (80 K)	about 2.5	......	...
Triglycine Sulphate	$(CH_2NH_2COOH)_3$-H_2SO_4	monoclinic	......	320	2.2	0.22	5	...
Lithium Ammonium Tartrate	$LiNH_4C_4H_4O_6$-$\cdot H_2O$	monoclinic	......	95	0.22 (80 K)	.....	......	8
Potassium Niobate	$KNbO_3$	tetragonal	......	693	about 26	.....	......	700

(a) Saturation polarization, taken at room temperature if Curie temperature is well above room temperature. Other temperatures used are indicated (b) Coercivity and switching speed (t_s) given are approximate values for crystals 0.2 mm thick and fields of 10 kc/cm (c) Highest value of the dielectric constant is quoted

Transistorized Horizontal

New horizontal-deflection and high-voltage circuits are designed around only two transistors. Circuits are stable and efficient

By **MARTIN FISCHMAN,** Sylvania Research Laboratories, Bayside, New York

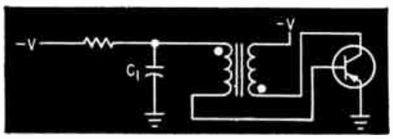


FIG. 1—Conventional transistor blocking oscillator

EFFICIENT AND STABLE, the 90-deg horizontal-deflection circuit and high-voltage generator that will be described uses only two transistors and a diode.

Blocking Oscillator

Before getting into the actual circuit design, a brief description of the operation of conventional transistor blocking oscillators will be given. Figure 1 shows that the blocking oscillator transformer provides regenerative feedback from the collector to the base of the transistor as soon as current starts to flow. The gain and feedback of the circuit cause the current to build up so that the transistor operates in the saturation region of its characteristic. In this region the collector current is substantially independent of the base current. Due to the absence of gain in the circuit under these operating conditions the transistor voltages remain practically in an equilibrium state for a period of time. This voltage-equilibrium state corresponds to the turned-on period or pulse width of the blocking oscillator. The equilibrium condition continues until the transistor operating point moves out of the saturation region into a nonsaturation region. A regenerative process then begins which rapidly turns off the transistor. Termination of the equilibrium condition may come about as a result of an increasing collector current, a decreasing base current or a combination of both; the cause depends on the relative values of capacitor C_1 transformer inductance and external resistive loading—if any exists. In this type of operation the pulse width is influenced by transistor characteristics, circuit loading, transformer characteristics and operating voltages.

An improved blocking oscillator circuit in which the pulse duration is accurately controlled by the transient response of a series *L-C* circuit is shown in Fig. 2A. Figure 2B shows the transient current and voltage waveforms of a series *L-C* circuit driven from a step voltage source. Current through the circuit is a damped sine wave oscillating about the zero current axis. Voltage across the capacitor is a damped cosine wave oscillating about the value of the step input voltage. The duration of the first half cycle of the sine wave is to a first approximation dependent solely on the *L-C* values.

The base circuit of Fig. 2A has a similar oscillatory response for the first half cycle. A step voltage provided by the base winding of the

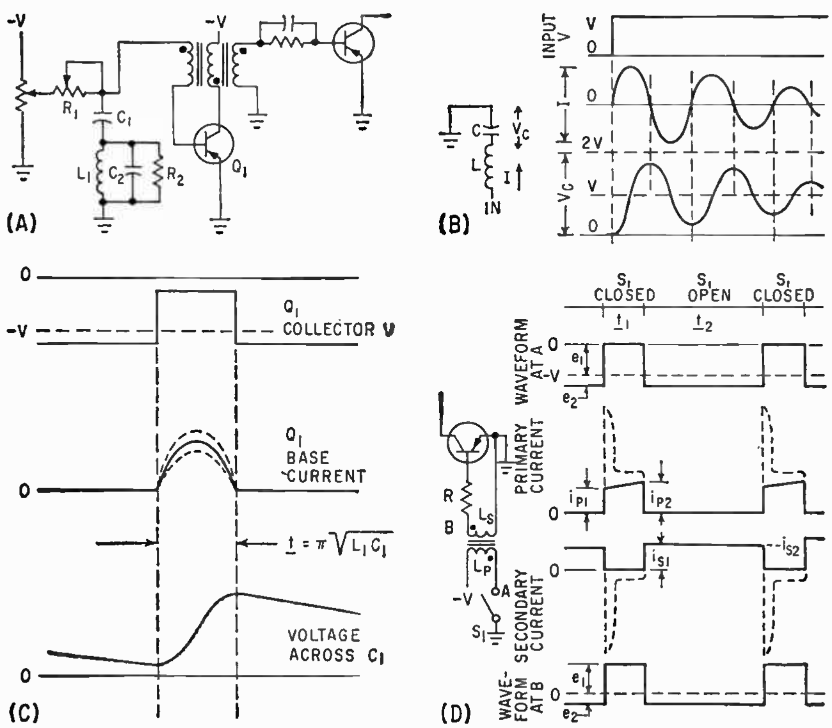


FIG. 2—Basic improved blocking-oscillator and driver (A). Equivalent series L-C circuit and its transient response to step input (B). Blocking-oscillator waveforms (C). Idealized waveforms of driver (D)

Deflection for Television

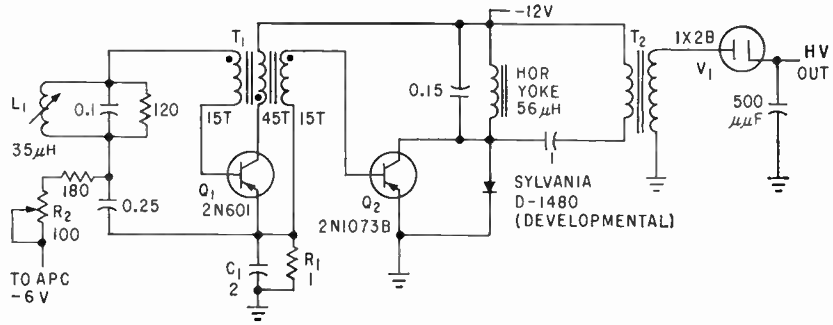
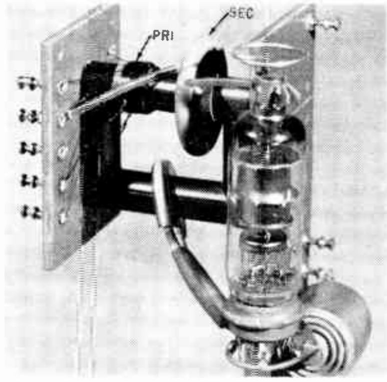


FIG. 3—Horizontal-deflection and high-voltage circuits. In typical operation, oscillator current is 0.12 amp, output-stage current 0.72 amp and p-p yoke current is 11 amp



Spacing between the high-voltage-transformer primary and secondary is about ¼ in.

transformer drives the series circuit consisting of L_1C_1 and the low base resistance of the forward-biased base-emitter diode. During the first half cycle of oscillation the transistor is operated in the saturation region; thus the collector current is independent of the base current drive for practically all of the base-current waveform. When the base current goes through zero after the first half cycle of oscillation, the transistor falls out of saturation and a regenerative turn-off process begins.

The base-emitter diode is now reverse biased and oscillation of the L-C circuit terminates. Capacitor C_1 remains charged with the proper polarity to maintain the transistor cut-off. Idealized waveforms at various points in the circuit of Fig. 2A are shown in Fig. 2C. The base-current waveform of Fig. 2C shows that the critical crossing of the zero current intercept in the base circuit occurs after a time, t, equal to $\pi\sqrt{L_1C_1}$, and is practically independent of the peak current amplitude. Due to storage effects a reverse current flows for a short interval before the transistor is turned off.

The frequency, or repetition rate, of the oscillator is determined mainly by the time constant C_1R_1 and the voltage to which R_1 is connected. Capacitor C_2 provides a high frequency by-pass across L_1 thereby increasing the initial rate of rise of base current during the edges or regenerative intervals of the pulse. Resistor R_2 provides damping of the L_1C_2 parallel-resonant circuit.

Driver Operation

The base-emitter diode of the output stage requires forward-current drive during the scan interval and reverse drive during the retrace interval. A simplified diagram of the circuit that accomplishes this is shown in Fig. 2D. Switch S_1 is closed during the retrace interval, t_1, and open during scan interval t_2. After steady-state conditions have been established the waveforms across the similar windings L_p and L_s have zero average values over a complete cycle; thus $e_1t_1 \approx e_2t_2$.

During interval t_2, forward-drive current approximately equal to e_2/R flows in the base of the output stage. Resistor R represents the total series resistance in the base circuit. Time constant L_s/R is assumed to be large in comparison to t_2. During interval t_2, energy is dissipated in the resistive elements. This energy of approximately $e_2I_2t_2$ is replaced during retrace interval t_1 by energy from the power supply equal to $e_1I_1t_1$; I_1 and I_2 are average values of the currents during the intervals t_1 and t_2 respectively. The energy replaced by the power supply during t_1 is stored in inductance L_p. The energy level at the beginning of the interval t_1, $L_p(i_{p1})^2/2$, is increased to $L_p(i_{p2})^2/2$ at the end of t_1. Upon opening switch S_1 the energy is transferred from the primary to the secondary circuit. During the next scan interval, t_2, energy level $L_s(i_{s1})^2/2$ is reduced a small amount to $L_s(i_{s2})^2/2$. The energy reduction is equal to the energy dissipated in the resistive elements in the secondary circuit during t_2.

Efficient output-stage operation requires rapid turn-off of the transistor at the end of the forward-drive interval. In order to accomplish this the ratio of reverse to forward drive current must be large. The ratio of reverse voltage to forward voltage across L_s is equal to t_2/t_1. If it is assumed that the forward and reverse base resistances are equal, the ratio of initial reverse base current to forward base current will be approximately equal to t_2/t_1. It is desirable for this ratio to be larger and means for increasing it will be discussed below. Secondary and primary currents flow simultaneously during the reverse-drive interval, unlike the forward drive interval in which secondary and primary currents flow alternately. The dashed lines of Fig. 2D show idealized waveforms of the relatively large-amplitude, short-duration drive pulses that flow in the circuits during the initial part of the retrace interval. Throughout the

Table 1—Transformer Design Data

Blocking-Osc Transformer

Winding	Turns	Inductance in millihenries
Collector	45	4.5
Output	15	0.5
Base	15	0.5

Wire: No. 30 Formvar
Core: Allen-Bradley No. 1,620-160A Ferrite WO-3

High-V Transformer

Pri.: 20 t No. 28 Formvar; single layer, close wound
Sec.: 2,200 t No. 38 Bondeze-2, pie-wound
Core: Allen-Bradley No. 1,620-160B, Ferrite WO-3

above discussion a transformer ratio of 1 to 1 has been assumed. In the actual circuit a different ratio is used in order to match the driver and output-base circuits.

To obtain an efficient, fast turn-off of the output transistor the forward base drive at the end of the scan interval should be just enough to maintain the transistor in saturation. This operating condition produces a minimum of stored base charge and reduces the reverse base-driving power requirement.

As previously mentioned, it is desirable to provide a high ratio of reverse to forward base drive. In Fig. 3, which shows the actual circuits developed, the circuit of R_1C_1 helps to accomplish this condition. This *RC* circuit also tends to reduce the steady reverse base-emitter current of Q_2 that normally flows when operating the emitter junction of Q_2 in the breakdown region. This current reduction decreases blocking-oscillator input power since less average power flows during reverse drive. Breakdown current is reduced because of the voltage drop across R_1 produced by the oscillator's collector current. Capacitor C_1 provides by-pass action during the initial interval of reverse base current flow when the stored base charge is swept out.

Blocking-oscillator transformers usually require damping after turn-off to prevent a large oscillatory voltage from appearing across the windings and retriggering the oscillator after a half cycle of the output wave. An efficient method of damping may be effected by a diode and series resistor placed across one of the transformer windings. In the circuit of Fig. 3 the emitter diode of transistor Q_2 damps the transformer when it is driven in the forward direction. If the blocking oscillator is to operate properly the emitter diode of the output stage must always be connected.

Automatic phase control of the oscillator may be obtained by connecting a control voltage to variable resistor R_2. The frequency sensitivity at this point is approximately one kc/v.

Deflection System

A basic energy-recovery deflection circuit is shown in Fig. 4[1]. This circuit consists of a voltage source *E*, a low-loss bi-directional switch and a deflection inductor shunted by a capacitor. Switch S_1 is periodically closed during the scanning interval and opened during the retrace interval. During the scanning interval the deflection current

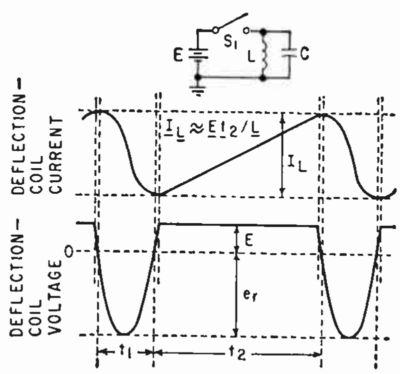


FIG. 4—Waveforms for equivalent deflection circuit indicate energy-recovery process

builds up at a rate $di/dt \approx E/L$. The switch opens during retrace interval t_1 ($t_1 = \pi\sqrt{LC}$) and the inductor current starting at its maximum value oscillates as a cosine wave for a half cycle, thus reversing its original polarity. In the low-loss case the reversed current that flows back into the power supply approaches the value of the previous forward current with the result that the net power taken from the supply approaches zero. Inductor voltage and current waveforms shown in Fig. 4 are for ideal conditions.

Peak Transistor Voltage

For a given retrace time and waveform, the peak collector voltage is determined solely by the power supply voltage. In the simplified circuit of Fig. 4 the average value of the voltage across the pure inductance *L* is zero over the cycle. It follows that the product $E \times t_2$ is approximately equal to the product of the average voltage during t_1 multiplied by t_1. Since the average value of the sine-wave retrace voltage over the interval t_1 is $e_r \times 2/\pi$ the ratio of peak retrace voltage to supply voltage is

$$\frac{e_r}{E} \approx \frac{t_2}{t} \times \frac{\pi}{2}$$

Supply voltage *E* appears across the transistor in addition to the retrace voltage. The ratio of peak collector-emitter voltage to supply voltage is therefore

$$\frac{e_r + E}{E} \approx \frac{t_2}{t_1} \times \frac{\pi}{2} + 1$$

For a given supply voltage the retrace interval is adjusted to be of long enough duration to limit the transistor collector voltage to its maximum safe value.

Additional factors to be considered in determining the retrace time are:

1. The ratio of peak retrace voltage to supply voltage may be reduced in the case of non-sinusoidal retrace voltage waveforms. The harmonic waveforms introduced by a combined high voltage and scanner arrangement may reduce the above ratio by about 20 percent.

2. Allowance should be made for the reverse base voltage pulse during retrace. The peak reverse collector-to-base voltage depends on the type of drive circuit employed.

3. Some allowance is required for possible low-frequency operation during oscillator frequency adjustments and for out-of-sync operation due to other causes. A reasonable estimate for increased collector voltage due to low-frequency operation might be about 5 to 10 percent.

4. Power-supply variations above the nominal voltage result in pro-

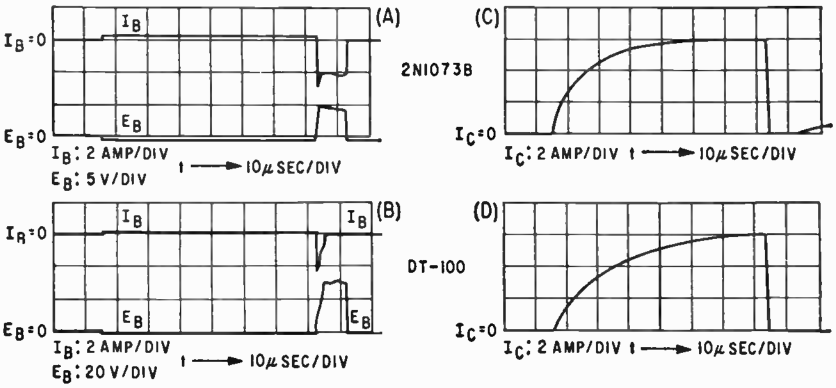


FIG. 5—Reverse base current in the 2N1073B flows during a positive pulse into its base (A) but in the DT-100, reverse current stops shortly after a positive base pulse appears

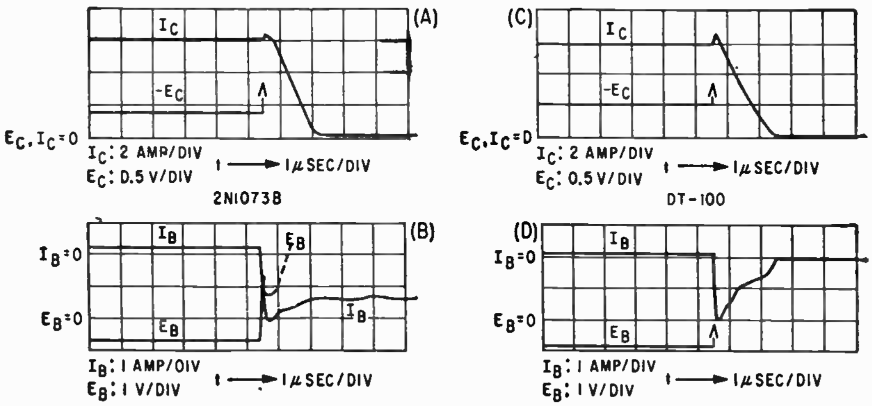


FIG. 6—For the 2N1073B, a reverse base current of 2 amp turns off a collector current of 6 amp in about 1.5 μsec. Waveshapes obtained with test circuits, as were waves of Fig. 5

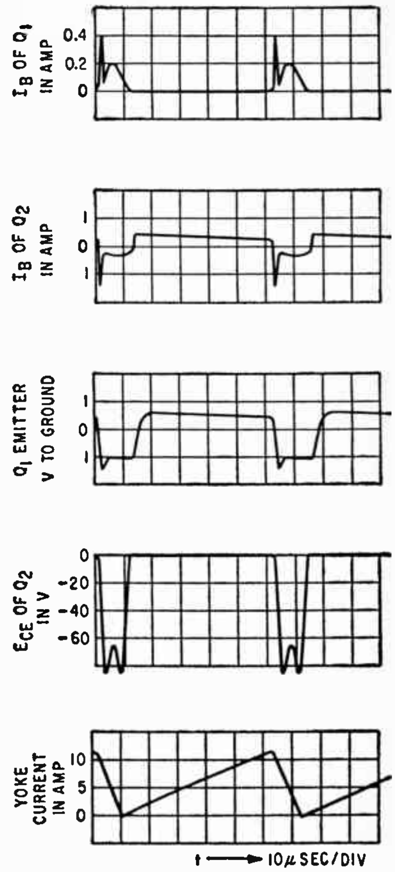


FIG. 7—These operating waveforms for the circuit of Fig. 3 are drawn to a common time scale

portionate increases in peak collector voltage.

The above considerations lead to a retrace time of not less than 12 μsec for a single transistor output stage having a maximum collector rating of 120 v and using a nominal 12-v supply.

Deflection and High Voltage

As mentioned previously, efficient operation of the output stage requires fast turn-off of collector current. This can be accomplished with alloy power transistors such as the DT-100 by providing large peak reverse drive current. However, as the voltage drop across the emitter junction during sweep-out of the base charge is considerable, large peak power is required from the driver stage. The diffused-alloy power transistor 2N1073B has the advantage of a much smaller voltage drop across the emitter junction during reverse current flow. Therefore, the required peak driving power is much reduced. To achieve the desired collector current cut-off time the 2N1073B is driven into the region of emitter-junction breakdown.

Some test-circuit comparisons (with resistive load) of the 2N-1073B and DT-100 power transistors are shown in Fig. 5 and 6. Fig. 5A and B show the difference in emitter junction voltage drop for similar reverse current between the two transistors. As indicated by Fig. 5C and 5D, forward-base drive performances are similar. Figure 6 compares transient responses during reverse drive.

Waveforms at various points in the oscillator-driver and output circuit are shown in Fig. 7 for typical operating conditions.

The deflection yoke is a Sickles 17496-11 90-deg model with an inductance of 56 μh. The yoke drives a ST2587A (Sylvania) 9/8-in.-neck tube. A step-up transformer with a turns ratio of 110 to 1 is driven from the deflection circuit and provides sufficient fly-back voltage for tube V_1 of Fig. 3. Leakage inductance of the secondary of transformer T_2 is adjusted by varying the lateral spacing between primary and secondary. This adjustment, which is normally about ¼ in, increases secondary voltage peaking, reduces peak collector and yoke voltages. Transformer data is given in Table 1.

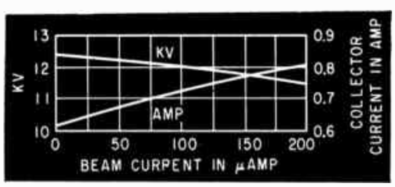


FIG. 8—Regulation of high-voltage output

Figure 8 shows the high-voltage rectifier output as a function of beam current.

Future improvements of reduced retrace time and less input power may be expected when power transistors having higher voltage-breakdown ratings and improved switching characteristics become available.

REFERENCE

(1) A. D. Blumlein, U. S. Patent No. 2,063,025, Dec. 8, 1936.

Computer Switching With

Here are the general considerations that influence computer designers in their choice of electromechanical or electronic types of switches

By G. L. LaPORTE and R. A. MARCOTTE,
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SEMICONDUCTOR DEVICES are not direct replacements for relays. They require supporting components in the logic package or switch. Economic justification for a point-by-point replacement of relays can only be found in such system requirements as speed, capacity and size.

In the low-and medium-power ranges, the normal applications of electronic and electromechanical switches overlap as shown in Table I, giving the designer a choice. Some of the considerations which influence the computer designer are generalized in Table II.

Examples of transistor logic circuits and a conventional relay OR circuit are given in Fig. 1. Each input of the complementary transistor resistor logic circuit (CTRL) or the complementary transistor diode logic circuit (CTDL) could be a relay point. But this is expensive because each leg requires a control device, losing the benefit of multipoint relays. Each input could be controlled by a transistor. However, the CTRL or CTDL make possible multiple input circuits utilizing either resistors or diodes and only one transistor.

Figure 2 is a transistor bilateral transfer circuit,

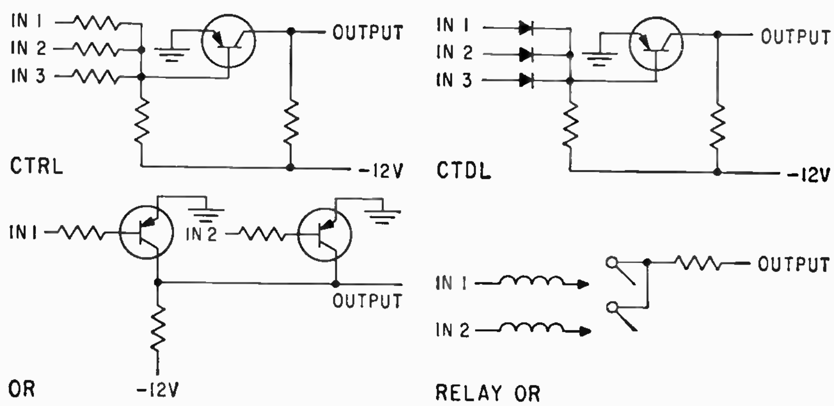


FIG. 1—Examples of basic building blocks for computer logic systems

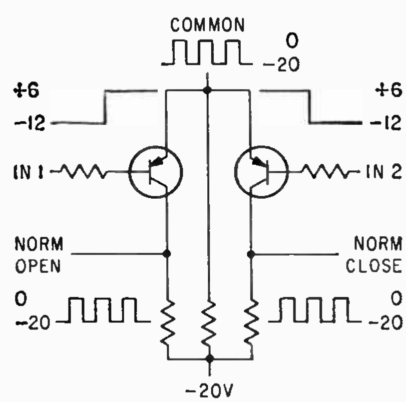


FIG. 2—Transistor bilateral transfer circuit

Table I—Normal Applications of Electronic and Electromechanical Switches

Electronic

Vacuum Tubes	Crystal Diodes	Transistors: Point Contact	Transistors: Diffused Junction	Transistors: Alloy Junction	Transistors: Photo	Transistors: Thyratron	Photo Diode	Heavy-Duty Diode

High Frequency Pulse Control	Low Level Switching	Intermediate Switching Low Power	Intermediate Switching Medium Power	Low Frequency High Power Control

Electromechanical

Special-Purpose Relay	Polarized Relay	Photo Switch	Thermal Switch	General-Purpose Relay	Heavy-Duty Relay	Contactor

Semiconductors and Relays

performing the same function as a relay transfer contact. Its two bilateral transistors have comparable majority carrier efficiencies at either junction. The circuit is shown at 0 to —20 v levels, but can operate between any levels within the rating of the transistor.

Complementary inputs are required for the two transistors, therefore a bistable device such as a trigger or inverter is required for this circuit. A single bistable device could drive as many as 25 sets of transfer circuits. Not considering the actuating device, about 20 ½-w resistors and eight bilateral transistors would be required to replace a four-position transfer relay. The relay actuating device would have fewer components than the transistor actuator.

Table II—Desirable Computer Switch Characteristics and Characteristics of Semiconductors and Relays

Characteristic	Semiconductor Devices	Electromechanical Relays
Bistability	bistable *on-off* device	bistable *on-off* device
Low resistance in either ON state	few ohms for transistors, around 10 kilohms for photoconductors	short circuit (1 ohm or less)
Infinite resistance in OFF states	many megohms for transistors, around 100 kilohms for photoconductors	infinite
Bidirectional for flexible polarity	unidirectional (bidirectional operation requires 2 or more in circuit)	inherently bidirectional
Flexible in speed of operation	10 milliseconds to a few millimicroseconds, higher speeds are feasible	250 microseconds or slower
Low input power	low power required	reasonable power, adds appreciable inductance to circuit
Long life, reliability	unit life over 10,000 hr including shelf life, 1–1.5 failures per 10^7 hr operation (total units in system)	average life 10^4 to 3×10^8 contact operations, indefinite storage life, 1 failure in 4×10^8 contact operations
Resistance to environments	performance affected by temperature and radiation	contacts may bounce due to shock, reasonably independent of heat and radiation
Design flexibility and restrictions	adds circuit flexibility, amplification, volume; single point, complicates power source, limited reverse voltage, transients may cause damage, needs more supporting components	single point or single control of multiple points, variety of configurations available, actuating coil introduces transients
Control versatility	control may be electrical pulse, magnetic field, thermal, light	control may be pulse, magnetic field, thermal; operation visible in some types
Range of current and load breaking capacities	relatively limited except in association with higher power devices, capacity affects operate time, excellent at low levels of current and load	can carry and break moderate and large loads, large loads restrict speed, contact materials and pressures restrict use in dry circuit (very low level) operation
No contact bounce or chatter	no contacts to bounce, but internal noise must be considered in some applications	bounce or chatter inherent in most types, especially during shock and vibration
Easy to mount	mounts in any position, suited to automatic assembly, may require heat dissipation, precaution during soldering	printed circuit, chassis and frame-mounting styles (depending on size), some require upright mounting
Small size	very small size, but size partially offset by added circuit complexity	small per point in multipoint relays, but relatively large in low-point numbers
Low cost	relatively high per point, cost must be justified by design requirements	low cost, multipoint relays can be made for 15¢ to 30¢ per point
Availability	standard types readily available, but many still in development	readily available, manufacturing experience in general longer than for semiconductors

Dynamic Testing of

Development of high-speed digital computer building blocks requires pulse sources that closely approximate the desired input to the units. The pulse source must be variable in frequency to remain useful as the search for higher operating speed progresses

By **ROSS W. BUCHANAN and BRUCE KAUTZ**, Staff Research Engineers, Denver Research Institute, University of Denver, Denver, Colo.

DYNAMIC TESTING of multiinput AND gates is expedited using the mega-pulse generator shown in the photograph. This device provides up to 18-mc pulses and can be used as a clocking system. A novel blocking oscillator allows synchronizing the generator with a HP212A pulse generator, or its equivalent, to obtain gating functions.

The generator was developed to provide a pulse source for testing the design of high-speed adders and gating circuits of various types. The gating provided at the generator's output allows testing circuits for 1st and *n*th pulse response as well as 50-percent duty cycle.

General Technique

This gated mega-pulse generator is based on a technique of overdriving a cathode follower with a sinusoidal signal and using grid cutoff for base clipping and diodes for peak clipping. The usable frequency range of the pulser is up to 18 mc.

The unit generates only positive pulses at each of its four outputs. These outputs are developed by four identical cathode followers. Output pulse amplitude is continuously variable between 0 and 20 v. A gating system incorporated in each of the four channels gives up to a 10-μsec burst of pulses or a 0- to 10-μsec blank in a string of pulses when gated by the HP212A pulse generator.

Direct synchronization with the external pulse source is secured from the mega-pulser control oscillator by use of a novel blocking oscillator technique.

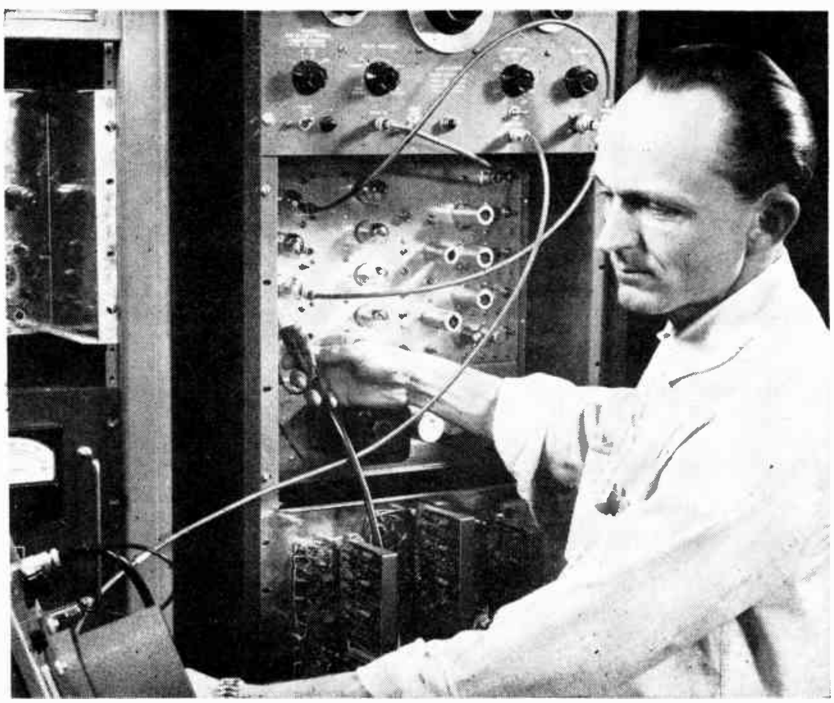
Control Oscillator

The pulser control oscillator is a basic self-biased Hartley type as shown in Fig. 1. Plug-in coils, L_1, are used for major frequency changes while minor adjustments are made with C_4. The amplitude of the oscillator is controlled by varying R_2 to adjust the plate voltage of V_6. Pulse width is controlled by R_3 which sets the bias level on the cathode-follower drivers.

By adjusting R_2 in combination with R_3 it is possible to adequately control the output pulse width and rise time. The rise time is a function of the oscillator since the system is degenerative from that point on.

Separate drivers are used for each of the four channels to prevent any coupling between channels. Resistors R_4, R_5, R_6 and R_7 prevent h-f oscillation in the cathode-follower stages. The output of cathode-follower driver V_7 is developed across R_8. This cathode must, in addition, drive pulldown resistor R_9.

Diodes D_1 and D_2 prevent the



One of the authors uses mega-pulse generator to test 10-mc dynamic logic units

Computer Building Blocks

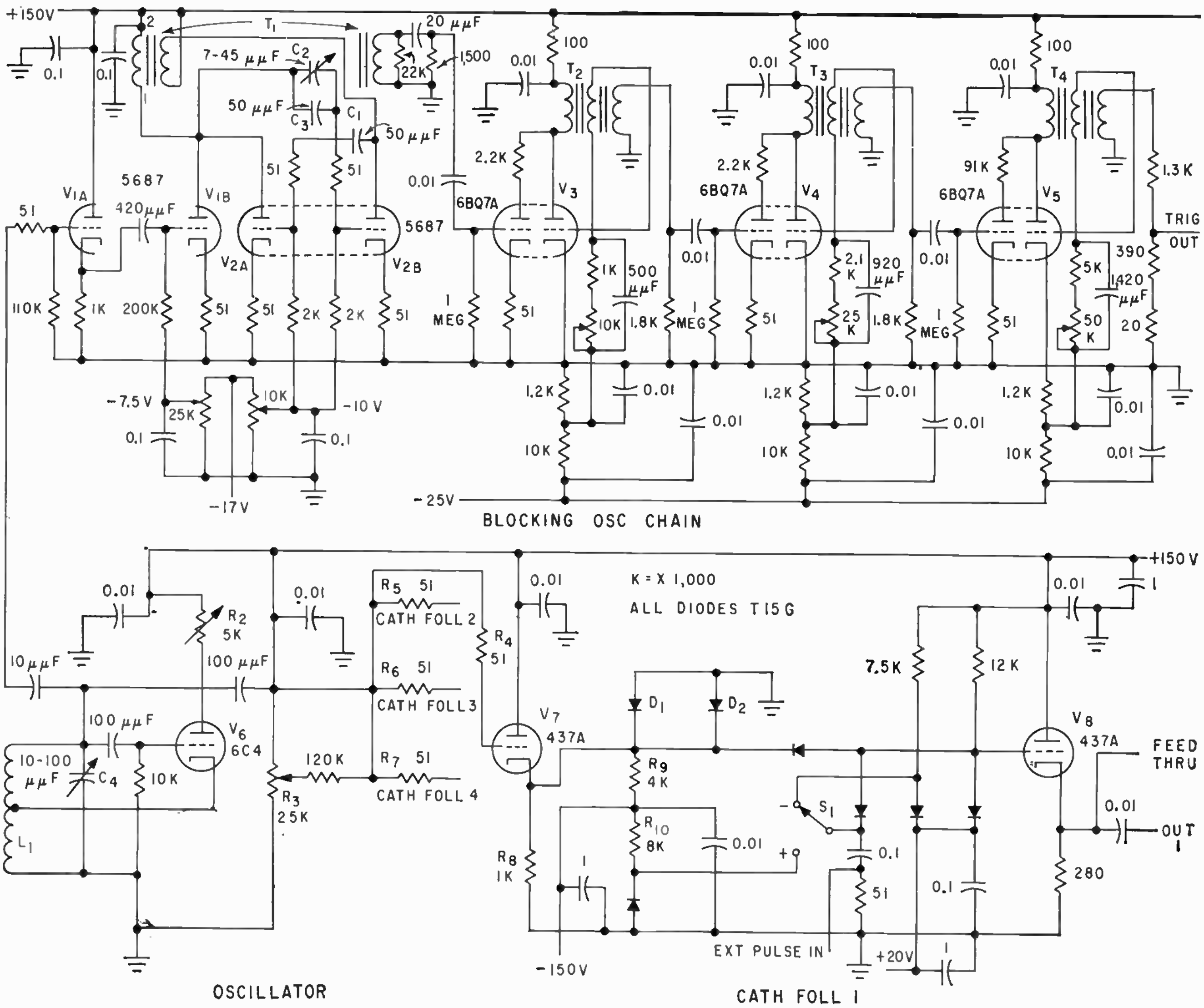


FIG. 1—Use of separate channel drivers prevents amplitude modulation of channels by eliminating coupling between channels

cathode of V_7 from being pulled below ground. This technique is used to discharge the capacitance at the output of V_7.

Switching

Cathode follower V_7 drives one input of a two-input AND gate directly. The other input is driven by the external pulser. Switch S_1 is used to secure either a 50-percent duty cycle or no output of the AND gate. When S_1 is in the minus position, 50-percent duty cycle is obtained. At the same time, if a negative pulse is applied to the gate by the external pulser, the external pulse turns off the gate and a blank interval, determined by the external pulse width, occurs in the string of output pulses.

When S_1 is in the plus position, the AND gate is held down by R_{10} and there is no output pulse. The output of the AND gate drives the output cathode follower V_8. Pulse amplitude is controlled by varying the voltage to which the grid of V_8 pulls up (shown as 20 v in Fig. 1). The output is varied from a single pulse to a 10 microsecond string of pulses by varying the width of a positive external input pulse.

The final output is available for a-c drive into a coaxial line or directly out on a feed through. Output impedance is 21 ohms and the output stage has a gain of 0.9.

Blocking Oscillator

The blocking oscillator chain is used to provide a synchronizing pulse for the external pulser. With no input to V_{1A}, the circuit would be free running.

The oscillator output is fed through cathode follower V_{1A} to the grid of V_{1B}, which is normally cutoff. The plate load of V_{1B}, winding 1-2 of T_1, is shared with V_{2A}.

When the signal on the grid of

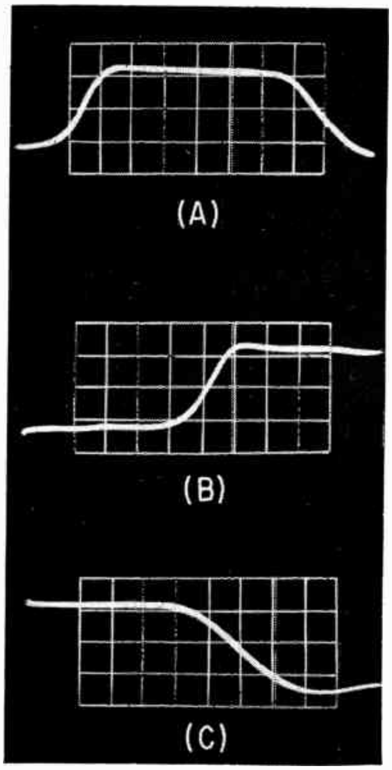


FIG. 2—Scope trace shows pulse (A), pulse rise (B) and pulse decay (C)

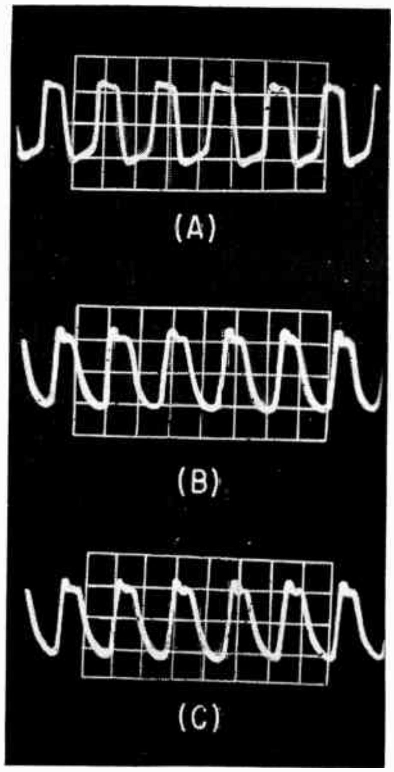


FIG. 3—Pulser output with no load (A), 50 $\mu\mu$f load (B) and 70μ μf load (C)

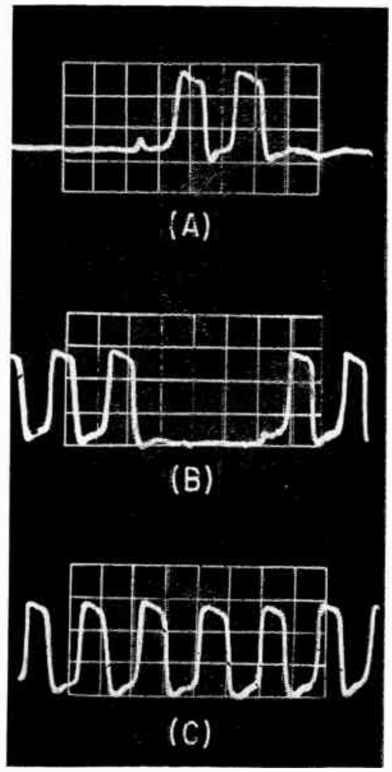


FIG. 4—Two pulses gated ON (A) and OFF (B) and ungated pulse (C)

V_{1B} causes V_{1B} to conduct a negative signal is applied to the plate of V_{2A}. Also, by virtue of transformer coupling, a positive signal is applied to the plate of V_{2B}. When V_{2A} is cutoff and V_{2B} is conducting, the application of the negative signal to the plate of V_{2B} causes them to reverse their states.

This action is compounded by the coupling capacitors between the grids and plates of V_{2A} and V_{2B}. At the instant V_{2A} starts to conduct the voltage at the plate of V_{2B} goes positive. During this interval the coupling capacitors are charged by the plate action. Since C_1 is smaller than the parallel combination of C_2 and C_3, the grid of V_{2A} is driven to cutoff before V_{2B} can turn on. Tube V_{2B} is finally turned on by the positive going voltage at the plate of V_{2A}.

The signal across the output of T_1 is an asymmetrical wave with high-amplitude narrow positive portion and a low-amplitude wide negative swing. This output is differentiated to produce a narrow positive triggering pulse. The circuit reliably divides an 18-mc input by six.

Pulser Output

Figure 2 shows the pulser output at 10-mc. and no load. The rise time is 7 millimicroseconds, the limit of the scope used. The decay time is 10 to 12 millimicroseconds. The effect of load on an output pulse of 10-mc is shown in Fig. 3. The 70 $\mu\mu$f load is greater than normal load requirements.

Figure 4 shows the output pulses being gated OFF and ON.

The pulser is especially useful for the dynamic testing of multiinput AND gates. Driving power is sufficient to drive several gate inputs in parallel. Thus, various combinations of input coincidence may be obtained by varying phasing and pulse width of the external gating pulses of only two channels. The variable output amplitude control provides a simple method of testing gate transient response as a function of input amplitude. These two features are used to thoroughly test gate designs before using them in prototype systems.

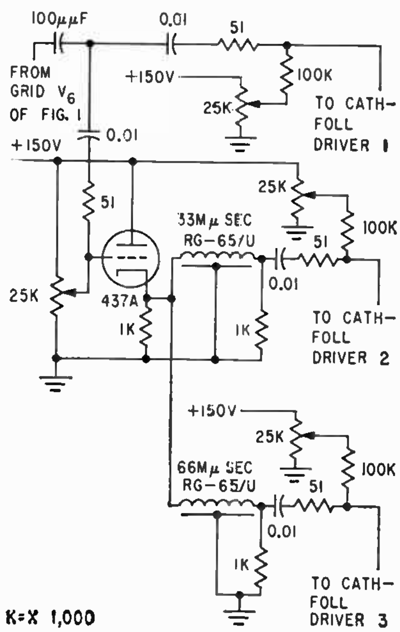


FIG. 5—Delay line is used to obtain impedance match

Clocking System

In addition to using the pulse generator for circuit testing, it is used to provide three- and four-phase 10-mc clocking for experiments where recirculation of pulses and pulse regeneration and reshaping are required. A three-phase clock system is shown in Fig. 5.

The delay line in the driver is necessary to secure proper impedance matching; otherwise, the circuit is the same as shown in Fig. 1.

The authors are indebted to the Department of Defense for sponsorship of this work and to Robert Bair, now with Colorado Research Corporation, for his aid in developing the blocking oscillator.

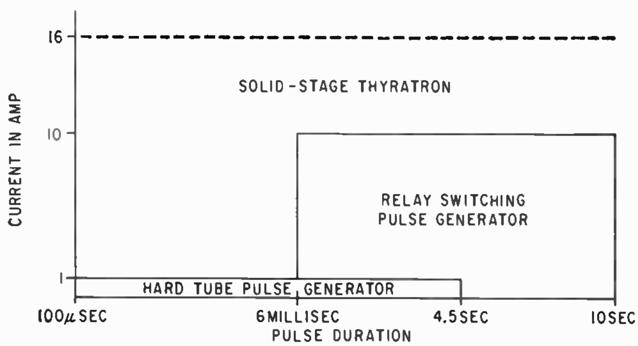


FIG. 1—Capabilities of solid-state thyratrons cover wide range

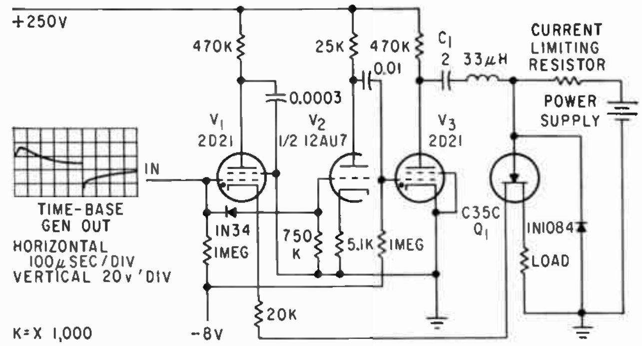


FIG. 2—A similar generator may switch currents of 100 amp

Generating Pulses With Solid-State Thyratrons

Single-pulse generator uses combination of electron tubes and solid-state device. Practical applications include testing of detonators, primers, squibs and explosive switches

By V. W. GOLDIE, R. G. AMICONE and C. T. DAVEY,
Franklin Institute Laboratories for Research and Development, Philadelphia, Pa.

SOLID-STATE THYRATRONS can be used to replace hard-tube and relay-switching pulse generators with a considerable saving in space, cost and power input. One application where the ability of these devices to switch average currents as high as 150 amp, for pulse durations up to 8 milliseconds[1], proves useful is in sensitivity investigations of very insensitive electro-explosive devices. Figure 1 compares the current capabilities of equipment used to evaluate electro-explosive components.

These electro-explosive devices propagate a chemical reaction when activated by an electric stimulus. Under actual working conditions the electric stimulus may be a battery, capacitor discharge or any configuration of electrical pulse.

An electro-explosive device is initiated by passing an electric pulse through a resistive element incorporated in the device. Initiation occurs when enough heat is absorbed by the explosive to cause a self-sustaining reaction. Two commonly used means of transducing electrical pulses into heat are small resistance wires and carbon films. In both cases the explosive is in contact with the element being heated. The d-c resistance may be as low as 0.1 to 10 ohms for the wire element and as high as 750 to 15,000 ohms for the carbon spot.

To minimize percent deviation in pulse width, pulse widths of 100 μsec or greater are used in the switching circuit shown in Fig. 2.

The input to the pulse generator is the differentiated output of a phantastron circuit. The leading positive spike of this pulse is used to trigger thyratron V_1, which closes the gate of solid-state thyratron Q_1 and starts it conducting.

At some predetermined time later, the trailing negative spike of the input is inverted and used to trigger thyratron V_3. This action causes C_1 to discharge, which in turn reverses the polarity of the applied voltage across Q_1 to stop conduction. The time lapse between the start and stop of conduction of Q_1 defines the pulse width. Satisfactory results have been obtained with this circuit and square wave pulses from 100 μsec to many seconds have been produced.

Currents varying from 50 ma to 16 amp and voltages from 100 mv to 100 v have been kept constant across electro-explosive devices ranging in resistance from 2 to 10,000 ohms. The rise time of the output pulse is less than 10 μsec, while the trailing edge falls to zero in less than 1 μsec.

The authors acknowledge the advice of R. F. Wood. This work was carried on under the sponsorship of Picatinny Arsenal (Contract DA-36-034-501-ORD-62).

REFERENCE

(1) T. P. Sylvan, Solid-State Thyratrons Available Today, ELECTRONICS, p 50, Mar. 6, 1959.

Geomagnetic Effects of Nuclear Bombs

ANALYSIS of changes that occurred in the earth's magnetic field when two nuclear bombs were exploded by this country at high altitudes is being carried out by the National Bureau of Standards. Results indicate the night-time explosions ionized the upper atmosphere at a distance of 2,000 kilometers to nearly daytime intensity, resulting in electric currents that temporarily altered the geomagnetic field.

The effects were recorded at regular magnetic observatories. Up to about 2,500 kilometers from Johnston Island, the firing point, magnetic field changes are ascribed to primary and secondary gamma radiation from the explosions.

Distant Effects

Effects at a site 3,400 kilometers away are attributed to charged particles from the detonations traveling along the lines of the earth's magnetic field toward the magnetic conjugate point, where artificial aurora were sighted on both occasions. Stations 4,000 kilometers or more from the explosions exhibited no distinguishable effect.

Analysis of rapid-run magnetograph results permits calculation of probable height of the lower explosion at between 35 and 50 kilometers and the other at about 20 kilometers or more higher.

Tidal Oscillation

Tests confirm geomagnetic theories dealing with quiet diurnal variations and magnetic storms. The Stewart-Schuster theory of diurnal variations in terrestrial magnetism assumes existence of two electromotive-force systems in the atmosphere. They result from tidal oscillation of the atmosphere across lines of force of the earth's permanent magnetic field—one system occurs in the daylight hemisphere and the other in the dark hemisphere. Because of ionizing action of the sun, electric currents flow in the daylight hemisphere but are virtually nonexistent at night.

Explosion of the weapons produced artificial ionization permitting currents to be driven by electromotive forces already present. The pattern of the resulting current system, which produced the magnetic effects, closely resembles the pattern of the current system regularly flowing during daylight. These artificially produced currents persisted for a little over half an hour after the explosion. The magnetic effects 2,000 kilometers away were nearly as large as if the lower layers of the ionosphere had been temporarily ionized to daytime intensity.

Field Changes

The magnetic field changes observed 3,400 kilometers away do not fit into this current system, but are due to local effects at the magnetic conjugate point. These effects persisted for well over an hour. The field changes exhibit erratic fluctuations commonly experienced by stations in high latitudes where auroral particles impinge on the atmosphere.

Electromotive forces generating currents about 3,400 kilometers away may have had two possible causes. One is the atmospheric turbulence resulting from heating the influx of charged particles. The other is that a magnetic field was propagated from the explosion along the earth's magnetic lines of force to the conjugate point of explosion on the opposite side of the geomagnetic equator.

Wide-Angle Tv Monitor

Closed-circuit tv at Atlantic City, N. J. airfield provides 7 by 3 aspect ratio picture. Developed by Grimson Color, Inc., monitor presents almost twice the information displayed by standord 4 by 3 aspect ratio screens

Low-Cost Particle Acceleration

EXTRAORDINARY effects of high-energy radiation have been known to laboratory research scientists for years. Crude latex was cold-vulcanized in seconds, chemical changes and reactions of many kinds were accelerated and fresh meats, fish, vegetables and fruits when irradiated became capable of remaining fresh, palatable and safe at room temperature for many months.

Scientists predicted that the whole world would some day enjoy the benefits of this discovery. But the cost of generating and using high-energy radiation prohibited its commercial use.

After four years of research and development, the Dynamitron is now being produced by Radiation

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by John Hickey,
Raytheon Industrial Products Manager

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Dynamics, Inc. The new accelerator uses a new concept in high-voltage generator design to convert large amounts of electrical power into kinetic energy of a beam of high-velocity atomic particles. Constant, well-regulated voltage and substantial output current is achieved in a compact, economical device. It produces an electron beam or X-rays.

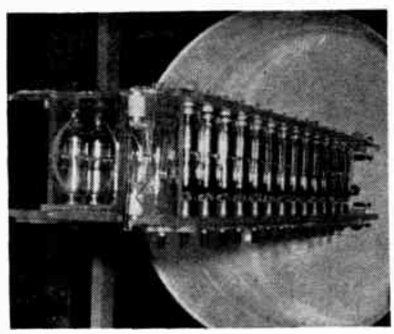
Construction

The unit converts low-voltage a-c to high-voltage d-c with a cascaded rectifier system driven in parallel by an r-f oscillator. The rectifier array is positioned between and spaced apart from a pair of large curved electrodes that form the tuning capacitance of the oscillator. The strong alternating field between electrodes induce intermittent current through the series-connected rectifiers, building up a large constant potential at the end of the array.

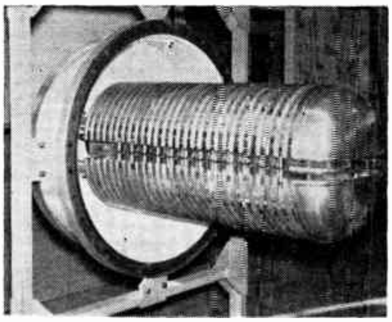
Interelectrode capacitance of rectifier tubes plus surface capacitance of corona shields attached to each rectifier junction provide adequate ripple control. Elimination of the usual filter capacitors with their high stored energy improves reliability.

In the center is an evacuated tube for acceleration of the beam of charged particles. The rectifiers, connected in series between ground and the high-voltage terminal, are positioned in two columns on opposite sides of the acceleration tube. The beam tube and rectifiers are enclosed by a set of corona shields bent into semicircular shape. The shields suppress sparks and corona discharges from the rectifier terminals and provide a large surface capacitance for coupling r-f power to the rectifier tubes.

The assembled elements are positioned between a pair of semicylin-



Bank of rectifiers produce a million volts of electron energy in evacuated beam tube



Corona shields of bent hollow metal tubes form capacitance that couples r-f to rectifiers

drical electrodes that form the tuning capacitance of an LC circuit. The entire apparatus is enclosed in a grounded pressure vessel. The resonant inductance is toroidal in shape and is mounted inside the vessel at one end and connected in parallel with the tuning electrodes.

Operation

In operation, r-f is fed to the toroidal coil at the proper frequency to produce a balanced a-c potential between the two cylindrical electrodes. Some a-c appears across each rectifier because of the capacitance between corona shields and resonant electrodes. A d-c bias is built up across each rectifier equal in amplitude to the induced a-c. Since the rectifiers are in series, the bias potentials add to produce a large d-c between opposite ends of the rectifier array. Electrons are drawn back and forth through the rectifiers from one bank of corona shields to the other by the alternating field between the cylindrical electrodes. Because of the rectifiers, electrons are pumped from ground to the high-voltage terminal against the constant field existing throughout the rectifier set parallel to the acceleration tube. D-c returns to ground through the particle acceleration tube.

The a-c generator is not connected directly to the rectifiers. The resonant electrodes act as a flywheel or energy storage device from which the rectifiers draw power by way of the capacitance of the corona shields. Thus a-c is fed in parallel to each rectifier, whereas d-c is drawn from the rectifiers in series. The high-pressure gas dielectric between resonant circuit and rectifiers permits both adequate d-c insulation and high-frequency a-c coupling.

How Liquid-State Switch Controls A-C

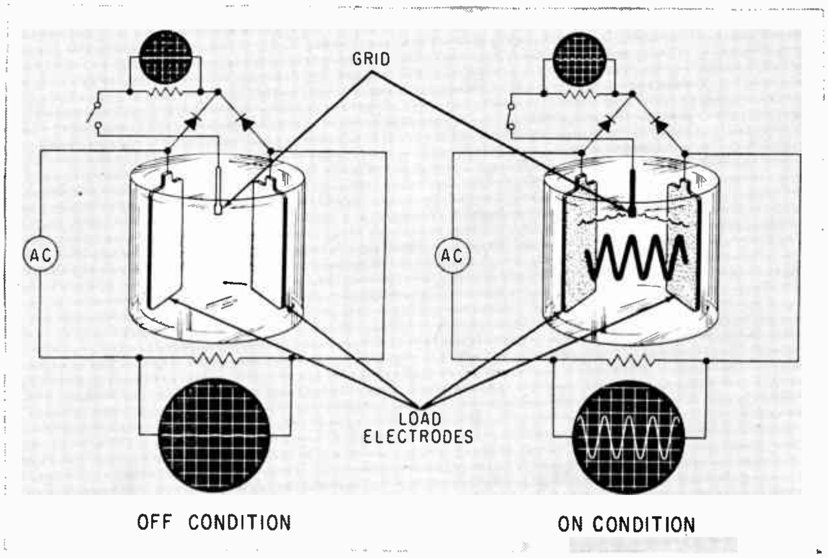


FIG. 1—Schematic diagram of Ovitron amplifier in off and on state. Diodes block a-c to the grid control circuit and allow the application of pulsating d-c potential on the grid and load-connected electrodes. Magnitude and potential of the control signals can be controlled by using a variable resistor instead of the switch

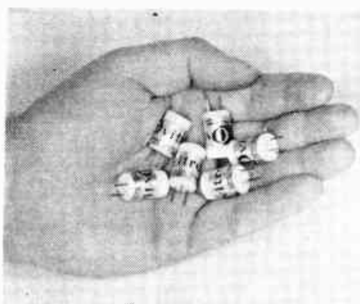
A STATIC COMPONENT for switching and modulating load currents consists of a permanently sealed wet cell that simply contains two load-connected electrodes and a grid control element immersed in an electrolytic bath.

Although component development to date has been devoted largely to commercial and industrial applications requiring control of a-c current in the milliamp to 15-ampere range, there appears virtually no limitation on the current carrying capacity of such a device, according to its inventor, Stanford R. Ovshinsky of Ovitron Corp., Detroit.

Neuron Analogy

The electro-ionic concept of current control was inspired, in part, by a theoretical study of the electrochemical dynamics of the human nervous system.

The neuron, or basic nerve cell of the human body, is a highly efficient and ultrareliable control component. This cell is surrounded by a semipermeable membrane which is charged positively on the outside and negatively on the inside. When a stimulus reaches the surface of the membrane, its permeability to certain ions increases with a corresponding decrease in resistance, and its surface becomes activated by a spreading wave of potential. This change in permeability during passage of impulse is accompanied by impedance changes on the membrane, thus effectively controlling the output of the large energy potential.



Miniaturized prototype models of Ovitron Electro-Ionic Control Units

The Ovitron devices are best described as having two membranes considered semipermeable to certain ions upon application of a stimulus from a grid element. This changes the surface condition of the membranes from a nonconducting to a conducting state, thus allowing large amounts of a-c to flow from one electrode to the other through the medium of the electrolytic field.

This high amperage is controlled entirely by the small energy stimulus, and in a manner which permits either switching or modulation. Moreover, modulation can be continuous without harmful effects.

When the control signal is removed from the grid element, or when another signal of opposite polarity is applied, the conductive surfaces are immediately restored to their original nonconductive state, thus effectively blocking the flow of current through the device.

Due to the simple concept and basic nature of the phenomena involved, the Ovitron principle of control through electro-ionic surface impedance change is inherently adaptable to a wide range of applications. Working models have been developed for proximity switches, logic devices, circuit breakers, error detectors, modulators, amplifiers, regulators, and time delays.

Oxide Film

The only changes which take place within the sealed unit are changes in the *surface state* of the electrodes—from nonconductive to conductive, and vice versa. The two load-carrying electrodes are coated with an oxide film. This causes them to act in the circuit as rectifiers back-to-back, and prevents current from flowing through the load.

Upon application of a small d-c potential to the grid control element, the two electrodes are polarized and metal ions are forced into the structure of the oxide film which changes the film from a nonconducting to a conducting state. Thus the load now "sees" two conducting electrodes and current passes between them. There are of course other effects as well—chiefly, the double-layer capacitive effects of the charges which are collected at the electrodes.

The chief function of the electrolyte is to provide convenient, instantaneous means for polarizing the two electrodes from the grid element. However, there is no change in the ionic state of the elec-

utmost in performance

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Sangamo Type 33M molded mylar* capacitors combine the excellent electrical performance characteristics of mylar* dielectric material with a molded case of high moisture resistant thermosetting plastic.

Temperature Range: "The Type 33M is designed to operate over the temperature range of —55°C. to +85°C. Satisfactory performance at 125°C. can be obtained by derating the voltage to 50% of the 85°C. value."

Dissipation Factor: The dissipation factor of the Type 33M capacitor does not exceed 1% at normal equipment operating temperature over the complete audio frequency range.

Tolerances: Available in capacitance tolerance values of ±5%, ±10%, ±20%.

Life Test: These units will withstand a life test of 250 hours at 125% of rated voltage at 85°C. Life tests at 125°C. should be made at 125% of the derated voltage.

Dielectric Absorption: Dielectric absorption of Type 33M capacitors is less than half that of oil impregnated paper capacitors.

Moisture Resistance: Type 33M capacitors will successfully withstand the moisture resistance tests specified in Spec. MIL-C-91A.

Insulation Resistance: The insulation resistance of these capacitors will exceed 5,000 meg/mfd. over the normal operating temperature range.

• Write for engineering bulletin TSC-206A

*DuPont's trademark for polyester film.

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SC-59-6

trolytic medium during conduction. The electrolyte has no transducing characteristics of its own, nor is its use based in any way upon Solion principles.

Life and Reliability

Both load electrodes and the grid control elements are impervious and nonreactable to the electrolytic bath, and show no indication of dimensional change with age or continuous repeated operation. The grid element has a mutual reduction and oxidation relationship with the two load electrodes which is expressed by the control current. During operation, small amounts of gases are formed by the grid control current only—not by the load current. A catalyst is used to return these gases to solution, thereby achieving a self-regenerative process within the device which prevents depletion of the fluid. When the unit is off, a mutual redox relationship maintains an equilibrium system in which no gases are formed.

Unlike mechanical devices and electron tubes, these devices are not affected by vibration, shock, impact,

Ultrasound Measures Nose-Cone Thickness

Nose cones for the Nike-Hercules missile here await inspection by use of an ultrasonic resonance gage made by Branson Instruments of Stamford, Conn. When the transducer is placed against the outside surface of the cone, high-frequency mechanical vibrations are transmitted into the metal. Fed back into an electronic circuit, resonant vibrations are shown by two or more vertical traces in the face of a cathode-ray tube. A scale indicates wall thickness directly. Wall thickness must be held to within ±0.006 in.

moisture and position. And unlike transistors, their operation is not dependent upon sensitivity to temperature or influenced by heat deviation characteristics.

Characteristics

Present Ovitron controls operate with characteristics comparable to magnetic amplifiers, and sufficient tests have been conducted to establish the fact that much greater speeds are obtainable if desired.

Load voltages of present devices are 3-v a-c minimum, 70-v a-c maximum. Multiple cell units may be supplied to obtain higher ratings. Current rating may be varied by increasing or decreasing size of unit and surface area of load carrying electrodes.

Ratio of control to load current can be varied from 10:1 to 50:1 or even higher, depending on specific application requirements. Speed of response is greater at lower ratios. Recorded control and load current characteristics show surges in the control circuit in the magnitude of 1½-2:1 of the steady state current. Power gain is in the order of 650.

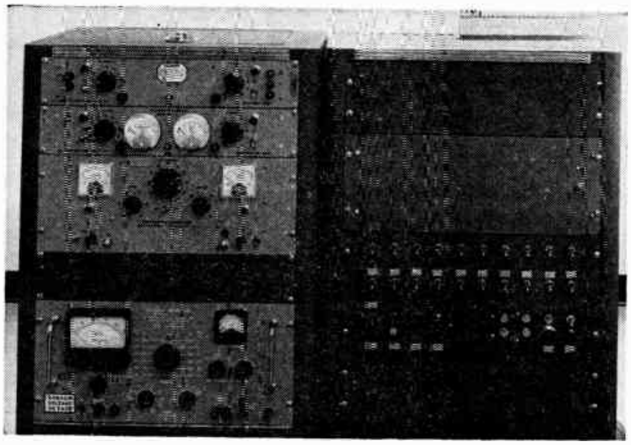
The break time has been controlled between one-half to three cycles of 60-cycle a-c under various conditions. If higher-frequency current is used, speed of response increases accordingly. Applied voltage does have a slight effect on break characteristics, but varying current within rating has no influence.

Strength of Ceramics

CERAMIC materials are being investigated at the National Bureau of Standards for the Air Force to develop a better understanding of the factors controlling their strength at elevated temperatures. As part of the program, the strength of aluminum oxide single crystals, sapphire and ruby, has recently been studied by J. B. Wachtman, Jr. and L. H. Maxwell at temperatures between 600 C and 1,000 C. The study, "Strength of Single Crystal Sapphire and Ruby As a Function of Temperature," supports the theory that, in properly oriented crystals, plastic deformation relieves stress concentrations, thus increasing crystal strength.

Set Tests 18 Transistor Values

By R. A. PLANCK, Military Products Division, International Business Machines Corp., Owego, N. Y.



Cabinet at left contains power supplies and bias supply programmer. Transistor rack is atop cabinet at right

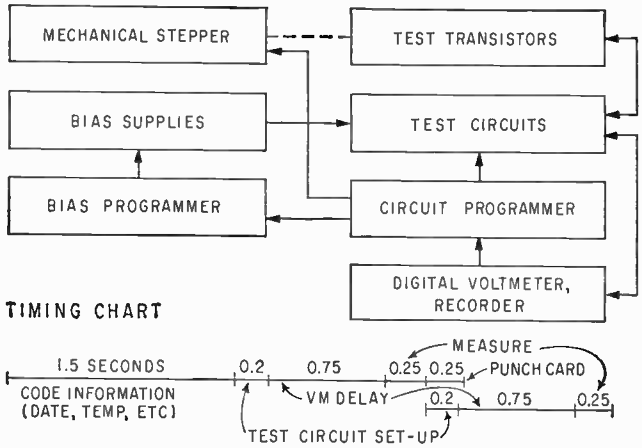


FIG. 2—Circuit programmer is heart of test set. Its program is manually selected by switches in right-hand cabinet

TRANSISTOR TEST set which automatically measures in 15 minutes up to 18 d-c parameters of 30 silicon or germanium transistors, with ratings up to 20 w, is described. Data may be recorded directly on punched cards for machine analysis.

A h_{fe} test circuit (Fig. 1) is the only novel circuit. It allows h_{fe} to be measured with constant collector voltage and current. The meter relay detects the difference between V_c and the reference voltage. Q_1 and Q_2 conduct according to the direction the meter relay swings. This starts the motor in the proper direction so that the transistor under test is *on* or *off* and changes the collector current to the desired value.

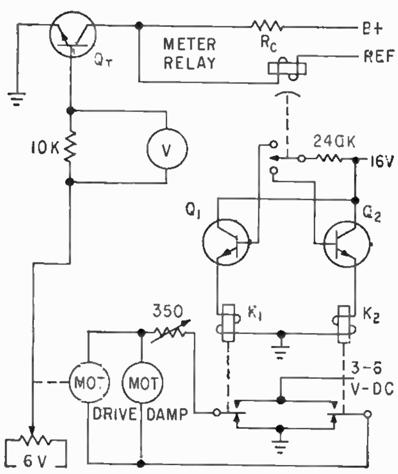


FIG. 1—The h_{fe} test circuit. Q_T represents the transistor under test

The collector resistor and $B+$ were selected so that with desired collector current, $V_c = (B+) - I_cR_c$. The circuit is accurate to 2.5 percent and repeatable within 1 percent.

A delay of about 3 seconds in the h_{fe} circuit allows it to null. Timing of all other circuits is determined by the voltmeter, which delays about ¾ second to allow the circuits to stabilize. The delay is obtained by a series of multivibrators triggering the voltmeter sweep.

Test Performance

Voltages of 0.1 mv to 199.9 mv are measured to ±2.5 percent. Current measuring accuracy is: 1 mμa, to 5 mμa, 20 to 4.5 percent; 5 mμa to 10 mμa, 4.5 to 2.5 percent, and 10 mμa to 20 ma, 2.5 percent. A 5-place digital voltmeter substituted for the 4-place unit used would extend 2.5 percent accuracy to 1 mμa.

Consistent of test conditions—important to long term comparison of data—is achieved by applying the same bias and allowing the same test time for each transistor.

Operation

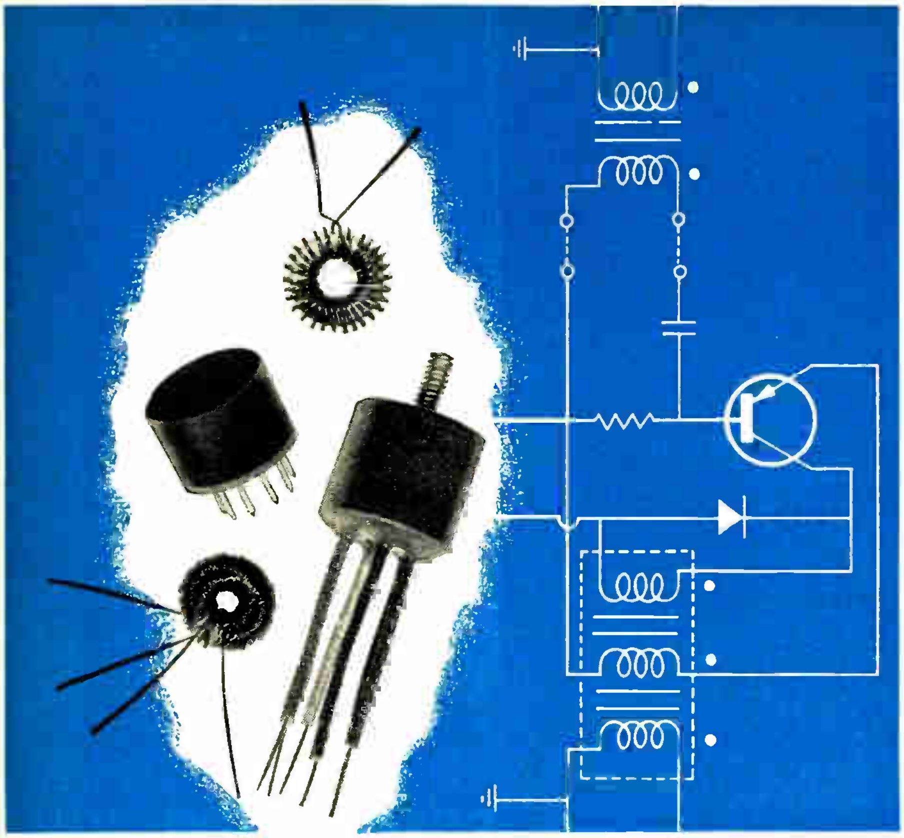
Major units and operating times of the system are shown in Fig. 2. The circuit programmer has a rotary switch, a dpst relay, a 4-position wire contact relay and 20 spdt toggle switches. Each measure-read-record cycle ends in a signal which advances the rotary switch and sets up the next test circuit.

A mechanical stepping mechanism delivers each transistor to the test station. A rack with 30 sockets holds the transistors. Contacts connected to the sockets are moved onto stationary contacts by a motor-driven chain. Rack travel is controlled by a 1-cycle clutch and a 6-station geneva disk. On each pulse to the clutch, the rack moves the distance between 2 sockets. The clutch is actuated by the circuit programmer.

Programming

Selector switches allow the measurement or skipping of any parameter wired on the test circuit panel. Any d-c parameter test can be applied; each test circuit is wired on an individual terminal block for a wire contact relay. The blocks are wired with easily changed taper pins. At present, all measurements being made are standard ones.

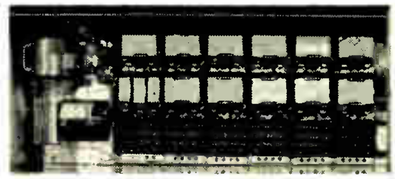
A plugboard programs the power supplies. The constant voltage or current to bias the test circuits is selected by the value of resistance used in various places on the plugboard. A board range of biases is provided. Bias voltages of 0.5 to



100 v and currents of 10 μa to 500 ma are available.

Two d-c power supplies and 1 dry cell battery provide low voltage biases. A high voltage supply and a current regulator provide constant current. Biases are applied to test circuits only after the transistor is connected, to avoid damage.

Top view of transistor rack and mechanical stepping mechanism



Test circuit relay gate (panel is closed in large photo)

Biases are applied through a 12-position wire contact relay which is delayed 10 to 12 msec with respect to the test circuit relay. All biases are removed 8 to 10 msec before the transistor is removed, by using a capacitor to delay relay dropout.

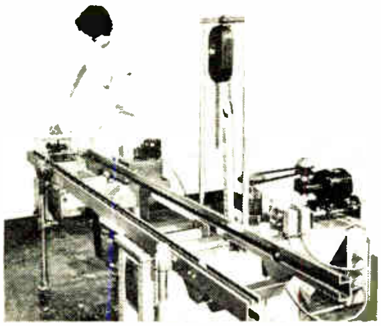
The set is prepared for operation by programming the plugboard, selecting *npn* or *pnp* by a switch, selecting parameters, loading transistors, positioning the transistor rack and pressing the start button.

Addition of a-c parameter tests is planned. The author acknowledges his appreciation to D. Salisbury and F. Alexander, of IBM Owego, and V. Winkler and F. Jordan, of IBM Poughkeepsie, for their contributions to design and construction of the tester.

Flux and Solder PC Boards with Waves

FLUX APPLICATOR, circuit board heating bank and conveyor have been added to the Fry Flowsolder solder wave dip soldering machine (ELECTRONICS, p 248, August 1, 1957), to make it an automated soldering system.

The flux applicator provides a wave of flux or solder resist. Fluid is pumped to a tank higher than the wave nozzle so that it is fed

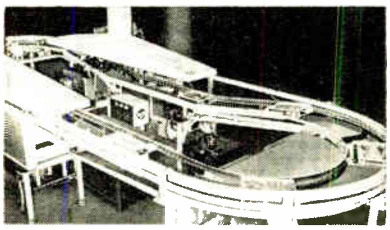


Conveyor carries boards from flux wave to solder wave. Infrared lamps heat board before soldering

through the nozzle by hydrostatic pressure. A vernier control adjusts wave height.

The board heater consists of infrared lamps in a reflector. The conveyor or transfer mechanism is chain-driven at speeds variable from 1 to 14 fpm. Clearance between channels is 10½ inches. A board carrying fixture, adjustable for boards up to 9½ inches wide, is included. The equipment is available in the U. S. from Electrovert, Inc., New York, N. Y.

Use Foaming Flux in P C Soldering System



IMPROVED VERSION of the cascade multiwave dip soldering system (ELECTRONICS, p 25, April 18, 1958) is available from Radio Corporation of America, Camden, N. J.

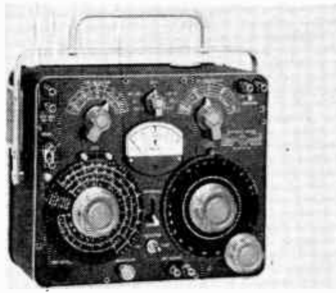
Portions of the conveyorized system apply flux, preheat the boards, solder and clean excess flux. Loading is by hand, into pallets, at rates up to 600 boards an hour. The boards pass at an angle over 4 ripples of solder.

Flux is applied as foam, rather than by brushing. Controlled air jets foam the liquid flux. RCA says this method has been found more efficient than brushing. The flux is made hot and tacky by the heater.

The system can be adapted to process boards in a continuous strip separated after inspection.

On The Market

Impedance Bridge
accurate unit



GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1650-A impedance bridge is a highly accurate instrument for the measurement of the inductance and storage factor, Q, of inductors, the capacitance and dissipation factor, D, of capacitors, and the a-c and d-c resistance of all types of resistors. Five separate bridge circuits give flexibility and wide range. One important feature is Orthonull, a new mechanical-ganging device which facilitates measurement of low-Q inductors (or high-D capacitors).

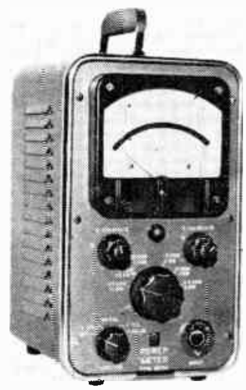
CIRCLE NO. 200 READER SERVICE CARD

TWT Amplifier
p-m focused

HUGGINS LABORATORIES, 999 E. Arques, Sunnyvale, Calif. Type HA-51 permanent-magnet focused twt amplifier has a frequency range of 250 to 500 mc. Signal gain is 20 db (min.); power output, 10 dbm (min.); capsule length, 16$\frac{3}{4}$ in.; net weight, 6 lb.

CIRCLE NO. 201 READER SERVICE CARD

Power Meter
± 5 percent accurate



FXR, INC., 26-12 Borough Place, Woodside 77, N. Y. The B831A temperature compensated power meter incorporates a unique method of controlling the accuracy of r-f power measurements, particularly in the lower power levels. The series 218 temperature compensated thermistor head is used as a required accessory. In the 218, a second and identical temperature sensitive element is mounted in proximity to the first or r-f element, but outside the r-f field. Both elements react identically to variations of ambient temperature but the circuitry of the B831A reconciles its spurious effect on the r-f sensitive element. This provides virtually drift-free operation, even in the 10 μw range.

CIRCLE NO. 202 READER SERVICE CARD

Power Supplies
for c-r tubes

AVIONICS RESEARCH PRODUCTS CORP., 1215 El Segundo Blvd., El Segundo, Calif. All power requirements for high intensity crt's with pre- and post-acceleration including focus and intensity controls and gate coupling condensers are provided in a space of less than 2½ by 4 by 5.5 in. with the Mark I high-voltage power supply. It meets applicable military specifications and is operational to more than 70,000 ft without pressurization. The practice of using solid state elements throughout results in extremely long life.

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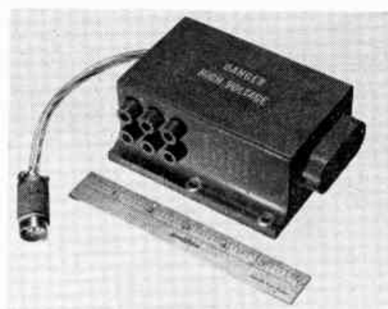

Tap Welder
for potentiometers

EWALD INSTRUMENTS, Box 124, Kent, Conn., has developed the Flash-Flow welder, a tap welder for potentiometers with built-in audible ohmmeter. The welder can be used to put taps onto single turns of windings made of 0.0005 to 0.008 in. diameter wire. It will handle most of the commonly used winding alloys in both precious and non-precious metals. The Flash-Flow

process uses a thin ribbon material to obtain tap connections with low terminal resistance. Use of this ribbon also greatly simplifies the handling of the tap material, and reduces the need for operator skill.

CIRCLE NO. 204 READER SERVICE CARD

Voltmeter phase-angle

NORTH ATLANTIC INDUSTRIES, INC., 603 Main St., Westbury, N. Y. Model 301 broadband phase angle voltmeter provides in one unit a conventional vtvm, a phase meter and a voltmeter that measures both quadrature and in-phase components with respect to a reference. It is adjustable to any frequency in the range 10 to 100,000 cps. Voltage measurement range is 1 mv to 300 v full scale, in 12 steps. Instrument is readily applicable as a phase-sensitive null indicator, ratiometer, detector for synchro bridges and for use in amplifier alignment and transducer calibration.

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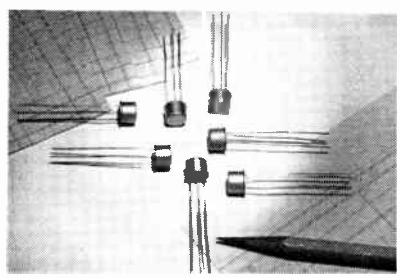

Silicon Transistors fixed-bed mounting

GENERAL ELECTRIC CO., Syracuse, N. Y., announces seven silicon h-f transistors designed for both amplifier and switching circuits and JEDEC type-designated 2N332 through 2N338. Fixed-bed mounting using a ceramic disk results in an extremely low thermal resistance which permits lower junction temperatures at high dissipation

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COAXICON offers not only the fastest method of attaching disconnects to your shielded wire . . . it is not only the most reliable disconnect you can buy—for either free hanging or panel mounted applications . . . not only the most economical on the market . . . but . . . COAXICON now fits shielded cable sizes up to ¼" O.D. with interchangeable contacts that permit a wide variation of inner conductor diameters in each cable size.

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levels. Accelerated life tests were run at an ambient temperature of 150 C and a dissipation of 75 mw. The military spec for these transistor types derates to zero dissipation at 150 C. Over the 1,000-hr tests, beta increased only about 20 percent and I_{co} was typically 2 millimicroamperes at 25 C. At 150 C, I_{co} is typical about 1 μa.

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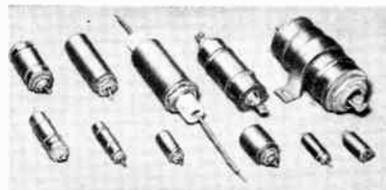
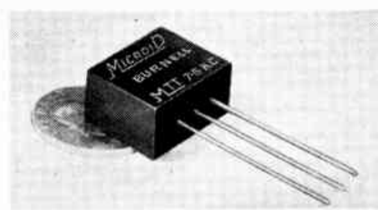


R-I Filters
bulkhead-mounting

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass., offers a series of 68 bulkhead-mounting low-pass filters for suppression of electronic interference generated by electrical and electronic equipment. Current ratings are from 5 ma to 50 amperes. Units meet military environmental conditions and operate at high temperatures. Complete technical information is listed in engineering bulletin 8100, available on letterhead request.



Filters
microminiature

BURNELL & CO., 10 Pelham Parkway, Pelham, N. Y. Type MTT Microroid band pass filters for transistorized circuitry measure ½ by 19/32 by 15/16 in. and weigh 0.3 oz. Range is 7.35-100 kc; bandwidth, 15 percent at 3 db and +60 −40 percent at 40 db. Fully encapsulated, they exceed MIL specs.

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TWT Amplifier
light, compact

MENLO PARK ENGINEERING, 711 Hamilton Ave., Menlo Park, Calif.,

announces TA 36 PM permanent magnet focused twt amplifier, applicable to many uses in the operating frequency range of 0.5 to 1.0 kmc. The ruggedized power supply provides 0.1 percent regulation, with maximum ripple on the helix less than 10 mv. Front panel metering is provided for helix voltage, helix current and beam current. Unit is designed for relay rack or cabinet mounting.

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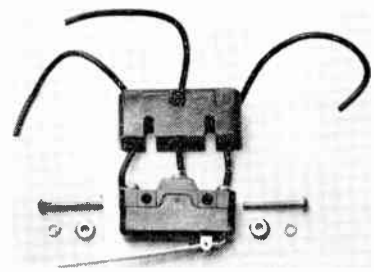

Terminal Protector long life

ROBERTSHAW-FULTON CONTROLS CO., P. O. Box 449, Columbus 16, Ohio. A new terminal protector, for use with basic switches having one inch mounting centers, has 11 knockouts, making possible many wiring possibilities. It may be used with either solder or screw terminals, in either flat or step base switches. It is made of high impact material for long life.

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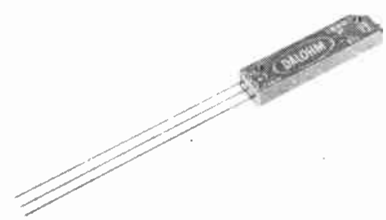

Trimmer Pot completely sealed

DALE PRODUCTS INC., Box 136, Columbus, Neb. Type 1000 W trimmer pot meets all humidity requirements of MIL-STD-202A, Method 106A or MIL-E-5272A, Procedure I. Power rating is 2.5 w to 70 C, mounted per MIL-R-19A with marking away from panel; 1.25 w to 70 C in free air. Resistance tolerance is ±5 percent standard; resistance range from 10 ohms to 50

K ohms, depending on value required. Temperature coefficient is 50 ppm/deg C maximum. End resistance is 3 percent maximum on all values; nominal resolution, from 0.1 to 1.5 percent; linearity, below ±3 percent on all values.

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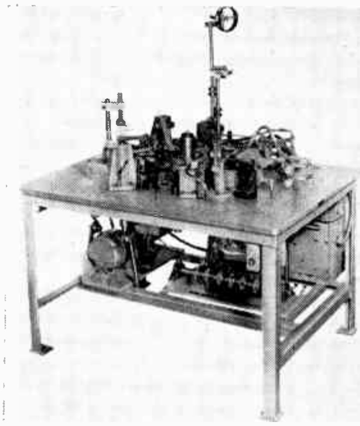

Soldering Machine for cat whisker wire

KAHLE ENGINEERING CO., Union City, N. J., announces a new machine that automatically feeds cat whisker wire from a spool into a tiny hole and solders it. The machine then precision cuts the wire and forms it into an "S" shape. The unit has been production tested for the intricate operations involved in automatically soldering cat whisker wires into the prong of ceramic crystal diodes. However the principle of the machine may be applied to similar operations involving similar shapes or parts.

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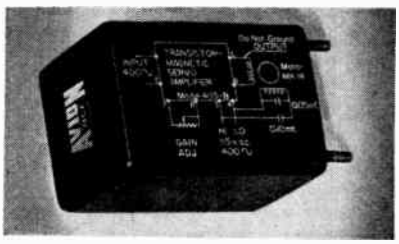

Servo Amplifier compact unit

AVION DIVISION, ACF Industries, Inc., 11 Park Place, Paramus, N. J. Model 403 transistor-magnetic servo amplifier is a compact, completely self-contained unit. It

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drives a 3.5-w Mark XIV or equivalent size motor from low-level a-c signals. It requires only 115-v, 400-cycle excitation. Servo stabilization is inherent in the design. Model 403-A has an input impedance of 30,000 ohms and a gain of 2,000 times; the 403-B, an input impedance of 500,000 ohms and gain of 900 times.

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Ring-Gun simply operated

WALDES KOHINOOR, INC., 47-16 Austel Place, Long Island City 1, N. Y. A new ring-gun is designed for high-speed, mass-production assembly of Truarc series 5103 Crescent rings, series 5133 E-rings and series 5144 reinforced E-rings. Rapid loading with Rol-Pak tape-wrapped stacked rings, illustrated in photo at top, assures a constant supply of the fasteners. In photo at bottom, the tool has been used to install three series 5144 rings on the roller studs. In each case, the tool was placed over the stud, the tongue of the actuating lever inserted into the groove and the trigger compressed.

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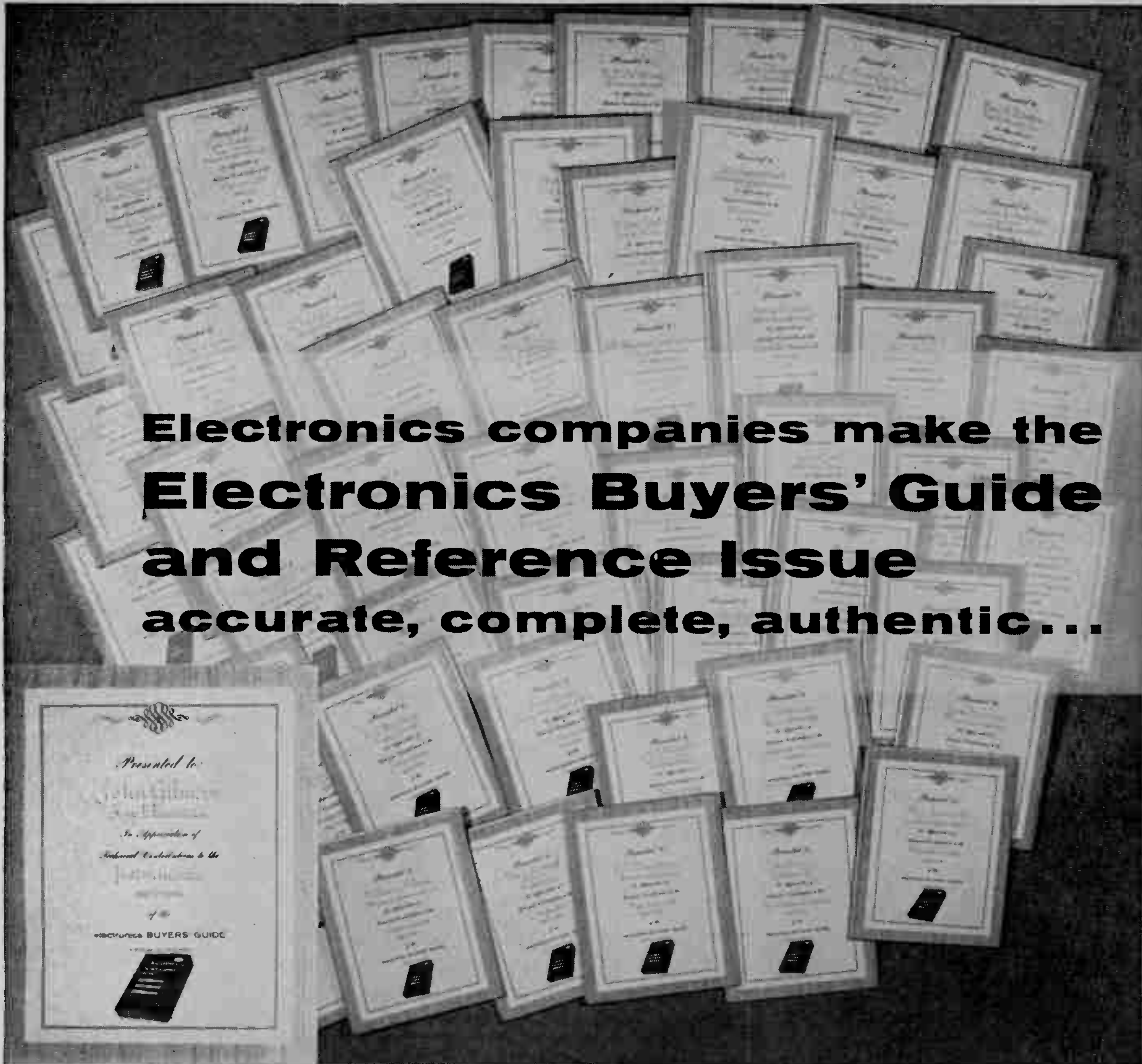
Insulating Parts oxide ceramics

MATERIALS FOR ELECTRONICS, INC., 152-25 138th Ave., Jamaica 34, N. Y. Degussit ceramics in pure sintered alumina, sintered spinel, sintered zirconium oxide (stabilized), sintered magnesium oxide and kaolin bonded corundum. Insulat-



For nineteen years, firms in the electronics industry have made direct contributions to the accuracy, completeness and authenticity of the BUYERS' GUIDE.

Recently, the staff of the BUYERS' GUIDE decided to award plaques to express appreciation to those in the industry who had made direct contributions to improve the product listings. The photograph above represents a few of the awards that have been made.

The awarding of the plaques is but one indication of how the BUYERS' GUIDE evolved over the years . . . a *cooperative effort between the publication and the industry it serves.*

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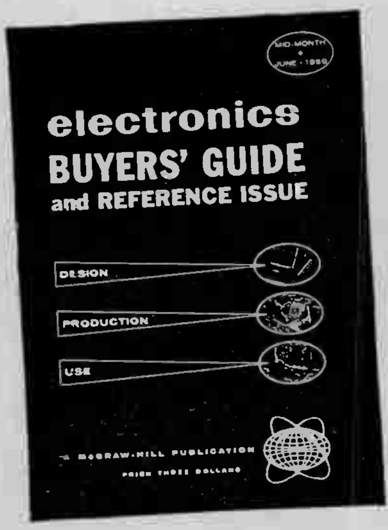

Published mid-year as the 53rd issue of **electronics**

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ing parts made from pure alumina body (A1-23) may be sintered into shapes without adding sintering auxiliaries. They are stable in oxidizing and reducing gases, high vacuum, against all tube metals and can be metalized by any process.

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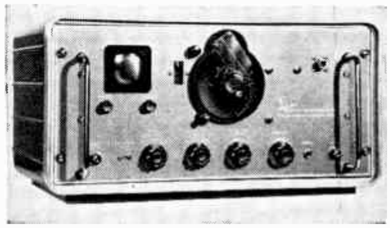

Frequency Meter self-contained

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn, N. Y. Type 504 is a self-contained precision heterodyne frequency meter that provides direct reading of frequency from 100 to over 10,000 mc to an accuracy of 0.03 percent. A simple twist of the wrist permits the meter operator to read frequency to 0.1 mc without any longhand interpolation, thanks to a unique automatic interpolation device. Calibration charts are not necessary.

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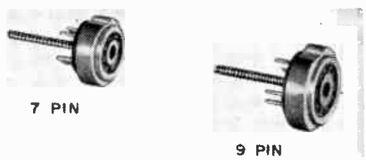

Tube Socket Saver meets MIL specs

FORWAY INDUSTRIES, INC., 122 Green Ave., Woodbury, N. J., has available a tube socket saver for 7 and 9 pin miniature, and octal type sockets. Designed for use in electron tube testers, these savers are inserted into the sockets of the test set panel. When the contacts become worn, the expendable saver can be thrown away, and a new one replaced without rewiring the test set. Height of the base is held to a minimum and therefore the socket saver will fit into a limited space. Maximum height above the

panel of the 7 and 9 pin is only 11/32 in.

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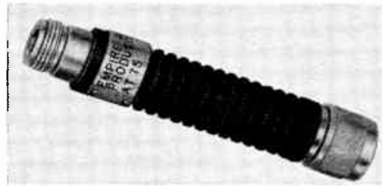

Attenuator Pad high power

EMPIRE DEVICES PRODUCTS CORP., Amsterdam, N. Y. Model AT-75 coaxial attenuator pad has a high power rating (up to 4 w continuous and 2 kw peak). Units are recommended for use as laboratory standards of attenuation at microwave frequencies, calibration and periodic checking of attenuators in signal generators and other measuring instruments, and as isolating pads when a source must "see" a low vswr not provided by the load.

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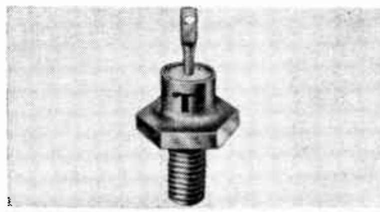

Power Rectifier heavy-duty

TRANSITRON ELECTRONIC CORP., Wakefield, Mass. A new heavy-duty stud-mounted silicon rectifier features a high-current rating of 35 amperes at 150 C case temperature. A standard 11/16 in. hex base encapsulation provides ease of mounting and an adequate heat-sink. Piv ratings range from 50 to 400 v. Opperating and storage temperatures range from —65 to 200 C.

CIRCLE NO. 218 READER SERVICE CARD

Rotary Switch replaceable wafers

CHICAGO DYNAMIC INDUSTRIES, INC., 1725 Diversey Blvd., Chicago 14, Ill., offers a rotary switch, any wafer of which lifts out without unsoldering or disassembling for

cleaning or replacement. Switches are available in sizes approximately 2 by 2 in., 3 by 3 in. and 4 by 4 in. with lengths to accommodate up to 36 wafers. Wafers can be made to include printed circuitry and components in addition to their normal switching function.

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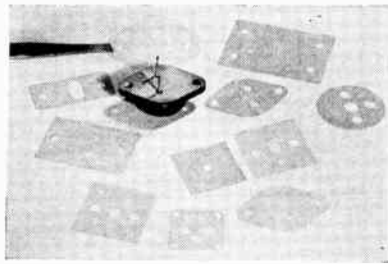

Mica Wafers protect transistors

FORD RADIO & MICA CORP., 536-540 63rd St., Brooklyn 20, N. Y., is now producing mica wafers stamped to fit the bases of standard transistors and diodes. An excellent insulator with dielectric strength of up to 6,000 v/mil, the mica prevents grounding with the chassis. A thermal conductivity of 0.00014 to 0.0008 allows rapid transfer of transistor or diode heat to chassis heat sinks, thereby preventing runaway semiconductor performance caused by overheating.

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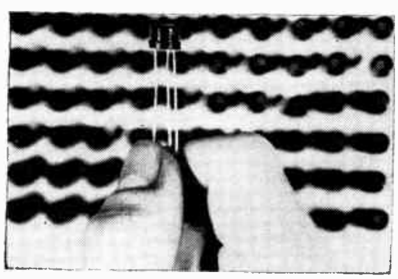


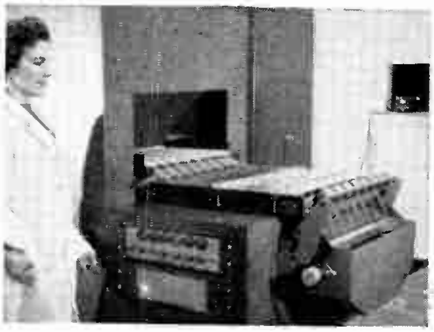
Diode Switch multijunction

WESTINGHOUSE ELECTRIC CORP., P. O. Box 2088, Pittsburgh 30, Pa., announces a 200-mw Dynistor diode switch. It is a multijunction, two-terminal germanium switch that can transfer from a blocking to a conductive condition in fractions of a microsecond. It is ideal for applications in computers and core-driver circuitry. It can also be used as a protection against transient

dekatron®

FOR FAST AND ACCURATE COUNTING

cold-cathode glow transfer counting TUBES up to 20,000 counts/sec



DELTA ENGINEERING CORP., When developing this high-speed Automatic Counting Machine, evaluated many preset counters. Delta decided on an electronic count control using Baird-Atomic Dekatron counting tubes. The machine can tally up to 5-million manufactured parts an hour with an accuracy of 1/10 of 1% — an application requiring the extreme reliability and performance gained by Dekatron's more than 10 years of service.

For full details on Dekatron glow-transfer tubes and patented drive circuits, write to . . . .

Baird-Atomic, Inc. Baird Atomic
33 UNIVERSITY RD. CAMBRIDGE 38, MASS.

Instrumentation for Better Analysis

CIRCLE NO. 125 READER SERVICE CARD

MEET ROLLY CHAREST

Associate Editor electronics

RESUME:

Charest, Roland J., Boston University, BS in Journalism. Formerly New England editor for **electronics**. Navy sonarman. Writer, reporter, editor for Lynn Item, Boston Globe, Boston Traveler. Won a New England Associated Press (AP) award in 1955 for writing feature articles in the major city newspaper class.

PRESENT OCCUPATION:

Rolly Charest supports Managing Editor Jack Carroll for editorial content accuracy and expediting putting each weekly issue to bed. Rolly reworks headlines for greater readability, is involved in makeup, and helps polish editorial content. Rolly's across-the-board background assures you accuracy in the face of journalistic pressures; articles in this week's issue that could be held over to the next deadline, but are not. The readers' interests come first!

REFERENCES:

If you're not a subscriber, if your subscription is expiring, if you will miss exciting features "in-the-works" by **electronics** 26-man staff, fill in box on Reader Service Card. Easy to use. Postage is free.

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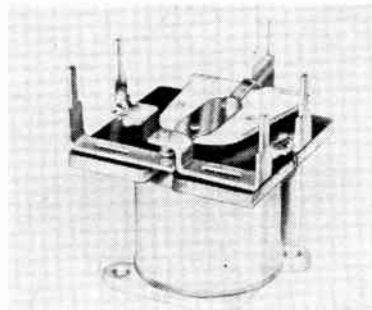
CIRCLE NO. 99 READER SERVICE CARD

overvoltages, as an oscillator, a sawtooth wave generator, a fast acting relay, and a phase controlled rectifier. It is available in four breakover-voltage categories ranging from 50 to 200 v.

CIRCLE NO. 221 READER SERVICE CARD



D-C Relay for p-c use

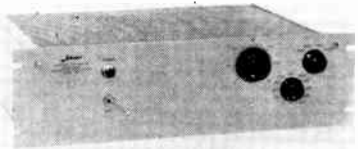
PRICE ELECTRIC CORP., Frederick, Md., announces a midget rugged spdt relay developed for use in printed circuitry where relay is self supporting. It is designed for use in radiosonde, mobile communications and commercial applications. Standard operating voltage is 3 through 24 v d-c; d-c resistance range, 8,500 ohms; d-c power requirement, 0.10 w. Standard contact rating is up to 1 ampere 50 v d-c, resitive.

CIRCLE NO. 222 READER SERVICE CARD

Resistance Furnace high vacuum

NRC EQUIPMENT CORP., 160 Charlemont St., Newton 61, Mass., announces a high-vacuum resistance furnace with the hot zone capacity to handle production as well as laboratory work and with the ability to operate at temperatures as high as 2,400 C (4,400 F). It is expected to find widespread application for heat-treating, brazing, sintering and testing of both reactive metals and ceramics. Completely self-contained, with the furnace chamber, pumping system, power supply, and controls in one cabinet, the model 2915 can be operated at absolute pressures of 10^{-5} mm of mercury, or under inert atmospheres. Vacuum is achieved by a 30 cfm rotary gas ballast pump for roughing operation, and a 6-in. high vacuum oil diffusion pump for evacuation in the high vacuum ranges.

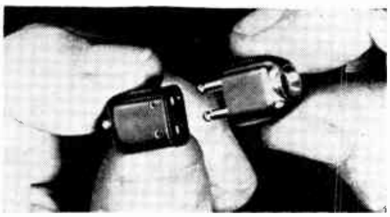
CIRCLE NO. 223 READER SERVICE CARD



Power Supply high stability

INTERSTATE ELECTRONICS CORP., 707 E. Vermont Ave., Anaheim, Calif. Model 304 is a 25 ma, 500 to 2,500 v, continuously adjustable power supply. Ripple is less than 0.5 mv. Load change is less than 0.002 percent for 0 to 25 ma output. Regulation is 0.003 percent change for line change of 97 to 137. Stability is 0.01 percent per hour, 0.1 percent per day.

CIRCLE NO. 224 READER SERVICE CARD



Miniature Connector snap-fit assembly

FLUOROCARBON PRODUCTS, INC., Camden 1, N. J. Featuring cost-saving snap-fit assembly a new Chemelec miniature connector is made of Nylon FM101. Entire unit weighs only 0.053 oz. The male and female sections are 0.490 and 0.580 in. in length respectively, 0.306 in. wide and 0.453 in. deep.

CIRCLE NO. 225 READER SERVICE CARD

CIRCLE NO. 103 READER SERVICE CARD

Literature of

MATERIALS

Control Cable. Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y. Bulletin DM5844 deals with thermoplastic all-purpose control cable with polyethylene insulation, double Densheath (PVC) jackets.

CIRCLE NO. 250 READER SERVICE CARD

Thermoplastic. The Polymer Corp. of Penna., 2140 Fairmont Ave., Reading, Pa., has available a bulletin on mill shapes of Polypenco Penton chlorinated polyether resins.

CIRCLE NO. 251 READER SERVICE CARD

Laminated Plastics. Formica Corp., 4614 Spring Grove Ave., Cincinnati 32, Ohio. More than 50 industrial Formica laminated plastic grades for a wide variety of products are described in a "Designer's Fact Book."

CIRCLE NO. 252 READER SERVICE CARD

COMPONENTS

Subminiature Resistors. Erie Precision Resistor Corp., 675 Barbey St., Brooklyn 7, N. Y. The "Min-istor" brochure details a line of subminiature wire wound resistors. A handy temperature conversion chart is included.

CIRCLE NO. 253 READER SERVICE CARD

Transistor Mica Washer. Ford Radio & Mica Corp., 536 63rd St., Brooklyn 20, N. Y. Bulletin 2965 describes 15 basic insulating washers to be used with popular types of transistors and diodes.

CIRCLE NO. 254 READER SERVICE CARD

Motor Frames. Air-Marine Motors, Inc., 369 Bayview Ave., Amityville, L. I., N. Y. A brochure covers the company's entire line of basic induction motor frame designs.

CIRCLE NO. 255 READER SERVICE CARD

Subminiature Switches. Unimax Switch Division, The W. L. Maxson Corp., Ives Road, Wallingford, Conn. Subminiature switches that

the Week

meet military specifications for a wide variety of rigorous services are described in the new 16-page catalog No. 159.

CIRCLE NO. 256 READER SERVICE CARD

EQUIPMENT

Graphic Level Recorder. General Radio Co., West Concord, Mass. A 10-page technical paper on a 20-cps to 200-kc transistorized, high-speed, graphic level recorder appears in a recent issue of the *Experimenter*.

CIRCLE NO. 257 READER SERVICE CARD

Digital Voltmeter. Franklin Electronics Inc., Bridgeport, Pa. Bulletin 309 describes a new series of digital voltmeters and multimeters for use in automatic data systems and for precision laboratory use.

CIRCLE NO. 258 READER SERVICE CARD

Power Supplies. Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J. Four-page catalog No. 114A describes the Magitran line of solid state regulated power supplies.

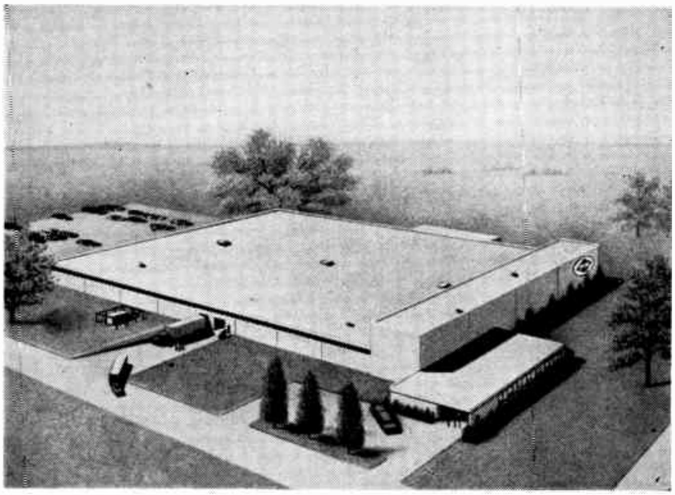
CIRCLE NO. 259 READER SERVICE CARD

FACILITIES

Precision Pots. Spectrol Electronics Corp., 1704 S. Del Mar Ave., San Gabriel, Calif. A 100-page catalog contains complete specification sheets for ordering standard wire wound single and multiturn precision pots. It also describes Spectrol's facilities and qualifications for design and production.

CIRCLE NO. 260 READER SERVICE CARD

Transistor Heat Dissipator. International Electronic Research Corp., 145 W. Magnolia Blvd., Burbank, Calif. A 22-page test report covers the subject of properly cooling transistors for improved performance and reliability by the use of type TO-3 transistor heat dissipators. Request copies on company letterhead.



PIW Moving to New Building

THE PHILADELPHIA INSULATED WIRE COMPANY announces construction of a new plant in Moorestown, N. J. New facility will have a manufacturing area of 50,000 sq ft and will be located on a 10-acre tract of ground.

Robert W. Campbell, sales manager of PIW, says the one-story plant has been designed specifically for the efficient production of insulated wire and cable, and will expand the present productive capacity for Teflon, vinyl, nylon, polyethylene hook-up wire and multiconductor cable, as well as new products such as Teflon 100. A complete line of standard hook-up wires and cables, as well as specialty constructions to customers' specifications, are available from this 138-year-old company.

PIW is presently involved in a considerable amount of Department of Defense contract work, plus commercial applications in the electronic and electrical fields.

Space for the general offices, as well as all manufacturing and warehousing facilities, will be at the new address. Construction will be completed on or about August 15. Until this date the general offices and factory will continue in operation in Philadelphia.

Robinson Joins McLean Labs

MCLEAN ENGINEERING LABORATORIES, INC. of Princeton, N. J., has appointed James G. Robinson as technical assistant to the president and company procurement director. McLean manufactures a line of packaged fans and blowers for electronic applications and for general industrial use.

Robinson was for 9 years a director of procurement and government contract administration for the Applied Science Corp. of Princeton.

III Expands Facilities

CONSTRUCTION was recently completed on two new additions to the plant of Industrial Instruments, Inc., in Cedar Grove, N. J. Company manufactures electrical test equipment and electrolytic conductivity apparatus.

The expansion will double the present facilities devoted to the engineering department, and provide increased space for stockroom, manufacturing, quality control activities, and a new metal finishing department.

Kennedy Now With Polarad

D. LAWRENCE JAFFE, president and chairman of the board of Polarad Electronics Corp., Long Island City, N. Y., announces the appointment of W. Vernon (Bud) Kennedy as manager of contracts administration for the company.

Kennedy was formerly chief of Financial and Economic Division, Fort Monmouth Procurement Office, Signal Corps; administrative assistant to the vice-president of the electronics division of Stromberg-Carlson; and more recently assistant to the president of A.R.F. Products, Inc., River Forest, Ill. In his new position he will be responsible for the negotiation and administration of all defense prime and subcontracts of the company.

NBFAA Honors Kidde Engineer

SAMUEL M. BAGNO (left) was recently presented a plaque by the National Burglar and Fire Alarm Association at a banquet held at the Sheraton-Ritz Carlton Hotel, Atlantic City, N. J. The award was made by Frank Guibert, outgoing president of the Association.

The plaque, the first ever awarded

by the NBFAA, is in recognition of his pioneering contributions in the development of electronic devices for the electrical protection industry.

Bagno is chief engineer of Kidde Ultrasonic & Detection Alarms, Inc., Clifton, N. J., and Guibert is general manager of Newark District Telegraph, Newark, N. J.

Name Gagnon V-P

APPOINTMENT of William J. Gagnon as vice president of Bradley Semiconductor Corp., New Haven, Conn., is announced. He has been general sales manager of the firm since he joined it in 1954.

In naming him to the key post, Charles D. Bradley, president, pointed out that Gagnon has spearheaded a major sales expansion program aimed at the addition of new electronic products to the company's line. As a result of developments by Bradley's engineering staff, an entirely new division has been set up for the production of silicon diodes. Although only a year old, the new division is rapidly assuming a major share of the company's total output.

To support the expansion program with new product developments, Gagnon said he will shortly announce the addition of more engineers which will triple the size of the firm's engineering staff.

McMahon Takes New Post

TRANSISTOR APPLICATIONS, INC., Boston, Mass., announces that Robert E. McMahon has joined the organization as a vice president and chief engineer.

McMahon was formerly a staff member at MIT's Lincoln Laboratory and pioneered in early transistor switching circuits. He developed impulse switching, a technique for increasing the speed of ferrite core memories.

News of Reps

CONTROL ELECTRONICS CO., INC., Huntington Station, N. Y., names four sales reps:

The **Col-Ins-Co.** of Orlando, Fla., will cover Florida, Georgia, Alabama, Mississippi, Tennessee, North and South Carolina. **Malcolm Ross & Company** of Los Angeles will handle sales in Arizona, Nevada and southern California. **Ernest E. Whittaker** of Ontario will have all sales in Canada, while **Southern Industrial Electronics, Inc.,** in Dallas will handle sales in Texas, Oklahoma, Arkansas and Louisiana.

Appointment of **David G. DeHaas Co.** of San Diego as sales rep for the Polytechnic Research & Development Co., Inc., Brooklyn, N. Y., is announced. Territory will be San Diego and Imperial Counties, Calif.

Balco Research Laboratories, Inc., Newark, N. J., appoints **Electrosources, Inc.** of Palo Alto sales rep for the northern California-Nevada territory. Balco specializes in development of high temperature plastic film capacitors.

Dayton Associates of Dayton, Ohio, now represents Telemeter Magnetics, Inc., Los Angeles, Calif., in Ohio and western Pa.

C. J. Fox has been appointed electronics sales engineer with **E. V. Roberts and Associates,** Los Angeles engineering representative.

Gordon T. Cook, and **Robert J. Underbrink** have joined the **Burt C. Porter Co.,** Seattle, Wash., engineering rep, as sales engineers.

Electronic Components Sales, Inc., Littleton, Colo., will cover Colorado, Wyoming, New Mexico and Utah for Grayhill, Inc.

COMMENT

Transistor Amplifiers

(Re: "Designing High-Quality A-F Transistor Amplifiers," p 60, June 12.)

On p 61 (Fig. 2), Mr. Minton's schematic shows two transistors purported to be in class B push-pull operation.

I believe that an error exists. Instead of emitter-to-emitter and collector-to-collector connections, a series circuit exists in part by connection of Q_7 collector to Q_8 emitter through the secondary of T_2.

N. P. SMITH

RADIO CORP. OF AMERICA
LOS ANGELES

Our redrafting error. The two transistors should be connected collector-to-collector through the secondary of T_2 and emitter-to-emitter through the primary.

Radar Test Systems

The June 5 issue of ELECTRONICS included an article (p 58) entitled "Radar Test Systems to Shorten Checkout Time," written by Major Wm. F. Kroemmelbein. The front cover was devoted to a picture of such a system in operation on the flight line.

As you may or may not know, that "system" is the AN/GPM-25 radar system tester developed for the U. S. Air Force by the mechanical division of General Mills. We are proud of this accomplishment, and were very happy to cooperate with Major Kroemmelbein in preparation of his article by furnishing the front cover photo, certain technical information, schematics, etc. We were naturally disappointed, however, when we learned that ELECTRONICS had totally omitted the name of our firm from the published text.

We believe your readers would be interested . . .

LLOYD E. PEARSON

GENERAL MILLS INC.
MINNEAPOLIS

Bank Automation

We read with interest your recent article covering today's rapid strides toward bank automation ("Big Bid for Bank Market," p 40, May 29).

However, the reference to National Cash Register as not having yet released equipment details is inaccurate. To the contrary, NCR was one of the first companies in the office equipment industry to announce a complete bank automation system based on magnetic character recognition as later recommended by the American Bankers Association. This announcement (in 1957) listed specifications of the various units of the system.

Today, more than 4,500 Post-Tronic machines, the nucleus of the NCR system, have been installed in more than 1,000 banks in all 50 states. These machines are posting electronically over 20 percent of the nation's checking accounts. In recent months, NCR has also demonstrated operating prototypes of forthcoming units of the system to bankers from all sections of the country. These include the fully automated Post-Tronic, the magnetic character sorter, magnetic amount printer, magnetic qualification printer, and other units.

O. B. GARDNER

NATIONAL CASH REGISTER CO.
DAYTON, O.

A misunderstanding merely. We were referring to the type of "equipment details" later discussed in the article: operating details of the electronic circuitry which reads and recognizes the magnetic characters.

One -ing After Another

(Re: "Circuit Design Using Magnetostrictive Filters," p 72, June 19).

I have seen the published article —a very good layout. One small error did creep in. In the bibliographical reference, you referred to *Electronic & Radio Engineering;* it should be *Electronic & Radio Engineer.*

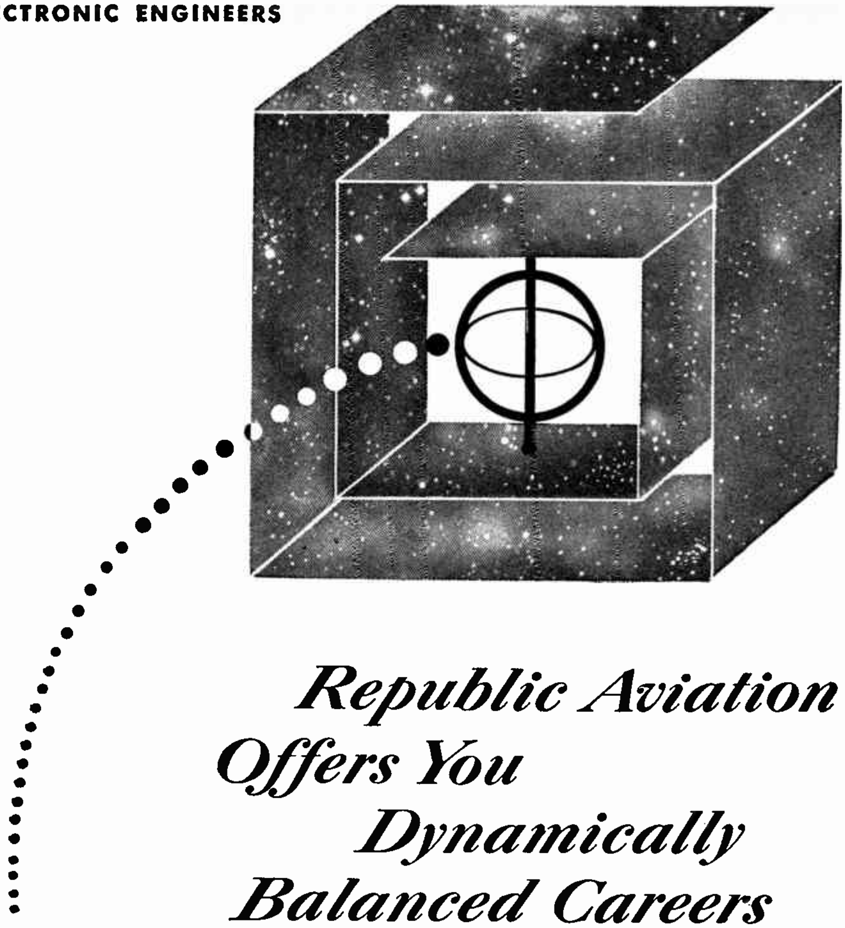
I would appreciate it if you would publish an amendment.

ALAN THIELE

COSSOR RADIO & ELECTRONICS LTD.
HARLOW, ESSEX, U. K.

Done.

ELECTRONIC ENGINEERS



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Engineering Employment Manager, Dept. 11H-3.

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HMED IS ALSO DESIGNING THE "HEART" OF THE SYSTEM In addition to its prime mission of providing systems management, HMED will design, develop and produce the data processing and display subsystem which is the "heart" of the 212L. Capable of rapidly and automatically detecting and tracking air targets, the subsystem operates without human assistance, except under unusual circumstances.

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The qualifications for these positions include a minimum of a Bachelor of Science degree in Engineering, Physics, or Mathematics; adequate industrial experience; and a record of aggressive pursuit of research and development objectives. Advanced degrees are required in some of the open positions and desirable for all of them. Persons with advanced degrees will be given preference.

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Assignments require the ability to check circuitry and effect repairs, along with the further ability to make suggestions which can lead to design improvements. Work involves use of all types of electronic test equipment.

If you feel you qualify fully for either type of position outlined above, please send your resume to Mr. James L. Purfield.

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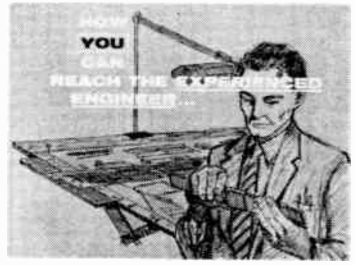

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- COMPONENTS
- ELECTRONIC AUTOMATION
- MICRO-MINIATURIZATION
- MICROWAVE TECHNIQUES
- RELIABILITY
- VACUUM TUBE APPLICATION

Mail brief confidential resume to

MR. T. H. TILLMAN
BENDIX, BOX 303-KE
KANSAS CITY, MISSOURI

Bendix AVIATION CORPORATION KANSAS CITY DIVISION

KANSAS CITY, MISSOURI

LONG TERM PRIME CONTRACTOR FOR ATOMIC ENERGY COMMISSION

*ADDRESS BOX NO. REPLIES TO: Box. No.
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Send to office nearest you.
NEW YORK 36: P. O. BOX 12
CHICAGO 11: 520 N. Michigan Ave.
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POSITIONS VACANT

Communications Technician wanted for assignment in North Africa. Familiarity with all aspects of H. F. Systems Essential. Salary commensurate with experience. Give full particulars. Reply to: The Ohio Oil Company, Room 7010, Findlay, Ohio.

B.S. and M.S. Electrical Engineers for re-search work on instrumentation and control problems related to the steel industry. Salary commensurate with training and experience. Large Research Laboratory, Pittsburgh Area. Forward complete resume and salary requirements to P-2283, Electronics.

TECHNICAL SALES—SEMICONDUCTOR FIELD

Large mid-east firm working in rapidly expanding field of ultra high purity silicon requires technical salesman. Must be willing to travel.

Degree in electronics, physics, chemistry, metallurgy, or engineering preferred. Age —25-35 years old. Previous experience in semiconductor or electronics field preferred.

Send complete resume, including salary requirements, etc. to

SW-2231, Electronics
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $24.75 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.40 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.
PROPOSALS, $2.40 a line an insertion.
BOX NUMBERS count as one line additional in undisplayed ads.
DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

SEARCHLIGHT Equipment Locating Service

NO COST OR OBLIGATION

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used electronic equipment and components *not currently advertised*. (This service is for USER-BUYERS only).

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

Searchlight Equipment Locating Service

c/o ELECTRONICS

P. O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service
c/o ELECTRONICS
P. O. Box 12, N. Y. 36, N. Y.

Please help us locate the following equipment components.

....
....
....

NAME ....
TITLE ....
COMPANY ....
STREET ....
CITY 8/14/59

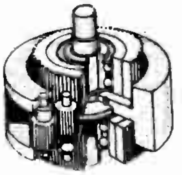
ELECTRONIC

WAR TERMINATION INVENTORIES

WRITE OR WIRE FOR INFORMATION ON OUR COMPLETE LINE OF SURPLUS ELECTRONIC COMPONENTS. ALL PRICES NET F.O.B. PASADENA, CALIFORNIA

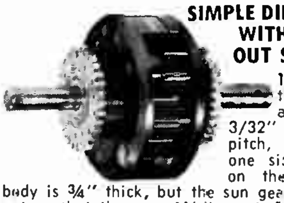
C&H SALES CO.
2176-E East Colorado St.
Pasadena 8, California
RYan 1-7393

SIMPLE DIFFERENTIAL WITH BALL-BEARING SUN GEARS



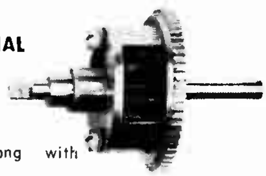
The 1:1 reverse ratio spur gears are 48-tooth, 32 pitch brass with 3/16" available face. On one side, the shaft is 23.64" dia. for 11/16" and has a pin hole, then increases in dia. to .377" for the remaining 3/16" of length. On the other side, the shaft is .377 dia. 1/4" lg. 2-13/16" dia. is required to clear the body.
Stock no. A6-115................each $15.00

SIMPLE DIFFERENTIAL WITH SPACED-OUT SUN GEARS



1:1 reverse ratio spur gears are aluminum, 3/32" face, 32 pitch, 32 tooth on one side, 48 tooth on the other. The body is 3/4" thick, but the sun gears are spaced out so that they are 1½" apart. 1/4" dia. shaft on each side is 23/32" long. OA length 3⅛". Requires 1-23/32" dia. to clear the body.
Stock no. A6-124................each $4.50

SIMPLE DIFFERENTIAL



1:1 reverse ratio, 60 teeth on large gear; 1/4" shaft. Size: 3" long with 1-15/16" dia.
Stock no. A6-104................each $3.95

DUAL SIMPLE DIFFERENTIAL

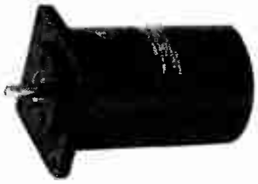
1:1 reverse ratio on both. Size. 3¼" long x 1-7/16" dia. Shaft size: ⅛" and 5/32".
Stock no. A6-107................each $7.50

SPERRY VERTICAL GYRO

Part #653265. Motor 115 volts, 3 phase, 400 cycle, 8 watts, 20,000 RPM. 3-minute runup, synchro pickoffs, roll 360°, pitch 85°. Synchro excitation 26 volts, 400 cycle, 150 m.a. Vertical accuracy ±½°. Weight 3½ lbs. Approx. dim. 5¾" L., 4½" W., 4½" H. Price $35.00

60 CYCLE GEARED SERVO MOTORS

mfr. Kollsman (dim. 1-23/32" x 2-13/16"



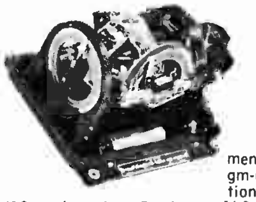
#1906P-0160-05 2 rpm, induction, 25 oz. in. torque 115 volts, 60 cycle weight 6.7 oz. $30.00

#1396D-0163-025 60 rpm, synchronous, 9 oz. in. torque 115 volts, 60 cycle weight 6.7 oz. $39.50

SYNCHROS SERVOS

1CT cont. Trans 90/55V 60 cy.	$34.50
1DG Diff. Gen. 90/90V 60 cy.	34.50
1F Syn. Mtr. 115/90V 60 cy.	34.50
1G Gen. 115V 60 cy.	34.50
1 HDG	37.50
1HCT	37.50
1HG	37.50
1SF Syn. Mtr. 115/90V 400 cy.	12.50
5CT Cont. Trans. 90/55V 60 cy.	34.50
5D Diff. Mtr. 90/90V 60 cy.	34.50
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.	37.50
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
7DG differential generator, 90/90 volts, 60 cycle	37.50
C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	17.50
C78249 Syn. Diff. 115V 60 cy.	5.00
C78410 Repeater 115V 60 cy.	20.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 22V 60 cy.	7.50
403 Kollsman Autosyn Mtr. 32V 60 cy.	7.50
FPE-25-11 Diehl Servo 75/115 v 60 cy.	12.50
FPE 49-7 Diehl servo motor, 115 volts, 60 cycle, 10 watts	30.00
FPE-43-1 Resolver 400 cy.	19.50
FJE-43-9 Resolver 115V 400 cy.	15.00
R110-2A Kearfott Cont. Mfr.	17.50
R111-2A	20.00
R112-2D-B	22.50
R200-1-A Kearfott Cont. Trans.	15.00
R220-1 Kearfott Receiver	20.00
R235-1D Kearfott Resolver	20.00
AY201-2B	15.00
AY201-3B	12.50
AY201S-1B	15.00
AY221-34	10.00

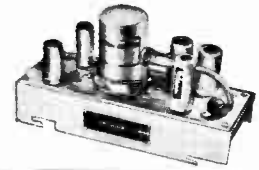
HONEYWELL VERTICAL GYRO MODEL JG7003A-1



115 volts, 400 cycles, single phase, 35 watts. Pitch and roll potentiometer pickoffs 890 ohms, 40 volts max. AC or DC. Speed 20,000 rpm, ang. momentum 12,500,000 gm-cm ²/sec. Erection system 27 VAC, 400 cycles, time 5 min. to ½°. Weight 5.5 lbs. Price $35.00 each

OPERATIONAL DC AMPLIFIER with BROWN INSTRUMENT CHOPPER

AM-1023 Made by Gilfillan Bros., Inc. Useful for computers . . . for polarity inversion . . . for isolation . . . and to amplify voltages from DC to 10 cps. Useful closed-loop gain is from 0.1 to 500. Maximum output range is from −150 v to +150 v. Drift less than 10 mv/hour. Input point tends to go to ground potential because of the feedback loop and internal circuitry; therefore determines the input impedance. Accuracy of the gain figure is important in instrumentation. It is the closed-loop gain divided by the open-loop-gain of 200,000; accuracy to match, a predetermined gain of 500 is accurate to ¼%, and lesser gains exceed the accuracy of practicable obtainable resistors. The amplifier is complete with tubes, chopper and circuit diagram. The circuit diagram gives the voltages to be furnished by an external power supply. The Brown Converter ("For Continuous Balance System") is the late type 6-pin plug-in with two-pin side connector.
Complete amplifier unit................$49.50



MINNEAPOLIS-HONEYWELL RATE GYRO (Control Flight)

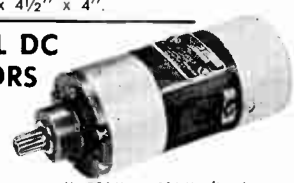
Part no. JG7005A, 115 volts A.C., 400 cycle, single phase potentiometer take off resistance 530 ohms. Speed 21,000 r.p.m. Angular momentum 2½ million, CM²/sec. Weight 2 lbs. Dimensions 4-7/32 x 3-29/32 x 3-31/64.
Price $22.50

VARIABLE SPEED BALL DISC INTEGRATORS (All Shafts Ball Bearing Supported)

No. 145 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"..........$17.50

No. 146 Forward & Reverse 4-0-4. Input shaft 5/16" dia. x ¾" long: Output shaft 15/64" dia. x 9/16" long. Control shaft 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4½" x 4½" x 4". **$18.50 ea.**

SMALL DC MOTORS



(approx. size overall 3¾" x 1¼" dia.:)

5067043 Delco 12 VDC PM 1" x 1" x 2", 10,000 rpm.	$7.50
5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled	15.00 ea.
5069600 Delco PM 27.5 VDC 250 rpm	12.50
#5069625 120 rpm, mfr. Delco, 27 VDC governor controlled	$15.00
5069230 Delco PM 27.5 VDC 145 rpm	15.00
506B750 Delco 27.5 VDC 160 rpm w. brake	6.50
506B571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled	15.00 ea.
#5069800 575 rpm, mfr. Delco, 27 VDC, PM reversible governor controlled, equipped with 27 VDC clutch	$17.50
5072735 Delco 27 VDC 200 rpm governor controlled.	15.00
5BA10A11B 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 rpm	15.00
5BA10FJ401B, G.E. 28 VDC, 215 rpm, 10 oz. in., .7 amp. contains brake	15.00
5BA10FJ421, G.E. 26 VDC, 4 rpm, reversible, 6 oz. in., .65 amp	15.00
S. S. FD6-21 Diehl 24 VDC PM 10,000 rpm. 1" x 1" x 2".	4.00
#SSFD6-34-1 14,000 rpm, mfr. Diehl, 24 VDC PM	5.00

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