electronics

SEPTEMBER · 1956

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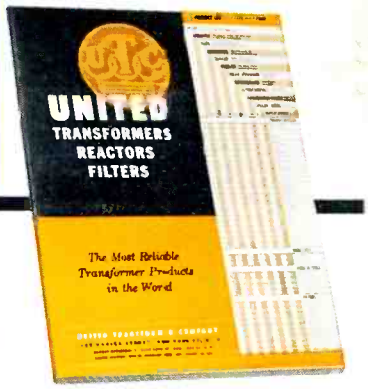

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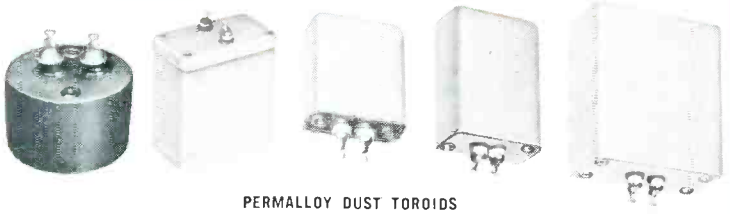

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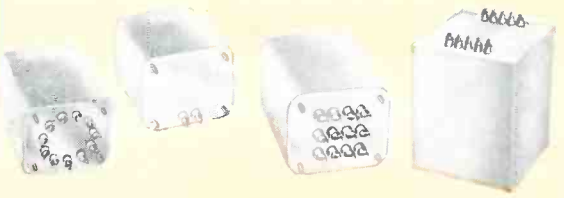
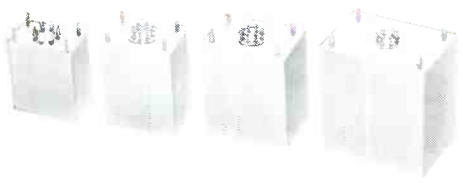


HERMETIC
Power, Plate, Filament Transformers and Reactors

HERMETIC AUDIO COMPONENTS
for Every Application



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PULSE TRANSFORMERS

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Transistor Transformers
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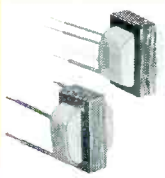
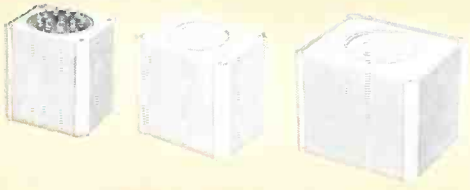
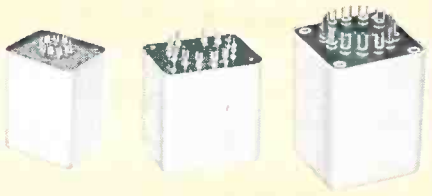


SUB and SUB-SUB OUNCER TRANSFORMERS
Audio Miniatures

OUNCER and PLUG-IN UNITS



LINEAR STANDARD SERIES
Tops in Fidelity



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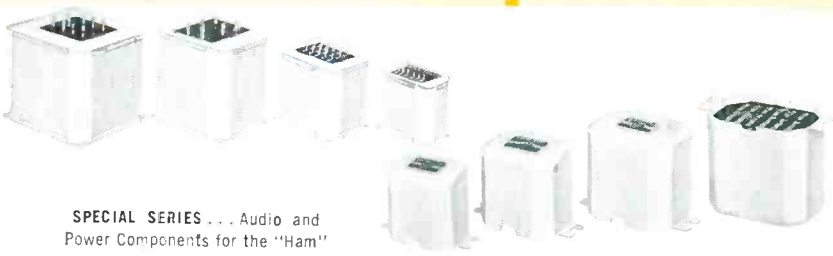
for Industrial Use



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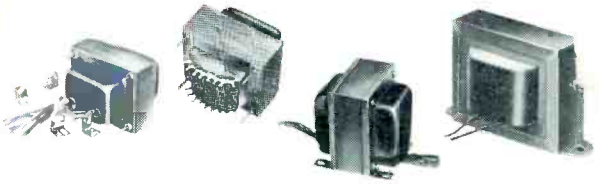
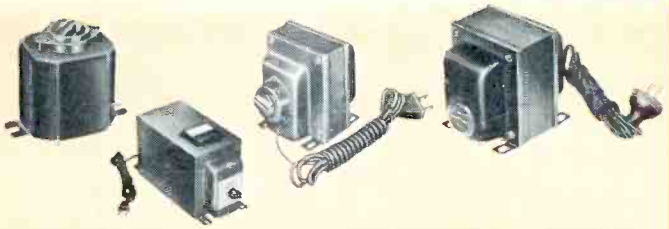


REPLACEMENT TYPES



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PHOTOFLASH TRANSFORMERS
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SEPTEMBER • 1956

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PROJECTILE FLIGHT TIMER—Potter Instrument equipment prints out, in four-digit Arabic numerals corresponding to tens of microseconds, flight time of projectiles in bursts up to 150 per second (see page 166). Photo arranged by J. A. Tolen of Aberdeen Proving Ground ..... COVER

CONTINUED ON NEXT PAGE

contents

continued

SHOP

▶ **SPECIAL REPORT** . . . Engineers, for all their skill and ingenuity, must work within the physical limitations of the materials on hand. This is true whether the job is designing a more economical flyback transformer or a circuit to work in the hot, gamma-ray infested nose of an intercontinental missile.

The chemist, physicist and metallurgist come to the aid of the electronic engineer. When materials such as electrically conductive plastic, soldering flux that is chemically active but still noncorrosive and organic plastics that bond metal parts tight as a weld appear, the "materials breakthrough" is at hand.

Editors Markus and Findlay have dug into all kinds of materials for more than six months for facts and figures on these products that will provide the components and circuits of tomorrow.

In their report, coming in the October issue, they provide down-to-earth information that will help the engineer select the material best adapted to his new design. Data on new foaming plastics for radomes and loudspeaker enclosures, laminates especially designed for mechanized production and unique wire insulations illustrate the diversity of subjects covered.

The report also covers new push-button sprays that make encapsulating electronic circuits as easy as

electronics

SEPTEMBER, 1956 Vol. 29, No. 9

Member ABC and ABP

TALK

MATERIALS for ELECTRONICS, our special report in the October issue, will contain information supplied by many companies. Some went beyond the call for data and sent along samples of fabricated components. Editorial assistant Barbara Hearst (above) is cataloging some of these for future reference

spraying shaving lather. Some new substances now in pilot production that will be available for tomorrow's designs are included.

Comprising 32 pages, *Materials for Electronics* will contain sections on adhesives, casting resins, ceramics and mica, coatings and tapes, foam plastics, glass, laminates, magnetics, metals and chemicals, plastics, wires, solders and fluxes.

▶ **SQUEEZE** . . . Editorial curiosity, piqued by trade gossip about a forthcoming fully automatic page printer, led to the article on computer input and output equipment on page 142, this issue.

Paradoxically we found ourselves last month with the article wrapped up and data on the automatic printer that triggered it not yet materialized. News being the perishable commodity it is, we decided to run the story regardless.

At the last minute our Cleveland office wired details on the printer—a web-fed device that weds a character-reproducing cathode-ray tube to an electrostatic printer. This rounded out the feature article. Also, a photograph of the device appears in this month's *Industry Report*, page 16.

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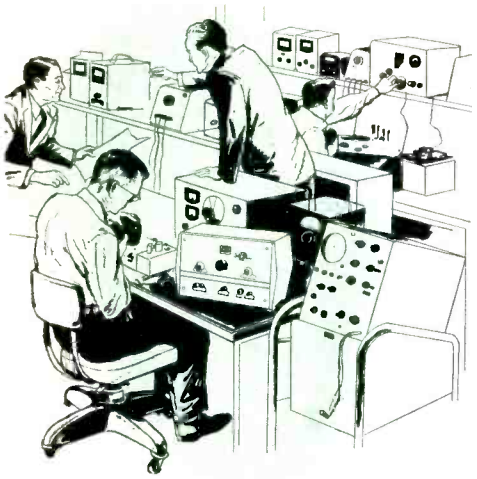
Single copies 75¢ for United States and possessions, and Canada; $1.50 for Latin America; $2.00 for all other foreign countries. Buyers' Guide $3.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years. Canada, $10.00 a year; $16.00 for two years. Other western hemisphere countries and the Philippines, $15.00 a year; $25 for two years. All other countries $20.00 a year; $30.00 for two years. Three-year rates, accepted on renewals only, are double the one-year rate. Entered as second-class matter August 29, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U.S.A.

BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; McGraw-Hill House, London, E. C. 4; Washington, D. C. 4; Philadelphia 3; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; 1321 Rhodes-Haverty Bldg., Atlanta 3, Ga.; 1125 West Sixth St., Los Angeles 17; 919 Oliver Building, Pittsburgh 23. ELECTRONICS is indexed regularly in The Engineering Index.

NOW-PORTABLE 400 cycle power



This new frequency changer makes it possible to provide well regulated 400 cycle power conveniently and quickly. This unit, Model FCR 250, is extremely useful in a wide variety of applications including testing, production, airborne frequency control, computers, missile guidance system testing, and in practically any application where the use of 400 cycle power is advantageous.

Model FCR 250 is only one of a complete line of frequency changers available from Sorensen . . . the authority on controlled power for research and industry. Write for complete information.

ELECTRICAL CHARACTERISTICS

Input	105-125 VAC, 1 phase, 50-65 cycles
Output voltage	115 VAC, adjustable 105-125V
Output Frequency	320-1000 cps in two ranges
Voltage regulation	±1%
Frequency regulation	±1% (±0.01% with auxiliary frequency standard fixed at 400 cycles)
Load range	0-250 VA

MODEL FCR 250

SORENSEN & COMPANY, INC. Sorensen STAMFORD · CONN.

Want more information? Use post card on last page.

SEND FOR THIS BROCHURE

"Vibration Measurement and Waveform Analysis"

This publication describes the Muirhead-Pametrada Wave Analyser and how it can be applied to the aircraft, automobile, shipbuilding and electricity supply industries.

Typical applications—noise level measurements, analysis of vibration components, tracing unwanted frequencies to source and checking after final elimination.

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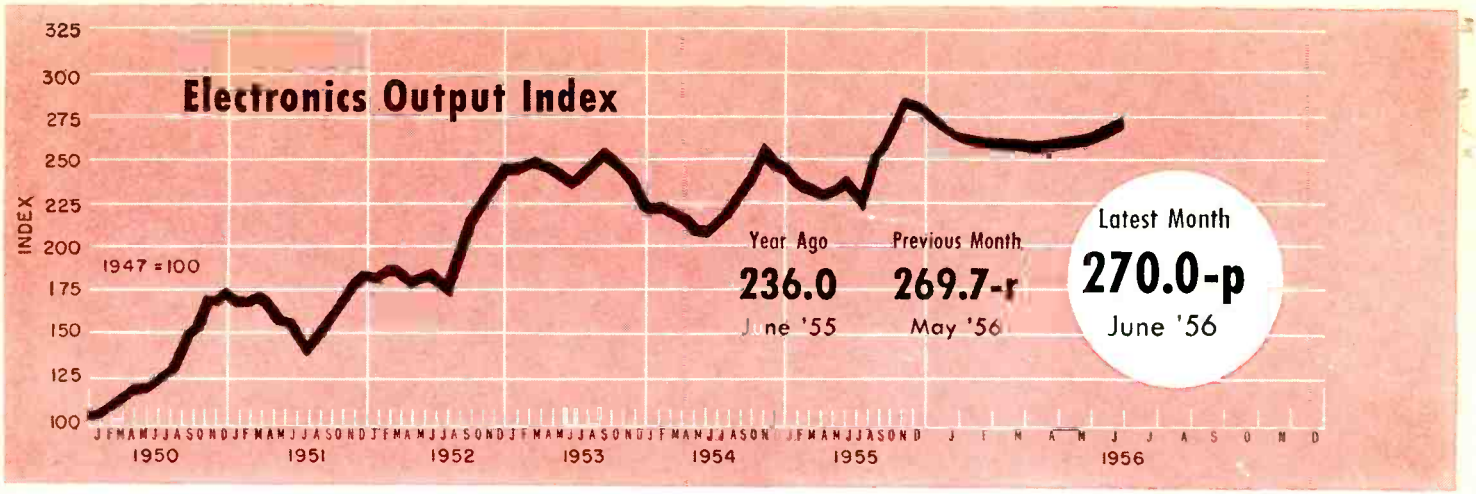


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month June '56	Previous Month May '56	Year Ago June '55
Television sets, total	553,025	467,913	589,973
With UHF	78,512	58,116	59,892
Color sets	nr	nr	nr
Radio sets, total	1,073,775	1,060,165	1,204,935
With F-M	nr	nr	9,106
Auto sets	296,256	282,611	584,567

RECEIVER SALES

(Source: RETMA)	June '56	May '56	June '55
Television sets, units	439,362	392,080	430,347
Radio sets (except auto)	839,830	566,357	421,387

RECEIVING TUBE SALES

(Source: RETMA)	June '56	May '56	June '55
Receiv. tubes, total units	39,037,000	33,015,000	40,819,961
Receiv. tubes, value	$32,176,000	$27,145,000	$31,254,324
Picture tubes, total units	776,601	906,732	706,890
Picture tubes, value	$13,663,408	$16,123,625	$13,244,499

INDUSTRIAL TUBE SALES

(Source: NEMA)	Quarterly Figures: Latest Quarter 4th '55	Previous Quarter 3rd '55	Year Ago 4th '54
Vacuum (non-receiving)	$9,967,411	$9,027,845	$9,338,181
Gas or vapor	$3,251,621	$3,438,835	$3,498,123
Magnetrons and velocity modulation tubes	$13,726,323	$10,998,967	$15,249,651
Gaps and T/R boxes	$1,578,767	$1,421,138	$1,788,780

MILITARY PROCUREMENT

(Source: Defense Dept.)	1st '56	4th '55	1st '55
Army	$40,490,000	$48,477,000	$2,833,000
Navy	$28,700,000	$20,378,000	$43,147,000
Air Force	$124,828,000	$131,938,000	$133,503,000
Total—Electronics	$194,018,000	$200,793,000	$179,483,000

BROADCAST STATIONS

(Source: FCC)	Latest Month July '56	Previous Month June '56	Year Ago July '55
TV stations on air	499	496	461
TV stations CPs—not on air	116	113	123
TV stations—new requests	42	43	17
A-M stations on air	2,922	2,896	2,748
A-M stations CPs—not on air	119	124	125
A-M stations—new requests	263	274	201
F-M stations on air	530	530	538
F-M stations CPs—not on air	19	16	17
F-M stations—new requests	7	10	4

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	June '56	May '56	June '55
Aeronautical	48,745	47,660	43,855
Marine	56,915	56,038	50,714
Police, fire, etc.	20,718	20,422	18,415
Industrial	30,597	30,287	24,845
Land transportation	8,990	9,073	7,668
Amateur	150,549	150,222	139,993
Citizens radio	18,602	17,835	12,334
Disaster	327	327	317
Experimental	706	698	625
Common carrier	2,308	2,283	1,950

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	May '56	Apr. '56	May '55
Prod. workers, comm. equip.	547,400-p	544,500-r	493,500-r
Av. wkly. earnings, comm.	$75.14 -p	$75.52 -r	$71.38
Av. wkly. earnings, radio	$71.82 -p	$72.00 -r	$69.25
Av. wkly. hours, comm.	40.4 -p	40.6 -r	40.1
Av. wkly. hours, radio	39.9 -p	40.0 -r	39.8

SEMICONDUCTOR SALES ESTIMATES

	May '56	Apr. '56	Mar. '56*
Transistors, Units	897,862	832,676	707,817

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	July '56	June '56	July '55
Radio-tv & electronics	412.6	405.1	484.8
Radio broadcasters	509.8	476.3	560.4

p—provisional r—revised nr—not reported
*1955 not available

FIGURES OF THE YEAR

	FIGURES FOR FIRST SIX MONTHS 1956	1955	Percent Change	1955 Total
Television set production	3,415,202	3,828,793	—10.8	7,756,521
Radio set production	6,659,165	7,058,889	— 5.6	14,894,695
Television set sales	2,868,250	3,202,995	—10.4	7,421,084
Radio set sales (except auto)	3,391,102	2,429,018	+39.6	6,921,384
Receiving tube sales	227,656,000	226,502,000	+ —	479,802,000
Cathode-ray tube sales	5,152,743	4,914,024	+ 0.05	10,874,234

INDUSTRY REPORT

Long-Range Missiles Swell Industry Coffers

Parallel development of cruising and ballistic missiles keeps many firms busy

DEVELOPMENT of long-range missiles, felt by some to be the key to national survival, is a top job for the electronics industry. About $5 billion have been spent for guided missiles.

This year $1.2 billion may be spent. Much of this money goes for guidance systems and test equipment.

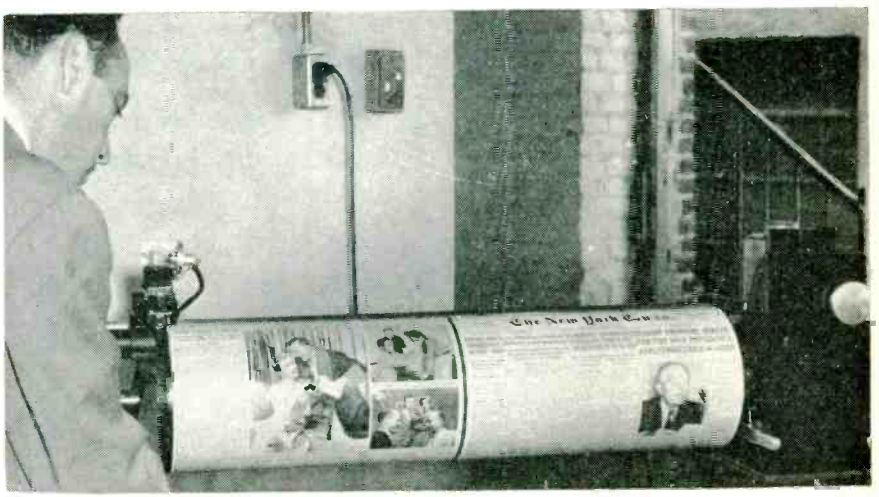
▶ **Backstopping** — To insure success in developing an intercontinental missile, the Air Force has two parallel programs: ballistic missiles or rockets that follow a parabolic course out of the earth's atmosphere and cruise missiles or high-speed pilotless aircraft that fly within the earth's atmosphere. Recently the Air Force has hinted at a second space satellite program.

▶ **Ballistic Missiles** — The Air Force ICBM program includes Atlas under development by Convair, San Diego, and Titan under development by Douglas, Santa Monica. Ramo-Wooldridge of Los Angeles has scientific and engineering direction of the project under the Western Development Division of the Air Research and Development Command.

Supplementing the Air Force missiles are Jupiter I, an Army-Chrysler development, and Jupiter II, a Navy-Chrysler development. These missiles are outgrowths of the 250-mile Redstone missile.

Guidance contractors include: GE, Syracuse, N. Y.; Bell Labs, Whippany, N. J.; Arma division of American-Bosch-Arma, Garden City, N. Y.; A. C. Spark Plug division of GM, Milwaukee, Wis.; Burroughs, Paoli, Pa.; and Remington Rand Univac division of Sperry Rand, St. Paul, Minn.

▶ **Cruising**—Backstopping the ballistic missile programs are cruise missile developments. These include the now-operational Martin Matador, the Northrop Snark, the Navy's Regulus built by Curtiss-Wright. Just completing initial test is the North American Navaho. Test vehicle for the Navaho cruise missile project was the twin turbojet aircraft X-7.



FRONT page is flashed across country in two minutes when . . .

Electronics Speeds News Coverage

Largest communications network covered party presidential candidate selections

ESTIMATED at 45 million homes, the U. S. television audience was treated to two weeks of highly coordinated programming during the conventions of the Democratic and Republican parties.

Radio broadcast signals covering the earth originated from these same conventions in Chicago and San Francisco, respectively. Countless telephone or teleprinter cir-

French development is one of small pickup units used by CBS. Amplifier, transmitter and battery are contained in the pack. Camera held in hand

West German import (Electronics, p 196, Aug. 1956) designed to inspect boiler tubes was snapped up by ABC to supplement subminiature tv gear

RCA-NBC camera uses ½-inch vidicon and 70 transistors for all circuits except transmitter, a cavity-stabilized oscillator. Range is one mile

cuits were set up to help spread the news.

A special facsimile circuit using Times Facsimile equipment was used to transmit newspaper pages from New York to San Francisco.

▶**Common Carrier**—Brunt of switching and distributing electronic news signals fell upon AT&T which operated 73,000 channel miles of broadband tv circuits to feed 400 stations in 270 cities. Some 1,600 radio stations were furnished audio circuits.

More than 760,000 miles of teletypewriter circuits were kept humming and 600 teleprinters clacked the stories. A wide-band facsimile circuit linking New York with San Francisco whined out copy at 175 sq in. a minute, comparable to 600 words a minute.

▶**Networks**—Despite competition among broadcasting groups, much of the coverage was done on a pool basis—six cameras covering each convention floor and about 75 microphones. In addition, ABC had 20 cameras of its own, CBS had 25 and NBC 35. Of high interest were the several small tv cameras shown in the photographs.

▶**Pictures**—Use of facsimile to distribute news pictures around the country is constantly expanding. A recent development is sending positive images rather than the negative images which wire services have been furnishing their clients since the middle thirties.

A positive image is favored by television stations. Often a positive image is sent to the editorial room of a newspaper while a negative one arrives simultaneously in the illustration department.

▶**Services**—The Associated Press reports that it serves about 500 newspapers with receiving facilities for negative facsimile images while about 100 newspapers and 100 television stations receive positive images. AP has about 350 facsimile transmitters around the country.

The United Press reports 142 newspaper facsimile clients and 115 television stations. International News Service has about 100 machines installed in television stations, industrial and commercial establishments.

U.S. Proposes Tax Reduction Plan

Internal Revenue Service asks industry comment on plan for more liberal research deductions

COMPANIES that support research programs will be allowed more liberal income tax deductions on the money they pour into research and experimental projects under a new regulation now being circulated by the Internal Revenue Service for industry comment. The proposal sets out the rules and procedures that the government will apply to firms taking such deductions. It carries out the deduction granted by Congress for research and experimental spending in the 1954 revision of the Internal Revenue Code.

Companies will be allowed to apply the rules retroactively to research costs incurred during taxable years beginning after Dec. 31, 1953 and ending Aug. 16, 1954.

▶**Definition**—The proposed regulation defines research and experimental expenditures as expenditures incurred in connection with a taxpayer's trade or business which are not deductible under any other provision of the Internal Revenue Laws such as depletion allowed extraction industries and which represent research and development costs in the experimental or laboratory sense.

Included are costs incident to development of an experimental or pilot model, plant process, product, formula, or invention and improvement of such existing properties. A firm may deduct research costs whether it does its own work or farms it out. However, farmed out work cannot be deducted unless it is the type of research that the company could deduct were it handling the job itself.

The research contractor must be an individual or a research institute, foundation, or engineering

(Continued on page 10)

NEW Power Transistor

—key COMPONENT in SYLVANIA'S "power-pack" for hybrid auto radio offers new features for general power applications

Sylvania's new Power Transistor Type 2N242 was developed as part of the hybrid auto "power-pack" which includes the Sylvania type 12J8 driver tube. The 2N242 provides 2½ watts class A output with 5% total harmonic distortion.

For general power applications, ten watts collector dissipation is provided. Other general-purpose features of this new power transistor include a welded hermetic seal for ruggedness and a storage temperature of 85° C to eliminate heat problems under idle conditions. Thermal drop characteristic of the 2N242 is 2° C per watt.

GENERAL FEATURES OF THE 2N242 POWER TRANSISTOR—

- 10 watts max. collector dissipation
- 2 amps max. collector current
- 40 volts max. collector voltage
- New welded hermetic seal
- 30 db minimum power gain (typically 35 db)
- 85° C storage temperature
- 100° C junction temperature
- Thermal drop — 3° C per watt (typically 2° per watt)

Engineering Sample Offer

Sylvania will honor all bona fide requests for engineering samples of this new power transistor. Write on your company letterhead indicating application, or call your Sylvania representative.

SYLVANIA

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company. It cannot be a rival manufacturer.

▶ **Depreciation**—A firm may deduct depreciation or depletion allowances on land or other property it buys or improves for use in a research project. It cannot deduct the money it spends to acquire or improve the property.

Not deductible as research and experimentation is money spent for quality control testing or inspection of materials or products; efficiency, marketing or management surveys; advertising or other promotional expenditures.

▶ **Ways**—Deductions may be taken as a current expense for the tax year when the money is actually laid out, or as a deferred expense, permitting the taxpayer to take the deduction over a period of at least five years, starting when the research results begin to yield income. The regulation spells out conditions under which a taxpayer may elect these alternatives.

Hot Tube Developed For Military Use

Hard-glass device raises heat barrier nearly 100 degrees, costs less

HIGH-temperature electron tubes, able to withstand 300 C have been produced under a manufacturing methods contract with Air Material Command, Wright-Patterson Air Force Base, Ohio. Sylvania Electric has completed a pilot line for the manufacture of type 6049, SD 1063A tubes under the contract.

The high-temperature, hard-glass tube is used on devices, like missiles, requiring high temperature ratings.

▶ **Cost**—Production cost has been reduced from $30 a tube to $7.50. Based on joint services present requirements of 100,000 tubes a month, the cost reduction represents a minimum saving of about $27 million a year, plus additional savings because of the tube's increased life expectancy and greater reliability.

Business Briefs

▶ **Largest** stock offering in U. S. financial history is the way AT&T's issue of 5,570,000 shares at $100 per share is described. The proceeds will be used for expansion

▶ **Transistor** production rate of 2 million units a year by 1957 is scheduled by General Transistor Corp., which plans to offer 100,000 shares of common at $3 per share. Proceeds will be used for additional machinery and equipment, to repay bank loans and for working capital

▶ **Computer** field growth prospects are reason behind recent placing of $1.5 million in debentures by Electronic Associates. Proceeds will go for expansion

▶ **Television** tape recorder manufacturer, Ampex Corp., which now has 100 of the units scheduled for production in 1957, sold 100,000 shares of its common at $33.50 per share for working capital

▶ **Electronics** manufacturer, Kay Lab, whose sales are estimated to be 63 percent in electronic instruments and 37 percent in industrial tv, plans the sale of 336,300 shares of class A common, $1 par, at $2.50 per share. Proceeds will be added to working capital

▶ **Loudspeaker** plant expansion underway by Altec Lansing in California will be financed by Altec Companies' sale of 100,000 shares at $13.50 per share

▶ **Agreement** to borrow $150 million from Prudential Insurance Co. of America has been made by IBM.

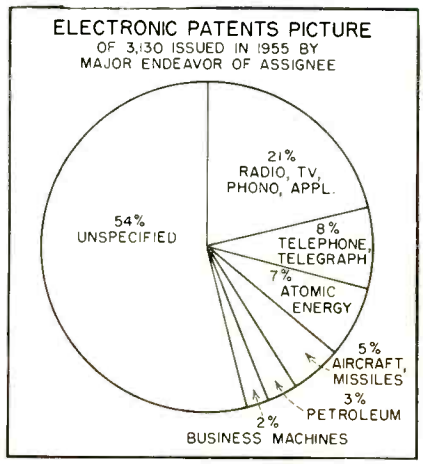
The net profits for the company hit $31.8 million in the first half of this year compared to $23.8 million in the first six months of 1955

Electronics Patents Increase

Almost as many were issued in first half of this year as in all of 1955

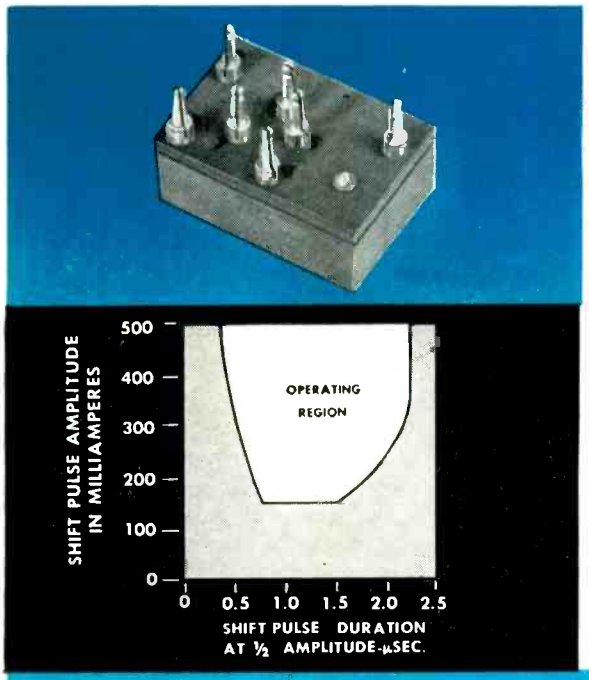
EXPANDING research activity in the electronics industry is evidenced by the increasing number of patents issued in the field. The Patent Office issued 3,084 U. S. electronics patents in the first six months of 1956 as compared with 3,130 in all of 1955.

▶ **Assignees**—The government obtained about 10 percent of the patents issued in 1955, 321 patents. Of



(Continued on page 12)

now . . . magnetic shift registers from SPRAGUE



operating frequency	0-200 kc
shift pulse	
Nominal Operating Current	300 ma
Voltage Drop Per Stage	6.5 volts
Duration (at half amplitude)	1.2 μsec
Rise Time	0.3 μsec
Fall Time	0.3 μsec
Peak Pulse Power	2 watt
input pulse	
Amplitude	10 ma
Duration	3 μsec
parallel output pulse	
Amplitude	15 volts
Ratio (Minimum)	10:1
Load Impedance (Minimum)	1500 ohms
diode	
Type	T-5 or equiv.

Nominal Performance Characteristics of Typical 200 kc Magnetic Shift Register

Now, from one reliable source, you can get a complete series of magnetic shift register assemblies . . . with read and write provisions . . . terminal wired and packaged to your special needs. *Plus* complete field engineering service for arriving at specifications and procuring registers that meet them.

Sprague's new registers are not only suitable for counters in computers and industrial controls, but for a wide variety of logical functions in "and", "or", and "not" circuits.

Five packages are standard, with others available if needed. The 71Z series have mounting ears, that simplify assembly of large arrays of bits in a single rack or frame. Series 70Z registers can be had in several terminal designs for mounting on etched wiring boards, or may be plugged into each other for permanent system flexibility. All 71Z units are mounted in hermetically sealed, corrosion-resistant metal cases with glass-to-metal solder-seal terminals for complete humidity resistance. Type 70Z units are embedded in resin for less demanding environments. Semi-conductor diodes may be externally connected between terminals, or integrally packaged in each assembly.

All Sprague shift register cores are subjected to rigid tests, assuring reliable operation in the final circuit use. Finished assemblies are 100% pulse performance tested to assure conformity with engineering specifications. Specifications for a typical 200 kc shift register, are shown above.

Complete specifications for all standard registers are in Engineering Bulletins 550C and 551, available on request to the Technical Literature Section, Sprague Electric Co., 35 Marshall St., North Adams, Mass.

the mark of reliability

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Export for the Americas Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT

these, 150 went to the Navy, 80 to AEC, 46 to Army, 22 to Defense, 10 to Air Force, 8 to Commerce, 2 to Interior and one each to Agriculture, R. F. C. and U. S. A.

▶ **Fields**—A total of 674 patents was issued to companies whose major endeavor applied to phonograph, radio, television and home appliances, 264 were applicable to telephone and telegraph equipment, 220 to atomic energy, 151 to aircraft and guided missiles, 92 to petroleum and 72 to business machines. The remainder, some 1,657, applied to electronics generally.

▶ **Firms**—RCA received 262 patents in 1955. Other corporate assignees included: Bell Telephone Laboratories, 170; GE, 118; Westinghouse, 85; IT&T, 51; Bendix, 50; Raytheon, 44; Stromberg-Carlson, 32; IBM, 30; DuMont, 29; Sperry Rand, 26; Collins, 24; Philco, 23; Motorola, Sylvania and Hughes, 22 each and Phillips Petroleum, 10.

▶ **Abroad**—Foreign patent breakdown showed 115 issued to British organizations or individuals, 40 to German, 33 to French, 21 to Swedish, seven each to Swiss and Dutch, four each to Belgium and Canadian, two to Moroccan and one each to Italian, Japanese, Australian, Czech and Liechtenstein. Not included were 70 patents issued to Hartford National Bank and Trust, trustees for a Netherlands company.

Transistor Sales Quadruple In Year

MANUFACTURERS sold over one million entertainment and nonentertainment type transistors in June and nearly 5 million units in the first six months of 1956, according to RETMA.

Total transistor sales in June were reported to be 1,130,756 units with a dollar value of $3,645,293. Sales during the first half of 1956 totaled 4,758,603 units with a dollar value of $13,728,111. The half-year figure compares with a total of 1,260,827 units worth $4,741,958 in the first six months of 1955.

RADAR surveying equipment and individual two-way radios appear as . . .

Electronics Boosts Army Efficiency

Battle helmet contains radio while jeep radar station speeds gun siting

AMERICAN artillery fire has won a well-justified reputation for accuracy. One reason is that guns are surveyed into position.

This fact is not unknown to enemy forces. U. S. Field Artillery surveyors are prime targets for enemy snipers.

▶ **Jeep Radar**—The job of surveying in field guns may become a lot less hazardous with a jeep-borne radar set designed by the Signal Corps Engineering Laboratories and developed by Motorola. The equipment measures 50-mile stretches.

Measurements are made between two jeep-borne stations. An automatic computer determines the time a signal requires for 10,000 round trips. Each radar station consists of a 25-ft collapsible antenna mast and three carrying cases—all weighing only 200 lbs. The station can be operated by one soldier.

▶ **Battle Hat**—Two-way radio communication for all combat soldiers may be possible with a transistorized f-m receiver-transmitter that weighs only one lb. The set is built into a soldier's helmet and operates one-half day on its set of small batteries.

Designed for short-range conversations, its range can be increased by an auxiliary antenna. At full range, the transmitter can reach receivers up to a mile away and receive powerful signals at greater distances.

A Signal Corps development, the radio set uses a thumb-sized microphone. It is equipped to send an acknowledging beep signal when the soldier depresses a button on the helmet.

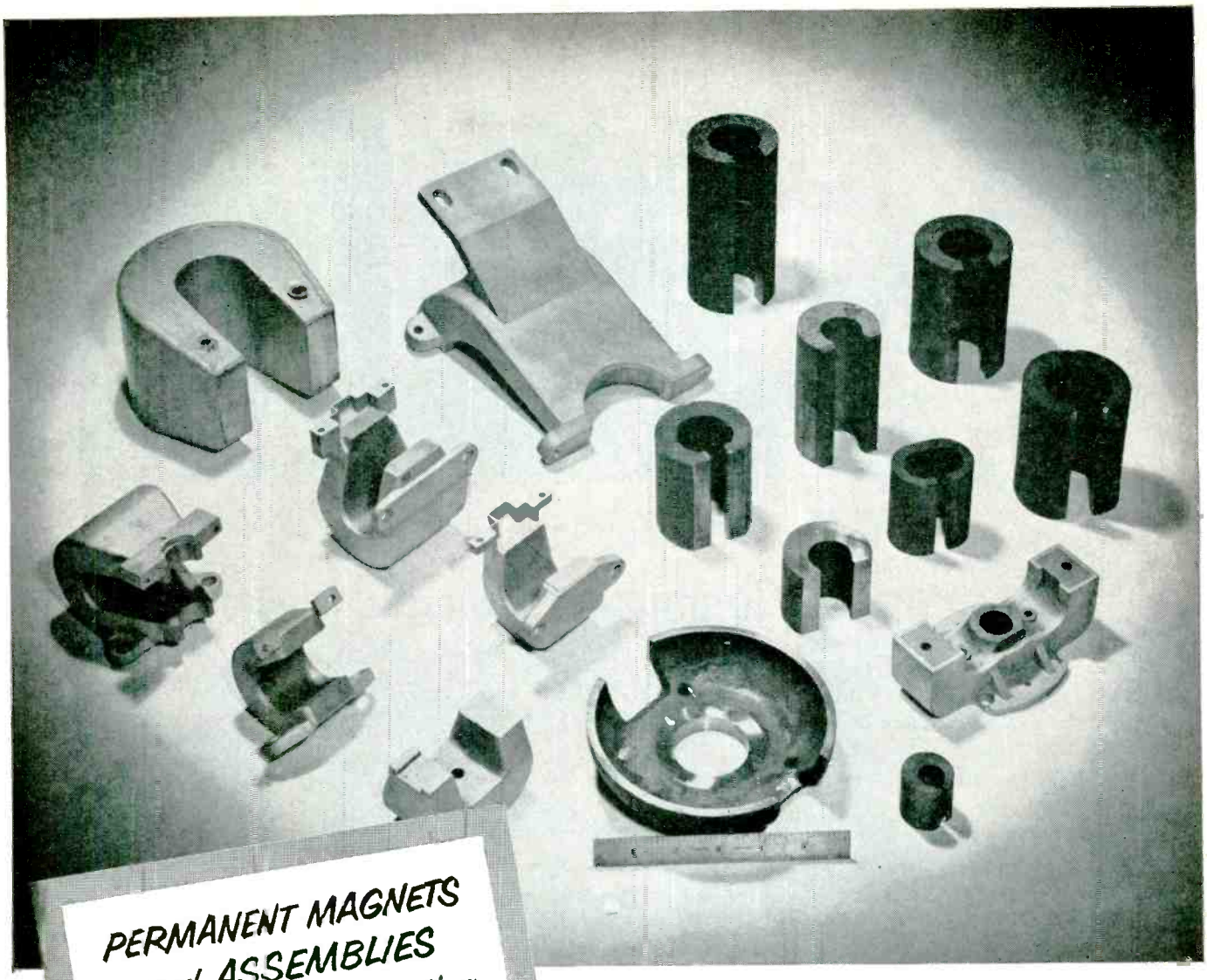
Two-Way Radio Gets Set For Expansion

Equipment manufacturers, military and business users push two-way radio communications

MOBILE radio business is continuing to increase. Leasing of equipment is gaining momentum, plant expansion is in progress, users are taking on more equipment and the industry in general foresees substantial future growth for the field.

▶ **Rental**—Leasing of two-way radio is on the upswing. GE was recently awarded a large leasing contract by the USAF Air Materiel Command for commercial two-way radio equipment. The lease, involving several million dollars worth of fixed station units and mobile radios, covers ground communication equipment to be used by Air Force bases and installations in the U. S. The company also recently signed a leasing agreement with a major

(Continued on page 14)



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★ Made to your specifications

★ Any size, shape or coating required

★ Send us your drawing for quotation

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"ARNOLD MAGNETIC MATERIALS"

32 pages of general data on all Arnold products: cast and sintered Alnico magnets; tape wound cores; Silectron C and E cores; bobbin cores; Mo-Permalloy powder cores; iron powder cores; special magnetic materials, etc.

ADDRESS DEPT. E-69

The group of magnets illustrated above are indicative of the great scope of Arnold production in this field. We can supply these permanent magnets in any size or shape you may need; in weights ranging from a few ounces to 75 pounds or more; and with die-cast or sand-cast aluminum jackets, Celastic covers, etc., as required. Complete assemblies may be supplied with Permendur, steel or aluminum bases, inserts and keepers as specified—magnetized and stabilized as desired. ● Let us handle your magnetron, traveling wave tube and wave guide permanent magnet requirements, *or any other magnetic material specification you may have.*

WSW 5996 C

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truck rental firm involving several thousand units.

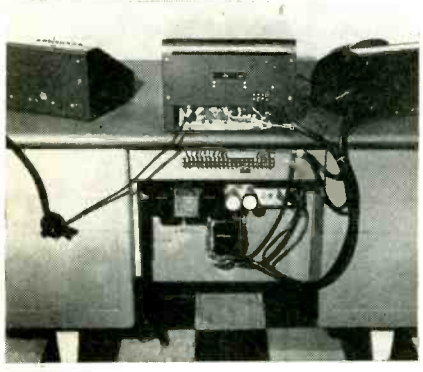
Another company, Tele-Dynamics, now has a total of more than 350 lease accounts for two-way radio using approximately 2,000 mobile units and 50 fixed stations. For some years the Bell System has leased two-way radio equipment and estimates that it now has some 25,000 mobile units on lease, representing about 3 percent of the market.

▶ **Use**—Railway and Air Express is increasing its use of two-way radio equipment. It now has 226 radio dispatched units of which 42 are used on depot tractors and 184 on street vehicles. The company owns the tractor radio equipment but leases the 184 street units.

With the equipment the firm has reduced pickup and delivery time by more than half. It plans to expand two-way radio use on its nationwide fleet of 13,000 trucks and tractors.

▶ **Building**—GE believes that industry sales of radio communications equipment will double in the next five years. It plans to build a new $4 million plant for the equipment in Gainesville, Fla. The company points out that the radio communications industry has grown 15 times in the past nine years.

▶ **Statistics**—FCC figures indicate the rise in two-way radio business. Number of transmitters authorized in fiscal 1955 totaled 767,893 compared to 652,794 for 1954. RETMA estimates that 160,000 applications for the service will be made in 1956 and 173,000 in 1957.



Desk-adapted Motorola two-way radio equipment is used in the Pentagon for interoffice and mobile communications

TRANSLUCENT plastic radome for DEW-line (left) and over-the-horizon antenna for White Alice (right) are latest additions as . . .

Continental Defense Pushes Ahead

Contracts covering DEW-line, Sage and White Alice may reach $3.5-billion mark

RECENT additions to the overall continental defense system indicate electronics' share in this effort.

▶ **DEW-Line** — Overall cost of DEW-line is estimated at $400 million. Estimates of electronics' share are not available for security reasons. However, the costs of labor and transportation required to erect such a system in remote areas are substantial.

Use of a new self-supporting glass fiber radome of struts, trusses and thin, flat panels reduces the hazard of collapse of the present rubber domes with attendant immobilization of the antennas.

Developed at Bell Telephone Laboratories, the dome can be erected in 18 hours, the maximum period for which weather in the Arctic can be predicted.

▶ **Sage**—Overall cost of the Sage project is estimated at from $1 to $3 billion.

The recent $12-million production contract for airborne data-link radio units awarded GE by the Air Force is a likely addition to Sage.

The data-link system provides fighter planes with intercept messages from a ground control station. The unit converts the message, which includes heading, altitude and speed required to vector fighter to target, for display on a cockpit indicator.

Intercept information could also feed plane's autopilot or be transmitted to guided missles.

▶ **White Alice**—The White Alice project will ultimately span 3,300 miles and have stations at some 33 sites. Cost of the project is estimated at $100 million.

The first section of this uhf system, which is to be used to improve vital communications between the Pacific Northwest, Alaska and the DEW-line, is to go into operation this October according to Western Electric, prime contractor on the Air Force project.

Community Antenna Systems Keep Growing

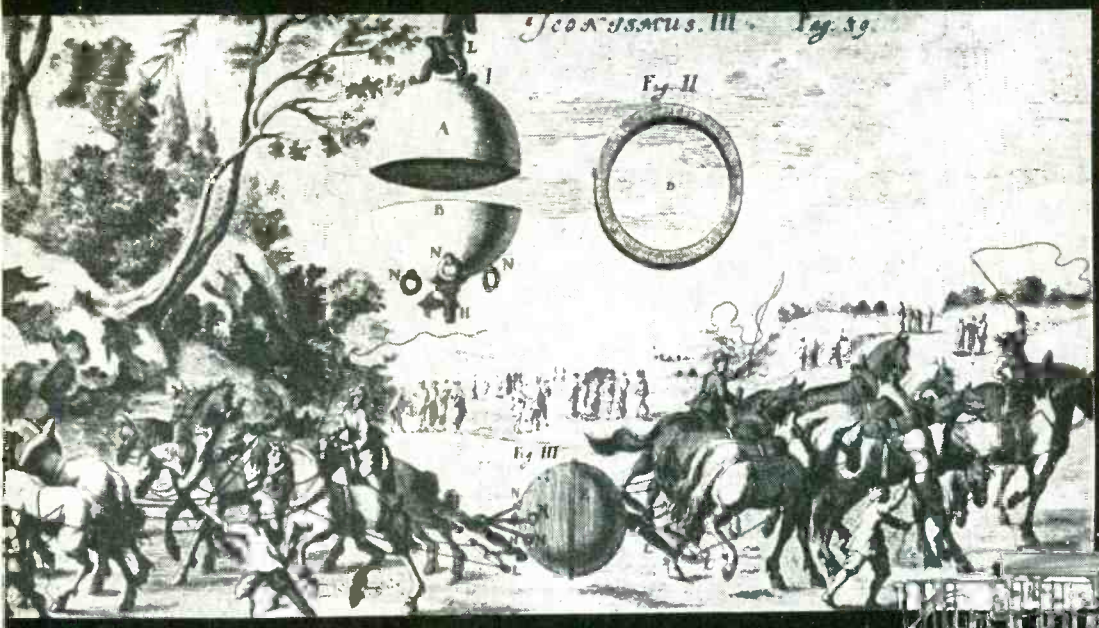
Number of operations nears 500, nearly double the number of two years ago

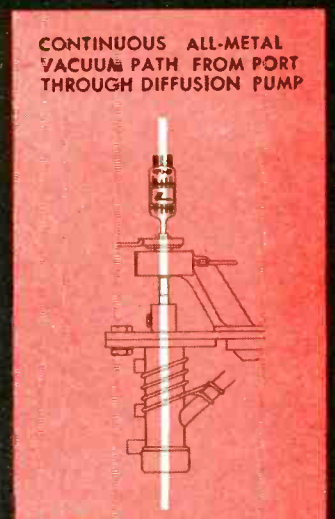
WITH an estimated half million U. S. families now receiving tv programs through some 500 community antenna systems, the field has become an important and apparently permanent part of the tv broadcasting picture. There were less than 10 systems in 1950, some 275 in 1954 and nearly 500

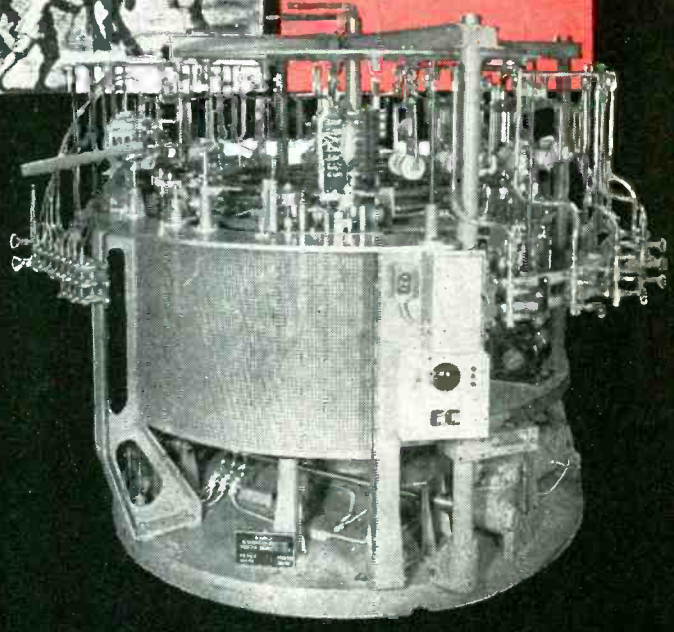
(Continued on page 16)

Most revolutionary development in vacuums.....

SINCE 1650 A. D.







Rotary Exhaust Machine #2694

The Magdeburg Hemispheres Test was the first demonstration of creating a vacuum. That was in 1650 over 300 years ago . . . today Kahle has demonstrated a revolutionary new concept in vacuum . . . a valve-less rotary *Exhaust Machine.*

This rapid-speed, rotary-in-line, automatic *Exhaust Machine* features a *continuous all-metal vacuum path from port through diffusion pump* . . . completely eliminates the conventional slide valve . . . individual automatic leak detector and shut-off valve on each port . . . water cooled compression chucks are automatically operated . . . automatic tipping torch and automatic tubulation remover are also employed.

Ultra-high vacuum is achieved with the unique design and rugged construction of Kahle's automatic *Exhaust Machine.* Ideal for exhausting cathode ray tubes, transmitting tubes, receiving tubes, x-ray tubes, and *all* other high-reliability types.

The type *Machine* illustrated is one of a wide selection of sizes and ranges available at Kahle.

Write today for valuable File Folder containing complete specifications and information.

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DESIGNERS AND BUILDERS OF AUTOMATIC AND SEMI-AUTOMATIC EQUIPMENT FOR ALL INDUSTRIAL OPERATIONS

operating or planned for operation this year.

▶ **Where**—In Pennsylvania mountainous terrain makes regular tv reception difficult over a large part of the state. There are some 87 community antenna systems in the state. Oregon has 44 systems; West Virginia, 38; Washington, 33; California and New York each, 28; Texas, 25; Idaho, 25 and Kentucky, 21. Some 40 states and Alaska have community tv systems in operation.

▶ **Makers**—About a score of companies specialize in community antenna equipment. One firm that has supplied equipment to many of the existing systems owns five community systems directly.

▶ **Future**—FCC proposal to shift all tv to uhf may have some effect on the future growth of community tv if it helps to put uhf stations into markets that would otherwise utilize antenna systems. However, community antenna system operators do not seem immediately concerned and are continuing to expand. So far this year about 10 more systems have begun operations and at least that many more are planned.

Printer Ties Computer Speed

Scans face of special cathode-ray tube; honeycomb computer memory is also introduced

ELECTRONIC digital computers often out-distance mechanical devices used to print out their results. See p 142, this issue.

▶ **All-Electronic**—Special cathode-ray tubes have been developed that spell out alphabetic and numerical information as fast as the computer can produce it. However, photographic processes have been used to obtain a permanent image; this introduces some delay. A possible answer is combining such a special crt with an electrostatic dry-printing process.

Experimental production model of a continuous electrostatic printer developed for General Dynamics by Horizons, Inc. of Cleveland handles 4,000 to 5,000 characters a second. Development is underway to extend this to 10,000.

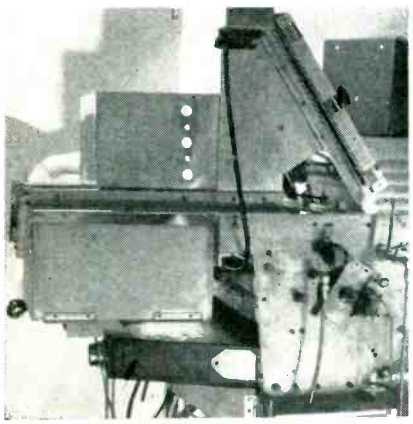
▶ **How It Works**—The machine displays on the face of a Charactron crt data received as electrical impulses. A modified Xerographic printing process produces a permanent image. Common newsprint is web fed through the machine to receive the image.

The Charactron is a product of General Dynamics' Convair division while Xerography was developed by Haloid of Rochester, New York.

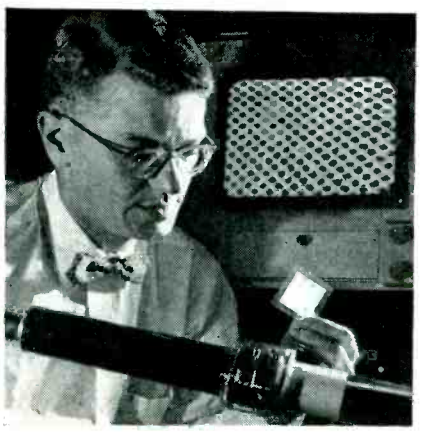
Applications of high-speed electronic printing systems may include reading out answers from engineering and scientific computers, automatic customer billing, preparation of inventories, payroll and production-control information and magazine subscription fulfillment.

▶ **Memory**—Another problem in computer design is the memory. Size of the memory often proves a bar to computer installation. One solution proposed by GE is a one-sq-in. honeycomb consisting of a sheet of glass in which holes have been etched and filled with metal.

The memory is part of a storage-tube system in which a reading electron beam picks up charges stored in the metal dots. Holes spaced 500 to the inch provide 250,000 cells a square inch. Each cell will recognize ten levels of charge intensity as established by the writing gun. Applications for the memory also include television cameras and scan converters for radar systems.



Laboratory model of Horizons, Inc. high-speed electrostatic printer. Eye of printer that scans crt face is at lower left. Web of newsprint passes through slanted surface at the upper right



Reading and writing storage tube using glass honeycomb memory. Television screen in background shows magnified portion of storage mesh that provides 250,000 cells a sq in.

UHF Continues In Limelight

All-uhf tv channels proposal pushed by congressional and business spokesmen

FEDERAL Communications Commission proposal for a long-range shift of all or part of U. S. tv stations to uhf and the immediate beginning of selective deintermixture, seems to be gaining support. The Senate Committee on Interstate and Foreign Commerce approved the plan although three members of the Committee have filed dissenting views. The Committee urged the FCC to move as rapidly as possible to accomplish its program and said selective deintermixture should be effected as broadly and rapidly as possible.

▶ **Report**—The FCC released figures on the 1955 financial picture of uhf stations. They show that 103 uhf stations had total broadcast revenues of $28.5 million in 1955. This compares to $25.4 million in

(Continued on page 18)

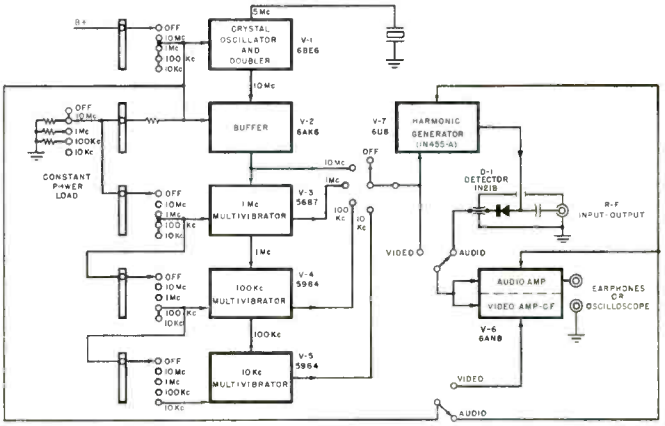
a complete new miniature standard for TIME/FREQUENCY measurements

The Type 1213-C Unit Time/Frequency Calibrator is a compact and inexpensive secondary standard of frequency. Contained in a single, small package are the circuits necessary for calibration operations which have hitherto required several instruments. This *one* instrument provides:

★ *Accurate 10-kc, 100-kc, 1-Mc, and 10-Mc fundamentals . . . plus harmonics to 1000 Mc*

★ *A crystal mixer of new design for use over the entire 1000-Mc range*

★ *Audio or video amplifier stages . . . to amplify beats from the mixer for frequency calibration or to amplify the accurately known multivibrator square waves for time calibration.*



Calibration points for oscillators and receivers can be located without need for additional equipment (other than headphones). By calibrating against WWV, accuracy can be made much greater than required in most applications.

General-purpose frequency measurements, including standardization of TV transmitters to 1000 Mc, may be accomplished by feeding an interpolating oscillator frequency into the Calibrator's mixer along with the unknown frequency.

For calibrating CRO time axes, the Type 1213-P1 Differentiator provides timing pulses at intervals of 0.1, 1.0, 10.0 and 100 μsec, at the accuracy of the crystal-oscillator frequency.

In its video position, this instrument serves as an accurate timer for pulse applications.

SPECIFICATIONS

OUTPUT FREQUENCIES: 10 kc, 100 kc, 1 Mc and 10 Mc; harmonics usable to 10 Mc, 100 Mc, 500 Mc and 1000 Mc respectively.

NARROW-RANGE FREQUENCY ADJUSTMENT: 2.5 ppm variation (25 cycles at 10 Mc).

TOUCH-BUTTON FREQUENCY DEVIATOR: introduces a momentary 1.8 ppm frequency decrease for establishing "sense" in indications near zero-beat.

OUTPUT AMPLITUDES: 10v peak-to-peak on 10-Mc output from pulse amplifier; 30v p-to-p at lower frequencies.

OUTPUT IMPEDANCES: 300Ω from video cathode follower; capacitively coupled r-f output from crystal-diode harmonic generator.

STABILITY: 1 ppm/°C after one hour warm-up with Type 1201-A Regulated Power Supply.

SENSITIVITY: usable beat notes produced with 50-mv signal input to mixer.

Type 1213-C Unit Time/Frequency Calibrator, supplied with **Type 1213-P1** Differentiator **$195**

Type 1201-A Unit Regulated Power Supply ..... **$ 80**

Type 480-P4U3 Relay Rack Panel, for mounting both Calibrator and Power Supply ..... **$ 10**

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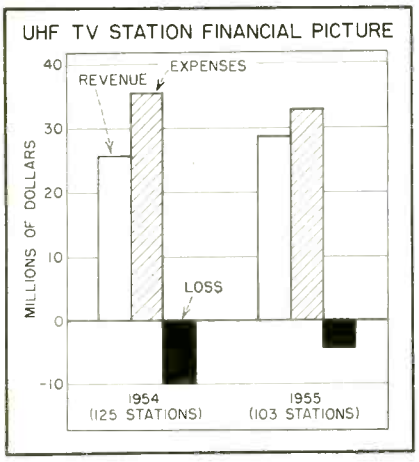


1954 for 125 uhf stations.

Despite the gain in revenue, the 103 stations had a loss of $4.5 million in 1955 although the loss was down substantially from the $10 million loss for 125 stations in 1954.

▶ **Time**—According to W. R. G. Baker, RETMA president and GE v-p, the average life of a tv set is seven years. He said that we are now entering a period of mass-replacement purchases of tv receivers. An early decision by the FCC to move tv to the uhf channels will insure that sets purchased will be capable of receiving uhf programs, he said.

Baker also urged that station operators should have the right to transmit simultaneously on both vhf and uhf channels during the proposed transition and should be permitted quick amortization of transmitters.

Military Electronics

▶ **Military** spending for this fiscal year is going up, says Defense Secretary Wilson. He plans to ask Congress for more money next year. Estimated defense spending for this year is $36 billion

▶ **Fast** tax amortization certificates that allow new defense plants to be depreciated within five years instead of 25 were awarded to 7 electronics firms in July. Amount certified totaled $18.1 million compared to $4.4 million in June. Biggest certificate covering $7.5 million went to IBM

▶ **Government** contracts awarded to Canada's electronics industry by the Canadian Department of Defence during May totaled $244,000 compared to $6.6 million in April

▶ **Directive,** issued by Defense Secretary Wilson, to improve reliability of new electronic equipment, calls for adequate design development and testing prior to equipment release for production as well as for adequate pilot production. The new procedure will not become a part of military contracts, but it is assumed that compliance with the directive is a requisite for approval of equipment

▶ **Transistorized** timing signal generators and other electronic timing equipment totaling over $500,000 is being built on a crash basis for Patrick Air Force Base by Electronic Engineering

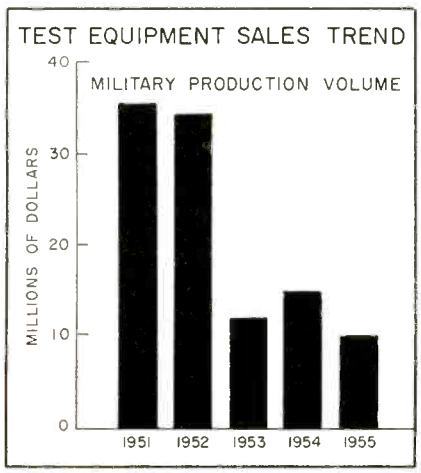
▶ **Contracts** for military airborne radar and indicating systems and development of new diffused transistors are included in $7 million in new business announced by Texas Instruments

Government Examines Test Equipment Field

Survey of business shows its importance to military equipment maintenance and operation

SURVEY of the electronic test equipment field by the Department of Commerce will aid military planners in helping improve the quality of instruments being procured and strengthening the defense posture of the industry.

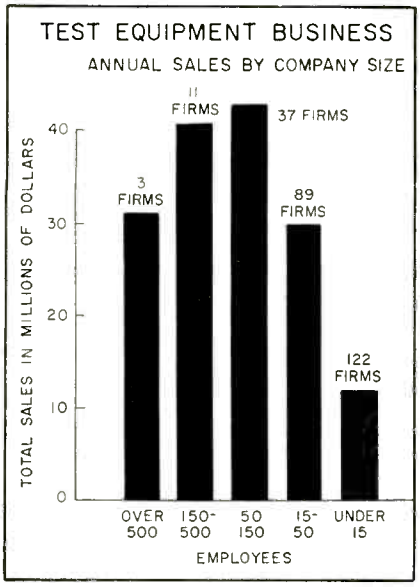
▶ **Volume**—The study shows that there are some 262 manufacturers of electronic test instruments in the U. S. For 81 of these manufacturers, the production of general-purpose electronic test instruments comprises more than half of the firms' total activity. These companies account for nearly 60 percent of the $157 million annual volume of the industry.



For 101 of the companies, test gear accounted for less than half of the firm's activity although other products made were closely related. These 101 companies accounted for $41 million, 26 percent of total sales.

For the remaining 80 companies,

(Continued on page 20)



test equipment production represented less than half of total activity. Other products of a different nature were the main business. These firms accounted for only 16 percent of the total test instrument dollar volume.

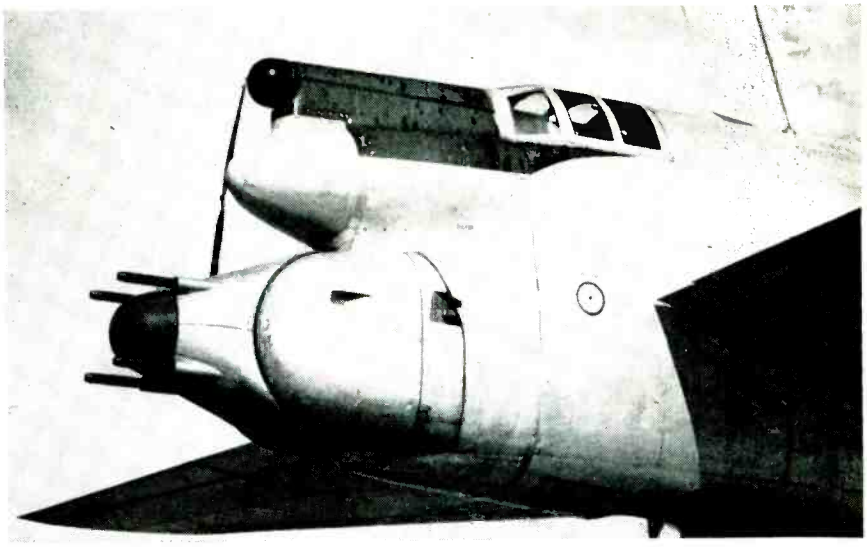
► **Size**—Companies with over 500 employees accounted for 20 percent of the $157 million annual volume of the field. Those with 150 to 500 workers accounted for 26 percent; 50 to 150 employees, 27 percent; 15 to 50 employees, 19 percent and those firms with under 15 employees accounted for 8 percent of total volume. The largest producer has less than 1,000 employees and receives less than ten percent of the total orders for the equipment. Fifty-one companies or 20 percent employ 9,000 workers or 75 percent of the total work force and produce $115 million each year or about 75 percent of total annual dollar volume.

► **Equipment**—The survey estimates that 36 firms produce voltage and current measuring instruments, 46 make frequency and time interval measuring instruments, 39 build impedance and standing-wave-ratio measuring instruments, 31 manufacture power and electromagnetic field measuring instruments, 45 make waveform measuring and analyzing instruments, 75 make signal generating instruments, 38 produce active network type instruments for test and measuring purposes and 44 companies build passive network type instruments for test and measurement purposes. Two of the three largest producers make equipment of every basic type.

► **Military**—The average military production since 1951 has been about $21 million a year. For the last three years through 1955 the average has been $12.5 million a year. Present requirements for military general-purpose electronic test instruments are less than 10 percent of the total volume.

During the entire period from 1951 through early 1956 largest military production has been concentrated on signal-generating equipment with a total volume of $43.8 million. Frequency and time interval measuring instruments ranked next with a total of $31.2 million, followed by waveform measuring and analyzing instruments with $15 million and impedance and electromagnetic field measuring instruments with $10.6 million.

Companies with over 500 employees accounted for only 5 percent of total military production volume in the period from 1951 to early 1956. Those with 150 to 500 employees for 30 percent; 50 to 150, 21 percent; 15 to 50, 35 percent and under 15, 9 percent.



TAIL OF B-52 is loaded with electronics as . . .

H-Bomb Carrier Gets Stinger

Defense system using radar and computer to control guns goes into production

ATTACK vulnerability on the B-52 intercontinental bomber has been determined to exist primarily at the tail.

► **Contract**—To provide a defense against possible attack at this point, a $200-million contract for the production of a new fire control system was awarded Arma division of American-Bosch-Arma by the Air Force. Of this, 40 percent is subcontracted to other manufacturers while 20 to 25 percent is subcontracted for small parts.

► **System** — Radars are used to search, acquire and track the target. Tracking information is fed to the computer which generates the gun lead angle.

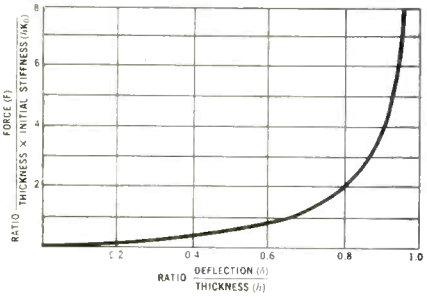
Provisions are made to track a target while still searching for others. An optical sight enables the gunner to control the guns manually. No provisions have been made for iff equipment.

The top blister shown in the photograph is the optical portion while the center contains the search equipment and the bottom the tracking equipment.

(Continued on page 22)

How to Design for Isolation during Sustained Acceleration

It is becoming increasingly important that vibration isolators continue to provide isolation during sustained acceleration. *This is a requirement in some classes of guided missiles* If the force-deflection characteristic of the isolator is linear, it is easy to calculate the required deflection by multiplying the static deflection of the isolator under the deadweight load by the sustained acceleration expressed as a dimensionless multiple of the gravitational acceleration. Unless it has clearances at least equal to this calculated deflection, the isolator bottoms during the sustained acceleration, and provides no vibration isolation. One way to alleviate this effect is to use an isolator having non-linear force-deflection



characteristics, as shown by this dimensionless curve and defined by the equation

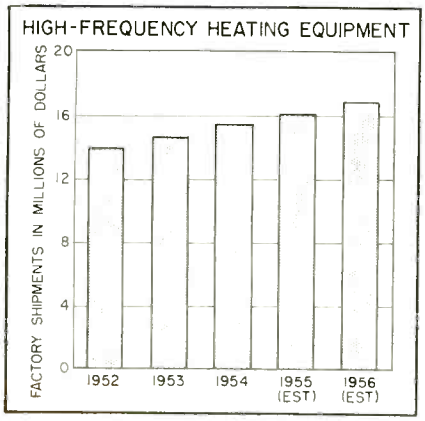
$$\frac{\delta}{h} = \frac{2}{\pi} \tan^{-1}\left[15.37\left(\frac{\ddot{x}_s}{f_0^2 h}\right)\right]$$

where δ is the deflection of the isolator under the sustained acceleration $\ddot{x}_s$, is the natural frequency under normal deadweight load, and h is the "effective thickness" of the load-carrying spring. When sustained acceleration increases the static force on the isolator, deflection increases, but less than if the stiffness of the isolator were linear. This increase in deflection is accompanied by an increase in stiffness; i.e., by an increase in the slope of the force-deflection curve. The effective natural frequency is thus increased because there is no increase in mass, and the transmissibility increases.

To simplify the evaluation of changes in transmissibility, we have prepared a nomograph and set of curves for graphic solution of this problem. Write for your free copy of these useful design data — Bulletin #THO-5 — to BARRY CONTROLS Incorporated, 707 Pleasant St., Watertown 72, Mass.

From "Natural Frequency of a Nonlinear System Subjected to a Nonmassive Load", Transactions ASME, January, 1954

High-Frequency Heating Grows



Factory sales double as more industrial applications are found

VOLUME of induction and dielectric heating apparatus has more than doubled in the past eight years and is now approaching an annual volume of nearly $17 million. Both types of equipment have grown substantially although induction dollar volume has moved faster and farther than dielectric.

► **Leader**—Induction heating apparatus accounted for about 70 percent of total high-frequency heating volume. Factory sales rose from $7.6 million in 1947 to $14.7 million in 1954.

During the same period factory sales of dielectric heating apparatus increased from $2.4 million to $3.6 million. But in the past two years dielectric sales have risen more sharply due to increased use in thermosetting plastic production. (ELECTRONICS, p 16, April, 1956.) For individual companies, sealing unit sales for 1955 ranged from $50,000 to $1.2 million representing for some companies a ten-fold increase within the past five years.

► **Use**—Behind the big rise in sales of induction heating equipment are the substantial savings the equipment affords in metalworking. For example, a nut-forming company recently installed an induction heating unit and stepped up capacity 50 percent.

FCC Actions

► **Arranged** with CAA for FCC field engineers to make joint flights for purpose of checking interference to aviation radio communications

► **Authorized** State of Ohio to install first private microwave tv in police developmental service. System will transmit automobile registration data from licensing bureau to highway patrol headquarters

► **Shifted** an educational reservation from vhf to uhf. This first instance of such a move is predicated on lack of evidence that channel would be used by educational interests in the foreseeable future

► **Amended** tv rules to permit channel assignments on basis of coverage and spacing measured from transmitter (rather than from post office). Mileage separation between transmitters is not reduced

► **Added** subpart to rules governing restricted radiation devices to cover permissible radiation from community antenna systems. It is a compromise between FCC April 1954 proposal and comments

► **Permitted** international fixed stations to send QTT and abbreviations for operating company and message-center city in Morse-code, omitting call signs

► **Modified** landing point of previously authorized AT&T twin deep-sea cables between Hawaii and U. S. from Point Reyes to Point Arena, California

► **Leaked** (via Commissioner Hyde's speech to Associated Police Communications Officers) impression that action might be forthcoming on two-year-old channel-splitting docket. Police radio men have not favored splitting

Industry Eyes Retirement Plans

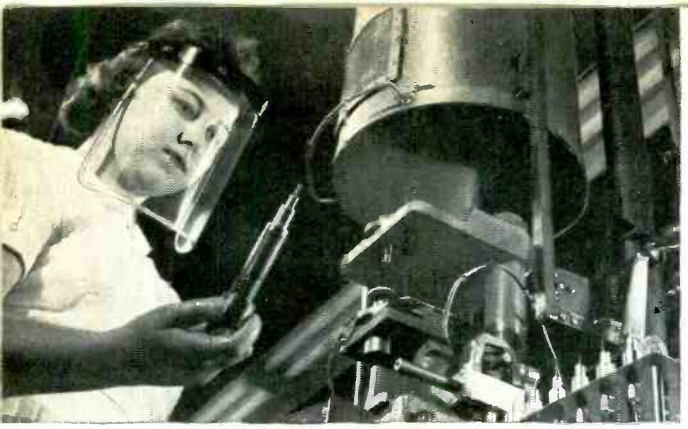
Manufacturers liberalize pension plans as fringe benefits become more important

COMPANIES in the electronics industry are liberalizing employee retirement plans. This is indicated by the Bankers Trust Company's latest study of employee retirement plans of industrial employers, for the period of 1953 through 1955. Employees covered by the plans of the study total approximately four million, about a third of all industrial employees currently covered by pension plans.

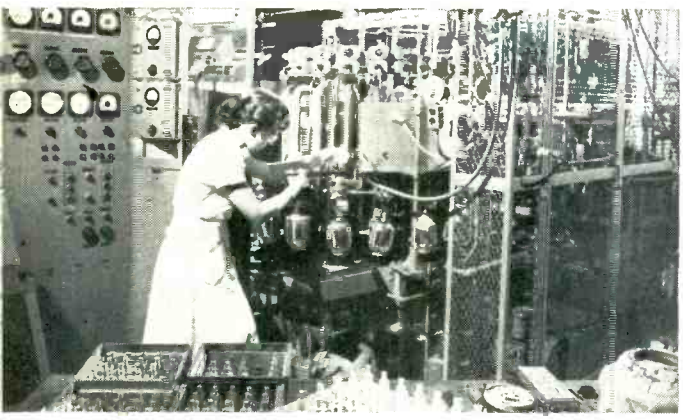
► **Growth**—GE has now paid out $150 million in pensions to employees. Monthly pension payments under the firm's present pension plan average $102 for employees who retired during the first four months of 1956. Over 33,600 employees have retired under GE pension plans. Of them, some 16,500 are on the active pension rolls at present.

Consolidated Electrodynamics, which started a profit-sharing retirement plan some three years ago, now has a trust worth $1.6 million. Some 800 eligible employees re-

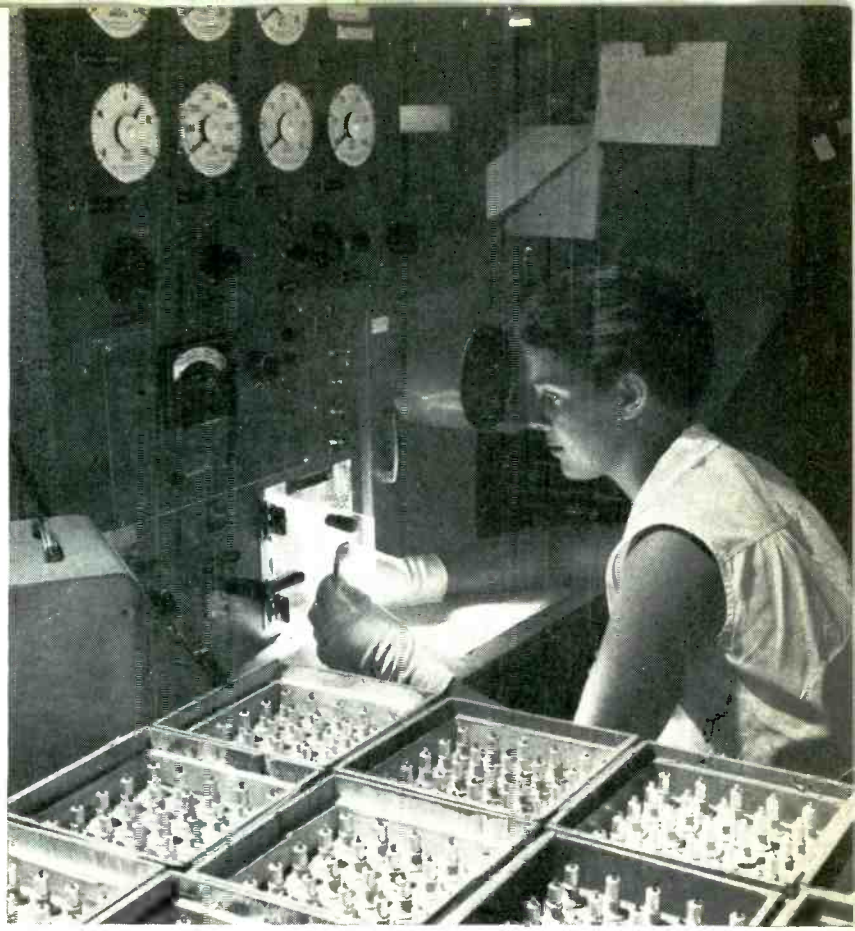
(Continued on page 24)



GL-6442 tubes in quantity production by General Electric are assembled by r-f brazing in a hydrogen atmosphere.



The tubes are evacuated by rotary exhaust machine; afterwards, their metal stems are pinched off and sealed.



GL-6442 triodes are individually tested for their electrical characteristics, in order to assure tube dependability and full-rating performance at all times.

Quantity production of General Electric's GL-6442 makes this 4000-mc tube available for immediate large-scale use!

GL-6442's are being manufactured and shipped in volume by General Electric. Consequently, design engineers can specify this small, rugged lighthouse triode for immediate quantity application in microwave airborne equipment for planes and guided missiles.

Less than 2⅝" high and ⅝" in diameter, the GL-6442 puts out 2 kw of useful peak power at 3500 mc, as a Class C plate-pulsed oscillator. The tube's r-f Class C output at 2500 mc is 1½ to 2 watts.

Dependable and long-lived! The GL-6442 will perform steadily at maximum ratings and still give full warranted tube life. Heat-resistant . . . with safe CCS operation up to 175 C seal temperature! Shock-resistant . . . tested up to 400 G!

Advanced metal-ceramic construction; ultra-modern co-planar design! Newest and best u-h-f triode for CW and pulsed power applications that put a premium on compactness, sturdiness, and the ability to withstand high operating temperatures.

Ask . . . now . . . for complete GL-6442 ratings and characteristics! *General Electric Company, Electronic Components Division, Schenectady 5, N. Y.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

1612-185

ceived a total of $211,095 representing 12 percent of the firms profits before taxes in 1955.

Sylvania has 17,650 employee members in its retirement and savings plan, under which the firm contributed $2.9 million and employees $2.1 million last year. Payments by the company in 1955 to those who left the company as well as to beneficiaries and pensioners amounted to $1.3 million.

American Bosch Arma costs were $1.6 million for two pension plans in 1955 compared to $843,955 in 1954.

Zenith provided $2.9 million for its profit-sharing retirement plans in 1955 and Burroughs made payments of $2.8 million. Texas Instruments paid $341,560 to its pension trust in 1955 compared to $336,607 in 1954.

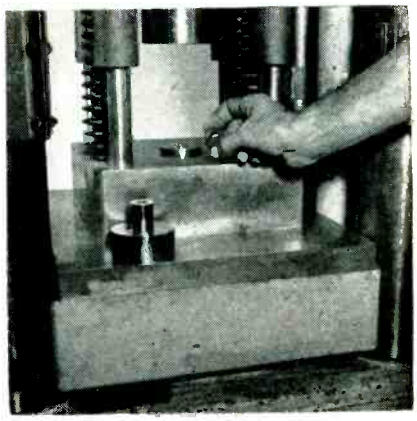
► **Trends**—The Bankers Trust study shows that companies have moved in the direction of covering all employees, regardless of position, with pension plans. Some 90 percent of the companies surveyed had full coverage.

A trend toward more liberal eligibility requirements for membership in conventional or nonunion plans was also shown. However, over 50 percent of the 239 plans studied have minimum conditions which an employee must meet to qualify for a pension.

► **Retirement**—Age 65 continues to be the normal retirement age for men. Only 3 percent of the plans have a retirement age higher than 65.

The retirement age for women is the same as for men in 95 percent of the plans. Provisions for earlier retirement either at the employees election or with the companies consent are included in 92 percent of the plans surveyed but only 46 percent permit retirement in case of disability. About 38 percent of the plans allowed early retirement only with the company's consent.

Vesting or the right to leave an employer without forfeiting accrued pension is provided in some form in about 74 percent of the plans.



NEW magnetic core material is rolled, left, and molded to shape as . . .

New Materials Perk Up Magnets

Military pushes magnetic developments as electronics consumption grows

WITHIN past months, two new magnet materials have been announced by the military. Purified manganese-bismuth, developed by Westinghouse for the Air Research and Development Command, is expected to yield permanent magnets with high resistance to demagnetization. (ELECTRONICS, p 7, July 1956).

Flakenol has been developed at Naval Ordnance Laboratory as a magnetic core material for electronic filter and communications systems. It is composed of iron, silicon and aluminum, has a high permeability and low eddy-current loss coefficients. Use of the new material may save many tons of nickel annually.

► **Industry**—About 175 million magnets were produced last year and the electronics industry used 50 to 75 percent. Over 40 million magnets were used in home radio and tv sets alone. One magnet maker foresees an annual production of 250 million magnets by 1960.

► **Nickel**—Use of nickel in magnets had climbed from 1.2 million pounds in 1951 to an estimated 2 million pounds last year, representing about 25 percent of all the nickel used in electronics.

► **Cobalt**—About 28 percent of total U. S. consumption of cobalt is used in magnets, according to Battelle Institute. World cobalt production was a record 14,000 short tons in 1955, up from 8,000 tons in 1950. Currently, about 55 percent of the cobalt consumed in the U. S. is produced in North America.

► **Cores**—Over 200 million magnetic cores are used by the electronics industry annually. A ferromagnetic plastic has been developed that is available in flexible rod and flexible tape as well as rigid cores.

Manufacturers Push TV Sales to Hotels

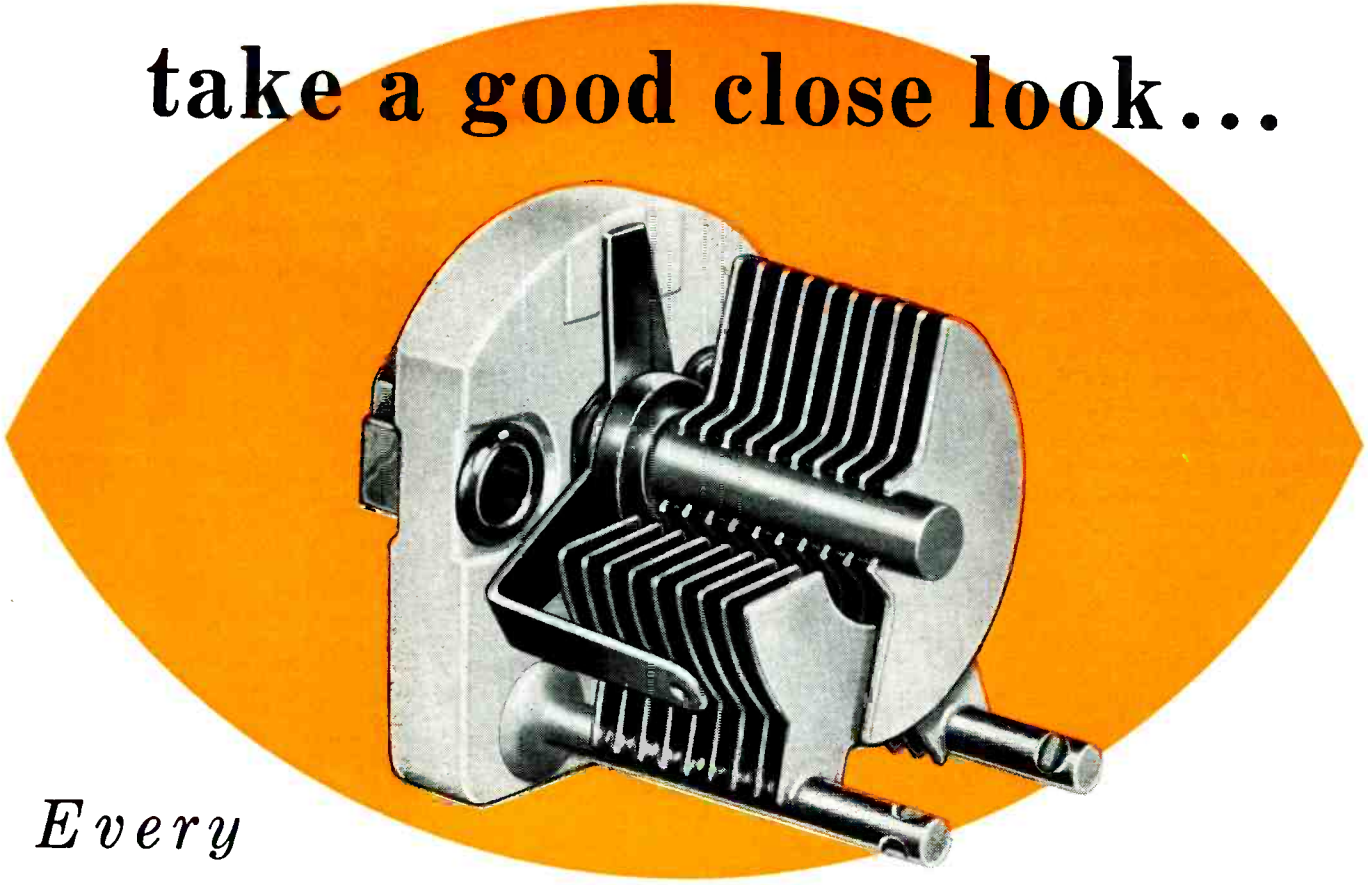
Market still holds potential for volume sales as new hotels and motels wire for video

ALTHOUGH most leading hotels and motels have tv sets available either as standard equipment in each guest room, in public rooms or as an additional service provided upon request, tv manufacturers are intensifying sales efforts in the field.

Two manufacturers have recently completed 1,000-set sales to established hotels. Another set maker is getting ready to supply nearly 500 color tv sets to a new hotel now under construction. The hotel has already been wired for direct tv reception as well as for closed-circuit tv within the hotel itself. Al-

(Continued on page 26)

take a good close look...



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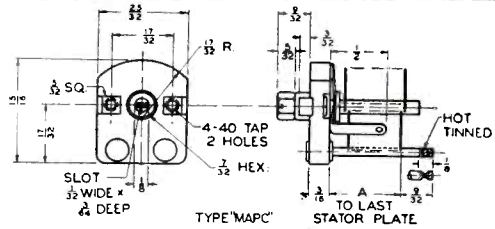
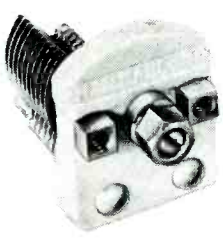
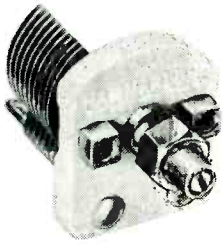




Standard screwdriver or wrench adjustment.



Vibration-proof split-bushing lock type shaft.

CODE	CAPACITY		PLATES	DIMENSION "A"
	Max.	Min.		
MAPC-15	15.	2.3	6	17/64
MAPC-25	25.	2.6	10	3/8
MAPC-35	35.	2.9	14	15/32
MAPC-50	50.	3.2	19	37/64
MAPC-75	75.	3.9	29	53/64
MAPC-100	100.	4.5	38	1-5/64

SPECIFICATIONS

Rotor and stator assemblies fabricated of brass parts, jig solder assembled and nickel-plated. Bearings spun securely in base to fill hex depression, insuring positive locking of bearing in base. Positive electrical contact attained using nickel-plated, heat-treated beryllium-copper contact spring. Bearing reamed to fit rotor and to obtain anti-gall characteristics with dissimilar metals. Mounting insulated from rotor and stator. Air gap .0135 nominal. Tested at 600 V. R.M.S. 60 cycle. Straight line capacity. Shafts for screwdriver or wrench adjustment and screwdriver adjustment for lock-type capacitors. Units also available with extended shaft for knob adjustment or coupling.

Write for Bulletin E-956

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most 100 miles of wiring have been used including 14 miles of coaxial cable.

Much new hotel or motel construction is now providing concealed cable conduits with outlets in all public and guest rooms for the eventual installation of tv. Receiver manufacturers see a big sales potential not only in older established hotels and in new units under construction but also in the hotel tv replacement market for both monochrome and color television receivers.

► **Market**—There are approximately 52,000 motels with 885,000 units, and about 15,000 hotels with some 1.5 million rooms. Together they add up to a market potential of almost 2.4 million sets. About 25 percent of the market has been sold, an increase of about 15 percent since 1951. In New York City only about 25 of its hotels are 100-percent tv equipped.

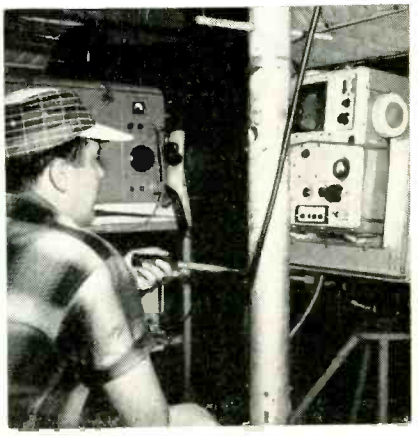
► **Sales**—Many set manufacturers have handled hotel and motel tv sales and installation through companies that specialize in the business.

These companies may sell the equipment outright, providing specialized installation, or may make lease arrangements in which they install, service and maintain the equipment. In all there are about ten hotel tv firms, each handling an individual manufacturer's receivers.

► **Programs**—A new corporation has been formed to make each hotel equipped with tv its own closed-circuit tv station. Through vidicon equipment in each hotel, Hotel TV Broadcasting Corp. will bring a specialized program service to each hotel on a regularly scheduled basis.

The company's plans call for expansion of hotel tv program service to at least 25 additional U. S. cities in the next two years, with a minimum of 50,000 hotel rooms to be included in the system. Initial installations in New York will be in two hotels, each with over 1,000 rooms. The service is scheduled to start in New York City during September.

TV Takes To Whirly Birds

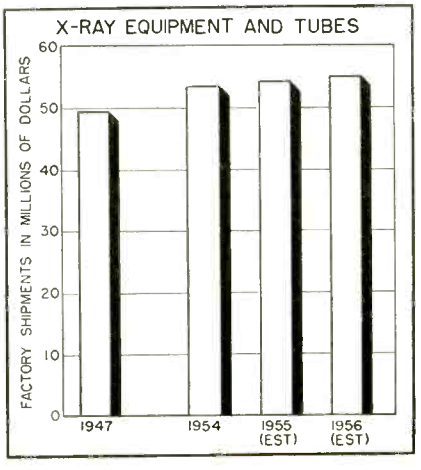


TV pictures have been transmitted from this helicopter at altitudes between 500 and 2,500 ft to a receiving location 50 miles distant. The tests were conducted at 894 mc. Developed at Philco, the new system may be used by the Navy for control of amphibious landings. The firm has also developed an airborne tv system for use in Air Force jet aircraft reconnaissance. The new Navy tv system includes an f-m transmitter of 100 watts erp, image orthicon camera, coder and high-gain antenna which is dropped after the helicopter is airborne

X-ray Business Holds Growth

Industrial volume shows five-fold growth since 1947. Medical and dental sales lag

ANNUAL sales of x-ray equipment to industry for nondestructive testing and inspection have grown at a faster rate than sales to any other x-ray market, and are now approaching $4 million a year. In 1947 factory shipments totalled approximately $700,000. During the same period factory sales of medical x-ray units declined some $6 million to a current volume of about $21 million. Dental x-ray units have maintained a yearly volume of about $2 million since 1947.



► **Parts**—With the increasing number of x-ray units of all types in use in the U. S., the parts and tube business for the equipment has grown. Tube sales volume including rectifiers has risen steadily and now accounts for about $10 million annually. Other parts such as transformers and diffraction equipment account for about $7 million.

Financial Roundup

Net profits for the first six months of 1956 show up better for many firms

ALTHOUGH many companies in the electronics field have enjoyed greater net profits during the first half of 1956 than in the comparable 1955 period, surveys indicate that for the industry in general, net profits are down substantially from last year's first six months.

This is indicated in the First National City Bank of New York report on the net income of 25 firms in the radio tv electrical equipment field. The report shows that net profits in 1956 for the 25 companies

(Continued on page 28)

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

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

OTHER 28 VOLT MODELS

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

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

6, 12, 115 VOLT (NOMINAL) MODELS

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

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

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in tubeless magnetic amplifier regulated DC POWER SUPPLIES

IMMEDIATE DELIVERY FROM STOCK

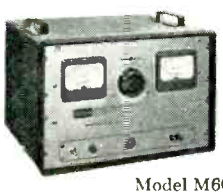
No Moving Parts • No Vibrating Contacts

Model MR532-15A

2-36 VOLTS @ 15 AMPS SPECIFICATIONS

Regulation:	5-32 Volt Range: ±½% 2-5 Volt and 32-36 Volt Range: ±2%
AC Input:	105-125 Volts, (for 2-32 V.DC), 110-125 V, (for 32-36 V.DC), 1 phase, 60 cps (8 amps)
Ripple:	1% rms max. (@ 36 volts and full load. Increases to 2% @ 2 volts and full load).

Remote Sensing • Vernier Control



Model M60V

0-32 VOLTS @ 25 AMPS SPECIFICATIONS

Regulation:	±1% @ 28 Volts (Regulation increases to 2% over range of 24-32 volts; does not exceed 2 volts over 4-24 volt range. Not stabilized for AC line changes.)
AC Input:	115 Volts, 1 phase, 60 cps (12 amps).
Ripple:	1% rms (@ 32 volts and full load – 2% rms max. @ any voltage above 4 volts).

Model MR1040-30A

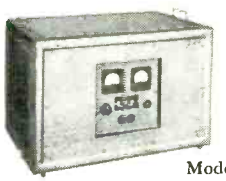
5-40 VOLTS @ 30 AMPS SPECIFICATIONS

Regulation:	±1% (over entire 5-40 volt range)
AC Input:	100-130 Volts, 1 phase, 60 cps
Ripple:	1% rms

Model 28-30 WXM

24-32 VOLTS @ 30 AMPS SPECIFICATIONS

Regulation:	±½%
AC Input:	100-125 Volts, 1 phase, 60 cps (20 amps). (Unit rated for DC output of 28 volts ±10% for 95-130 volt input.)
Ripple:	1% rms



Model MR2432-100XA

24-32 VOLTS @ 100 AMPS SPECIFICATIONS

Regulation:	±½%
AC Input:	208, 230 or 460 Volts, ±10%, 3 phase, 60 cps (14, 12 and 6 amps respectively). 230 volt input will be supplied unless otherwise specified.
Ripple:	1% rms

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was $150.4 million compared to $184.8 million for the first half of 1955, a decline of 19 percent. For the second quarter alone, the net profit of the companies was down 10 percent from that in the 1955 period, going from $93.3 million last year to $84.3 million for the second quarter of 1956.

▶**Profits**—Following are the net profit reports of companies in the electronics field, for the fiscal periods indicated:

Company	Net Profit 1956	1955
ACF 6m	$6,855,000	$8,008,000
Clevite 6m	1,556,087	2,672,957
Consolidated 9m.	1,555,648	---
Consol. Electro. 6m	568,147	295,961
Daystrom 3m	527,000	496,000
A. B. DuMont 6m	*484,000	*1,249,000
Electronic Specialty 3m	5,000	---
Hoffman Elect. 6m	783,972	419,179
IBM 6m	31,868,620	23,870,992
Kay Lab 6m	71,239	*23,775
Magnetics 6m	91,458	51,276
Minn. Mining 6m.	17,670,767	15,781,268
Motorola 6m	3,066,207	2,945,001
NCR 6m	9,383,984	7,614,578
Packard-Bell 9m.	487,847	362,131
RCA 6m	20,037,000	22,061,000
Servomechanisms 6m	307,447	227,544
Stewart Warner 6m	3,178,028	2,810,383
Sylvania 6m	7,323,515	6,088,019
Lear 6m	1,017,044	876,366
Westinghouse 6m	*11,713,000	29,417,000
Van Norman 6m.	465,910	300,357
Zenith 6m	2,530,824	3,126,061

*Loss

Picture-Phone TV Gets A Boost

Experimental Picture-phone tv system developed by Bell Labs uses two ordinary telephone lines, a conventional vidicon camera and either a pair of Iatrons or a small c-r tube with a magnetic-drum storage system. One complete picture is transmitted every two seconds, requiring a 600-cps bandwidth

Meetings Ahead

Sept. 10-12: Information Theory Symposium, IRE, MIT, Cambridge, Mass.

Sept. 10-14: Electron Transport In Metals And Solids, International Union of Pure and Applied Physics, Ottawa.

Sept. 11-12: Second RETMA Conference on Reliable Electrical Connections, University of Pennsylvania, Philadelphia.

Sept. 14-15: Sixth Symposium, IRE, PGBTS, Mellon Institute, Pittsburgh.

Sept. 14-15: Conference On Communications, IRE, Roosevelt Hotel, Cedar Rapids, Ia.

Sept. 17-21: Eleventh Annual International Instrument-Automation Conference and Exhibit, ISA, New York Coliseum, New York, N. Y.

Sept. 20-21: Annual Meeting, IRE PGNS, Mellon Institute Auditorium, Pittsburgh, Pa.

Sept. 24-25: Industrial Electronics Conference IRE, AIEE, Hotel Manger, Cleveland, Ohio.

Sept. 24-28: Trade Fair of the Atomic Industry, Atomic Industrial Forum, Navy Pier, Chicago, Ill.

Sept. 26-29: 1956 Convention of the Audio Engineering Society, New York Trade Show Bldg., New York, N. Y.

Sept. 27-30: New York High Fidelity Show, New York Trade Show Building, New York.

Oct. 1-3: IRE Canadian Convention, Automotive Bldg. Exhibition Park, Toronto.

Oct. 1-3: Twelfth Annual National Electronics Conference, Hotel Sherman, Chicago.

Oct. 1-4: Semiconductor Symposium Electrochemical Society, Statler Hotel, Cleveland, Ohio.

Oct. 8-12: SMPTE 80th Convention, Ambassador Hotel, Los Angeles, Calif.

Oct. 8-9: Second National Symposium on Aeronautical Communications, IRE, Hotel Utica, Utica, N. Y.

Oct. 10-11: Engineering Convention of the Central Canada Broadcasters Association, Seaway Hotel, Toronto.

Oct. 11-12: URSI Fall Meeting, University of California, Berkeley, Calif.

Oct. 15-17: Radio Fall Meeting, IRE, RETMA, Hotel Syracuse, Syracuse, N. Y.

Oct. 16-18: Conference On Magnetism & Magnetic Materials, IRE, AIEE, APS, AIMME, Hotel Statler, Boston, Mass.

Oct. 22-23: Fall Meeting of Assembly, Radio Technical Commission for Aeronautics, Hotel Marrott and CAA Technical Development Center, Indianapolis, Ind.

Oct. 25-26: Second Annual Technical Meeting of the IRE Professional Group on Electronic Devices, Shoreham Hotel, Washington, D. C.

Industry Shorts

▶**Radar** designed specifically to track storms for the Weather Bureau is being built by Raytheon. There are 39 units costing $3.8 million on order with delivery scheduled to start early in 1958. Eight of the units will be used by the Navy's Bureau of Aeronautics. (See ELECTRONICS, p 14, July 1956.)

▶**Factory** unit sales in the phonograph field for the first five months of 1956 totaled 975,747 units made up of 95,138 record player attachments, 737,230 phonographs and 143,379 phonograph combinations.

▶**Radio** telescope, measuring 250 ft across, being built by Manchester University in England, is to be equipped as a radar transmitter to track man-made satellites as they circle the earth.

▶**Australia's** first tv station in Sydney began test operations and is scheduled to begin regular commercial telecasting in September. Two other tv stations in Sydney and three in Melbourne are under construction.

▶**Industrial** tv is being used by Zenith to aid guards to regulate the flow of truck traffic in and out of its main plant in Chicago.

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

NEW KAY *Vari-Sweep*

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

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

Price: **$695.** FOB Plant

SPECIFICATIONS

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

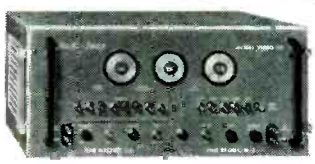
RF Output: 1.0 v. RMS into 70 ohms, metered. Flat within ±0.5 db over widest sweep and frequency band.

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

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

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

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



NEW KAY *Marka-Sweep* MODEL VIDEO 50

Combined Video and IF Sweeping Oscillator with Marks

- Variable Center Frequency, Variable Sweep Width • Includes Low End of Video Spectrum • Permits Observation of Complete Spectrum to 50 mc or Any 4 mc Part Over the Range • Markers at Set Frequencies or as Specified.

SPECIFICATIONS

FREQUENCY RANGE: Continuously variable, 50 kc to 50 mc.

SWEEP WIDTH: Linear, continuously variable, 4.0 mc to 50 mc.

SWEEP RATE: Variable around 60 cps; locks to line frequency.

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

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

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

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

write for new 1956 Kay catalog

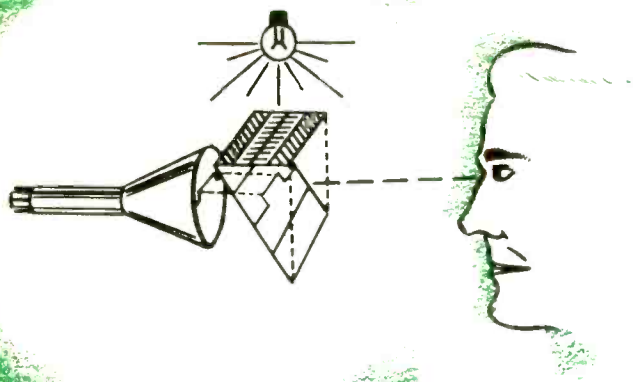
KAY ELECTRIC COMPANY Dept. E-9

14 MAPLE AVENUE PINE BROOK, N. J. CAldwell 6-4000

Want more information? Use post card on last page.

Lavoie

Are you interested in quantitative or qualitative measurements?

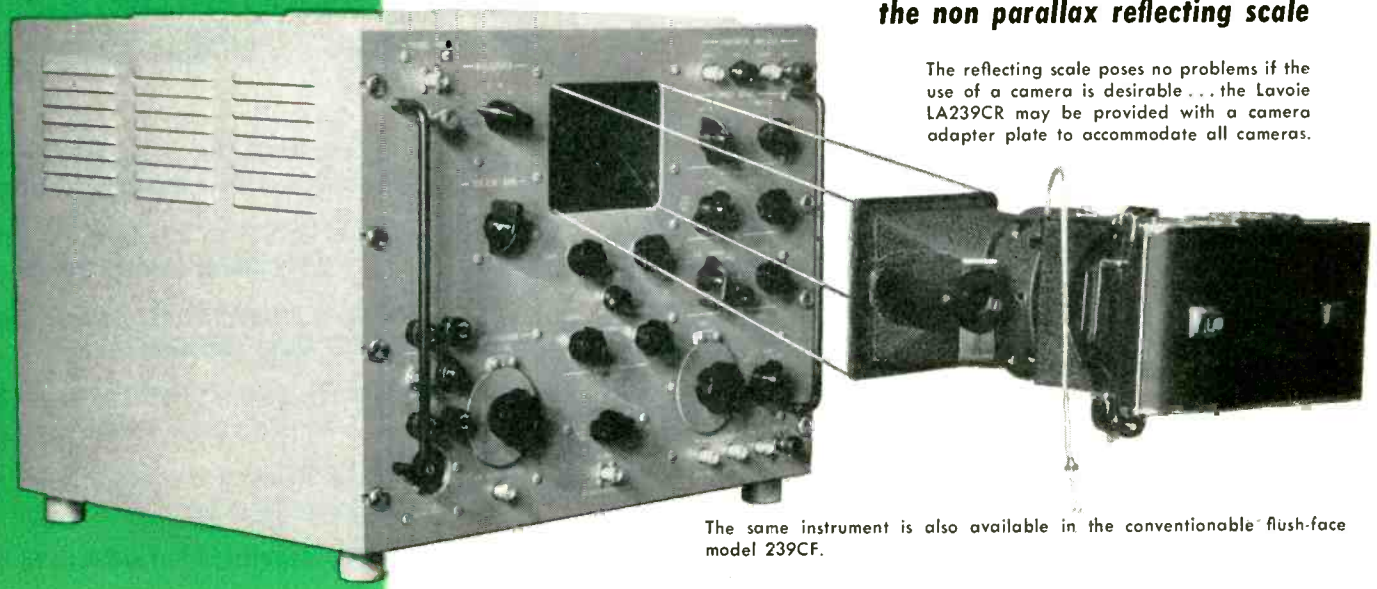


Voltage calibration and sweep calibrations are held to 2½% accuracy in the Lavoie LA-239CR Oscilloscope. To minimize observation errors and make maximum use of this accuracy, non-parallax viewing is employed. High accuracy of measurement is achieved by employing separate calibration circuits within the oscilloscope to calibrate the voltage sensitivity and sweep speed. This approach provides the maximum accuracy when highly stable circuits for sweep and vertical amplifier, such as those employed in the LA-239CR, are used. Change in horizontal and vertical deflection sensitivity due to aging, tube changes and environmental effects are immediately corrected through the self-checking feature.

The Lavoie 239CR (AN/USMC-50A)

OSCILLOSCOPE

is the ONLY commercial scope with the non parallax reflecting scale



The reflecting scale poses no problems if the use of a camera is desirable . . . the Lavoie LA239CR may be provided with a camera adapter plate to accommodate all cameras.

The same instrument is also available in the conventionable flush-face model 239CF.

- wide band — 10 cps — 15 mc
- extended sweep frequencies
- high stability
- militarized construction
- non-parallax screen
- time and voltage calibration
- higher signal sensitivity
- regulated power supply

See for Yourself

The Lavoie nationwide group of engineer-representatives can arrange a practical demonstration of this outstanding Oscilloscope AT YOUR PLANT — on short notice — to suit your convenience. Write for illustrated brochure with complete specifications—and the name of the Lavoie representative nearest you.

Supporting Equipment for Military Systems

The Lavoie 239CR Oscilloscope is the official general purpose instrument for the military services (AN/USM50A). Available with dust cover or for standard rack mount. Extremely rugged and easy to use under the most exacting field or laboratory conditions.

Lavoie Laboratories, Inc.

MORGANVILLE 1, NEW JERSEY

ADVANCED ELECTRONICS • *Research* • *Development* • *Manufacture*

Rugged EIMAC 2C39B UHF Ceramic Triode Operates up to 250°C

TYPICAL OPERATION
(RF Oscillator 2500mc)

D-C Plate Voltage	900v
D-C Grid Voltage	-22v
D-C Plate Current	90ma
D-C Grid Current	27ma
Useful Power Output	15w

Unilaterally interchangeable with the 2C39A, but designed with outstanding extras, Eimac's ceramic-and-metal 2C39B has proved its advantages in such UHF applications as missiles, air navigational systems and communications systems.

Because of its unique design and ceramic-metal construction, this air-cooled, planar-type, 100 watt triode has an envelope temperature rating of 250°C, ceramic replaces glass. And the copper anode is fitted terminal surfaces are silver plated. Sturdy, low-loss ceramic replaces glass. And copper anode is fitted with lightweight fins for forced air cooling.

Used in systems up to 3000mc, the 2C39B has all the virtues of the 2C39A plus a longer life, more useful power output, and a greater immunity to damage by thermal and physical shock.

For additional information, contact our Application Engineering Department.

Eimac

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA
The World's Largest Manufacturer of Transmitting Tubes

NOW GLASS-SUPPORTED VINYL SLEEVING

UL APPROVED FOR 105°C

UL File No. E-15253

BH VINYL-SIL 105

Now electrical and electronic equipment manufacturers who require insulation UL-approved for 105°C. can speed product acceptance by using BH Vinyl-Sil 105. While unsupported vinyl sleevings may flow and cut-through over sharp edges, Vinyl-Sil's supporting braid holds the vinyl and prevents shorts. Now Vinyl-Sil offers two big advantages. First, 8,000 volt *minimum* short-time dielectric breakdown for emergency protection against unexpected loads. Second, UL-approved heat resistance to 105°C. But, that isn't all, check these additional features:

- High heat-aging resistance
- High flow resistance
- High chemical and oil resistance
- High abrasion resistance
- Low temperature flexibility to −45°C.
- No capillary attraction to water

BH Vinyl-Sil 105 is available in Green and Yellow, with product name on the sleeving to distinguish it. Data sheets and samples are yours for the asking . . . get them and make your own tests.

BENTLEY, HARRIS MANUFACTURING COMPANY
1309 Barclay St.
CONSHOHOCKEN, PA. Telephone: TAylor 8-0634

BENTLEY, HARRIS

Fiberglas* SLEEVINGS

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U.S. Patent No. 2393530; 2647296; 2647288). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

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now OHMITE® offers the ONLY complete line of RESISTORS to meet MIL-R-26C characteristics

Y HIGH TEMPERATURE 350C CHARACTERISTIC
HIGH INSULATION RESISTANCE

V HIGH TEMPERATURE 350C CHARACTERISTIC

AND **G**

TAB-TERMINAL TYPE
Characteristics V and G

Style	Over-all Length	Diameter	*Watts	††Watts
RW-29	1¾″	½″	8	11
RW-30	1″	19/32″	8	11
RW-31	1½″	19/32″	10	14
RW-32	2″	19/32″	12	17
RW-33	3″	19/32″	18	26
RW-35	4″	29/32″	38	55
RW-36	4″	1-5/16″	54	78
RW-37	6″	1-5/16″	78	113
RW-38	8″	1-5/16″	110	159
RW-47	10½″	1-5/16″	145	210

TAB-TERMINAL TYPE
Characteristic Y

Style	Over-all Length	Diameter	†Watts
RW-30	1″	19/32″	11
RW-33	3″	19/32″	26
RW-37	6″	1-5/16″	113
RW-47	10½″	1-5/16″	210

FLAT TAB-TERMINAL TYPE
(Stack Mounting)
Characteristics V and G

Style	Over-all Length	Width and Thickness of Core	*Watts	††Watts
RW-20	2½″		15	21
RW-21	3¼″	1-3/16″	22	31
RW-22	4¾″	x	37	53
RW-23	6″	¼″	47	68
RW-24	7¼″		63	91

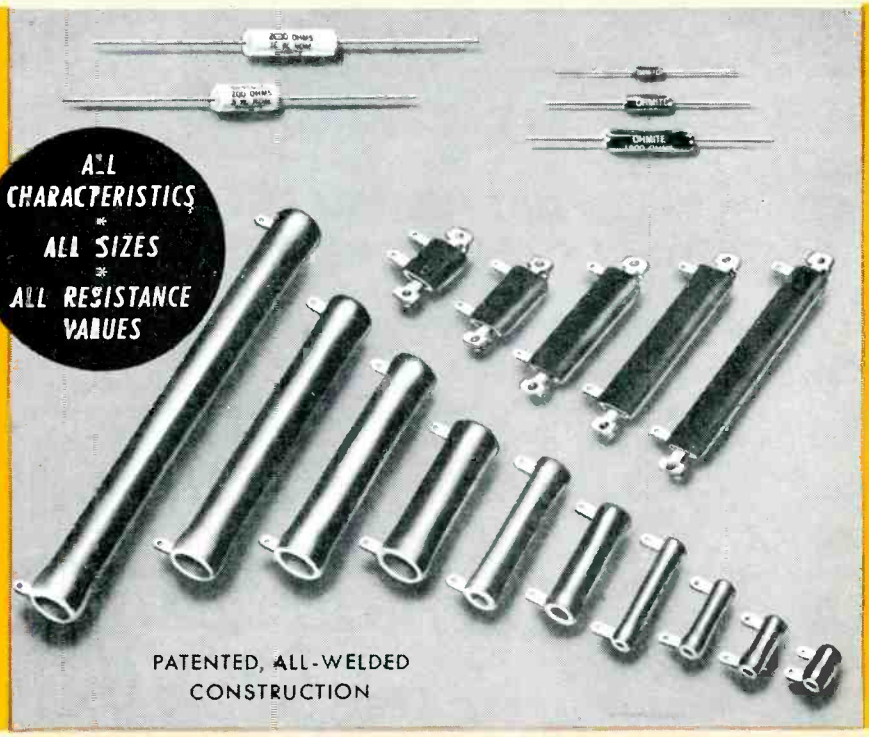
AXIAL-TERMINAL TYPE
Characteristics V and G

Style	Length of Core**	Diameter	*Watts	††Watts
RW-55	1⅜″	15/32″	5	7
RW-56	2″	15/32″	10	14
RW-57	1″	5/16″	5	6.5
RW-58	1⅞″	11/32″	8	11
RW-59	½″	3/16″	2.5	3

*Watts free air MIL Characteristic "G."
†Watts free air MIL Characteristic "Y."
††Watts free air MIL Characteristic "V."
**1-½″ wire leads.

Even including resistors wound with the finest wire size (.00175)

The Ohmite resistor types shown in the table above can withstand a continuous operating temperature of 350C—the high temperature requirement of MIL-R-26C, Char. "V." These resistors also meet Characteristic "G." The new Char. "Y" combines all requirements of Char. "V" and "G" plus extremely high insulation resistance at the end of the moisture-resistance test. Under all three Char., "V," "Y," and "G," Ohmite resistors have to satisfy severe moisture-resistance tests, thermal shock tests, vibration tests, and many others. The Ohmite line of wire-wound resistors is the most extensive available in the industry.



Be Right with OHMITE®

RHEOSTATS
RESISTORS
RELAYS
TAP SWITCHES
TANTALUM CAPACITORS

OHMITE MANUFACTURING COMPANY, 3610 Howard Street, Skokie, Illinois

OHMITE®

the only complete line of RHEOSTATS meeting the requirements of MIL-R-22A

OHMITE MODEL	TYPE	WATT RATING	ENCLOSED	"OFF" POSITION
H	RP101	25	NO	NO
	RP102		NO	YES
	RP103		NO	YES
	RP111	12.5	YES	NO
	RP112		YES	YES
	RP113		YES	YES
J	RP151	50	NO	NO
	RP152		NO	YES
	RP153		NO	YES
	RP16	25	YES	NO
	RP162		YES	YES
	RP163		YES	YES
G	RP20	75	NO	NO
	RP202		NO	YES
	RP203		NO	YES
K	RP25	100	NO	NO
	RP252		NO	YES
	RP253		NO	YES
L	RP301	150	NO	NO
	RP302		NO	YES
	RP303		NO	YES
P	RP351	225	NO	NO
N	RP401	300	NO	NO
R	RP451	500	NO	NO
T	RP501	750	NO	NO
U	RP551	1000	NO	NO

Ohmite can furnish rheostats in *every* one of the 26 type designations to meet the requirements of MIL-R-22A. By standardizing on Ohmite rheostats, you can cover all of your needs for both civilian and government jobs and, at the same time, give your customers the utmost in rheostat performance. Ohmite rheostats have proved their dependability in meeting the severe requirements of MIL-E-22A . . . the 5-hour vibration test, 50-hour salt-spray corrosion test, 150-hour 95% humidity electrolysis test . . . and others. Their all-ceramic construction . . . uniform windings locked in place by vitreous enamel . . . smoothly gliding, metal-graphite brush . . . insure close control and years of trouble-free service. It will pay you to standardize on Ohmite rheostats for your products.

Also, Aircraft Rheostats produced in accordance with Specification MIL-R-6749 (Drawing AN-3155).

Be Right with OHMITE®

OHMITE MANUFACTURING CO.
3610 Howard St., Skokie, Illinois

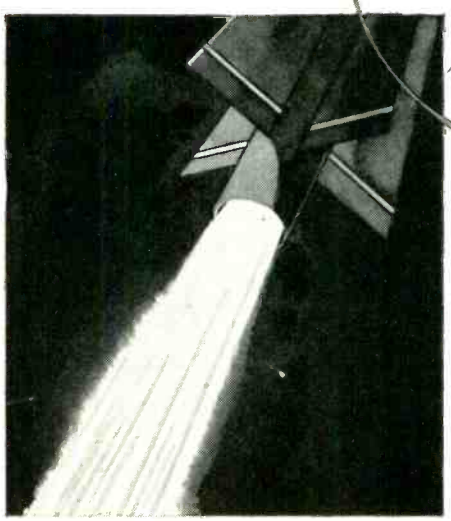
RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES • TANTALUM CAPACITORS

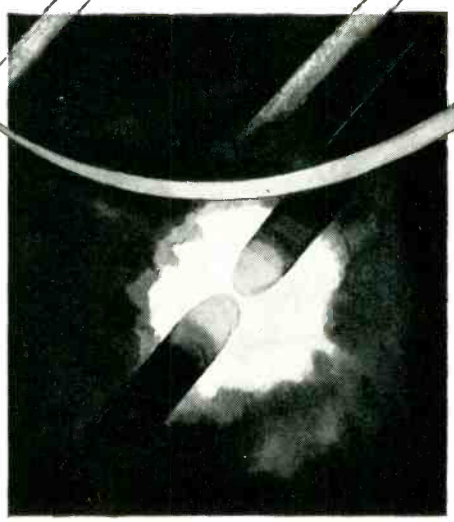
Linde SAPPHIRE

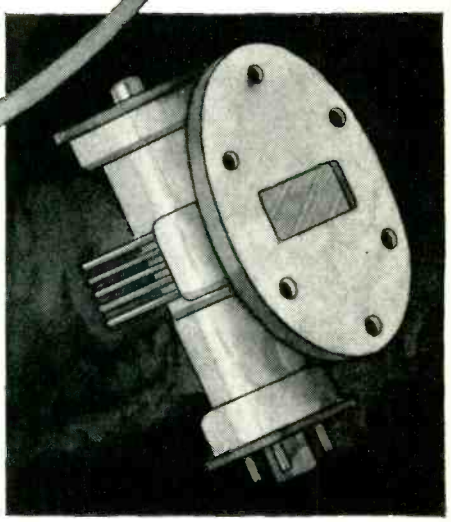
Trade-Mark

WINDOWS ON THE WORLD OF...

INFRA-RED... ULTRA-VIOLET... MICROWAVES







Windows of industrial sapphire made by Linde Air Products Company have excellent infra-red and ultra-violet transmission characteristics. These transparent, *single* crystals are especially suitable for klystron, magnetron, and TR tube windows, as well as for infra-red and ultra-violet devices.

LINDE sapphire is a non-porous, non-sintered crystal with excellent thermal conductivity. Ultra-violet transmission is 66% at 2000 Angstroms, 20% at 1500 Angstroms (2mm thickness). Infra-red transmission is 92% at 3 microns, 50% at 6 microns (1mm thickness). High- and low-temperature seals can be made to metal as well as to glass and ceramics. Stock diameters of LINDE industrial sapphire windows range from ¼ to 3 inches. In addition to windows, LINDE supplies sapphire in the form of tubes, rods, balls, and special shapes.

If you would like further information, or to discuss your particular application in detail, please write to Crystal Products, Dept. BD9.

Linde Trade-Mark

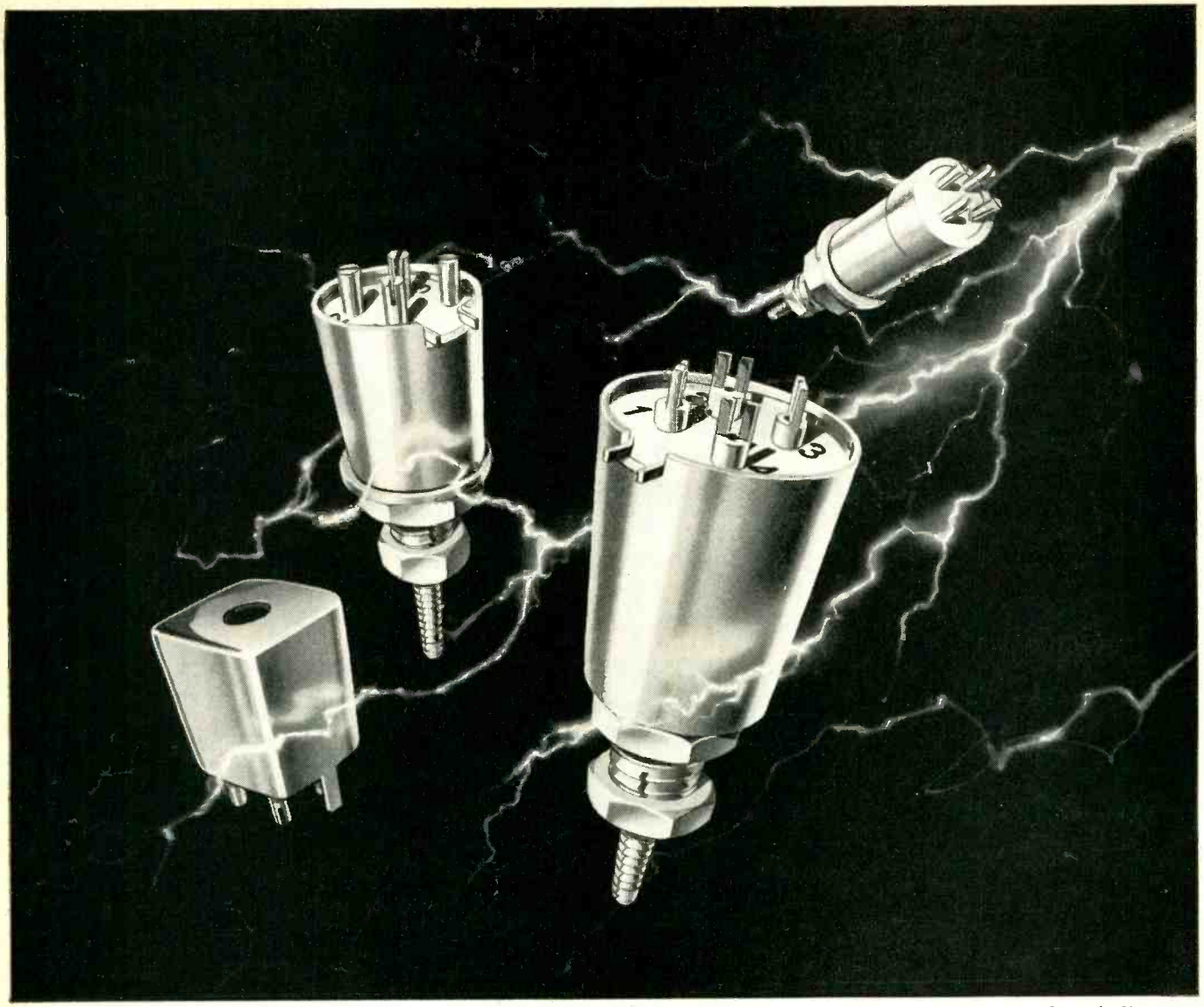
LINDE AIR PRODUCTS COMPANY

A Division of Union Carbide and Carbon Corporation

30 East 42nd Street UCC New York 17, New York

In Canada: Linde Air Products Company, Division of Union Carbide Canada Limited, Toronto

The term "Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.



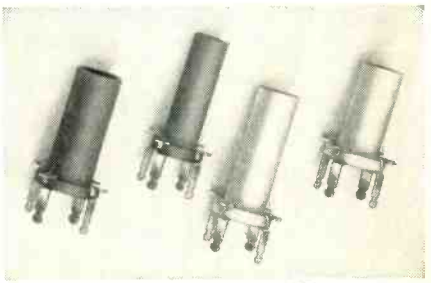
Four sizes of shielded coil forms cover a wide range of design requirements. Dimensions when mounted, including terminals, are: LS-12 (square type for printed circuits), ½" x ½" x ½"; LS-9, 7/16" diameter x ½" high; LS-10, 5/8" x 15/16"; LS-11, 1 5/16" x 17/32". Each form mounts by a single stud. Windings may be universal or wound to your specifications.

Where shock treatment doesn't work

CTC miniaturized shielded coil forms are highly shock resistant. With mechanically enclosed, completely shielded coil windings, they bring all the ruggedness and dependable performance you require for your "tight spot" applications — IF strips, RF coils, oscillator coils, etc.

CTC combines *quality control* with *quantity production* to supply exactly the components you need, in any amount. CTC *quality control* includes material certification, checking each step of production, and each finished product. And CTC *quantity production* means CTC can fill your orders for any volume, from smallest to largest.

For samples, specifications and prices, write to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass. On the West Coast contact E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, and 61 Renato Court, Redwood City, Cal.



TYPE SPC phenolic and ceramic printed circuit coil forms can be soldered after mounting. Phenolic forms: ¾" high when mounted, in diameters of .219" and .285". Ceramic forms: ¼" diameter, in mounted heights of 5/8" and 1 1/16", with 10/32" powdered iron core, and collars of silicone fibreglas. Forms come with threaded slug and terminal collar. Units mount through two to four holes, as required. Available as forms alone or wound as specified.

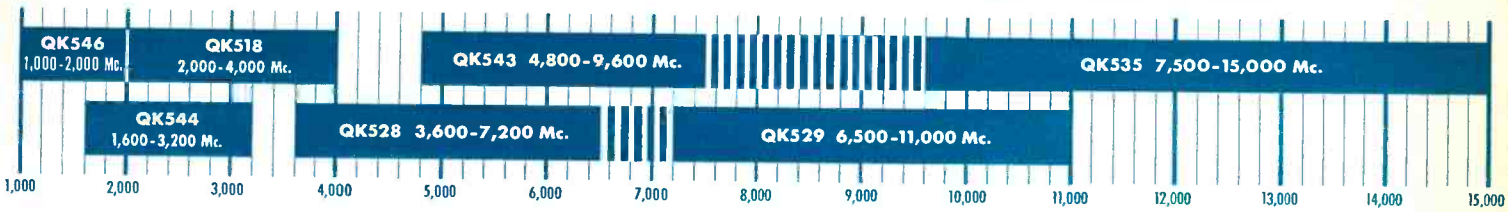
CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components custom or standard

Raytheon — World's Largest Manufacturer of Magnetrons and Klystrons

VOLTAGE TUNABLE



QK518 specifications

Frequency: 2,000-4,000 Mc.

Rapid electronic tuning by varying delay line voltage from 150-1,500 Volts.

Power output: 0.1 to 1 watt.

Complete with compact permanent magnet.

Approximate maximum dimensions: 10" long, 4⅜" high, 4⅞" wide.

NEW Raytheon Backward Wave Oscillator Series for wide, rapid electronic tuning—1,000 Mc. to 15,000 Mc.

The tubes in this revolutionary new line of Raytheon Backward Wave Oscillators give you four outstanding performance advantages:

1. Electronically tunable over an *extremely* wide range of frequencies
2. Frequency insensitive to load variations
3. High signal-to-noise ratio
4. Can be operated under conditions of amplitude or pulse modulation

These new tubes are finding fast-growing applications in microwave equipment, including radar and signal generators.

Write today for free Data Sheets on this series of Backward Wave Oscillators. We'll also be happy to answer any questions you may have on this new line.

Excellence in Electronics

RAYTHEON

RAYTHEON MANUFACTURING COMPANY

Microwave and Power Tube Operations, Section PT-51, Waltham 54, Mass.

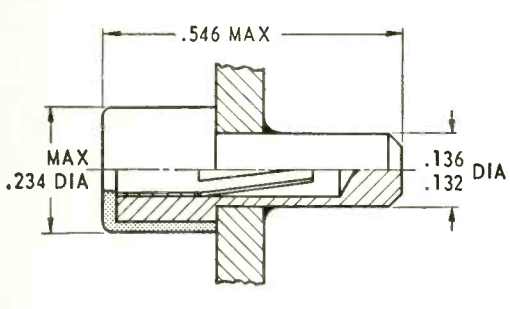
Regional Sales Offices: 9501 W. Grand Avenue, Franklin Park, Illinois; 622 S. LaBrea Avenue, Los Angeles 36, California

Raytheon makes: Magnetrons and Klystrons, Backward Wave Oscillators, Traveling Wave Tubes, Storage Tubes, Power Tubes, Receiving Tubes, Picture Tubes, Transistors

NEW SOLUTIONS

From RAYTHEON—a quality

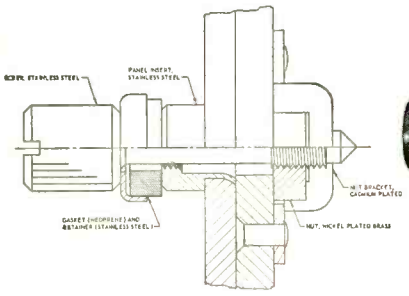
TEST JACKS FOR PRINTED CIRCUITS

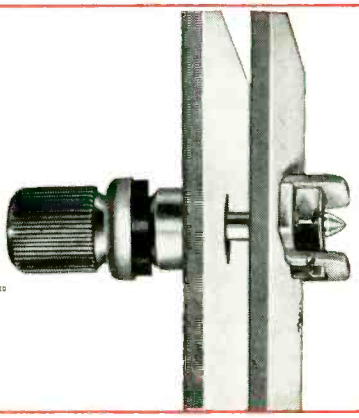


PROBLEM—Convenient test points are needed on printed circuit panels. Jacks must lend themselves to easy assembly and automatic dip soldering.

SOLUTION—Raytheon's new printed circuit test jacks. No mounting hardware—for panels 1/32 to 1/4" thick. Can be dip soldered. Unique beryllium copper spring-pin contact. Accomodates standard .080 diameter test prod. 8 colors. (Also available—Raytheon subminiature and standard test jacks.)

CAPTIVE HARDWARE

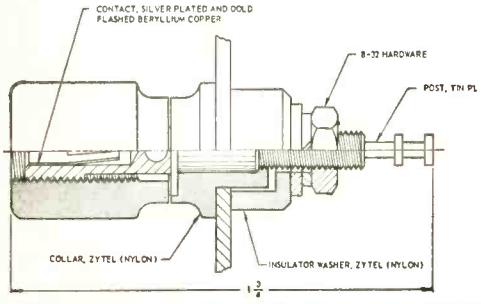




PROBLEM—To meet military specifications for captive hardware.

SOLUTION—Raytheon supplies the complete assembly at the lowest cost available. Consists of a stainless steel captive screw (variety of lengths) and panel insert; nickel plated brass floating nut; cadmium plated nut bracket; Neoprene gasket and stainless steel gasket retainer. Thread sizes: 10-24, 1/4-20, 5/16-18.

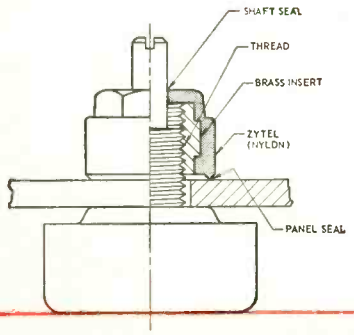
5-WAY BINDING POSTS



PROBLEM—A compact, high-strength binding post incorporating a test jack is required.

SOLUTION—Raytheon binding posts are made of nylon and brass and include a beryllium-copper spring pin contact for plug in of .080" diameter prods. Other connections: prod or wire clamped thru center hole; wire coiled around post and clamped. Turret Terminal for solder connection. Available in black or red.

SHAFT LOCKS



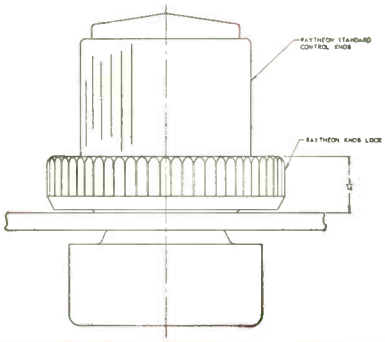
PROBLEM—To retain adjustment of slotted shaft potentiometers under conditions of vibration and shock.

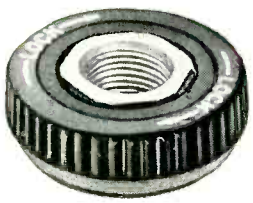
SOLUTION—Raytheon shaft locks provide constant drag on potentiometer shafts. Permit smooth adjustment without unlocking, but prevent vibration or shock from moving shaft. Also provide water and dust proof seal of shaft and panel. Made of nylon and brass. Replaces potentiometer mounting nut. For 1/4" and 1/8" shafts.

TO OLD PROBLEMS

line of panel components

KNOB LOCKS

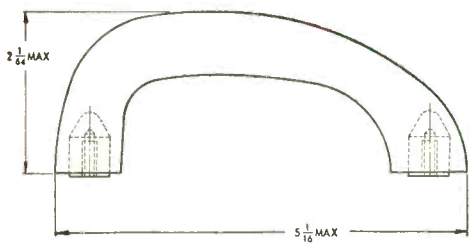




PROBLEM—To retain control settings under conditions of vibration, shock or accidental manual contact, yet permit easy adjustment.

SOLUTION—Raytheon knob locks are rotated one eighth turn clockwise to hold setting securely under all conditions. Reversing lock permits easy re-setting of control. Simple rugged construction. Design matches Raytheon Standard Control Knobs.

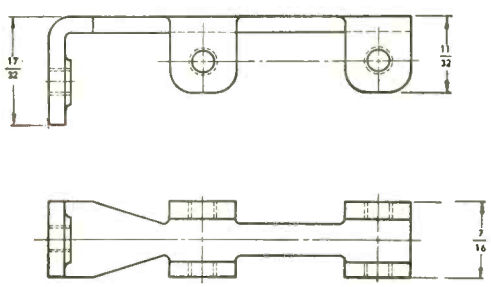
PULL HANDLES



PROBLEM—Functional design, high strength and attractive appearance are needed for pull handles.

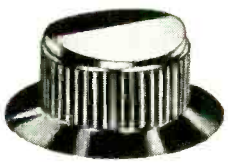
SOLUTION—Integrated in design and appearance with Raytheon Standard Control Knobs, Raytheon pull handles have a unique "contour grip" shape. Molded of "Tenite II" with anodized aluminum inserts for maximum strength and impact resistance. Mirror or matte finish available.

TERMINAL BOARD MOUNTING BRACKETS



PROBLEM—Brackets which meet military specifications for vibration and shock are required for mounting terminal boards or printed circuit panels.

SOLUTION—Made of cadmium plated steel, Raytheon mounting brackets meet mil specs for withstanding rugged conditions. Brackets may be used for mounting one or two boards. Available in four sizes—2-1/16 to 3-9/16" overall length for panels ranging from 1-3/8 to 3-7/16" wide.



Available from Raytheon—A complete line of Standard Control Knobs designed to meet rigid mil specs.

Now available for the first time, all the components shown here—designed to meet your specific needs. These components, in conjunction with Raytheon's Standard Control Knobs series, form a *complete, integrated line from one source*—to satisfy virtually all your requirements.

For full information and prices, please write Dept. 6120A.

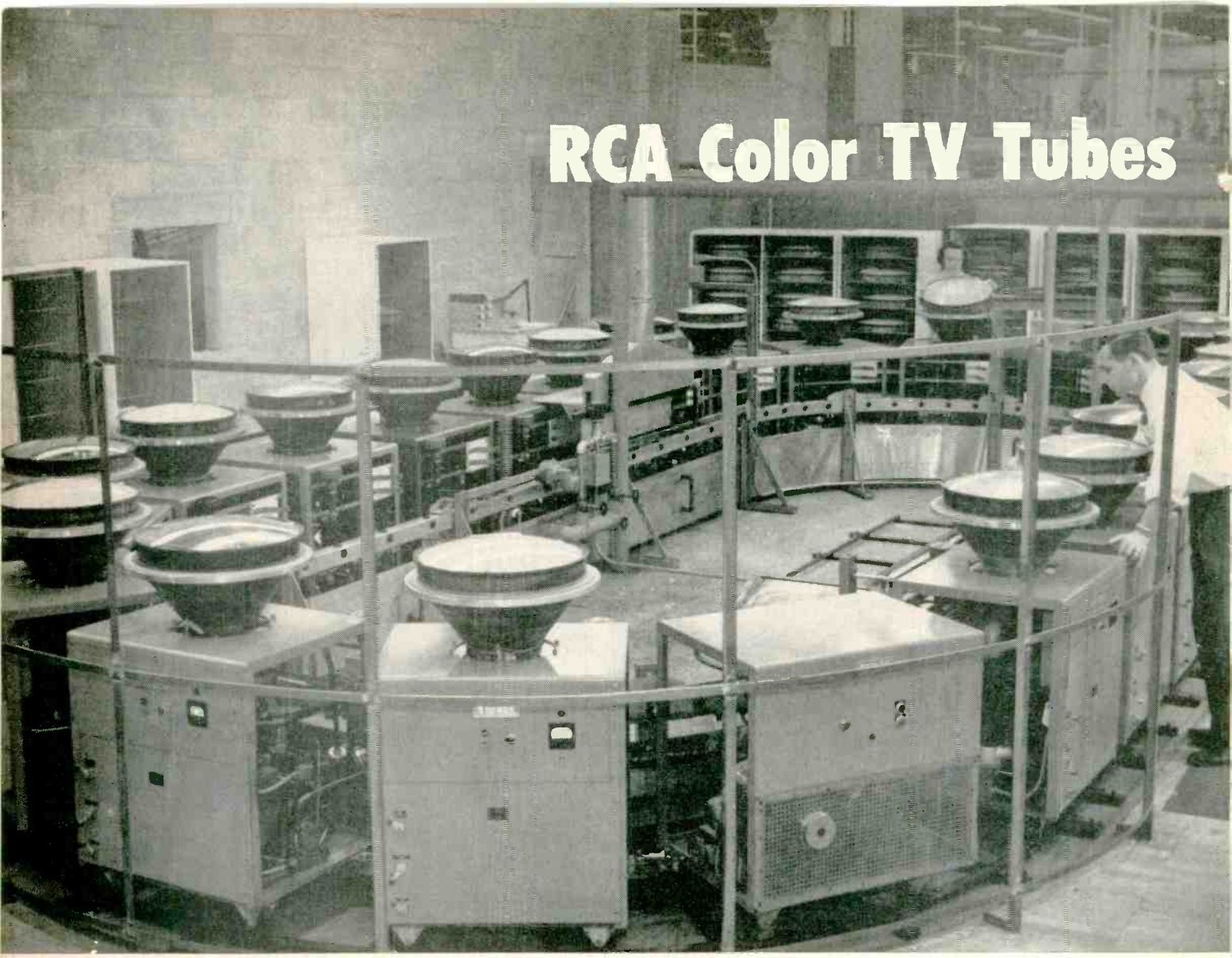
Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

Equipment Marketing Department, Waltham 54, Mass.

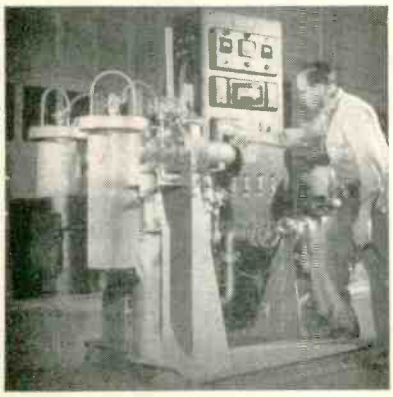
RAYTHEON

A-1006

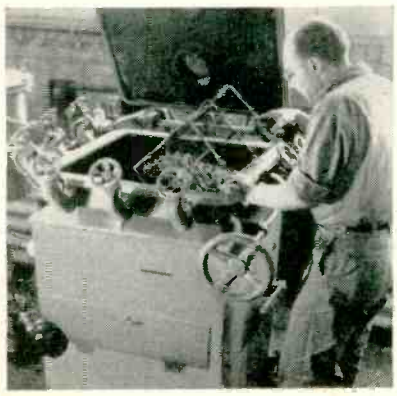


Automatic production at high output per man-hour is obtained from this complete in-line Stokes aluminizing system, used for color TV tube face plates at the RCA tube plant, Lancaster, Pa.

Electronic equipment manufacturers are profiting from other Stokes Vacuum Equipment...



Vacuum Metallizers. Stokes manufactures a complete line of vacuum metallizing equipment to plate selenium rectifiers, printed circuits and other conductive coatings on non-conductive materials.



Vacuum Impregnators. Manufacturers of electronic equipment use Stokes vacuum impregnation systems for obtaining improved characteristics of coils, capacitors and other components.

Vacuum Furnaces. Stokes melting and heat-treating furnaces permit electronic manufacturers to pre-process raw and semi-finished materials with less contamination, for increased life and performance.

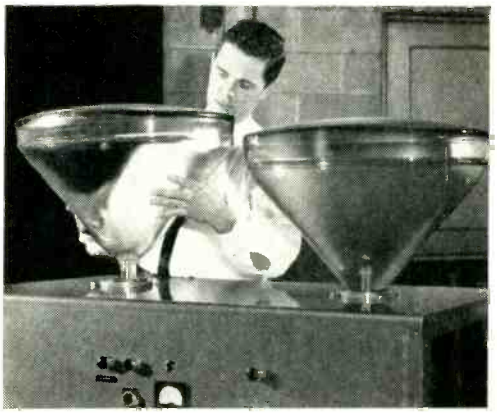
Aluminized on Stokes high-production in-line system

The first continuous production installation for aluminizing color TV tube face plates is now operating at the RCA tube plant, Lancaster, Pa. — using a Stokes automatic in-line system.

APPLICATION to this unique tube design demonstrates the versatility that is characteristic of Stokes aluminizing systems. These systems are adaptable to all the television tube constructions . . . both for black and white and for color . . . that are now being used or developed in the industry. They are engineered to provide high output and flexibility to meet changes in production rates and tube sizes.

The combination of Stokes high speed "Ring-Jet" vapor pumps and mechanical forepumps gives rapid evacuation, short cycles and fast production. Systems are compact . . . require little floor space. Removable electrodes simplify filament replacement. Internal cooling coils reduce oil temperature rapidly in the booster pump before vacuum is released. Systems are available in a complete range of capacities and prices.

A Stokes engineer will be glad to talk over your specific tube production requirements. He is well qualified to apply Stokes' 30 years of experience in high vacuum engineering and automatic production techniques, to solve your problem on the most efficient and economical basis. For a consultation, or for literature useful in your own applications, write to Stokes today.



Exclusive Stokes twin-tube unit aluminizes two TV tubes at a time. These units can be furnished completely automatic or manually controlled, in-line or stationary . . . in a range of capacities to meet your requirements.

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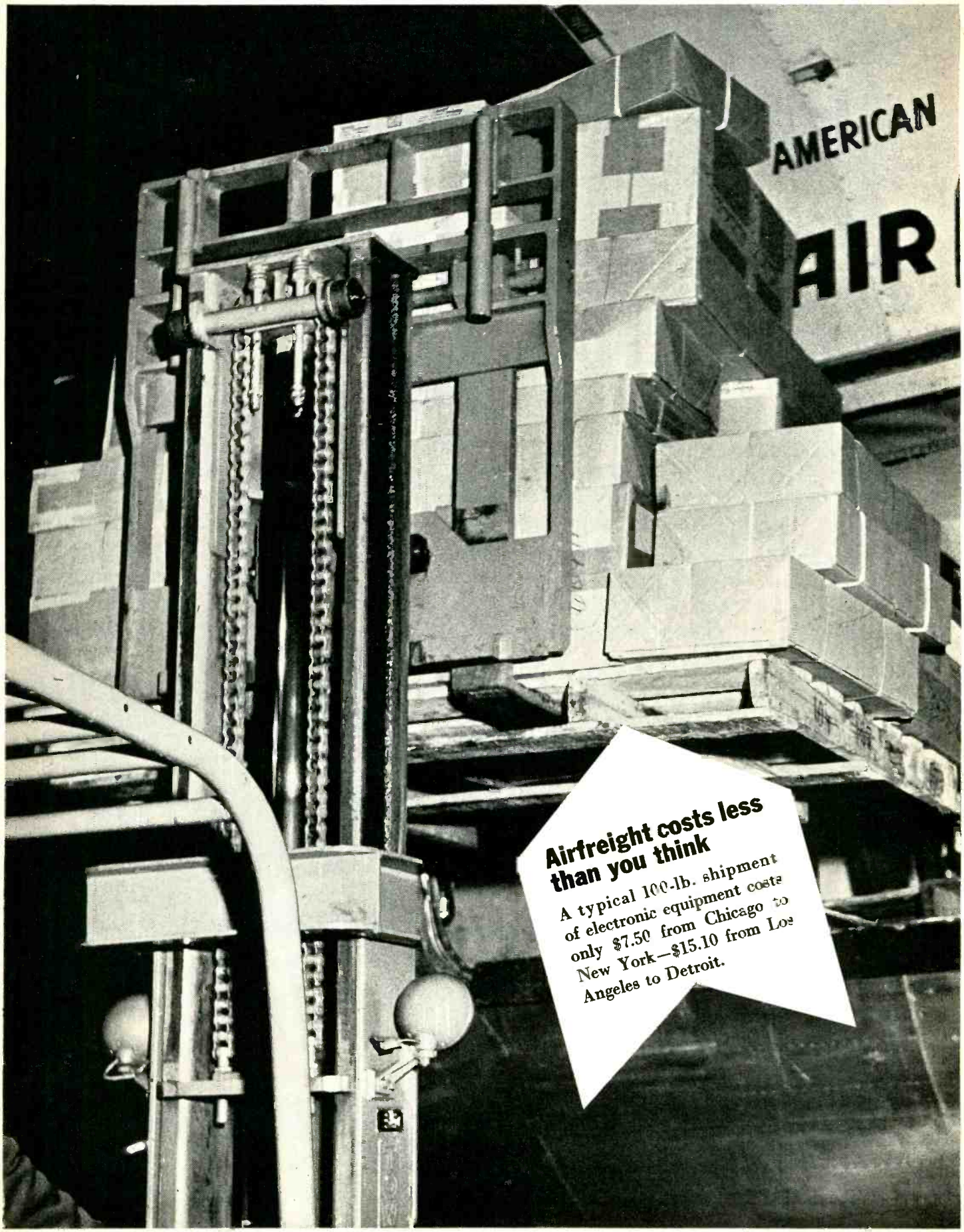

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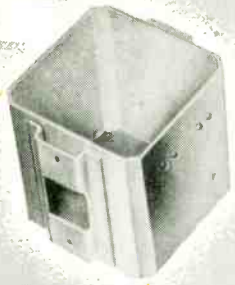

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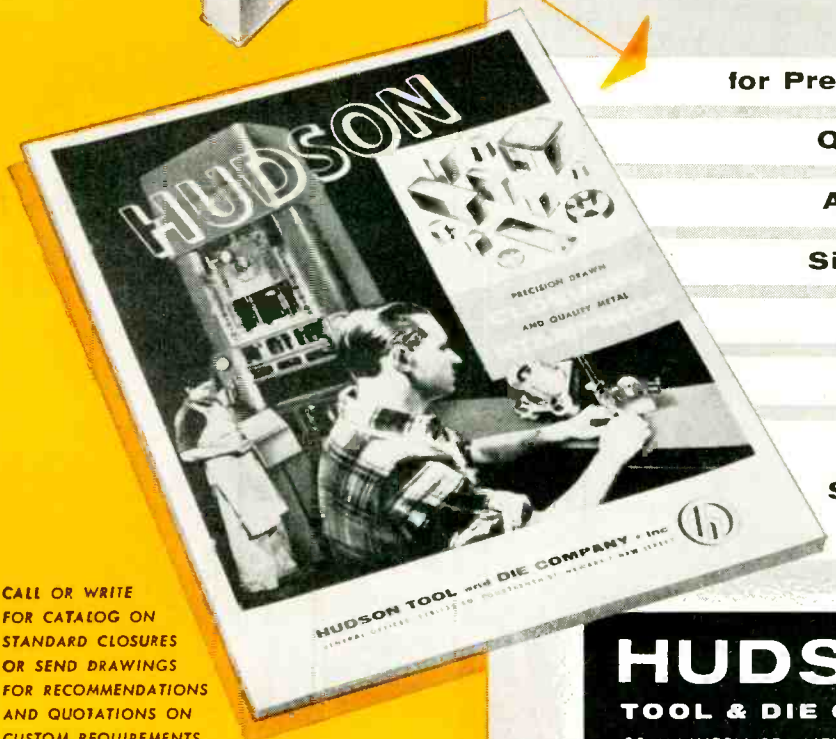

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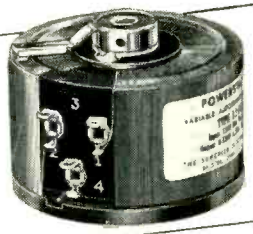
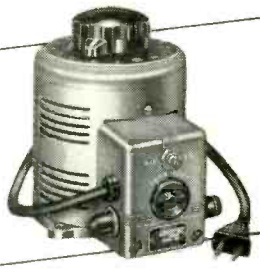


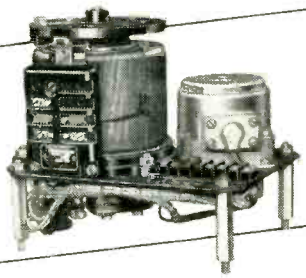
TYPE 10-1002 — With complete rotation; this compact unit is ideal for servo-mechanisms and temperature regulators.
INPUT: 120 volts, 50/60 cycles, single phase
OUTPUT: 0-120 volts, 1.25 amperes, 150 VA

PILOT LIGHT



TYPE 116-1005 — A POWERSTAT of 1 KVA capacity with pilot light to indicate when unit is energized.
INPUT: 120 volts, 50/60 cycles, single phase
OUTPUT: 0-140 volts, 7.5 amperes, 1.0 KVA

MOTOR DRIVEN For 50 or 60 Cycles

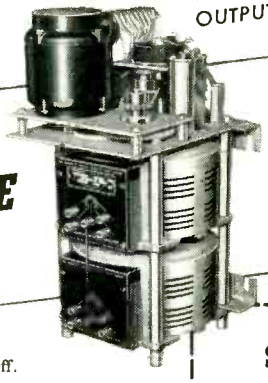


TYPE 116-1004 — A motor-driven assembly of 1 KVA capacity featuring rapid control and silent operation for use on 50 or 60 cycles.
INPUT: 120 volts, 50/60 cycles, single phase
OUTPUT: 0-140 volts, 7.5 amperes, 1.0 KVA

DUST PROOF CONTAINER

TYPE 1126-1001 — For high frequency applications — supplied in dust proof container with AN connector and screwdriver slot control with locking device.
INPUT: 115 volts, 400/800 cycles, single phase
OUTPUT: 0-130 volts, 15.0 amperes, 1.95 KVA

FOR TEMPERATURE CONTROL



TYPE 136-1003 — A motor-driven unit with potentiometer on shaft for temperature control applications using electric proportional control.
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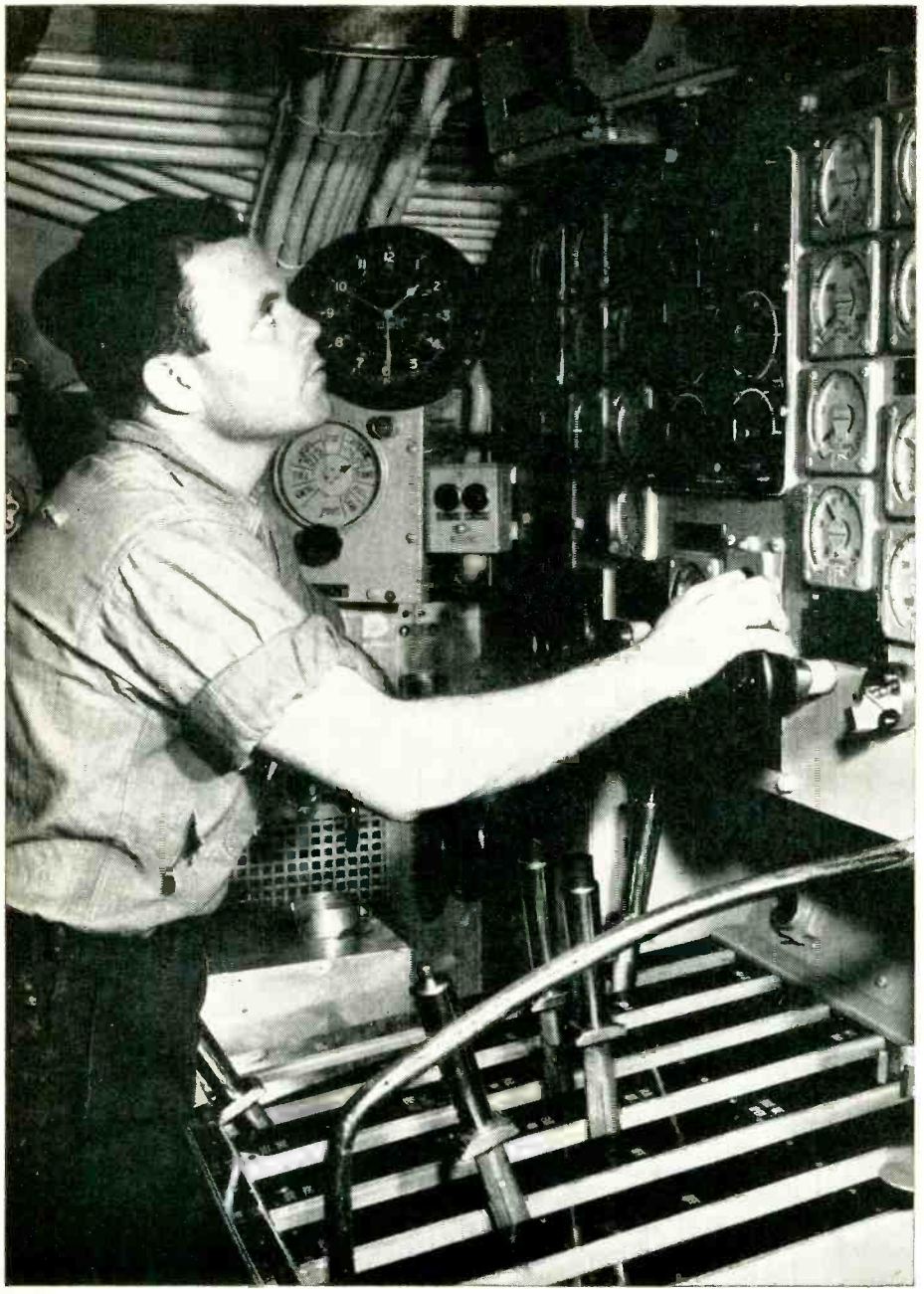

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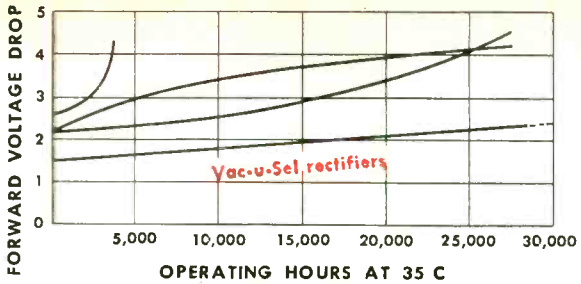
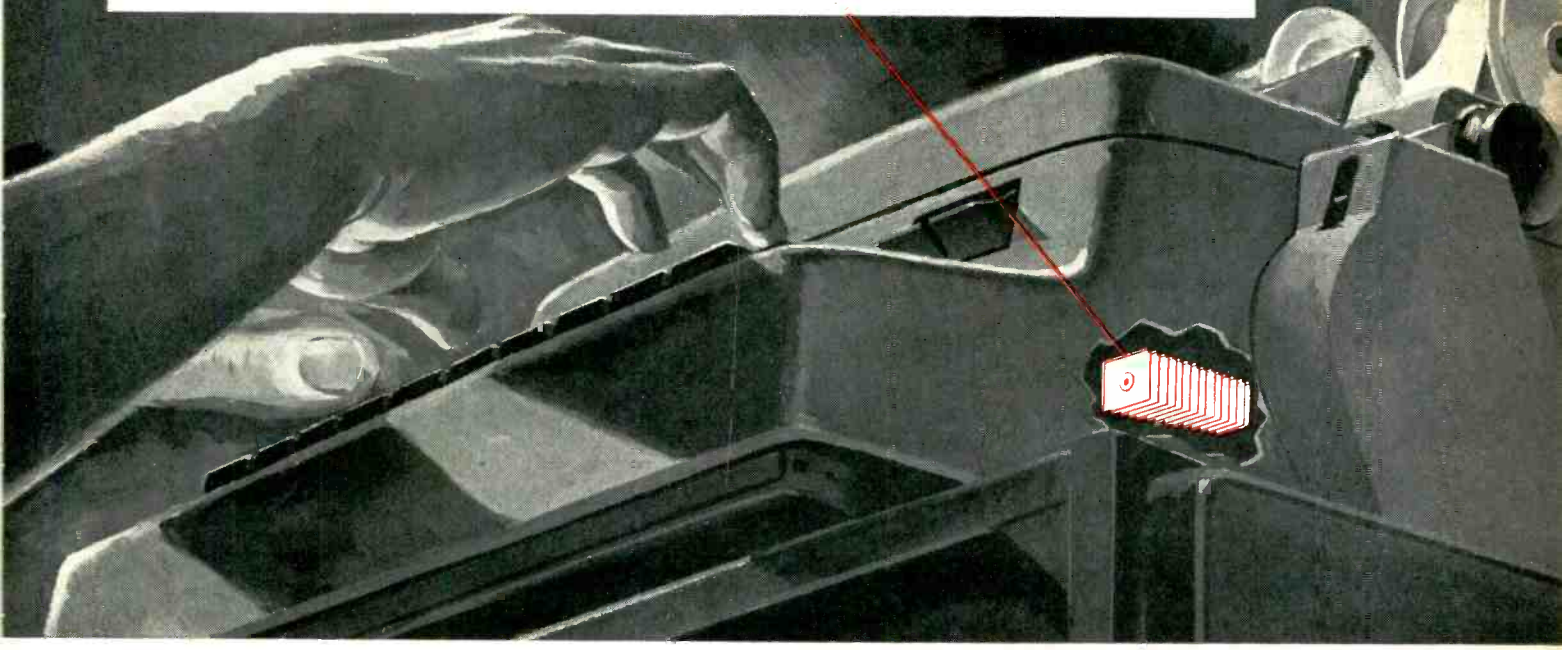
A COMPARISON GRAPH between General Electric Vac-u-Sel rectifiers and three other makes, showing the change in forward voltage with time. Note that all other makes have at least doubled their forward resistance (completely aged) in less than 30,000 hours. Vac-u-Sel rectifiers' long life makes them ideal for such applications as business machines.





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G-E Vac-u-Sel* Rectifiers Will Give 80,000 Hours of Reliable Life

When you're designing a circuit for a business machine or other essential-service type of industrial machine, two important objectives are absolute dependability and maximum life. Therefore, it will pay you to take advantage of the special characteristics of General Electric Vac-u-Sel rectifiers. This long-life rectifier has more than adequately proved its dependability in many years of outstanding service.

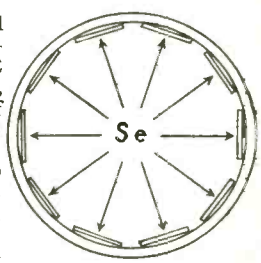
THE VAC-U-SEL RECTIFIER IS UNIQUE in that it is manufactured by an exclusive sphere-type, vacuum-evaporation process, which G.E. has been using for over 15 years. The ultimate benefit is 80,000 hours life expectancy at full-rated current and voltage. This is at least ⅓ longer than the life expectancy of ordinary selenium rectifiers under the same conditions.

In addition, the Vac-u-Sel rectifier gives you low forward resistance, and minimum heat loss.

A full line of Vac-u-Sel rectifiers is available. Contact your nearest G-E Apparatus Sales Office, or write for Bulletin GEA-6273 to: Section 461-42, General Electric Co., Schenectady 5, N. Y.

* Vac-u-Sel is a trade-mark of the General Electric Co. It designates top-quality selenium rectifier cells manufactured by a unique sphere-type vacuum-evaporation process. Vac-u-Sel rectifiers are produced by the Rectifier Department, Lynn, Mass., headquarters for silicon, germanium, selenium and copper-oxide component rectifiers.

THE SECRET'S IN THE SPHERE



A vacuum-tight sphere is used to evaporate selenium onto aluminum plates. This unique G-E process results in a more even, natural-crystalline formation of selenium. It also eliminates contaminants, and permits better control over the more than 100 variables encountered in the manufacture of selenium rectifiers.

The end result is a Vac-u-Sel rectifier made by a precision process more closely related to a science than an art. This makes it possible to accurately predict performance, repeat the same dependability, and maintain the same high quality.

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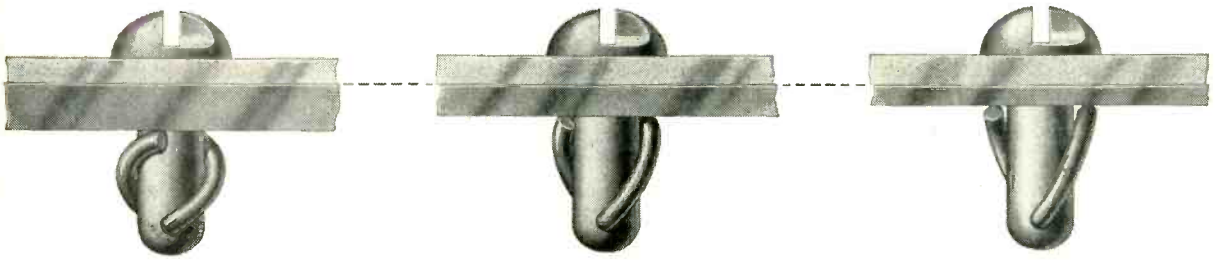

Spring-Lock—the easy-to-use removable fastener for modern designs—works whether panel thicknesses run over or under specifications! Spring wire deflects automatically to handle greater or lesser thicknesses. Spring-Lock's design flexibility makes it more than a fastener: it can be adapted as a shelf support, door strike, knob or any similar panel-mounted device. Many standard shapes and sizes of Simmons Spring-Locks are available from stock.

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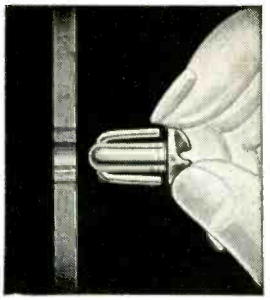
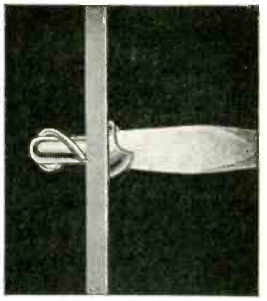


1. *Insert fastener.*



2. *Half-turn locks it in place.*

With production costs on the uptrend, you can figure on Spring-Lock as an assembly time and money-saver, because:

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Send for details and samples, or write us about *your* fastening problem.

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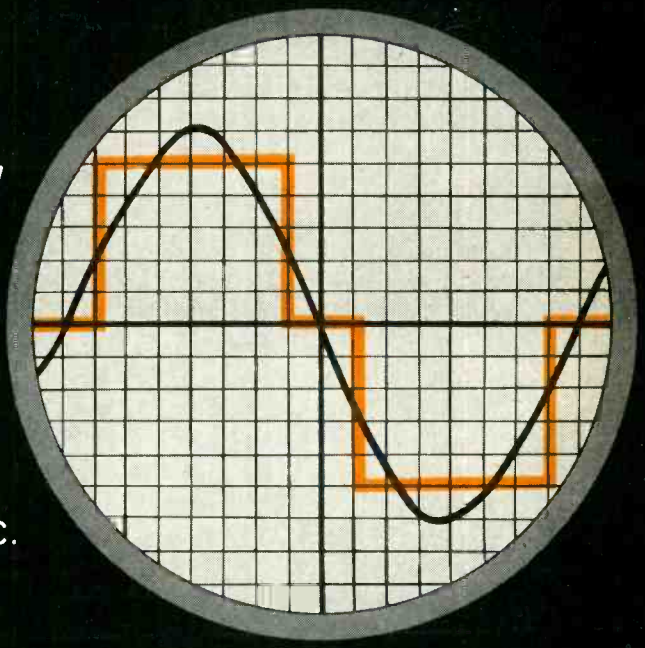

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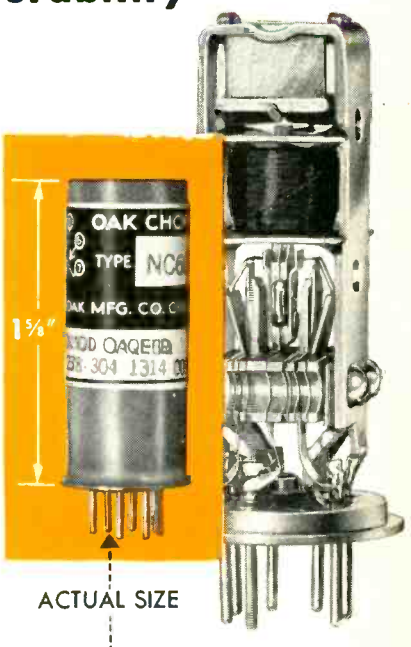

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 15/16" diameter composition	 Hollow shaft twist ear mounted 15/16" diameter composition for screwdriver adjustment	 Bushing mounted 15/16" diameter concentric tandem composition with SPST switch	 15/16" diameter watt composition
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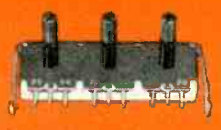
 1-1/8" diameter concentric tandem tone switch and composition variable resistor with SPST on-off switch	 Twist ear mounted 15/16" diameter composition with SPST switch	 Self-supporting snap-in bracket mounted 15/16" diameter composition with SPST switch	 1-1/8" diameter composition
 1-1/8" diameter composition with SPST switch	 Twist ear mounted 15/16" diameter preset tandem	 Self-supporting snap-in mounted compact 3-section multiple composition	 1-1/8" diameter 2 watt composition
 1-17/64" diameter 2 watt wirewound	 Miniaturized clinch ear mounted composition	 Miniaturized bushing mounted 3/4" diameter composition	 1-17/64" diameter 2 watt wirewound with locking type bushing
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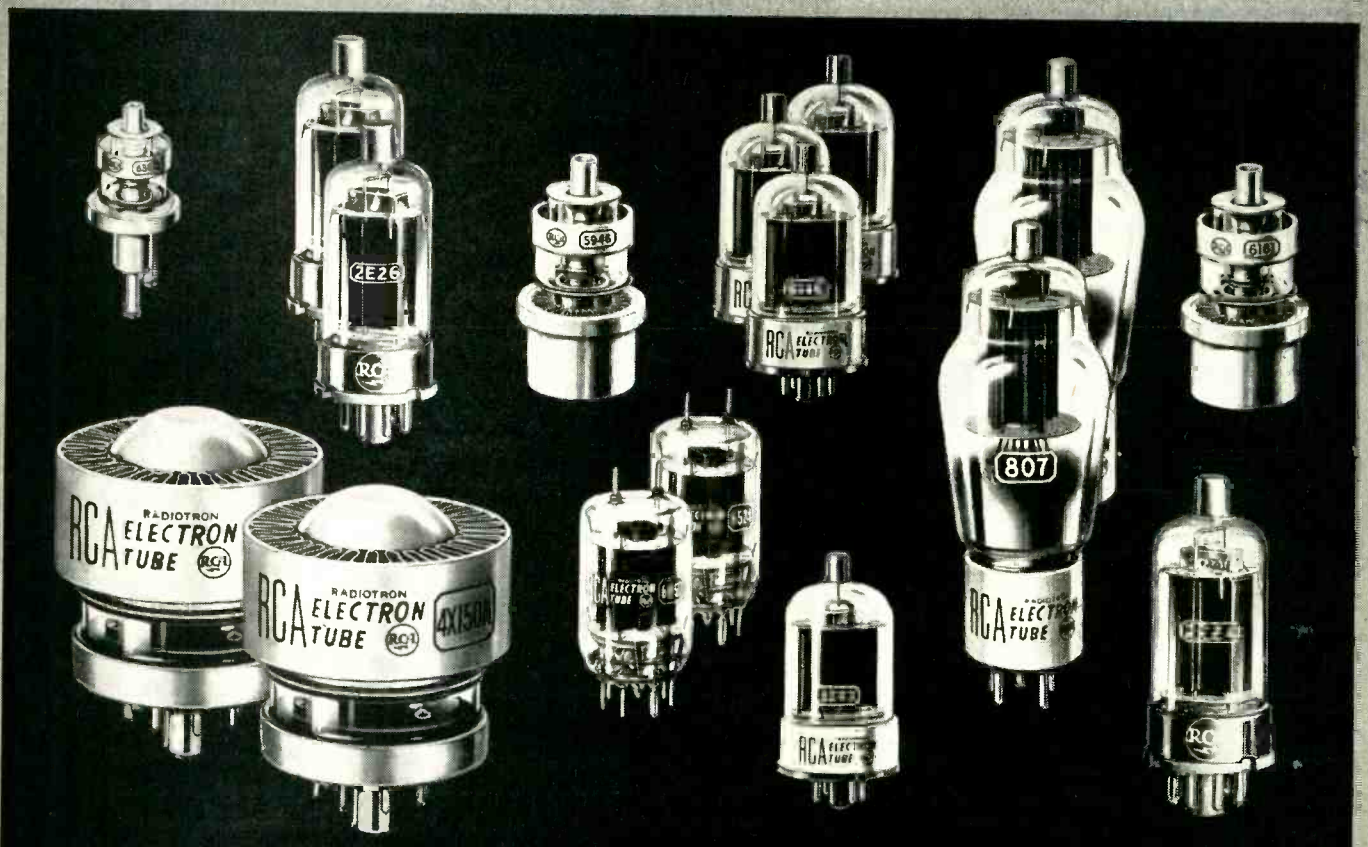

POWER TUBES...for Fixed...Mobile...Aircraft Applications

RCA-6146, -6383, -6159 ... small, sturdy, beam power tubes. Each type is useful as an rf power amplifier and oscillator, as well as an af power amplifier and modulator. In CW service, handles up to 90 watts input (ICAS) to 60 Mc, 60 watts input at 175 Mc. Maximum plate dissipation is 25 watts (ICAS). The **6146** has 6.3-volt heater for fixed and mobile equipment; the **6383** has 12.6-volt heater for mobile equipment; and the **6159** has 26.5-volt heater for aircraft equipment.

RCA-2E24 ... beam power tube designed for mobile and emergency-communications equipment. It may be operated as an rf power amplifier, oscillator, or modulator with full input to 125 Mc, reduced input to 175 Mc. Maximum plate dissipation is 13.5 watts (ICAS). Has 6.3-volt quick-heating filament.

RCA-6524 -6850 ... compact, twin beam power tubes. Each type is primarily for use as a push-pull rf power amplifier or as a frequency tripler to 470 Mc. Also may be used as an af power amplifier or modulator. Maximum plate dissipation is 25 watts (ICAS). The **6524** has 6.3-volt heater; the **6850** has 12.6-volt heater.

RCA-4X150A, -4X150D ... compact, forced-air-cooled beam power tubes for use as power amplifiers or oscillators up to 500 Mc. Also useful as wide-band amplifiers in video applications. Maximum plate dissipation is 150 watts (CCS). The **4X150A** has 6.0-volt heater; the **4X150D** has 26.5-volt heater.

RCA-6293 ... small, sturdy, beam power tube for pulse modulator service in fixed or mobile equipment. Can deliver peak plate current of 3 amperes during pulse length of 30 microseconds under conditions with duty factor of 0.003 and plate-supply voltage of 2000 volts; or 1.4 amperes during pulse length of 200 microseconds with duty factor of 0.02 and plate-supply voltage of 3500 volts. Similar to **RCA-6146** in appearance. Has 6.3-volt heater.

RCA-807, -1625 ... general-purpose beam power tubes for use as rf power amplifiers, oscillators, af power amplifiers, and modulators. In CW service, may be operated at full input to 75 Mc, at reduced input to 125 Mc. Maximum plate dissipation is 30 watts (ICAS). The **807** has 6.3-volt heater and small 5-pin base; the **1625** has 12.6-volt heater and medium 7-pin base.

RCA-2E26, -6893 ... small size, beam power tubes for use as rf power amplifier and oscillators, as well as af power amplifiers and modulators. Can be operated with full input to 125 Mc. Maximum plate dissipation is 13.5 watts (ICAS). The **2E26** has 6.3-volt heater for fixed and mobile equipment; the **6893** has 12.6-volt heater for mobile equipment.

RCA-6161 ... forced-air-cooled power triode of the integral-radiator type for uhf service in TV and CW applications. Can be operated at full input to 900 Mc, with reduced ratings to 2000 Mc. Maximum plate dissipation is 250 watts (CCS). Has 6.3-volt heater.

RCA-6383 ... compact liquid-and-forced-air-cooled power triode for uhf service where transmitter-design factors of compactness, light weight, and high power output are prime considerations. Full plate voltage and input up to 2000 Mc. Maximum plate dissipation is 600 watts (CCS). Has 6.3-volt heater.

RCA-5946 ... compact forced-air-cooled power triode for uhf plate-pulsed oscillator and amplifier service; has maximum plate dissipation of 250 watts (CCS), and can be operated with full input up to 1300 Mc. Similar to **RCA-6161** in appearance. Has 6.3-volt heater.

For further technical data on these and other power tubes, refer to RCA Tube Handbook HB-3.

FOR DESIGNERS

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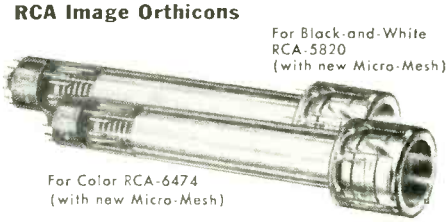

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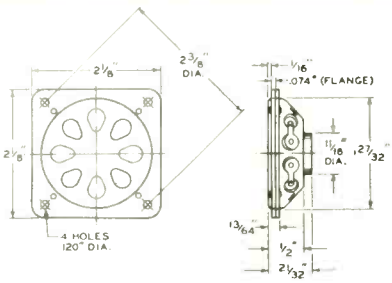

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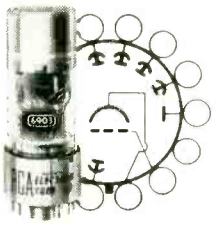

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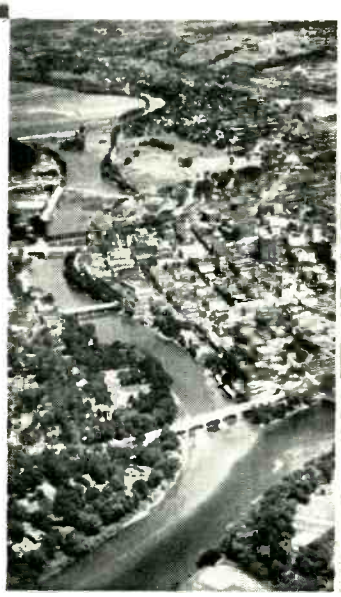

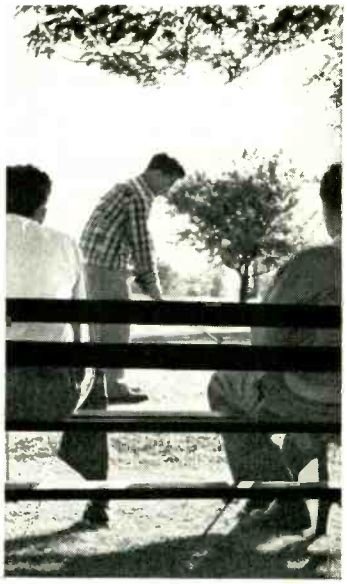

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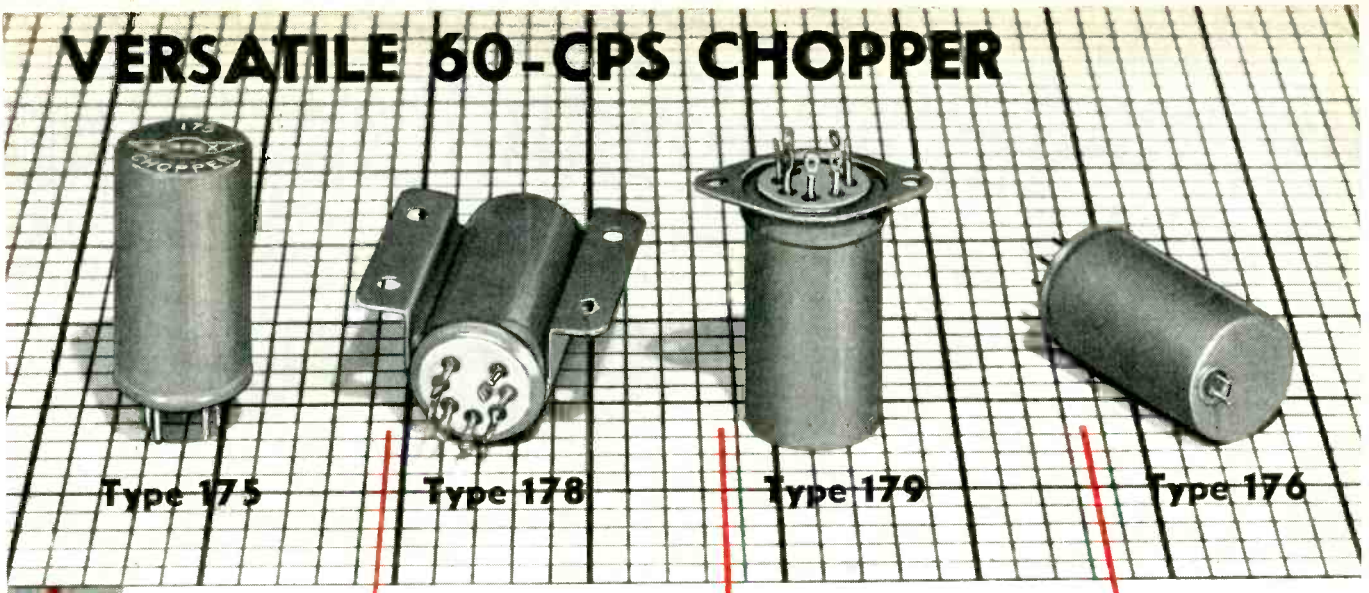

Long Life

Here is a miniature 60-CPS chopper of proven life. Manufactured under rigid controls that assure you of uniformity, Type 175 choppers are still operating in the field after 10,000 hours. Life naturally depends on operating conditions; our experience is available to you in planning your circuit to take full advantage of the characteristics listed below.

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Quasiresonant drive mechanism operates in any position. As a consequence, you can mount this versatile chopper as is most convenientin packaging your equipment. Where space is limited, use a unit with solder-lug terminals. The chopper is hermetically sealed. Fumes and moisture cannot degrade performance.

Low Noise

Noise level is inherently low. For still quieter operation, drive-coil leads can be brought in through the top. All types are also available on special order with mu-metal cans.

Chopper Ratings

Drive

Frequency	60 ± 6 CPS
Voltage	6.3 ± 0.6 RMS volts

Contacts

Dwell Time	165 ± 15 electrical degrees
Balance	15 electrical degrees
Phase angle	20 ± electrical degrees
Voltage	0 to 100 DC volts
Current	0 to 2 MA in resistive circuit
Noise	50 RMS microvolts average

Above ratings are for operation in an ambient of 23 C.

Chopper Application

The chopper is a basic component; a SPDT switch that runs continuously and in synchronism with its drive voltage. It is an excellent modulator; requires no bias to maintain a zero null; produces 100% modulation. It is an equally fine synchronous detector. Choppers are used in such equipments as autopilots, machine controls, test equipments, and stabilized DC amplifiers.

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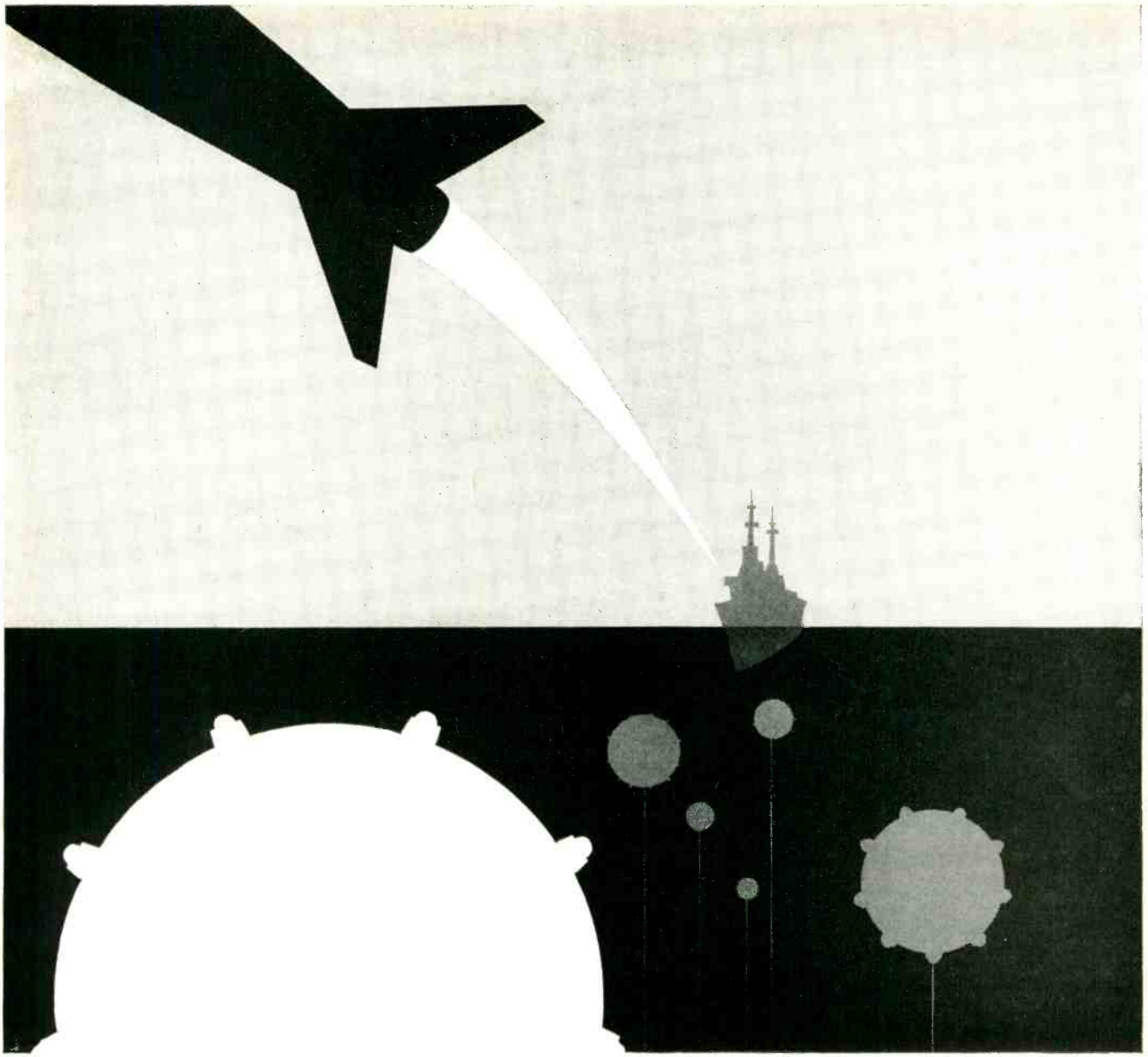

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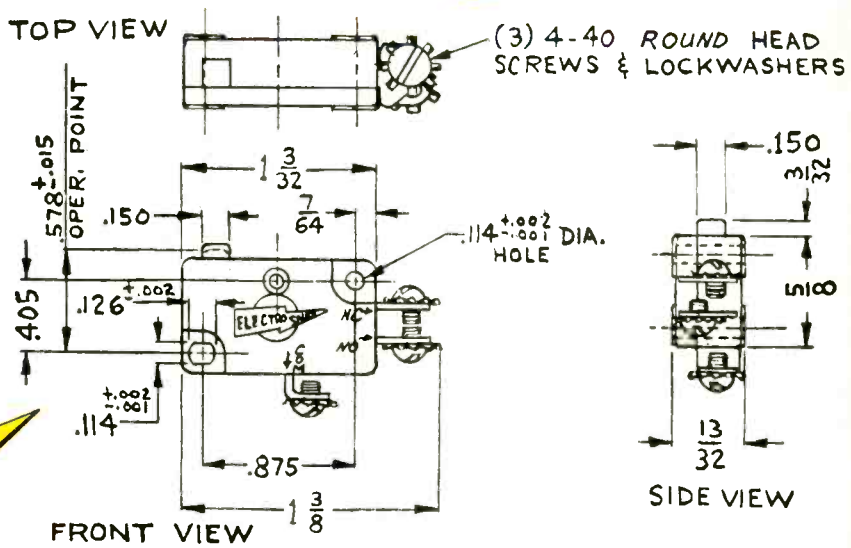
30 V.D.C. 110/250 V.A.C.
(RATING FOR AIRBORNE APPLICATION;
6 AMP 30 V.D.C. INDUC.)

Operating Force	7 to 12 oz.
Reset Force	4 oz. Min.
Pretravel	3/64 Max.
Movement Differential	.011 ± .005
Overtravel	1/32 Min.



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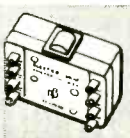
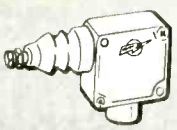
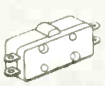

MULTI-POLE SWITCHES


ONE-WAY LIMIT SWITCH


BASIC SWITCH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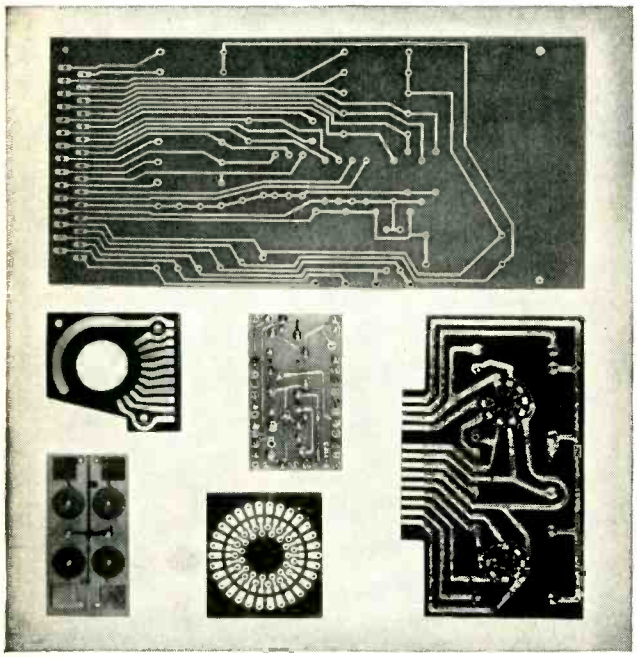

Printed circuits based on C-D-F materials are being used with great success in military electronic equipment, commercial television and radio sets, telephone switchboards—even sub-miniature radiosonde equipment and hearing aids.

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BOND STRENGTH—0.0014" foil (Lbs. reqd. to separate 1" width of foil from laminate)	7 to 11	5 to 9	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMP. (Deg. C.)	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil.)	800	800	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35° C. & 90% RH	50,000	25,000	20,000	Over 10^6 megohms
DIELECTRIC CONSTANT 10^6 Cycles	4.20	4.20	4.54	2.85
DISSIPATION FACTOR 10^6 Cycles	0.026	0.052	0.018	0.0006
ARC-RESISTANCE (Seconds)	10	5	120	180
TENSILE STRENGTH (psi.)	16,000 x 13,000	12,000 x 10,000	48,000 x 44,000	23,000 x 21,000
FLEXURAL STRENGTH (psi.)	21,000 x 18,000	18,000 x 16,000	65,000 x 55,000	13,000 x 11,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.40 x 0.35	0.40 x 0.35	13.5 x 11.5	6.0 x 5.0
COMPRESSIVE STRENGTH flatwise (psi.)	28,000	22,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Cotton rag paper	Cotton rag paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural greenish	Natural Brown	Natural	Natural

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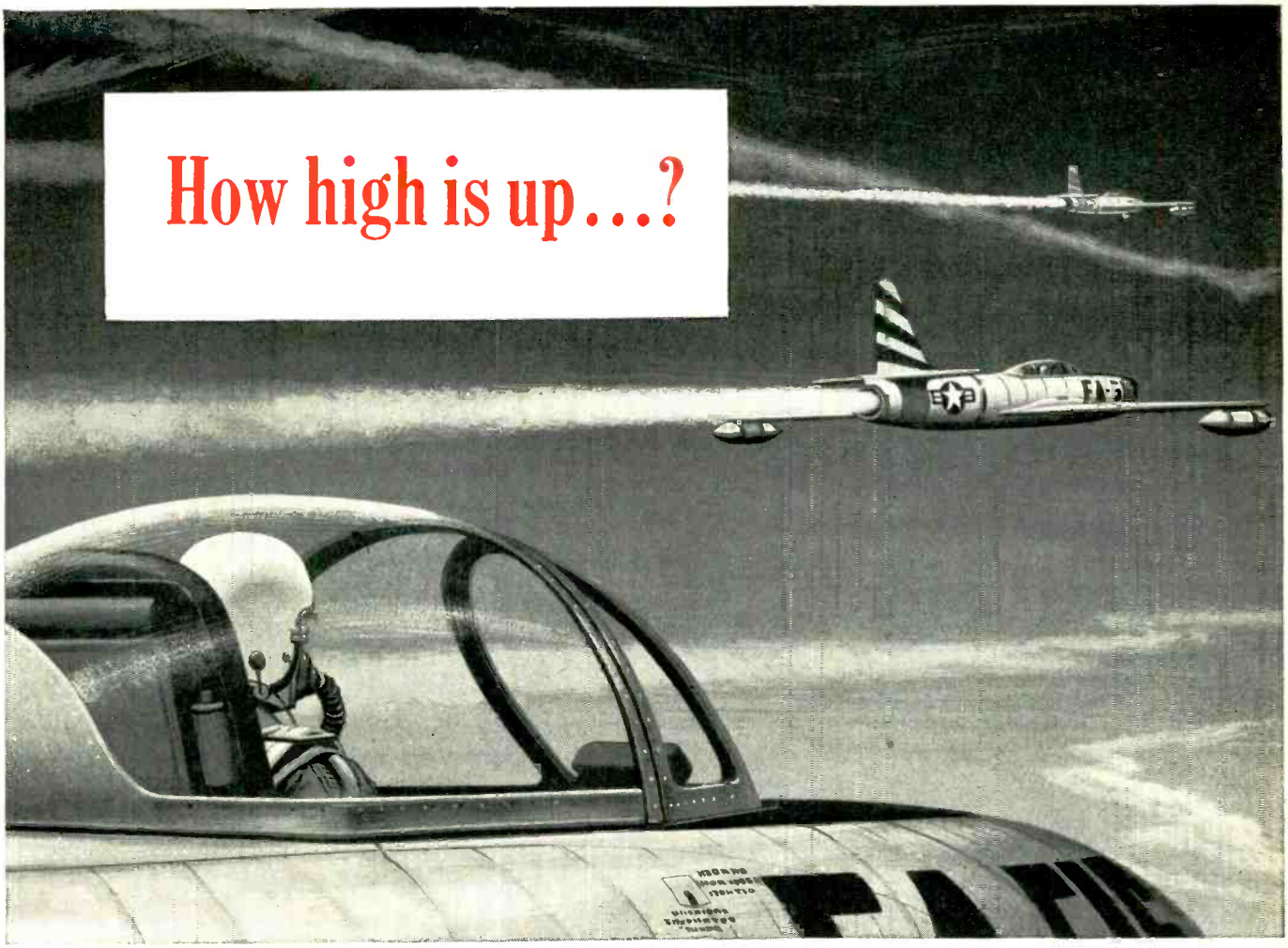

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THE SHORTAGE OF SCIENTISTS AND ENGINEERS:

What Caused It?

WHY is the United States confronted with a serious shortage of scientists and engineers?

One reason, discussed in earlier editorials in this series, is that the increasingly complex technology needed for national security and for an expanding economy has raised enormously the demand for technically trained people.

But it is clear also that too little has been done to increase the supply of scientists and engineers and to make most effective use of the limited number now available. It is with this second reason for the shortage that this editorial deals.

Too few bright young people have been attracted to careers in the sciences and engineering. Many with technical training have been leaving these professions, with the exodus from teaching being especially alarming. And the technical talent now employed in industry, government and education is, in too many instances, being utilized less effectively than it might be.

Paying for a Miscalculation

A legacy of the depression provides part of the explanation for the current shortage of young people entering scientific and engineering careers. Because of low birthrates in the 1930s, there are now about one million fewer boys and girls of college age than there were in the early 1940s. Not until 1960 will there be as many in the 18-21 age group as in 1945. And from the brightest young people of these ages must come, not only scientists and engineers, but the new members of all the professions needed by our growing economy.

A miscalculation in the late 1940s, when our future needs in various occupations were being gauged, provides another part of the explanation. Occupational counselors and high school students were advised that, because of heavy postwar enrollments in engineering and other technical fields, "it is likely that the shortages of trained men will be alleviated in a few years."*

Instead of being alleviated, however, the shortages became more acute. Job opportunities grew rapidly, while graduating classes dwindled. Fewer than half as many students received degrees in engineering in 1955 as in 1950, the peak postwar year. The trend has been reversed, but graduating classes will not be large enough to narrow the gap for several years.

Lost Talent

Beyond these temporary conditions, there is another explanation for the failure of the number of scientists and engineers to keep pace with our rising needs. This is the staggering loss between high school and college of young people with the talent to be successful in science and engineering. **Last year between 60,000 and 100,000 high school graduates of college ability failed to enroll in college for financial reasons and perhaps an additional 100,000 did not enter college because of lack of interest.†**

Of the most intelligent 20 percent in the group of college age, fewer than half enter college and only about a third graduate from college. Educational authorities estimate that fewer than 2 percent of those in the college age group who are mentally equipped to obtain Ph. D. degrees will actually obtain such degrees.

Another crucial stage is in the high

*U. S. Bureau of Labor Statistics, *Occupational Outlook Handbook* (Bulletin 940), p. 63.

†Charles C. Cole, Jr. (assistant dean, Columbia College, Columbia University), *Higher Education*, November 1955.

schools, where future scientists and engineers receive their first training in science and mathematics. There are serious weaknesses and signs of deterioration in this vital part of our educational system.

One-quarter of all American high schools offer no chemistry or physics. One-quarter offer no geometry. In many of the schools offering science and mathematics courses, the quality of instruction is low. Last year in the New York City school system alone more than 10,000 students were in science classes taught by teachers who were not trained in science.

This is a situation that threatens to become much worse. Between 1950 and 1955 the number of graduating teachers qualified to teach high school mathematics dropped 53 percent and those qualified to teach science dropped 59 percent. Furthermore, only about 60 percent of the graduates certified to teach mathematics or science in 1955 entered teaching as a career.

On the students' side — partly because of inadequate guidance programs — there has been a drift away from science and mathematics courses. The result of low student interest, and poor high school programs, in science and mathematics is virtually to foreclose careers in science and engineering to many bright young people. They miss the necessary basic training. Many who do attempt to obtain college training in these fields are ill-equipped. Engineering school deans report that fully half of their students enter with deficiencies in mathematics.

Misuse of Trained People

Scientific and engineering careers have long had a reputation for low salaries and limited opportunities for advancement. In recent years starting salaries have sky-rocketed and have been accorded wide publicity. But unfortunately there has been much less improvement in the salaries paid experienced engineers and scientists, especially in government and education. This has lowered the morale of experienced men and provided an incentive to desert engineering and research positions for higher paying jobs in sales or management.

Engineers and research scientists complain also that too much of their time now is spent on tasks that draftsmen and technicians could perform. Unfortunately for easy solution of this problem, however, there is an acute shortage of technicians as well. Worse still, there are indications that some companies in industries using large numbers of engineers have gobbled up technical manpower at a faster rate than they can effectively employ these scarce people.

Another drain on the supply of newly-trained scientists and engineers is military service. About 8,000 of this year's 27,000 engineering graduates were in ROTC programs and committed to active duty after graduation. Dr. A. W. Davison, chairman of the Engineering Manpower Commission of the Engineers Joint Council, says that in most cases no attempt is made by the Armed Services to assign these young officers to duties for which their engineering education specifically prepared them. They are not only withheld from industry and education for two years but also are not utilized in defense programs requiring more engineers and research scientists.

Some of the causes for the present shortage of scientists and engineers — bad advice a few years ago and a college age group held down by depression birthrates in the 1930s — are gradually being overcome. But others, such as the deterioration of science and mathematics training in our public schools and the many instances of ineffective utilization of scarce technical talent, enjoy no such prospect of automatic correction. The final editorial in this series will deal with some practical suggestions for meeting these problems.

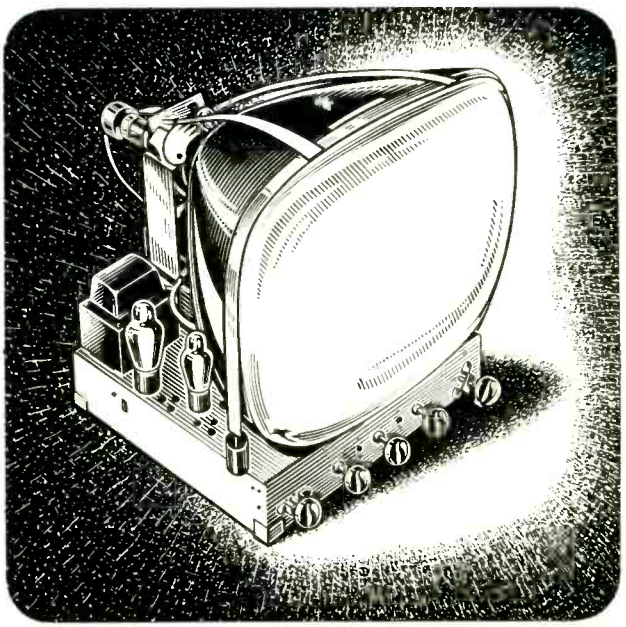
High Purity

Baker ELECTRONIC CHEMICALS

For your electronic tubes and screens—

- Acetic Acid
- Aluminum Nitrate
- Aluminum Sulfate
- Ammonium Carbonate
- Ammonium Chloride
- Ammonium Hydroxide
- Ammonium Phosphate
- Antimony Trioxide
- Barium Acetate
- Barium Carbonate
- Barium Fluoride
- Barium Nitrate
- Benzene
- Boric Acid
- Cadmium Chloride
- Cadmium Nitrate
- Cadmium Sulfate
- Calcium Carbonate
- Calcium Chloride
- Calcium Fluoride
- Calcium Nitrate
- Calcium Phosphate
- Ether, Petroleum
- Hydrochloric Acid
- Hydrofluoric Acid
- Lithium Carbonate
- Lithium Chloride
- Lithium Nitrate
- Lithium Sulfate
- Magnesium Carbonate
- Magnesium Chloride
- Magnesium Oxide
- Manganous Carbonate
- Methanol
- Nickelous Chloride
- Nickelous Nitrate
- Nickelous Sulfate
- Nitric Acid
- Potassium Dichromate
- Potassium Hydroxide
- Radio Mixtures
- Silicic Acid
- Sodium Carbonate
- Sodium Chloride
- Sodium Hydroxide
- Sodium Phosphate Dibasic
- Strontium Nitrate
- Sulfuric Acid
- Toluene
- Triple Carbonate
- Zinc Chloride
- Zinc Nitrate
- Zinc Oxide

PURITY BY THE TON
-for production use



BAKER CHEMICALS FOR THE ELECTRONIC INDUSTRY are manufactured to rigid standards of chemical purity. They are ideally suited for the production of phosphors, emission coatings, activating agents, etc. used in military and civilian radar, radio and television equipment.

For many years, J. T. Baker Chemical Co. has supplied tonnage chemicals of controlled purity and uniformity for industries where precision is the key word.

Today, the increasing demands of high fidelity and color TV equipment present for ever-new challenges of closer tolerances. Baker works closely with chemists and electronic engineers to aid in meeting these challenges. You may be sure that Baker is well-equipped to supply your industry with the high purity tonnage chemicals you need—when you need them.

Look over the list of Baker electronic chemicals on this page—write for prices and samples of those which interest you in your production. Further, if your development and research requires these or other chemicals to precise standards, Baker is your logical source of dependable supply.

J. T. Baker Chemical Co.
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Want more information? Use post card on last page.

PHILCO

SBT*2N240

HIGH SPEED SWITCHING TRANSISTOR

with response time in millimicrosecond range

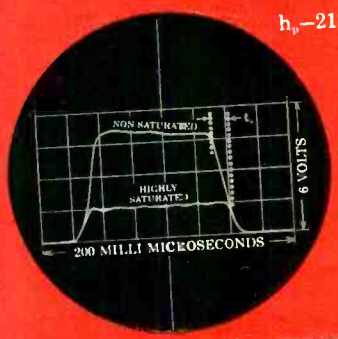
GUARANTEED CHARACTERISTICS

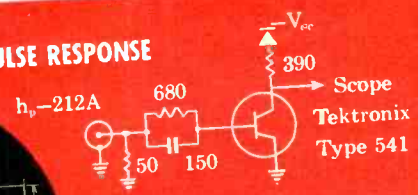
CHARACTERISTIC	CONDITION	VALUE
"ON"	$I_b = -.3$ ma, $I_c = -2$ ma. $I_b = -2.5$ ma, $I_c = -8$ ma.	$V_{ce} = -0.07$ V MAX. $V_{ce} = -0.10$ V MAX.
"OFF"	$V_{be} = -0.10$V., $V_{ce} = -4.5$V.	$I_c = -150\,\mu a$ MAX.
h_{fe} (COMMON EMITTER CURRENT GAIN)	$V_c = -3$V., $I_c = -.5$ ma.	16 MIN.
C_{ob} (COMMON BASE OUTPUT CAPACITY)	$V_c = -3$V., $I_c = -5$ ma.	6 $\mu\mu$f. MAX.
I_{co} (COLLECTOR CUTOFF CURRENT)	$V_{cb} = -5$ V	3 μa MAX.
I_{eo} (EMITTER CUTOFF CURRENT)	$V_{eb} = -5$ V	3 μa MAX.

MAXIMUM RATINGS

$V_{ce} = -6$ V. $I_c = -15$ ma. $P_c = 10$ mw @ 40°C.

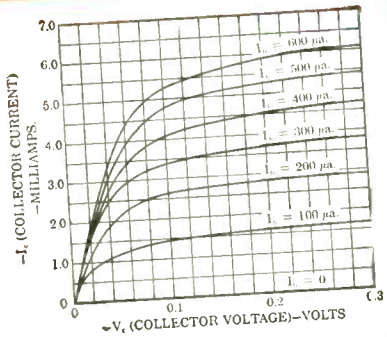
PULSE RESPONSE



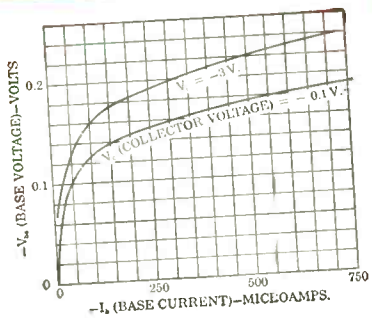


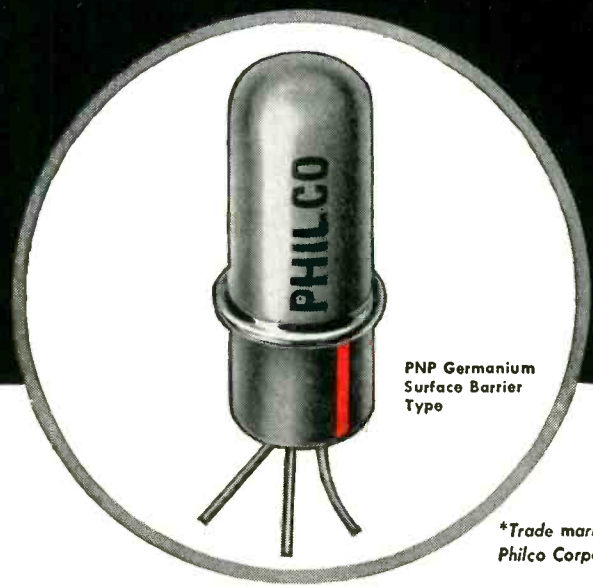
Test Conditions: V_{cc} is set to −6V and pulse input is adjusted until transistor is just in saturation. V_{cc} is then lowered to −1.5V for saturated pulse curve. t_s = hole storage time.

COLLECTOR CHARACTERISTIC IN SATURATION REGION



INPUT CHARACTERISTIC





PNP Germanium Surface Barrier Type

*Trade mark of Philco Corporation

FEATURES

- Low saturation resistance
- Low saturation voltage
- Ideal electrical characteristics for direct coupled circuitry
- Extremely fast rise and fall time
- Absolute hermetic seal
- Available *now* in production quantities

Proven performance of the Philco Surface Barrier Transistor has made it the basis for design of both military and commercial computers where speed and reliability are the major considerations. And now this transistor goes even farther . . by giving reliable performance in 20 megacycle switching circuits!

Make Philco your prime source of information for high speed computer transistor applications.

Write to Dept. E, Lansdale Tube Company Division, Lansdale, Pa.

PHILCO CORPORATION

LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA

ENGINEERING BULLETIN

ON MICRO-BEARINGS

Miniature Instrument Ball Bearings

NEW HAMPSHIRE BALL BEARINGS, INC.

PETERBOROUGH 1, NEW HAMPSHIRE

Subject: **FACTORS TO CONSIDER IN MINIATURE BEARING APPLICATION**

TYPES OF BEARING

The Retainer Bearing fitted with the one-piece crown retainer is well suited for the great majority of instrument applications. Even ball spacing produces good performance at low-moderate speeds, and it can also handle radial or thrust loads. Improved fabricating techniques result in crown retainers being specified for low-torque requirements.

Phenolic Retainers machined from phenolic plastic allow higher speeds and also provide some retention of lubricant. This retainer is used with angular contact bearings where one land is ground away from the inner or outer ring to permit bearing assembly. Such a design permits thrust *only* in the direction of the side having the full land.

CROWN

The Full Bearing has a full complement of balls. Filling notches are ground on one side of each ring to allow assembly. This type is steadily being replaced by retainer bearings which cost less to manufacture and assemble. It has an advantage for certain applications requiring maximum radial load capacity, but is unable to handle thrust loads because of possible interference between the balls and filling notches. Contact between the balls creates friction which makes the full bearing unsuitable for low torque or high speed applications.

PHENOLIC

MATERIALS

Stainless Steel's anti-corrosive properties have made it first choice for bearings used in precision instruments, and it has become one of the standard materials for this purpose. It can be ground and finished to a high degree of precision.

Chrome Steel should only be specified when bearings must operate at critical limits of capacity, a condition not often encountered in instruments. It has a somewhat higher load rating than stainless steel but is subject to rapid corrosion if not protected during handling and use.

Beryllium Copper should be restricted to applications which definitely require non-magnetic properties in the bearings. All components of the bearing are fabricated from this material. If non-magnetic properties are not required, stainless steel is a better selection.

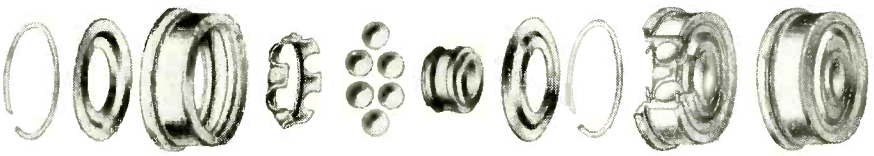
LOAD RATINGS

A miniature bearing is seldom operated at or near its rated load capacity. However, the designer must have sufficient information to assure intelligent selection. The load ratings presented in the New Hampshire Ball Bearings, Inc. catalog tables are based on standards established by the AFBMA after extensive studies and tests.

Dynamic load ratings apply to bearings that are rotating. Time-consuming calculations can be avoided by making use of the C factor shown in our catalog.

Static load ratings apply to bearings at rest. Since this exists in relatively few cases, static load rating is not usually given much emphasis. Formulae have been developed, however, and the need for this information is increasing, — primarily for units subjected to shock loading.

Retainer Bearing — Exploded and Assembled Views



Retainer Bearing — Flanged and Shielded

RADIAL AND AXIAL PLAY

Radial play is the displacement of one ring with respect to the other along the *diameter* of the bearing.

It is important in the successful application of precision bearings and should be specified in orders. A range of .0002" to .0005" is satisfactory for most applications but tighter or looser clearances may be required. The minimum clearance should be .0001" and the total spread from min. to max. should be at least .0002".

Axial play is the displacement of one ring with respect to the other along the bearing axis. It is specified only when axial positioning of the shaft must be held within certain limits. Radial and axial play are mutually dependent factors and the former is the one usually specified.

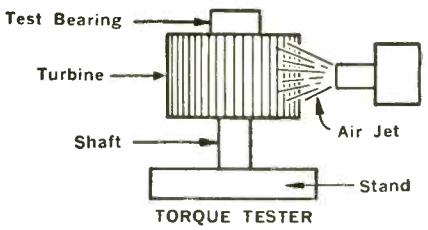
Radial Play — Maximum distance one race may move diametrically with respect to the other without the application of measurable force when both races lie in the same plane.

Axial Play — The maximum relative axial movement of inner race with respect to the outer, when both races are coaxially centered, without the application of measurable force.

TORQUE TESTS

Sensitive instruments require bearings with minimum inherent friction. Starting, or breakaway, torque is most often used to define limits. This is the force necessary to induce rotation from standstill under clearly established conditions of mounting and loading.

Torque tests can reveal much about the true quality and geometry of the bearing. Investigations being conducted constantly are producing valuable contributions to the refinement of instrument bearings.



TORQUE TESTER

MOUNTING PRACTICE

An improper fit to the shaft or housing can cause malfunctioning and failure of a precision bearing. The factors vary so with each application that bearing manufacturers are reluctant to make definite recommendations unless adequate information is furnished. The user cannot be sure that he has selected proper fits unless he has considered the variables involved in the manufacture of both instruments and bearings.

For selective assembly "coded bearings" can be supplied. This involves sorting bores and outside diameters in .0001" increments. It produces four possible groups within the quantity ordered but quantities in any *one* group cannot be assured. Coding should be specified only when definite advantages justify the additional cost.

DESIGNERS HANDBOOK *FREE* TO ENGINEERS

If you work with miniature bearings, you'll find this new, 70 page authoritative publication a great help in solving problems in designing instruments or small electro - mechanical assemblies.

Free to engineers, draftsmen and purchasing agents.

Write New Hampshire Ball Bearings, Inc., Peterborough 1, N.H.

GOLD BONDED

NOW...
a complete range of
RADIO RECEPTOR GERMANIUM DIODES
that meets the exacting requirements of the GOLD standard

These subminiature glass diodes, the result of Radio Receptor's controlled gold bonding process, are long lived and dependable. They include such desirable characteristics as high conductance, low leakage and fast reverse recovery, all at a low cost that makes them practical for every type of service. Individually tested in our factory, RRco. gold bonded diodes give superior service in the field under the most rigorous conditions.

Production quantities available for immediate delivery

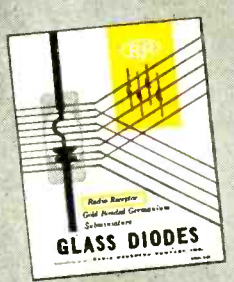
general purpose types

high temperature types

high conductance types

computer types

military types



If your production includes computers, receiving equipment, transistor biasing, magnetic amplifiers, modulators, demodulators, pulse circuitry, logic circuitry, metering, varistors, or any other circuitry requiring diodes, write for our comprehensive new catalog today. It includes typical characteristic charts and additional information pertaining to our complete line.

Radio and Electronic Products Since 1922

Semiconductor Division, RADIO RECEPTOR CO., INC.
240 Wythe Avenue, Brooklyn 11, N. Y.

Please send me your new diode catalog No. G-60

Name..... Position.....

Company.....

Address.....

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

E

CAMERA PICK-UP TUBES FROM WESTINGHOUSE

Image Orthicon (WL-5820), left

Vidicon (WL-6198), right

For superlative tube performance in your television cameras, you'll find this worth remembering.

The same fine quality you have learned to count on in all other Westinghouse Tubes is available to you in the Vidicons and Image Orthicons that are in production today at Westinghouse. Improved versions for military and industrial applications are under development.

Born of Westinghouse experience and workmanship, these precision-built TV pick-up tubes are absolutely unexcelled for clarity and brightness of image and for long, economical life.

Whether you build TV cameras or use them —for commercial, industrial or defense applications—we invite your inquiries. Simply write our Commercial Engineering Department at the address below.

ENGINEERS! For challenge, security, growth potential, investigate career opportunities now being offered by Westinghouse Electronic Tube Division. Write Technical Placement Director today.

Westinghouse RELIATRON® Tubes

6ET-4113

WATCH WESTINGHOUSE *WHERE **BIG** THINGS ARE HAPPENING FOR **YOU!***

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, N. Y.

STACKPOLE

50th year

FOUNDED 1906

Starting half a century ago, Stackpole engineering centered around two of the most basic, versatile elements . . . carbon and graphite. Singly, in combination or mixed with metal powders, these age-old elements were developed into materials and components that consistently met advanced engineering requirements in many fields.

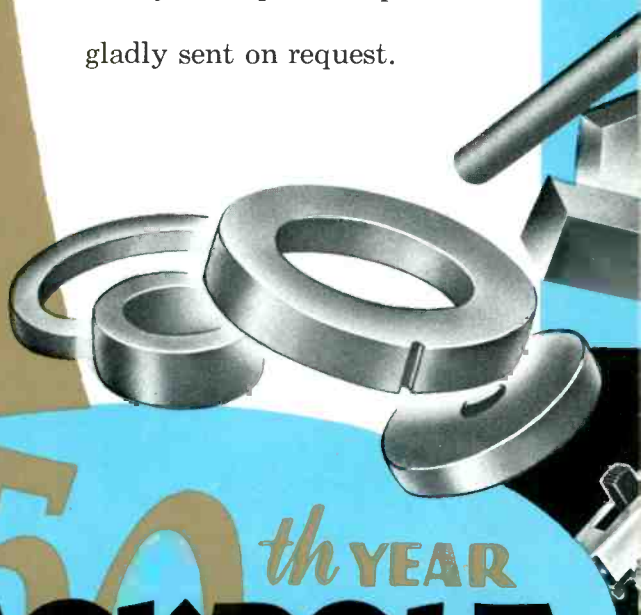
With the commercial advent of radio, this specialized experience provided a head start for the production of composition resistors.

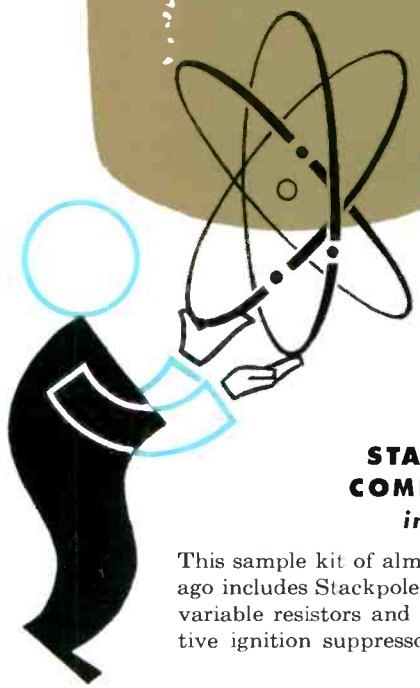
Thus established in 1928, the Stackpole Electronic Components Division expanded rapidly in full keeping with the remarkable growth of the industries it serves.

Today's electronic lines, as illustrated on the following pages, offer convincing evidence of the progress that has been made . . . progress that continues today at an accelerated pace.

pacing ELECTRICAL-ELECTRONIC COMPONENT *Progress*

In addition to complete ranges of standard component types listed here, Stackpole regularly develops and produces special designs and adaptations for quantity users. Full details on any Stackpole component gladly sent on request.





50th YEAR
STACKPOLE

STACKPOLE COMPONENTS *in 1928*

This sample kit of almost 30 years ago includes Stackpole fixed and variable resistors and automotive ignition suppressors.

Electronic Components Division
STACKPOLE CARBON COMPANY, *St. Marys, Pa.*
Plants in St. Marys, Pa. (2); Kane, Pa. (3); Johnsonburg, Pa. and Toronto, Ontario.

STACKPOLE

FIXED Composition RESISTORS

Stackpole's position as one of today's major resistor suppliers is based on two factors: (1) Consistently dependable, quality-controlled resistors; and (2) close personal service in matching resistor requirements and in assuring "on time" deliveries.

½-, 1- and 2-watt sizes are supplied in all standard RETMA ranges and tolerances.

STACKPOLE

MOLDED COIL FORMS

Standardized, low-cost types stocked for prompt delivery. Molded of high-resistance powdered iron with firmly-anchored, easy-to-solder wire leads.

STACKPOLE

FERROMAGNETIC CORES

Wherever ferromagnetic cores are used, Stackpole Ceramag cores have set the quality standards. Characteristics are maintained with remarkable uniformity regardless of size or shape. Write for Bulletin RC-10E.

STACKPOLE

SLIDE SWITCHES

Over 20 inexpensive types for radio and TV receivers, instruments, appliances, small motors, electrical toys, battery-operated lighting circuits and many others. Switch Bulletin RC-10D sent on request.

STACKPOLE

POWDERED IRON CORES

Outstandingly uniform. Insert, cup, sleeve, threaded, choke coil, side-molded and plain core types. Stackpole Preferred Type "EE" cores meet 8 out of 10 needs at prices substantially less than custom cores.

STACKPOLE

LINE SWITCHES

Types to provide practically any switching arrangement for Stackpole Variable Resistors. Similar switches with outside toggles provide dependable switching for record changers, push-button tuners and other units.

STACKPOLE

PERMANENT MAGNETS

These new, low cost ceramic magnets are extremely resistant to demagnetization, even when exposed to strong opposing fields. Use no critical materials. Are virtually electrical non-conductors. Require no "keepers" or other closed-circuit conditions. Write for new Stackpole Ceramagnet Bulletin RC-10A.

STACKPOLE

VARIABLE RESISTORS

Single, concentric shaft duals, and new midgets including types for transistorized sets. Write for handy Volume Control Chart for quick guide to Stackpole standard units.

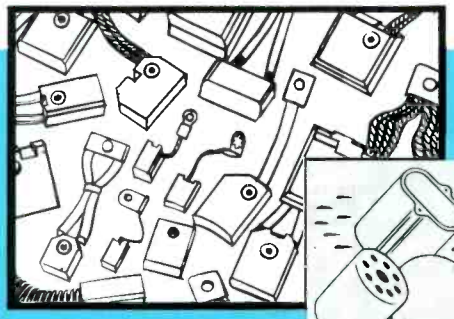
STACKPOLE

LOW VALUE CAPACITORS

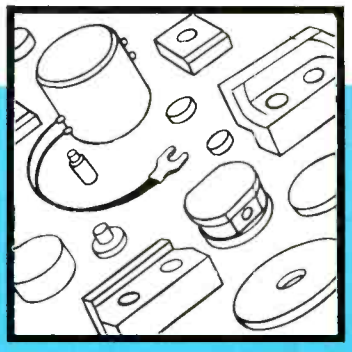
The simplest, most economical fixed composition capacitor types yet produced. Operating stability is adequate for the great majority of uses. Values from 0.10 to 10.0 $\mu\mu$f, each stamped with RETMA color code.

50th YEAR
STACKPOLE

"Everything in Carbon but Diamonds!"

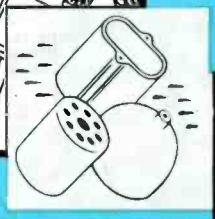


BRUSHES
for all rotating electrical equipment

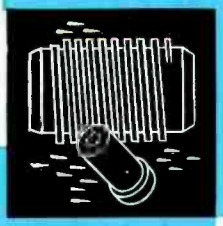


Metal powder and rare metal
CONTACTS

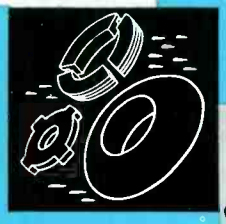
POROUS CARBON



POWER TUBE ANODES

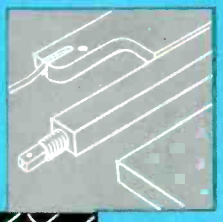


BEARINGS



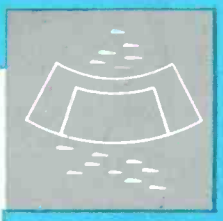
SEAL and
CLUTCH RINGS

DASH POT PLUNGERS



GRAPHITE
CHEMICAL
ANODES

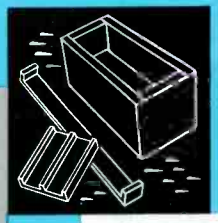
GROUNDING ANODES



FRICTION SEGMENTS

ELECTRIC FURNACE
HEATING ELEMENTS

BRAZING BOATS

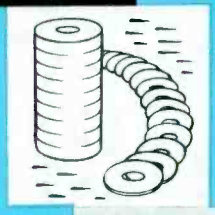


PUMP VANES

MOLDS and DIES

RESISTANCE
WELDING and
BRAZING TIPS

VOLTAGE
REGULATOR
DISCS



TROLLEY and
PANTAGRAPH
SHOES

WATER HEATING
and
PASTEURIZATION
ELECTRODES

SALT BATH
RECTIFICATION RODS

WELDING RODS
and PASTE

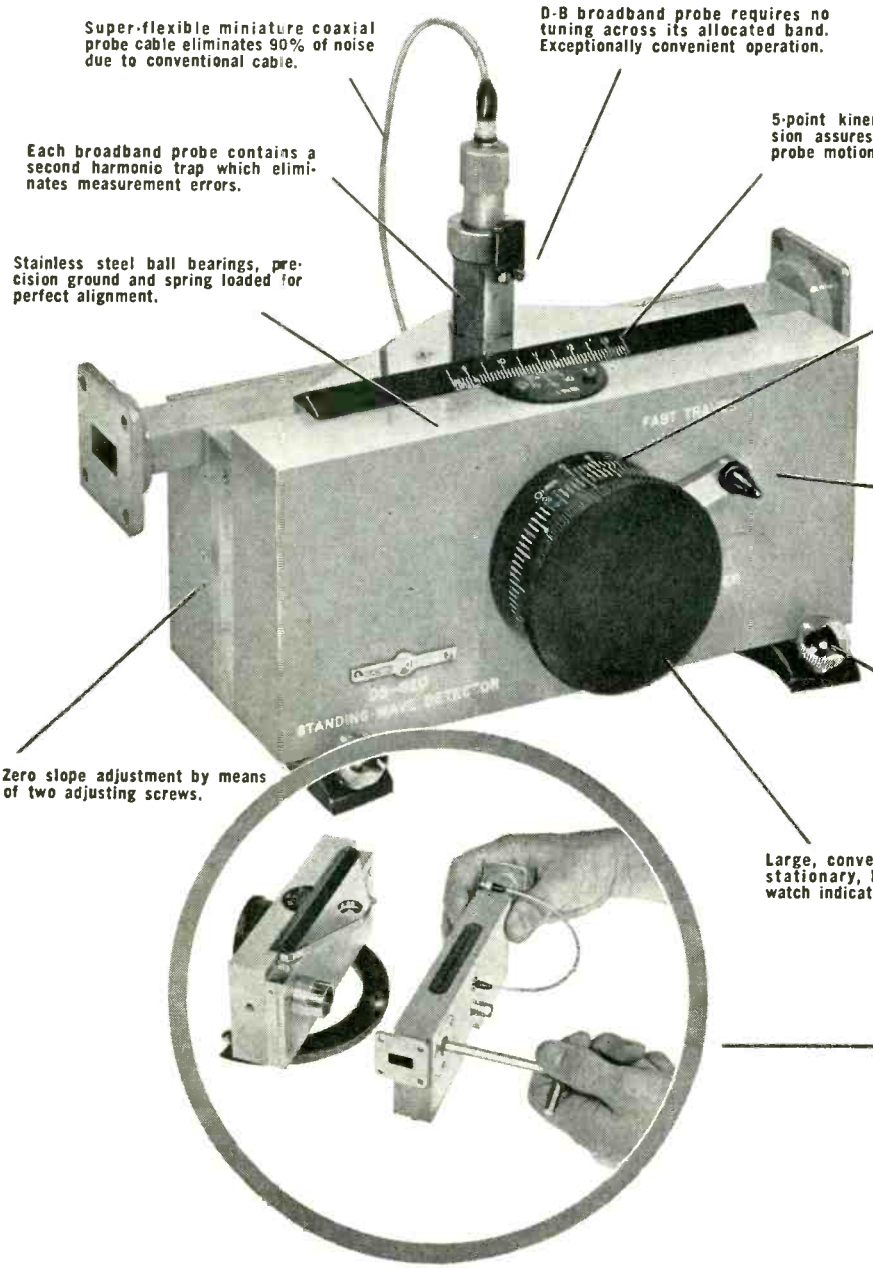
In addition to the Electronic Components shown on the preceding pages, Stackpole makes the Carbon, Graphite and Metal Powder products illustrated above. *Write for details on any product.*

STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

It's easy to obtain Precise Measurements with a D-B Standing Wave Detector

—easy because D-B units are built without the usual sources of error. You get perfect parallelism between slot and waveguide axis...between probe travel and waveguide axis. The waveguide is precision-formed in one piece to provide a uniform path for measured waves, thus minimizing residual VSWR. You can use any D-B slotted line to measure adjacent frequency bands. Merely substitute different-size waveguide blocks and probes—the alignment accuracy is guaranteed to remain unimpaired.

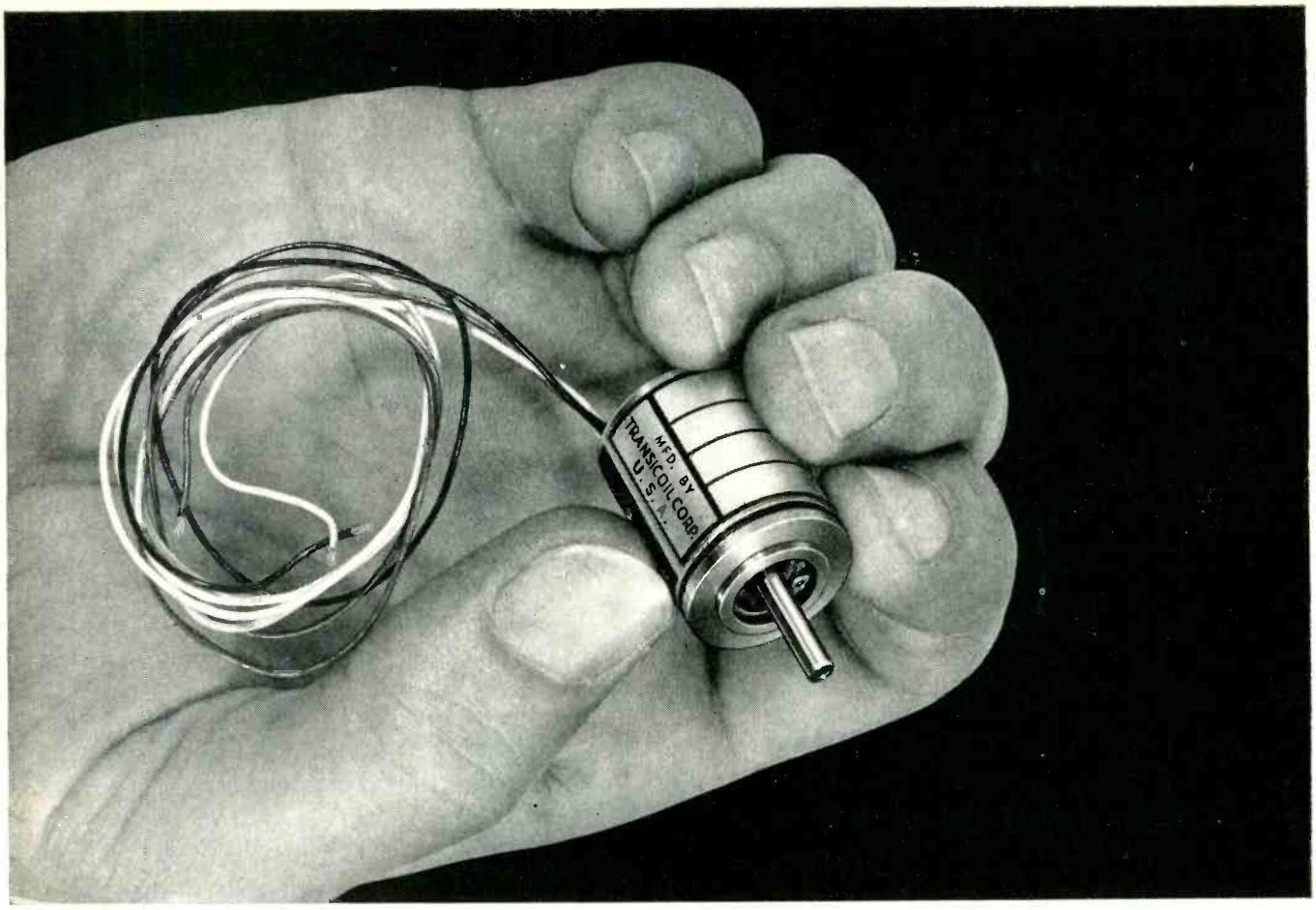
Check the unique features below for further proof of D-B convenience and exceptional accuracy. Literature on request.



D E M O R N A Y - B O N A R D I

780 SOUTH ARROYO PARKWAY · PASADENA, CALIFORNIA

DE MORNAY BONARDI



NEW Size 8 servo combination rivals Size 9 performance

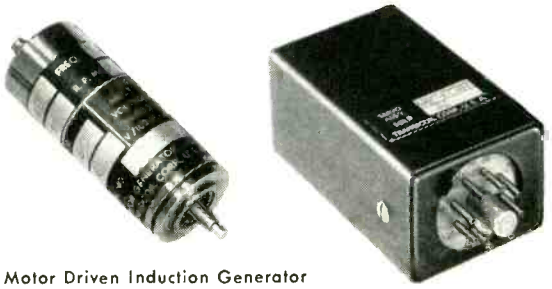
Here, no bigger than your thumb, is the smallest *practical* servo control motor currently produced. Combined with Transicoil's new Size 8 motor driven induction generator, and powered by a new completely-transistorized servo amplifier, this motor offers you the unusually high torque-to-inertia ratio of 28,000 radians/sec^2.

Compared with a Size 9 control motor—until now, the smallest practical unit available—Transicoil's new Size 8 measures only 0.75 inches in diameter, 10% smaller, and weighs only 1.4 oz., 40% lighter. Yet it operates on standard voltages from 26 to 52 volts, and 52 volts with center tap, at 400 cps, permitting push-pull transistor application.

Hence, just as Transicoil's introduction of plate to plate wiring eliminated the transformer, once necessary in servo systems, the Size 8 units and transistor amplifiers mark another milestone in miniaturization.

This is just one more example of how Transicoil can solve your control problems whether they involve miniaturization or control complexity, and go on to manufacture systems and components of the utmost precision and accuracy. You pay only for results—on a fixed fee basis for equipment delivered and performing properly.

Technical data on the new Size 8 combination and the transistorized amplifier is yours for the asking. But you'll end up with a better system if you write outlining your servo control problem.



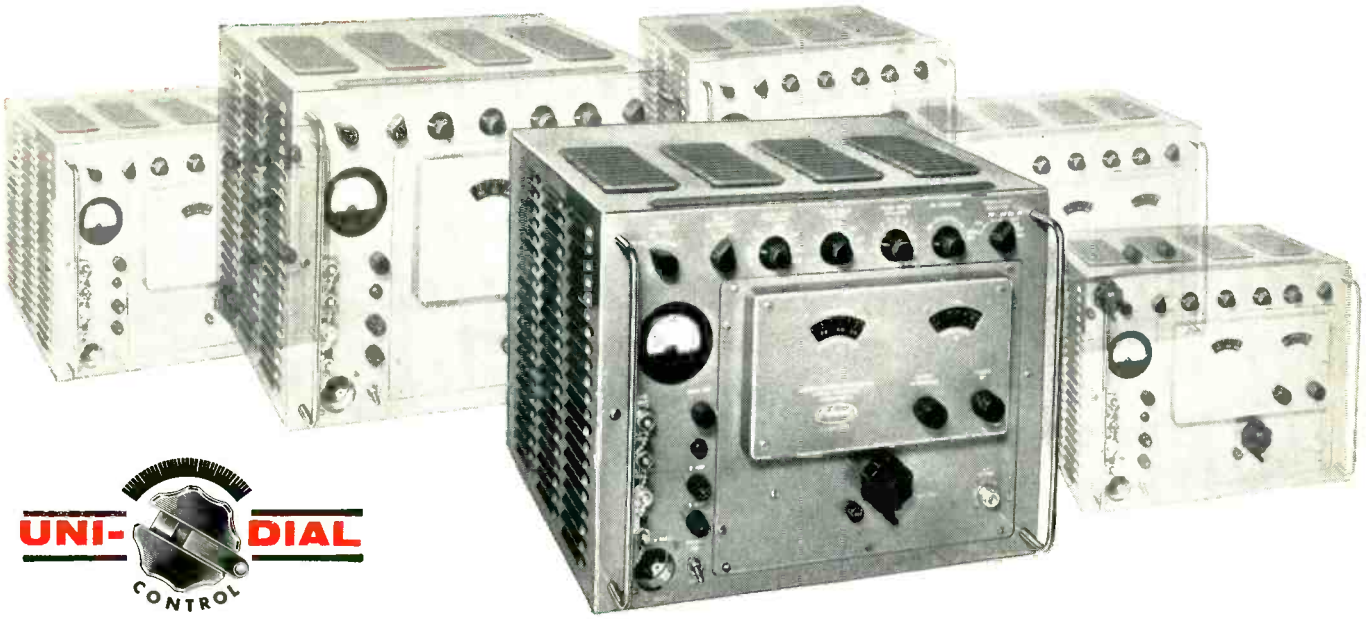
Size 8 Motor Driven Induction Generator and Transistor Amplifier. All units of the Size 8 system have been designed for maximum performance in minimum space.

TRANSICOIL CORPORATION

Worcester, Montgomery County · Pennsylvania

MICROWAVE SIGNAL GENERATORS

950 to 11,500 mc



UNI-DIAL CONTROL

JUST ONE POLARAD MICROWAVE SIGNAL GENERATOR CAN MAKE ALL THESE MEASUREMENTS

- Receiver sensitivity
- Noise figure
- Signal to noise ratio
- Image rejection
- Beacon sensitivity
- Bandwidth
- Standing wave ratio
- Antenna gain and pattern
- Conversion gain or loss
- Attenuation
- Filter characteristics
- Multi-pulsed systems, such as Beacons, DME, Tacan, etc.

Each Polarad Microwave Signal Generator (4 models cover 950-11,500 mc) is equipped with the unusually simple UNI-DIAL control that tracks reflector voltages automatically while tuning continuously. Frequency, accurate to ±1%, is read directly on the single frequency dial. There are no mode charts, no slide rule interpolations necessary.

But, most significant are the built-in features that enable use of these rugged instruments for so many applications: internal modulation, pulse and FM; internal square wave modulation; synchronization outputs, delayed and undelayed; provision for multi-pulse modulation input; provision for external modulation and synchronization; variable attenuator calibrated directly in - dbm; engineered ventilation to insure specification performance over long operating periods.

Contact your local Polarad representative or write directly to the factory for the latest detailed specifications.

SPECIFICATIONS (all models unless indicated)

Model #	Frequency Range
MSG-1	950 - 2400 mc
MSG-2	2150 - 4600 mc
MSG-3	4450 - 8000 mc
MSG-4	6950 - 10,800 mc
MSG-4A	6950 - 11,500 mc

Frequency accuracy: ±1%

Power output:
MSG-1 & 2: 1 mw
MSG-3, 4 & 4A: 0.2 mw

Attenuator range: 120 db

Attenuator Accuracy: ± 2 db

Output impedance: 50 ohms nominal

Internal pulse modulation:
Pulse width: 0.5 to 10 microseconds
Delay: 3 to 300 microseconds
Rate: 40 to 4000 pps
Synchronization: internal or external, sine wave or pulse

Internal FM:
Type: Linear sawtooth
Rate: 40 to 4000 cps
Synchronization: Internal or external, sine wave or pulse
Frequency deviation:
MSG-1 & 2: ±2.5 mcs
MSG-3, 4 & 4A: ±6 mcs

Internal square wave modulation:
40 to 4000 pps

External pulse modulation:
Polarity: Positive or negative
Rate: 40 to 4000 pps
Pulse width: 0.5 to 2500 microseconds
Pulse separation (for multiple pulses): 1 to 2500 microseconds

Output synchronizing pulses:
Polarity: Positive, delayed & undelayed
Rate: 40 to 4000 pps
Voltage: Greater than 25 volts
Rise time: Less than 1 microsecond

Price:
MSG-1, 2 .....**$1,720.00**
MSG-3, 4 .....**$2,190.00**
MSG-4A **$2,450.00**

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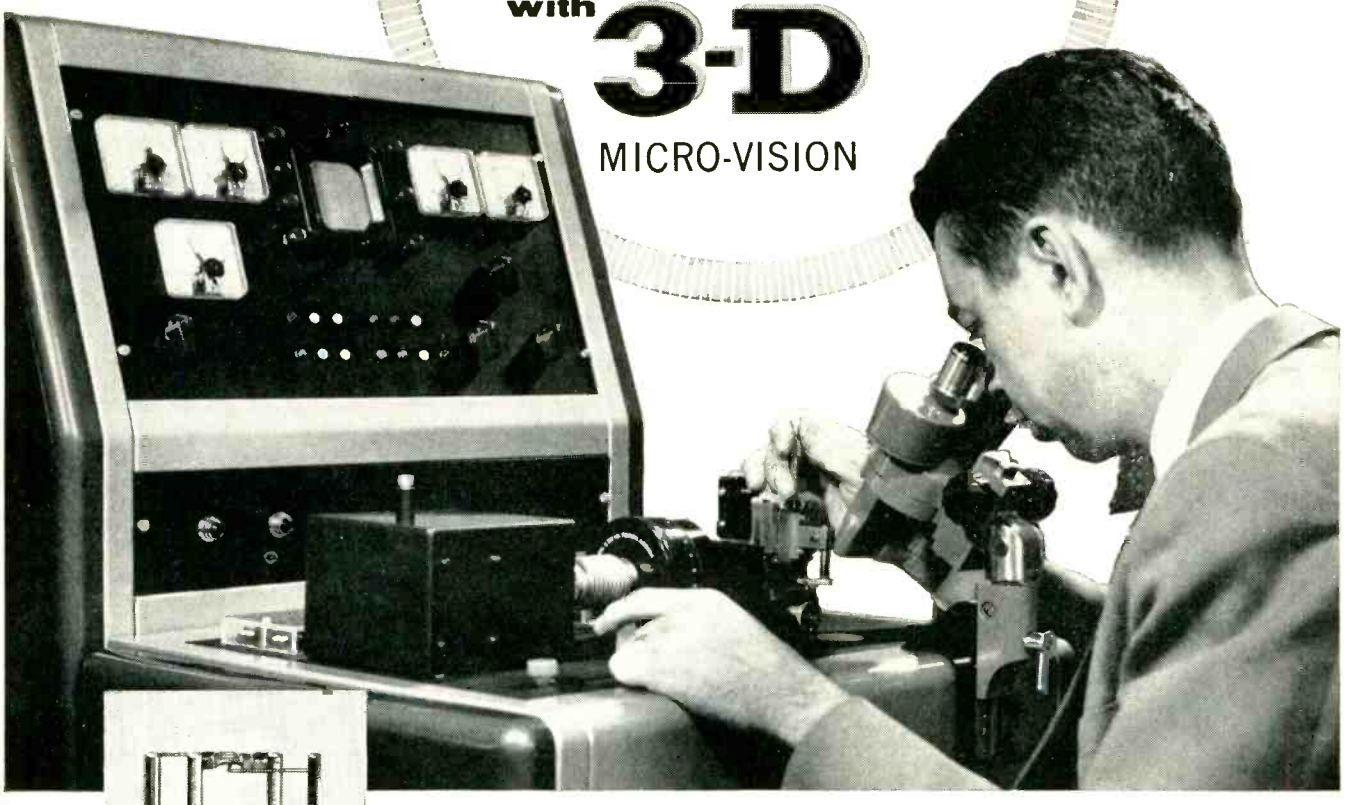

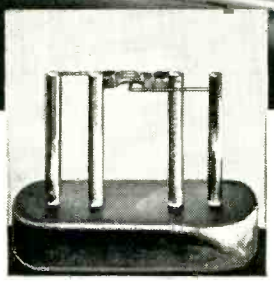

This transistor is enlarged 6 times. You can't see much detail in its actual size, like this . . . That's why Bausch & Lomb Stereomicroscopes are built right into Bell Laboratories' ingenious experimental machine, "Mr. Meticulous," which automatically assembles hair-thin elements in steps involving movements of 1/20,000 of an inch! Without visual fatigue, technicians get vividly magnified views of these tiny parts and intricate operations. We're mighty proud of the part B&L Stereomicroscopes play in helping Bell Laboratories achieve miracles in electronic technology to improve telephone service.

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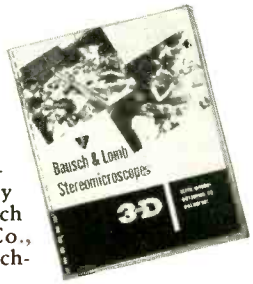

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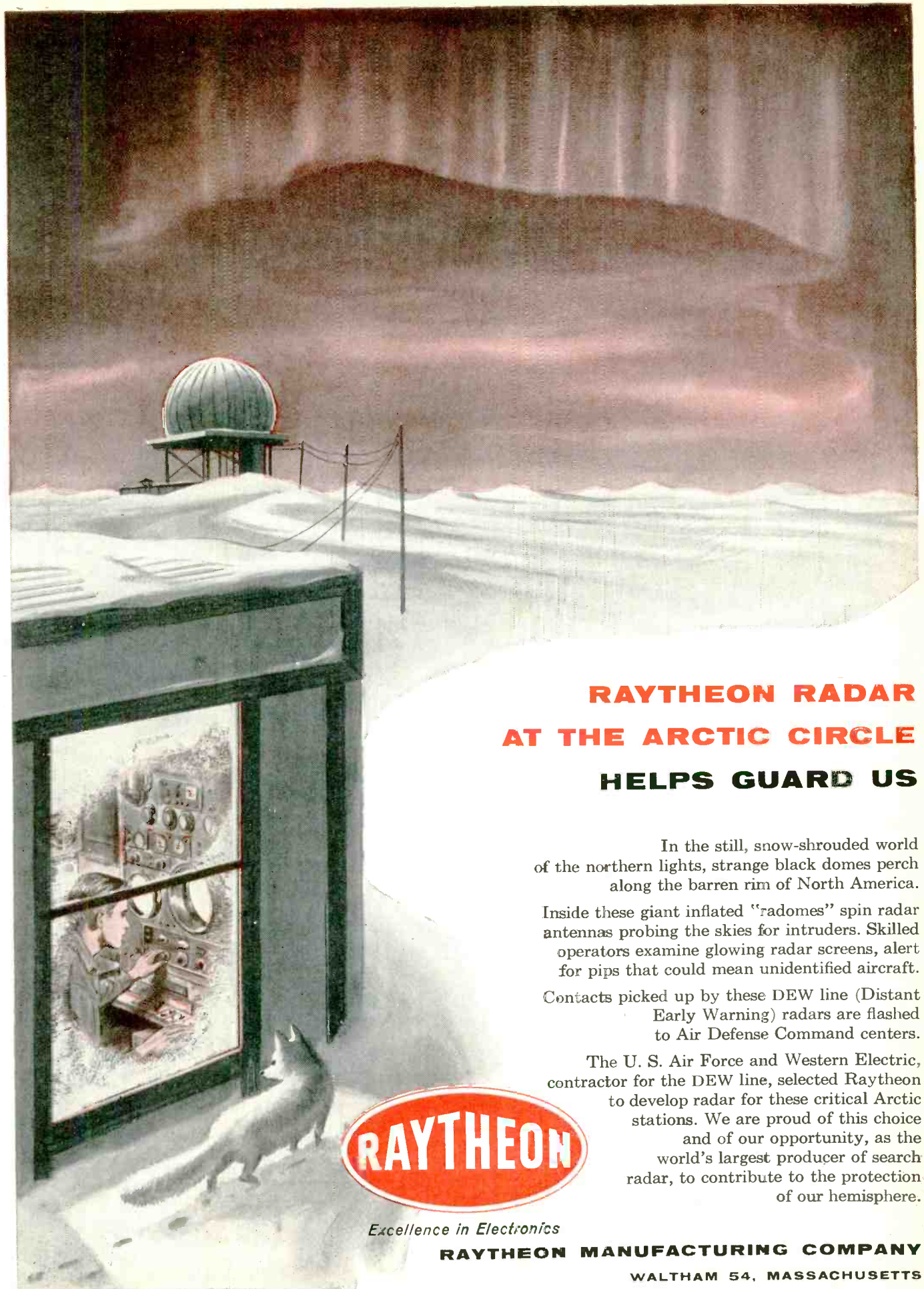
STEREOMICROSCOPES



RAYTHEON RADAR AT THE ARCTIC CIRCLE HELPS GUARD US

In the still, snow-shrouded world of the northern lights, strange black domes perch along the barren rim of North America.

Inside these giant inflated "radomes" spin radar antennas probing the skies for intruders. Skilled operators examine glowing radar screens, alert for pips that could mean unidentified aircraft.

Contacts picked up by these DEW line (Distant Early Warning) radars are flashed to Air Defense Command centers.

The U. S. Air Force and Western Electric, contractor for the DEW line, selected Raytheon to develop radar for these critical Arctic stations. We are proud of this choice and of our opportunity, as the world's largest producer of search radar, to contribute to the protection of our hemisphere.

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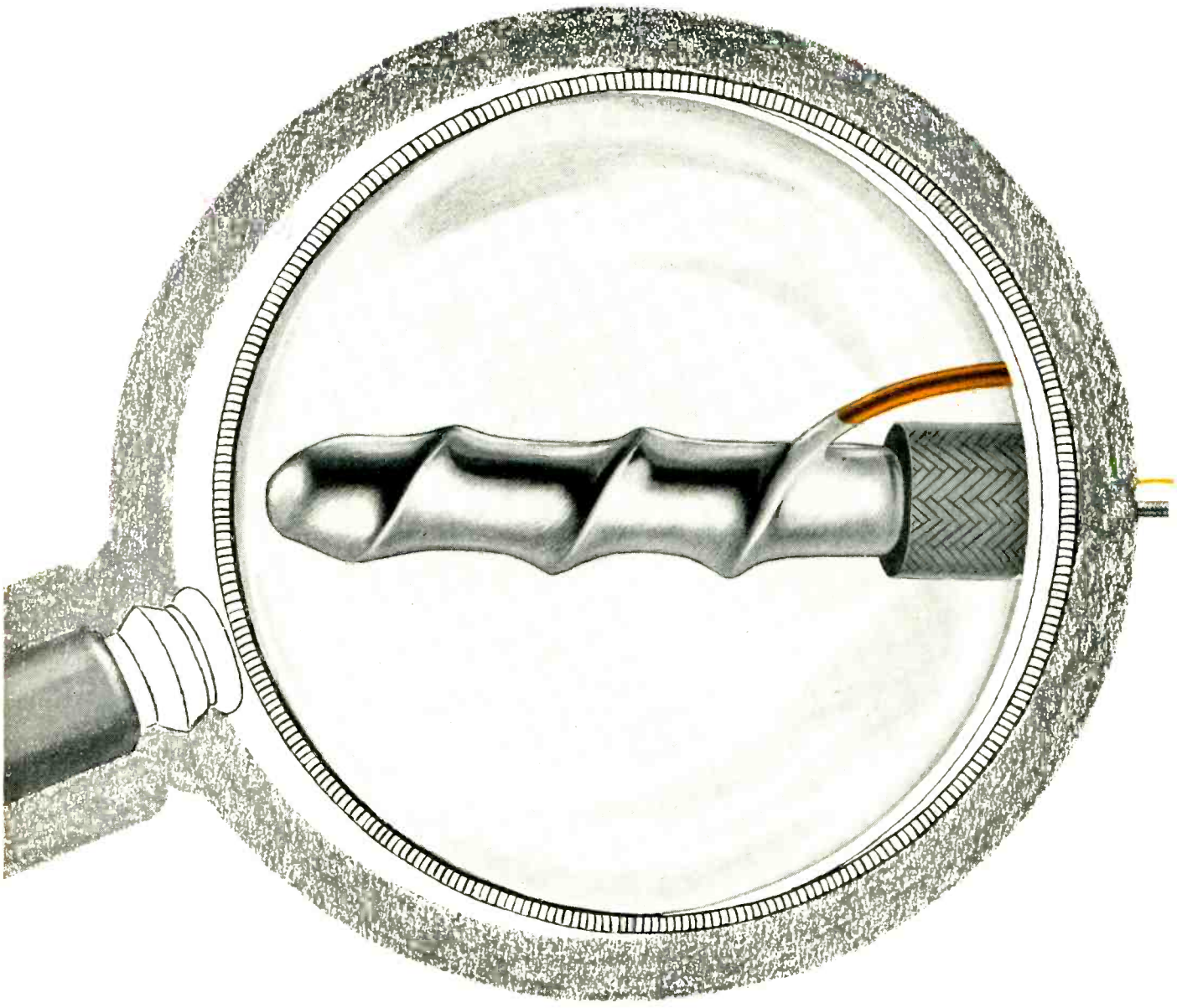
RAYTHEON MANUFACTURING COMPANY

WALTHAM 54, MASSACHUSETTS

PHELPS DODGE SODEREZE®

CUTS



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ENDS STRIPPING, CLEANING— SOLDERING COSTS!

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

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

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

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

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

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

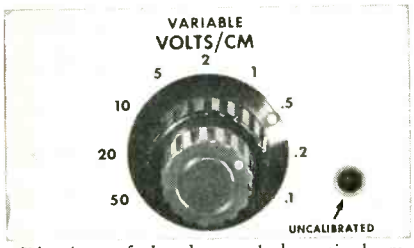
PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA

TECHNICAL DATA on the NEW Type "515"

DC-to-15 MC PASSBAND

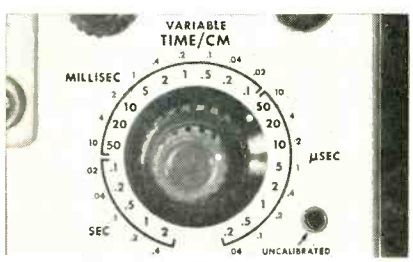
High in performance, but low in size, weight, and cost, the Type 515 fits a relatively new requirement area. Besides its extra capabilities in applications requiring vertical response out to 15 megacycles, it occupies less space and is easier to handle than most other general-purpose laboratory oscilloscopes.



Risetime of the dc-coupled vertical amplifier is less than 23 millimicroseconds. Sensitivity is accurately calibrated, 0.1 v/cm to 50 v/cm in nine steps. A variable control adjusts the sensitivity between calibrated steps and out to 125 v/cm. To help avoid accidental inaccurate readings, a warning light indicates an uncalibrated condition when the variable control is in use. A balanced network delays the signal 0.25 μsec to permit observation of the leading edge of the waveform that triggers the sweep. Direct input capacitance of approximately 36 μμf is reduced to approximately 10 μμf by use of the 10x attenuator probe supplied with the instrument.

SIMPLIFIED SWEEP CONTROL

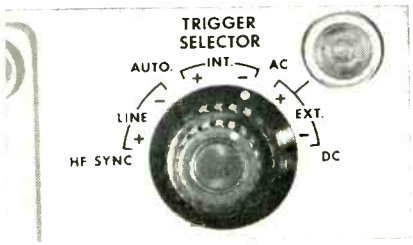
All 22 of the Type 515's accurately calibrated sweeps are selected by the same control knob. This knob also indicates the sweep time-per-centimeter when the 5x magnifier is in use, making mental calculation of time intervals unnecessary. The normal sweep is expanded to 50 centimeters by the magnifier, and the horizontal-position control has sufficient range to display any 10 centimeters of the magnified sweep. To maintain uniform bias on the control grid of the cathode-ray tube for all sweep speeds and repetition rates, the unblanking waveform is dc-coupled.



Calibrated fixed sweeps extend from 0.2 μsec/cm to 2 sec/cm. A variable control makes the sweep range continuous from 0.2 μsec/cm to 6 sec/cm. Here again a warning light indicates an uncalibrated condition when variable control is in use.

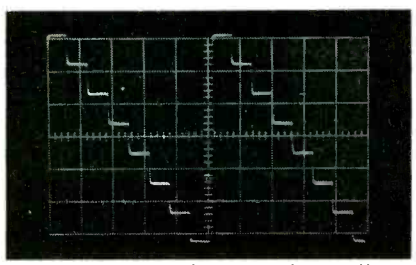
AUTOMATIC TRIGGERING

Automatic triggering is a real convenience in a great many oscilloscope applications. This one position, without further adjustment of the triggering controls, permits signals of widely differing frequencies and amplitudes to initiate the sweep, and provides a reference trace on the screen in the absence of an input signal. The automatic circuit operates at a natural rate of about 50 cycles, but synchronizes readily with incoming signals from 60 cycles to 2 megacycles.



Triggering versatility is one of the many highly-useful qualities of the Type 515. You can trigger the sweep from either the positive or negative slope of an internal, external, or line-voltage signal. On any of these signals, you can trigger the sweep at a selected amplitude level. You select either ac or dc-coupling through the trigger circuitry. You can synchronize the sweep with sine-wave signals up to and beyond 20 megacycles. You can block out the low-frequency component of a composite signal, permitting the high-frequency component to trigger the sweep. These complete triggering facilities make possible a steady display of just about any signal you are likely to encounter.

LARGE DISPLAY AREA



A full 6-centimeter by 10-centimeter linear display can be presented on the screen of the new Tektronix cathode-ray tube, Type T55P, developed especially for this instrument. Characteristics of this new tube help make possible the wide signal-handling range and excellent transient response of the Type 515. Accelerating potential is 4000 volts. A T55P2 is normally supplied, but a P1, P7, or P11 screen is available on request at no extra cost.

PORTABILITY

It's a bit unusual for higher performance to come in an oscilloscope that's smaller and lighter than previous models. But this combination of compactness and performance makes the Type 515 most convenient for those more-exacting field applications. Handling ease and simplified controls are characteristics also desirable in the increasing number of production-line test stations where high performance is a new requirement. The Type 515 weighs only 40 pounds and measures 9¾" wide, 13½" high, 21½" deep.

OTHER CHARACTERISTICS

Many of the other features you'd expect to find in any Tektronix Oscilloscope are part of the Type 515. Square-wave amplitude calibrator, sweep sawtooth and gate available at front panel, illuminated graticule, and electronically-regulated power supply are some of the "standard equipment". New style cabinet with removable sides speeds any maintenance that may be necessary.

TYPE 515 . . . $750

f.o.b. Portland (Beaverton), Oregon

If, from the above description, the Type 515 looks good to you, get in touch with your Tektronix Field Engineer or Representative and let him know you are interested. He'll see that you receive any further information you may need to make your decision.

See and try the Type 515 at the National Electronic Conference in Chicago, Booths 192 and 193.

Tektronix, Inc.

P. O. Box 831, Portland 7, Oregon
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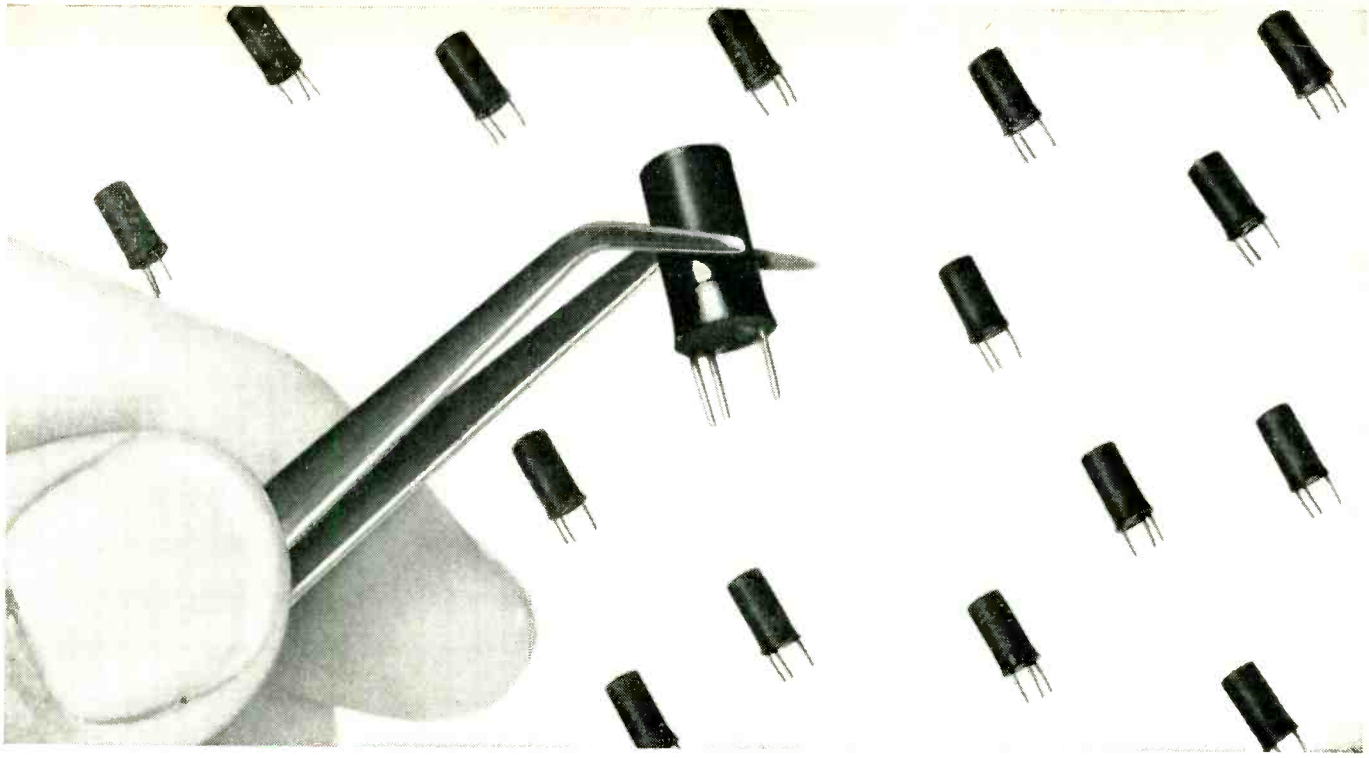
ENGINEERS—interested in furthering the advancement of the oscilloscope? We have openings for men with creative design ability. Please write to Richard Ropiequet, Vice President, Engineering.



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MODEL 1304

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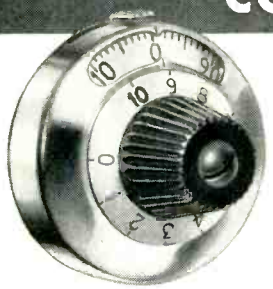
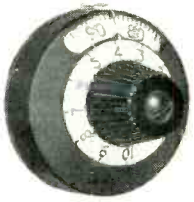


MODEL 1320
Bright Chrome Cover
Satin Chrome Dials

MODEL 1322
Satin Chrome Cover
Satin Chrome Dials

MODEL 1324
Gloss Black Cover
Satin Chrome Dials



MODEL 1326
Dull Black Cover
Satin Chrome Dials

MODEL 1321
Bright Chrome Cover
Gloss Black Dials

MODEL 1323
Satin Chrome Cover
Gloss Black Dials

MODEL 1325
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Gloss Black Dials

MODEL 1327
Dull Black Cover
Dull Black Dials

New finger tip brake (optional) prevents accidental change of setting. Available in 8 attractive, easy-to-read dial and cover combinations. Black Bakelite knobs on all models. 1¾" in diameter. • Easy to read. Turn counting dial clearly distinguishes between tenth turn and zero point. Large increment dial affords maximum separation of graduations for precise reading. Rotation is continuous in either direction. No backlash. Easily installed. Indicates position to an indexed accuracy of 1 part in 1000.

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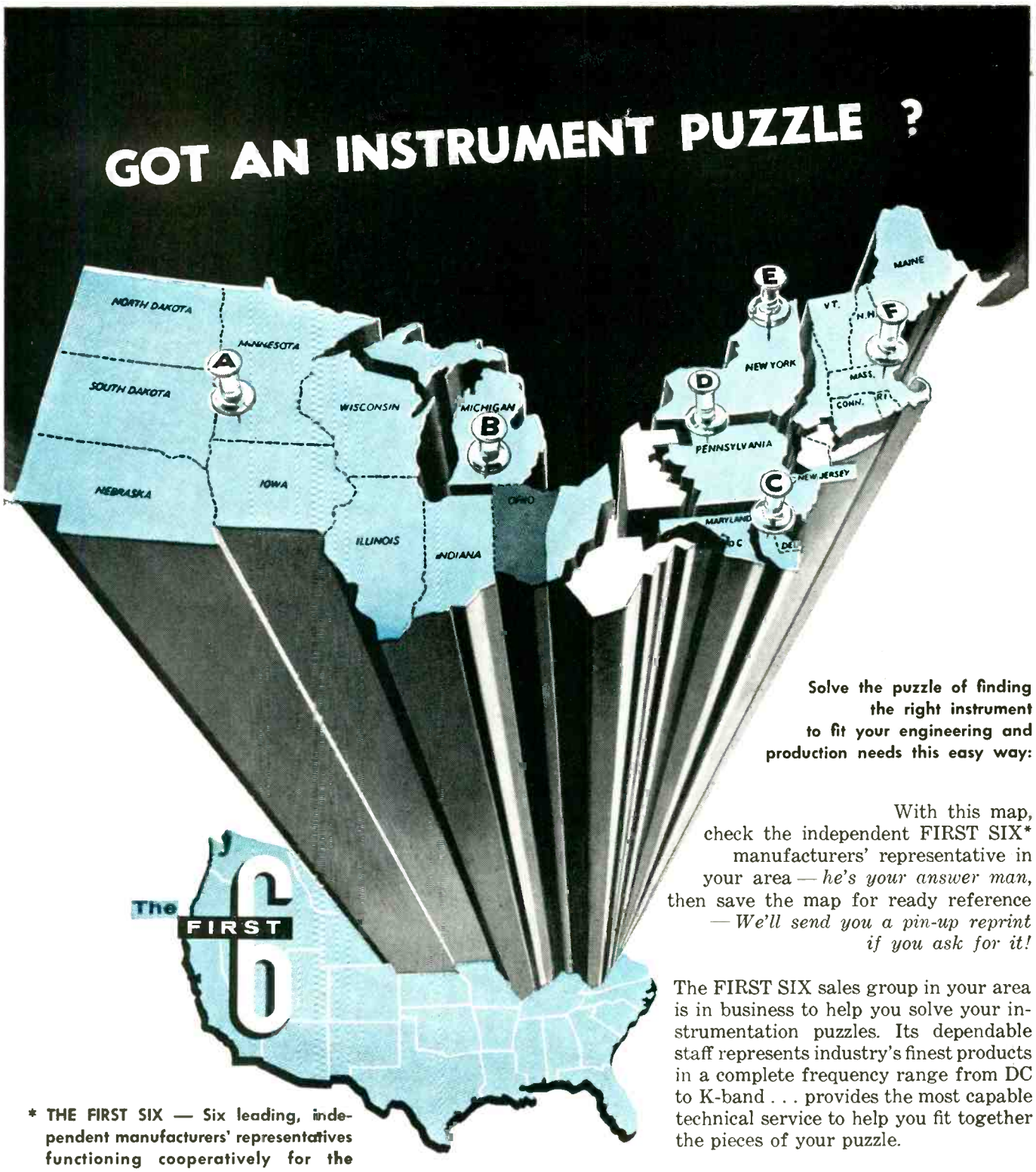

Solve the puzzle of finding the right instrument to fit your engineering and production needs this easy way:

With this map, check the independent FIRST SIX* manufacturers' representative in your area — *he's your answer man,* then save the map for ready reference — *We'll send you a pin-up reprint if you ask for it!*

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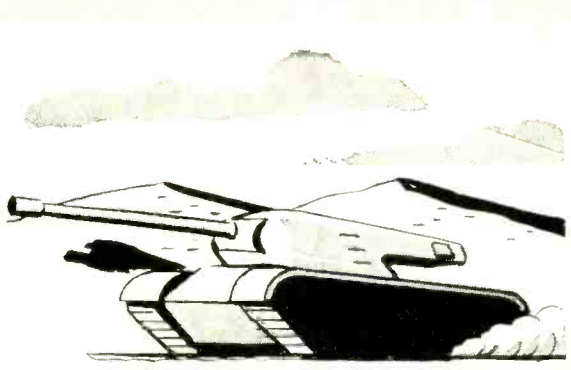
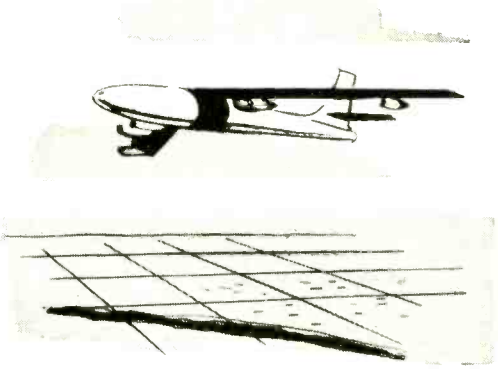
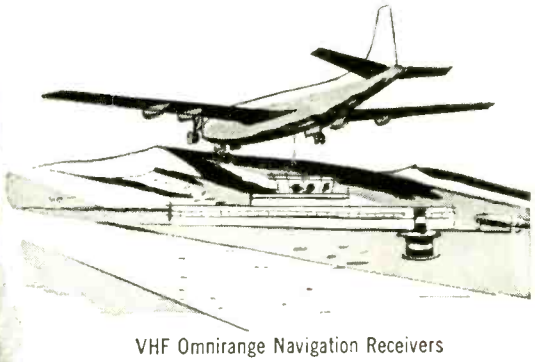


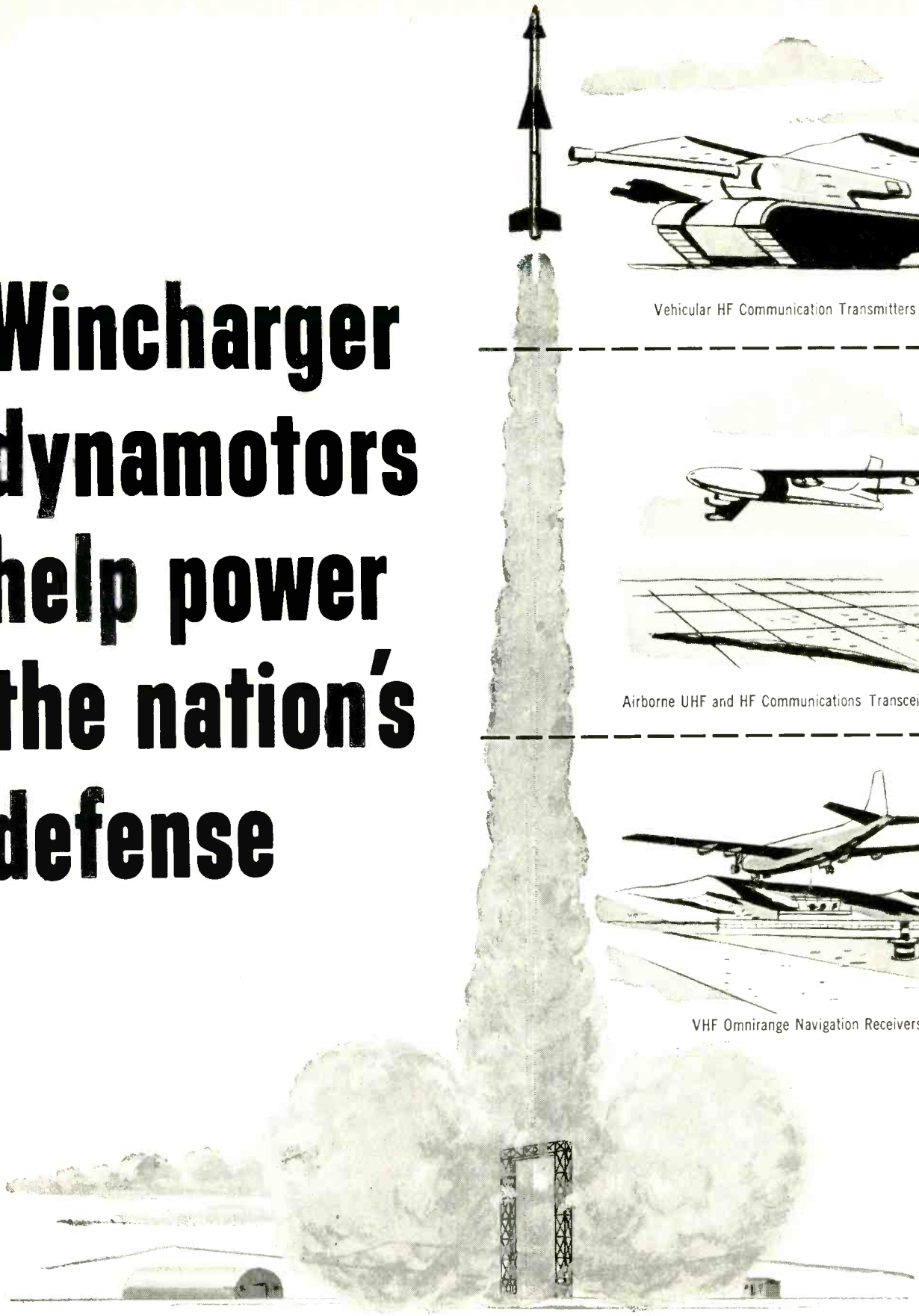
Vehicular HF Communication Transmitters



Airborne UHF and HF Communications Transceivers



VHF Omnirange Navigation Receivers



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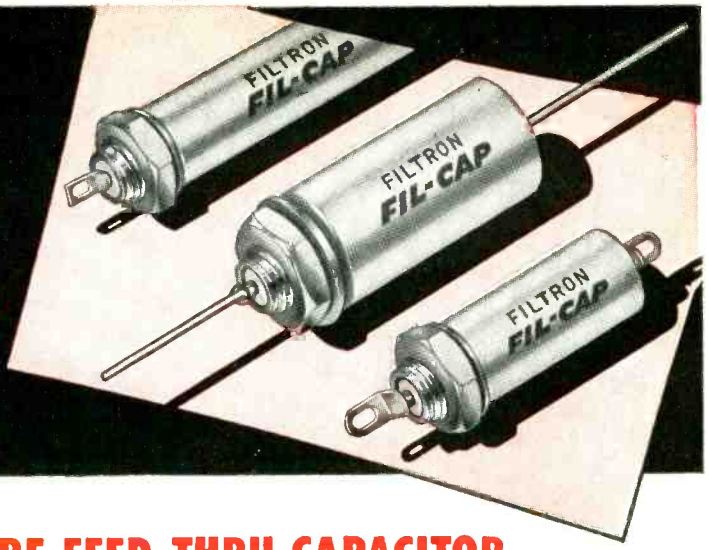
the Difference is INSIDE the FIL-CAP®



FILTRON'S NEWEST SUBMINIATURE FEED-THRU CAPACITOR SETS A NEW STANDARD OF RF ATTENUATION PERFORMANCE

1 For the first time—a complete line, ratings for 5 AMPS & 10 AMPS, continuous duty

2 Advanced internal circuit design . . . specially processed impregnant

3 Meets Spec MIL-C-11693 (proposed) for suppression capacitors

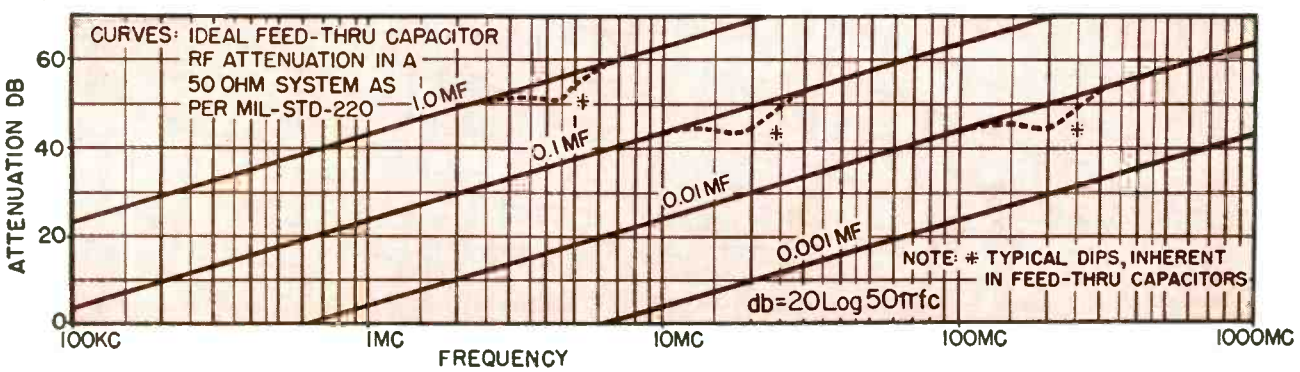
4 Closely matches theoretically ideal attenuation characteristics

An unusual internal circuit arrangement, precision mechanical components, and a specially processed silicone impregnant combine to afford outstanding electrical characteristics and stability—unobtainable in conventional feed-thru capacitors ordinarily used for interference suppression in electronic equipment.

Basically, FIL-CAPS are a four-terminal network inserted in the current-carrying line. The power line to be filtered must be broken, and each end connected to an insulated terminal of the capacitor. The feed-thru ground-plane mounting prevents mutual impedances between input and output terminals. The FIL-CAP design includes compression glass insulated terminals, and milled flats on the threaded mounting neck, to prevent rotation during installation and under service conditions.

Type FV is rated for 5 amps AC-DC continuous operation, and Type FX is for 10 amps AC-DC continuous operation. Both types are available in operating voltages of 100, 200, 300, 400 and 600 volts DC; 125 and 250 volts AC; 0 to 400 cycles.

All FIL-CAP subminiature feed-thru capacitors are 100% tested and inspected before shipment.



If your requirements call for greater attenuation than is obtainable with feed-thru capacitors, Filtron also manufactures a complete line of RF interference filters. More than 5000 filter types are offered for military, industrial, nuclear and commercial applications. Filtron is the world's largest manufacturer of RF interference filters. Details and literature furnished on request.

For complete engineering data and installation diagram, ask for Filtron Catalog FV, and FV Supplement for FIL-CAP equivalents to MIL-C-11693 military designations.

Main Plant, Flushing, New York

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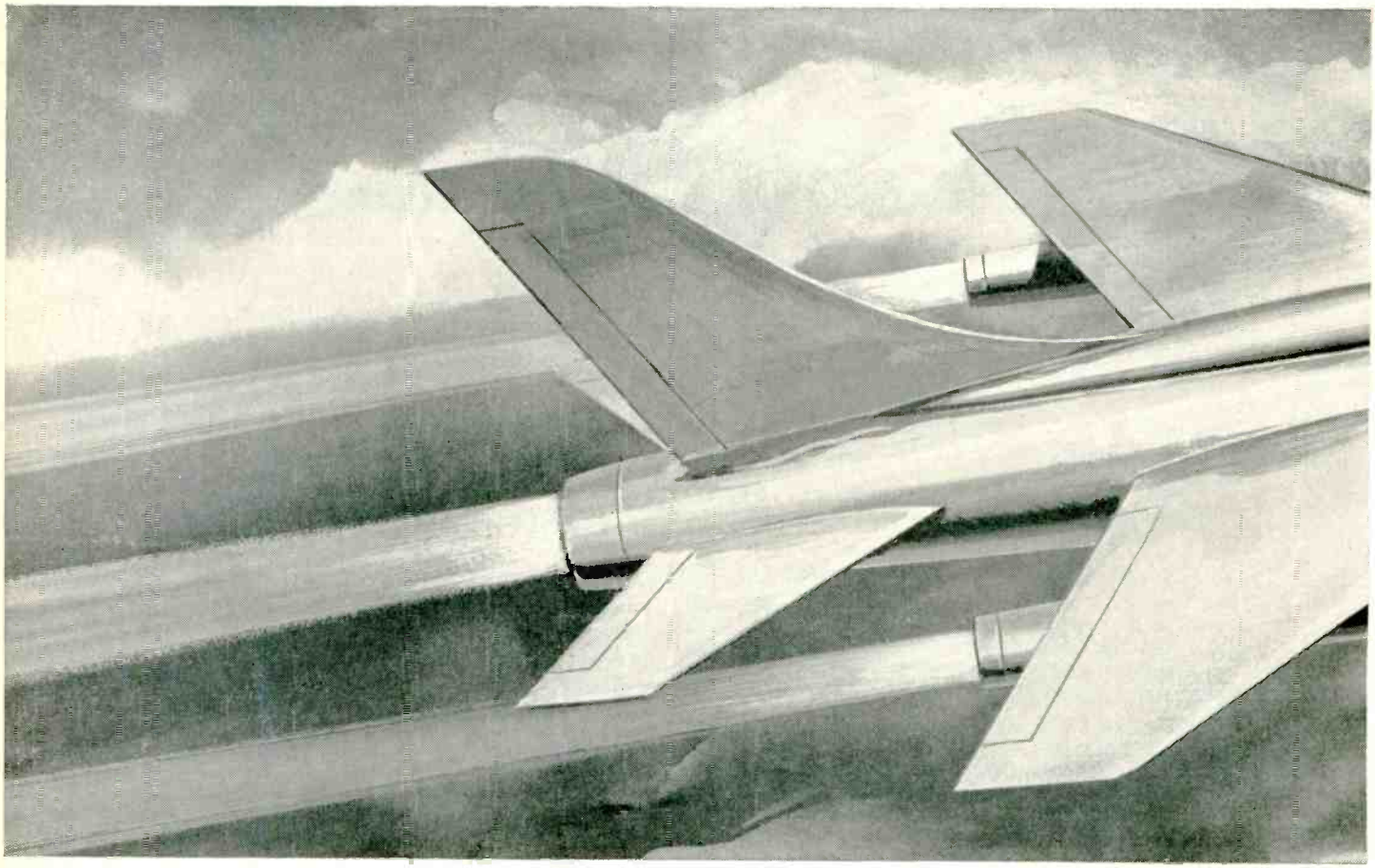
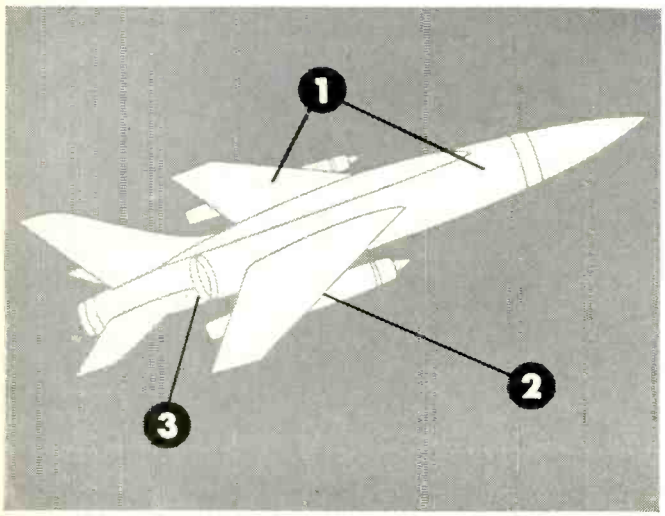
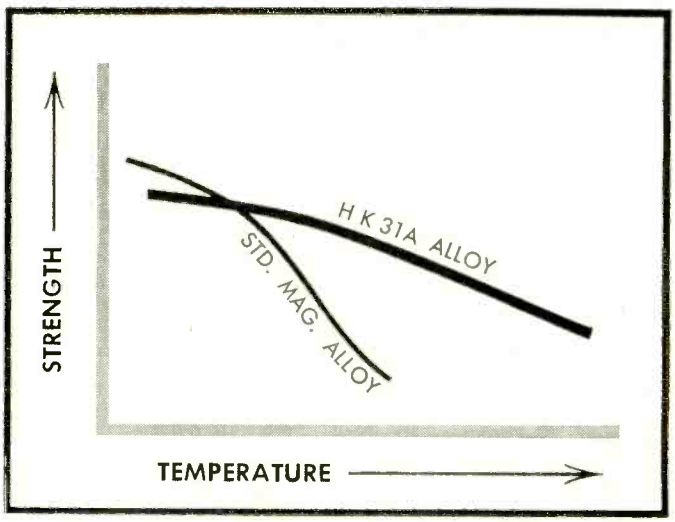
PLANTS IN FLUSHING, NEW YORK, AND CULVER CITY, CALIFORNIA

NEW DOW MAGNESIUM ALLOYS





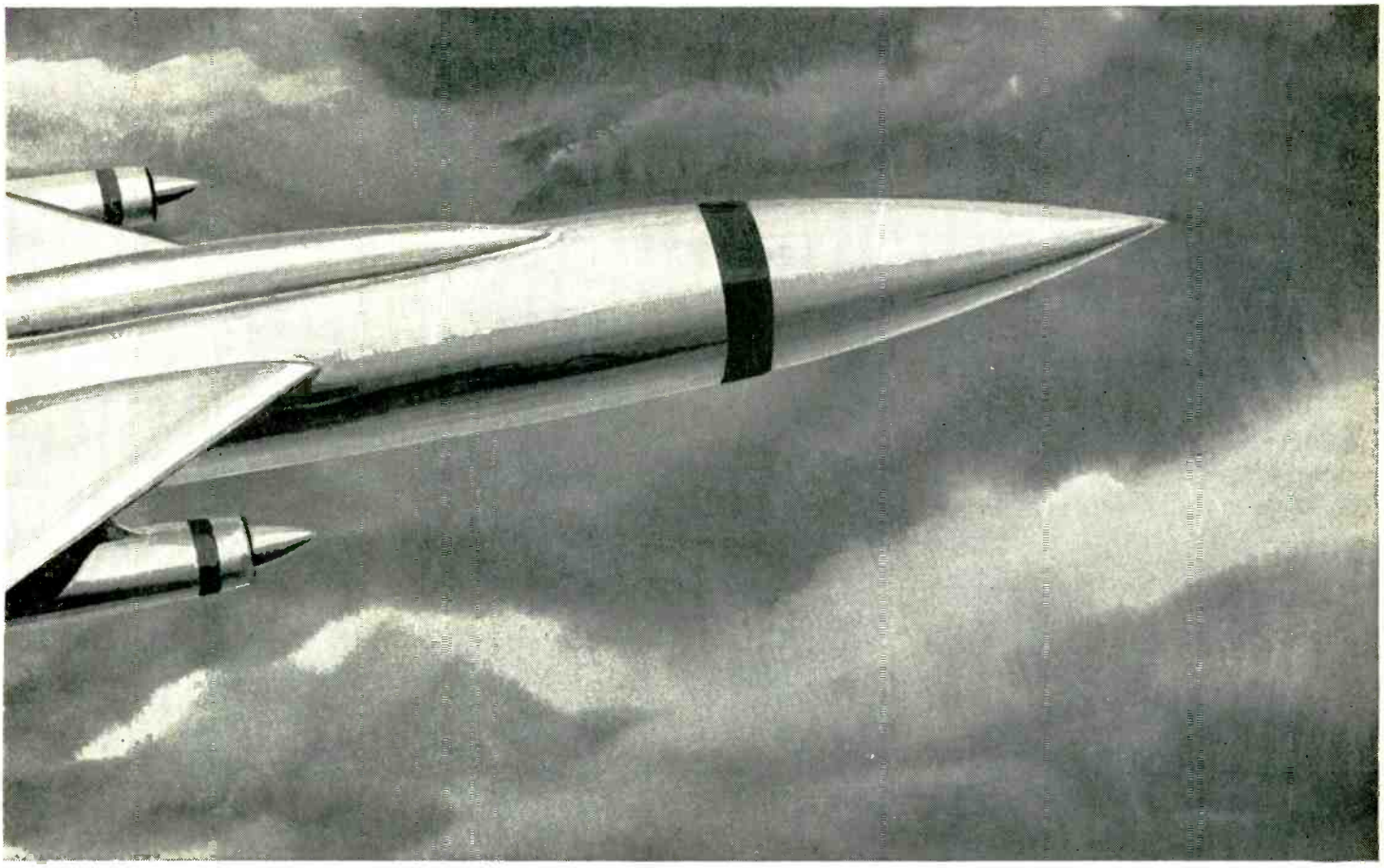
Now suggested *for a broad range of uses in missiles and aircraft, the new Dow magnesium alloys are available in the form of (1) sheet or plate, (2) extrusions, (3) castings.*



Maintenance of strength *at high temperatures is illustrated by this chart. Performance data on the new alloys at elevated temperatures can be obtained by request.*

DOW

CRACK HEAT BARRIER!



High temperature magnesium alloys are available to lighten aircraft and missile structures

Once again the horizons for aircraft structural design have been widened. Dow has developed a series of high temperature magnesium alloys which are already in pre-production use on aircraft, missile and engine structures. These alloys show advantages at temperatures up to 700° F. Limited test data on properties up to 800° F. are available for some of these alloys.

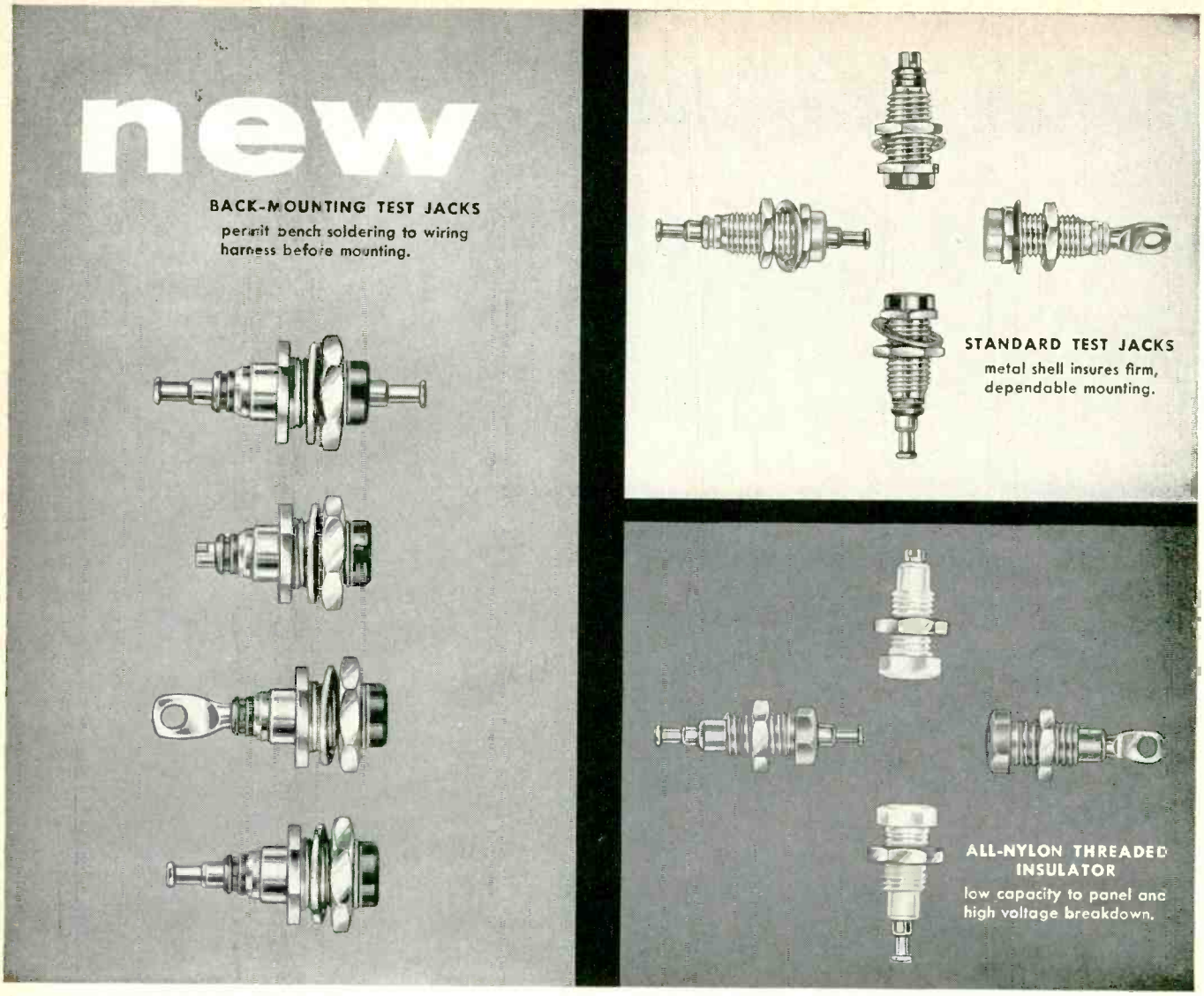
The new alloys save precious pounds because of their good combination of modulus and properties, including creep strength, at temperature. Shop characteristics include good formability and weldability.

One of the available alloys is the magnesium-thorium composition, HK31A, which is manufactured in rolled and cast form. Under development is a similar alloy for extruded shapes and forgings. HK31A sheet and plate are available from stock and from current mill delivery schedules in standard sizes from 0.016″ to 2″.

These new magnesium alloys by Dow should be considered for your high temperature requirements. Contact your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, Magnesium Sales Dept., MA 361JJ, Midland, Michigan.

you can depend on DOW MAGNESIUM

DOW



Test Jacks by Ucinite

The introduction of Ucinite's back-mounting jacks makes available for the first time a *complete* line of *high quality* test jacks suitable for use in equipment where long life and dependability are essential.

Ucinite Test Jacks, designed for standard .080 phone tips, are available in a variety of colors ideally suited to coded application. Silver-plated, heat treated beryllium copper contact is made in one piece with large terminal ends for easy soldering. The feed through type is provided with a one-piece brass terminal stud, tin-plated.

The specialized abilities and experience of Ucinite's own staff of design engineers are available for work on new and unusual problems. Volume production facilities ensure fulfillment of the largest requirements.

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

ELECTRICAL ASSEMBLIES
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RADIO AND AUTOMOTIVE

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

Specialists in Electrical Assemblies, Radio and Automotive

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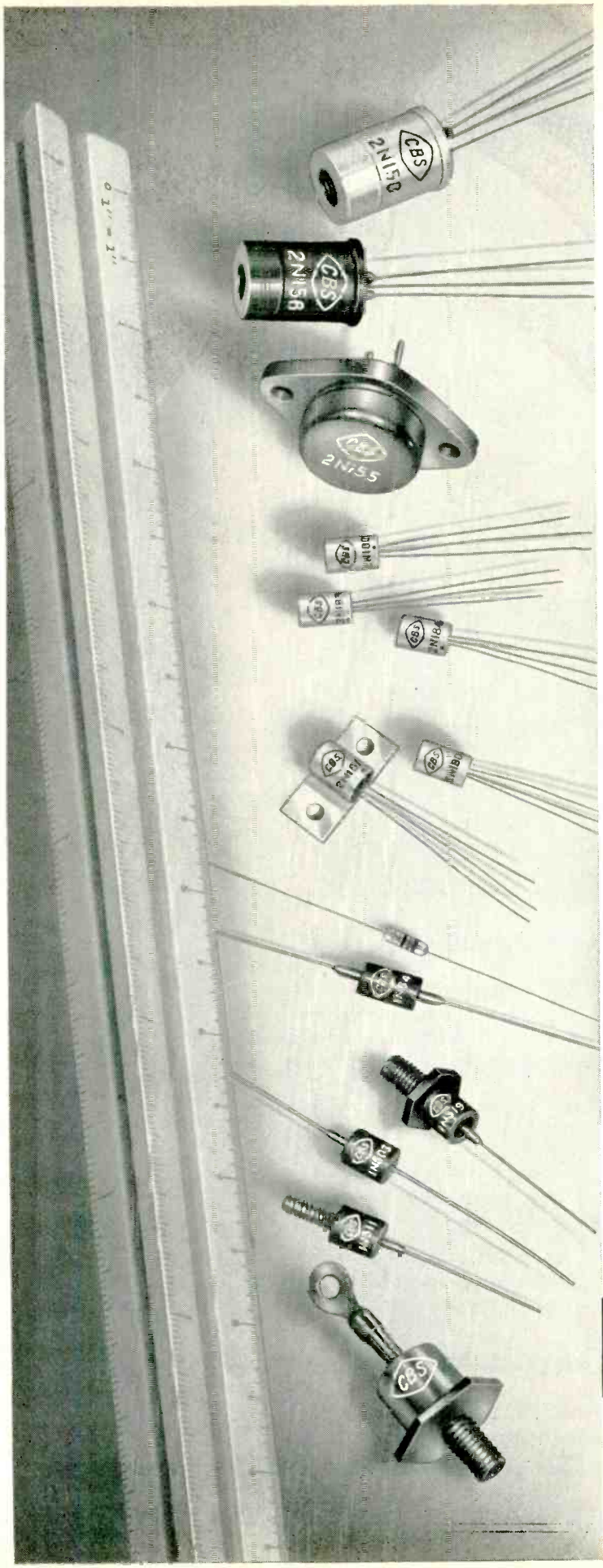


growing line of CBS semiconductors features uniformity and reliability

Users rate the rapidly expanding line of CBS semiconductors as "exceptionally uniform and reliable." They have also discovered that CBS' mass production insures dependable delivery and competitive prices. You, too, will prefer advance-engineered CBS semiconductors. Write for data and quotation on the types you need.

Power Transistors Popular auto-radio type 2N155. General-purpose 2N156 (12-volt) and 2N158 (28-volt). And *new higher-power and higher-voltage versions* for larger audio output systems and power supplies.

High-Frequency Transistors Uniform and reliable performance up to 20 mc. CBS 2N182, 2N183, 2N184 are NPN symmetrical, permitting unusual applications.

General-Purpose Transistors CBS 2N180 and 2N181 are noted for outstanding dependability. Integral C-clamp mounting of 2N181 permits dissipation up to 250 mw.

Diodes A complete line from one source: Glass . . . plastic . . . point-contact . . . bonded-junction . . . entertainment . . . general-purpose . . . and computer.

Silicon Power Rectifiers Series 1N503-1N508 rated at ½ amp . . . 1N511-1N516 at 1 amp . . . 1N519-1N524 at 1¼ amp. Also *a new much higher-current series* for heavy-duty power supplies.

Reliable products
through Advanced-Engineering

CBS semiconductors

CBS-HYTRON
Semiconductor Products, Lowell, Mass.
A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

Want more information? Use post card on last page.

New Grant 3400 *thinslide*

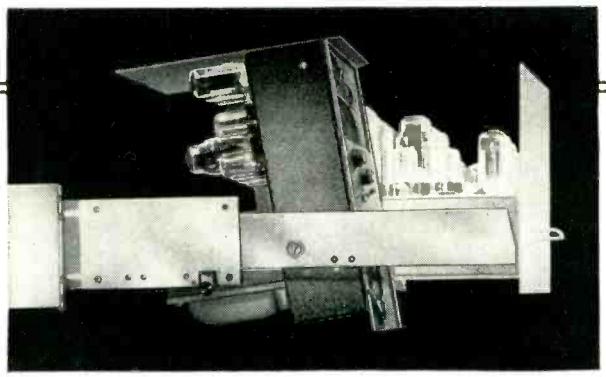
mounts standard 17" chassis in standard 18" rack or cabinets

REQUIRES ONLY 19/64" SPACE PER SIDE—

YET HAS

FULL ROLLER ACTION

(fits RETMA *rack hole spacing)*



The Grant 3400 Thinslide requires only 19/64" space per side—installs readily in standard racks and cabinets. Allows instant access to chassis measuring from 10" to 16" deep. Tilts through 100° for under-chassis servicing. Positive lock in "out" position. Lock has finger-tip release for instant return or removal of chassis. Eight hardened steel rollers carry the rated load of 100 lbs. smoothly and easily—durability insures frictionless rolling for thousands of cycles of use.

Slide mounting not only provides for quick access—it usually eliminates need for rear access doors and rear aisles—a very important saving of space.

The Grant 3400 is a versatile slide, suited for use in your *product*, in *plant equipment*, *prototype* and *breadboard* work, and in *production line or field test equipment*. Very moderate cost allows a wide range of applications in original equipment.

Write today for Grant 3400 Thinslide Technical Bulletin—contains full data and specifications.

Grant INDUSTRIAL SLIDES

Grant Pulley and Hardware Corporation

factories: **31-73 Whitestone Parkway, Flushing 54, N. Y.**
944 Long Beach Avenue, Los Angeles 21, Calif.

NOW. . . custom designs available in volume!

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HIGH TEMPERATURE METAL-CERAMIC SEALS

Outstanding results over wider temperature/frequency ranges. Available for silver solder brazing, hard or soft solder. Rapid, volume delivery of both custom and standard designs from greatly expanded production facilities.

Dependable, permanent bonding . . . close dimensional tolerances . . . strong Alumina ceramics with extremely low dielectric loss . . . excellent insulation resistance . . . high softening temperature . . . outstanding mechanical and electrical characteristics over entire temperature range . . . improved glaze with superior surface resistivity . . . high tensile and impact strengths . . . greater resistance to chipping and spalling.

To assure optimum performance, American Lava engineers cooperate in establishing proper specifications and configurations on custom designs.

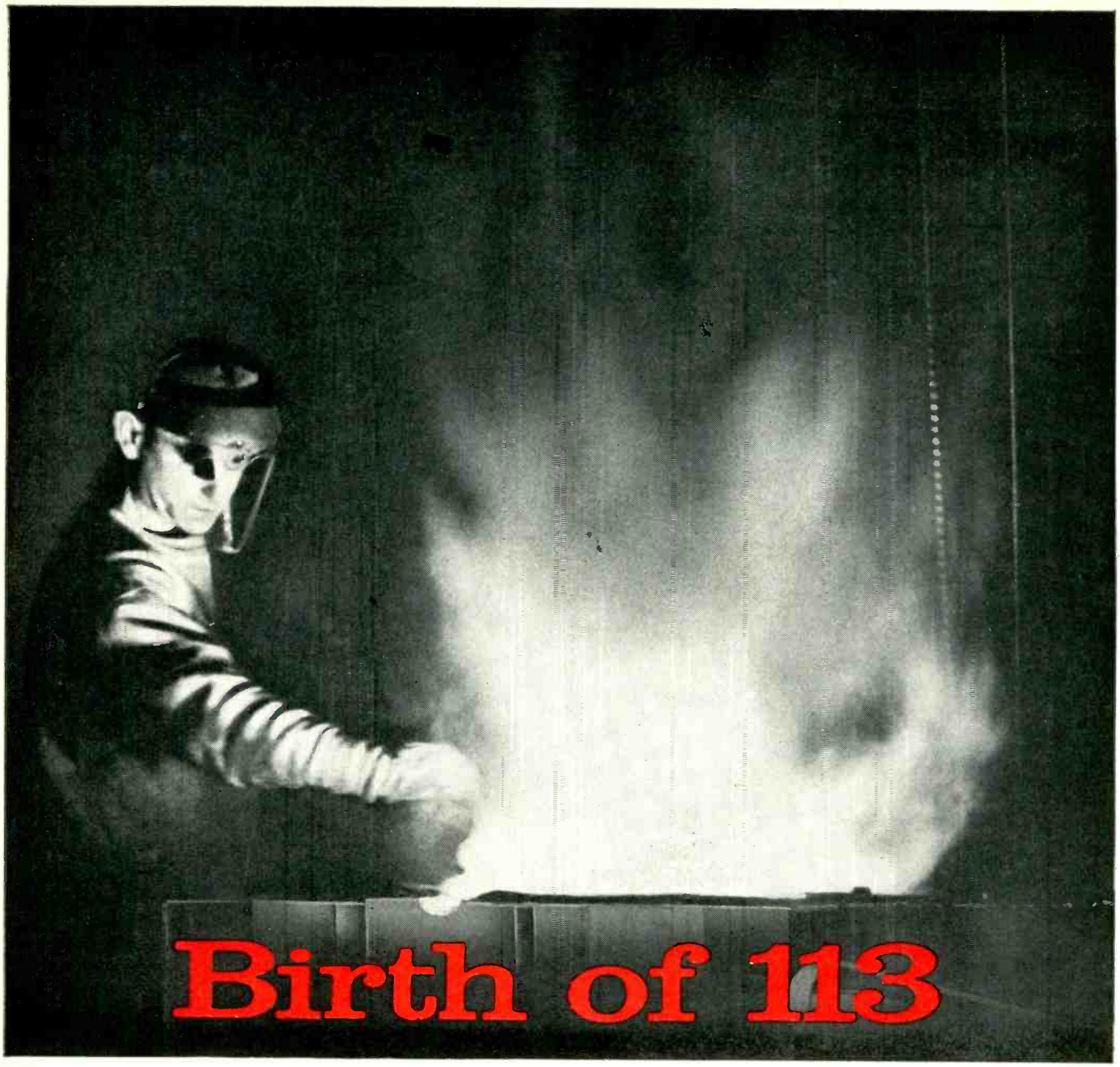
For complete information on AlSiMag Metal-Ceramic Seals for your application—in either high or low temperature fields—send blueprint with your planned installation and operating temperatures, electrical requirements or other pertinent data.

A Subsidiary of Minnesota Mining and Manufacturing Company

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
55TH YEAR OF CERAMIC LEADERSHIP

For service, contact Minnesota Mining & Manufacturing Co. Offices in these cities (see your local telephone directory): Atlanta, Ga. • Boston: Newton Center, Mass. • Buffalo, N. Y. • Chicago, Ill. • Cincinnati, O. • Cleveland, O. • Dallas, Texas • Detroit, Mich. • High Point, N. C. • Los Angeles, Calif. • New York: Ridgefield, N. J. • Philadelphia, Pa. • Pittsburgh, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Calif. • Seattle, Wash. **Canada:** Minnesota Mining & Manufacturing of Canada, Ltd., P. O. Box 757, London, Ont. **All other export:** Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.



At this stage, #113 is just a number. If all proceeds as planned, it will shortly acquire a name — the name of Driver-Harris's newest special-purpose alloy . . . made, as always, to meet the needs of a specific manufacturer.

When someone asks us for an alloy we do not have, we try to make it. Usually we succeed. To date we have succeeded 112 times. Many of our long line of electrical, electronic, and heat-resistant alloys — Nichrome*, Nichrome* V, Advance*, Karma*, Manganin, Nilvar*, and the rest — are today famous names in industry the world over. And each of these was originally custom-made . . . produced exactly to the specifications of someone who needed it.

Are you in need of an alloy with special properties, not yet available? Put your specifications in our hands. You will gain the benefit of the 57 years of experience which has developed the largest variety of alloys ever made by any one company.

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

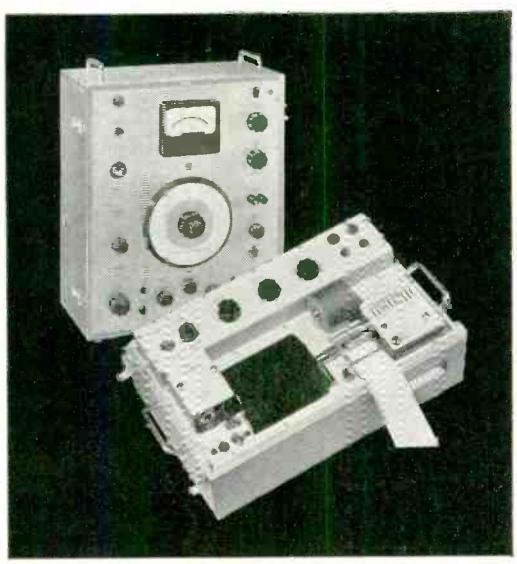
Driver-Harris COMPANY HARRISON, NEW JERSEY

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

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

BRUSH . . . *complete systems for noise or vibration measurement*

Records noise output of guided missile vacuum tubes



Brush–B & K Beat Frequency Oscillator BL-1014 and Level Recorder BL-2304 are used at Raytheon in development and production tests.

Electrical noise developed when a vacuum tube is subjected to mechanical shock and vibration affects missile performance—thus must be held within close limits to meet military requirements.

In this test setup, Raytheon Manufacturing Co. vibrates vacuum tubes by using a Brush–B & K beat frequency oscillator to supply a swept signal to a shaker table. Then a level recorder provides a chart of the tube noise output vs. frequency, at vibrations up to 5,000 cps, with accelerations up to 15G. Test results help to evaluate new designs, and aid in controlling noise output in production tubes.

This application of Brush – B & K equipment is typical of environmental testing by manufacturers and users of electronic components and complete assemblies. For a complete line of instrumentation to simplify your sound, vibration or strain measurements, call your Brush Representative now for application assistance or write for a brochure.

For complete information write Dept. K-99.

BRUSH ELECTRONICS COMPANY
3405 Perkins Avenue, Cleveland 14, Ohio
DIVISION OF CLEVITE CORPORATION

Want more information? Use post card on last page.

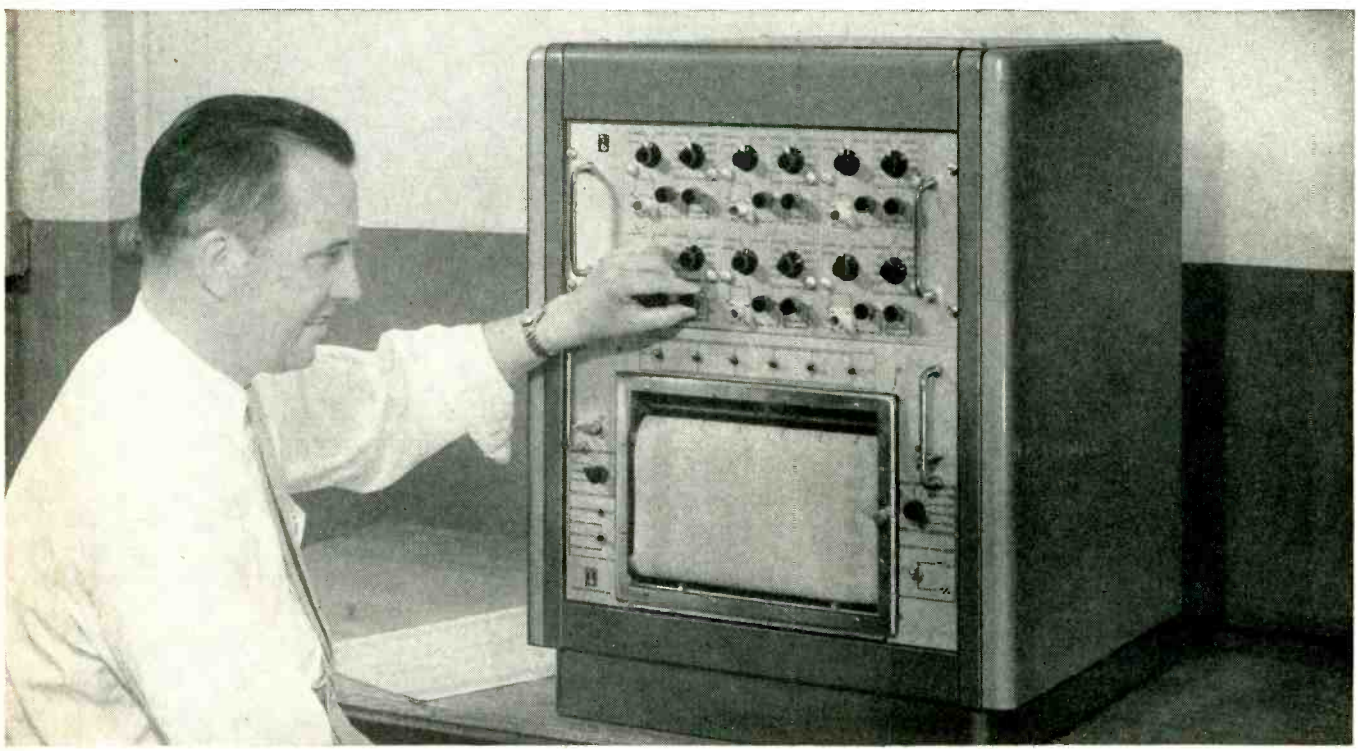
New instrumentation by Brush...

The new Brush amplifier permits more compact, flexible, multi-channel recording systems. Six completely interchangeable plug-in d.c. amplifier sections, plus power supply, plus a six-channel oscillograph, can now be mounted in a bench-top console only 29½ inches high.

The new design offers these outstanding features:

- *Measurement range from 0.050 to 400 volts*
- *Excellent zero line stability*
- *A unique internal calibration system*
- *Frequency response d.c. — 100 cycles*

Brush Recording Systems incorporating these new amplifiers are ideal for applications such as computer readout. Call your Brush representative or write for complete information.

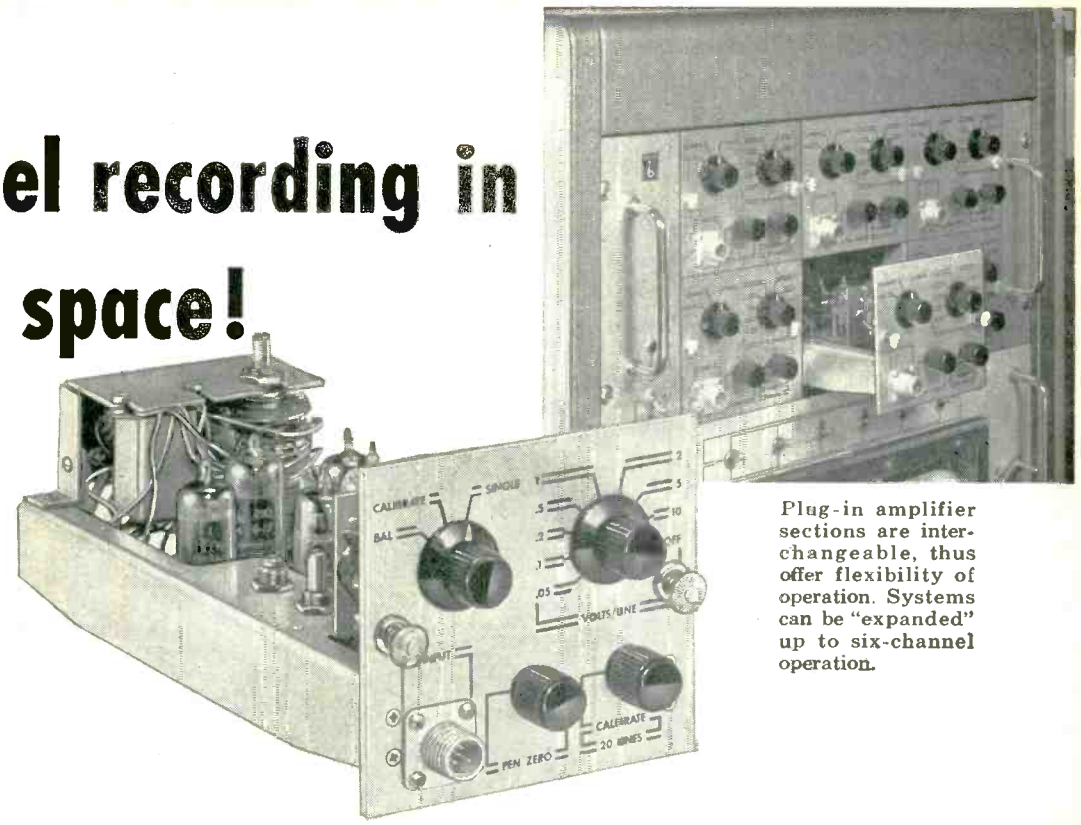


29½-inch console with new amplifiers contains complete six-channel recording system. New amplifiers take only *one-half* the space required by conventional units.

FOR COMPLETE INFORMATION

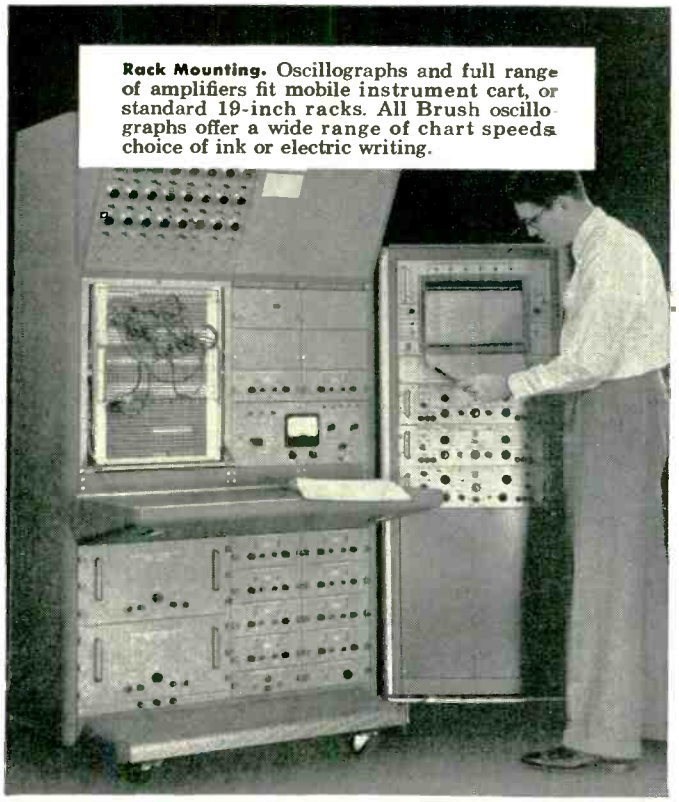
Write Dept. K-9:
Brush Electronics Company
3405 Perkins Avenue
Cleveland 14, Ohio

6-channel recording in far less space!

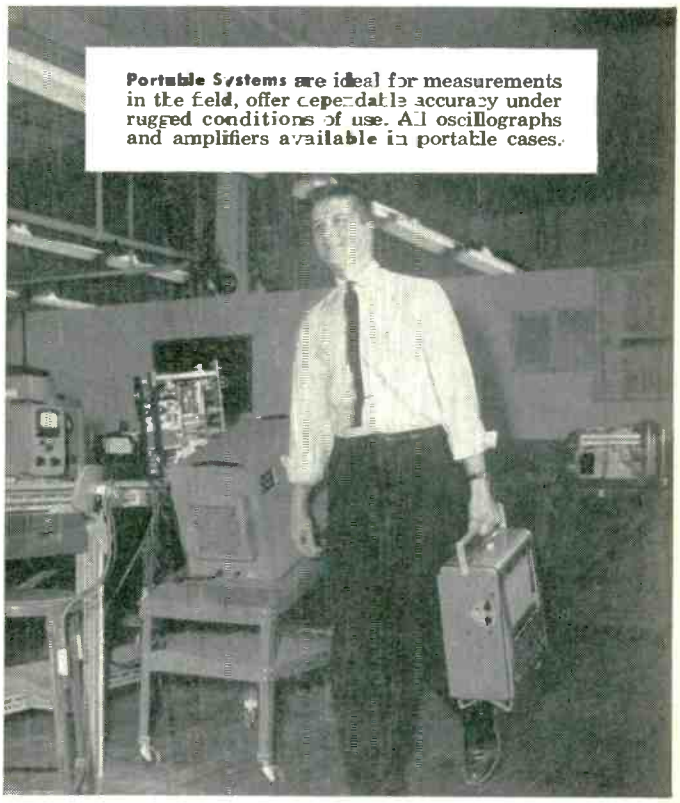


Plug-in amplifier sections are interchangeable, thus offer flexibility of operation. Systems can be "expanded" up to six-channel operation.

BRUSH SYSTEMS MEET ALL RECORDING REQUIREMENTS



Rack Mounting. Oscillographs and full range of amplifiers fit mobile instrument cart, or standard 19-inch racks. All Brush oscillographs offer a wide range of chart speeds choice of ink or electric writing.



Portable Systems are ideal for measurements in the field, offer dependable accuracy under rugged conditions of use. All oscillographs and amplifiers available in portable cases.

BRUSH ELECTRONICS COMPANY
3405 Perkins Avenue, Cleveland 14, Ohio

BRUSH 6 ELECTRONICS

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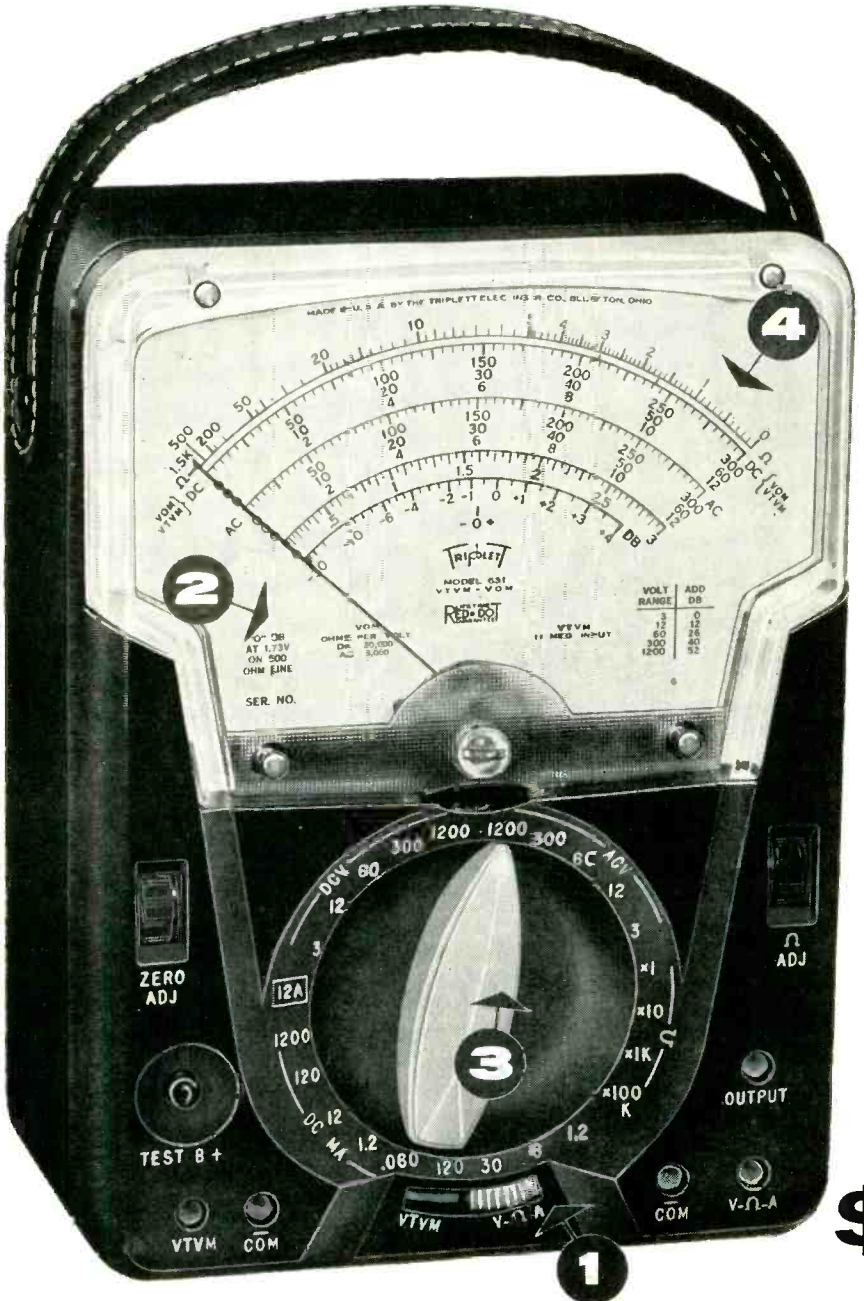
a VOM ...plus a VTVM when you need it.

DOUBLE USE...HALF THE PRICE

TRIPLETT MODEL 631—In one year accepted as the standard COMBINATION VOM-VTVM



Battery operated

1 Just flip the switch.

2 Standard sensitivities as used in servicing manuals.

3 34 ranges—with the famous Triplett single knob control.

4 Extra long scales —unobstructed visibility.

$59.50

By using the Volt-Ohm-Mil-Ammeter for all general testing (90% of your testing) and the Vacuum Tube Voltmeter only when you need it, you have the advantage of a VTVM with extremely long battery life. Batteries are used only about one-tenth as much as in the ordinary battery-operated VTVM. Features: Ohms, 0-1500-15,000 (6.8-68 center scale. First division is 0.1 ohm.)

Megohms: 0-1.5-150 (6,800-680,000 ohms center scale.) Galvanometer center mark "—0+" for discriminator alignment.

RF Probe permits measurements up to 250 MC. $7.00 net extra.

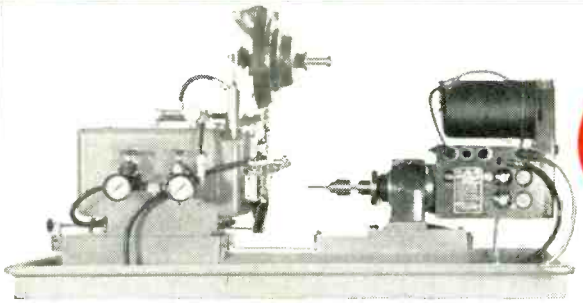
Featured by leading electronic parts distributors everywhere.

TRIPLETT

TRIPLETT ELECTRICAL INSTRUMENT COMPANY • 52 years of experience • BLUFFTON, OHIO

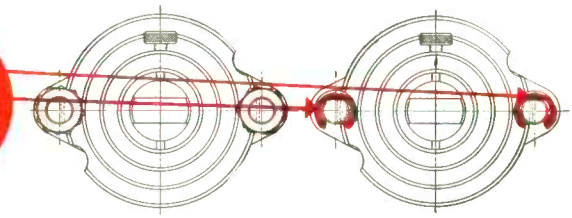
Triplett design and development facilities are available for your special requirements for meters and test equipment.

Waldes Truarc Retaining Rings Eliminate Machining and Parts—Cut Assembly Time on Drill and Tapper



Beco Model 410 Drill and Tapper

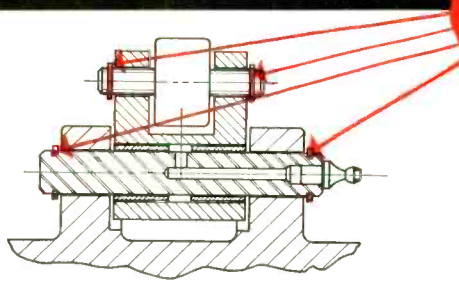
The Batchelder Engineering Co., Inc., Springfield, Vermont uses 4 different sizes of 2 different type Waldes Truarc rings in their new BECO Model 410 Automatic Drill and Tapper. Truarc rings speed assembly, reduce machining, improve design.



ALTERNATE DESIGN TRUARC DESIGN

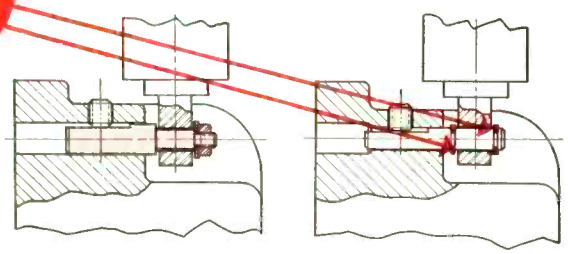
Clamp Cylinder Rod Stop Assembly

Truarc "E" Rings (Series 5133) replace stop nuts in the Clamp Cylinder assembly. They eliminate need for threading 2 rods ...the danger of cross-threading nuts...and costly rejects. Truarc Rings cut assembly time and cost.



Bell Crank Pivot Assembly

Truarc Rings (Series 5100) in Bell Crank Pivot assembly permit grease hole not possible with cotter pin fastener. Use of nuts would have increased machining and assembly costs considerably.



ALTERNATE DESIGN TRUARC DESIGN

Hopper Cylinder Anchor Pin Assembly

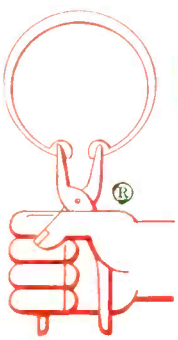
2 Truarc Rings (Series 5100) secure and position end of vertical air cylinder. Rings eliminate extra cost of machining 3-diameter pin, threading and undercutting...plus nut and washer. Assembly is quick and sure.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

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



WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC.
47-16 AUSTEL PLACE, L. I. C. 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N.Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
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E098

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

New! Low Cost! Wideband!

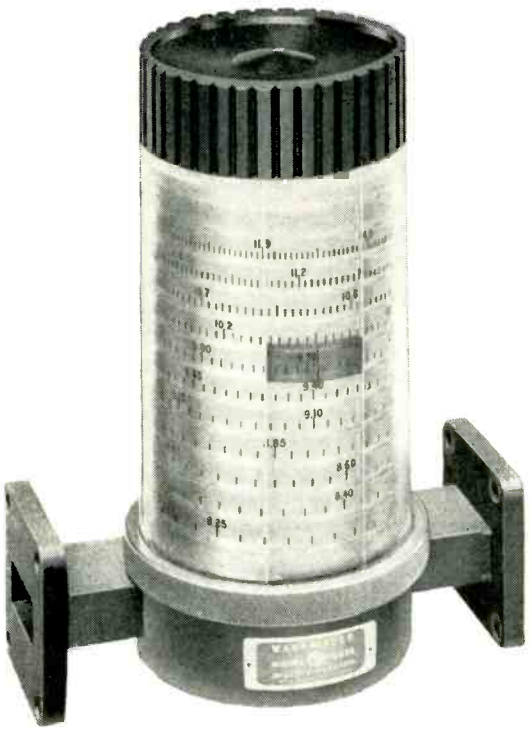
DIRECT READING

X-BAND FREQUENCY METER

Check the specifications and see if you don't agree the new *-hp-* X532A is the best value in commercial X-band frequency meters offered today.

The instrument comprises a special waveguide section mounting a high Q resonant cavity tuned by a choke plunger. No sliding contacts are used, and the waveguide section is arranged to transmit virtually full power at resonance. Resonance is indicated by a 1.5 db dip in output and is constant throughout range without spurious modes. Tuning is by a precision lead screw, spring-loaded to prevent backlash. Effective length of the spiral scale is approximately 77" with calibration in 5 MC increments. Frequency is read directly with accuracy 0.08%. No interpolation or charts required.

Model X532A is of quality construction throughout and is moderately priced. *-hp-* 532 series precision frequency meters for other waveguide bands will be announced shortly.



-hp- X532A Frequency Meter

SPECIFICATIONS

Frequency Coverage:	**8.2 to 12.4 KMC**
Accuracy:	**0.08 %**
Resettability:	**0.01 %**
Backlash:	**0.005 %**
Q:	**8,000 approximately**
Dip:	**1.5 db approximately**
Weight:	**3½ pounds**
Price:	**$125.00 f.o.b. factory**

See the hp general catalog for a com

Which of these additional hp waveguide elements can speed and simplify *your* present project?

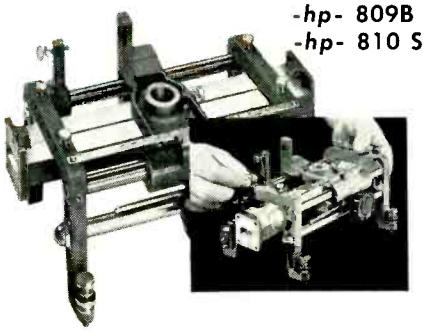
-hp- X365A X-BAND ISOLATOR

Truly broad band—covers 8.2 to 12.4 KMC, offers almost flat rejection full range. Min. reverse attenuation 25 db. Max. forward attenuation 1.5 db. Max. SWR 1.2; Max. power dissipation 5 watts. $225.00.

-hp- 382A PRECISION ATTENUATOR

Broad band attenuation to 50 db. Completely independent of frequency. Phase shift constant all attenuations. Calibrated range 0 to 50 db, maximum error ±2% of db reading. SWR less than 1.15 full range. G, J, H, X and P bands. $500.00 to $250.00.

-hp- 809B PROBE CARRIAGE
-hp- 810 SLOTTED SECTIONS



Convenient, all-purpose *-hp-* 809B carriage operates with six different *-hp-* slotted sections, waveguide and coaxial. Mounts sections covering frequencies 3 to 18 KMC; *sections interchange in 30 seconds!* Precision-built carriage calibrated in mm to 0.1 mm; dial gauge may be mounted. Operates with *-hp-* 442B Broad Band Probe and *-hp-* 440A Coaxial Detector in combination; or with *-hp-* 444A Untuned Probe. *-hp-* 809B, $160.00.

-hp- 810A/B Slotted Sections. -hp- 810B, for mounting in 809B carriage. Flanged waveguide section with accurately machined slot tapered at ends to minimize reflection. Available in 5 waveguide bands, 3.95 through 18 KMC. *-hp- S810A,* complete slotted section assembly including probe carriage, for S-band only, $450.00. *-hp-* 810B (G, J, H, X and P bands) $90.00.

-hp- 752 MULTI-HOLE COUPLER

Directional couplers available in 3 models with coupling factors of 3, 10 and 20 db ±0.7 db over full range of waveguide. SWR better than 1.05. Directivity 40 db or better full range. Available in S, G, J, H, X, P, K and R bands. $375.00 to $75.00.

-hp- 420A/B CRYSTAL DETECTORS

Employs a silicon crystal to detect rf signals in Type N coaxial line. Covers frequencies 10 MC to 12.5 KMC. Model 420B, for reflectometer measurements, $75.00. Model 420A, $50.00 (Latter uses modified 1N26 crystal.)

-hp- 477B COAX THERMISTOR MOUNT

For fast, accurate power measurements, 10 MC to 10 KMC. SWR less than 1.5. Thermistor element is 200 ohm negative. $75.00 (including thermistor).

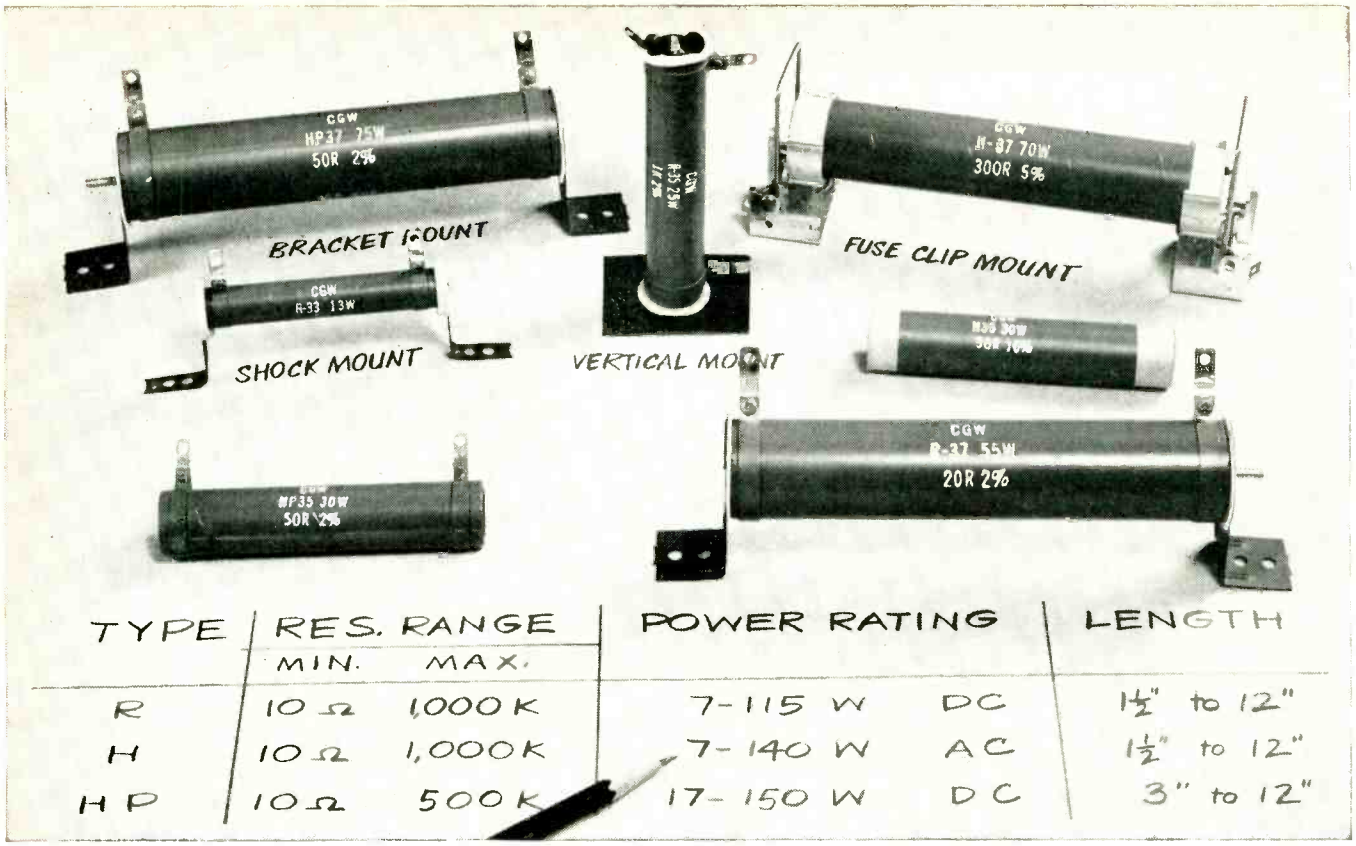
-hp- 281A WAVEGUIDE-COAX ADAPTERS

For convenient transition between waveguide and coaxial systems. Each unit covers a full wave-guide range with SWR less than 1.25. Equipped with Type N connectors. $50.00 to $25.00.

Data subject to change without notice. Prices f.o.b. factory.

HEWLETT-PACKARD COMPANY
3922A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
CABLE "HEWPACK" • DAvenport 5-4451
Field engineers in all principal areas

plete line of hp waveguide equipment!



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

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

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

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

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

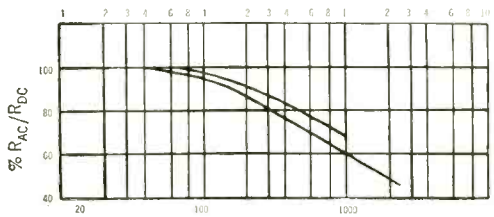
These Corning Resistors are remarkably stable regardless of moisture and humidity.

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

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

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

Our catalog sheets give far more complete details than we are able to here. We'll be glad to send you copies with current price lists.



FREQUENCY IN MEGACYCLES X RESISTANCE IN KILOHMS

Ask for information on these other Corning Resistors:

Low-Power—3-, 4-, 5-, and 7-watt sizes. Highest resistance range of any low-power resistor.

Type S—Stable performance to 200° C. Meet MIL-R-11804A specs. Values to 100,000 ohms.

Type WC-5—5 KW water-cooled. Range, 35 to 300 ohms. Versatile, adaptable.

Type N—Accurate grade. Made to meet all requirements of MIL-R-10509A. Characteristics X and R.

Specials—To your specifications—Co-axial Line Elements, Dummy Loads, HF Elements, Peak Pulse Loads, High-Voltage Resistors.

Other products for Electronics by Corning Components Department: Fixed Glass Capacitors*, Transmitting Capacitors, Canned High-Capacitance Capacitors, Subminiature Tab-Lead Capacitors, Special Combination Capacitors, Direct-Traverse and Midget-Rotary Capacitors*, Metallized Glass Inductances, Attenuator Plates.

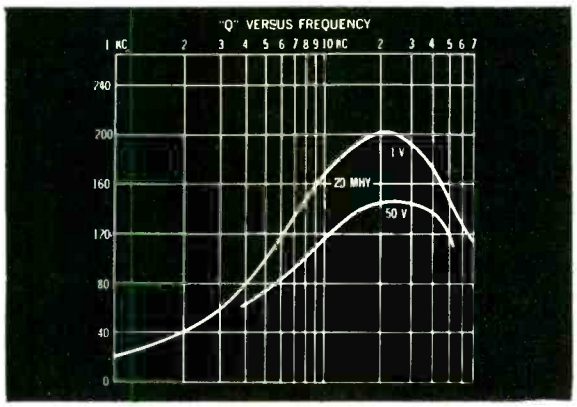
**Distributed by Erie Resistor Corporation*

CORNING GLASS WORKS, 91-9 Crystal Street, **CORNING, N. Y.**

Components Department, Electrical Products Division

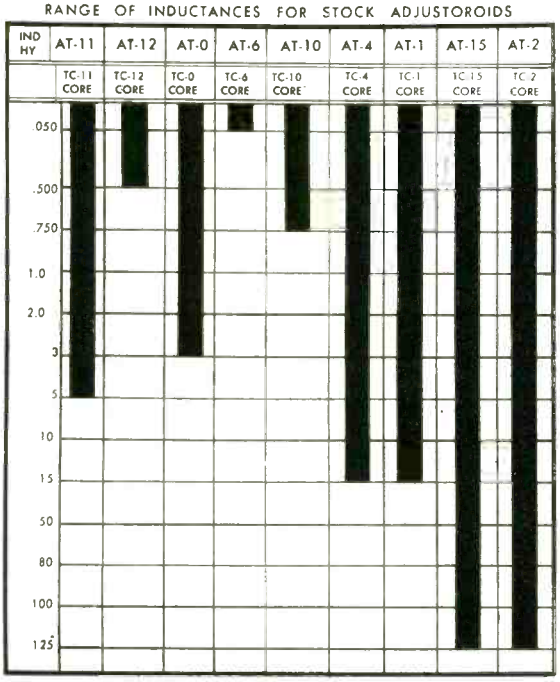
Corning means research in Glass

variable "L" by BURNELL



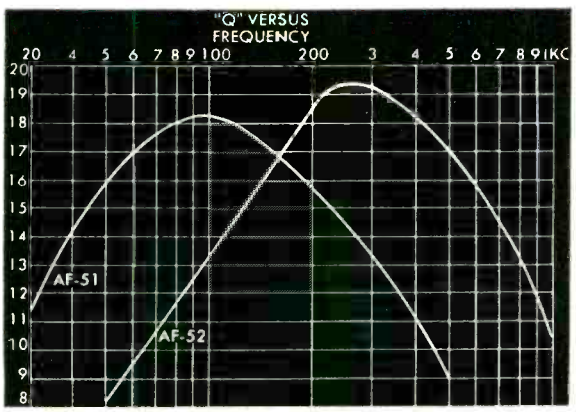
Typical Q vs. frequency characteristics of AT-10.

RANGE OF INDUCTANCES FOR STOCK ADJUSTOROIDS



For nominal D. C. R. values refer to Burnell catalog No. 103.

COMPLETE TECHNICAL INFORMATION UPON REQUEST.
℗ copyrighted, patent applied for.



Typical Q vs. frequency characteristics of Variable Inductors.

ADJUSTOROIDS®

The Adjustoroid, a low cost adjustable toroid, exclusively developed by Burnell & Company, Inc., contains an actual complete toroid which relays all the excellent characteristics of the non-adjustable types. Adjustment is obtained by a completely stepless function with magnetic biasing.

The nominal inductance value for an Adjustoroid is the **maximum** value, and the inductance range is the nominal value minus approximately 10%.

Hermetically sealed to meet Government MIL specifications. Many types of networks in tuned circuits are being produced which employ the Adjustoroid in completely hermetically sealed packages.

Intermediate inductance values as well as special taps and extra windings available on special order with minimum delay.

For additional technical data on Adjustoroids, refer to equivalent toroid in catalog.

AT-0, AT-6, AT-10, AT-4

AT-1, AT-2, AT-11, AT-12

ADJUSTOROID & VARIABLE INDUCTOR DIMENSION CHART

	LENGTH/DIA.	WIDTH	HEIGHT
AT-0, AT-6	1-1/16"		1"
AT-10, AT-4	1-19/64"		1-1/4"
AT-15	1-31/32"		1-7/8"
AT-11, AT-12	45/64"	45/64"	3/4"
AT-1	1-3/4"	1-3/4"	1-1/4"
AT-2	2-3/4"	2-3/4"	2-1/4"
AF-51, AF-52	1-19/64"		2"

You are cordially invited to inspect these and other Burnell products at Booth 1308 at the Wescon Show, and to discuss your network problems with us.

and now ...

VARIABLE INDUCTORS

AF-51 AF-52

(30-500 cycles)
Maximum Q at 100 cycles

(50-1000 cycles)
Maximum Q at 250 cycles

Burnell Variable Inductors have the similar characteristics to the Adjustoroid except they are especially designed for low frequency applications or for conditions where high inductance values are required. Variable Inductors are available in all inductance values up to 1000 Hys. With variation of —10% from nominal.

BURNELL & CO., INC.

YONKERS 2, NEW YORK Teletype: Yonkers, N. Y. 3633

Pacific Division: 720 Mission St., S. Pasadena, Calif.

Why you can rely on BUSS Fuses . . . for dependable electrical protection!

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

To make sure of top quality and proper operation—BUSS fuses are tested in a sensitive electronic device. Any fuse not correctly calibrated, properly constructed and right in all physical dimensions is automatically rejected.

That's why BUSS fuses provide maximum protection to users' equipment against damage due to electrical faults. And just as important, BUSS fuses by their unfailing dependability, help safeguard users of your equipment against irritating, useless shutdowns by eliminating needless blows.

When you specify BUSS fuses you can be sure of fuses that will operate properly and help safeguard the reputation of your equipment for quality and service.

To meet your needs, a complete line of BUSS fuses is available . . . plus a companion line of fuse clips, blocks and holders.

If you have an unusual or difficult protection problem, let the BUSS fuse engineers work with you and save you engineering time. If possible, they will suggest a fuse already available in local wholesalers' stocks, so that your device can be easily serviced.

BUSSMANN MFG. CO.
(Div McGraw Electric Co.)
University at Jefferson St. Louis 7, Mo.

ELRC
856

For information on BUSS and Fusetron small dimension fuses and fuseholders . . . Write for bulletin SFB.

BULLETIN SR-A

International Rectifier

World's largest supplier of
industrial metallic rectifiers
announces a complete line
of quality

Silicon Power Rectifiers

IN FULL PRODUCTION!

A WORLD OF DIFFERENCE • THROUGH RESEARCH •

International Rectifier Corp. has long been recognized as a leader in the development and manufacture of rectifiers of all types. Now, in addition to a complete line of Selenium and Germanium units, International is pleased to announce the availability of a **COMPLETE LINE** of Silicon rectifiers in production quantities. This brochure contains brief specifications on types now available for low and medium power applications.

You are invited to submit your application problem to our Application Engineering Dept. for an experienced and practical solution.

International
SILICON RECTIFIERS

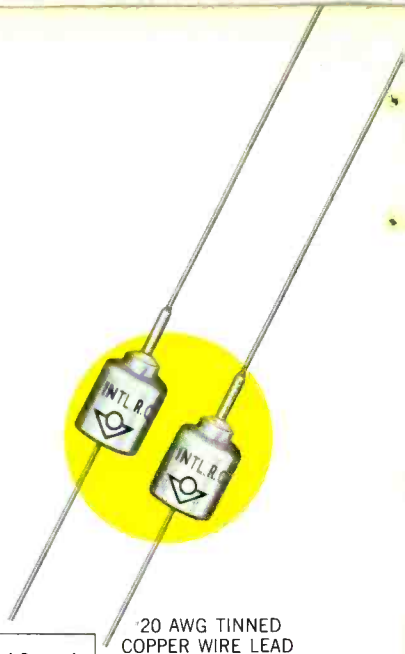
FEATURES:

- **Wide Temperature Operating Range.** −55° C to +150° C ambient.
- **Storage Temperature Range.** −55° C to +170° C.
- **Widest Range of Voltage Ratings in the Industry.** Individual units rated from 50 volts to greater than 8,000 volts.
- **High Power Handling Capacity.** Up to 1.25 amperes dc output current per junction.
- **Hermetic Sealing Throughout.** Provides complete environmental protection and long life.

HIGH VOLTAGE

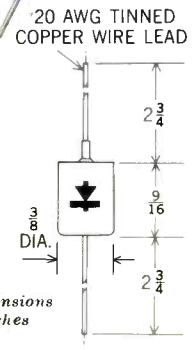
HERMETICALLY SEALED

STYLE J



PIGTAIL CONSTRUCTION

Type	Rated PIV Volts	Rated DC Output Current ma @ 75° C ambient
EM1J2	600	125
FM1J2	800	125
GM1J2	1000	125



All dimensions in inches

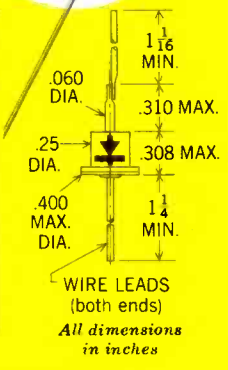
PIGTAIL CONSTRUCTION

HERMETICALLY SEALED

STYLE S

Available in 100 and 300 ma Ratings

Magnetic Amplifier[1] Type	Power Supply[1] Type	Rated PIV Volts	Rated DC Output Current[2], ma
3AS2	3AS1	50	300
3BS2	3BS1	100	300
3CS2	3CS1	150	300
3DS2	3DS1	200	300
3ES2	3ES1	300	300
3FS2	3FS1	400	300
3GS2	3GS1	500	300

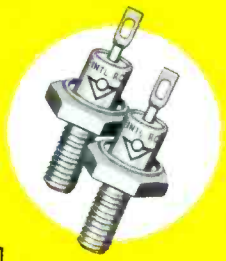


All dimensions in inches

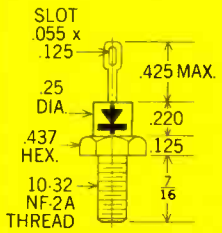
STUD MOUNTED CONSTRUCTION

HERMETICALLY SEALED

STYLE T



Magnetic Amplifier[1] Type	Power Supply[1] Type	Rated PIV Volts	Rated DC Output Current[2], [3] ma
3AT2	3AT1	50	800
3BT2	3BT1	100	800
3CT2	3CT1	150	800
3DT2	3DT1	200	800
3ET2	3ET1	300	800
3FT2	3FT1	400	800
3GT2	3GT1	500	800



All dimensions in inches

1. Magnetic amplifier type diodes are designed for application requiring exceptionally low reverse leakage and forward voltage drop. Power Supply type diodes offer low reverse leakage and forward voltage drop for standard industrial applications.
2. No current derating at ambient temperatures up to 100° C.
3. Mounted directly on copper fin 2" x 2" x .025".

STABILITY | QUALITY | RELIABILITY

International Rectifier Corporation silicon rectifiers are designed and constructed to the most stringent specifications of stability and reliability for both military and industrial applications. The rectifier junction is formed by an International Rectifier Corporation production process which has resulted in silicon diodes of outstanding electrical performance and mechanical stability. The junctions are assembled in housings providing hermetic sealing and shock resistance exceeding the most severe humidity, shock and vibration requirements for military duty.

All International Silicon products are subjected to rigorous 100% production and quality control test procedures. At all times, quality is controlled in accordance with the terms of the U. S. Signal Corps Reduced Inspection Quality Assurance Plan (RIQAP) which has been in force at International Rectifier Corporation for over one year. Under the interservice agreement, this quality level is equal to or better than that required by any of the military services.

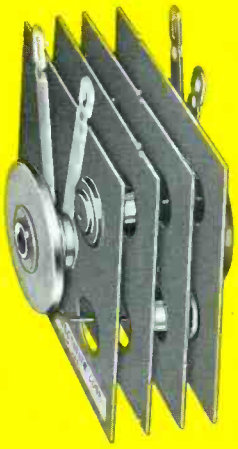
For comprehensive information on any of the products appearing in this brochure, write, wire or telephone the Application Engineering Department of International Rectifier Corporation.

International

SILICON RECTIFIER

STACKS

HERMETICALLY SEALED



International silicon stacks are recommended for maximum reliability and optimum performance in applications formerly requiring marginal operation of other rectifier types. The high efficiency and high temperature characteristics of these stacks reduces the heat loss load which must be removed.

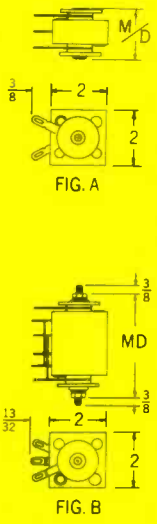
These stacks consist of hermetically sealed junction diodes mounted on copper cooling fins. They are stacked in essentially the same manner as other metallic rectifiers, including the inter-connections required for the specified rectifier circuit.

The table at right provides a partial listing of standard assemblies now available. For engineering details on additional types, contact your nearest International representative, or our Application Engineering Department at the factory.

SPECIFICATIONS FOR SILICON JUNCTIONS on 2" x 2" FINS

SILICON RECTIFIER TYPE	MAX A.C. RMS INPUT	DC OUTPUT* VOLT	DC OUTPUT* AMP	CIRCUIT	MOUNTING DIMEN. M/D (±.06 INCH)	
66B1H1B2E S8	70	27	1.25		1.0"	
66B1H1B2E T8	105	43	1.25	Single	1.0"	
66B1H1B2E U8	140	58	1.25	Phase	1.0"	Fig.
66B1H1B2E V8	210	89	1.25	Half	1.0"	A
66B1H1B2E W8	280	117	1.25	Wave	1.0"	
66B1H1B2E X8	350	145	1.25		1.0"	
66B1B1B2B S8	70	54	2.5		2.5"	
66B1B1B2B T8	105	86	2.5	Single	2.5"	
66B1B1B2B U8	140	116	2.5	Phase	2.5"	Fig.
66B1B1B2B V8	210	178	2.5	Bridge	2.5"	B
66B1B1B2B W8	280	234	2.5		2.5"	
66B1B1B2B X8	350	290	2.5		2.5"	
66B1C1B2E S8	70	27	2.5		1.0"	
66B1C1B2E T8	105	43	2.5	Single	1.0"	
66B1C1B2E U8	140	58	2.5	Phase	1.0"	Fig.
66B1C1B2E V8	210	89	2.5	Center	1.0"	A
66B1C1B2E W8	280	117	2.5	Tap	1.0"	
66B1C1B2E X8	350	145	2.5		1.0"	
66B1T1B2B S8	70	86	3.75		3.44"	
66B1T1B2B T8	105	135	3.75	Three	3.44"	
66B1T1B2B U8	140	182	3.75	Phase	3.44"	Fig.
66B1T1B2B V8	210	273	3.75	Bridge	3.44"	B
66B1T1B2B W8	280	364	3.75		3.44"	
66B1T1B2B X8	350	455	3.75		3.44"	
66B1S1B2E S8	70	42	3.3		1.25"	
66B1S1B2E T8	105	67	3.3	Three	1.25"	
66B1S1B2E U8	140	92	3.3	Phase	1.25"	Fig.
66B1S1B2E V8	210	139	3.3	Half	1.25"	A
66B1S1B2E W8	280	185	3.3	Wave	1.25"	
66B1S1B2E X8	350	231	3.3		1.25"	
66B1U1B2B S8	70	43	4.5		3.44"	
66B1U1B2B T8	105	70	4.5	Three	3.44"	
66B1U1B2B U8	140	91	4.5	Phase	3.44"	Fig.
66B1U1B2B V8	210	136	4.5	Center	3.44"	B
66B1U1B2B W8	280	182	4.5	Tap	3.44"	
66B1U1B2B X8	350	227	4.5		3.44"	

*Into resistive and/or resistive-inductive load.



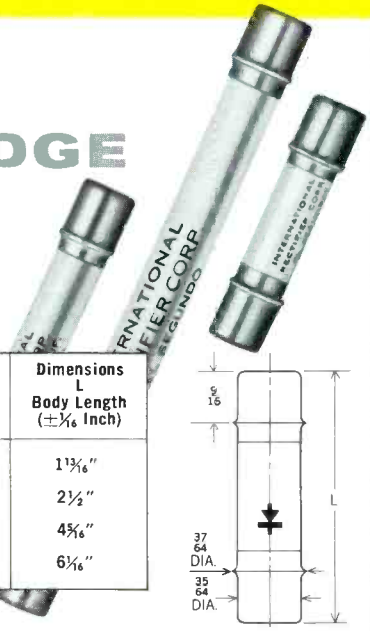
All dimensions in inches

International

CARTRIDGE

SILICON RECTIFIERS

HERMETICALLY SEALED

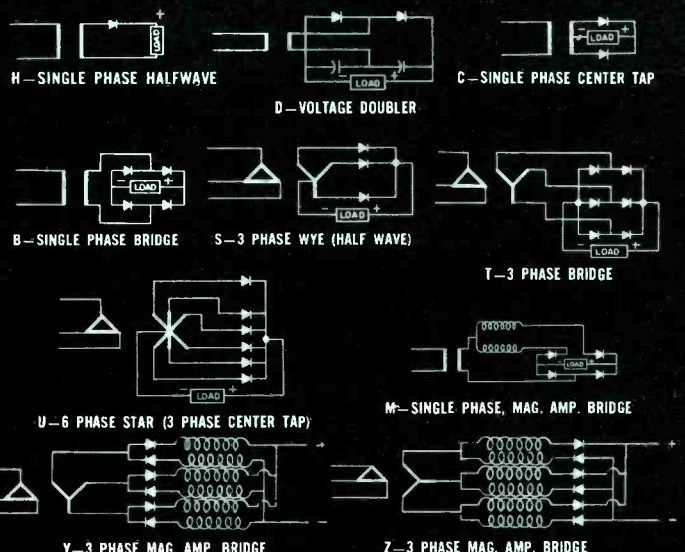


Range of PIV	Maximum DC Output Current 1, 2 Range	Dimensions L Body Length (±1/16 Inch)
300 to 1600	100 to 60 ma	1 13/16"
900 to 3200	80 to 50 ma	2 1/2"
1700 to 6000	70 to 50 ma	4 5/16"
3100 to 8000	55 to 45 ma	6 1/16"

All dimensions in inches

1. The rated maximum dc output current is determined by the number of junctions connected in series.
2. No current derating at ambient temperatures up to 75° C.

CIRCUIT DIAGRAMS



International SILICON CARTRIDGES

Designed specifically for applications where high temperature and high efficiency are prime factors, these cartridge type units are typical of the advanced design techniques characteristic of all International Rectifier Corporation products. These high voltage silicon cartridges are constructed from selected P-N junction diodes connected in series. They are hermetically sealed within a metallized ceramic, cylindrical housing, having ferrule terminals for clip-in applications into standard 30 ampere fuse clips.

PRINCIPAL CIRCUITS

International Silicon Rectifiers are made in all circuit types, including those illustrated above. It is possible to arrange them in series and in parallel to increase voltage or current ratings. Like all semiconductor rectifiers, they should be carefully selected for series or parallel operation to insure equal load distribution, adequate voltage rating and maximum reliability.

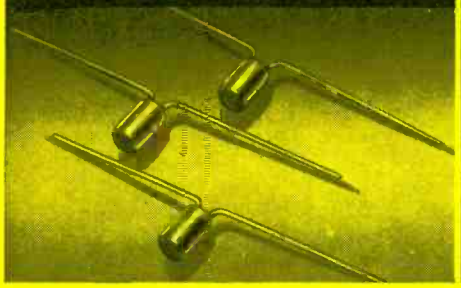
It is recommended that standard stacks be ordered at all times (unless single fins are recommended by the factory Application Engineering Department) and that the type of rectifier circuit be specified on all orders.

In the interest of product improvement, the manufacturers reserve the right to change specifications without notice.

International Rectifiers

SELENIUM · GERMANIUM · SILICON

SUB-MINIATURE SELENIUM DIODES



Developed for use in limited space at ambient temperatures ranging from −50°C to +100°C. Encapsulated to resist adverse environmental conditions. Output voltages from 20 to 160 volts; output currents of 100 microamperes to 11 MA. **Bulletin SD-1B**

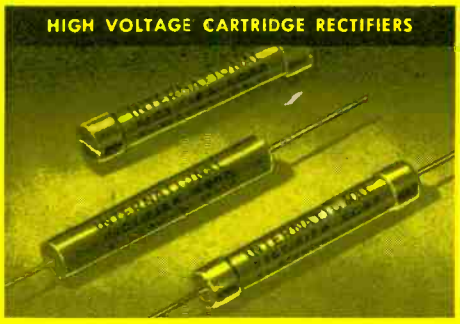
GERMANIUM DIODES

This series of general purpose, high quality point contact diodes provide excellent rectification efficiency for very high frequency applications. Special "RED DOT" series available for ambient temperatures from −55° C to +100° C. **Bulletin GD-2**

SILICON POWER DIODES

For temperature applications to 150° C, these fused junction diodes withstand exposure from −55° C to +170° C. Peak inverse voltage rating from 50 volts to 600 volts. Welded, hermetically sealed construction. Four types. **Bulletin SR-132**

HIGH VOLTAGE CARTRIDGE RECTIFIERS



Designed for long life and reliability in Half-Wave, Voltage Doubler, Bridge, Center-Tap Circuits, and 3-Phase Circuit Types. Phenolic Cartridge and Hermetically Sealed types available. Operating temperature range: −65°C to +100°C. Specify **Bulletin H-2**

TV AND RADIO RECTIFIERS

The widest range in the industry! Designed for Radio, Television, TV booster, UHF converter and experimental applications. Input ratings from 25 to 195 volts AC and up. DC output current 10 to 1,200 MA. Write for application information. **Bulletin ER-178-A**

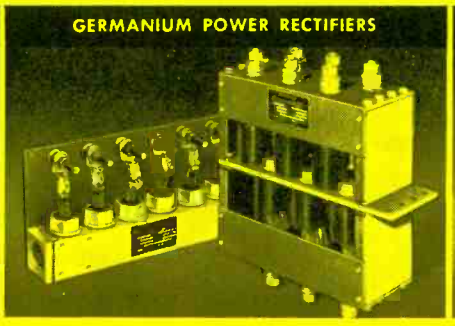
SELENIUM PHOTOCELLS — SUN BATTERIES

Self-generating photocells available in standard or custom sizes, mounted or unmounted. Optimum load resistance range: 10 to 10,000 ohms. Output from .2 MA to 60 MA in ave. sunlight. Ambient temperature range: −65°C to +100°C. **Bulletin PC 649**

SELENIUM POWER RECTIFIERS

For all DC power needs from microwatts to kilowatts. Features: long life; compact, light weight and low initial cost. Ratings: to 250 KW, 50 ma to 2,300 amperes and up. 6 volts to 30,000 volts and up. Efficiency to 87%. Power factor to 95%. **Bulletin C-349**

GERMANIUM POWER RECTIFIERS



3 Styles featuring efficiency to 97%, low forward drop, high reverse to forward current ratio, unlimited life. Ratings: 26 to 66AC input v. per junction. 150 to 100,000 amps DC output. Operating temperature range: −55° C to +75° C. **Bulletin GPR-1**

SILICON POWER RECTIFIERS

High power- 5 amp to 100 amp- silicon fused junction type. Input ratings to 200 PIV. Temp. range: up to 150° C case temperature. Available in individual diodes or all usual power rectifier circuits. Data available on models for forced air and liquid cooling.

Bulletin SPR-1

a world of difference through research!

For bulletins on products described WRITE ON YOUR LETTERHEAD *to our* PRODUCT INFORMATION DEPARTMENT

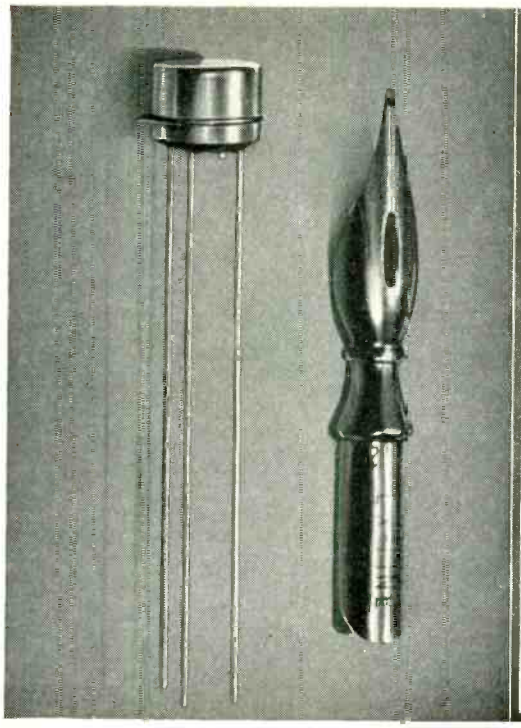
International Rectifier

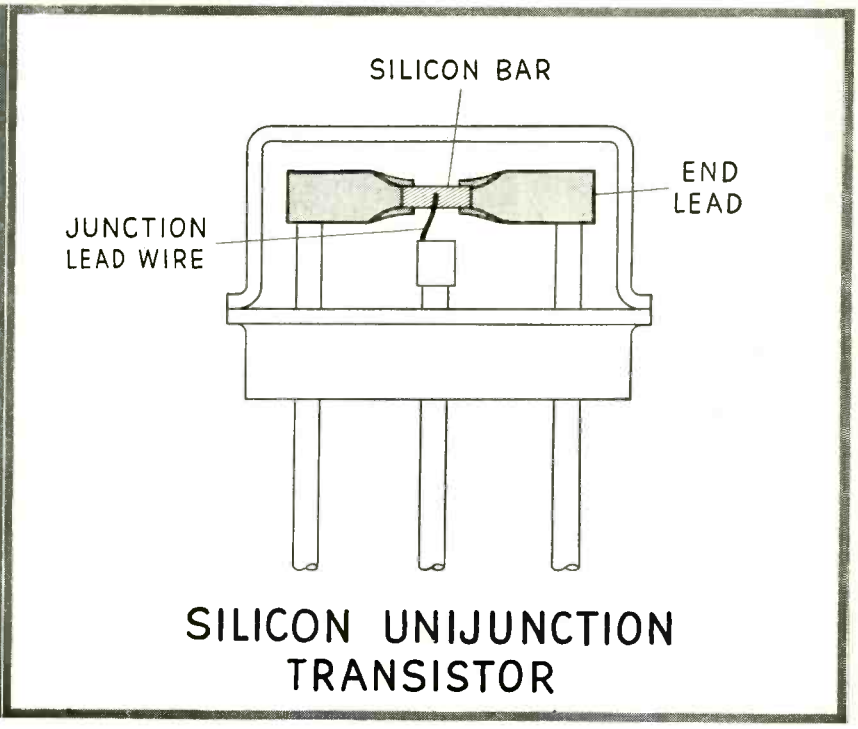
CORPORATION

EXECUTIVE OFFICES: 1521 E. GRAND AVE., EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281

WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS

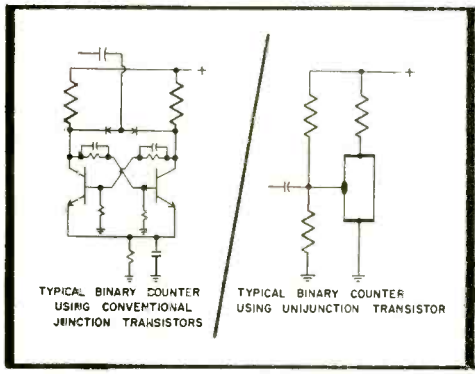
BIG NEWS FOR COMPUTER AND INDUSTRIAL DESIGN ENGINEERS

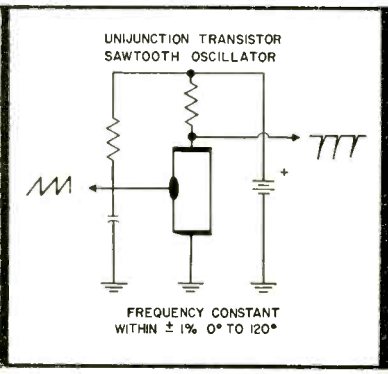


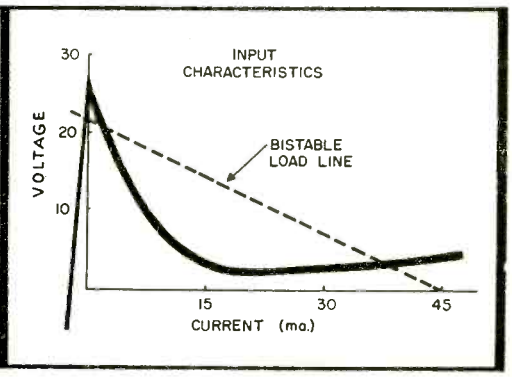


New General Electric Silicon Unijunction Transistor simplifies circuitry...improves reliability!

THIS single device, the new G-E Unijunction Transistor, does the work of two transistors and several other circuit components...reduces circuit complexity, improves reliability factors and leads to ultimate lower cost. Invented by General Electric and developed under Air Force contract, the new Unijunction Transistor combines the uniformity, stability, and reliability of a junction transistor with the desirable characteristics of point contact transistors. Its dependable high-temperature performance is commended for missile, electronic switching and relay applications. For further information on the Unijunction Transistor, call or write: *General Electric Co., Semiconductor Products Department, Section X496, Electronics Park, Syracuse, New York.*







Progress Is Our Most Important Product

GENERAL ELECTRIC

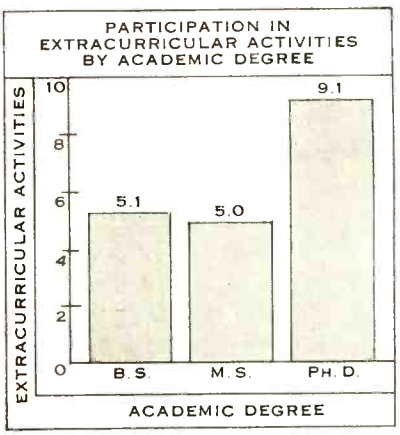
Want more information? Use post card on last page.

SIDELIGHTS ON THE SCIENTISTS *number* **6** *of a series*

Drums to dramatics

Don't be surprised to learn that the engineers and scientists at Hughes who have the highest academic degrees are those who were the most active on the campus.

This series has consistently revealed that the higher the degree, the more active the man. Interests in campus activities ran all the way from playing the drums (or the banjo) in an orchestra to playing the hero (or the villain) in a play... from cheerleading to chess teams... from football to forensics or what you will.



Campus Activities vs. Academic Study
Data obtained from a 20% random sample of personal facts about the 2400 professional engineers and scientists on the staff of Hughes Research and Development Laboratories.

Here at Hughes more than half the engineers and scientists in our Laboratories have had one or more years of graduate work. One in four has his Master's, one in 15 his Doctorate.

Our research program is of wide variety and scope, affording exceptional freedom as well as superior facilities for these people. It would be difficult to find a more exciting and rewarding climate for a career in science. Too, we are continually stepping up projects which will insure success in commercial as well as military work.

Hughes is pre-eminent as the developer and manufacturer of the electronic armament control system now standard equipment on all Air Force all-weather interceptors. Our program also embraces ground systems radar, the Hughes Falcon and other guided missiles, automatic control, and synthetic intelligence.

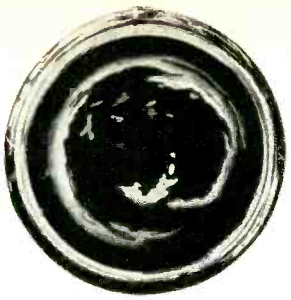
Projects of broader commercial and scientific interest include research in and manufacture of semiconductors, electron tubes, digital and analog computation, data handling, navigation, and production automation.

Scientific Staff Relations

HUGHES

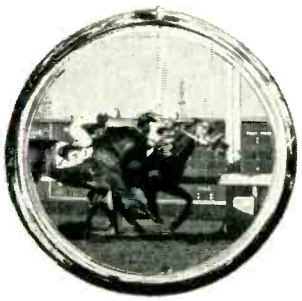
RESEARCH AND DEVELOPMENT LABORATORIES
HUGHES AIRCRAFT COMPANY
Culver City, Los Angeles County, California

The Laboratories now have positions open for engineers in a highly trained organization giving support to the armed services and airframe manufacturers using Hughes equipment. Write for details.



Weather radar with brilliant half-tone picture.

Narrow band, slow scan. Closed-circuit TV.



Freeze action until intentionally erased.

HUGHES PRODUCTS

proudly announces

TONOTRON

Full circle persistence

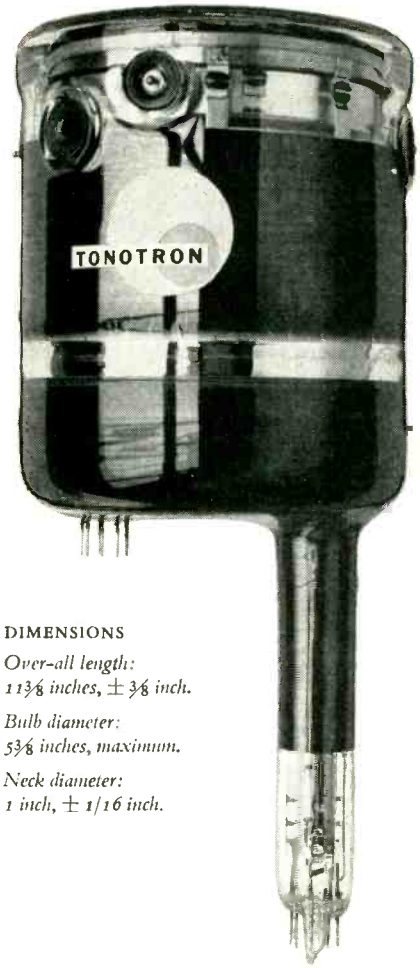
Displays complete spectrum of gray shades

Controllable persistence

Controllable rate of decay

No hood needed, even in direct sunlight

5-inch screen

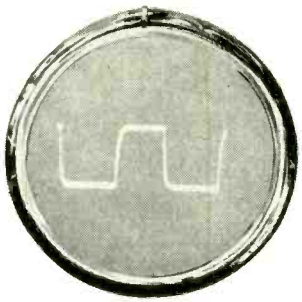


DIMENSIONS

Over-all length:
11⅜ inches, ± ⅜ inch.

Bulb diameter:
5⅜ inches, maximum.

Neck diameter:
1 inch, ± 1/16 inch.



Single transient pulse, 20 microseconds wide with a one microsecond rise time, showing writing capabilities of one million inches per second. This photo was taken in full daylight without a hood.

ELECTRON TUBES

MEMOTRON

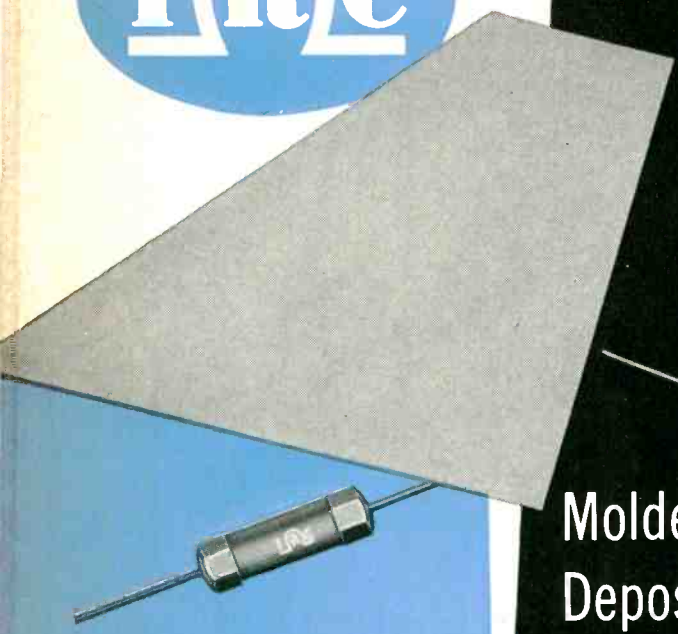
Memotron gives instant and permanent display of one or successive transients.

HUGHES PRODUCTS

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

For descriptive literature write to
HUGHES PRODUCTS
ELECTRON TUBES
International Airport Station, Los Angeles 45, California

IRC OFFERS MORE TYPES OF 1%



Deposited Carbon

Here's 1% accuracy in an extremely stable non-wire wound resistor at a price low enough to permit its use wherever the characteristics of composition carbon resistors are not fully suited. IRC's unmatched experience in producing film type resistors has led directly to the superior reliability and stability of IRC Deposited Carbons. Outstanding characteristics include load, environmental and age stability and ability to operate at higher temperatures than MIL specification requirements, low wattage coefficient, and low capacitive and inductive reactance in high frequency applications.

3 SMALL SIZES—DCC ½ WATT
DCF 1 WATT and DCH 2 WATTS

MEET ALL REQUIREMENTS OF MIL-R-10509A SPECIFICATION

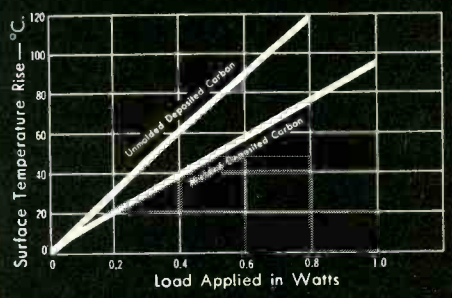
Wherever the Circuit Says

Subsidiaries :
Circuit Instruments Inc., St. Petersburg, Fla. • EMEC, Inc., Sylmar, California • Hycor Company, Inc., Vega Baja, Puerto Rico

Molded Deposited Carbon

Molded Deposited Carbon resistors are now available from IRC in 5 sizes: Types MDA—⅛ watt, MDB—¼ watt, MDC—½ watt, MDF—1 watt, MDH—2 watts. The *molded* plastic housing provides complete mechanical protection, minimizes the effect of moisture and improves load life characteristics. These 1% precision film type units exceed MIL-R-10509A specifications.

COMPARISON SURFACE TEMPERATURE RISE VS. LOAD
Molded vs. Unmolded Deposited Carbon Resistors



Boron Carbon

Where a high degree of accuracy under widely varying temperatures is required, IRC Boron Carbons offer an ideal combination of characteristics. Their superior temperature stability is provided in 3 sizes: Types BOC—½ watt, BOF—1 watt and BOH—2 watts—all 1% accuracy. Considering weight, size and cost factors, plus lower capacitive and inductive reactance, these film type precision resistors can satisfactorily replace wire wounds.

IRC TYPE	BOC	BOF	BOH
Equivalent MIL Style	RN 20R	RN 25R	RN 30R
Wattage (40°C. Ambient)	½	1	2
Max. Continuous Voltage	350 V.	500 V.	750 V.
Minimum Ohms	10	20	30
Maximum Ohms (IRC)	0.5 meg	2.0 meg	5.0 meg

makes them all . . . can recommend without bias . . .

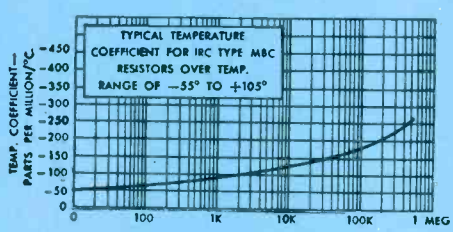
HYCOR DIVISION of IRC, Sylmar, Calif.

TOLERANCE RESISTORS than any supplier in the industry

Molded Boron Carbon

Only from IRC can you obtain Boron Carbon resistors with the protection of a *molded* plastic housing. Any risk of mechanical damage to the coating or of insulation breakdown is overcome. Any need for special handling is eliminated, and moisture and load life characteristics are improved. 5 sizes—Types MBA—⅛ watt, MBB—¼ watt, MBC—½ watt, MBF—1 watt, MBH—2 watts. All exceed MIL-R-10509A specifications.

TYPICAL TEMPERATURE COEFFICIENT



Wire Wound

IRC's winding skills and automatic assembly equipment provide precision windings to exacting standards. Continuous inspections at every stage of manufacture assure maximum reliability in each finished resistor. Available in 7 sizes including tiny Type WW10J—$^{13}/_{32}$'' x $^{9}/_{32}$''. Standard tolerance ±1%; minimum tolerances are shown below.

Minimum Tolerances

Resistance	Types WW2, 3, 4, 5, 8 and 11J	Type WW10J
10 ohms & up	0.1%	
5 ohms & up	0.25%	
1 ohm & up	0.5%	
1500 ohms & up		0.1%
200 ohms & up		0.25%
65 ohms & up		0.5%

Encapsulated Wire Wound

Series "PH" Encapsulated resistors are produced to IRC's high standards and represent many years' experience in the development and manufacture of precision wire-wound resistors. Available in many types and styles, including types for use in printed wiring assemblies and subminiature Type 128A. Standard tolerance ±.1%. Also, ±1%, 0.5%, .25% and .05% can be supplied. Series "PH" offers the most complete selection of Encapsulated precision wire-wound resistors available . . . all designed to meet MIL-R-93A specifications.

MANY COMBINATIONS OF CHARACTERISTICS AND OPPORTUNITIES FOR COST REDUCTION ARE INVOLVED WHEN SPECIFYING CLOSE TOLERANCE RESISTORS. NO OTHER SINGLE SOURCE CAN OFFER YOU THE SCOPE OF TECHNICAL GUIDANCE AVAILABLE FROM IRC.

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In Canada:

International Resistance Co., Ltd., Toronto, Licensee

INTERNATIONAL RESISTANCE COMPANY

Dept. 235, 401 N. Broad St., Philadelphia 8, Pa.

SEND ME TECHNICAL BULLETINS ON—

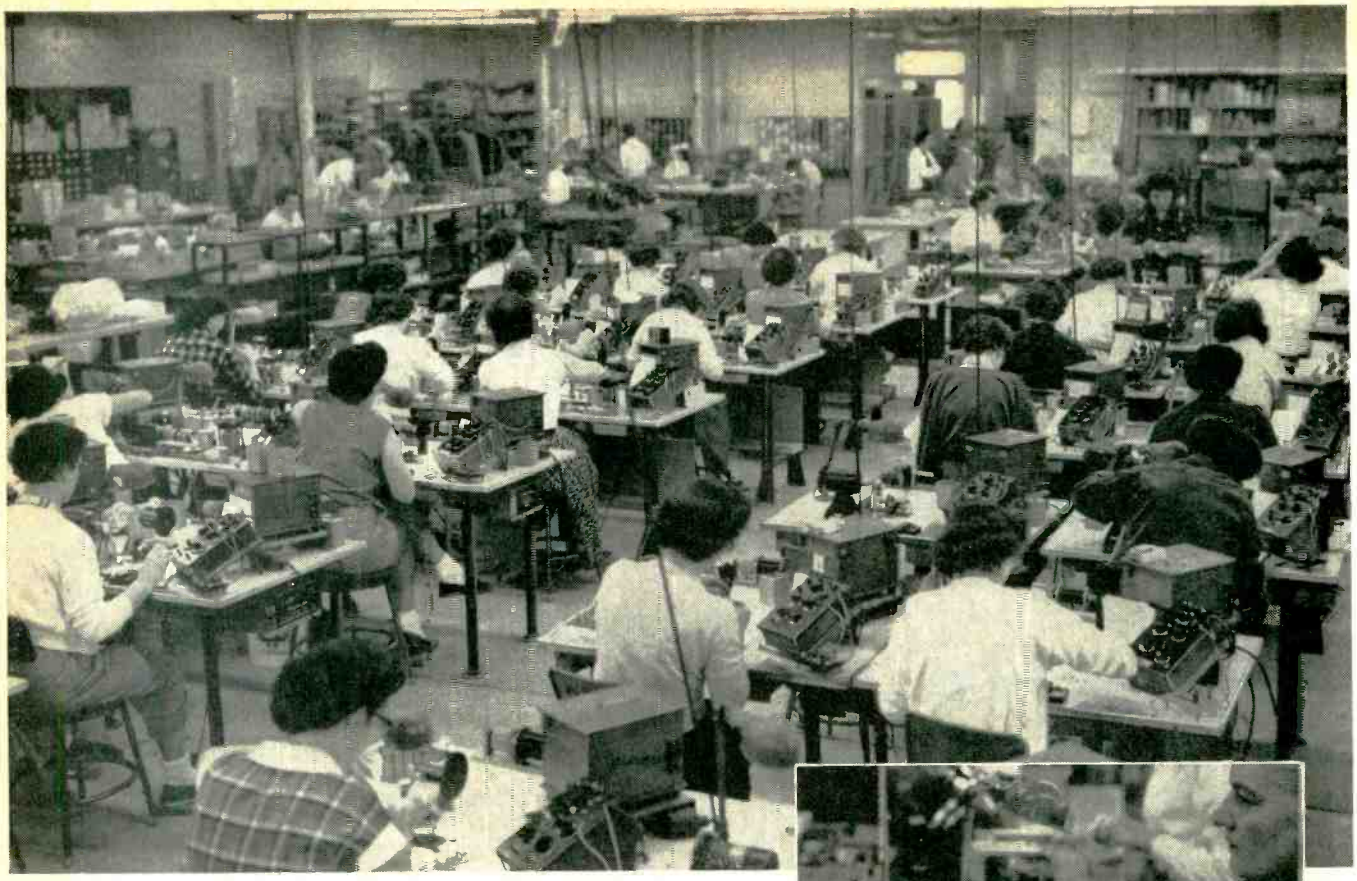
- ☐ Deposited Carbons
- ☐ Molded Deposited Carbons
- ☐ Boron Carbons ☐ Molded Boron Carbons
- ☐ Type WW Precisions ☐ Series PH

Name_____

Company_____

Address_____

City_____ **State**_____



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

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

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

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

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

LEEDS NORTHRUP
instruments automatic controls • furnaces

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

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

Jrl. Ad E-53(11)

UNCASED TOROIDS

Basic inductor component. Plain, wax or plastic dipped with flex-leads. Hi Q values 10cps to 10mc. Complete range of sizes: subminiature, wedding ring and up to 12" OD. Standard inductances stocked for immediate delivery. Mass production utilizing CAC-designed winding equipment enables swift completion of large orders.

PLASTIC CASED TOROIDS

CAC compression molded toroids per Mil specs have become the standard of the industry. Most compact design — may be stacked — mounted by center bushing which absorbs mounting pressures — sturdy, tinned terminals — arrangements available up to 6 terminal connections. Standard inductance values shipped from stock — special inductances and configurations supplied promptly on request.

C-A-C®

TOROIDAL INDUCTORS

Precision...Delivery...Quality...

Growth and development of CAC has been rapid since its organization following World War II. It is made up of young, but highly experienced management and personnel. Unique manufacturing equipment (much of it CAC-designed) and leadership in production "know-how" offer PRECISION ...DELIVERY...and QUALITY.

Whether your need is for one toroidal component...or a million, CAC is prepared to serve you.

COMMUNICATION ACCESSORIES CO.

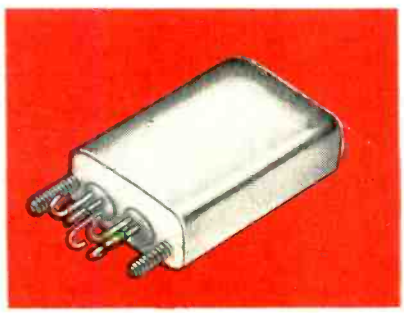
World's Largest Exclusive Producer of Toroidal Windings

HICKMAN MILLS, MISSOURI • PHONE KANSAS CITY, SOUTH 1-5528

A Subsidiary of Collins Radio Company

HERMETICALLY SEALED CASED TOROIDS

CAC "HS" series provides metal encased, hermetically sealed units complying with MIL specifications. Mounting area minimized — extremely low hum pickup — terminals of proven design using Teflon assure permanent seal at temperature extremes. Rugged construction — convenient mounting facilities. To insure stability, cores are thermo-cycled prior to encasement. Standard inductances in stock.



SUBMINIATURE TOROIDS

Uncased, plastic molded and hermetically sealed in three standard core types (others available). Designs for all requirements—for chassis mount or printed circuits.

For the engineer whose design considerations dictate the utmost in electrical performance versus size, CAC's subminiature toroids present the answer.

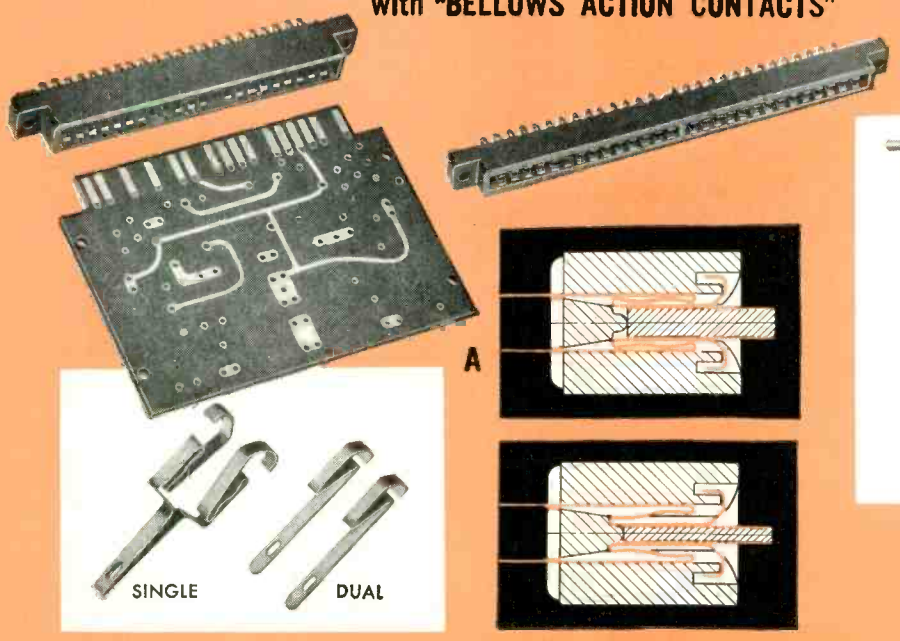
Catalogs on Individual Components are Available on Request.

Continental Connectors

AMERICA'S FASTEST GROWING LINE

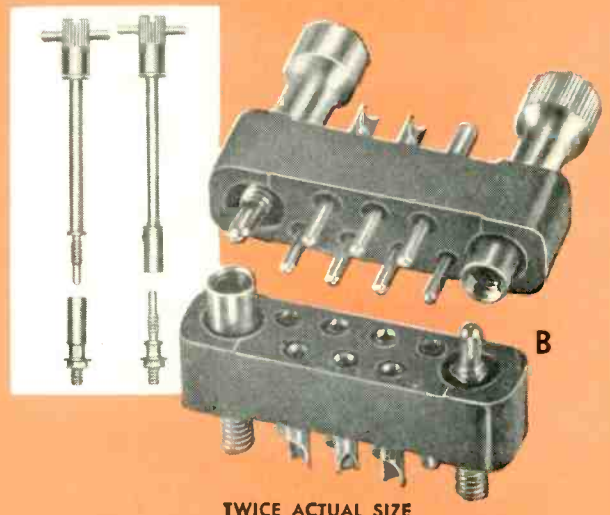
featuring the two most important connector developments in recent years

PRINTED CIRCUIT CONNECTORS with "BELLOWS ACTION CONTACTS"*



MINIATURE and SUBMINIATURE CONNECTORS with POLARIZING SCREWLOCKS

Pat. #2746022



TWICE ACTUAL SIZE

*Patent Pending

A) PRINTED CIRCUIT CONNECTORS ("Series PC") New "Bellows Action Contacts" grip printed circuit board over 100% of board contact area. Contacts in single or double rows permit up to 56 connections. Drawings demonstrate how bellows contact grips oversized and undersized board with equal retention. To fit 1/16", 1/32", and 1/8" boards.

B) POLARIZING SCREWLOCKS* to prevent accidental disconnection due to vibration now available in Series 20 Miniature and Series SM-20 Subminiature Continental Connectors.

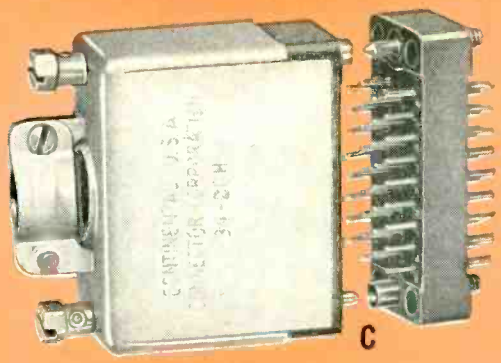
C) SERIES 20 MINIATURE CONNECTOR with Hood and Polarizing Screwlocks. Available with 7, 8, 9, 11, 14, 18, 20, 21, 26, 34, 41, 50, 75 and 104 contacts for #20 AWG wire. Rating: 5 amps; Voltage: 2100V. RMS.

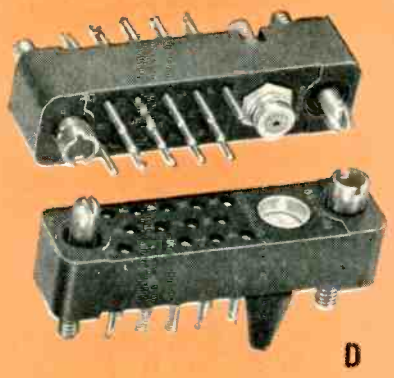
D) SERIES 20 with 50-ohm matched impedance coaxial contacts and 14 or 18 standard #20 contacts. Rating: 5 amps; Voltage: 2100V. RMS.

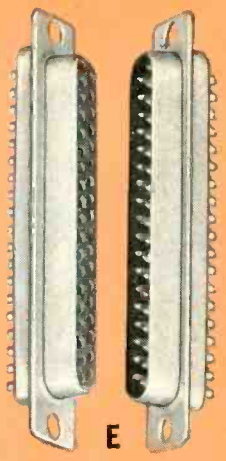
E) SERIES CCC 20 in stainless steel shells, recommended for airborne applications. 37 contacts for #20 AWG wire. (15 and 25 contacts on request.)

F) SERIES E-Z Easy Release Connectors with up to 34 solder cups or solderless taper pin contacts. Aluminum hoods, polarizing screwlocks and coaxial contacts available on order. Rating: 10 amps; Voltage: 4500V. RMS.

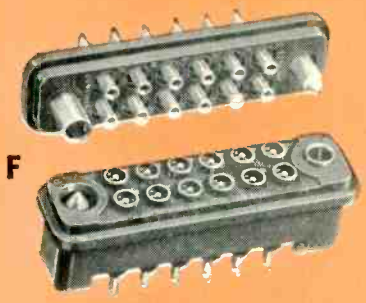
G) SERIES 1300 MINIATURE AN-TYPE Connector with one-piece molded inserts. Rating: 7.5 amps; Voltage: 3000V. RMS. Two shell sizes: 3, 4, 5 contacts, and 15, 19, 27, 31 contacts.







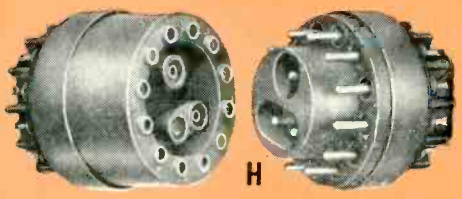
CONTINENTAL "SERIES 20" MINIATURE CONNECTORS



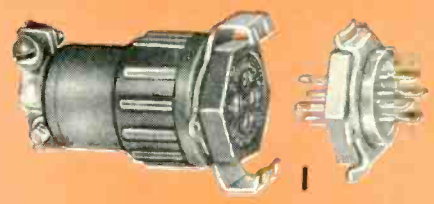
EASY RELEASE

Pat. #2736870

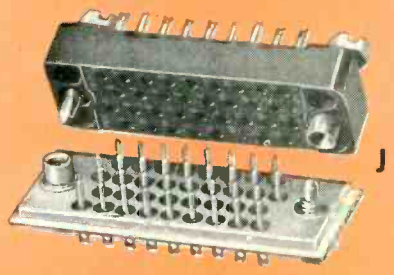
MINIATURE AN-TYPE

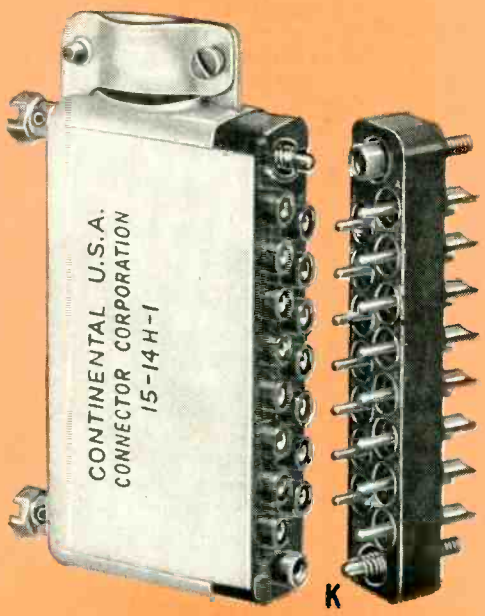


HIGH VOLTAGE AN-TYPE

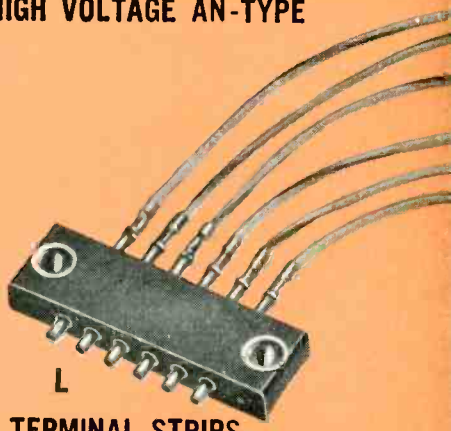


HERMETIC SEAL CONNECTORS

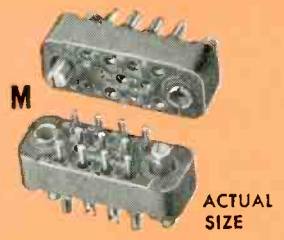




POWER CONNECTORS



TERMINAL STRIPS



SUBMINIATURE CONNECTORS

H) SERIES 800 HIGH VOLTAGE AN-TYPE Connector for AN-36 shell. 15 contacts. 3 high voltage contacts in center are removable. Current ratings: 10 and 20 amps.

I) SERIES HC-20 HEXAGONAL Hermetic Plug has solid glass insert. Choice of 4, 5, 7, 9 and 10 contacts.

J) SERIES H-20 Hermetic Plug for #20 AWG wire. Contacts individually compression sealed in glass. Fits Series 20 receptacles. With polarizing screwlock or guide pin and guide socket.

K) SERIES 14 Power Connector (illustrated with hood and polarizing screwlock.) Choice of 7, 9, 10, 15 or 18 contacts for #14 AWG wire. Rating: 10 amps; Voltage: 4500V. RMS.

L) SERIES MB Terminal Strip. Choice of 6 or 10 contacts. Mounting holes permit stacking in small area. For #20 AWG wire. One side accommodates taper tab solderless wiring, other side conventional wiring.

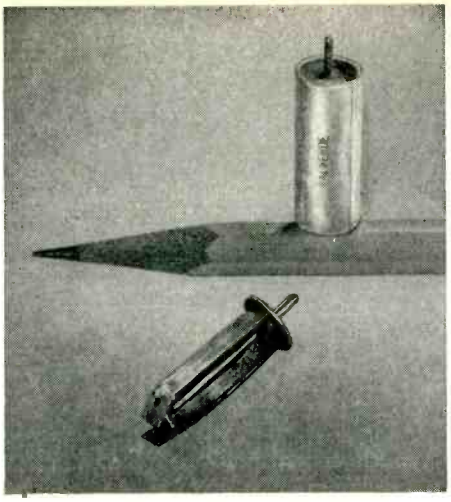
M) SERIES SM-20. Model shown has 11 contacts for #20 AWG wire. Available in 7, 11, 14, 20, 26 and 34 contacts. Rating: 5 amps; Voltage: 1900V. RMS.

High precision, dependable Continental Connectors have achieved a reputation for excellence throughout the aircraft and electronics industries. The widest range of applications can be made from our standard line.

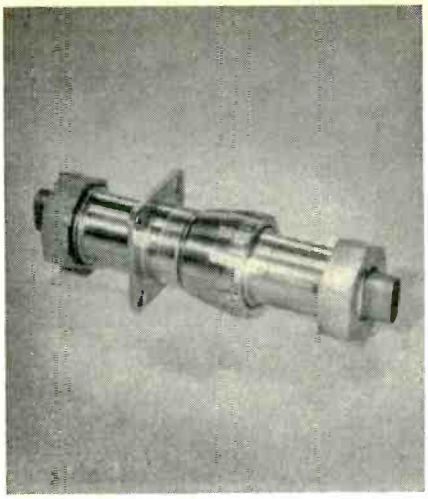
For special designs and technical data sheets on these connectors write Electronic Sales Division, DeJUR-Amsco Corporation, 45-01 Northern Blvd., Long Island City 1, New York.

you're always sure with **DeJUR**

Variable-resistor trouble caused by failure of spring to resist corrosion and heat. Or by failure to permit sound weld on collar. SOLVED WITH INCONEL* NICKEL-CHROMIUM ALLOY. *Resistor shown is used in power field, also in welding equipment. Sliding Inconel spring clip, silver contact rivet, assure corrosion resistance, weldability, and constant pressure. Despite 570°F temperatures at times, Inconel spring takes overloads. Replaced plated-steel springs. Used last 5 years by International Resistance Co., Philadelphia, Pa.*



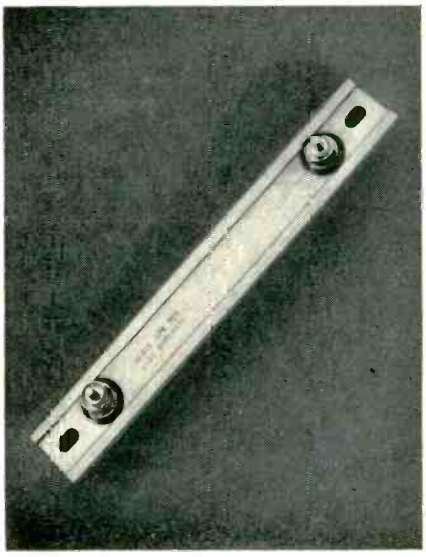
Sticking, fouling, commutation trouble on conductive actuating contact springs. Encountered in miniature thermostats. SOLVED WITH DURA-NICKEL* AGE-HARDENABLE NICKEL STRIP. *Constant elasticity gives true snap action. In ⅜" x 15/16" unit shown, temperature control is held to within 2°F up to 350°F. No drift, no sticking, no fouling in this "Val 90" miniature thermostat. Resists fatigue and relaxation. Made by Valverde Laboratories, 252 Lafayette St., New York 12, N. Y.*



Vibration and heat trouble often pose problems to designers of electrical connectors used, for example, continuously at 800°F in aircraft. SOLVED WITH "R"* MONEL FREE-MACHINING NICKEL-COPPER ALLOY . . . OR CAST MONEL. *Units fabricated from these nickel-copper alloys never rust or freeze together. Show no carbide precipitation at 800°F. Permit quick make-break connection of watertight, gas-tight joint such as above "Hot Zone" Electrical Connector that defies vibration. Produced by American Phenolic Corp., 1830 South 54th Ave., Chicago 50, Ill.*

Electrical-resistance trouble from oxide on terminal lug of rheostat. A problem when contact brush is moved from resistance wire to terminal lug very infrequently. SOLVED WITH MONEL* NICKEL-COPPER ALLOY. *Monel lug allows excellent electrical contact. Used on rheostats for 22 years by Ohmite Manufacturing Co., 3601 Howard St., Skokie, Illinois.*

Liquid-corrosion trouble due to attacks by chemicals, brine and the like. On sheathing of strip heaters, for example. SOLVED WITH MONEL* NICKEL-COPPER ALLOY. *This Monel sheath resists deterioration from heat as well as corrosives, yet permits delivery of heat up to 750°F. Unit shown is product of Waage Electric, Inc., Kenilworth, N. J.*



Trouble-spots . . .

removed by designers using Inco Nickel Alloys

Take no chances. Use components that will back up your designs.

Those illustrated give trouble-free performance, thanks to vital parts made from Inco Nickel Alloys.

Component manufacturers use Inco Nickel Alloys where parts require combinations of properties. High mechanical properties, specific electrical properties, corrosion resistance, resistance to high or low temperatures, good workability and machinability.

Inco's research staff can recommend the right alloy for your trouble. So whenever you have a component problem, check with us.

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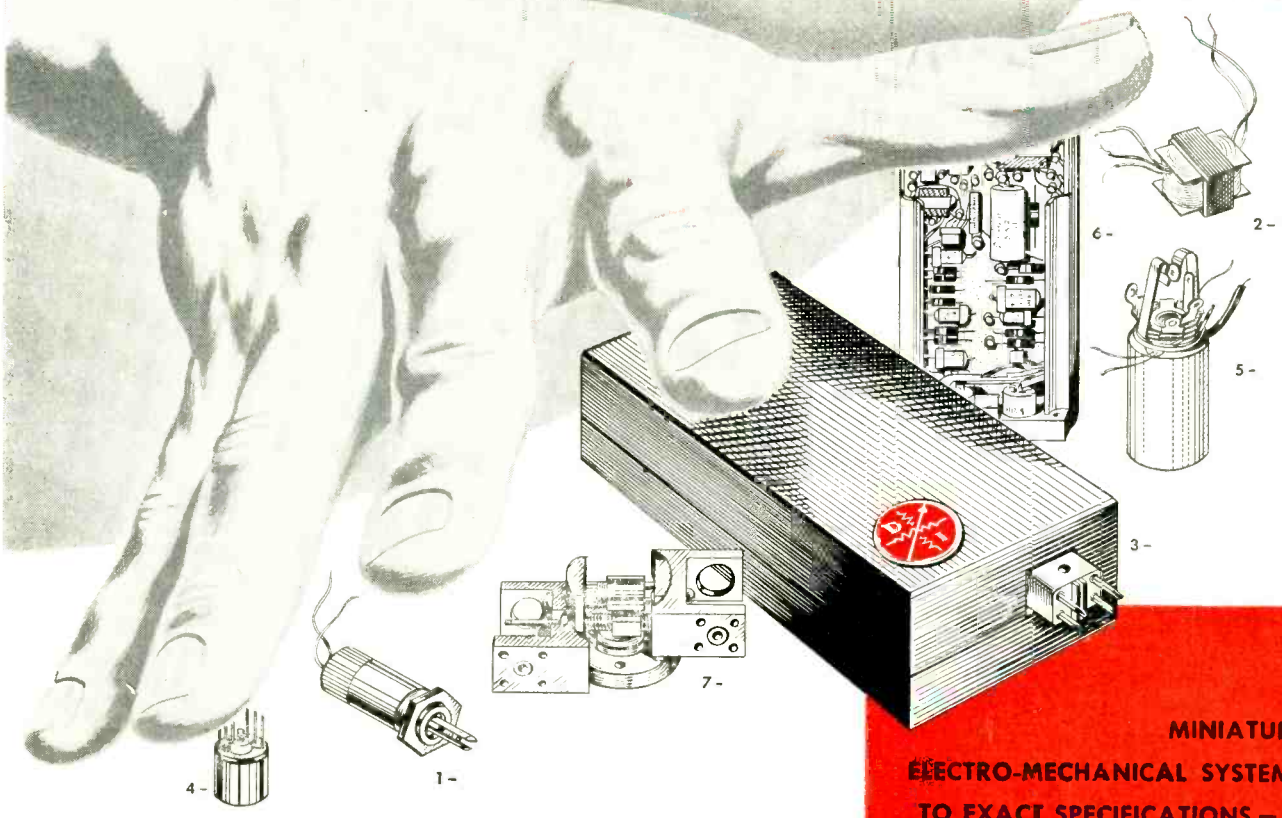
The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK

SYSTEMS ENGINEERING and PRODUCTION...



for commercial and military applications

The span of Daystrom's "know-how" is unparalleled in development, design and production. Under one roof—from drawing board to finished product—Daystrom meets all rigid quality standards . . . high reliability . . . and low costs. In the field of miniaturization Daystrom has developed many general-purpose miniaturized components, through the design and manufacture of complete systems involving fire control, computers, missile applications and process control. Daystrom can help you, too. Write for further information.

SEE THESE . . . and other production units, at our Booth 102 I. S. A. Show in September

MINIATURE ELECTRO-MECHANICAL SYSTEMS TO EXACT SPECIFICATIONS –

1 – Miniature Solenoids
2 – Driver Transformers
3 – Transistorized Receivers
4 – Miniature I. F. Transformers
5 – Perimeter Jacks
6 – Power Transistor Servo Amplifiers
7 – Miniature Ball Disc Integrator

These were developed for Daystrom miniaturized systems such as All-Attitude Indicators—Transistor Servo Amplifiers—Transistor Circuitry for Telemetering Computors and Control Applications—Dead Reckoning Indicators—Magnetic Pick-ups—Miniature Differentials, and others.

DAYSTROM INSTRUMENT

DIVISION of DAYSTROM INC.

ARCHBALD, PENNA.

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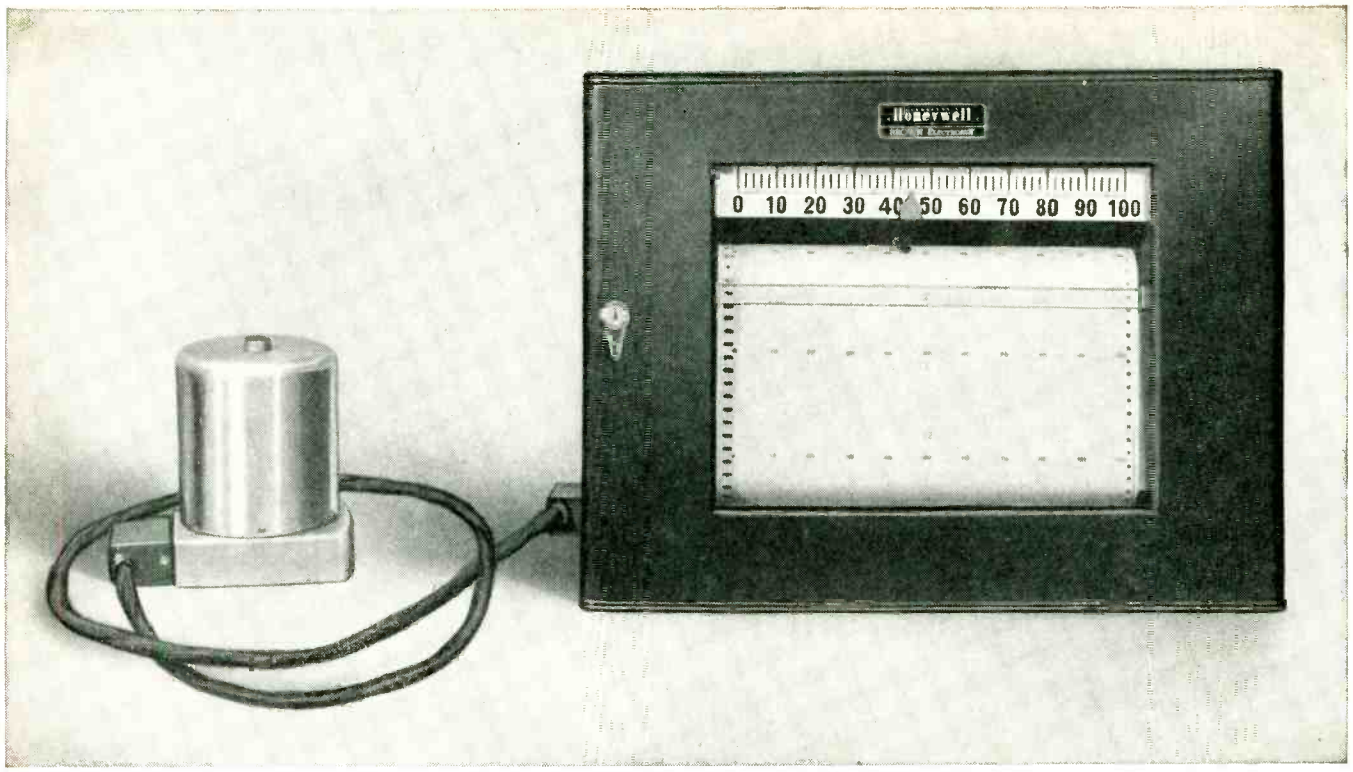

Record radiation data in lab or plant

...with the BROWN ELECTROMETER

Valuable aid in chemical nucleonics, this instrument records currents as small as 10^{-15} ampere . . . useful in isotope tracer studies, nuclear fuel reprocessing, and similar atomic investigations.

THE exceptionally high sensitivity of the Brown Electrometer makes it ideal for a wide range of atomic radiation measurements. Use it with beta gages, ion chambers, photoelectric scintillation counters or other detecting elements which produce minute currents. It is excellent, too, for use in mass spectrometers . . . in spectroscopic analysis using vacuum phototubes.

The Electrometer consists of a preamplifier head connected to a special *ElectroniK* recorder. In addition to current measurements, it can be supplied as a high-impedance millivoltmeter. Full scale range is 10^{-13} amperes for maximum sensitivity model . . . can be changed by 10 or 100 to 1 by means of a range switch. System accuracy is approximately 1% of scale. Zero drift should not exceed 0.3 millivolt per day. Input resistor is 10^{11} ohms for highest current sensitivity . . . also supplied in values down to 10^5 ohms.

High stability and low system noise assure dependable measurements. Switches can be provided in the instrument to actuate external alarms at preset limits of radiation level.

The Brown Electrometer, proved by years of use in leading atomic installations, is a valuable asset in any lab doing nuclear studies. Call your local Honeywell field engineer for a discussion of your application . . . he's as near as your phone.

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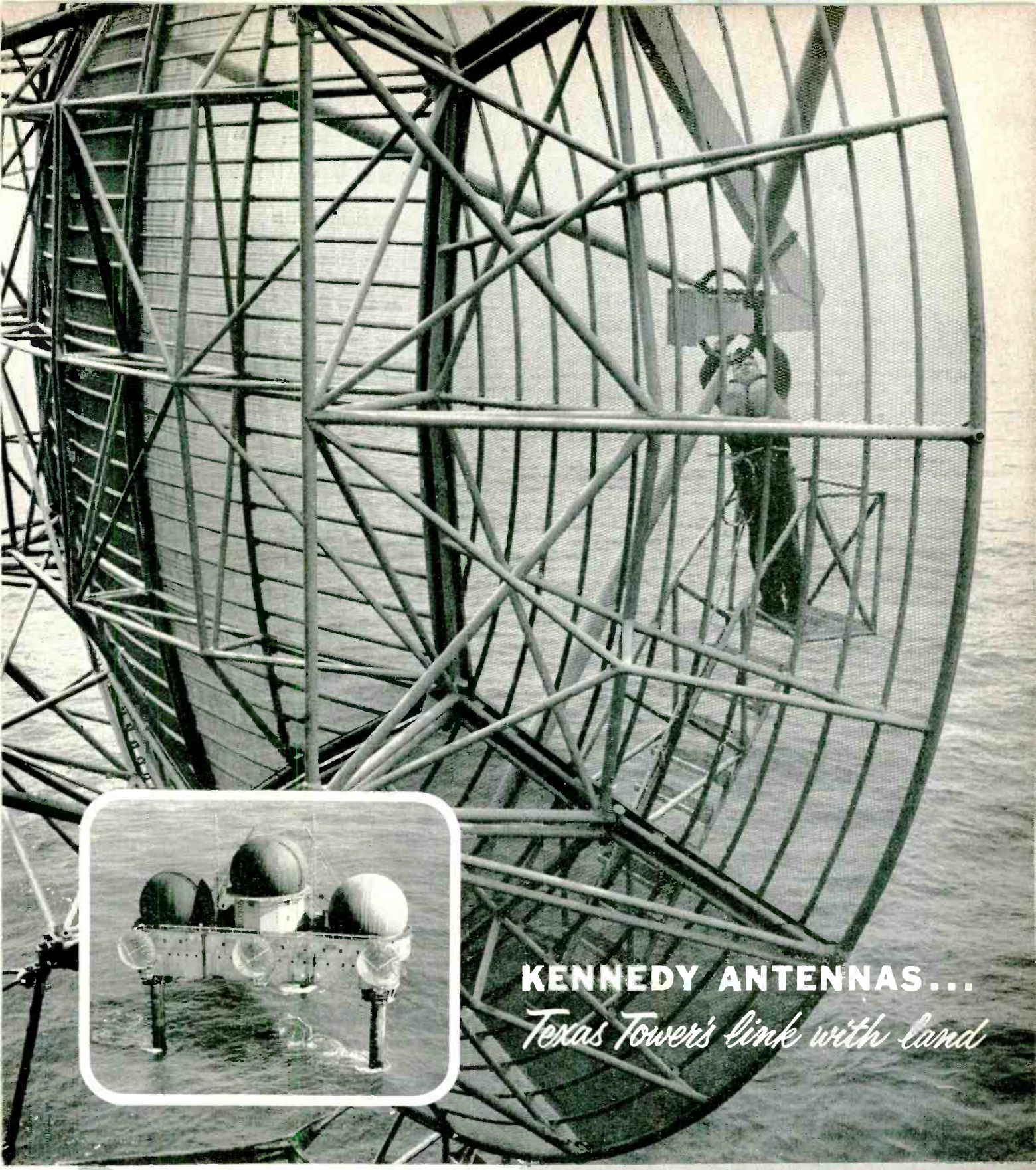
● **REFERENCE DATA:**
Write for Data Sheet No. 10.0-4b, "Minute Current Measurement."

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls



KENNEDY ANTENNAS...

Texas Tower's link with land

Perched high above the Atlantic, an Air Force technician makes an adjustment on a 28′ scatter antenna — one of three standard Kennedy antennas assigned to a very special job on Texas Towers. These silent sentries relay incoming signals to the mainland, where the message can be read the same instant it is received off shore. Like the many mighty Kennedy antennas performing defense duty all over the free world, they're solid evidence that Kennedy is the name to remember when you are faced with antenna problems.

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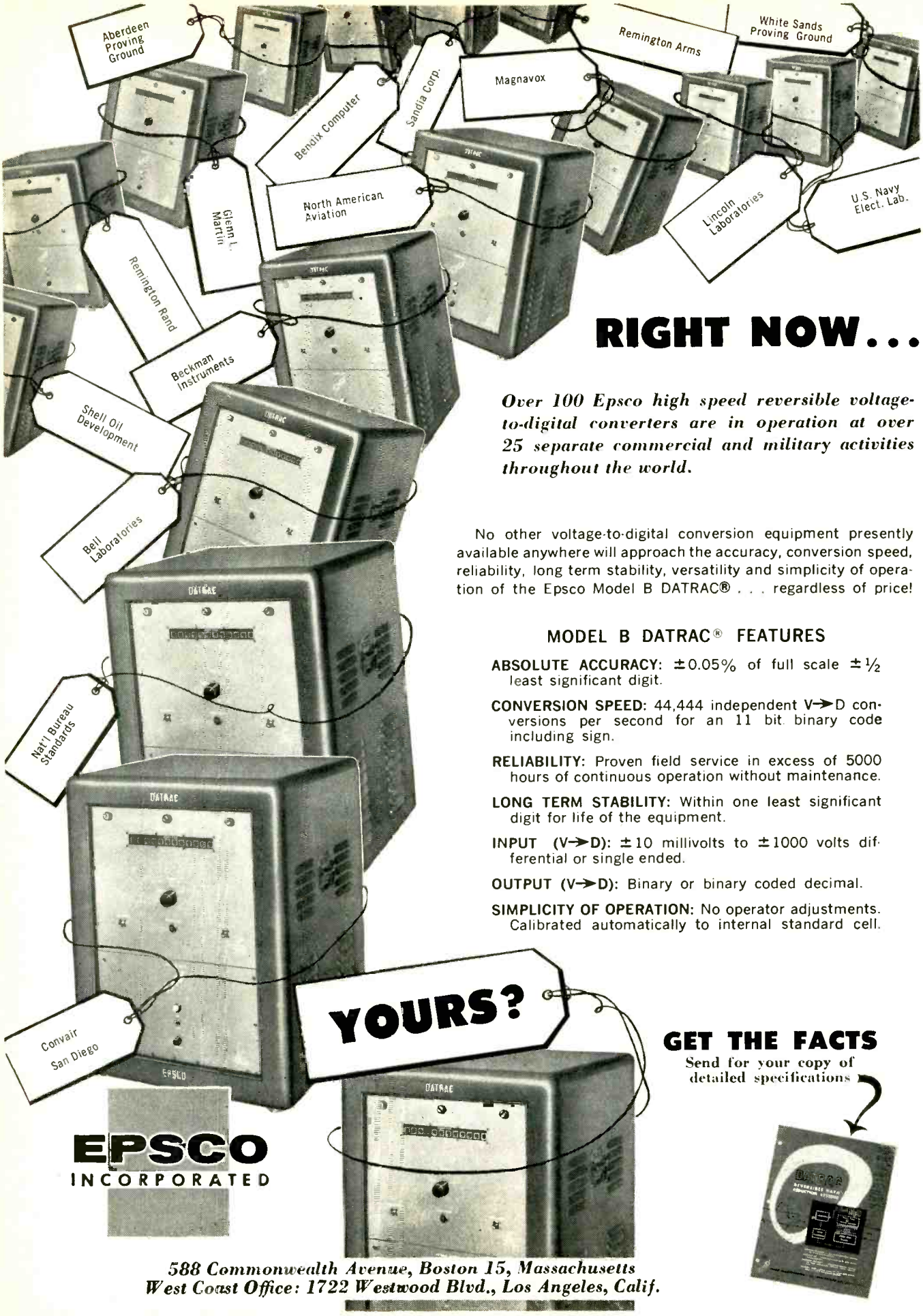
Ionospheric Scatter — Tropospheric Scatter



RIGHT NOW...

Over 100 Epsco high speed reversible voltage-to-digital converters are in operation at over 25 separate commercial and military activities throughout the world.

No other voltage-to-digital conversion equipment presently available anywhere will approach the accuracy, conversion speed, reliability, long term stability, versatility and simplicity of operation of the Epsco Model B DATRAC® . . . regardless of price!

MODEL B DATRAC® FEATURES

ABSOLUTE ACCURACY: ±0.05% of full scale ±½ least significant digit.

CONVERSION SPEED: 44,444 independent V➔D conversions per second for an 11 bit binary code including sign.

RELIABILITY: Proven field service in excess of 5000 hours of continuous operation without maintenance.

LONG TERM STABILITY: Within one least significant digit for life of the equipment.

INPUT (V➔D): ±10 millivolts to ±1000 volts differential or single ended.

OUTPUT (V➔D): Binary or binary coded decimal.

SIMPLICITY OF OPERATION: No operator adjustments. Calibrated automatically to internal standard cell.

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GET THE FACTS

Send for your copy of detailed specifications

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INCORPORATED

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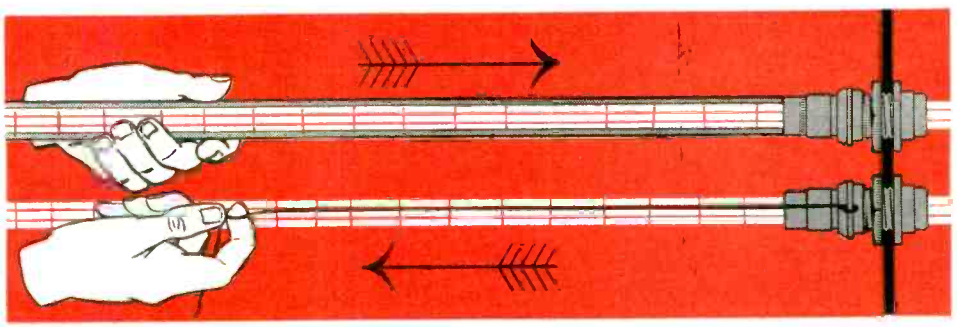
West Coast Office: 1722 Westwood Blvd., Los Angeles, Calif.

Designed for your impossible installations . . . where space is at a premium. You can't see, feel, or even reach it, but somewhere at the other end of your gear-filled nightmare a connection has to be made without lockwiring . . . disconnected without twisting.

So you use a Deutsch miniature Push-Pull Connector. Push to connect, automatically lock and seal . . . pull back to disconnect instantly . . . all in a straight line. Push. Pull. That's all. Incidentally, Deutsch Push-Pull Connectors meet AN "E" requirements.



Where the connection is remote...
connect with a tube, disconnect with a lanyard. The Deutsch miniature push-pull operates in the direction of plug travel, without threading, bayonet or coupling nut.

Want to make some good professional connections? We've prepared an 8-page illustrated report, which tells all about our Push-Pull Connectors, and our line of miniature quick-disconnects. It's number 901A.

Did you hear what the Man from Convair told the Man from Douglas? Startling! It all took place at the Symposium on Electrical Connectors, reported in Technical Paper 901B. We'd be pleased to send you a copy in a plain wrapper.

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ELECTRICAL CONNECTORS · FITTINGS · CLAMPS / BLIND RIVETS
HYDRAULIC FITTINGS / INDUSTRIAL FITTINGS / GAS VALVES

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VARO 400 CYCLE FREQUENCY METER

Completely insensitive to wave form and accurate to better than 0.01%

MODEL 6503

Frequency range from 397-403 cps with accuracy better than 0.01%; or 370-430 cps with accuracy of 0.1%.

The VARO Model 6503 will accurately measure the repetition rate of voltage spikes, sawtooth waveforms, or badly distorted sine waves. It will also measure frequency of input signal voltage between 6 and 250 volts without need for adjustment.

Designed for laboratory and control applications, the Model 6503 provides an exceptionally linear recorder output circuit which may be adjusted to 1 volt output for 30 cycle frequency deviation. Write for complete details.

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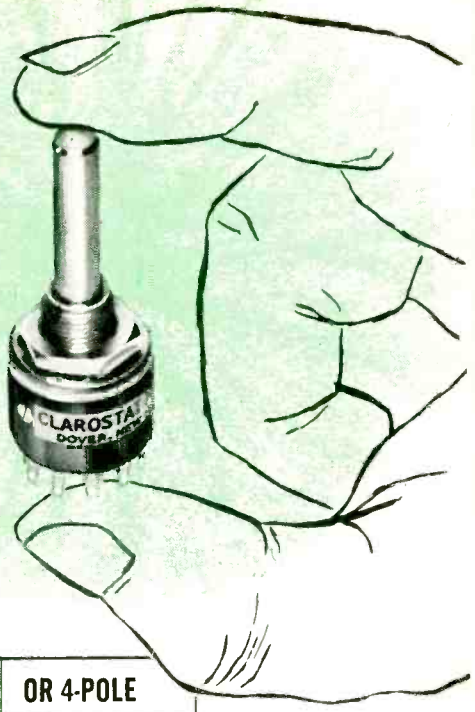
Miniaturized rotary selector switch

available from

CLAROSTAT

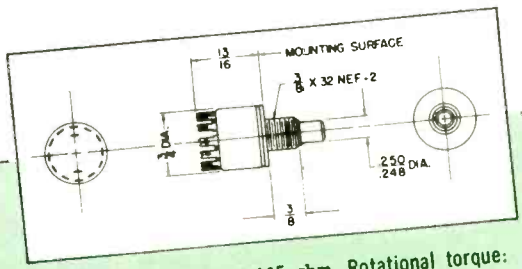


Series BH Rotary Selector Switch is compact yet versatile. Opens the door to still smaller designs in both military and civilian electronic equipment. Tested under MIL-S-3786 specifications. Meets severe-service requirements with maximum convenience in multiple-switching functions.

1-	2-	3-	OR 4-POLE
12-	6-	4-	OR 3-POSITION

ACTUAL SIZE

U.S. Pat. No. 2,463,945



Featuring . . .

- ★ In single-pole to and including 12 positions; two-pole to six positions; three-pole to four positions; four-pole to three positions.
- ★ Shorting or non-shorting, as required.
- ★ Current ratings: 50 ma. at 300 v. AC or DC; 500 ma. at 30 v. AC or DC.
- ★ All moving parts and contact mechanism totally enclosed for protection from dust.
- ★ All current-carrying members of phosphor-bronze with coin-silver overlay.
- ★ Contact resistance: 0.005 ohm. Rotational torque: 12 to 20 oz./in.
- ★ Dielectric strength: tested at sea level, 1000 v. for 1 minute; at high altitude (1.3 in. Hg.) 450 v.
- ★ Insulation resistance: 10 megohms minimum.
- ★ Mechanical shock: refer to MIL-S-901 Type C.
- ★ All units pass 10,000 cycle test.
- ★ Standard: ⅜ x 32, ⅜" long threaded mounting bushing. ¼" round shaft.
- ★ Available as encapsulated units.

Write for further details. Your specific inquiries invited for engineering collaboration and quotations.

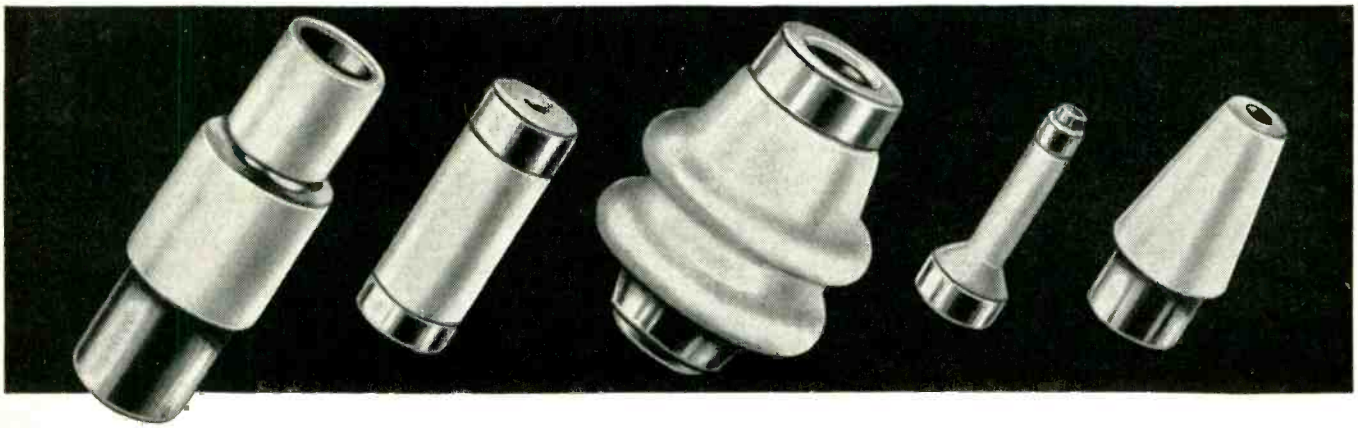
CLAROSTAT®

Controls and Resistors

CLAROSTAT MFG. CO. INC., DOVER, NEW HAMPSHIRE

British Commonwealth of Nations: A. B. Metal Products Ltd., 17 Stratton Street, London, W. 1, England

Here's an exciting new development in metallized ceramics!



NICOTE METALLIZED CERAMIC COATING

for use with both hard and soft solders!

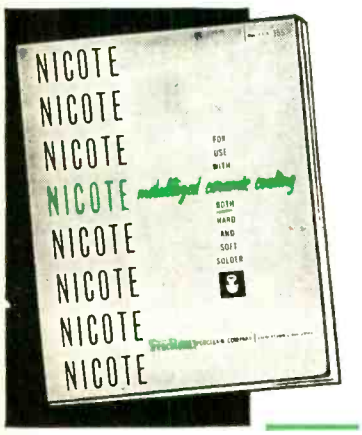
Here is Frenchtown's revolutionary answer to a problem that has baffled industry for years . . . a satisfactory *single* metallic coating for refractory ceramic bodies which provides a surface for applying solders with melting points between 275° and 1600°.

NICOTE, applied to refractory ceramic bodies by high temperature firing, in most applications requires no expensive preliminary processing such as buffing, electroplating, or tinning to form a strong, firmly-adhering bond with either *hard* or *soft* solders.

Whether the problem requires the fastening of a metal part or other metallized ceramic parts to its surface, NICOTE offers distinct advantages over ordinary silver soft receptive coatings as well as molybdenum and tungsten hard solder coatings. It will withstand molten soft soldering *indefinitely* . . . it's less costly to produce . . . requires no expensive processing.

NICOTE'S mechanical bond to the refractory ceramic body approximates ceramic strength, making it ideal for hermetic seals, high strength mechanical seals, and vacuum type applications.

Like to know more about the amazing possibilities of NICOTE Metallized Ceramic Coating for your product? Bulletin 155 contains complete engineering details. Write for a free copy today. There's no obligation, of course.



This idea starter is free for the asking . . . contains complete facts and details about NICOTE . . . Frenchtown's new single metallic coating for use with both hard and soft solders. Ask for Bulletin 155.

frenchtown PORCELAIN COMPANY

86 MUIRHEAD AVENUE | TRENTON 9, NEW JERSEY

New Leesona No. 108 Coil Winders (foreground) in the plant of Ram Electronics, Inc., Irvington, N. Y., where Leesona Winders have become "standard equipment." These were added as best winders for producing short runs of stick-wound coils of varying specifications. (Inset) Ram has built an excellent reputation for winding quality coils and transformers used in radio and TV equipment.

RAM standardizes on Leesona coil winders...adds No. 108 machines

These winders help maintain highest quality standards . . . with good production performance

Ram Electronics, Inc. (Irvington, N. Y.) earned its fine reputation by adhering to unusually high quality standards.

This reputation, of course, is one they intend to keep. So in adding to coil winding facilities they picked Leesona No. 108 Coil Winders, standardizing on Leesona equipment which has served them so well in the past. To quote Mr. Del Vecchio, plant manager:

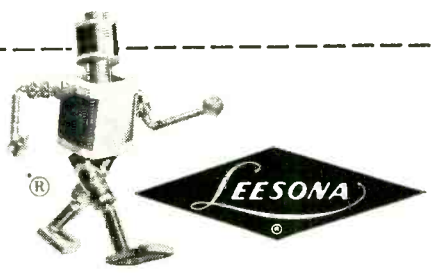
"We have come to count on Leesona Coil Winders to assure the high quality coils we insist upon for our products. That's why any additions to our present installation will be Leesona winders."

The Leesona No. 108 Hand Feed Coil Winder was designed specifically for complete accuracy, great flexibility and top production at low operating cost.

Investigate

how Leesona No. 108 Coil Winders can perform with great efficiency in your plant. The coupon will bring you complete details, together with other helpful coil winding information. Why not check and mail it today?

23B-5-6



FOR WINDING COILS
IN QUANTITY...
ACCURATELY...USE
LEESONA WINDING MACHINES

UNIVERSAL WINDING COMPANY

P. O. BOX 1605, PROVIDENCE 1, RHODE ISLAND, Dept. 124

Please send me

- ☐ Bulletin on the Leesona No. 108 Hand-Feed Coil Winder.
- ☐ Condensed catalog of Leesona Winders.
- ☐ Bulletin on the new Leesona *Pay-As-You-Profit Plans* for purchasing or leasing modern coil winding machinery.

Name.....Title.....

Company.....

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

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For High Q and Excellent Capacitance Stability

CP

PLASTICON CAPACITORS are made with NATVAR Styroflex®

CP Plasticon Type P Capacitors are available with metal can containers in 22 capacities ranging from 0.1 mfd at 1000 vdc to 25 mfd at 100 vdc; and with tubular "Glass-mike" containers in 22 capacities from .001 mfd at 1000 vdc to 1.0 mfd at 100 vdc.

Capacitors designed and manufactured by Condenser Products Co., Division of New Haven Clock & Watch Co. are extensively used in calculators, computers, integrating circuits, electronic controls, sawtooth oscillators, and other equipment where stability and low dielectric loss are important.

Natvar Styroflex film is used as the dielectric because it has all of the outstanding properties of polystyrene, plus complete flexibility due to bi-axial orientation during the manufacturing process.

If you need an insulating material with the desirable characteristics of polystyrene—plus flexibility, it will pay you to investigate Natvar Styroflex. Ask for new data sheet ST-1, just off the press.

Natvar

Natvar Products

- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fiberglas
- Varnished papers—rope and kraft
- Slot cell combinations, Aboglas®
- Isoglas® sheet, tape, tubing and sleeving
- Vinyl coated—varnished—lacquered tubing and sleeving
- Extruded vinyl tubing and tape
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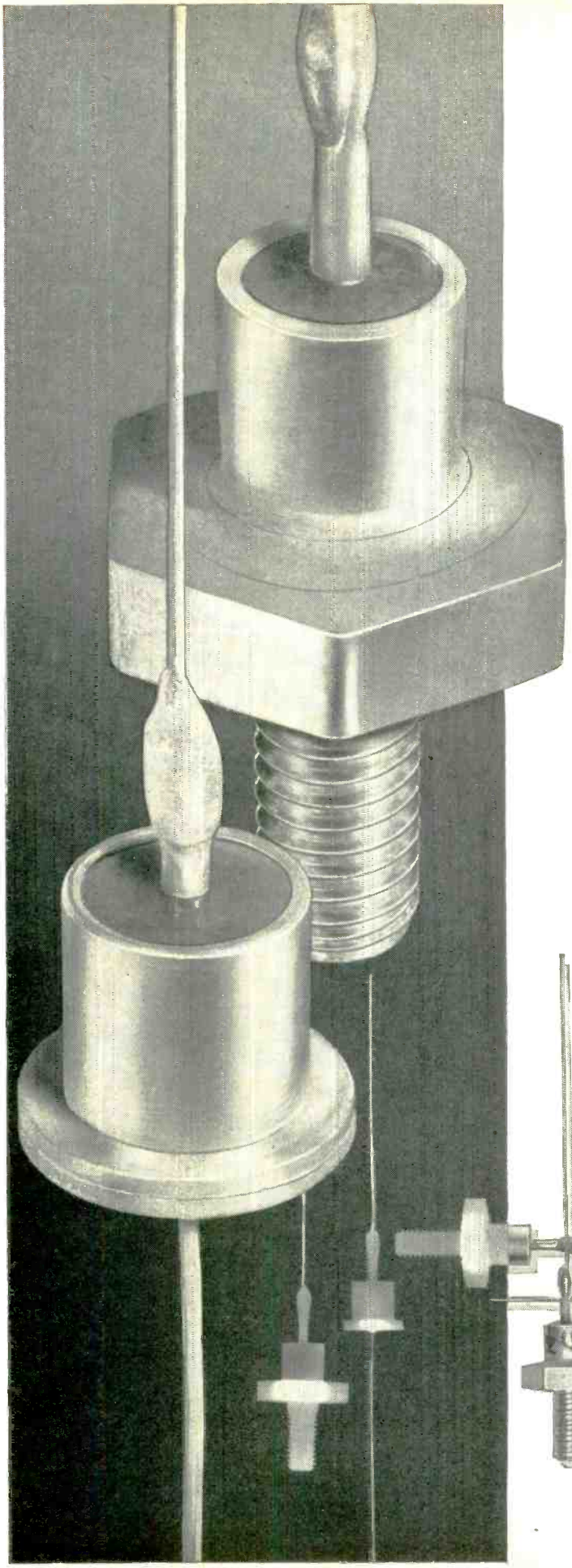


WESTINGHOUSE
SILICON DIODE

High peak inverse voltages . . . extremely low reverse current

The Westinghouse XP-5052 fused-junction silicon diode can handle 500 ma continuous d-c current at peak inverse voltages from 50 to 600 volts.

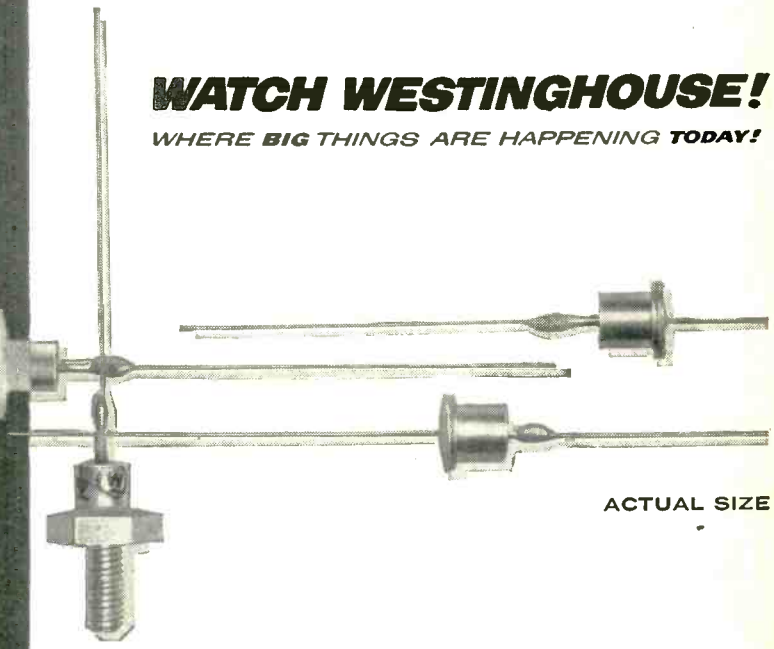
Leakage at rated voltage is extremely low . . . result is increased efficiency and temperature ranges never before attainable.

This diode is suitable for use in radio and TV, radar, aircraft, magnetic amplifiers, voltage regulators, computers, precipitators, and other industrial applications. Two case designs are immediately available . . . pigtail (XP-5052) and threaded stud (XP-5053).

For more information on the XP-5052, or any other silicon rectifier requirements, regardless of voltage and current, call your nearest Westinghouse apparatus sales office, or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-09001

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***



ACTUAL SIZE

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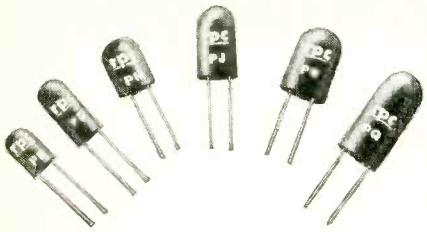
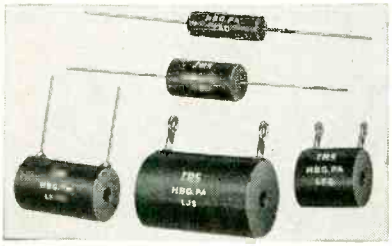


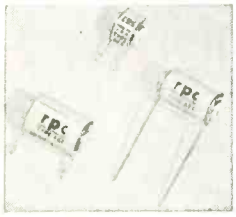
NEW **Printed Circuit Precision Resistors**

To meet the requirements for printed circuitry, RPC has developed Type P Encapsulated Wire Wound Precision Resistors Miniature, single ended units designed for easy rapid mounting on printed circuit panels with no support other than the wire leads. Many newly developed techniques are employed in the manufacture of Type P Resistors. These units can be operated in ambient temperatures up to 125°C. and will withstand all applicable tests of MIL-R-93A, Amdt. 3 Available in 6 sizes, rated from 1/10 watt to .4 watt. ¼" diameter by 5/16" long to ⅜" diameter by ¾" long. Resistance values to 3 megohms. Tolerances from 1% to 0.05%.



Encapsulated Precision Wire Wound Resistors

RPC Type L Encapsulated Resistors will withstand temperature and humidity cycling, salt water immersion and extremes of altitude, humidity, corrosion and shock without electrical or mechanical deterioration. Type L resistors are available in many sizes and styles ranging from sub-miniature to standard with lug terminals, axial or radial wire leads. Available for operation at 105° C. or 125° C. ambient temperatures. These resistors will meet all applicable requirements of MIL-R-93A, Amdt. 3. Type L can be furnished with all resistance alloys and resistance tolerances from 1% to .02%.



Wire Wound Precision Resistors

Type A Precision Resistors are widely used for all general requirements. They are available in a wide variety of sizes, styles and terminal types. They can be furnished with all resistance alloys in tolerances from 1% to .02%. Type A will meet the requirements of MIL-R-93A, Amdt. 2, Characteristic B. Special winding techniques, impregnation and thermal aging result in resistors of exceptional stability. Matched resistors, networks and special assemblies can be supplied.

HIGH QUALITY RESISTORS FOR ELECTRONICS

RPC is a widely recognized supplier of high quality resistors to industry, Government Agencies and the Armed Forces. Advanced production methods, modern equipment and scientific skill enables RPC to manufacture resistors of *highest quality* in *large quantities* at *reasonable cost*. Modern manufacturing plant is completely air conditioned and equipped with electronic dust precipitators to insure highest production accuracy. RPC resistors are specified for use in instruments, electronic computers, radiation equipment, aircraft equipment and scientific instruments.

Test equipment and standards for checking and calibrating are equalled by only a few of this country's outstanding laboratories. Our ability to produce resistors of highest quality coupled with prompt delivery have established RPC as a leading manufacturer of resistors. Small or large orders are promptly filled.

Representatives in principal cities. For full information send for latest catalog.

Wire Wound Precision Meter Multiplier Resistors

Type MFA and MFB High Voltage Wire Wound Resistors are Hermetically Sealed in glazed steatite tubes with ferrule ends for maximum protection against all adverse environmental conditions. Fully meet all requirements of JAN-R-29. Special multi-section winding insures greatest safety factor due to low voltage gradient between sections. Standard resistors up to 6 megohms, 6 KV, 0.5% tolerance. Higher resistance and closer tolerances available. MFA 9-25/32 inches long x 1 1/32 inches diameter. MFB 5 9/32 inches long x 1 1/32 inches diameter.

High Voltage Resistors

Type B Resistors are stable compact units for use up to 40 KV. These resistors are used for VT voltmeter multipliers, high resistance voltage dividers, bleeders, high resistance standards and in radiation equipment. They can be furnished in resistance to 100,000 megohms. Available as tapped resistors and matched pairs. Sizes range from a 1 watt resistor 1 inch long x 5/16 inch diameter rated at 3500 volts, to a 10 watt resistor 6½ inches long x 9/16 inch diameter rated at 40 KV. Low temperature and voltage coefficients. Standard resistance tolerance 15%. Tolerances of 10%, 5% and 3% available. Tolerance of 2% available in matched pairs.

High Megohm Resistors

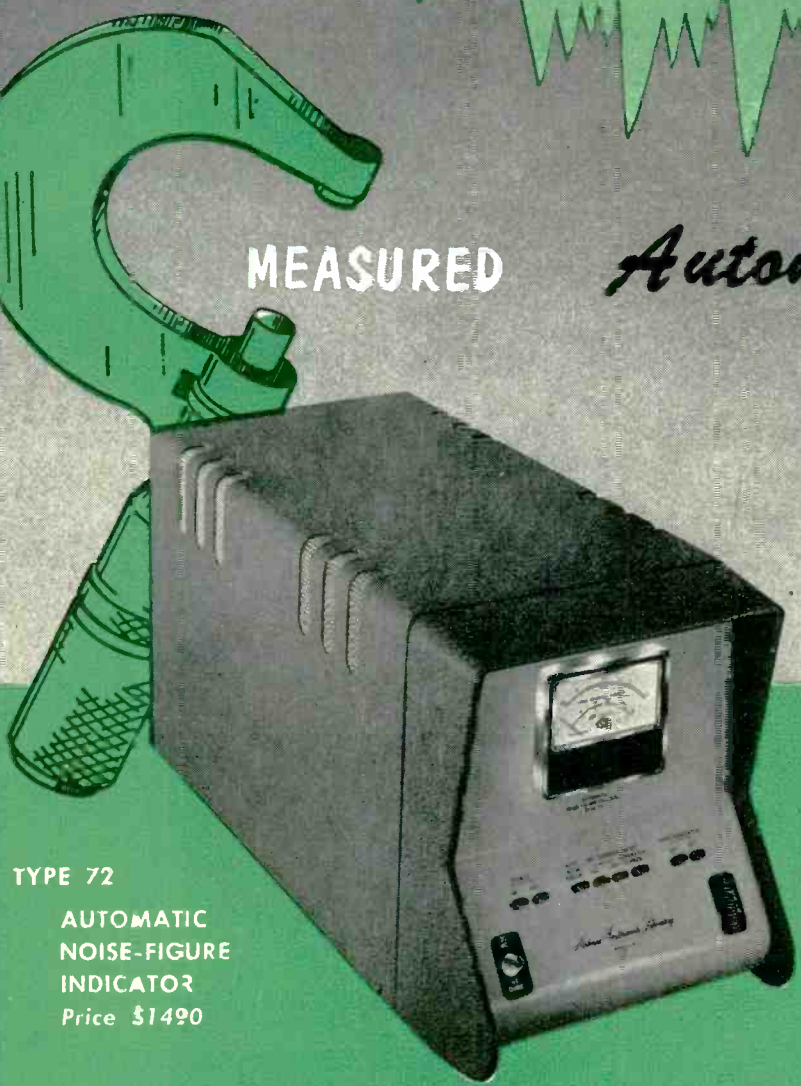
Type H Resistors are used in electrometer circuits, radiation equipment and as high resistance standards. Resistance available to 100 million megohms, (10^{14} ohms). For utmost stability under adverse conditions Type HSD and HSK Hermetically Sealed are recommended. Eight sizes from ⅛ inch to 3 inches long are available. Voltage rating to 15,000 volts. Low temperature and voltage coefficients. Standard resistance tolerance 10%. Tolerance of 5% and 3% available. Also matched pairs 2% tolerance.

RESISTANCE PRODUCTS CO. 914 S. 13th Street HARRISBURG, PA.

At Last

Receiver NOISE FIGURE

MEASURED *Automatically* and *Continuously*



TYPE 72
AUTOMATIC
NOISE-FIGURE
INDICATOR
Price $1490

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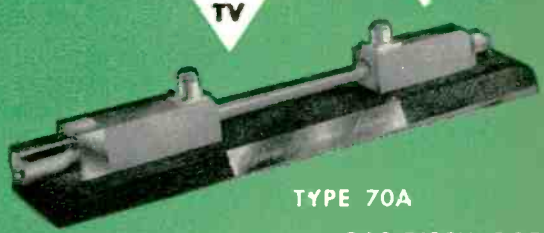
FOR RADAR TV

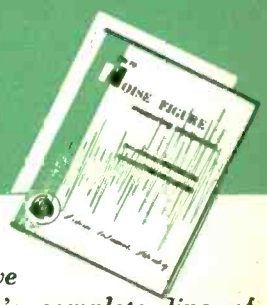
ON THE PRODUCTION LINE



TYPE 70A
GAS-DISCHARGE
NOISE SOURCE
200 TO 2600 MC
Price $330

RANGE 0-20 db ACCURACY ±0.5 db

0-40 db version available at additional cost, on request



AIRBORNE INSTRUMENTS LABORATORY
INCORPORATED.

160 OLD COUNTRY ROAD, MINEOLA, L. I., N. Y.

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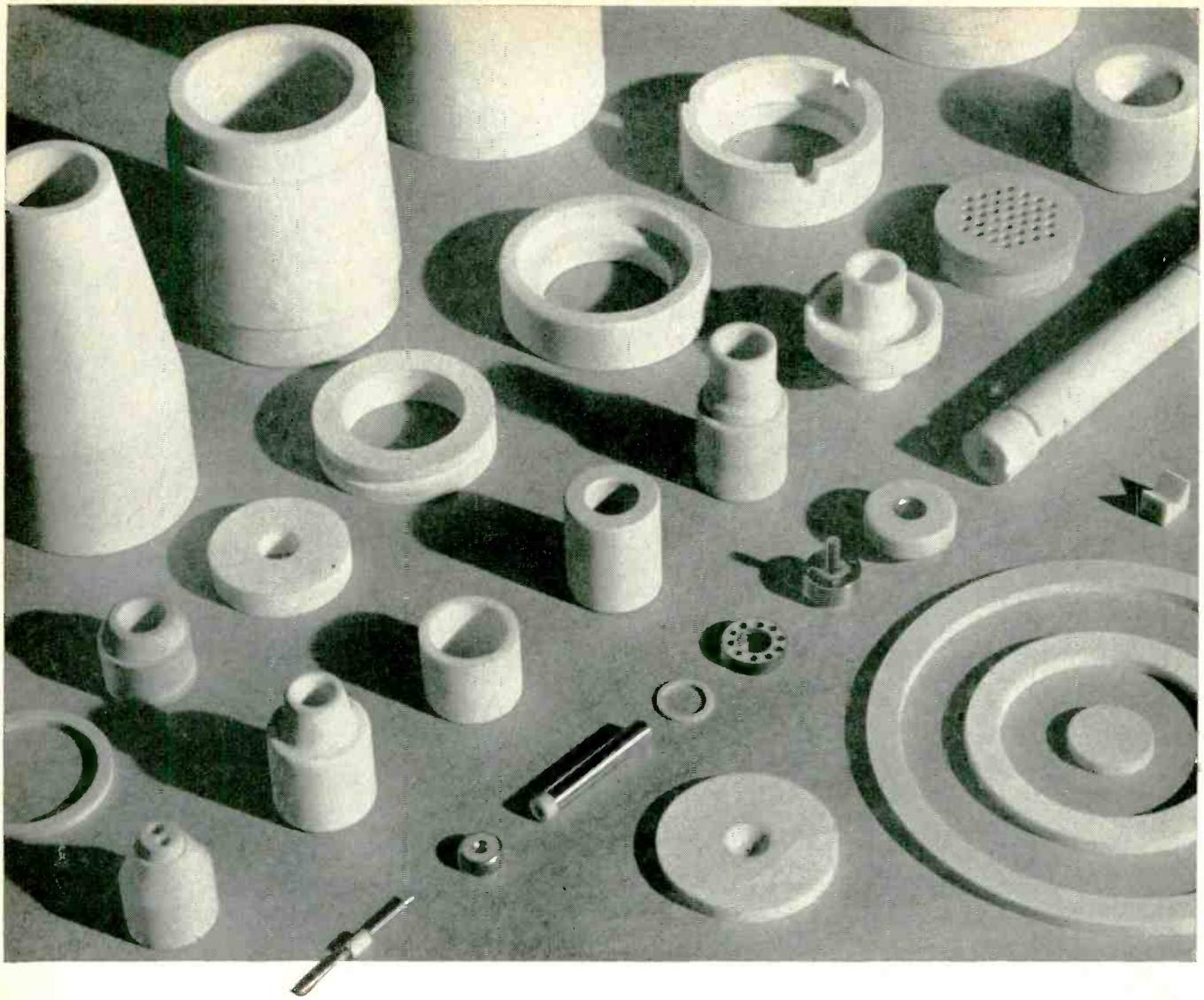
For fully descriptive literature on AIL's complete line of Noise-Figure Measuring Equipment. Ask for Series 70 brochure.



Can ALITE solve a materials problem for you?

For designers seeking a material that possesses exceptionally high dielectric characteristics, plus superior mechanical strength and high temperature stability, Alite offers many interesting possibilities.

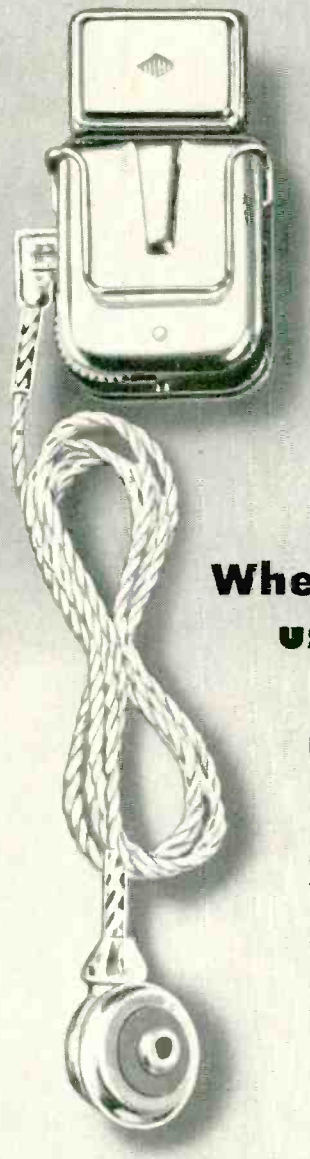
Alite comprises a series of sintered metallic oxides which we can form to practically any shape by extruding, pressing, molding or casting, and can finish to any precision you require by diamond wheel grinding. The series of Alite formulations based on aluminum oxide exhibit a wide range of excellent physical and electrical properties which make them well suited for many critical applications. Alite retains its diamond-like hardness, abrasion resistance and physical strength at working temperatures well above 2000°F. It has proved highly successful in such uses as rotating seals, pump plungers, slide valves, bearings, bushings, and extrusion dies.

Alite Formulation AE-212 is designed specifically for electronic applications. It is ideal for use as tube envelopes, as insulating supports—anywhere that a combination of high dielectric and mechanical strength is required.

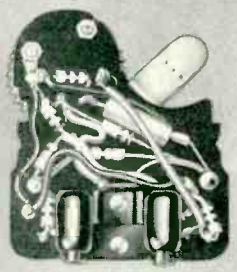
If you are designing a new product or improving an existing one, you'll certainly want to explore all the advantages of Alite. Bulletin A-7 gives complete comparative data. Write for a free copy today.

U. S. STONEWARE
AKRON 9, OHIO

340E

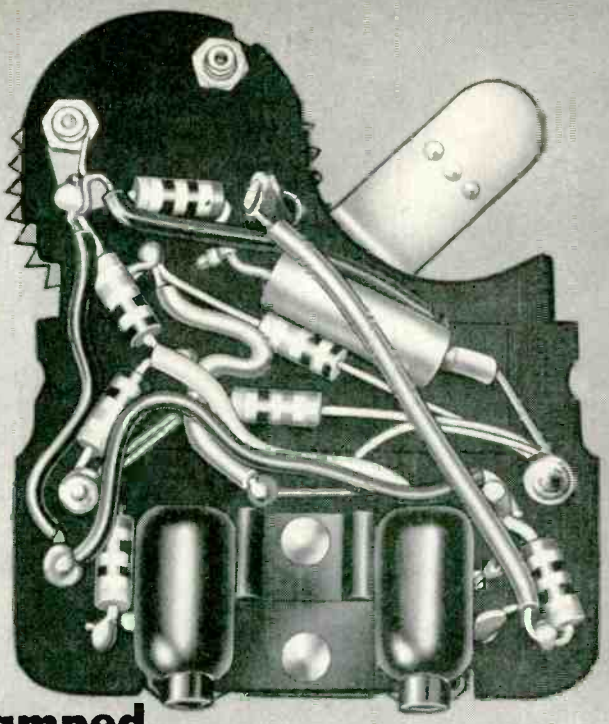


ZENITH
Hearing Aid Chassis



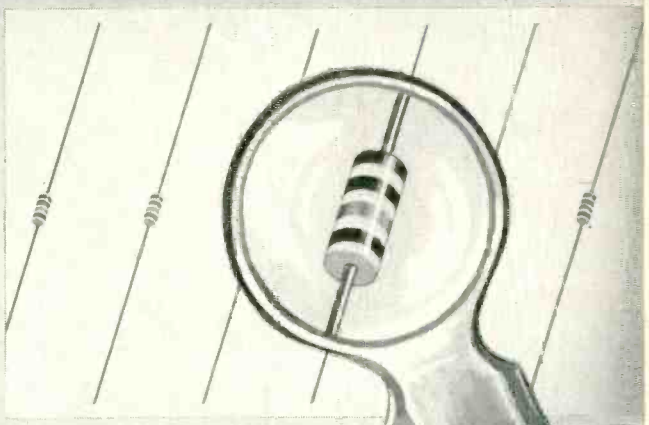
ACTUAL SIZE

The tiny chassis of the Zenith "Crest" hearing aid carries the components for the transistorized amplifier, with 6 Allen-Bradley Type TR tiny resistors.



Where space is cramped, use Allen-Bradley Type TR resistors

If you have a miniaturization problem and you must cramp a handful of components into an "impossibly small space," then install Allen-Bradley Type TR tiny resistors. They really are small . . . 0.067 in. diameter and 0.140 in. long. The maximum continuous wattage rating at 70 C is 0.1 watt.



ACTUAL SIZE

These solid molded units have an insulating coating and can be operated continuously with the insulation subjected to a maximum potential of 200 v, d-c.

Type TR resistors are available in standard RETMA and MIL resistance values at standard tolerances of plus or minus 5, 10, and 20%.

The lead wires are 1⅛" long and are specially processed so they can be soldered with amazing ease, even after long periods in stock.

The Type TR resistor is not only the smallest resistor on the market but, as is true for all Allen-Bradley resistors, catastrophic failure (except through physical abuse) cannot happen!

Write, today, for complete Type TR data.

ALLEN-BRADLEY
RADIO & TELEVISION COMPONENTS

Allen-Bradley Co.
110 W. Greenfield Ave., Milwaukee 4, Wis.

Please send me technical data on the A-B Type TR resistors.

Name_____

Address_____

City_____ State_____

■ *". . . Indox I provides the designer with space conservation in a new direction . . ."*

■ *". . . Indox I shows exceptional promise for use in traveling wave tubes . . ."*

■ *". . . The high coercive force of Indox I permits both, or all, of the poles to be located on one surface of the magnet, so pole pieces can be eliminated . . ."*

■ *". . . Indox I magnets can be placed behind decorative coverings without an excessive loss in holding force—a significant design feature when equipment styling is important . . ."*

■ *". . . The high-temperature coefficient of Indox I opens a completely new field for permanent magnets . . ."*

from "Applied Magnetics"

CERAMIC MAGNETS

If you use permanent magnets, you should investigate the advantages of Indox I . . . the most significant permanent magnet development since the introduction of Alnico!

Indox I opens new and wider horizons of design possibilities. The applications listed below are only some of the more promising.

Smaller size . . . a longer effective life . . . lighter weight . . . savings in cost . . . improved performance . . . are just a few of the benefits already reported by users of this ceramic magnet.

Indox I is *not* a substitute for the magnetically stronger magnets such as Alnico. Instead, it extends the field of application for magnets . . . permitting design changes not always possible with Alnico.

Investigate the advantages Indox I may hold for *your* product. Our design and application engineers will be glad to help. And, because we make *all* types of permanent magnet materials, you can be sure our recommendations will be for that magnet material which will do the best job in your product. For prompt recommendations, without cost or obligation, call or write to Valparaiso today!

These special properties of Indox I:

1. **No critical materials**
2. **High coercive force**
3. **Magnetization before assembly**
4. **High resistivity**
5. **Low specific gravity**
6. **Cost advantage**
7. **High potential energy**
8. **Low incremental permeability**

. . . offer significant advantages in these applications:

ELECTRONIC
- *TV focuser (1, 2, 5, 6)
- Traveling wave tube (2, 3, 5)
- *Loud-speakers (1, 2)

HOLDING (1, 3, 6, 7)
- *Cabinet latches
- *Can openers
- *Holding assemblies (flashlights, fishing poles)
- Door closers (refrigerators)
- Conveyors (automation)
- *Toys and novelties

POLARIZING (2, 4, 8)
- Sonar
- Magnetostriction cleaning homogenizing ultrasonics

ELECTRO-MECHANICAL
- *Synchronous drives (1, 2, 6, 7)
- Motors
  - d-c fields (2, 6)
  - a-c rotors (1, 3, 6, 7)

MISCELLANEOUS
- *Arc blowout (2, 4)
- *Temperature control

Note: The numbers following each application, or group of applications, identify those properties of Indox I that make it particularly well-suited to that product.

**Indox I magnets are currently being produced for these applications.*

ALNICO
Conventional-type television focuser used three Alnico magnets . . . as shown to right.

INDOX I
Shaded area shows ring type magnet . . . with simpler mounting. There are savings in space and weight.

ALNICO
Note depth of conventionally designed magnet drive unit.

INDOX I
Note *shorter* length of drive unit made of Indox I . . . which also is lighter.

Here's "Applied Magnetics" (Vol. 4, No. 3) which gives you detailed information on the design and application of Indox I Ceramic Permanent Magnets. Use this coupon to ask for your copy:

The Indiana Steel Products Company
Dept. A-9
Valparaiso, Indiana

World's Largest Manufacturer of Permanent Magnets

Please send "Applied Magnetics" (Vol. 4, No. 3).

name_____

company_____

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city_____ zone____ state_____

INDIANA PERMANENT MAGNETS

1 KW OUTPUT

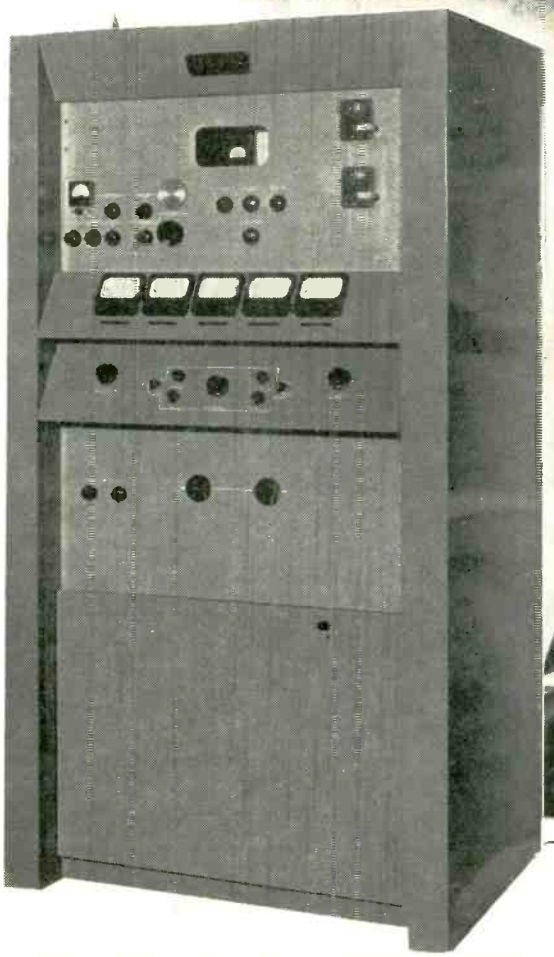
From 3 to 32 MC.

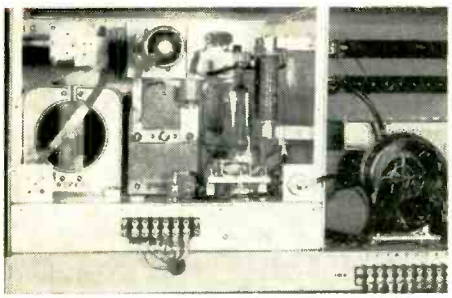
GATES Hi-Watter SERIES

a Reservoir of **POWER**

Here is a new Gates high frequency transmitter with a conservative rating at 1000 watts output, high level modulated and continuously variable from 3 to 32 Mc. Model HF-1M is one of four similar Hi-Watter models manufactured on the same production line, assuring advanced commercial quality, yet eliminating a premium price tag. This new Gates transmitter may be employed for telegraph, telephone or wide response short wave broadcasting. FSK or high speed keying up to 400 WPM may be added with ease.

HF-1M is a big and husky commercial grade equipment with excellent cooling facilities and a complete complement of laboratory proven components for long trouble-free service. Fully described on Page 98 of Gates catalog No. 59, yours for the asking.





Two control veeder counter logging covers 3-32 Mc range of tank and output Tee network. A total of 4 RF stages select into 10 crystal positions. All stages are self-neutralized.

MODEL HF-1M: Range 2-32 Mc, continuously variable 3-32 Mc from front panel control. Single ended output full Tee network to 49/73 ohm line. Power amplifier single 4-1000A forced air cooled. High level Class B modulation (two 833A tubes) ±2½ Db. 30-10,000 cycles or for voice when used with M5263 amplifier (below); ±2½ Db. 200-2500 cycles. For 230 volts, one phase, 50/60 cycles.

M5263 LIMITER/FILTER AMPLIFIER: Optional accessory to meet FCC requirements for voice transmission in communications service. Accommodates microphone and 600 ohm line. Includes fast action limiter circuit and audio cut-off filter. Gain 86 Db. For 115 volts, 50/60 cycles.

GATES

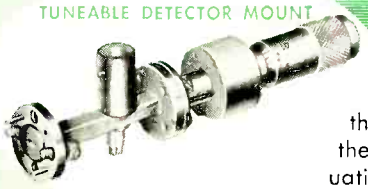
GATES RADIO COMPANY • *Manufacturing Engineers Since 1922* • **Quincy, Illinois, U. S. A.**

big enough?

Built in 283 B.C., the mighty Colossus of Rhodes gave its name to all ensuing efforts of tremendous proportions. It took the Greek sculptor, Chares, 12 years to create and stood 160 feet high. Cast in bronze, with a stone pedestal, it was considered to be the fourth wonder of the world.

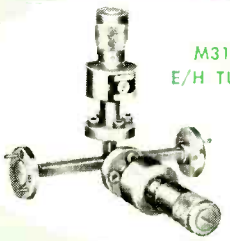
These mm Midgets PERFORM MICROWAVE MIRACLES

M206B
TUNEABLE DETECTOR MOUNT

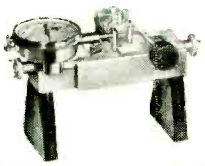


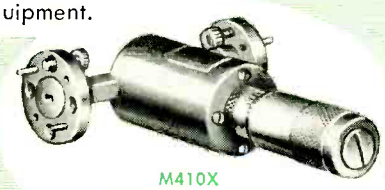
Although the complete line of FXR Millimeter Test Equipment includes the smallest waveguide instruments made, they are *big* in performance. Used for evaluation of microwave components and materials, in the range of 33 to 90 KMc/sec., these units reflect the high degree of engineering and craftsmanship which has made FXR a looming giant among designers and builders of Microwave Test Equipment.

M312B
E/H TUNER



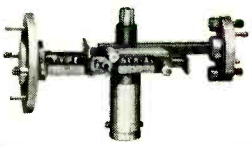
M103A
SLOTTED SECTION



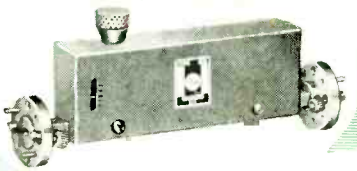


M410X
FREQUENCY METER

M780X
HARMONIC GENERATOR



M151A
FLAP ATTENUATOR



M501A
TERMINATION

FIRST BY FAR

Electronics & X-Ray Division

F-R MACHINE WORKS, Inc.

26-12 BOROUGH PLACE, WOODSIDE 77, N. Y. • ASTORIA 8 2800

Send for complete New 1956-57 Catalog of
FXR PRECISION MICROWAVE TEST EQUIPMENT.

AER-O-COM

DEFINITELY DEPENDABLE!

Aerocom's Dual Automatic Radio Beacon

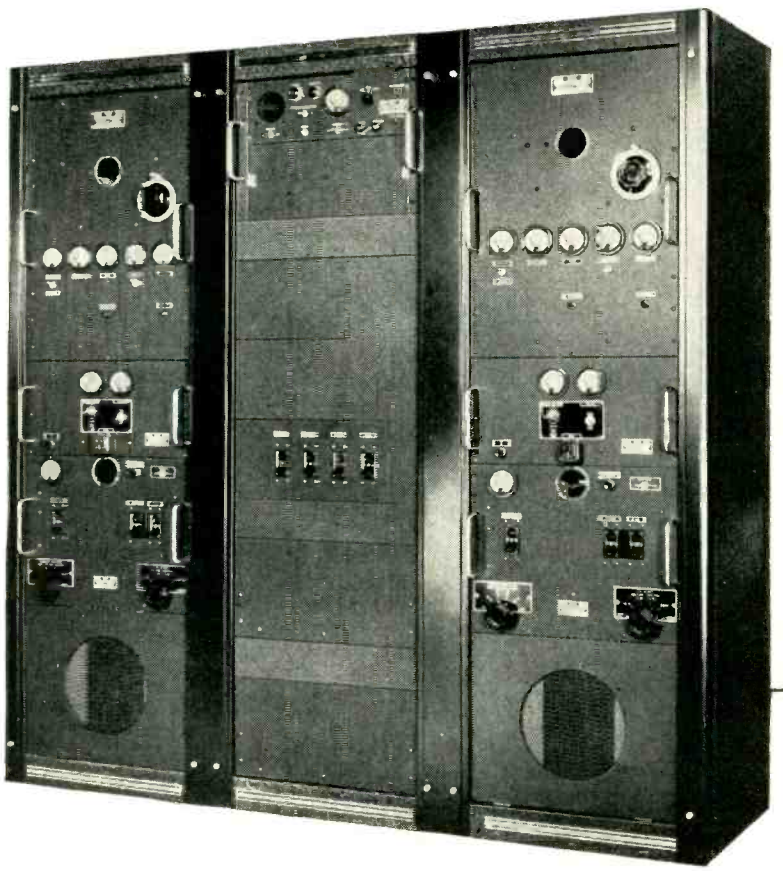
Reliability is built into every part of this dual 1000-watt aerophare unit. Ruggedly constructed and conservatively rated, it provides trouble-free unattended service, and at truly low operating and maintenance cost. It operates in the frequency range 200-415 kcs, using plug-in crystal for desired frequency.

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

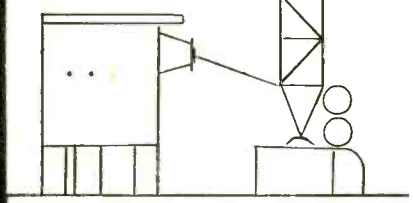
Nominal carrier power is 1000 watts. High level plate modulation of final amplifier is used, giving 30%-35% tone modulation. P-T switch interrupts tone, permitting voice operation. Operates in ambient temperatures from -35°C to 50°C, humidity up to 95%.

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

Antenna may be either vertical tower or symmetrical T type.



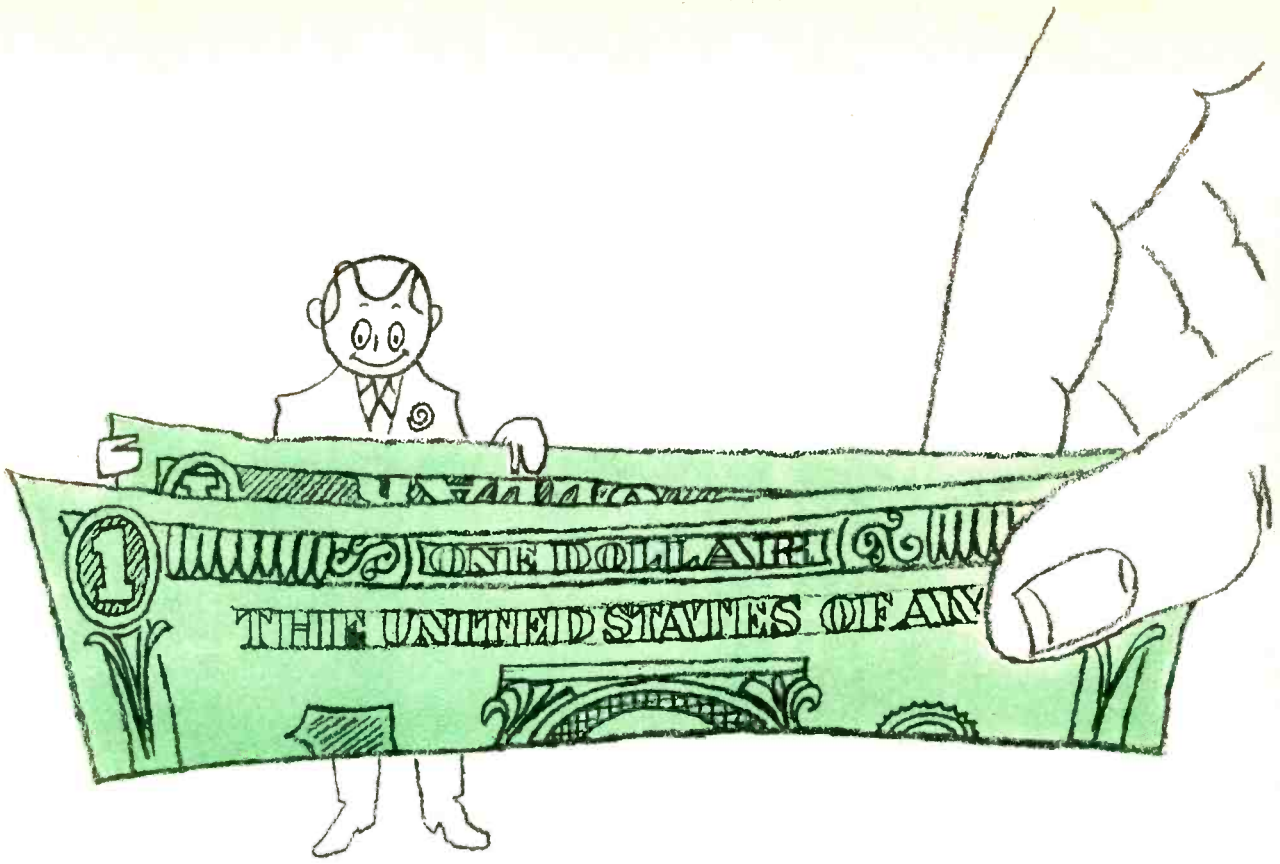
Now! Complete-package, lightweight airborne communications equipment by Aer-O-Com! Write us today for details!



A-101

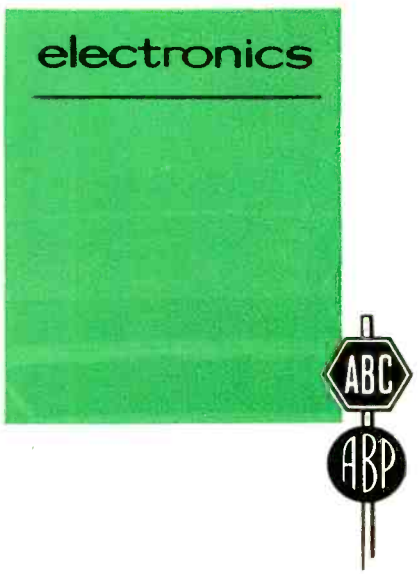
AER-O-COM

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



Want a GIANT DOLLAR'S WORTH?

That's what electronics advertisers get



The price tag is 1.5 cents apiece.

That buys you 40,000 subscribers *paying $6 each* . . . a total readership estimated at 86,000.

But that's not *all* you get from **electronics.**

You reach *every* man who is important in this field. You reach *all* the working engineers who specify and buy raw materials, component parts and equipment.

And results?

electronics produces more sales measured in actual total dollars. This has been established by manufacturers' representatives . . . who do 80% of the business in this industry.

In **electronics** you get a *giant* dollar's worth!

electronics

...of course!

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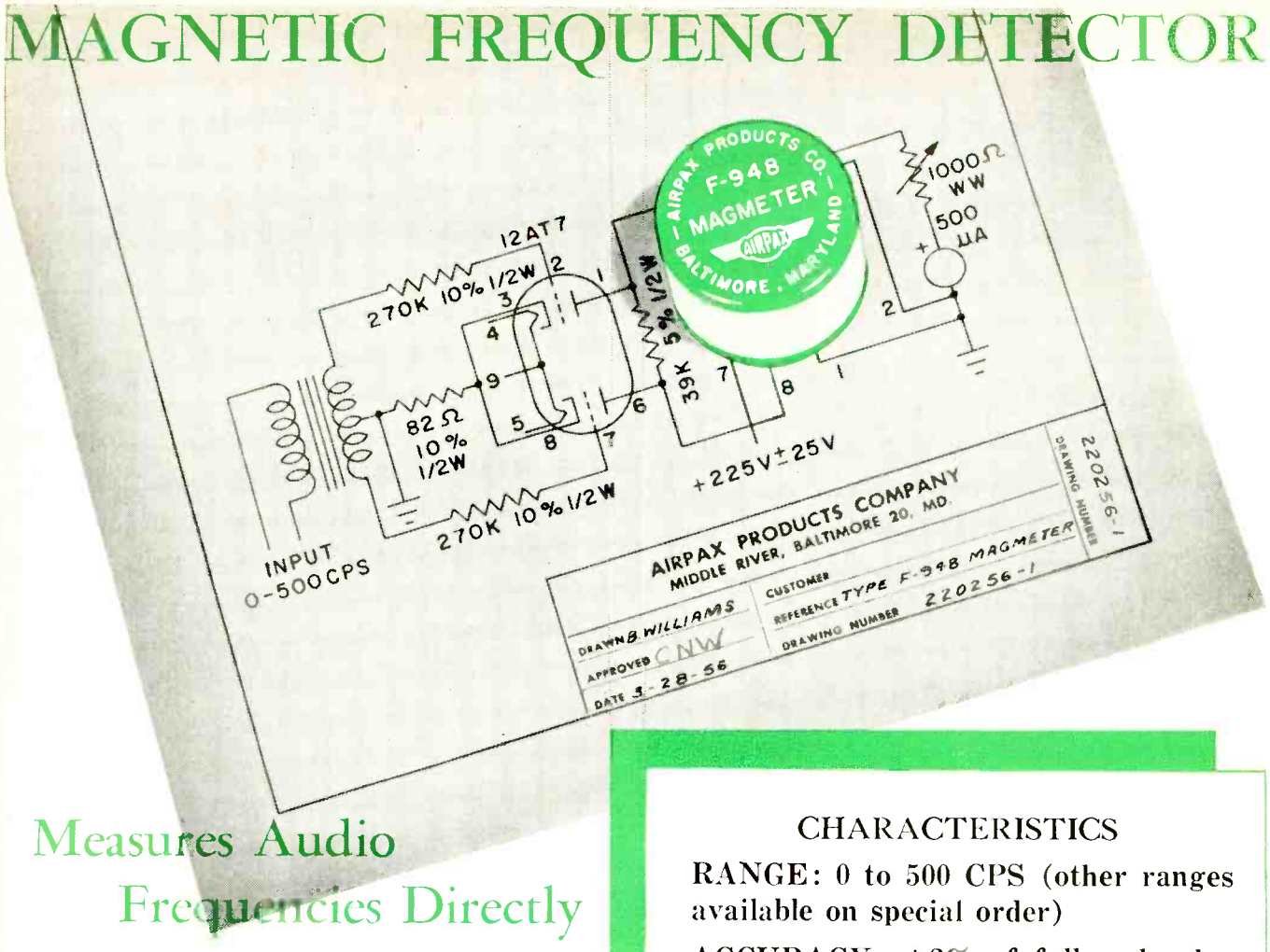
Want more information? Use post card on last page.

MAGNETIC FREQUENCY DETECTOR



Measures Audio Frequencies Directly

Magmeter is an entirely new product—the result of Airpax leadership in developing magnetic components. The Magmeter produces an output signal directly proportional to the input frequency.

In the circuit shown, the 12AT7 dual triode drives the Type F-948 Magmeter over the rated frequency range of 0 to 500 CPS. A 0-500 microampere meter, connected to the Airpax Magmeter, indicates frequency directly. A resistor in series with the meter calibrates the circuit when it is installed. Once adjusted, the Magmeter holds the calibration for long periods of time to at least 2% of full scale.

The Magmeter is completely contained in a can 1¼ inches high and 1½ inches in diameter with a standard octal base. This compact component weighing only 3.4 oz. can be used wherever frequency is measured: in test equipment, AC servos, speed indicators and controls, and power frequency regulators.

You probably have an application in which this one component can replace considerable circuitry. We have a detailed data sheet ready for you, just write to

CHARACTERISTICS

RANGE: 0 to 500 CPS (other ranges available on special order)

ACCURACY: ±2% of full scale plus temperature variation of 500 ppm/C

WAVEFORM SENSITIVITY: less than 1% change in indication for sine, triangular, and square waves of same rectified average value

SHOCK: 30g shocks of 11± 1 milliseconds duration in each plane, case clamped

VIBRATION: 10g in each plane at 10 to 55 CPS, case clamped

TEMPERATURE: —55C to +72C operate; —65C to +85C storage

LIFE: comparable to that of a well made transformer

ENCLOSURE: hermetically sealed

AIRPAX

DESIGNERS ENGINEERS

MIDDLE RIVER BALTIMORE 20, MD.

These tubes died young; a G-E Inductrol* could have saved them

FLUCTUATING VOLTAGE killed off these electronic tubes. Overvoltage murdered most; a five percent overvoltage cuts tube life by almost fifty per cent (see chart below). Undervoltage, which resulted in cathode bombardment of gas or mercury-filled types, ruined more. Even while in use, poor voltage regulation made these tubes perform erratically. And when they died, downtime expenses and replacement costs ran high.

GOOD VOLTAGE gives you maximum tube performance. General Electric Inductrols — induction voltage regulators—are the answer for circuits 600 volts and below. They automatically maintain constant output voltage, help assure accuracy and peak performance of electronic equipment.

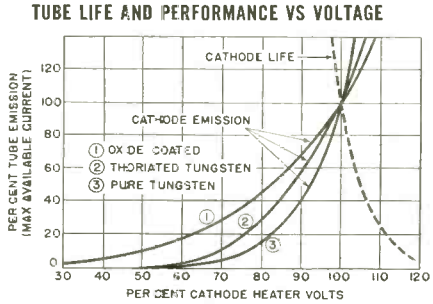
HIGHEST RELIABILITY, no brushes to maintain, and inherent short-circuit strength, make G-E Inductrols a simple, economical solution to voltage problems. Automatic stepless regulation is obtained, accurate within $\pm 1\%$ bandwidth.

MANUFACTURERS build Inductrols into induction heating equipment, radar gear, radio and TV transmitters, computers—to get consistent performance wherever voltage is critical.

USERS of all types of electronic equipment help assure performance and cut costs with Inductrols. For details, see your G-E Apparatus Sales Office or Agent, or write Section 425-4, General Electric Co., Schenectady 5, N. Y.

*Trade-mark of General Electric Company for Induction Voltage Regulators.

TUBE LIFE AND PERFORMANCE VS VOLTAGE

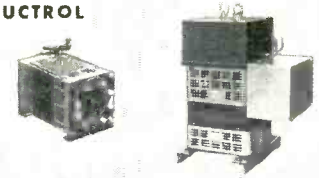


A GENERAL ELECTRIC INDUCTROL FOR EVERY NEED

AUTOMATIC INDUCTROL

Automatic Inductrol—Applied where there is a need for constant voltage, as on radar equipment, electronic computers, induction heaters, rectifiers. Available for single- or three-phase circuits, 600 volts and below.

HAND- OR MOTOR-OPERATED INDUCTROL



Hand- or Motor-operated Inductrol—Provides stepless variable-voltage output over any desired range. For testing, heating, or precipitation equipment, and similar applications. One- and 3-phase—600-v and below.

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GENERAL ELECTRIC

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AVAILABLE AS
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- Transmitters
- Receivers
- Differentials
- Resolvers

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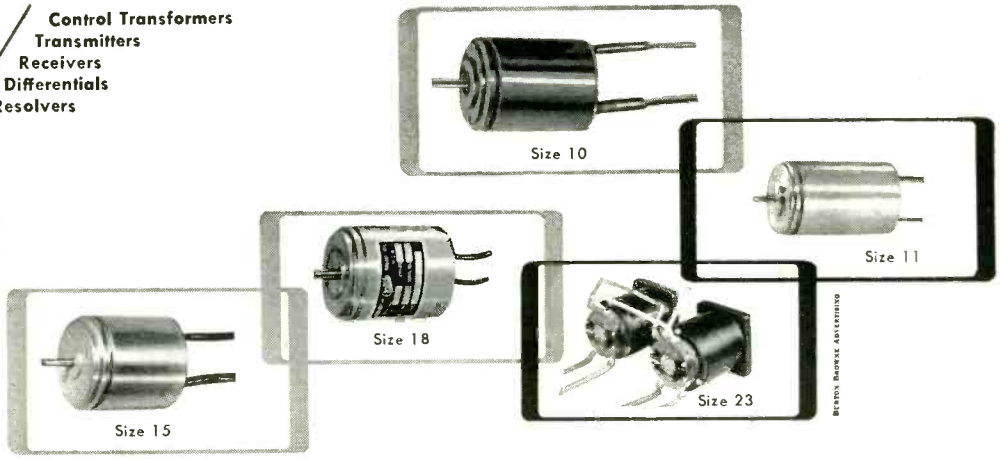

TYPE SYNCHRO	SIZE	OSTER TYPE	Frequency C.P.S.	Input Rotor Volts	Input Rotor Amps	Input Rotor Watts	Output Stator Volts	Input Stator Volts	Input Stator Amps	Input Stator Watts	Output Rotor Volts	Rotor Resistance Ohms	Stator Resistance Line to Line Ohms	Null Voltage	Angular Accuracy Maximum Spread
Control Transformer	10	3G-4055	400	26	0.030	0.30	11.8	11.8	0.060	0.20	21.3	160	45	0.050	30′
Control Transformer	10	3G-4079	400	26	0.008	0.10	11.8	11.8	0.018	0.10	20.3	510	200	0.050	30′
Transmitter	10	3G-4075	400	26	0.180	1.4	11.8	—	—	—	—	25	11	0.070	30′
Receiver	10	3G-4059	400	26	0.180	1.4	11.8	—	—	—	—	25	11	0.070	1½°
Differential	10	3G-4071	400	—	—	—	—	11.8	0.070	0.30	11.8	90	45	0.050	30′
Resolver	10	3G-4063	400	26	0.033	0.40	11.8	11.8	0.050	0.20	18.0	235	42	0.050	30′
Resolver	10	3G-4067	400	26	0.011	0.10	11.8	11.8	0.018	0.10	20.3	450	165	0.050	30′
Control Transformer	11	2C-4105	400	26	0.040	0.030	11.8	11.8	0.085	0.19	22.5	91.5	14.2	0.050	20′
Transmitter	11	2C-4125	400	26	0.150	0.80	11.8	—	—	—	—	20	4.3	0.050	20′
Transmitter	11	2C-4123	400	26	0.230	1.0	11.8	—	—	—	—	10.3	4.0	0.070	20′
Control Transformer	15	2G-4005	400	26	0.065	0.40	11.8	11.8	0.150	0.40	21.4	40	10.2	0.050	15′
Transmitter	15	2G-4025	400	26	0.225	1.25	11.8	—	—	—	—	9.5	3.8	0.070	20′
Receiver	15	2G-4009	400	26	0.10	0.45	11.8	—	—	—	—	16	6.7	0.070	45′
Differential	15	2G-4021	400	—	—	—	—	11.8	0.325	0.9	11.8	—	—	0.040	20′
Differential	15	2G-4041	400	—	—	—	—	11.8	0.120	1.3	11.8	14	10.2	0.050	15′
Resolver	15	2G-4017	400	26	0.014	—	18.0	18.0	0.015	—	21	239	180	0.050	40′
Transmitter 12 Power	18	3H-3309	400	26	0.77	2.3	11.8	—	—	—	—	1.032	0.675	0.050	20′
Differential	18	3H-3301	60	—	—	—	—	90	0.070	2.0	90	730	385	0.125	24′
Transmitter	23	3J-4222	60	115	0.120	3.2	17.0	—	—	—	—	140	8.3	0.050	30′

MANY OTHER VARIATIONS AVAILABLE. YOUR DETAILED SPEC GOVERNS:

- Angular accuracy
- Impedance
- Transformation ratio
- Input and output
- Phase shift
- Humidity treatment
- Fungus treatment
- Mil specs to be met
- Operating temperature range

Consult Oster specialists on your synchro problems today.

Other products include Actuators, Servos, AC Drive Motors, Servo Mechanism Assemblies, DC Motors, Motor-Gear-Trains, Fast Response Resolvers, Servo Torque Units, Reference Generators, Tachometer Generators, Motor Driven Blower and Fan Assemblies and Synchro Indicators.

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Avionic Division
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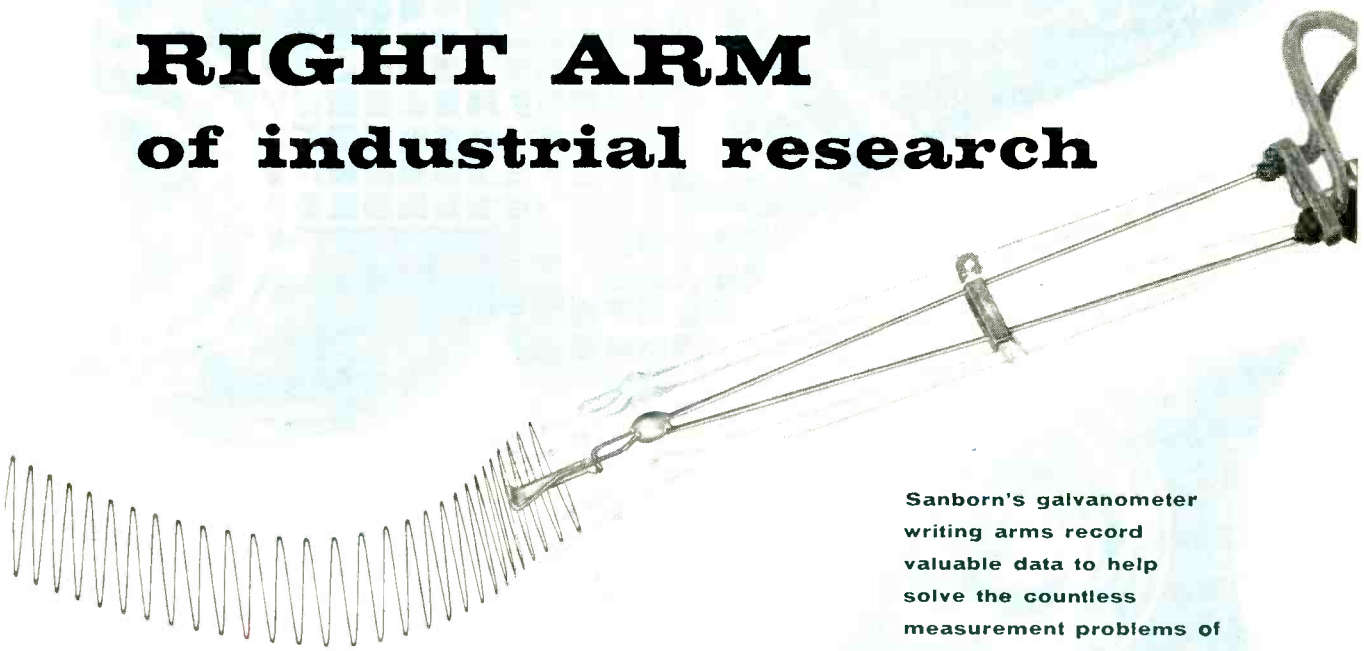
RIGHT ARM
of industrial research



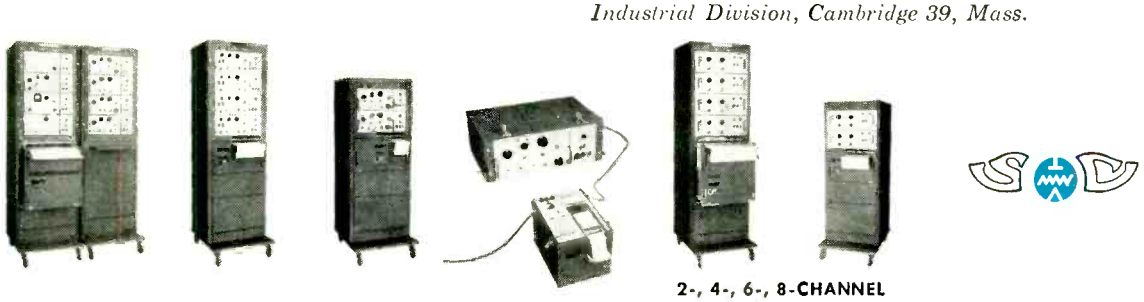
Sanborn's galvanometer writing arms record valuable data to help solve the countless measurement problems of research, design, and production testing.

SINGLE to 8-channel inkless and permanent recording in true rectangular coordinates of 0-100 cps phenomena — ranging from telemetered aircraft data to atomic reactor characteristics — is the vital and growing role of Sanborn oscillographic recording systems in industry. The Sanborn file of users indicates that such recordings are aiding in the dynamic analysis of jet engine starters, machine tools, agricultural machinery and oil drilling equipment; performance of pilotless target aircraft, modern submarines and tracking radar systems; and the production testing of servo components, valve positioners and precision potentiometers. Sanborn systems designed especially for recording analog computer output extend applications further — in simulated flight set-ups, solution of complex problems with six or eight variables, etc.

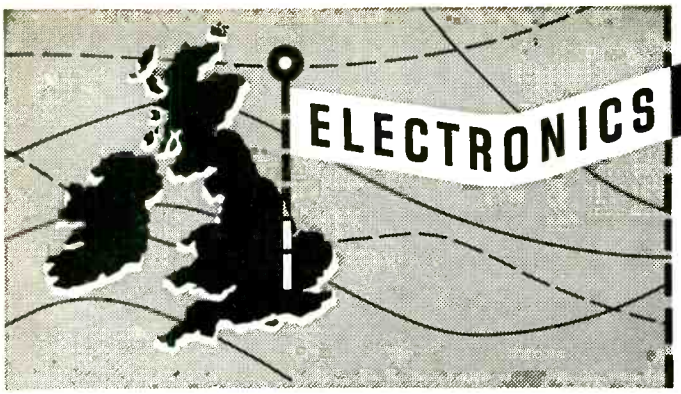
The advantages of making Sanborn equipment the "right arm" of *your* recording problems include extreme *flexibility*, by means of a dozen different interchangeable, plug-in "150 Series" preamplifiers which quickly and economically adapt a basic system to changing requirements; choice of 1-, 2-, 4-, 6- or 8-channel systems, in vertical mobile cabinets or "portably packaged"; numerous chart speeds, many individual channel controls, and high over-all system linearity.

To see how oscillographic recording the Sanborn way can become the "Right Arm" of *your* analysis work, write for detailed information or contact your Sanborn Representative. Sixteen-page "150 System" catalog on request.

SANBORN COMPANY
Industrial Division, Cambridge 39, Mass.



8-, 6- CHANNEL | 4-CHANNEL | 2-CHANNEL | 1-CHANNEL | 2-, 4-, 6-, 8-CHANNEL ANALOG COMPUTER SYSTEMS



The British Electronics Industry is making giant strides with new developments in a variety of fields. Mullard tubes are an important contribution to this progress.

EF86

Another Mullard contribution to high fidelity

The Mullard EF86 audio frequency pentode is one of the most widely used high fidelity tubes in Britain today. It has been adopted by the leading British manufacturers whose sound reproducing equipment is enjoying increasing popularity in the United States and Canada.

The marked success of this tube stems from its high gain, low noise and low microphony characteristics.

By careful internal screening, and by the use of a bifilar heater, hum level has been reduced to less than 1.5μV. Over a bandwidth of 25 to 1,000c/s equivalent noise input approximates 2 μV.

When operated below 1,000c/s, internal resonances of the EF86 are virtually eliminated. Even at higher frequencies chassis and tube socket damping are usually sufficient to make vibration effects negligible.

Supplies of the EF86 are now available for replacement purposes from the companies mentioned here.

Principal Ratings

Heater	6.3V, 0.2A
Max. plate dissipation	1W
Max. screen dissipation	0.2W
Max. cathode current	6mA

Characteristics

Plate voltage			250V
Screen voltage			140V
Grid voltage			—2V
Plate current			3mA
Screen current	0.6mA	Transconductance	1800 μmhos

Base

Small button noval 9-pin

Supplies available from:—

In the U.S.A. International Electronics Corporation,
Dept. **E9,** 81 Spring Street, N.Y.12,
New York, U.S.A.

In Canada Rogers Majestic Electronics Limited,
Dept. **IL,** 11-19 Brentcliffe Road,
Toronto 17, Ontario, Canada.

Mullard

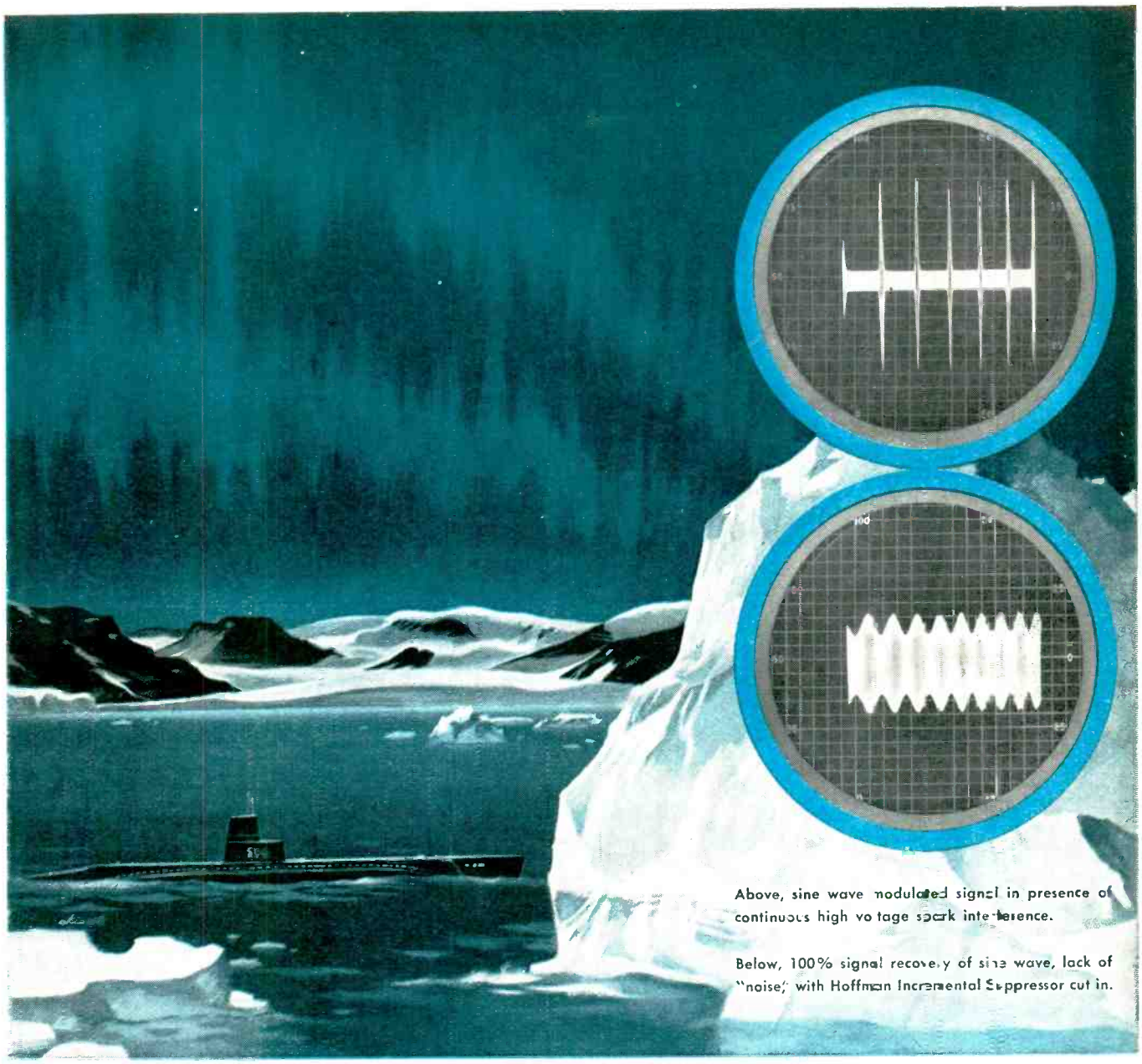
ELECTRONIC TUBES

used throughout the world

MULLARD OVERSEAS LTD., CENTURY HOUSE, SHAFTESBURY AVE., LONDON, ENGLAND

Mullard is the Trade Mark of Mullard Ltd. and is registered in most of the principal countries of the world.

MEV 3-



Above, sine wave modulated signal in presence of continuous high voltage spark interference.

Below, 100% signal recovery of sine wave, lack of "noise," with Hoffman Incremental Suppressor cut in.

HOW TO GIVE NOISE THE SILENT TREATMENT

SITUATION: *A submarine surfaced somewhere in iceberg country, attempting to establish communications with distant base.*

PROBLEM: *Interference, or "noise," critically garbles message reception. Radio operator cannot hear message above interference.*

SOLUTION: *Operator switches on Hoffman Incremental Interference Suppressor, an exclusive feature of Hoffman Communications Receivers. Atmospheric noise is silenced—vital message comes through loud and clear.*

This significant achievement in the science of communications has undergone extensive field tests under rugged service conditions. Tests demonstrate that in CW, FSK and AM communications, Hoffman-developed noise limiting techniques can give 100% message recovery from a signal containing atmospheric static 80 decibels greater than the carrier. Interference caused by static, corona discharge, lightning and most man-made noise is reduced to a minimum. Result: clear, reliable radio-communications under extremely adverse operating conditions. The imaginative engineering teamwork and skill that pioneered in the reduction of noise in radio communications is ready to tackle your communications problems too—from basic research through final production.

Hoffman Laboratories is engaged in these many other associated fields of electronics:

Airborne Radar and Navigational Equipment ... Missile Guidance and Control Systems ... Electronic Countermeasures ... Advanced Communications Techniques in the VLF, HF, VHF and UHF regions ... High Speed Search and Electronically Tuned Receivers.

This creates a constant need for engineers and physicists of highest calibre. Professional stature in mechanical engineering, electrical or electronics engineering or physics is required.

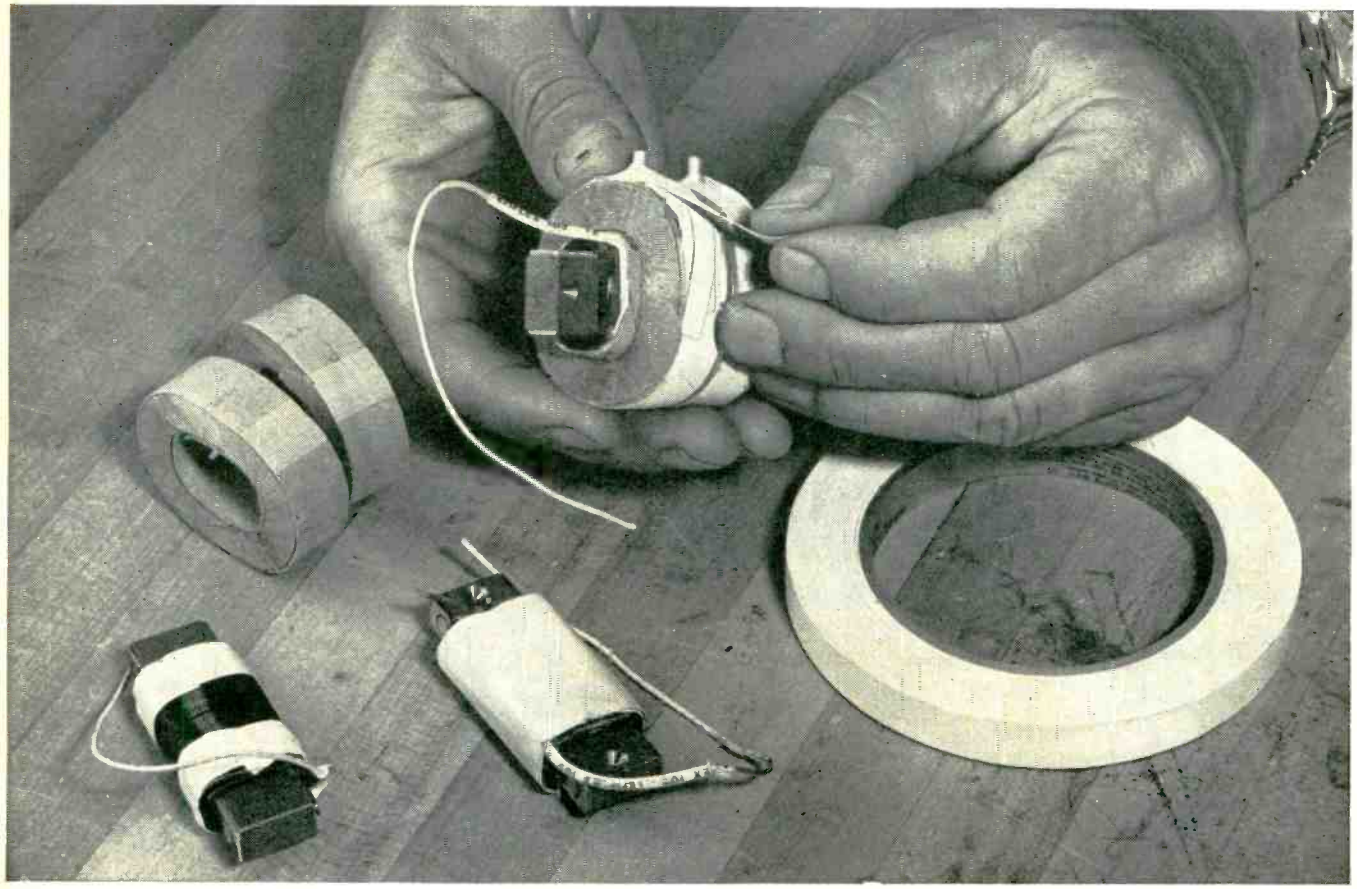
Write Vice President of Engineering:

Hoffman
LABORATORIES, INC.

A subsidiary of Hoffman Electronics Corporation
3761 SOUTH HILL STREET, LOS ANGELES 7, CALIFORNIA

"SCOTCH" 28 prevents solvent action in Fairbanks-Morse coils

White acetate-cloth tape has true thermosetting adhesive



Insulating tape *must* hold on top-quality resin-encapsulated coils such as those turned out by Fairbanks-Morse. *True thermosetting* adhesive tapes are unaffected by solvent action of synthetic casting resins, especially those containing monomeric components. Result: A completely cured coil with no soft or wet spots. That's why "SCOTCH" Brand Thermosetting Tape No. 28 anchors primary leads and holds terminal posts on the secondary in Fairbanks-Morse coils.

"SCOTCH" Brand Thermosetting Tapes have a pressure-sensitive adhesive that sticks at a touch. After the curing process, these tapes become highly resistant to the solvent action of waxes, varnishes and resins, preventing softening or throw-out. Adhesive holding power actually *increases*, positively anchoring all components under high-heat conditions.

Next time you have a heat or solvent-resistant job for tape, think of the pressure-sensitive tapes with the *true thermosetting* adhesive — "SCOTCH" Brand! For more information, write 3M, Dept. CA-96, St. Paul 6, Minnesota.

Reg. U. S. Pat. Off.

SCOTCH BRAND Thermosetting Tapes

PRODUCT OF 3M RESEARCH

The term "SCOTCH" and the plaid design is a registered trademark of Minnesota Mining and Manufacturing Company, St. Paul 6, Minn. Export Sales Office: 99 Park Ave., New York 16, N. Y. In Canada: P.O. Box 757, London, Ontario.

3M COMPANY

CHASE® NICKEL LEADED COMMERCIAL BRONZE

Tensile Strength up 27%
Yield Strength up 20%
above leaded commercial bronze!

Rugged is the word for Chase Nickel Leaded Commercial Bronze. It has *all* the corrosion resistance of Leaded Commercial Bronze, *plus* increased tensile and yield strength. At the same time, Chase Nickel Leaded Commercial Bronze has a high relative machinability of 80%, which is excellent for screw machine work.

This is the bronze alloy—moderately priced—for your products that take a beating! Products like electrical fasteners, pole line hardware, nuts and bolts.

Chase Nickel Leaded Commercial Bronze is available in round and hexagonal rod form. Round sizes from ¼" to 1" diameter. Hex sizes from ¼" to ⅞" diameter. For further information, write Chase Engineering Service, Dept. A.

Chase®

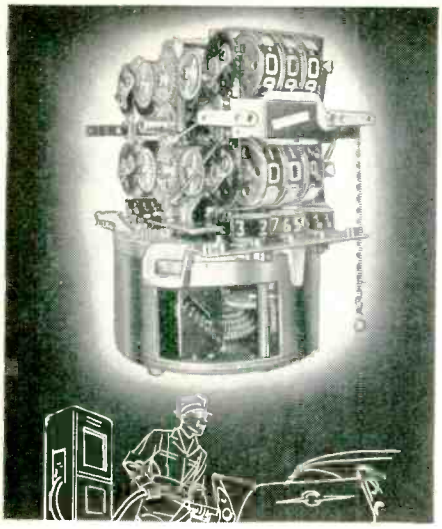
BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

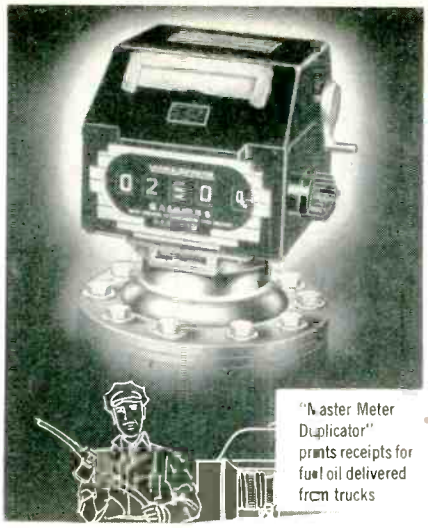
The Nation's Headquarters for Brass, Copper and Stainless Steel

Atlanta, Baltimore, Boston, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Grand Rapids, Houston, Indianapolis, Kansas City, Mo., Los Angeles, Milwaukee, Minneapolis, Newark, New Orleans, New York, Philadelphia, Pittsburgh, Providence, Rochester, St. Louis, San Francisco, Seattle, Waterbury

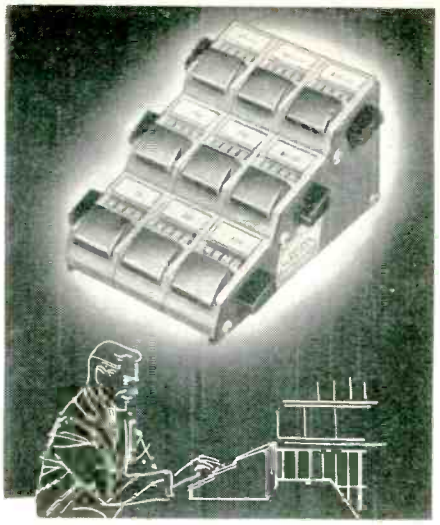
Want more information? Use post card on last page.



Computing Head for Gasoline Pumps

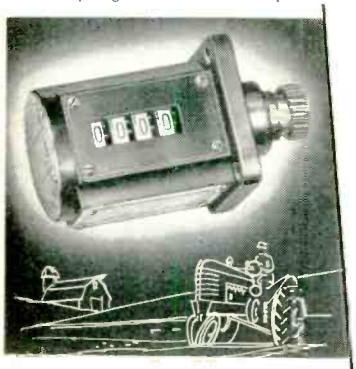


"Master Meter Duplicator" prints receipts for fuel oil delivered from trucks

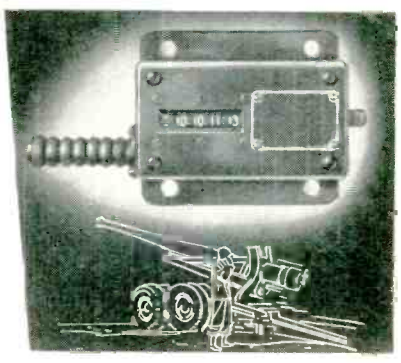


"Vary-Tally" Multi-Unit Reset Manual Counter

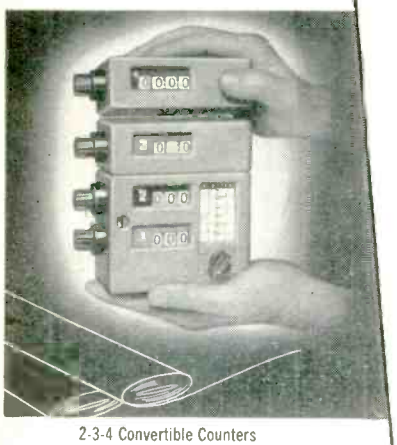
Everyone Can Count on VEEDER-ROOT



Rev-Counter for all types of engines



Recoil Counter for new 280 mm atomic cannon

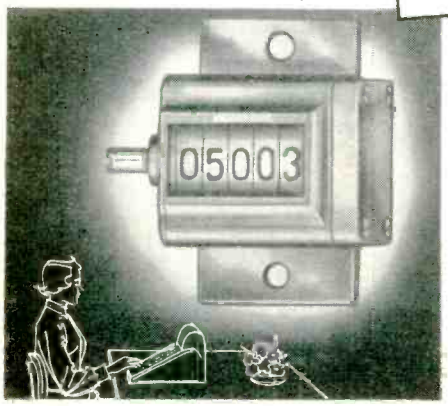


2-3-4 Convertible Counters (and others) for textile machinery

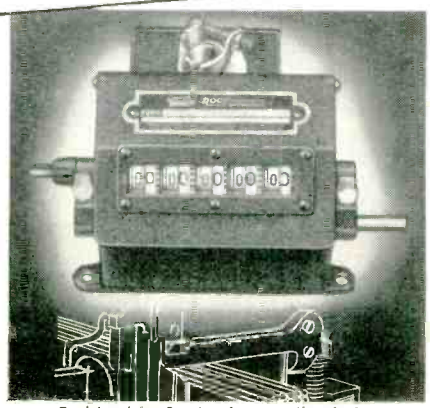
Fuel-Remaining Counter for aircraft . . . subtracts as fuel is used

Everywhere you look in everyday life, you see a familiar face . . . the face of a Veeder-Root Counter or Computer. From gasoline pumps to fuel oil trucks to textile mills . . . in the home, on the farm, in business and commerce, in modern automated industry . . . Veeder-Root standard and special devices are keeping everything under *Count*rol . . . manually, mechanically, electrically. And the mathematical probabilities are mighty high that *you* can count on Veeder-Root, too . . . to your advantage and profit. Why not let us figure out how, *right now*?

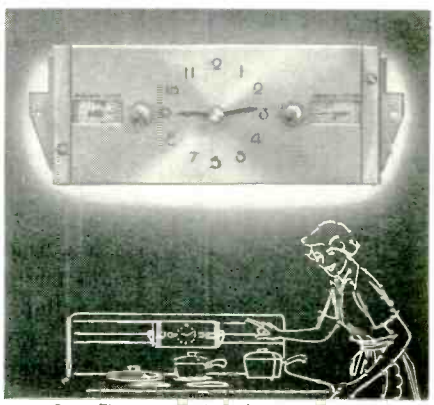
VEEDER-ROOT INC. • HARTFORD 2, CONN.



Small Square-Case Counters for office and other machines



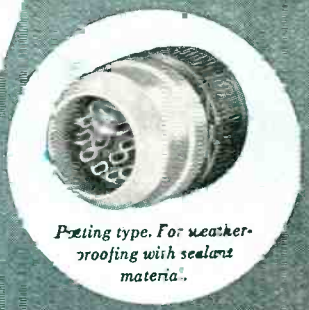
Predetermining Counters for preventing short and over-runs on production machines



Range Timer . . . easy to read . . easy to set

STOCKS OF STANDARD COUNTERS AVAILABLE AT — Greenville, S. C. • Chicago 6, Ill. • New York 19, N. Y. • Los Angeles • San Francisco
Montreal 2, Canada • Offices and Agents in Other Principal Cities

Want more information? Use post card on last page.



Potting type. For weatherproofing with sealant material.

"F" Series. Submersible to 550 ft. in water.

weatherproof cannon plugs

"AN-E" Series. Sealed from cable to cable.

"AC" Series. For use on military vehicles.

Cannon "weatherproof" connectors include a range of types from moisture-proof to watertight. Each has been designed to meet one or several of these and intermediate requirements. A variety of sealing methods are used.

Potting types meet BuAer requirements.

Most rugged type is the "W" Series... with brass shells in 3 sizes, heavy acme threads, sealing rings, 50 insert arrangements. Requires sealing at entry by user.

"AN-E"s feature force-fitting resilient inserts, sealing grommets and followers, integral cable clamp, telescoping bushings. "AO"s include sealing grommets over the terminals, rugged parts. "2E"s feature wing-blade engagement device, watertight and pressure sealing. "BRS"s have sealing rings. "XKW"s have rubber bushings, packing rings, sealing washers.

All types meet MIL-C-5015B Cold Tests.

Write for catalog information, indicating application problem.

"XKT" Series. Weatherproofed.

"BRS" Series. Sealed for shipboard radio.

"2E" Power Plugs. Watertight and pressurized.

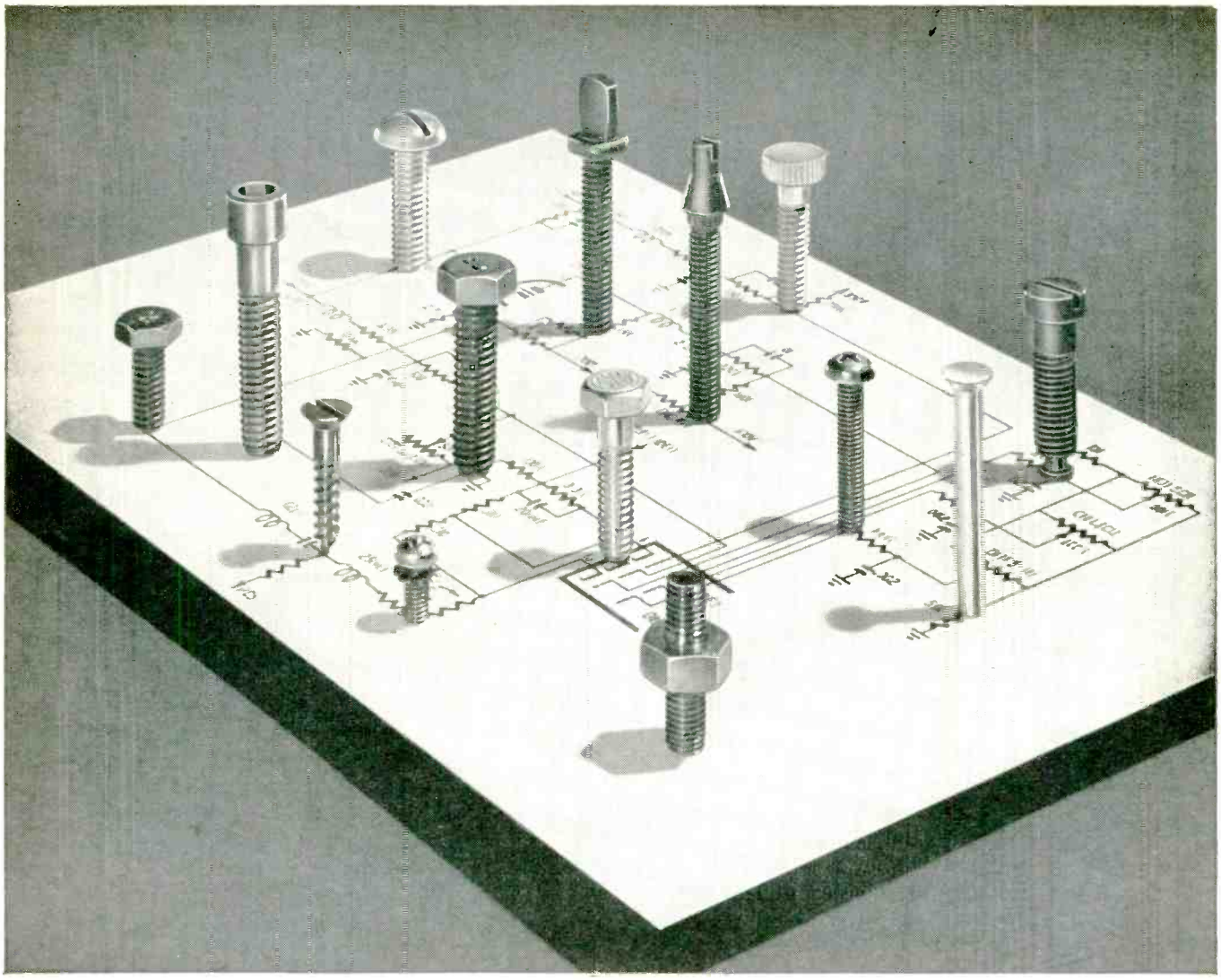
MINIATURES, TOO!

CANNON ELECTRIC

CANNON ELECTRIC

Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif. Factories in Los Angeles; East Haven; Wakefield; Toronto, Canada; London, England; Melbourne, Australia. Licensees in Paris, France; Tokyo, Japan. Representatives and distributors in principal cities. See Telephone Yellow Book.

Please Refer to Dept. 120



QUALITY PERFORMANCE

depends on small things

Manufacturers of electronic equipment recognize that such small things as fastenings are vitally important to the operation of that equipment...to the service that it gives...to the length of life that it serves.

Harper Everlasting Fastenings cost no more and you benefit by:

- The speed of assembly due to the clean threads and precision manufacture.
- The assurance of quality performance due to corrosion resistance and superior strength.
- The improvement in appearance due to the fact that Harper fastenings never rust.

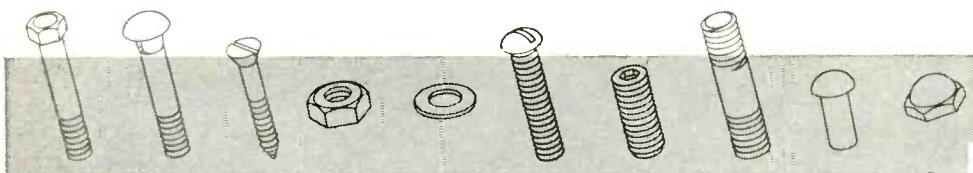
More than 7000 different Harper fastening items are carried in stock in both non-ferrous and stainless steels. See your nearest Harper distributor or write for the Harper catalog.

THE H. M. HARPER COMPANY
8244 Lehigh Avenue, Morton Grove, Ill.

If you have a headed part that you are now milling from bar, it will pay you to investigate the Harper Flo-Form® method of producing such parts in quantities economically. Savings range up to 50%. Information on request from a Harper Field Engineer.

Specialists in all corrosion-resistant fastenings

Bolts • Nuts • Screws • Rivets • Washers
of Brass • Bronze • Monel • Aluminum • Stainless



OVER 7000 ITEMS IN STOCK...HARPER DISTRIBUTORS EVERYWHERE

HARPER
Everlasting Fastenings

MEMO

FROM: The NJE Production Staff

TO: Electronics Purchasing Agents

SUBJECT: LOOK **BEHIND** THE PROMISE

Let's let our hair down, gents, and talk about delivery promises.

Most "catalog" equipment is available on short, accurate delivery schedules. For example, of the 881 power supplies in our catalog, all but 52 of them are available in from 1 to 20 days, and we rarely muff a delivery promise.

Custom equipment presents a much more complex problem. The most sincere delivery estimate is still an estimate. How can you evaluate the accuracy of a delivery promise before awarding a contract?
We say — look behind it:

- **How much of the job is under the vendor's control?**—NJE, for example, manufactures over 85% of its product under its own roof. We build our own transformers, sheetmetal components, have our own finishing, engraving, and welding facilities. We buy only standard catalog resistors, capacitors, and tubes.
- **How much experience background does the vendor have at his command?**—NJE, for example, has a file of over 4,000 custom designs to draw on for rapid revision to meet your specs.
- **How "deep" is the organization technically?**—NJE has the largest engineering staff in its field —15 engineers, 7 mechanical designers, all with wide professional experience.
- **Is the vendor big enough for the job?**—NJE has reached a productive capacity of $200,000 worth of custom power supplies per month — it leads the field.

Look behind an NJE delivery promise — you'll find more than enthusiasm.

NJE corporation
Electronic Development & Manufacturing

345 CARNEGIE AVENUE, KENILWORTH, NEW JERSEY

Competent Engineering Representation Everywhere | Rapid, complete, competitive custom quotes from 1000 Amperes (low voltage) to 250 KV (low current.)

POWER SUPPLIES UNLIMITED

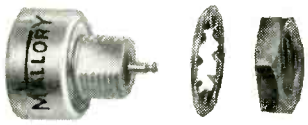
MALLORY

At temperatures from —55° to +200° C, Mallory XT Tantalum Capacitors maintain stable capacity, series resistance and impedance . . . and provide long life.

Mallory Tantalum Capacitors

lead in long, stable life at extreme temperatures

New Mounting Designed for heavy shock and vibration



Mallory XT tantalum capacitors are now available in a single hole mounting design which will withstand severe shock and vibration. A flatted neck with ½-20 threads fits through a keyed slot in the chassis . . . is held in place by a lock washer and hex nut. Assembly takes only seconds . . . requires no strap or other hardware. This design is supplied in a variety of ratings, with cases up to 2¼" in height. Write for information.

WHEN YOU design for extreme temperatures . . . in military electronic equipment, miniaturized apparatus and the like . . . be sure to choose capacitors that you *know* will meet severe conditions.

Specify Mallory XT tantalum capacitors . . . proved by test and field usage to give consistently long, stable service across an extremely wide temperature range. Pioneered by Mallory, these units embody design and production techniques developed during twelve years of research and manufacturing in the high temperature capacitor field.

Standard XT's cover the range from —55° C to +175° C. When specified, they can be supplied rated for continuous operation at 200° C. A complete selection of capacitance and voltage values is available.

Representative performance data, based on sampling tests representing hundreds of thousands of capacitors, is now available on Mallory tantalum capacitors. To see for yourself the specifications which these units can be relied upon to meet, write today for our latest Technical Bulletin.

Expect more . . . get more from

P. R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

CROSS TALK

► **MONEY TALKS** . . . Inadequate maintenance often renders military electronic equipment submarginal in operation and, at times, useless. One reason is the high turnover of military electronics personnel; civilian engineers supplied by industry on contract cannot do the job under all field conditions.

Long-term solution of the problem may require better inducements for career electronics officers. Physicians and surgeons receive higher rank and bonus pay, and are relieved of duties not related to their specialty. A similar setup may be required for electronic engineers in the armed forces.

► **CENTIHEIT, FAHRENGRADE** . . . Research men specifying characteristics of new materials seem to state temperature in Centigrade, while production people appear to use Fahrenheit. So some manufacturers use C in their printed matter, some use F, some use both, and others flick back and forth between the two from one product to another.

The result is pretty confusing to the potential buyer.

► **LANGUAGE BARRIER** . . . The crys of French crows, recorded on tape, excite American crows, who obviously recognize the sounds made by their own kind. But our local birds do not respond to these cries as they do to sounds made by their immediate neighbors, exhibiting confusion more than anything else.

► **ALL IS NOT GOLD** . . . We seem to be living momentarily in an era of "something for nothing" selling. Perhaps this is because when business is good some suppliers try to make a killing, and many people who ordinarily would be more conservative are sucked into buying dubious extras.

One example of this current phenomenon is the craze for trading stamps at the corner store. We thought this gimmick went out with grandma. In our industry the period is marked by rapidly increasing complaints from purchasers, particularly of test instruments, that equipment does not live up to publicized claims. Not that it is bad merchandise, but that it was over-sold.

There will, eventually, be the usual reaction . . . a return to solid and measurable values.

► **ELECTRONICS HATH CHARMS** . . . Twenty-four percent of the exhibitors at the Music Industry Trade Show showed electronic equipment.

It ranged all the way from television sets and high-fidelity phonographs (many featuring stereophonic sound) through electronic organs, carillons and harps to vidicon camera chains.

LOOKING AHEAD

Television telephones farthest along in the laboratory now transmit just enough frames per second to give picture definition consistent with voice quality; conservation of wireline bandwidth is major objective

Miniaturization of airborne equipment has progressed to the point making it a safe bet that many aviation devices of the future will be complete within the indicator case except for sensing devices and power

Promising magnetic powder consisting of iron, silicon and aluminum will soon be commercially available

Several companies now have contracts to produce automatic navigation devices using the sun, or a star, for the fix

TRENDS IN COMPUTER

SUMMARY —— Electronic data-processing machines of the future will need INPUT DEVICES that accept source documents directly without transcription on punched cards, perforated or magnetic tape and OUTPUT DEVICES that will keep pace with high-speed computing circuitry. Character readers, high-speed printers, special cathode-ray tubes and dry-printing techniques offer possible solutions that may also benefit the printing and publishing business

SPOTTY PROGRESS in mastering the three *R*'s is not uncommon among precocious eight-year olds. Undeniably the automatic digital computer has earned straight *A*'s in 'rithmetic. But thus far less perfect grades in reading and 'riting have kept it off the business honor roll.

Large internally programmed computers such as Univac, IBM 700 series, Bizmac and Datamatic are fed from magnetic tape. In many installations, card-to-tape converters enable the computer to accept data on punched cards. Smaller computers can sometimes accept punched cards or punched paper tape.

However, in business each transaction must often be substantiated by an original document which may be a voucher, invoice, cancelled check or duplicate sales receipt. These documents are today seldom produced as punched cards, magnetic or punched paper tape. Restrictions on the form of input data mean that computer installations sometimes must have batteries of typists preparing data on punched cards or other media.

In scientific computing installations, too, the computer language problem can be considerable. At one guided-missile test range a proposal is afoot for a quarter-million-dollar unit to convert between two types of magnetic tape and two kinds of punched paper tape in use at the establishment.

Computer output is likewise a problem since results for management information are best printed out in page copy. In some cases auxiliary equipment must convert results from magnetic tape to punched cards then print them out. Printing speeds of 150 lines a minute or so provided by mechanical bar printers are much slower than the computer's speed of operation.

Ideally, therefore, the computer should be able to accept data prepared in the native language of the business world and print out its results in page copy. For most efficient operation, input and output equipment should keep pace with the computing process.

Conductive-Dot Code

Reading source documents electronically involves either scanning printed characters to obtain recognizable code signals or using a special code to represent the characters.

The Stanomatic system developed

READING Operator at console feeds checks into SRI's Electronic Recording Machine Accounting (Erma) system. Models under development will read directly characters printed in magnetic ink. Present system relies on code bars

INPUT/OUTPUT DEVICES

By JOHN M. CARROLL
Associate Editor
ELECTRONICS

ADDRESSING Equipment for maintaining subscription lists includes punched card feeder and two 900-line-a-minute wire printers. One printer prepares magazine mailing labels for entire list. The other addresses promotion literature to holders of expiring subscriptions

PRINTING High-speed printer for Univac computer attains speeds up to 600, 130 character lines a minute. Printing mechanism includes rotating print drum and electrically controlled print hammers

by Standard Register of Dayton, Ohio uses a code in which patterns of electrically conductive dots represent numerals 0 to 9. A Stanomatic unit has been in operation for some time at the First National Bank of Chicago where it is used to identify serial numbers on travelers' checks. The bank handles some 20,000 to 30,000 checks daily.

The system provides for thirty digits across the face of a check. Each digit requires five bits. The first bit represents the value 1, the second bit 2, the third bit 4 and the fourth bit 7. The fifth bit is a parity check so that the one's count for a given digit will always be two. Therefore, numeral 1 is represented by 10001 and 2 by 01001 and so on.

Reading Head

A reading head is provided for each bit position. The reading head consists basically of a balanced-bridge circuit which is unbalanced by the presence of a conductive dot on the paper. Stanomatic handles 500 documents a minute. At present output consists of punched cards carrying the information contained in the dot pattern.

The dot pattern is applied at the time the check is imprinted with the name of the agent bank. Dot imprinting may be accomplished by letterpress using special ink, typewriter using special ribbon or carbon paper or by a special sales register. The sensing and decod-

ing unit uses about 1,000 electron tubes.

Another type of source document reader which uses a dot pattern code is under development by Todd of Rochester, New York, a Burroughs Corp. subsidiary. Details of the system have not as yet been released but it uses a pattern of

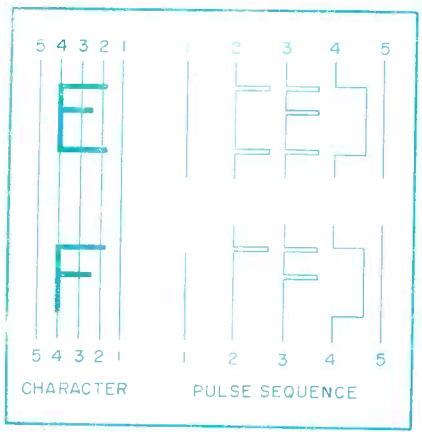


FIG. 1—Scanning patterns for letters *E* and *F* show how electronic character readers translate printed characters into electrical pulse sequences

phosphorescent dots to represent characters.

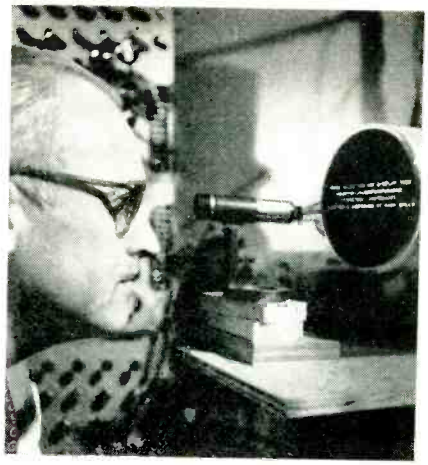
Magnetic-Bar Code

Coding may also be achieved by magnetic patterns. Erma, a data-handling system developed by Stanford Research Institute for the Bank of America uses a code of five magnetic bars to represent each numeral.

In this system 00101 represents 1, 10100 represents 2 and so on. Erma reads 100 checks a minute each having an 11-digit number. The information may then be filed on magnetic tape or drum. Reading speed is about 1,000 characters a second. A photograph shows an operator at the control panel.

The bars are printed with ink containing magnetic oxide powder. Five reading heads are used for each digit. The printed bar is first magnetized before passing under the reading head.

First model of Erma will be delivered to the bank's San Jose, California branch where it will handle the bookkeeping for 50,000 checking accounts. The second development phase of the program is aimed at producing a unit to recognize arabic numerals printed in magnetic ink.



Character font displayed on face of RCA tube. Any desired font can be imaged on tube's photocathode, making the tube useful for composing reproduction copy as well as providing a 100,000-word-a-minute output

Ferromagnetographic printer uses rotating magnetic drum to receive latent magnetic image which is made visible by iron filings. These are absorbed by wax-surfaced paper to provide positive page copy

Also operating on the principle of recognizing magnetized code patterns, National Cash Register's Post-Tronic equipment will likewise be used for bank bookkeeping. The reading heads scan magnetic symbols in the form of two magnetic bars along each of eight strips on the back of each form. Regular production of the equipment is scheduled by NCR for later this year.

Reading Printed Characters

Use of special codes presupposes control of the source when special imprinters are required. Greater flexibility would be provided by a system capable of reading typed or printed characters and translating then into electrical code sequences upon which the computer can operate.

A machine developed by Intelligent Machines Research of Arlington, Va., translates typed or printed alphabetic or numerical material into electrical signals capable of operating card punches or other equipment. Models operate at 100 characters a second but can be made to work twice to three times as fast if required. Prices start at $15,000.

Two of the machines are in use reading account numbers on oil-company invoices. The information

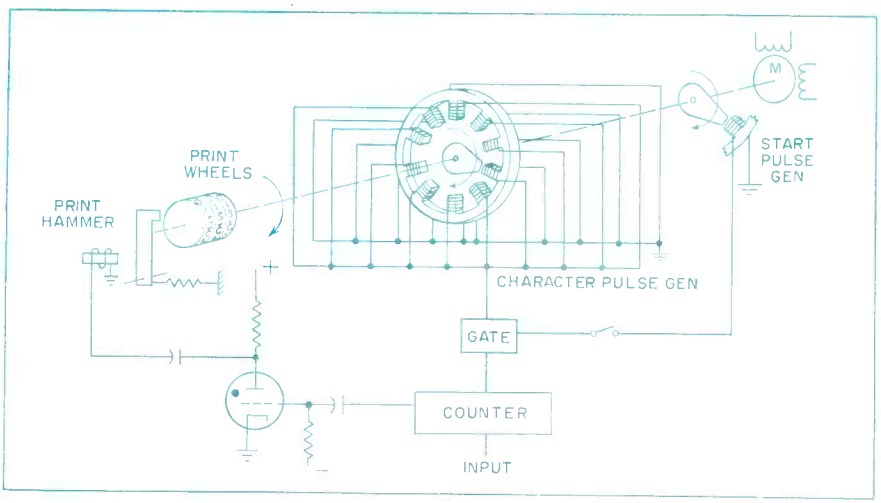


FIG. 2—Wheel-and-hammer printers rely on electromechanical pulse generator to tell which character is under print hammer. Coincidence of character pulse with input from computer releases print hammer through thyratron circuit

is punched into cards after being read electronically. The account numbers are produced by imprinters used at the various gas stations.

Another machine is used to read typewritten names and addresses. The information is then punched into cards. Up to four lines of typewritten material can be handled. A machine is under development which will read two widely separated lines on paper invoices and punch the data into cards.

The typed or printed material is scanned photoelectrically. A photocell is focused on a small dot that travels continually up and down as the document moves at right angles to it.

Figure 1 shows how the reading circuits translate a printed character into a distinctive electrical code sequence. The pattern is then recognized by logical circuitry and signals produced to actuate the card punch or other equipment.

Another character reader operating on the photoelectric scanning principle has been developed by Laboratory For Electronics of Boston. This machine uses a column of photocells to recognize the printed characters. The machine can read arabic numerals at rates up to 1,600 characters a second without restriction as to type style. It could be made to operate at twice this speed.

In a project sponsored by Chase Manhattan Bank of New York, such a machine was built to read numbers on bank checks. With the checks fed at 16 a second, the machine was able to read 400 characters a second. Output could be to a sorter, printer or accumulator. Future developments are under way to determine the identity of a character using statistical techniques which may further remove restrictions as to size, style and quality of printing.

Another character reader was developed by the Burroughs Corp. and field tested in the First National City Bank of New York where it was used to read serial numbers on travelers checks. The machine handled 7,200 checks an hour. It used photoelectric scanning and operated a card punch.

Character recognition equipment is reportedly under development at IBM. This work has been directed towards reading characters printed in magnetic ink.

Wheel Printers

High-speed printers working off digital input are either wheel-and-hammer printers or wire printers. The Synchroprinter produced by Anelex of Boston is an example of the wheel-and-hammer printers. An electric motor drives a print roll or drum which consisits of a print wheel for each character of a line. Around the periphery of each wheel are engraved the characters available for printing at that particular position in the line, 10, 18 or 36 according to the model. Figure 2 illustrates operation of a wheel-and-hammer printer.

An electromechanical pulse generator attached to the motor shaft emits a pulse each time a character is in print position. Another pulse generator emits a pulse once each revolution to determine the start of the pulse cycle. The pulse stream is fed to an electronic counter. When the character identification signal from the pulse generator matches the desired character signal from the computer or other input device, the counter triggers a thyratron circuit which operates the printing hammer. One type of wheel-and-hammer printer, the Univac high-speed printer is shown in a photograph.

Wire Printers

The Burroughs Series G is representative of wire printers. Characters are made up of dots printed by wires selected from a 5-by-7 matrix. Figure 3 shows how characters are built up from such a dot pattern. Input is from punched cards. The punches are sensed by the card brush.

When coincidence between pulses from the card reader and the synchronizing pulse generator is established in one of the AND gates, two thyratrons are triggered and the actuating pulses sent through a network of relays and diodes to the proper wire groups. The pulses actuate electromagnets

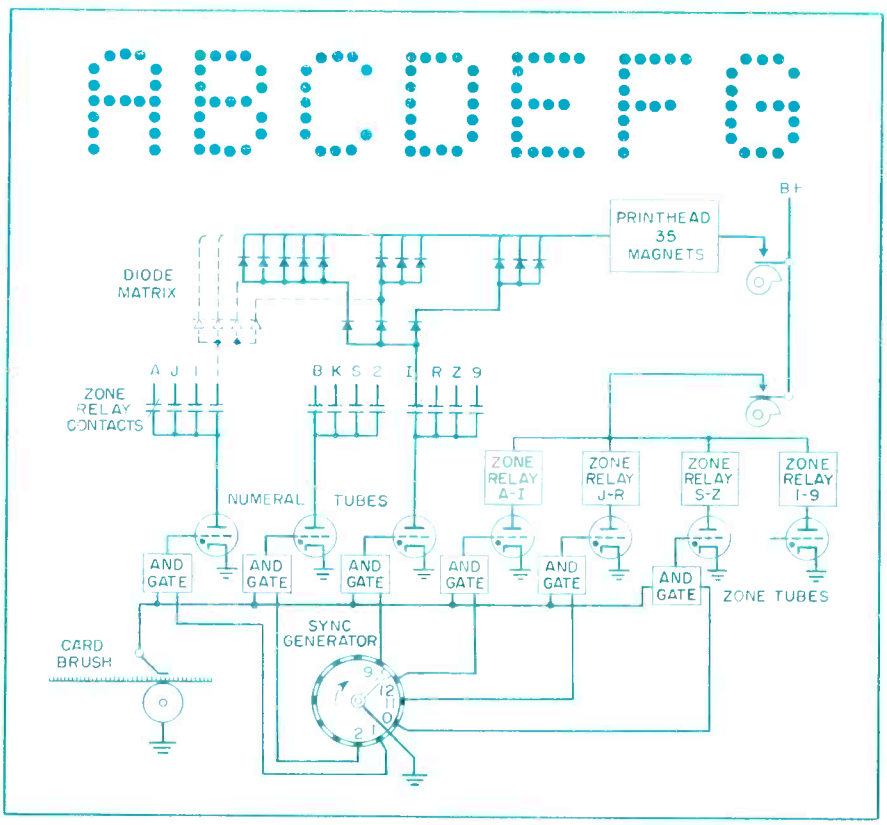


FIG. 3—Wire printer uses coincidence of synchronizing and character pulses to trigger thyratron control tubes. Relay contacts and diode matrix set up 5-by-7 pattern in print head. Strip at top shows sample of wire printing

and the wires are moved about 0.025 in. by mechanical linkage. Two wire printers along with card feed and electronic control unit are shown in a photograph.

The Burroughs Electrographic technique may do away with mechanical travel of the printing wires. Here the character is produced first as a latent electrostatic charge pattern on high-resistivity coated paper. The image is made visible by inking with powder which is fixed by heat. The charge pattern is made up by electrical discharge from point electrodes to a grounded metal platen. A matrix printing technique is employed.

The paper moves continually past a row of seven electrodes maintained a fixed distance from it. Figure 4A shows the recording head structure. A character is made up from five successive choices of the seven pins.

An electronic pulsing circuit as shown in Fig. 4B is connected to each pin. A 40-microsec input pulse is required. A 5-by-7 magnetic matrix and decoding circuits as shown in Fig. 4C provide a buffer between the pulsing circuits and the information source.

Table I lists several high-speed printing devices that may be used as output devices for computers. For the purposes of this article, the lower speed limit for so-called high-speed printers has been more or less arbitrarily established at around 300 lines a minute. For some computer applications, even this is faster than necessary and there are many electromechanical bar printers that operate satisfactorily around 150 lines a minute. For some applications, electrical typewriters working at about 10 characters a second are adequate.

Character Display Tubes

A display device designed to operate at speeds compatible with high-speed electronic computers ideally should not be restricted by mechanical operations such as travel of print hammers. One approach is use of cathode-ray tubes designed to display numerical and alphabetic characters.

The Charactron tube, a development of the Convair Division of General Dynamics, directs a beam of electrons at a thin metal disk which may have 64 characters arranged in an 8-by-8 matrix cut out like a stencil. As illustrated in Fig. 5A, the beam is defocused such that its diameter is sufficient to cover the largest character in the matrix while selection plates placed between the electron gun and the metal disk direct the beam at the desired character.

After the beam is extruded through the character stencil, it passes through a convergence coil and compensation plates which redirect the beam along the tube axis. A final deflection system, which may be either electrostatic or electromagnetic, positions the beam to strike a desired spot on the phosphor screen.

A 19-in. Charactron will display up to 15 characters an inch. Some special 5-in. tubes are capable of showing 65 character an inch. Printing rates of 100,000 characters a second at densities of 150 characters an inch do not seem unreasonable.

Permanent Display

The Typotron shown in Fig. 5B is a character-display cathode-ray tube developed by Hughes Aircraft which can hold a display as long as desired. The tube provides 63 characters in its matrix and is similar to the Charactron. Final deflection is electrostatic.

Display persistence is achieved with a dielectric storage mesh in front of the phosphor screen and flood gun mounted beside one of the final deflection plates. The flood gun covers the target with low-velocity electrons.

The high-velocity character-shaped beam bombards the storage screen charging it positively by secondary electron emission. Flood electrons then penetrate the storage screen where the positive charge exists and are accelerated toward the phosphor screen. The flood electrons serve also to regenerate the charge pattern. To erase a written pattern, the mesh potential is dropped below its normal value. Printing rates of 25,000 characters a second have been achieved.

Photocathode Tube

An electron tube for teleprinting that works on a somewhat different principle has been developed by RCA and is illustrated in Fig. 5C. The tube has a photoemissive cathode on which a letter chart or character font is projected. When a potential of about 100 v is applied to the conductive coating, electrons are liberated from the cathode in the form of the entire character font.

The first focus coil directs the beam such that only the desired character is allowed to pass through the small selecting aperture. The metal cylinder following

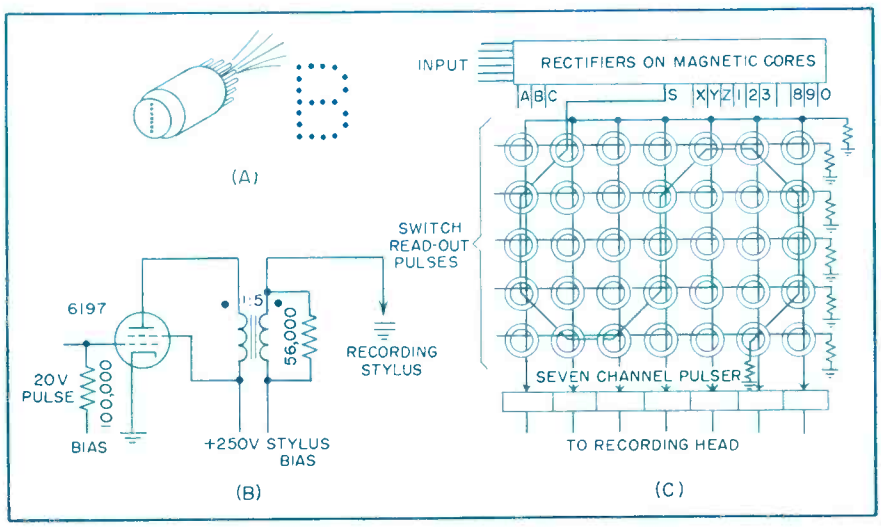


FIG. 4—Electrographic printer uses column of 7 electrodes operating 5 times rather than 5-by-7 wire matrix (A). Electronic pulsing circuit does away with mechanical travel of print wires (B). Magnetic core matrix selects proper electrode sequence (C)

the selecting aperture is held slightly negative to suppress secondary electron emission.

The second focus coil and positioning coils position the single-character beam to strike the desired spot on the phosphor screen. The beam is accelerated by 20 to 30 kv on the conductive coating near the phosphor screen.

The tube has a 5-in. circular face. Any kind of font can be imaged onto the photocathode providing a practically unlimited choice of characters and type styles. Up to 4,500 characters have been reproduced on the tube face. Character display can take place at speeds up to 10,000 characters a second. In tests, 2,000 characters a second have been recorded on 35-mm photographic film. A photograph shows the face of the RCA tube as an example of how it reproduces alphabetic and numerical characters.

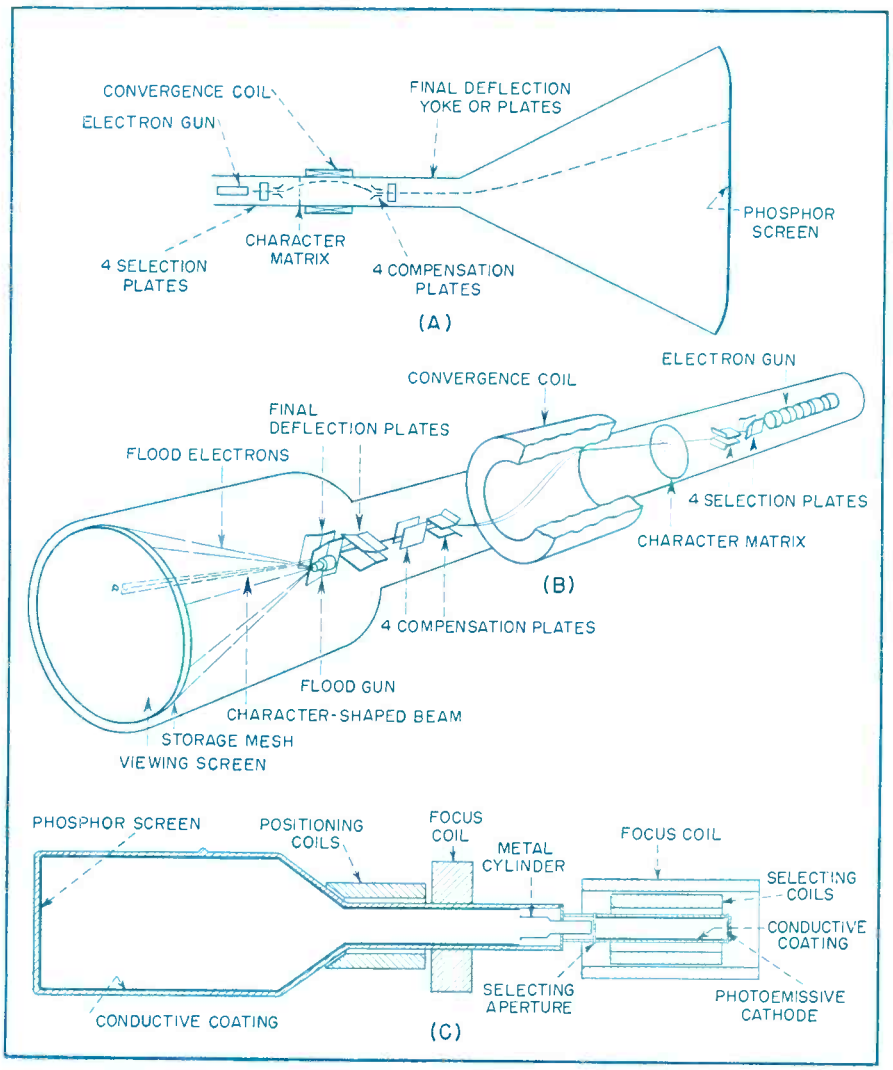


FIG. 5—Charactron display tube extrudes electron beam through character stencil to form pattern (A). Typotron adds storage mesh and flood gun to achieve permanent display (B). RCA tube forms all characters by projecting type font on photoemissive cathode, then selects desired character (C)

Xerography

When a permanent record is desired of information displayed on a cathode-ray tube face, it has usually been necessary to photograph the tube face. A continuous in-line output in such a system is impossible. However, several so-called dry printing processes are in existence or under development that may permit making one or several copies from a tube screen or other display device in a continuous operation. Many dry printing processes are electrostatic in nature and some are magnetic.

There are many dry duplicating processes that involve neither electrostatics nor electromagnetics. Some of these may be photographic, chemical or thermal in nature. Others employ standard printing processes such as lithography or modified letterpress. Only electrostatic and electromagnetic processes are discussed here.

Xerography, a development of Haloid of Rochester, N. Y., makes use of a selenium-coated plate which is charged positively. Copy is then projected onto the plate. Positive charges disappear in light areas. A negatively charged powder is tumbled over the plate to bring out the latent image.

The image is then transferred to a sheet of paper or offset master by placing the master over the plate and applying a positive charge to it. The powder is attracted from the plate to produce a direct positive image which is thermally fixed.

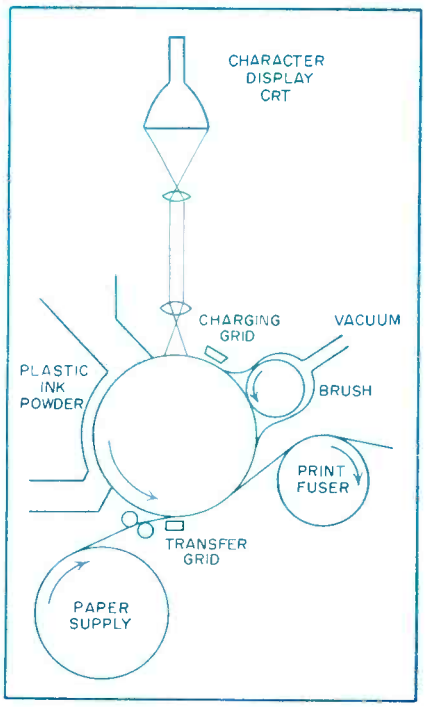


FIG. 6—Drum-type Xerographic printer is one possible answer to continuous direct computer read out. Output is displayed on special cathode-ray tube and made permanent by electrostatic dry-printing process

Drum-Type Printer

Continuous recording from a cathode-ray tube face has been accomplished at least experimentally by a drum-type Xerographic

Table I—Typical High-Speed Printing Equipment for Computers and Data-Handling Systems

Manufacturer	Model	Characters Available	Characters a Line
Addressograph-Multigraph Corp. Cleveland, Ohio	851	Reproduces what it reads	250 a card
" "	855	" "	" "
" "	860	" "	" "
" "	862	" "	" "
" "	863	" "	" "
" "	852	" "	" "
" "	856	" "	" "
Addressograph-Multigraph and Eastman Kodak Co. Rochester, N. Y.	Tape-Programmed Electronic Printer	———	———
ANelex Corp. Boston, Mass.	Digital	Numerals 0 to 9	40
" "	Octo-Decimal	18	40
" "	Alpha-Numerical	36	40
" "	56–120	56	120
" "	56–24	Numerical or Alpha-Numerical	24
" "	18–40	18	40
" "	18–72	"	72
Atomic Inst. Co. Cambridge, Mass.			
Burroughs Corp. Detroit, Mich.	Series G	52	48
" "	Electrographic Printing Technique	———	———
IBM Corp. New York, N. Y.	719	47	60
" "	720	"	120
Potter Inst. Co. Great Neck, N. Y.	Flying typewriter	51	Up to 120
" "	Magnityper	———	" "
Shepard Labs. Summit, N. J.	190	Up to 64	80, 120, 140, 190
Sperry Rand Corp. New York, N. Y.	Univac High-Speed Printer	51	120

printer as shown in Fig. 6. There are stations around the periphery of a rotating selenium-coated drum that charge the drum's surface, expose it to an image of the crt face, dust the drum surface with plastic ink powder, transfer the ink pattern electrostatically to paper and brush the drum clean of ink powder for the next cycle. Paper is fed into the printer in a continuous roll. Finished prints come off a drum that fuses the image to make it permanent. See Fig. 6.

A web-fed electrostatic printer using a Charactron and a modified Xerographic printing process has been developed by Horizons, Inc. of Cleveland. It handles 4,000 to 5,000 characters a second and may be able to handle up to 10,000.

Another electrostatic printing process, an RCA development, is Electrofax. A uniform electrostatic charge is placed on paper coated with powdered photoconductor such as zinc oxide in resin binder. Charging can be accomplished by corona discharge from a wire mesh connected to negative 4 to 7 kv.

The plate is then exposed and the latent electrostatic image developed by brushing fine pigmented thermoplastic resin powder over the plate. Since the powder takes on a strong positive charge when rubbed against iron, a magnetic brush is used. This brush is made up of iron filings attracted to a permanent magnet rod. The thermoplastic powder forming the image is fixed thermally by melting the resin onto the zinc oxide coating.

Smoke Printing

Smoke printing is under development by Standard Register of

Lines a Minute	Input Media	Principle of Operation
800	Image-bearing cards	Printing scanned photoelectrically. Signals actuate bar-and-helix facsimile printing system. Produces four-line mailing labels 7/8 in. wide
"	" "	Produces labels in duplicate
"	" "	Prints documents of varying size
"	" "	Prints two original copies simultaneous
"	" "	Prints three original copies simultaneously
"	" "	Like 851. Compares punched information on cards
"	" "	Like 856. Compares punched information on cards
3,000	Magnetic tape. Punched card to tape converter handles 600 cards a minute. Selective tape recording system records punched-card data	Tape is read into electronic matrix which stores data and programs 5-by-7 wire printer. Sequence is plugboard controlled
900	Magnetic tape and drum, punched cards and paper tape	Several print wheels comprise rotating print drum which is struck by solenoid-controlled hammers
"	" "	" "
"	" "	" "
"	" "	" "
1,200 numerical 600 alpha-numerical	" "	" "
900	" "	" "
"	" "	" "
900	Punched cards (tape operation may be made available)	Electronically controlled 5-by-7 wire printer
300,000 characters (continuous tape)	————	Seven electrodes create 5-by-7 electrostatic charge pattern which is brought out by ink powder and thermally fixed
1,000	Magnetic tape	Electronically controlled 5-by-7 wire printer
500	"	" "
300	Magnetic tape, punched cards & tape, computers	Uses rotating print wheel and solenoid-controlled hammers
900	" "	Uses rotating print drum and solenoid-controlled hammers. Format control by punched paper tape
900 alpha-numerical 1,800 numerical	Magnetic tape, punched cards and paper tape, computers	Rotating print drum, solenoid-controlled hammers. Printers furnished to RCA, National Cash, GE and BTM
600	Uniservo tape handler	Rotating print drum, solenoid-controlled hammers

Dayton, Ohio. This is an electrostatic process that uses a fine pigmented mist or smoke to develop a latent electrostatic image. This process grows out of the so-called onset process in which conventional letterpress printing is accomplished by using an electrostatic field to assist in transferring ink to paper rather than doing it exculsively by mechanical force.

In smoke printing, the information to be printed is imaged onto a glass plate having a metallic coating on one side. The light creates an electric charge pattern in the coating. Ink spray is then given an opposite electric charge and a roll of paper interposed between the ink source and the charged plate. The ink is attracted to the paper and developes the latent electrostatic image. A smoke printer has been delivered to Wright Air Development Center.

Magnetic Printing

Ferromagnetography is a GE development capable of printing 2,500 lines a minute. The printing mechanism measures 6½ by 5½ by 15 inches and is illustrated in a photograph. An image of the material to be printed is formed by magnetizing its outlines on a rotating magnetic cylinder. The process makes one complete cycle during a rotation of the cylinder.

Iron filings stick to the magnetized areas. Being black in color, the filings act like ink and form the latent magnetic image. Next a roll of heated paper coated with wax is pressed against the magnetized cylinder. The iron filings adhere to the wax coating and are absorbed as the paper cools.

The survey discussed in this article reveals that electronic maintenance personnel want technical information emphasized in the following order

Order	Percentage Concurring	Item
1	100	Schematic Diagram
2	98	Circuit Description
3	91	Oscilloscope Waveforms
4	98	Voltage and Resistance Diagrams
5	99	Tube Replacement Instructions
6	97	Block Diagrams
7	85	Trouble-Shooting Chart
8	75	Called-Out Internal Views
9	50	Tube Location Diagrams
10	50	Resistor-Board Details

By PETER N. SHERRILL

Publications Department
Hewlett-Packard Company
Palo Alto, California

What to Emphasize in

COMPLEXITY of modern electronic equipment has increased the need by maintenance technicians for good servicing information. How best to present this material in manual form leads to a reappraisal of traditional methods by Hewlett-Packard during the past year. This reappraisal has been based on experimentation and follow-up evaluation and more recently, on a survey conducted among several hundred people who maintain equipment and who can be considered manual users.

Requirements

Some say, to make a good maintenance manual, it is necessary only to follow the military specifications. The superiority of military manuals, however, has not evaded challenge. Some editors of commercial manuals feel the detailed nature of instruction, the cumbersome simplicity and rigid adherence to general specifications make the military manual difficult to use quickly. In addition, the objective avowed by at least one government agency is different from that of commercial manufacturers. A recent amendment to a Signal Corps specification says that in preparing the manuscript the writer shall assume that the reader has no previous knowledge of the equipment and that his education may not extend beyond the grammar school level.

In commercial manual preparation, an assumption is usually made that the technician or reader has a knowledge of electronics, has been trained to some extent in his art and understands most language on a technical level. Our survey indicates that the great majority of technicians possess technical competence well beyond the grammar school level.

Most technicians work in a repair facility which has technical requirements for the job. To assume a complete lack of technical background when preparing a manual would not only be in hazardous taste, but also economically unfeasable.

Types of Information

Aside from the parts list, maintenance information can be written or graphic in nature. It can be presented as rote procedures or indirectly as a circuit description. There are many traditional aids at the editor's disposal for presenting this information.

Each type of information is important, depending to some extent upon the nature of the equipment. However, some order of importance becomes helpful when making a preliminary manual to meet a production schedule or when preparing a simple manual on a limited budget. Technicians feel the list shown represents a desirable order of importance.

Schematic Diagram

By far the most important single piece of information, the schematic is by no means the most standard. Some schematics are naked and difficult to read, with little thought put into artful layout of information. Others are so loaded with miscellaneous data that the original intention is lost in a welter of signal paths, waveforms, checkpoints and voltage codes.

Some manufacturers, in an effort to simplify the schematic problem have broken up the circuit into functional elements which are reproduced separately. Others have gone to one large, military-type, fold-out schematic. About 75 percent of the technicians surveyed want both types as a minimum requirement in the same manual. When they were pressed to make a choice the split was even. Objections were directed at both types. The fold-out type wears out easily with use and is difficult to use in a confined space. The sectionalized type provides no overall circuit relationship.

Some manufacturers provide a block diagram. The block diagram does not occupy a prominent position on the priority list and while,

SUMMARY —— Analysis of survey of several-hundred maintenance manual users indicates definite preference for certain types of information, such as schematic diagrams, circuit descriptions and waveforms. Other types of information, such as resistor-board details, which are usually included in manuals, were found to be considered unnecessary

Maintenance Manuals

as an aid to circuit description, it is invaluable, it was not looked upon generally with favor as a substitute for a large integrated schematic. When a piece of equipment is complex enough to warrant a set of sectionalized schematics, it deserves one complete schematic as well.

Schematic Information

Regarding how much information should be put on a schematic diagram, technicians want the following, in order of importance:

(1) Component values
(2) tube pin voltages
(3) functions of circuit sections labeled
(4) functions of tubes labeled.

The following information, sometimes appearing on schematics, was considered unnecessary: common voltage points connected (simply labeling the voltage was preferred); waveforms on schematic; signal paths.

Circuit Description

Sometimes referred to as theory of operation, the circuit description, when accomplished thoroughly, is a primary servicing aid. About 55 percent of maintenance technicians feel it should be emphasized more than detailed service procedures. It must be aimed at providing a complete understanding of the instrument. This means lots of partial schematics, critical voltages and waveforms, either actual or idealized, provided some peak-voltage information is given.

The technician feels that if he understands a piece of equipment he can repair it with no other aid than a schematic. Supervisors, however, give a different impression. They feel that many bright technicians like to entertain themselves with their own analysis of a trouble rather than fixing it as quickly as possible. In high-volume distribution of equipment and manuals, detailed service procedures are indicated as well as a competent description of the circuit.

It seems clear that technical pride would prompt many technicians to say that all they need is a circuit description, however it is felt that complete reliance on a circuit description, no matter how complete, to accomplish fast repair of equipment demands a substantial technical proficiency on the part of the reader. Consequently such a description must take into account the exact technical level to which the material is directed.

Technicians consider parts list's essential. They like them set up straight through by circuit reference—no grouping. Show individual component manufacturer and his stock number

Waveforms

The oscilloscope has become as essential as the voltmeter on the service bench.

The most satisfactory method for handling waveform presentation is to furnish input and output waveforms for critical tubes. However, unless peak voltages are given along with the sweep speed employed by the scope, waveform information is no good.

Voltage and Resistance Diagram

One of the oldest maintenance aids is the voltage and resistance diagram; many old timers believe in nothing else. Its rated importance indicates that it should be included in every manual and for simple equipment, it probably deserves to be ahead of the waveforms in priority. Most service men prefer to have the tube-pin voltages on the schematic. In this case, the tube-pin resistances could either be tabulated in the manual elsewhere or placed on a standard voltage and

Maintenance Information in Order of Importance	Remarks
(1) Schematic Diagram	If equipment is complex, furnish both fold-out integrated type and single-page sectionalized type. Include component values, pin voltages and tube functions on schematic
(2) Circuit Description	The more complete the better
(3) Waveforms	Peak voltages should be given
(4) Voltage and Resistance Diagram	Too useful and simple to leave out
(5) Tube Replacement Chart	Show adjustments to be made when tubes are replaced. Describe critical tubes
(6) Circuit Block Diagram	Good in circuit description, but well organized schematic is superior for servicing
(7) Trouble-Shooting Chart	It should check and adjust unit completely, rather than act as catalog of possible failures
(8) Internal Views	Necessary only when chassis cannot be silk-screened clearly
(9) Tube Location Diagram	Mark chassis instead
(10) Resistor-Board Details	Mark boards instead

resistance diagram with voltages repeated.

Tube Replacement Chart

More frequently than not, troubles can be attributed to tube failure, this is particularly the case with conservatively designed equipment. Sometimes tubes are critical for one reason or another and simple replacement is only part of the answer. If circuit adjustments are desirable after tube replacement, the technician should be so informed. If tubes require selection for particular characteristics, this also should be stated clearly.

The most direct manner of getting this information across is to include a chart listing all tubes in the instrument with replacement notes for each tube position. The chart can refer the technician to an adjustment section or to a particular paragraph discussing the specific problem.

Many equipments cannot be restored to optimum performance by random tube replacement; and even if no adjustment is required, often there is a simple check that can be made after replacing noncritical tubes, as a matter of good practice.

The service technician wants tube replacement information indexed in one place in the manual so that he can quickly determine whether or not further work is required.

Circuit Block Diagram

While an aid to teaching and circuit description, the circuit block diagram falls off in importance when the technician sits in front of a piece of equipment that won't work. Its position on the priority list indicates that it must be supplemented by other information before it can be included in a manual of servicing instructions.

Trouble-Shooting Chart

When service information becomes extensive enough to include a trouble-shooting chart it should be systematic. Starting with the power supply, measurement points giving ripple specifications, voltages, degree of regulation and the like, should be organized so that completing the procedures will uncover most substandard performances. If nothing else, the chart could be a repeat of production testing procedures for such things as calibration adjustments, checking performance specifications and setting-up proper operation. Make the trouble shooting chart check-out the equipment rather than list many possible causes of equipment failure.

When adjustment resistors and capacitors are not marked on the chassis with a circuit reference or function, it is desirable to include photographs or preferably drawings to locate them. A picture literally is worth a thousand words if a writer has to tell a technician how to find a particular trimmer buried in a complicated chassis.

Locating Key Components

Technicians feel that using call-outs for every component on a chassis is unnecessary. Call-outs, should be limited to electrolytics, adjustments, particular test points or critical components. The majority prefer to have the chassis marked rather than having to refer to internal views. Many replies were received saying, "No good. Mark the chassis."

Tube Location Diagram

A simplified drawing of the instrument calling out location of tubes is considered necessary only in two cases: where tubes and circuit references are not marked on the chassis; where a piece of equipment is large and contains a great many tubes located on various decks.

Detailed drawings of resistor boards are not only given a low priority, but are considered unnecessary by a great many technicians on the basis that the circuit-reference information they contain should be on the boards themselves.

Parts List

Another section of the maintenance manual is generally a list of replaceable parts. At least 80 percent of the technicians concurred on its organization as follows:

(1) List parts in numerical order by circuit reference straight through. No grouping, repeat if necessary.

(2) List value, type or composition, tolerances and ratings.

(3) List equipment manufacturer's stock number.

(4) List component manufacturer's name and stock number.

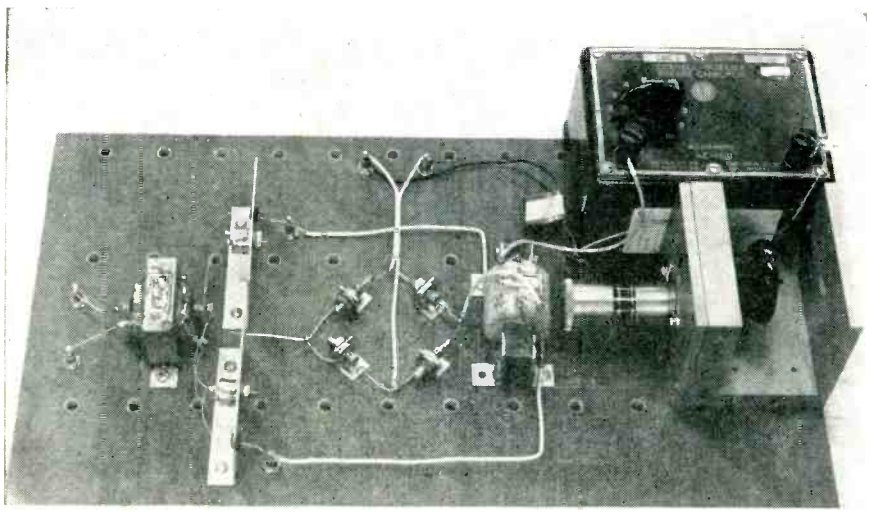
The last point is not the least important since furnishing this information makes replacing parts from a local supplier much easier.

Servo Amplifiers Use Power Transistors

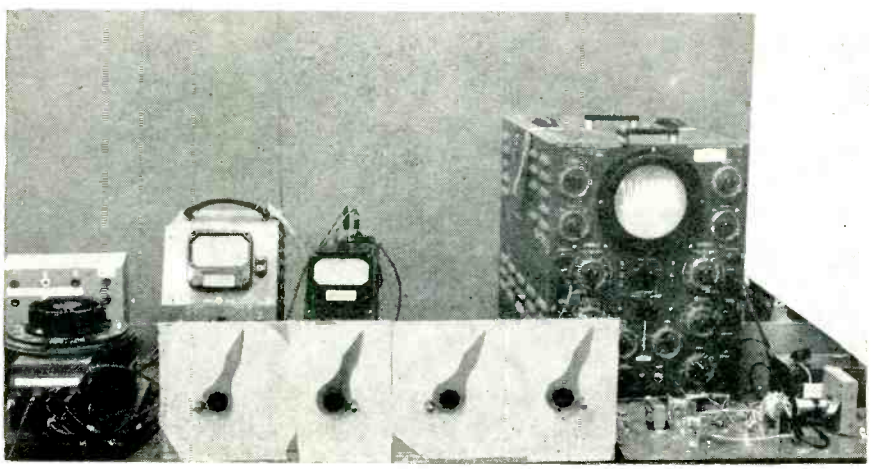
By BRUCE M. BENTON

Research Engineer, Acoustics-Electrical Staff Unit
Boeing Airplane Company, Seattle, Washington

SUMMARY —— Transistor servo amplifier using pulsating collector supply voltage rectified from a-c servo power supply has much lower collector power dissipation than a comparable class B amplifier. One prototype circuit described controls an a-c servo motor. A second circuit is designed for d-c loads and works well into two resistors or an electrohydraulic control valve. Both circuits use germanium power transistors and junction rectifiers



Breadboard of servo amplifier for a-c loads showing the two power transistors with their heat sinks and four junction rectifiers in bridge circuit



Laboratory test-bench setup used to evaluate performance of servo amplifier designed to control a two-phase directional servomotor

INCREASED AMBIENT temperatures limit maximum power output and reliability of airborne control equipment using semiconductors. Therefore, a more efficient servo amplifier was developed so that the internal temperature rise, above ambient, of the semiconductors would be kept to a minimum.

A servo amplifier in a positioning system raises error signal power to a sufficient level to operate a positioning controller. In general when the error signal is d-c, a zero-center d-c amplifier and polarized d-c controller are used. When the error signal is phase-directional a-c, a single-frequency a-c amplifier and a two-phase a-c controller are used.

Alternating-current servo amplifiers are single-frequency amplifiers in which the error signal is essentially either in phase or 180 deg out of phase with the system power supply.

Amplifiers for A-C Load

Figure 1 shows the new servo amplifier driving a two-phase a-c motor. This circuit is identical to the conventional class B amplifier except that the collector power for the transistors is derived from full-wave rectification of the servo power supply.

The transistors with unfiltered

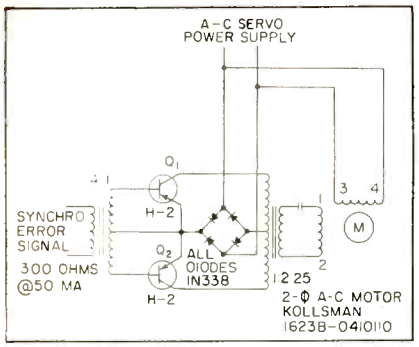


FIG. 1—High-efficiency servo amplifier designed to drive an a-c servo motor

the transistor at full load is shown for the on half cycles of Q_1. Figure 2B shows the same transistor voltage drop for pure d-c collector supply power as found in a conventional class B amplifier.

The motor shown in Fig. 1, can be series tuned by the capacitor to appear as a resistive load. In this case, as shown in Fig. 3, the transistors operate over a series of load lines which extend from peak load line Q_1 through zero to peak load

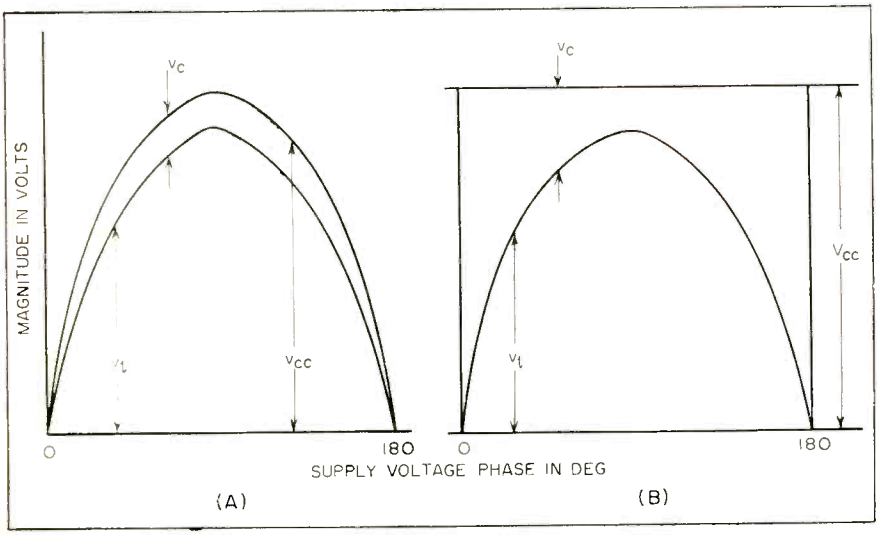


FIG. 2—Load and collector supply voltage curves for high-efficiency amplifier (A) and for comparable class B amplifier (B)

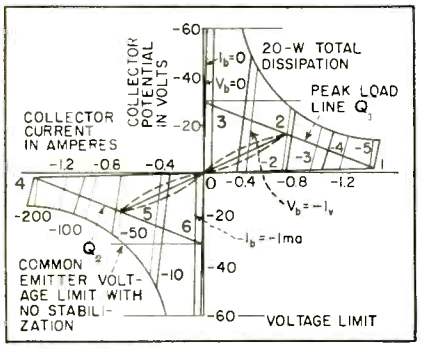


FIG. 3—Common-emitter characteristic curves for H-2 germanium power transistors showing no-load (3-0-6), ½-load (2-0-5) and full-load operation (1-0-4). Dashed lines are for inductive loads

full-wave rectified power operate with maximum full-load efficiency because the wave shapes of the load voltage and the supply voltage differ only by the saturation voltage of the transistor. That is, the collector-to-emitter voltage for maximum transistor power output.

This is illustrated in Fig. 2A, where the voltage drop v_c across line Q_2. At zero load drive signal the two transistors operate on the load line 3-0-6, at ½ load 2-0-5 and at full load 1-0-4.

Operation of the transistors into an inductive load has not been evaluated to date. However, a reduction in efficiency is expected. In Fig. 3, the dashed line is the load line for a typical inductive load.

Power Loss

The collector power loss for the amplifier is

$$P_L = (V_{cc} I_c/2) + (V_{cc} I_{co}/2) - (V_L I_c/2)$$

The collector loss for the same transistor operating class B is

$$P_L = (2/\pi)\ V_{cc} I_c + V_{cc} I_{co} - (V_L I_c/2)$$

Since

$$(V_{cc} I_c/2) + (V_{cc} I_{co}/2) < (2/\pi)\ V_{cc} I_c + V_{cc} I_{co}$$

the collector power losses of the transistors in the new servo amplifier are always less than in a comparable class B amplifier. Thus, the transistors in the amplifier shown in Fig. 1 always operate with cooler junction temperatures than they would have in a comparable class B amplifier.

At full load using typical values of $V_{cc} = 30$ v, $V_L = 29$ v, $I_c = 1.4$ amp and $I_{co} = 0.0001$ amp, power loss ratio is 6.4/0.7.

Efficiency

The maximum theoretical efficiency of the amplifier is 100 percent as compared to a maximum of 78 percent for class B amplifiers. However, the actual efficiency depends upon the quiescent value of the collector current and supply voltage, the saturation voltage and I_{co} of the transistors, the efficiency of the output transformer and the level of power output. In practice, the efficiency of this amplifier at full power output level operating into a resistive load using good quality transistors is greater than 95 percent.

The efficiency is given by

$$\text{Efficiency in percent} = (V_{cc} - V_c)/V_{cc}[1 + (I_{co}/I_c)]$$

Since at maximum drive signal $V_{cc} >> V_c \rightarrow 0$ and $I_c >> I_{co} \rightarrow 0$, collector efficiency $\rightarrow$ 100 percent.

Using typical values of $V_{cc}/V_c = 30/1$ and $I_{co}/I_c = 0.0001/1.4$ collector efficiency is 96.6 percent.

These efficiency calculations have been considered with the transistors operating at a drive signal which produces maximum transistor power output. Maximum collector power dissipation in the transitors does not occur at this point, however, but at some value of reduced transistor power output.

For the new amplifier this maximum power dissipation occurs when the drive signal produces an rms

DEFINITION OF TERMS

- I_b = Peak base current
- I_c = Peak collector and load current
- I_{co} = Peak collector leakage with base open circuited
- P_L = Collector power loss for one cycle
- v_c = Instantaneous collector-to-emitter voltage
- v_{cc} = Instantaneous collector supply voltage
- v_l = Instantaneous load voltage
- V_b = Peak base voltage
- V_c = Peak collector-to-emitter voltage
- V_{cc} = Peak collector supply voltage
- V_L = Peak load voltage

voltage, across the load equal to ½ the rms supply voltage. Maximum possible collector power dissipation is 25 percent of full-load power.

In a comparable class B amplifier the maximum possible transistor collector power dissipation is 40 percent of full load (Fig. 4). Thus the first amplifier, within the transistors' maximum voltage and current limits and with its greater efficiency, is capable of a maximum power output of over 1.5 times its class B counterpart.

Amplifier for D-C Loads

A method for applying this new circuit to d-c loads is illustrated in Fig. 5. This circuit amplifies and rectifies the servo error signal to supply a d-c voltage across controller loads 1—2 or 3—4 depending upon the phase relation of the fixed-frequency power source and the error signal, thus determining the direction of control.

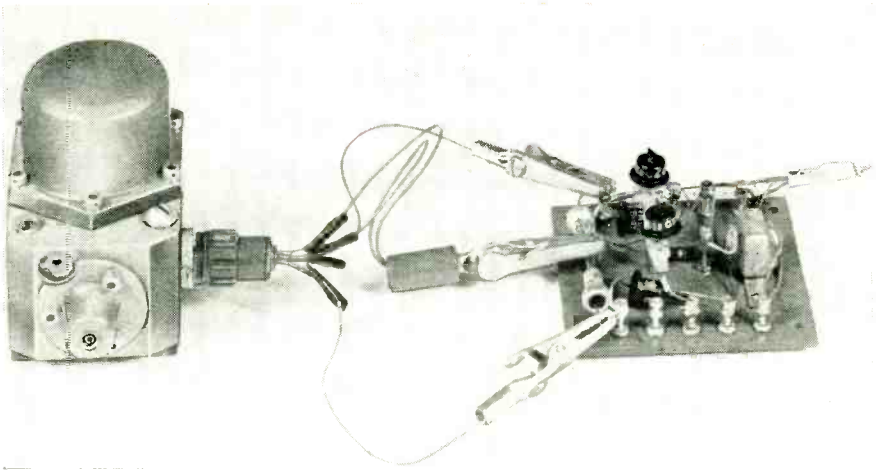
This circuit is really two half-wave amplifiers in parallel. One amplifier amplifies and half-wave rectifies the error signal when it is in phase with the reference voltage. The other amplifier performs the same function when the error signal and reference supply voltage are 180 deg out of phase.

The advantages gained by such an amplifier to control polarized directional-sensitive d-c loads are high efficiency and simplicity plus the fact that the zero-reference voltage has the low drift of balanced a-c systems. For maximum efficiency, the controller loads should be designed as resistive loads.

Smoothing capacitors can be added if desired as indicated in Fig. 5. However, this can be done only at the sacrifice of efficiency. Complete smoothing will reduce the collector efficiency to that of a class B amplifier.

The first functional test circuit Fig. 5 used two resistors as loads.

A second functional test circuit uses a centertapped electrohydraulic transfer valve. This valve was primarily designed to operate from the d-c output of an electron-tube circuit and was therefore not well suited to the pulsating d-c output from transistors. The inductive valve load and the valve's fast response required the addition of smoothing capacitors to obtain the desired performance. These capacitors reduced the efficiency.



Servo amplifier designed for d-c loads drives electrohydraulic valve. Tantalum smoothing capacitors shown are necessary because of inductive load

The two circuits are prototypes and better utilization of the amplifier can be realized by properly designed controller loads.

Conclusion

With a constant load impedance power output is insensitive to small source-voltage variations because the transistors are current amplifiers and tend to be self regulating. Low source voltage becomes a limitation when there is insufficient voltage to support the current through the transistor saturation resistance and the load.

The prototype amplifiers operate well on distorted a-c single-frequency power sources such as transistorized square-wave inverters.

The amplifiers are not frequency sensitive within the normal frequency variation range of the fixed-frequency power supply.

Over-driving protection of the amplifier can be accomplished by designing the input transformer to saturate at the maximum amplified rating of the phase-sensitive load or at the maximum temperature derated output power of the transistors.

A 20-watt amplifier will fit into a volume which is only slightly larger than a package of cigarettes.

Push-pull preamplifier stages can be added to increase the error signal drive. Collector power for these stages can be of the pulsating d-c type obtained from the bridge rectifier of the power amplifier. See

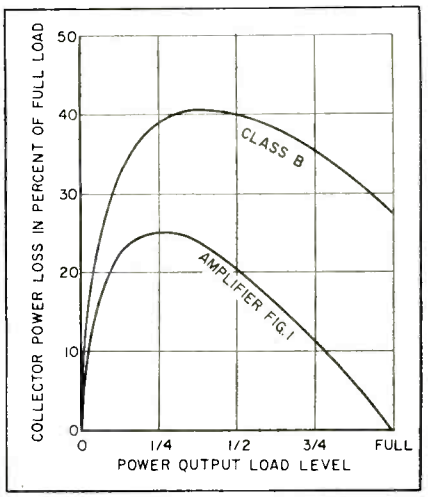


FIG. 4—Variation of average collector power loss with power output level for high-efficiency amplifier and class B amplifier

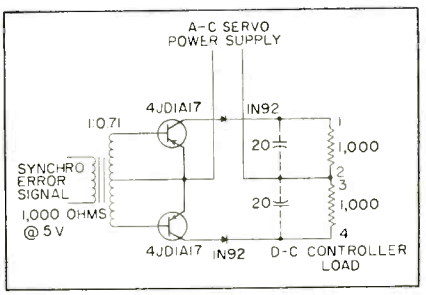


FIG. 5—High-efficiency a-c servo amplifier designed to drive a d-c controller. Two resistors simulate a resistive load

The author thanks K. D. Johansen, G. L. Keister and R. A. Yereance for their comments during the preparation of this article, B. E. Bush and G. W. Freeman for conversations about the operation of the transistors and W. L. Belnap for construction of test circuits.

SUMMARY —— Because time is money to broadcast stations, engineers must find ways to keep programs on the air continuously. Methods are simple, foolproof and inexpensive. Often commercial equipment is adapted to a particular mode of operation. Among the techniques and circuits applied by practical broadcasters are centralized alarms, insulating and shielding methods and even a novel link antenna orientation

By ALEXANDER A. McKENZIE
Associate Editor
ELECTRONICS

How To Reduce

TO KEEP carrier and program on the air for the convenience of the public and the production of necessary revenue, broadcast engineers show great ingenuity.

Their first line of defense is a comprehensive maintenance program. But if and when failure occurs, their second line of defense is a system of alarms and indicators, alternate equipment and quick intercommunication.

Unbalance Detector Alarm

Combining outputs of two amplifiers by use of a bridge circuit is frequently done to insure continuity of service even though one amplifier may fail. In this case, considerable power may have to be dissipated by the dummy load that is a part of the bridge.

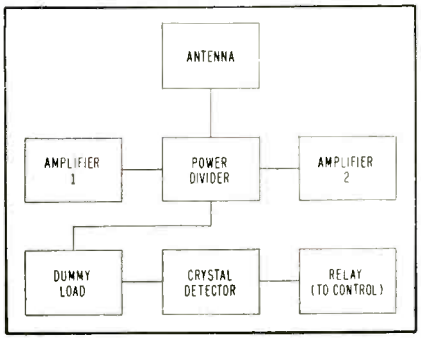
In the block diagram is shown the generalized output setup of a television picture transmitter. A crystal detector senses increased power in the dummy load whenever there is a failure of one amplifier, such as might be caused by arc-over in the plate cavity.

The relay actuated by the crystal diode flashes a warning indicator and a separate pair of contacts opens the main control circuit of the transmitter. This generally clears the arc, whereupon automatic application of plate voltage through the control circuit restores service to normal and, balance being restored, transmission resumes at full power. The dummy load can be designed to handle short-term overloads without damage.

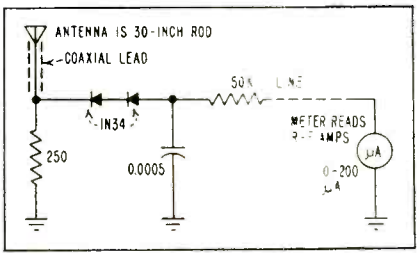
Remote Tower Meter

The operating engineer must know at all times that transmitter power is actually being radiated from his antenna system. Current in each antenna tower at WNEW, New York, is simply read at the transmitter building using a microammeter calibrated in r-f amperes.

A 30-inch rod antenna is mounted near the base of the tower. It is connected through coaxial cable to a metal box containing two resistors, a capacitor and pair of semiconductor rectifiers



Unbalance power in dummy load operates signal relay



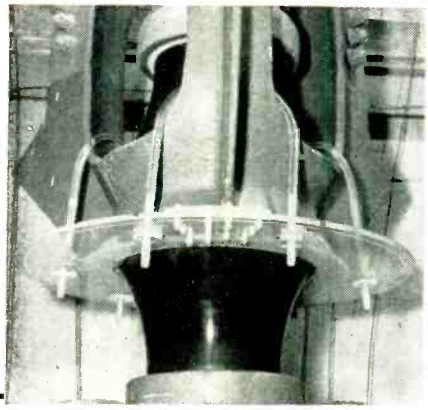
Simple pickup and rectifier supplies d-c to remote meter

as shown in the diagram. The line carries direct current that is measured by the meter.

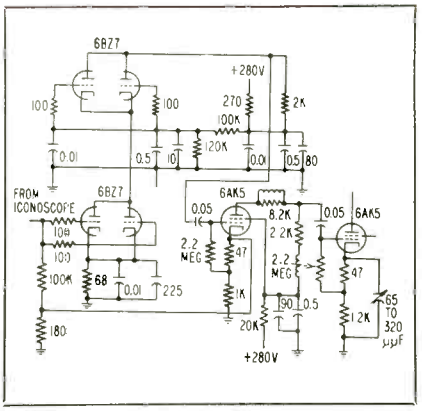
Eliminating Flashover

Radio engineers working with high-power radio-frequency have always had the problem of maintaining the high-resistance qualities of the insulators used. Ingenious methods have been used to prevent damaging flashover across the large compression insulators at the foot of each WNEW (New York) antenna tower. Located in the New Jersey Meadows, the insulator surfaces are attacked by industrial smoke, salt spray and other conducting impurities.

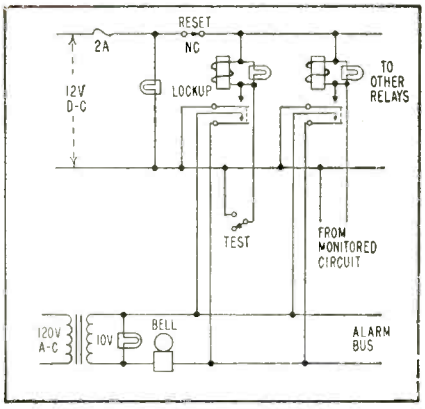
It was decided that if rain water could be deflected from flowing across these surfaces, the incidence of severe arc-overs could be lessened. Accordingly, Lucite shields were attached using nuts and bolts



Plastic spray keeps arcover tracking to minimum on insulators



Cascode amplifier as used in iconoscope film camera



Lockup circuits provide central visual and aural alarm

Off-Air Time

of the same material, as shown in the photograph. The high r-f field precludes use of metal fixtures.

This method proved only partially successful. After an arc-over, the glazed insulator surface is now sprayed with clear Krylon 1302 and has thus been protected from the damaging grooves of prolonged arcing. Insulators supporting the feed line have likewise been sprayed to good effect. A moisture-resistant spray, Krylon 1301, is not recommended for this type of electronic or television use.

Inverted Antenna

Attempting to operate a 150-mc cue circuit between a nemo and the Empire State tower in New York City, Engineers of WOR-TV found great difficulty in reception, caused by the more than 20 transmitters of various kinds located on the tower.

The ground-plane antenna used, a commercial product with four rods set at an angle below the horizontal (exclusive of the top vertical rod) was tried in several locations in the normal position, with the ground plane pointing downward.

When the antenna assembly was turned upside down at a location below most of the more powerful transmitting antennas, interference was sharply reduced and reception become satisfactory on 150 mc. Station engineers theorized that the inverted ground plane was acting as a shield against interfering signals.

TVI in Film Chain

Sometimes reliability requires that equipment be modified to operate in an environment of which the manufacturer had no knowledge. Field changes made by broadcast engineers are often incorporated in later commercial models.

Television stations do not generally attempt to operate a film chain close to one or more high-power transmitters. When they do, it is necessary to isolate the low-level stages and provide shielding.

At WOR-TV in the Empire State tower, New York City, it was found necessary to make several modifications to the TK20A camera pickup head. Filters were installed in the power line to eliminate pulses and finger stock was fastened to the edges of the metal enclosure to insure good contact and perfect shielding.

To facilitate servicing as well as to shorten the low-level path between iconoscope tube and preamplifier, the latter unit was attached to a Jones plug, with a grid clip for connection to the ike, this unit uses the circuit shown.

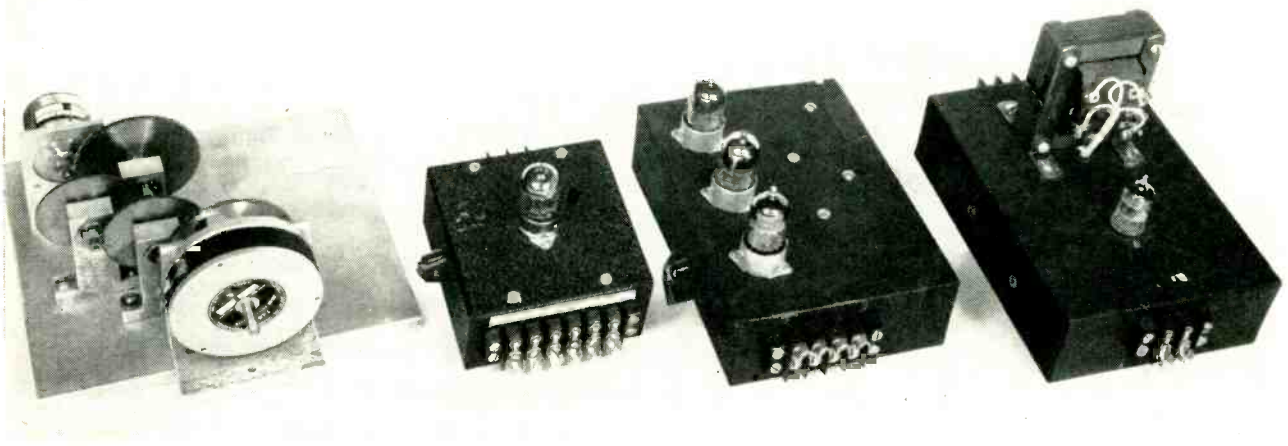
This cascade amplifier was originally described (ELECTRONICS, p 166, Dec. 1953) as a modification to earlier camera chain equipment.

Central Alarm Panel

Individual alarms attached to equipment spread throughout the broadcast plant are likely to be confusing to operators in time of emergency. Such alarms have been centralized at WNEW, New York, where both visual and audible signals are actuated. In addition, the alarm circuit relays are wired to lock up so that the alarm continues until manually reset.

In this particular installation, each of ten relays and their associated parallel pilot lights are connected in series with a 12-volt d-c supply and the circuit to be monitored. For simplicity, only two relays are shown in the diagram. A test switch trips one of the circuits. Alarm circuits in use include antenna arc-over, diesel water temperature and oil pressure, Conelrad carrier-off, Conolrad 1,000-cps tone, dummy antenna water temperature and pressure. Other circuits have been included on the panel located at the audio rack to take care of future expansion of the alarm system.

Material presented above was obtained through the courtesy of Max Weiner and Karl Neuwirth of station WNEW and that of Harry Tilley and George Riley, WOR-TV.



Variable-speed drive and potentiometer transducer are at left; cathode follower, operational amplifier and modulator are at right

Potentiometer Tachometer

MANY DIFFERENT types of tachometers have been developed, including centrifugal, liquid, reed and electrical. This article describes a new electromechanical tachometer which covers a wide input range and also appears to be capable of a much higher sensitivity than any existing tachometer.

Signal-to-noise level is such that input speeds as low as 1/200 rpm are readily measured. The tachometer provides a continuous indication of both speed and direction of rotation. A high degree of linearity is achieved since only basically simple components such as resistors, capacitors, potentiometers and tubes are used.

System Operation

Figure 1 shows the overall system. Input-shaft rotation is sensed by a resistance potentiometer, which converts the input angle into a proportional electrical signal. The output from this transducer is fed to a cathode follower or isolation amplifier which prevents loading of the transducer and produces a low output-impedance level. A high-gain operational ampilfier with derivative feedback is connected to the cathode-follower output.

The output of the operational amplifier is a d-c voltage proportional to the input rate.

Continuous Rotation

It is possible to have unlimited mechanical rotation of the potentiometer transducer. However, an electrical discontinuity is encountered whenever the wiper arm passes over the dead space.

This difficulty may be partially overcome by using a continuous track with taps as shown in Fig. 2A. With such an arrangement, the output voltage of the potentiometer is continuous for unlimited rotation of the input shaft (Fig. 2B), but there is still a discontinuity in the rate of change of this voltage as the wiper arm moves past the 90 and 270-degree taps (Fig. 2C).

If it is desired to produce the characteristics of a true tachometer and measure actual shaft velocity with unlimited rotation, a more elaborate setup is required. The basic arrangement is shown in Fig. 3A. Here, two transducer channels are employed. Each potentiometer is connected to its own operational amplifier. The two potentiometer shafts are ganged together with the arm of the output commutator switch that selects the output voltage from the appropriate operational amplifier for any angle of rotation of the input shaft.

Operation is described with reference to Fig. 3B, which shows how the potentiometers are phased. By using two ganged input potentiometers and two differentiating amplifiers, with a switching arrangement, true tachometer performance is obtained for unlimited rotation.

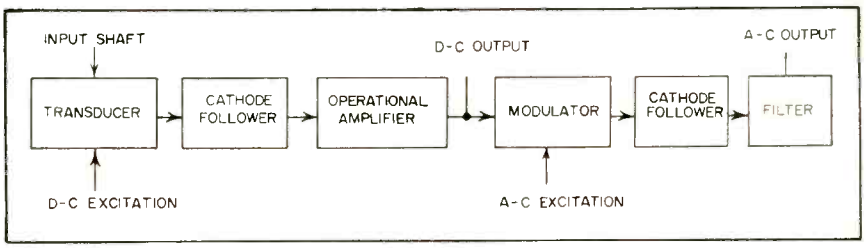


FIG. 1—Basic potentiometer-type tachometer system block diagram

SUMMARY — Rotational speeds as low as 1/200 rpm are measured by electromechanical device that is at least 100 times as sensitive as existing tachometers. Consisting of linear potentiometer and operational-type differentiating amplifier, the tachometer's operating range can be varied over wide limits by changing time constant of feedback network or excitation on potentiometer. Shaft rotation may be in either direction

By GARETH M. DAVIDSON and MELVIN PAVALOW

Senior Engineer
Arma Division
American Bosch Arma Corp.
Garden City, New York

Senior Systems Engineer
Republic Aviation
Guided Missiles Division
Hicksville, New York

Has High Sensitivity

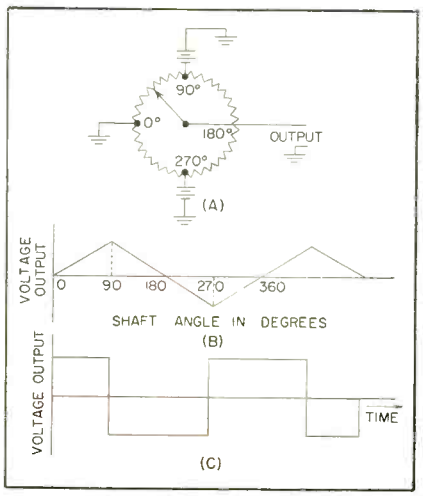


FIG. 2—Potentiometer winding for continuous electrical output (A), potentiometer output as a function of angle of rotation (B) and operational-amplifier output as a function of time for constant speed of rotation (C)

The switch continuously selects the appropriate potentiometer so that operation always takes place over the rising portions of the transducer output curves.

Switching is perfectly smooth, since the output terminal is never disconnected from the system and shorting is effected only between points of equal potential. The switch must be placed after the operational amplifiers rather than immediately after the transducers themselves. Also the transducers and amplifiers for the two channels must have matched characteristics.

Potentiometers may be easily matched by trimming the excitation voltages, if the linearity errors are small. Matching of the differentiating amplifiers is done by trimming the time constant of the R-C feedback network.

Special potentiometers with accurate taps are not required. Standard units with a small section of discontinuity between the fixed ends may be used. The two potentiometers must be mounted such that the outputs of the wiper arms are 180 degrees apart in space phase. Fabrication of the commutator switch is relatively simple since high angular precision is not required.

Isolation-Stage Circuitry

Because the input impedance of the differentiating operational amplifier is directly equal to the reactance of the input feedback capacitor, a buffer amplifier is recommended to isolate the potentiometer transducer. In most cases, a simple cathode-follower stage will serve this purpose. The output impedance obtained by this method is given by $R_o = r_p/\mu + 1 \approx 1/g_m$.

If an extremely precise derivative output is wanted, then an isolation amplifier such as a high-gain feedback amplifier with a lower output impedence is required.

Operational Amplifier

The derivative signal which is the desired output of the rate system is produced by the operational differentiating amplifier.

A schematic of the complete operational amplifier is shown in Fig. 4. Conventional push-pull stages are employed throughout. The d-c open-loop gain is of the order of 5,000.

By careful layout of the chassis wiring, stray capacitance feedback was kept to a minimum and no trouble was experienced from high-frequency instabilities.

If high-frequency oscillations are encountered, an R-C compensation network will cure the difficulty. Another possibility is to shunt the 5-megohm feedback resistor with a small capacitance of the order of 50 $\mu\mu$f. This capacitor also reduces the high-frequency noise at

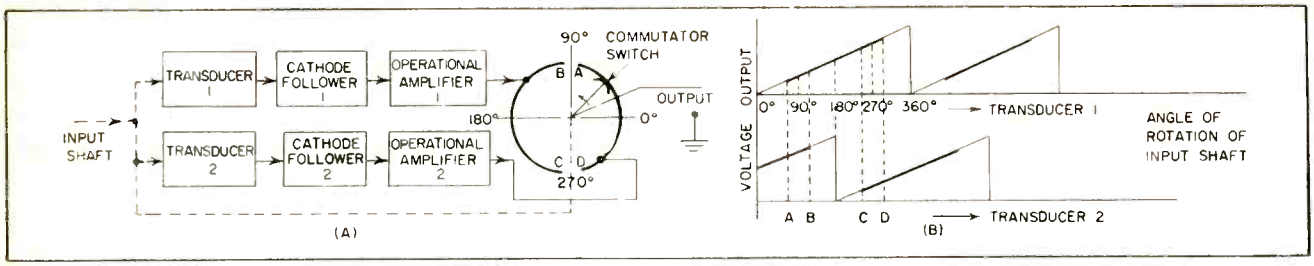


FIG. 3—Basic arrangement to measure actual shaft velocity with unlimited rotation (A). Diagram shows how potentiometers are phased (B) to obtain true tachometer performance for unlimited rotation

the output which arises because closed-loop gain increases directly with increasing frequency over a wide frequency range.

In the actual equipment, this noise was not found to be objectionable.

No precautions were taken to minimize drift in the d-c amplifier. For zero-frequency or d-c operation, the 2-μf input capacitor acts as an open circuit and the first grid is effectively isolated from the input source. Thus, except for leakage resistances to ground, the input grid is effectively tied directly to the high side of the output. The drift at the output is of the same order of magnitude as that at the input grid.

For the amplifier tested, drift at the output was readily kept below 5 millivolts. The maximum output voltage available was +80 volts. Total warmup time was of the order of 5 minutes.

Chopper stabilization is unnecessary. In addition, d-c power supplies with only moderate regulation are adequate.

The 1,000-ohm balance potentiometer in the cathode of the first stage adjusts the tube biases for optimum linear operation.

Diode Modulator

In those applications where only a d-c voltage proportional to input rate is required, the voltage out of the operational amplifier may be considered as the output. However, in many control systems and computers, particularly those of the a-c carrier type, the output must be a scaled a-c carrier voltage rather than a d-c signal. Therefore, a d-c to a-c signal converter was included in the system. This includes a diode modulator followed by an L-C filter, which provides a sinusoidal output with a low degree of distortion.

The modulator is shown in Fig. 5. It is an electronic switch using a balanced-bridge to eliminate the reference carrier component from the signal output. The d-c input voltage is of much smaller magnitude than the amplitude of the a-c bridge reference voltage. This means the reference voltage opens and shorts the two diodes during alternate half cycles. When the diodes are shorted, point A is shunted to ground through the two 10,000-ohm resistors in parallel; the output voltage is low due to the drop across the 20,000-ohm input resistor.

On the next half-cycle when the diodes are open, there is no voltage divider action and the input voltage is transmitted directly through to the output with negligible attenuation. The output of the modulator is thus a square wave whose amplitude corresponds to the magnitude of the d-c input and whose frequency is that of the reference carrier which happens to be 400 cps.

The two trimmer capacitors minimize the quadrature component of the carrier voltage which would appear at the output due to residual-capacitance unbalance of the two diodes. This effect becomes more noticeable as the carrier frequency increases. The 2,000-ohm potentiometer compensates for unbalances due to the slight mismatching of the 10,000-ohm bridge resistors, the diode resistances or the two halves of the reference transformer. It is adjusted by bringing the output voltage to its minimum value with the d-c input terminals shorted together. For the circuit shown, a maximum noise level including harmonics of less than 10 millivolts was readily attained.

Filter

To convert the square-wave output of the diode modulator to a sinusoidal signal, a band-pass L-C filter was employed. The circuit elements and their values are given in Fig. 6. A bandwidth of ±20 cycles was obtained with a center frequency of 400 cps. The amplitude and phase characteristics of the filter require that the deviation of the carrier frequency from its nominal value be kept extremely small if a reasonable accuracy of transmission is to be obtained. Powdered-iron cores are used for the inductive elements of the circuit to reduce errors due to magnetic nonlinearities.

A minimum error of at least a few percent may be expected from the input of the modulator to the

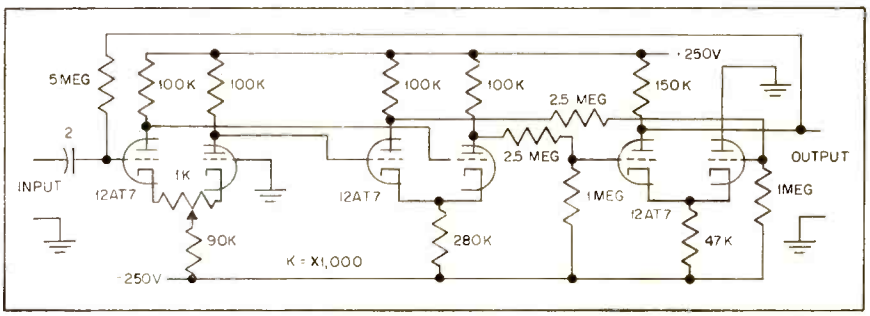


FIG. 4—Complete operational amplifier has d-c open-loop gain of 5,000

output of the filter. If a high accuracy a-c carrier output from the tachometer is desired, a different type of modulator must be used. To obtain the minimum possible error a servo modulator having a motor geared to a ganged potentiometer will probably be required. A circuit using thermal-resistance elements should be suitable where errors of the order of 0.5 to 1 percent can be tolerated. It is thus possible to get a sinusoidal waveform without a filter.

Results

Let the excitation voltage on the input potentiometer be such that the transducer gradient is V_p volts per revolution and let T be the time constant in seconds of the R-C feedback network in the differentiating operational amplifier. Then, if m is the overall gain of the isolation amplifiers and conversion circuits, the output gradient K in volts per rpm is $K = V_p T_m/60$.

In the experimental model, a 10,000 ohm single-turn potentiometer was used with 67.5-volts excitation. Hence, the transducer gradient was 67.5 volts per revolution. A feedback resistance of 5 megohms and a feedback capacitor of 2 μf were employed in the operational amplifier with a resulting time constant of 10 sec. The value of m including the modulator was approximately

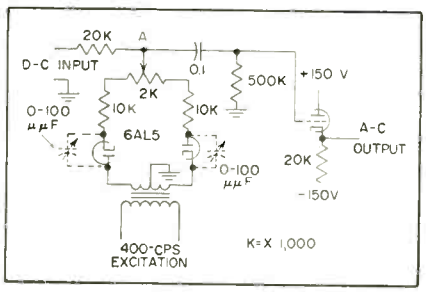


FIG. 5—Diode modulator and cathode follower for d-c to a-c output signal conversion

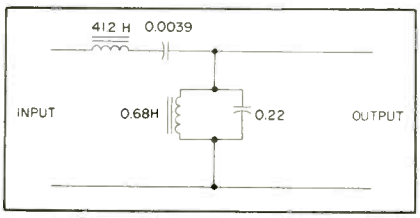
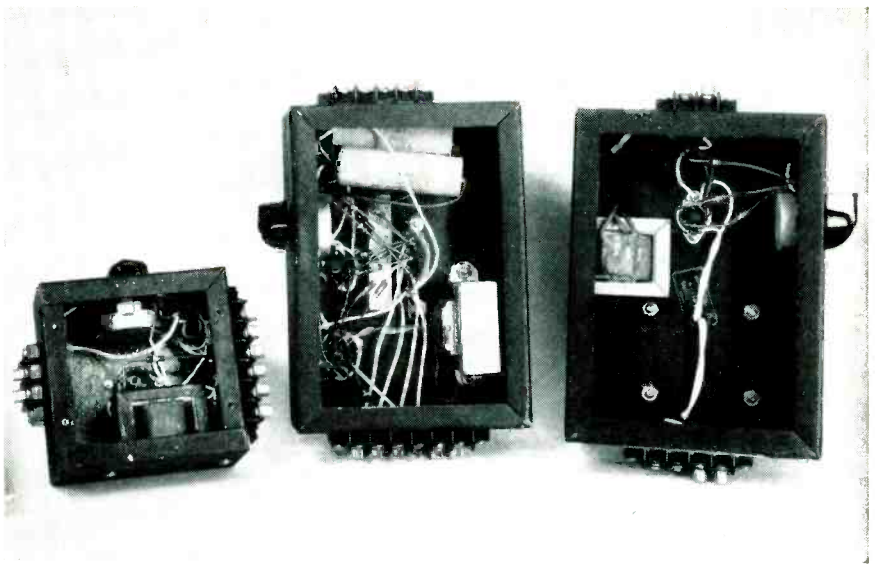


FIG. 6—Four-hundred-cycle band-pass filter with component values



Underchassis views of cathode follower, operational amplifier and modulator

0.3. The output gradient obtained was therefore 3.4 volts per rpm.

The output noise level could be held to a maximum value of 5 millivolts which corresponds to an input speed of 0.005/3.4 = 0.0015 rpm. In contrast, the gradient of commercially available induction generators is usually of the order of tens of millivolts per rpm or less, while the noise level is usually of the order of 10 millivolts. Thus an improvement of about several hundred to one in sensitivity has been achieved with the new unit.

The speed range over which the tachometer is capable of operating is determined at the lower end by the noise level and at the upper end by the maximum output of the operational amplifier. For the circuit of Fig. 4, a maximum output of about ±80 volts was available. Thus with a noise level of 5 millivolts, the speed range is approximately $80/(5)(10^{-3}) = 16{,}000{:}1$. This represents a practical improvement of at least 2:1, as compared with the range of an ordinary induction-generator tachometer.

Scale factor can readily be varied to change the lower and upper limits of the speed range by changing either the feedback time constant or the potentiometer excitation level. It is therefore possible to measure not only relatively low speeds but also the higher speeds which normally fall within the range of other tachometers. The upper speed limit is determined by the wear characteristics of the particular transducer used.

Overall accuracy is determined by the precision of both the basic components and the various electronic circuits.

By careful selection of parts and circuitry it should be possible to at least equal the accuracy obtained in standard electromagnetic tachometers. Moreover, there is no need for the intricate temperature compensation which is usually required of high-accuracy electromagnetic types.

The scale factor is directly proportional to both the time constant and transducer excitation. This permits direct multiplication of the input speed by the voltage excitation on the potentiometer.

Overall linearity error of the first laboratory model was about 0.5 percent. This can be reduced by a considerable factor through various circuit refinements. For best results a potentiometer with infinite resolution such as the film or the single-wire type should be used for the shaft transducer.

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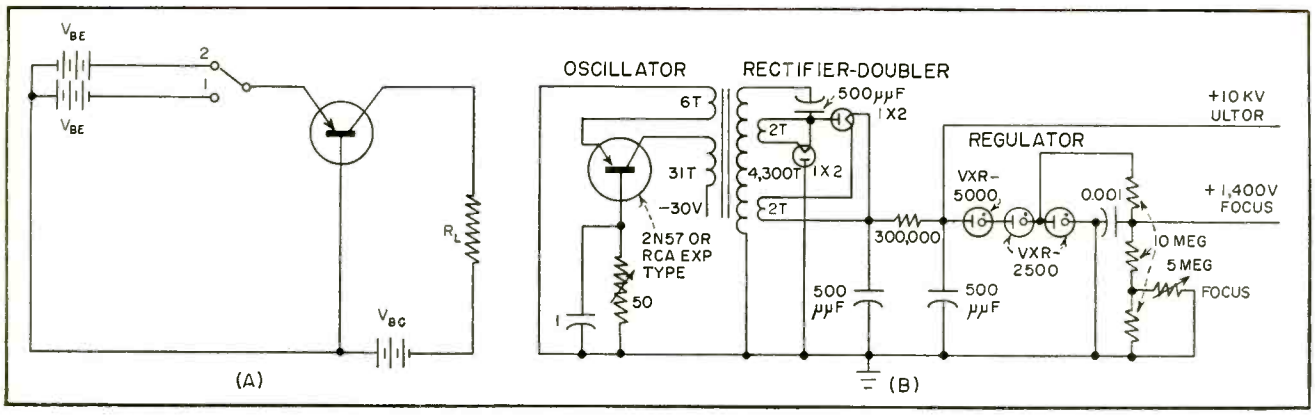


FIG. 1—Basic power-supply circuit (A) and actual circuit (B) showing transistor oscillator, rectifier-doubler with pi-section filter, and regulator which makes use of three corona-discharge tubes connected in series

CRT Power Supply Uses

SUMMARY —— High-voltage power supply uses 12.5-kc oscillator with positive-feedback tickler. Output voltage is doubled, rectified and held to 10 kv by three series corona-discharge tubes. Filament voltage for two electron-tube rectifiers is obtained from transistor oscillator coil. Only external power required is negative 30-v collector supply. Unit supplies high voltage for monitor picture tube in a televison repeater

By P. M. TOSCANO and J. B. HEFFNER

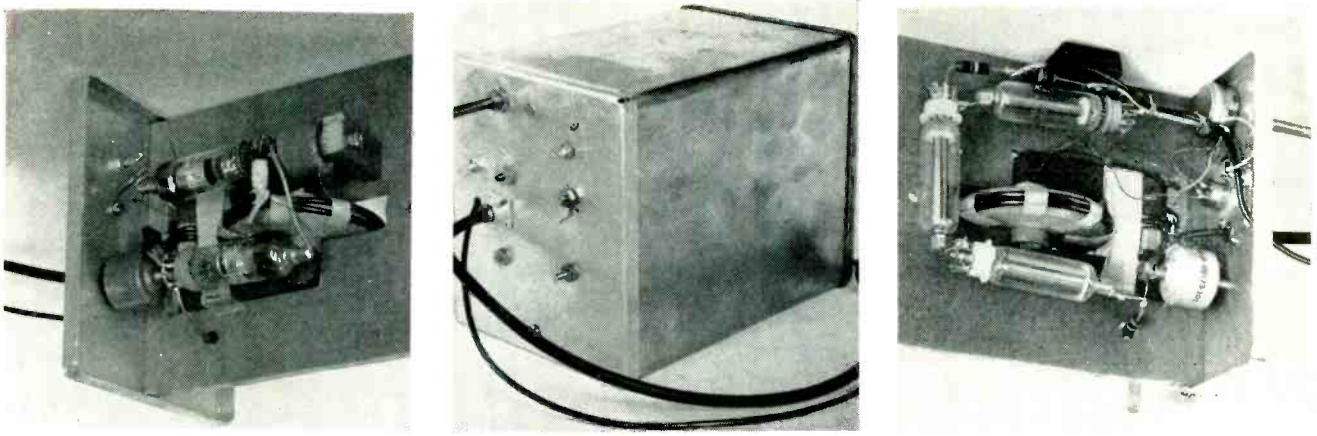
Engineer *Engineer*
Airborne Systems Department
RCA Defense Electronic Products
Radio Corp. of America
Camden, New Jersey

POWER OBTAINABLE from a single-transistor voltage converter is limited by the allowable collector dissipation and the current gain at high levels of emitter current.

Since the current gain falls off with increasing emitter current, beyond a given value high power outputs can be had only at the expense of efficiency. For the transistors used in this study, this is about 500 milliamperes.

Thus with an input of 30 v, an input power of 15 w may be handled by the transistor. Assuming an efficiency of 60 percent, it would be capable of delivering 9 w to the load. Assuming the same current and efficiency, operation at 60 v would be expected to provide 18 w. However, the maximum dissipation rating of the transistors used in power supply is only 10 watts.

At higher temperatures, increased collector current will cause greater transistor dissipation with consequent loss in overall efficiency. It is necessary to derate the output power sufficiently to keep the transistor junction temperature within safe limits. On the basis of published specifications, germanium power transistors seem capable of



Rectifier-doubler circuits, left, use 1X2A diodes and high-voltage capacitors. Entire unit is shown in case, center. Regulator circuit, right, includes three corona-discharge tubes. Power transistor uses front of case as heat sink

Transistor Oscillator

operating at reasonable power levels to 70 C. Silicon power transistors may raise this limit.

Basic Operation

The simplified circuit of Fig. 1A shows that the transistor has two operating conditions. When the switch is in position 1, the emitter is reverse-biased and the collector current is almost equal to leakage current I_{co} of the reverse-biased collector-to-base diode. Since I_{co} is usually small, the collector dissipation $(V_{BC} - I_{co} R_L)\ I_{co}$ is extremely small.

When the switch is in position 2, the emitter current depends on V_{BE} and the resistance of the forward-biased base-to-emitter diode. This resistance is low and the current is large. The collector can never reach a collector current greater than V_{BC}/R_L and for this value, the voltage actually appearing at the collector is zero, causing collector dissipation to be zero.

However, the power in the load is V_{BC}^2/R_L. If sufficient emitter current can be supplied to bottom the collector, an appreciable amount of power can be handled in the collector with negligible dissipation.

While the switch is in position 2, however, power must be supplied to the emitter. This power can be held to a minimum by choosing V_{BE} just large enough to bottom the collector for the value of R_L used. Because of a peculiar characteristic of the collector in the zero and slightly positive region, it is advantageous to supply extra emitter current. This contributes power to the load and increases efficiency.

The low input resistance of the transistor allows small magnitudes of V_{BE} to supply the required emitter current for collector bottoming. The high-current alpha of the transistor should permit making $V_{BC} - \alpha I_e R_L = 0$ with reasonable values of emitter current.

Circuit Operation

The power converter is shown in Fig. 1B. The transistor has positive feedback from collector to emitter. When the transistor begins to conduct, the voltage developed across the primary winding of the transformer induces feedback in the tickler winding which increases the forward bias on the emitter. This increased drive further increases the collector current and the collector will be driven to a bottom condition. A voltage approximately equal to the supply voltage will appear across the primary winding.

For the collector to remain at bottom, the magnetic flux must continue to increase according to $E = -m\ d\phi/dt$. This can be accomplished with little exciting current until the core is saturated. Upon core saturation, the demand for exciting current rises so sharply that the transistor is unable to sustain the flux increase.

The voltage across the primary winding decreases. This causes a reduction in emitter drive, further reducing collector current. The transistor quickly proceeds to a shut-off condition.

Collector voltage reaches a value about twice the collector supply voltage or slightly more, −60 to −70 v. This voltage is in the col-

lector breakdown region but the reverse-biased base-to-emitter diode insures that no appreciable current will flow. With restraining bias on the emitter, the collector can sometimes be driven to about −100 v.

When the transistor is completely shut off, the cycle is repeated at a rate determined by the resonant frequency of the transformer, approximately 12.5 kc. The collector-voltage waveform is nearly square. It is close to zero during conduction and approximately twice the supply voltage during the shut-off period.

This waveform is shown in Fig. 2, left, along with the emitter voltage waveform which is similar. The output voltage waveform is of the same shape.

Increasing Supply Voltage

The efficiency of the circuit will be high because the transistor conducts only when the collector is bottomed. The efficiency of the transistor should approach a limit established by its inherent losses when functioning as an on-off switch. The inherent losses are nearly all attributable to the emitter power necessary to establish the desired collector currents.

Greater power output can be obtained by increasing the supply voltage. Such an increase introduces no additional losses. The peak inverse collector voltage, however, is a limiting factor.

Since the collector voltage rises to approximately twice the supply voltage during the shut-off interval, supply voltage is fixed at approximately half the rated maximum collector voltage. The maximum collector voltage rating for the transistors used in common-base configuration, is 60 v. The supply voltage was 30 v.

Collector Inverse Voltage

The largest transistor losses take place in the emitter. The collector suffers small power losses during switching, but on the other hand actually delivers power back to the transformer. This is the peculiar condition that was mentioned previously.

When the emitter is overdriven, the collector characteristics can pass through zero into the positive region. Figure 2, right, shows a family of collector characteristic curves of a typical transistor. The sharp break around zero collector voltage does not occur until the collector is slightly positive.

If the collector is driven to exactly zero during the conduction, the collector dissipation must be zero. If the collector is driven still further it becomes positive. The product of collector-to-base voltage and collector current represents power delivered to the primary.

This extra power can be deducted from the power supplied to the emitter. Thus the emitter supplies power directly to the load during positive collector operation. Such a condition therefore decreases the net losses and boosts the oscillator efficiency.

The limit occurs at the break in the collector characteristic. Beyond this point the emitter power requirements exceed the rate at which the collector can return power to the transformer. The efficiency will fall if the emitter is driven further.

Feedback can now be considered uncritical. Small variations in the feedback signal should not affect the efficiency much because the collector is heavily overdriven.

Supply voltage changes will not contribute as much to efficiency variations as they would if the collector were driven just to zero. Also, the interchangeability of transistors should not be as critical as in a nonoverdriven circuit.

A-C to D-C Conversion

The 15-kv peak-to-peak square wave on the secondary is applied to two 1X2A high-voltage rectifiers in a half-wave doubler. Filament power is obtained from the transformer. Smoothing is done by the capacitor-input pi-section filter.

Voltage is then applied across three corona regulator tubes in series. The first tube regulates at 5,000 v and the others at 2,500 v each. The operating current range of these regulator tubes is 25 to 1,000 microamperes.

The right-hand VXR-2500 is shunted by three 10-megohm resistors in series. One of these resistors is in parallel with the 5-megohm focus potentiometer. The 10 kv for the kinescope ultor is picked off at the anode of the VXR-5000. The variable focus voltage is picked off the voltage divider.

Power conversion efficiency tests

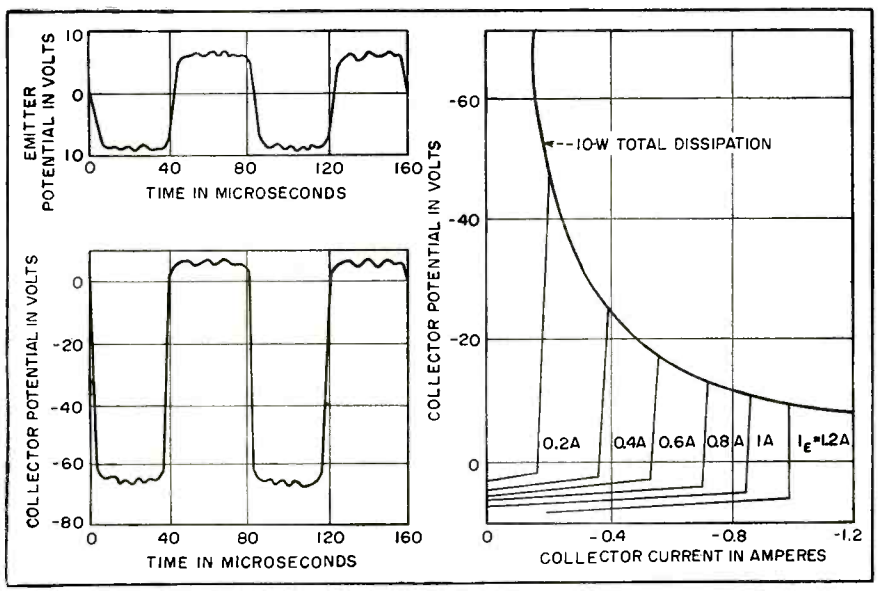


FIG. 2—Collector and emitter-voltage waveforms for transistor oscillator, left, and collector characteristics for power transistor with common-base connection right

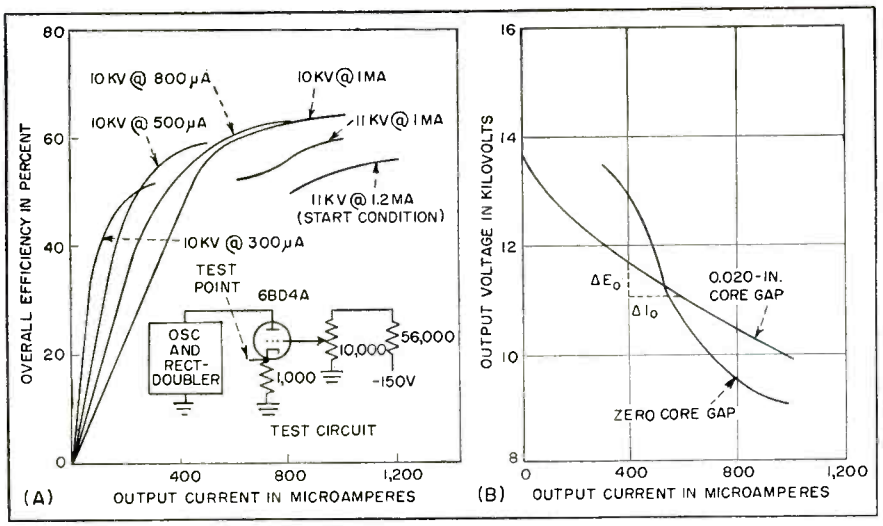


FIG. 3—Load current-efficiency characteristic of power supply with test circuit (A) and voltage regulation properties (B)

for overall d-c to d-c conversion were performed for six different output conditions. The results are plotted in Fig. 3A. These tests were performed without the corona-discharge regulator tubes.

The rectifier doubler output was filtered and applied across a 6BD4A. The load circuit is shown in Fig. 3A. Runs two and three are much shorter than the others because at the lower currents for 11-kv output, the peak inverse collector voltage approached excessive values.

In the test the oscillator and load were adjusted for a given voltage output and maximum current, the load current reduced from the original starting current and overall efficiency plotted against the load current. The starting conditions for the six runs are given in Fig. 3A.

Overall Efficiency

The maximum overall d-c to d-c conversion efficiency was 64 percent. This occurred at 10-kv and 1 ma output. Efficiencies as high as 66 percent were reached by tuning the primary of T_1. This made the efficiency dependent on the tuning and thus far more critical.

Transistor dissipation was recorded by monitoring the shell temperature. The transistor efficiencies were calculated to be about 80 to 85 percent on the basis of temperature.

The tests of output voltage against load variation produced the data shown in Fig. 3B. This test was conducted without the corona-discharge regulator tubes. Measurements were made while the core gap was varied from 0 to 0.050 in. in 0.005-in. steps.

Core Gap

The optimum gap was approximately 0.020 in. The curves in Fig. 3B show only the 0 and 0.020-in. gap data plotted from no load to 1 ma load current. Supply impedance is approximately 3 megohms, derived from the slope of curve *A* between the 400 and 600-μa points.

In another test, seven H2 transistors were tried. In these tests, d-c to d-c conversion efficiencies ranged from 46.7 to 60.2 percent. The average was 54.3 percent. This is considerably better than that found in tests of 15 transistors of the 2N57 type. The difference is attributed to the greater high-current alpha of the H2.

Design Notes

The design of the transformer is not exceedingly critical. Most core materials used for audio transformers could be used. The leakage inductance, however, should be kept to a minimum to avoid large voltage spikes on the collector during the transistor shut-off interval or in case of load removal. Such spikes could be troublesome and might even cause transistor failure.

Turns Ratio

The ratio of primary turns to tickler turns is obtained by the ratio of collector-voltage swing to emitter-voltage swing necessary to produce the collector-current variations desired. The number of primary turns is a compromise between copper losses and the need for restraining excitation current. The operating frequency also enters into the compromise.

Operating frequency is established on the low end by size and economical design and on the high end by the switching ability of the transistors. The high end is more desirable from a filtering standpoint. The transistors used in this study should produce good results from 2 to 14 kc.

The fact that the oscillator produces a square-wave output is not detrimental since the higher harmonics are filtered by any conventional network which is effective against the fundamental. A transistor regulator system might prove more efficient than corona-discharge tubes.

Rectifier Tube

The 1X2A tube was chosen in preference to a semiconductor rectifier because stacked dry rectifiers would not have saved any more space and they are generally not as efficient as electron-tube rectifiers at the voltages used in this converter. The unit measures 5 by 5¾ by 7 in. It weighs 5.45 lb.

The writers thank J. A. Doughty and C. H. Chandler for their encouragement and suggestions. This work was done under contract to the U. S. Naval Bureau of Ordnance.

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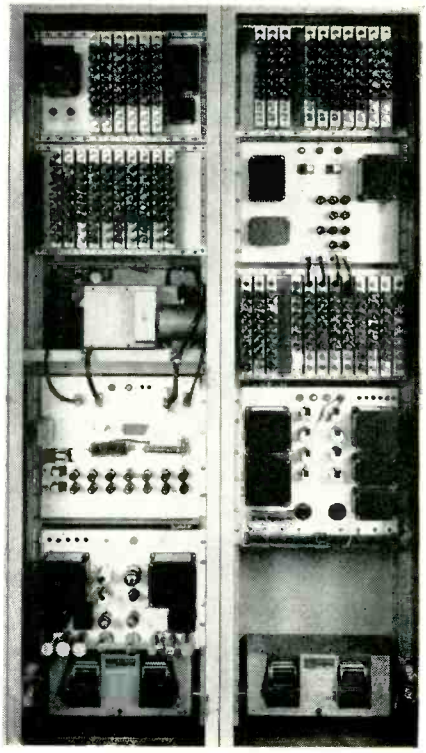
The Front Cover

Operators measure distance between photoelectric detector screens on weapons range at Aberdeen Proving Grounds before checking projectile flight times electronically



Two equipment racks comprise timing and printing portions of equipment

High-Speed Printer

SUMMARY —— Flight-time measurements on projectiles fired from rapid-fire guns are printed out at rates up to 150 a second with 10-microsecond accuracy by electronically controlled stylus printer. Only valid rounds are indicated and each tenth round is emphasized. Binary-coded-decimal to decimal conversion system may be useful in other digital data-handling applications. Use of 3-5 printing matrix simplifies circuits while preserving intelligibility

By JAMES D. FAHNESTOCK
Potter Instrument Company
Great Neck, New York

MANY WIDELY different schemes have been devised and are in use for measuring and recording data at high sampling rates.

Mechanical printers are often limited to about 10 measurements a second. For higher sampling rates, data can usually be stored on magnetic tape or some other medium and later transferred to a mechanical printer for interpretation.

The system to be described prints arabic numerals pertaining to digital measurements made at rate as high as 150 a second. It was designed specifically for recording data concerning times of flight of projectiles fired from rapid-fire automatic weapons at Aberdeen Proving Ground.

Although the application described is specialized, the techniques and circuits are readily applicable to other digital measurement problems.

System Design

The application called for measuring times of flight between two accurately spaced photoelectric detector screens to an accuracy of ±10 microseconds, at rates as high as 9,000 times a minute. In addition, only rounds exhibiting flight times within predetermined maximum and minimum limits were to

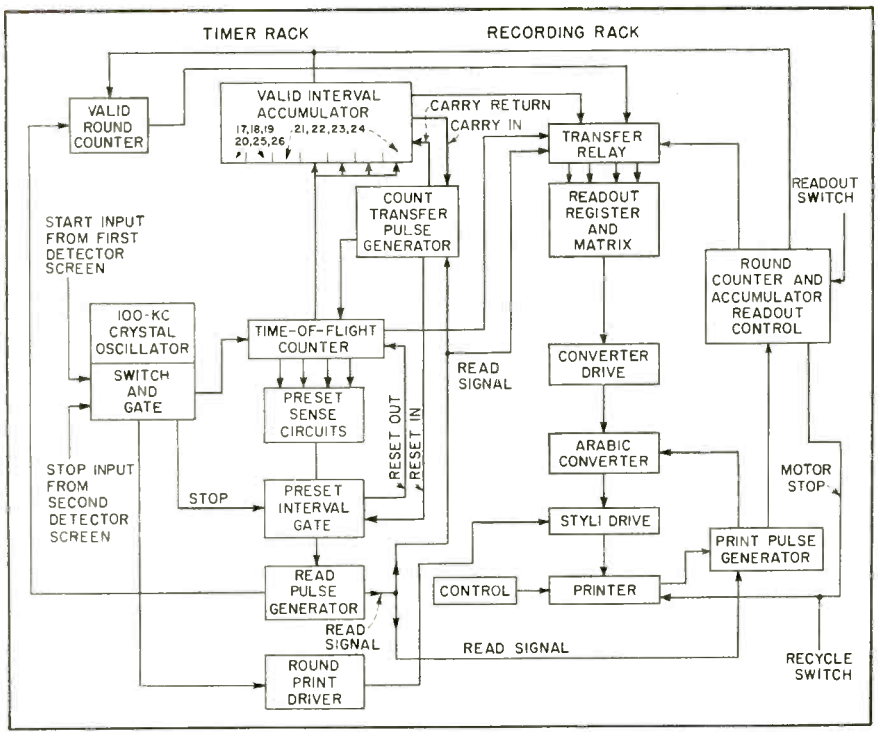


FIG. 1—System includes circuits for timing, counting and accumulating binary bits as well as circuits for converting to arabic numerals and printing

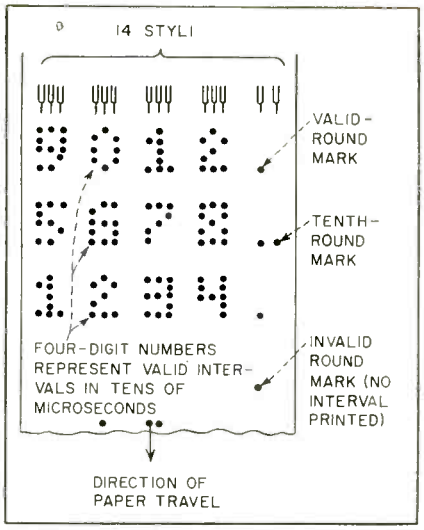


FIG. 2—Recording tape fragment showing 3-by-5 matrix and additional data

for WEAPONS TESTING

be measured. Throughout this article, the term round is used in the ordnance sense.

Figure 1 is a block diagram of the system. Start and stop signals are derived from a pair of photoelectric detector screens whose separation is known. When the projectile interrupts the light plane of the first screen, the output of a 100-kc crystal-controlled oscillator is gated into the time-of-flight counter. When the projectile passes through the second detector screen the gate is closed, interrupting the flow of 100-kc pulses. The count indicated by the counter represents the number of 10-microsecond increments elapsed during the projectile's flight between the two screens.

Each time the first screen detects a projectile, the round print driver conditions the print circuits to place a round mark on the recording paper. If the measured interval falls within the limits selected by the preset sense circuits, the four-digit number describing that interval is shifted into the readout register which activates the arabic converter and causes the interval to be printed out in four arabic numerals across the recording tape along with the round mark.

Each valid interval is also transferred to the accumulator, which adds each interval to those of preceding rounds. The completion of an acceptable interval also causes the valid-round counter to be advanced by one.

Printing Operations

Upon completion of a burst, or series of bursts, the operator depresses the readout switch signaling the equipment to print out the data contained in the accumulator and round counter. These data are shifted through the readout register through the transfer relay which permits use of a single register for both in-step measurements and accumulated and round count data.

Printing is achieved by passing electrically sensitive paper at right angles to a row of fourteen styli arranged in four groups of three each for printing numbers and two additional styli for total round marks and tenth-round emphasis.

Numbers are printed in a 3-by-5 matrix as illustrated in Fig. 2.

As the paper tape is moved past the stylus assembly, programmed pulses are applied to the styli causing dots to be printed on the paper. To ensure uniformly shaped numbers at different paper speeds, printing is clocked from paper-travel increments by a photoelectric system that looks through a slotted wheel coupled to the paper-tape drive mechanism.

The four binary-coded decimal numbers are shifted in parallel into the readout register from the time-of-flight counter. The readout

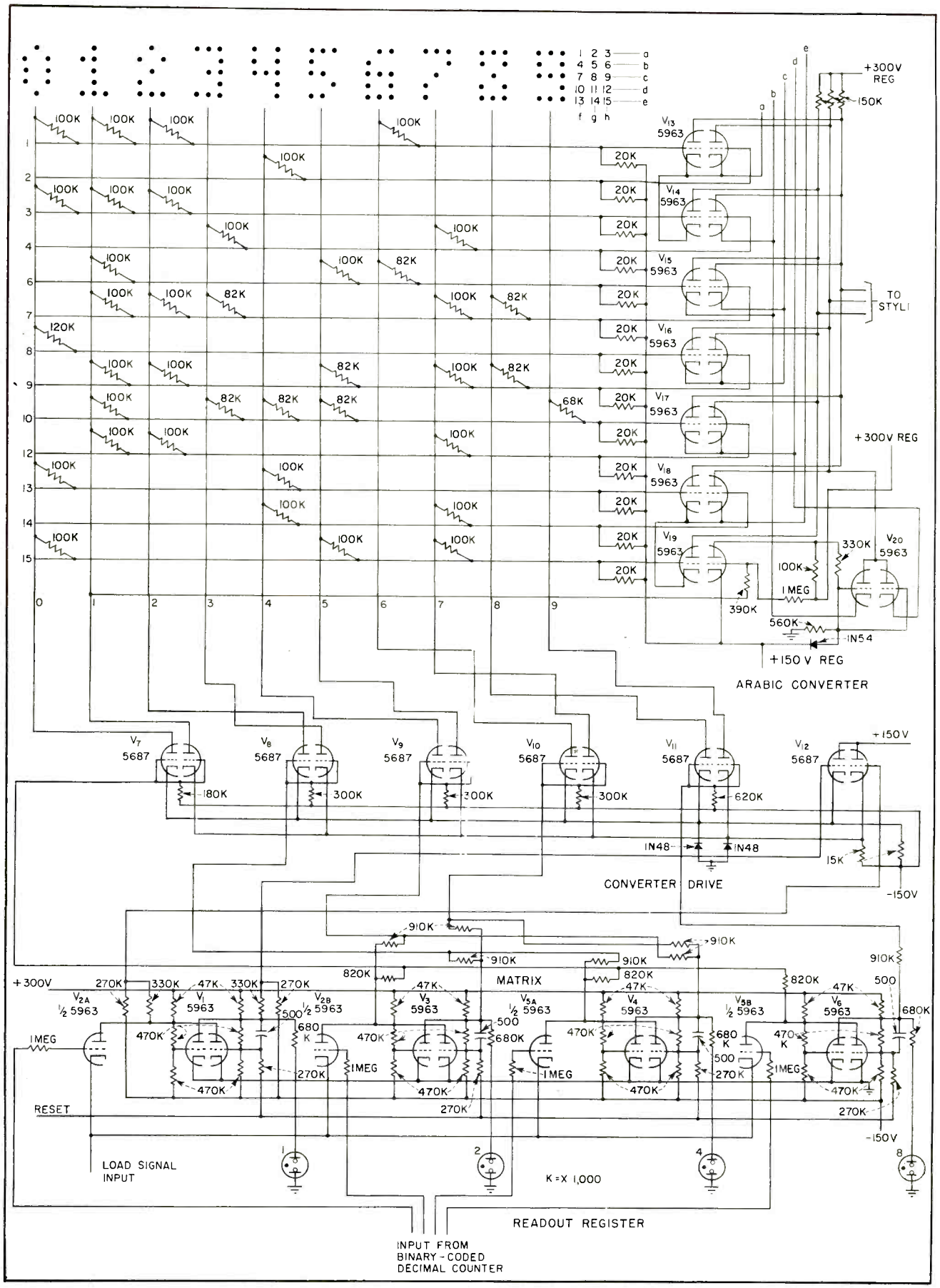


FIG. 3—Twenty electron tubes are required for printing one arabic digit. Circuits include readout register, resistor matrix, converter drive and converter. Three-by-five dot pattern for arabic numerals 0 to 9 is also shown

register consists of 16 flip-flops. Each circuit has associated with it a loading tube whose grid senses the on or off condition of the corresponding counter stage in the time-of-flight counter and whose cathode receives a load pulse when a valid round interval has been established.

Readout Register

Figure 3 shows the circuits associated with one digit of readout register and arabic converter. The bottom row of tubes comprises a portion of the readout register pertaining to any one of the four digits to be printed.

Prior to transfer of the digit into the register, a negative reset pulse is applied to the reset bus, conditioning V_1, V_3, V_4 and V_6 with their left-hand sections conducting and their right-hand sections cut off.

Load tubes V_2 and V_5 have their grids connected through one-meg-ohm resistors to points in the time-of-flight counter so that a negative potential is applied to load-tube grids associated with off counter stages, and zero potential is applied to the load-tube grids which are associated with the on counter stages.

Initially, the load signal input bus is held at a positive potential, preventing the load tubes from conducting. The load pulse reduces the common cathode potential of the load tubes to zero. Load tubes whose grids are at ground potential conduct, but those having negative grid potentials remain cut off.

Conduction of plate current by a load tube causes a voltage drop at the normally high-potential plate of the corresponding readout register. The action of the flip-flops preserves this momentary change after the load pulse is removed. Thus the counter indication is transferred simultaneously to all 16 flip-flops of the readout register.

Resistor Matrix

The resistance matrix, composed of 910,000 and 820,000-ohm resistors connected to various readout register tube plates, converts the binary-coded decimal notation to conjugate-pair notation for activating the converter drive tubes which convert from conjugate-pair to decimal notation.

Tubes V_7 through V_{11} each convey two decimal digits to the arabic converter, V_7 being involved with 0 and 1, V_9 with 2 and 3, V_{11} with 5 and 6 and so on. Tube V_{12} looks at the one's stage of the binary-coded decimal register and determines whether the odd or even number of the activated converter drive tube applies.

Conditioning

Upon receipt of a load pulse, the first two stages of the readout register four-tube group will be turned on. That is, V_1 and V_3 will be conditioned with their right-hand sections conducting and their left-hand sections cut off. The reverse will be true of stages V_4 and V_6.

The right-hand plate of V_1 will be at a low potential and its left-hand plate will be at a high potential. These conditions are conveyed to the right-hand and left-hand grids, respectively, of odd-or-even tube V_{12}. The high potential at the left-hand grid of V_{12} causes that tube section to conduct. Similarly, the low potential at the right-hand grid holds that section cut off.

Because of plate-current conduction in the left-hand section of V_{12}, the cathode of that section will be at a positive potential, while the right-hand cathode will be clamped to ground by the 1N48 diode.

Since the left-hand cathodes of V_7 through V_{11} are connected to the positive potential cathode of V_{12}, those tube sections will not conduct for either possible grid potential level that is furnished by the conjugate-pair matrix associated with the readout-register

The right-hand cathodes of V_7 through V_{11} are, however, connected to the ground potential cathode of V_{12}, and those tube sections will conduct if their grids experience the ground potential level furnished by the readout-register conjugate-pair matrix.

The grids of converter drive tube V_8 are connected through resistors to high-potential plates of readout-register tubes V_3 and V_4 for numeral 3. All other converter drive tube grids are connected to at least one low-potential readout-register tube plate.

Since the left-hand cathode of converter drive tube V_8 is positive, plate-current flow will be prevented in that section, despite the ground potential applied to its grid. The right-hand cathode, however, is at ground potential, and plate current will flow in that particular tube section.

Thus plate current associated with the right-hand section of converter drive tube V_8 will flow through the vertical 3's bus in the arabic-converter matrix, lowering the potential on horizontal busses 4, 7 and 10 and the grid potentials of the converter tubes to which they are connected.

Digit Scanning

The first digit scan pulse, which is applied to terminal *a*, affects cathodes of converter-tube sections whose grids are not connected to horizontal matrix busses that are attached to the current-carrying vertical 3's bus. Thus these grids are at high relative potential.

When the cathodes connected to bus *a* are brought to the + 150-v reference potential during the first digit scan pulse, all three tube sections conduct and the three styli are energized, causing the top row of dots to be printed on the recording paper.

As the paper advances, the second digit scan pulse is applied to bus *b*, bringing the right-hand cathode of V_{14}, the right-hand cathode of V_{15} and the left-hand cathode of V_{20} to reference potential.

The right-hand grid of V_{14} is at low relative potential because it is connected to horizontal bus 4, which is connected through a resistor to the conducting vertical 3's bus. This low grid potential prevents printing the first dot in the second row, as required for printing a 3.

The second dot in the second row is likewise inhibited by the left-hand section of V_{20}, and the third dot in the second row is allowed to print because the left-hand grid of V_{15} is connected to horizontal bus 6 which is not connected to the conducting vertical 3's bus.

This process continues until all five rows have been scanned and printed.

PORTABLE COLOR

SUMMARY —— Checking and adjustment of color circuits in monitors, matrix adders, encoders and receivers are facilitated. The instrument is used mainly to check gray scale setup, quadrature setting, hue or phase adjusting for I, Q, R–Y and B–Y decoders, relative I and Q gain setting (or R–Y, B–Y or G–Y setting). It can also be used for matrix, color killer and color cross coupling checks

By J. R. POPKIN-CLURMAN
Director of Engineering
Telechrome Manufacturing Corp.
Amityville, N. Y.

COLOR SIGNAL SYNTHESIS is provided by the equipment to be described.

The output signal contains a horizontal sync pulse, a 3.58-mc reference burst, a black bar, a color bar and a white bar. The color can be set by pushbutton control for any of the following NTSC standard signals: I, Q, R–Y, B–Y, G–Y ∠90°, saturated red, blue, green, cyan, yellow or magenta bars. Each saturated signal contains the correct proportions of chroma and luminance.

Arrangement of stages is shown in the block diagram of Fig. 1.

A selection of four different operating conditions is available, complete color, chroma only, black and white only, and black and white plus burst.

The signal is available at either video or radio frequencies with phase accuracy of all color signals held at 2 degrees or better. A novel feature is the generating of a signal phased 90 degrees from G–Y, called G–Y ∠90°. This signal facilitates matrix checks on color monitors and receivers by providing a null signal for G–Y adder. (Same relationship and balance function as B–Y to R–Y.) It is also useful in working on matrix adders and encoders.

Circuits

The r-f portion of the instrument uses a dual triode. One half is a 4.5-mc crystal-controlled oscillator, the second half is the picture oscillator, continuously variable from channel 2 to 6.

The essential elements of a standard RETMA encoder and bar generator are provided except that no vertical interval is produced. Referring to the block diagram of Fig. 1, the subcarrier generator V_1 is a 6AU6 or 6AK5 electron-coupled oscillator. Its output feeds a bifilar phase splitter.

The output of the phase splitter, consisting of two 3.58-mc signals of zero and 180-degree phase, is fed to a number of R-C phase-shifting networks to allow selection of a desired color signal. In each case, the R-C is so chosen as to give correct phase and amplitude for each color output; both these functions are adjustable.

While +I, +Q, +(R–Y), +(B–Y), G–Y ∠90° are independent of amplitude, the amplitude is such that with a pedestal, the subcarrier for any one pulse would not be higher than sync.

Amplitude of the color information is adjusted by a series output attenuator. As part of the same switching arrangement, the pedestal for the amount of brightness Y also varies so that when a pushbutton is engaged for yellow, it automatically adds the correct proportion of Y component. The amount of Y component is proportional to the brightness of each color.

Essential circuits are shown in Fig. 2. The master timing oscillator is a cathode-coupled square-wave multivibrator, V_2. This oscillator is adjusted for a duty cycle of 2 to 1

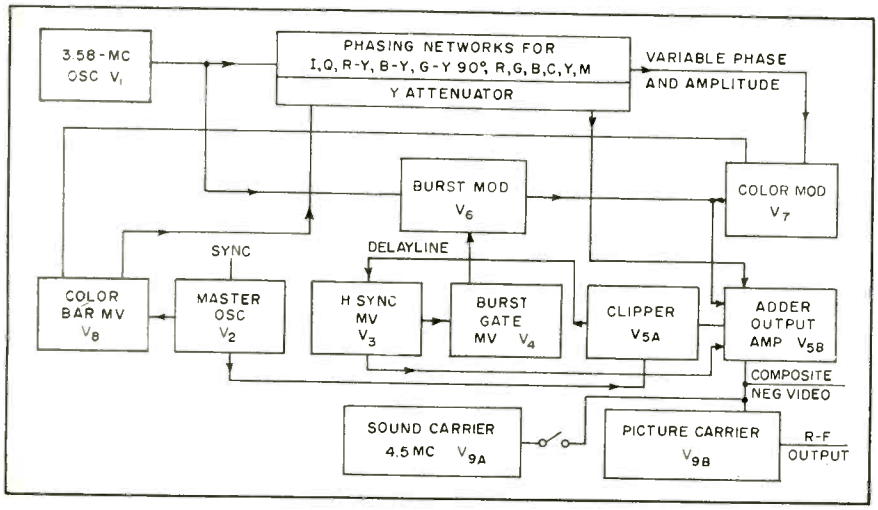


FIG. 1—Functions of stages and their interconnections for providing wide range of output signals for adjusting receiving, transmitting and monitoring equipment

SIGNAL GENERATOR

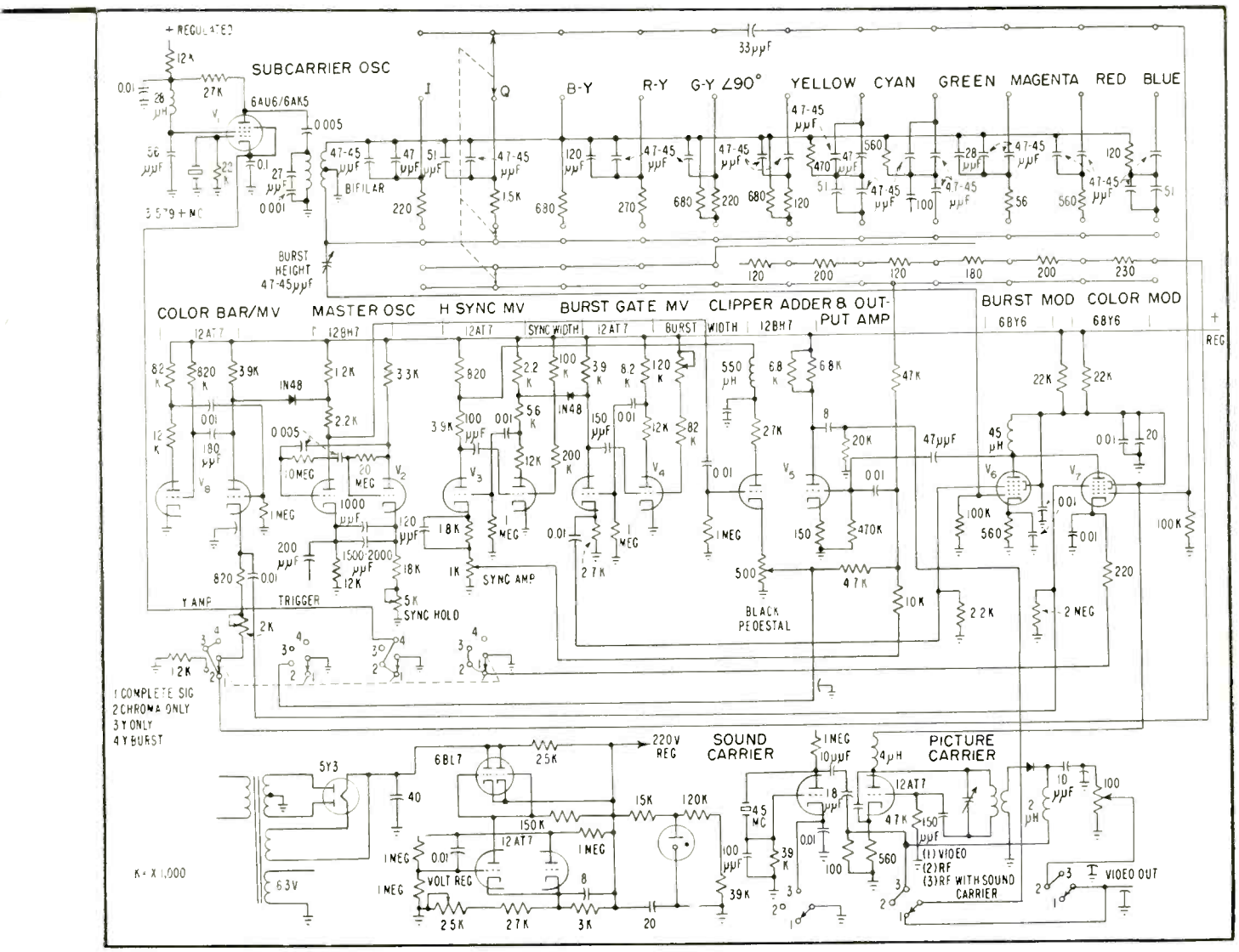


FIG. 2—Complete circuit of color signal synthesizer includes encoder, bar generator and other necessary units

so that the basic signal is at black level at the beginning of the trace for $\frac{1}{3}$ of its time, then at white level for the remaining $\frac{2}{3}$ trace.

The master oscillator triggers a color bar multivibrator V_8. This multivibrator in turn generates a pedestal which adds from white toward black, so that for any given color signal, it makes a pedestal from white toward black corresponding to the amount required for the Y component. This is accomplished by feeding the output of the color bar multivibrator to the attenuator steps on the push-button switch.

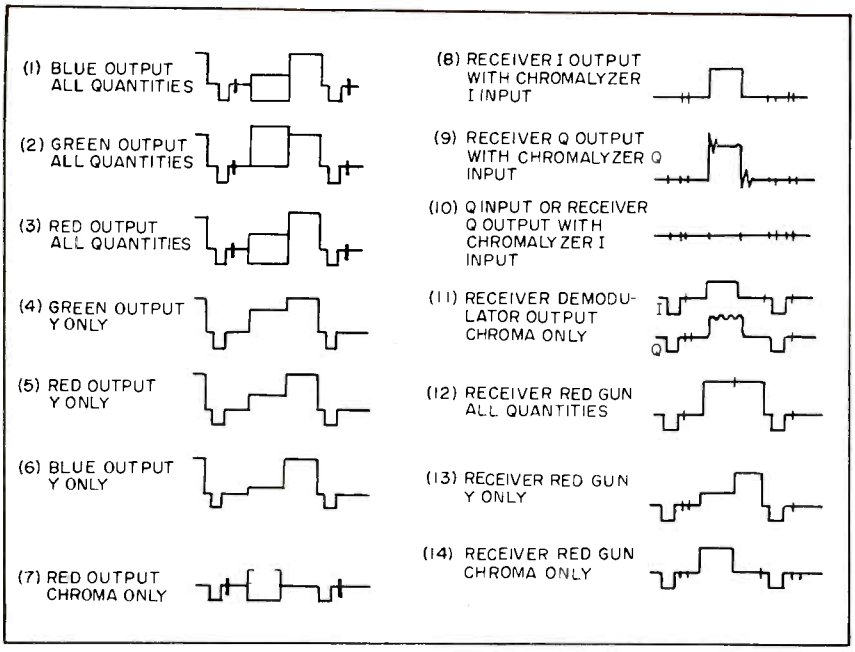
For maximum pedestal, it would equal black. For any other intermediate pedestal, it is set by the Y attenuator. The black pedestal signal generated by the master oscillator is not quite square; it is, therefore, passed through clipper V_{5A} for squaring and a delay line, to delay the starting time of the horizontal sync generator, V_3. This provides synchronizing pulses with a front porch.

The trailing edge of the horizontal sync multivibrator is fed to a burst gate multivibrator V_4. The output supplies a gate pulse whose duration is adjustable, governing the length of time that the burst will be on.

Variable Burst

The output of the burst gate multivibrator is fed to the burst modulator V_6. The burst is fed into grid 3 and, at the same time, a sample of the zero-phase 3.58 mc is fed into grid 1 of the same tube. An attenuator control permits adjusting burst amplitude. It is normally set to be equal in amplitude to sync pulse. The burst information at the plate of V_6 is on for only the burst gate time.

The color bar multivibrator gen-



Waveforms 1 through 7 are outputs of Chromalyzer and 8 through 14 are those at points in receiver circuits demonstrating use of instrument in calibrating and checking

erating the Y pedestal also provides the color bar gate to allow the color modulator V_7 to open, passing through the different phases and amplitudes of chroma depending upon the position of the pushbuttons. The output of V_6 and V_7 (modulators) will show burst and color information.

This output is fed to adder V_{5B}. At the same time, the pedestal generated in the color bar multivibrator and fed through the Y attenuator is added to the chroma information. Sync, as well as black pedestal, is also added so that in V_{5B} the complete signal is put together. The high-frequency components of the chroma signal are added by capacitive coupling. The Y attenuator output, the pedestal and the sync are added through a resistive network.

The Y pedestal output is a precise RETMA signal except for vertical interval which, in a color set, contributes no useful information.

Output

The composite negative output from V_{5B} is fed to an r-f oscillator, whose frequency range is between channels 2 and 6. The oscillator is cathode modulated.

The sound carrier generator adds 4.5-mc carrier to the video.

Video is available at 1.5 v in 75 ohms, black negative. With a 500-ohm termination, 4 or 5 volts can be obtained. Signal from the instrument can be fed through the r-f portion of a receiver for overall response checking.

The four-position function switch selects the following operating conditions: position 1—complete signal (sync, burst, black, chroma, white) for overall checking purposes. Position 2—chroma information only (with burst): This allows checking for cross coupling into the Y channel and facilitates decoder measurements and adjustments. Position 3—Y signal alone (luminance): This allows gray scale check, B, R, M, G, C, Y buttons. Position 4—Y (luminance) plus burst. This enables checking performance of the color killer (if one is used) or the ratio of lock to unlock in a subcarrier regenerator. This is done by switching from Y alone to Y with burst.

In aligning typical receivers using I—Q decoders, quadrature is set up by looking at the output of the Q channel with the I button depressed; if correctly aligned, the output should be zero. Similarly looking at the output of the I channel with the Q button depressed, the output should be at maximum and the same condition should prevail in the Q channel with the I button depressed. The R—Y and B—Y signals are made up of I and Q components. If the receiver has I and Q gain controls, these may be readily adjusted for correct B—Y and R—Y output.

To prevent demodulator loading, the oscilloscope is connected to the cathode of the I or Q phase splitters. Should these points be inaccessible, the oscilloscope can be connected at any of the tricolor tube guns and the chroma-alone position of the instrument used.

If the receiver has a narrow band decoder of the R—Y, B—Y type, it becomes possible to set quadrature using B—Y and looking at the output of R—Y for zero or R—Y looking at the output of B—Y for zero. The nulls are much more sensitive as indicators than the maximums. Assuming that I and Q or R—Y and B—Y decoders are properly adjusted, the output of the matrices (with Chromalyzer set for chroma only) which form R—Y, B—Y and G—Y may be examined.

For example, looking at B—Y with the R—Y signal, the relative gain of Y and Q are set for zero output at B—Y. In the same way, by depressing B—Y, the R—Y matrix is checked for null. The G—Y adder should read zero since signal of G—Y $\angle 90°$ is used to give a null reading.

To check the composite signal for correct proportions of I, Q and Y or R, B and G, a color button is depressed and the adder output or tricolor tube grid input is examined. If the decoded signal is correct, sync, with space corresponding to burst, (if there is burst keyout in the receiver) black, color and white will show in sequence. Both color and white should be of equal amplitude.

Similarly, red can be checked by pushing the red button and looking at the output of the red channel. Further checks may be obtained with yellow, cyan and magenta. These must show an equal amount of color in two channels.

The final check is the overall subjective viewing of red, blue, magenta, green, cyan and yellow to see if the correct colors come up. Since a black signal and a white signal are also present, it is possible to adjust the background and screen controls.

Quasi-Complementary Transistor Amplifier

SUMMARY — Transistorized phonograph amplifier uses a quasi-complementary output circuit to provide 6 watts output with less than 1-percent distortion at midfrequencies. Input signal passes through three preamplifiers and a predriver stage before reaching the quasi-complementary output stage. Output feeds directly to loudspeaker voice coil. Operation is satisfactory over temperature range from 0 to 50 C

By H. C. LIN*
Research Engineer
RCA Laboratories
Princeton, N. J.

OPERATING between a variable-reluctance pickup and a conventional 16-ohm loudspeaker, the amplifier to be described has a frequency response flat within 1½ db from 30 to 15,000 cps and tone controls with boost and cut for bass and treble.

A discussion of some considerations in a transistor phonograph amplifier precedes the description of the circuit.

Distortion

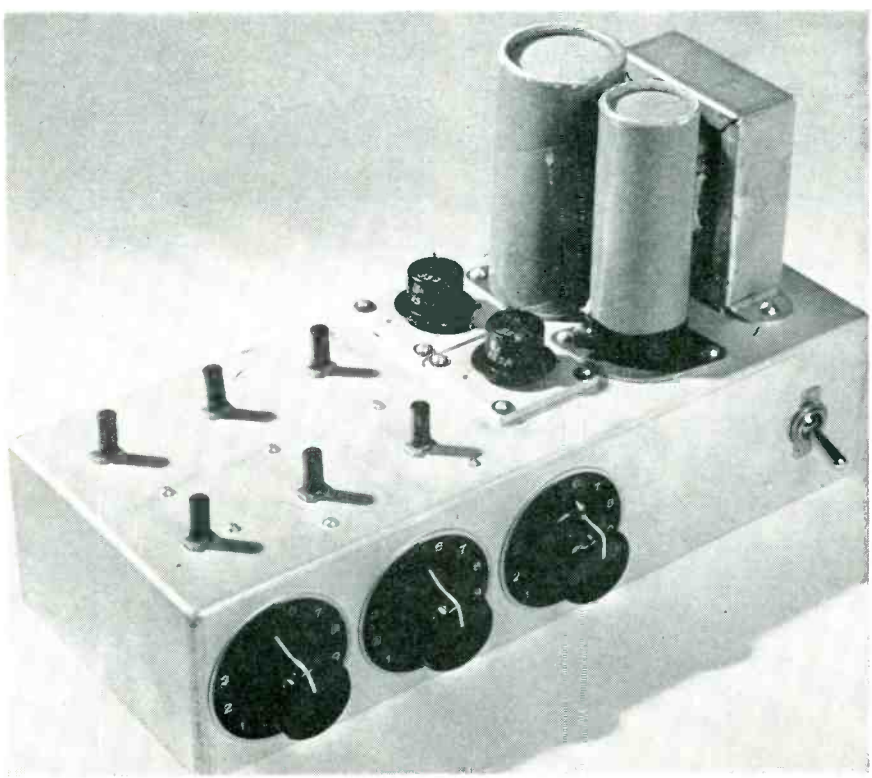
Distortion in a transistor amplifier is usually due to variations with current of either the current-amplification factor, the transconductance or both. When driving a grounded-emitter transistor amplifier stage from a current source (generator Z >> input Z) distortion depends on the variation in collector-to-base current-amplification factor. At high currents, the current-amplification factor usually diminishes.[1]

When a grounded-emitter transistor amplifier stage is driven from a voltage source, (generator Z << input Z), distortion may arise from the dependence of transconductance on base-to-emitter voltage. This nonlinearity in tranconductance may be caused by too low or too high an operating current.[2] Either of these distortions can be reduced by negative feedback.

Frequency Response

A system employing an RCA SPC-1 variable reluctance pickup and the RIAA recording characteristic requires high and low-frequency equalization in the reproducing amplifier. High-frequency equalization can be obtained by making the amplifier input resistance equal to 7,000 ohms. Since the common-emitter transistor input resistance is generally less than 7,000 ohms, the input resistance can be increased by adding resistance to either the base or emitter circuit.

If a resistance, R_E is connected in series with the emitter, the input resistance is increased by approximately βR_E where β is the collector-to-base current-amplification factor. Here the input re-



Compact transistorized amplifier uses 12-watt filament transformer, with rewound secondary, as power transformer

*Now with CBS-Hytron, Lowell, Massachusetts.

sistance depends directly on the value of β, which may be different for different transistors.

Noise

The noise performance of these two input circuits is not the same. For a low-power transistor operating at an emitter current of about one ma, the s/n ratio of the circuit with added base resistance is generally 10 to 15 db lower than that of the circuit with added emitter resistance. Hence, the configuration for better interchangeability of transistors is not compatible with the configuration for lower noise.

The required low-frequency equalization can be accomplished by an R-C low-pass filter in which the attenuation increases at a rate of 6 db an octave. Above 500 cps, the attenuation stays constant. The location of this filter is dictated by noise and overload. Location at the amplifier input may cause objectionable noise. Location at high-level stages may cause overloading at high frequencies in the early stages. A good compromise is to place the filter immediately after the first stage.

Quasi-Complementary Circuit

The basic quasi-complementary circuit is shown in Fig. 1A. If a sine-wave signal is applied to the input terminals, the two upper transistors conduct during the negative half-cycle and the two lower transistors conduct during the positive half-cycle. During the conduction of the two upper transistors, emitter-following action makes the emitter voltage of Q_7 follow closely the input voltage at the emitter of Q_5 which, in turn, follows the input voltage at the base of Q_5. Since the input current is amplified by Q_5 and Q_7, the output current is equal to $\beta_5\beta_7$ times the input current.

Similarly, during the conduction of the two lower transistors, emitter-following action makes the voltage at the emitter of Q_6 follow closely that at the base and the output current is equal to $\beta_6\beta_8$ times the input current. If $\beta_5\beta_7 = \beta_6\beta_8$, the input resistance during either half of input signal wave is approximately equal to $\beta_5\beta_7 R_L$. Therefore, the quasi-complementary circuit is in balanced operation.

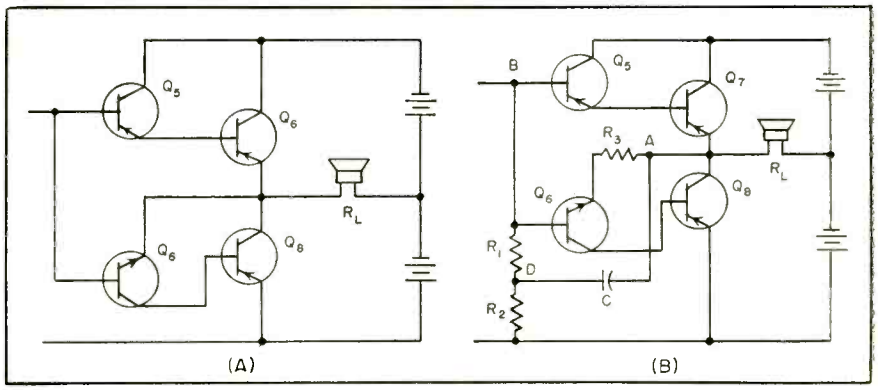


FIG. 1—Basic quasi-complementary circuit (A) and modified circuit to lower input resistance (B)

In practice, the basic configuration presents too high an input resistance so that the d-c coupling resistor of the preceding stage usually tends to shunt a large portion of the input signal current. This high input resistance can be reduced by connecting one or both of the stages in common emitter configuration.[3,4]

Modified Circuit

For the quasi-complementary circuit, a scheme as shown in Fig. 1B may be used. Capacitor C is connected between output junction point A of the series-connected output transistors and tap D on coupling resistors R_1R_2. This returns the input current through C and R_2. So long as R_1 is much greater than the input resistance between the driver base point B and point A during conduction, useful signal

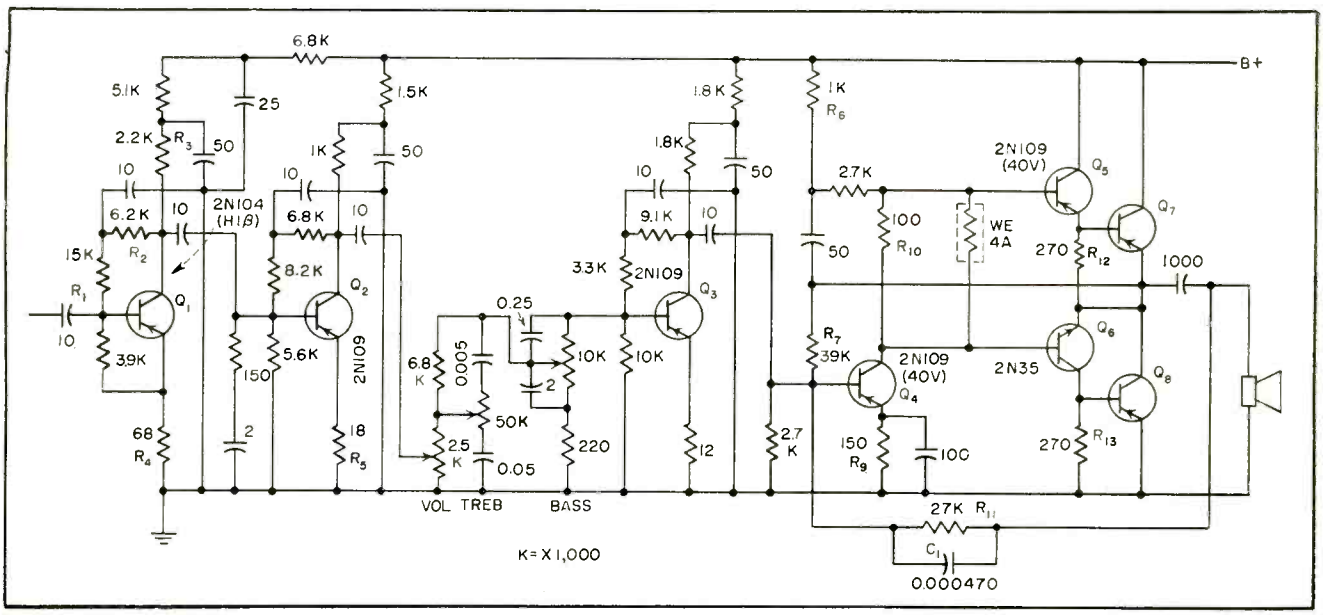


FIG. 2—Complete amplifier schematic. Tone controls provide either boost or cut

will not be diverted into R_1.

For the negative half cycle the input resistance between B and A is approximately $r_5 + \beta_7 r_7$, where r_5 and r_7 are the base lead resistances of Q_5 and Q_7. For the positive half-cycle, the input resistance is approximately r_6, the base lead resistance of Q_6. For perfect balance, these input resistances could be made equal by connecting R_8 in series with the emitter of Q_6, as shown. However, R_8 can usually be dispensed with if R_1 is large. R_2 should be much greater than R_L since the former is in shunt with the latter.

Complete Circuit

The complete schematic diagram of the amplifier is shown in Fig. 2. There are six stages, consisting of the quasi-complementary driver-output circuit, a predriver and three preamplifiers. Transistor Q_1 is an experimental transistor similar to the 2N104 but with somewhat higher collector-to-base current-amplification factor $\beta \cong 85$. Transistors Q_4 and Q_5 are experimental *pnp* transistors with characteristics similar to those of the 2N109 but with a collector breakdown voltage of over 40 v. Experimental *npn* transistor Q_6 has characteristics complementary to that of Q_5. Both Q_7 and Q_8 are *pnp* power transistors.

In the first stage, an unbypassed resistor R_1, connected in series with the emitter reflects an input resistance of 7,000 ohms at the base. The base-to-emitter bias is furnished by R_1 and R_2 connected between collector and base. These resistors with collector resistor R_3 constitute a d-c feedback circuit for stabilizing the operating point against ambient temperature variations.[5] Similar biasing arrangements are used in the next two stages. Bypassing capacitor C_1, connected to the junction of R_1 and R_2 presents degeneration. Resistor R_5 linearizes the transconductance of Q_2 and reflects an input resistance of approximately 800 ohms.

Predriver

The predriver Q_4, operates class A. The output is directly coupled to the input of the driver. Resistors

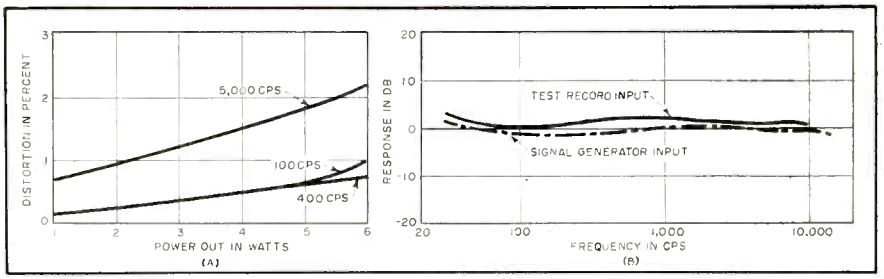


FIG. 3—Curves show distortion with change in power out (A) and frequency response for two input conditions (B)

R_6, R_8 and R_{10} form the return path for the d-c collector current of Q_4. The flow of d-c through R_{10} creates a forward base-to-emitter bias for drivers Q_5 and Q_6 which eliminates crossover distortion. The required bias voltage to maintain class B operation of the driver decreases with increase in temperature. The thermistor, in parallel with R_{10}, provides this bias.

Since the voltages at the emitters of Q_5 and Q_7 follow closely the voltage at the collector of Q_4, any change in collector current will upset the balance of the subsequent stages. To hold Q_4 collector current constant, emitter resistance R_9 and negative d-c feedback through R_7 are used.

Feedback

Since the output is capacitively coupled to the 16-ohm load, the d-c power supply need not have a center tap. Negative feedback is applied from the hot side of the loudspeaker voice coil to the base of Q_4 through R_{11} and R_7. C_2 is connected in parallel with R_{11} to give a step-response in the feedback loop for stability. The use of R_{12} between emitters of the drivers helps to temperature stabilize the driver stage. Resistor R_{13} also serves this purpose by reducing the external d-c resistance between base and emitter to a low value.

The peak a-c voltage swing at the collectors of the transistors Q_4 through Q_8 is nearly equal to the supply voltage. Since the no-signal supply voltage is 40 v, the transistor breakdown-voltage must be in excess of this.

Output

The envelope of the power-output transistor is electrically connected to the collector and must be insulated from the main chassis. The envelope should also have good thermal contact with the main chassis to remove the heat generated in the transistor. For these purposes, an anodized aluminum plate which insulates electrically but conducts thermally, is sandwiched between the power transistor and the main chassis.

Performance

Amplifier distortion is shown in Fig. 3A. Note that the distortion for 100 cps and 400 cps is below 1 percent at six watts, whereas the distortion for 5,000 cps is somewhat higher because of the reduction in current gain and negative feedback.

The frequency response is shown in Fig. 3B. Measurements were made with the tone controls at mid-position and the volume control at maximum. The upper curve shows the response to an RIAA test tone record using the SPC-1 variable reluctance pickup. The lower curve was taken with a signal generator whose output voltage was adjusted to conform with RIAA characteristics and connected in series with a variable reluctance pickup head. At other volume control settings, the frequency response does not vary appreciably.

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(3) D. D. Holmes, T. O. Stanley and L. A. Freedman, A Developmental Pocket-size Broadcast Receiver Employing Transistors, *Proc IRE*, 44, June 1955.

(4) A. Aronson, Transistor Audio Amplifiers, "Transistor I," p 515, RCA Laboratories, 1956.

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Energy Source Delivers Half-Sine Pulses

SUMMARY — For certain pulse applications such as providing an energy burst for testing fuzes where a rectangular waveform is not essential, reliable and predictable half-sine pulses are acceptable. Pulse generator described uses 2D21 thyratron and provides half-sine-wave pulses at power-line frequency or each time a pushbutton is depressed. This circuit can also be used as a frequency meter

PULSE TECHNIQUES require reliable and predictable pulses. A predictable pulse has an established and well-defined spectrum. The rectangular pulse is a most popular variety and there are many methods of generating such a waveform.

In many applications, a rectangular pulse is not essential and the half-sine-wave pulser will provide an acceptable waveform.

Theory of Operation

The circuit of Fig. 1A contains the essentials of the half-sine-wave pulser. A thyratron is biased beyond cutoff for the applied d-c voltage V. The plate voltage is applied through an isolation resistor and a series resonant circuit is connected in shunt with the tube.

Since the tube is cut off, the capacitor will charge to the available plate voltage, anticipating the firing of the thyratron. If a trigger pulse is injected into the thyratron to fire it, the capacitor will discharge through the inductor and tube into the load resistor which is in the cathode circuit of the tube. Since the conducting drop of the tube is small, the discharge will theoretically follow the relationship

$$i = (V/LN)\exp(-mt)\sin Nt$$

where $N = [(1/LC) - (R/2L)^2]^{1/2}$

and $m = R/2L$

If the damping term is small, a necessary condition for best operation, the equation becomes

$$i = [V/(L/C)^{1/2}]\exp(-Rt/2L)\sin t/(LC)^{1/2}$$

The surge impedance $(L/C)^{\frac{1}{2}}$ determines the amplitude of the damped sinusoidal waveform, the damping is determined by cathode load R and the radian frequency of oscillation is $1/(LC)^{\frac{1}{2}}$.

Deionization

Although the first half-cycle is in accordance with the equations, the second half-cycle, Fig. 1B, puts a negative voltage on the tube to extinguish it. This negative plate voltage will quench the thyratron, stopping oscillations. Hence only the first half-sine wave of the discharge pulse exists.

The first negative pulse must be of sufficient magnitude and time to deionize completely the gas tube. Keeping the damping term small will insure that the negative pulse

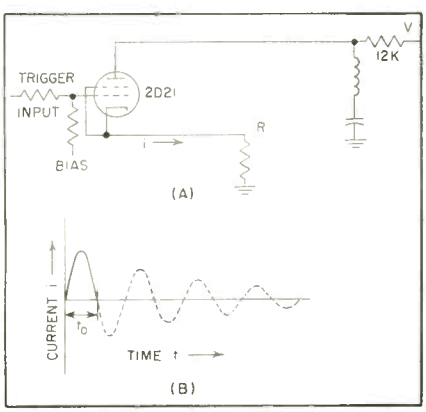


FIG. 1—Basic circuit of half-sine-wave pulser (A) and current waveform showing a damped sinusoid (B)

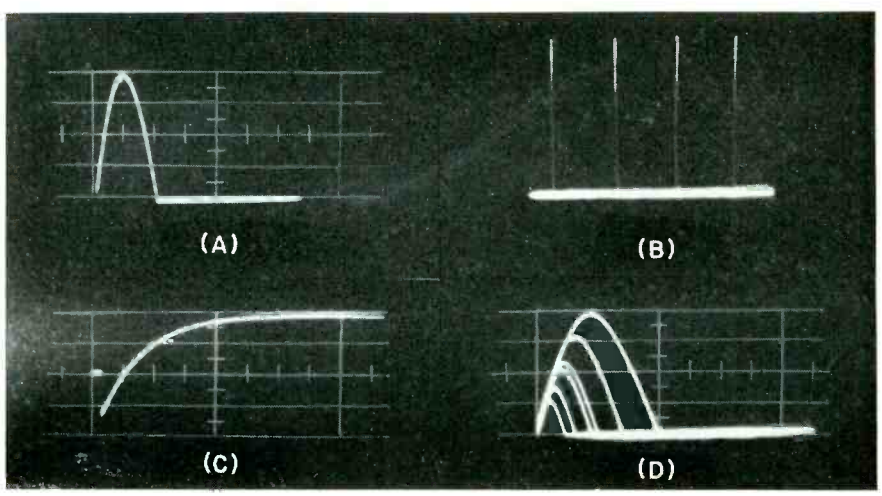
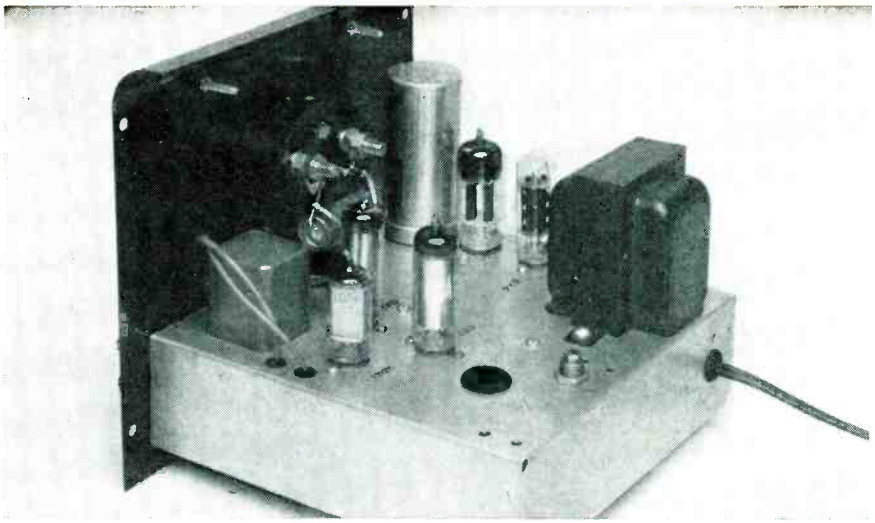


FIG. 2—Half-sine waveform (A), waveform at 60 cps (B), plate voltage waveform of thyratron (C) and effect of increasing inductance on pulse height and width (D)

By LOUIS A. ROSENTHAL
Associate Professor of Electrical Engineering
Rutgers University
New Brunswick, New Jersey



Rear view of half-sine-pulse energy source showing thyratron and variable inductor in foreground. Power-supply design is conventional

is sufficiently large. During the time that the tube fires, the isolation resistor allows a current to be passed into the thyratron.

This leakage current acts as a pedestal upon which the half-sine wave rides and represents an addition component of tube current to be cancelled during the second half-cycle. The isolation resistor should be large enough to limit this current to small values and at the same time allow the voltage across the capacitor to recover to the supply voltage. As narrower pulses are generated, this resistor can increase since the duty cycle will decrease if the pulse is repetitive.

The peak current is approximately

$$i_{peak} = V/(L/C)^{1/2}$$

Pulse width is

$$t_o = \pi(LC)^{1/2}$$

If the pulse is repetitive at an interval T seconds, the rms value of the current is

$$i_{rms} = [V/(L/C)^{1/2}]\ (t_o/2T)^{1/2}$$

and the average value is

$$i_{ave} = [V/(L/C)^{1/2}]\ 2t_o/\pi T$$

In a typical operation L was 50 millihenrys and C was 0.05 microfarad. The surge impedance was calculated to be 1,000 ohms and, with a 250-v supply, the peak current would be 250 ma.

Similarly the pulse width was computed as 157 microseconds. The rms current would be 17.1 ma and the d-c current 1.5 ma if the pulses were generated at a rate of 60 cps.

Actually, measurements were within 6 percent of the theoretical values. The form factor for this waveform was 11.4 indicating a high ratio of rms to average value.

Modifying Circuits

Pulse amplitude can be varied by adjusting the supply voltage or by changing the surge impedance. The values of L or C control the pulse width. The circuit has been used to generate pulses down to 1.0 microsecond wide at 60-cps rates.

Recovery time limits the maximum pulse width and the minimum pulse width is limited by the trigger pulse width and the isolation resistor. By selecting different thyratrons and different parameters, the circuit can be scaled up or down.

The output is taken off the cathode load and the impedance seen looking back at the cathode is the surge impedance of the resonant circuit. Since the damping should be small, it is desirable to work into low impedances for symmetrical waveforms.

The basic waveform is shown in Fig. 2A for a 200-microsecond pulse. At a 60-cps repetition rate the waveform is shown in Fig. 2B. In Fig. 2C the plate voltage of the thyratron is shown. The initial flat region corresponds to the pulse discharging. The tube drop is low. Afterwards the plate goes negative putting the thyratron out.

The recovery at a slow rate, is determined by the charging time constant. During the charge, the inductor is not significant and the isolation resistor is most important. In Fig. 2D the capacitor value is progressively increased. The pulse widens and the amplitude increases as the capacitance increases.

Triggering Circuits

To trigger the pulser, any source of clean narrow pulses can be used. The firing pulse must be shorter than twice the half-sine wave so that the second half of the discharge cycle will deionize the tube. The differentiated output of a multivibrator or a Schmidt trigger will provide excellent pulses if they are sufficient to overcome the cut-off bias of the thyratron.

Repetitive Pulsing

A convenient pulsing arrangement is shown in Fig. 3. Repetitive pulses of line frequency or single pulses are available. In both cases the pulse shape and amplitude are identical.

In the REPEAT position, the voltage across a small neon tube when supplied with 60-cps power through a dropping resistor, is injected into the thyratron grid. The voltage which appears across the neon tube is shown in Fig. 4A. It is a clipped sine wave with a discontinuity at

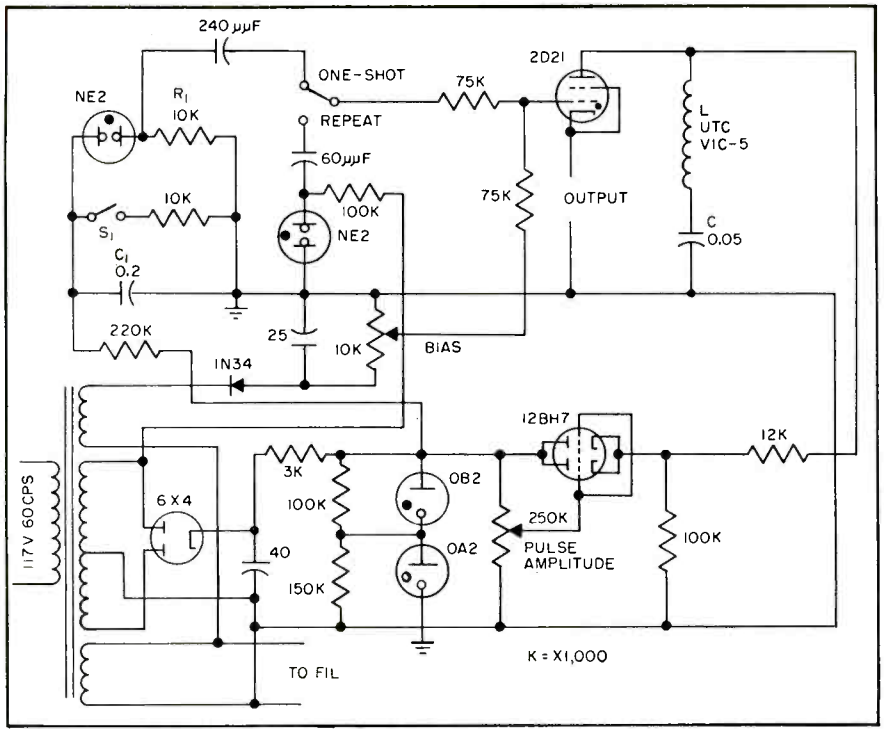


FIG. 3—Complete pulser for generating half-sine pulses either at power-line frequency or singly each time pushbutton is depressed

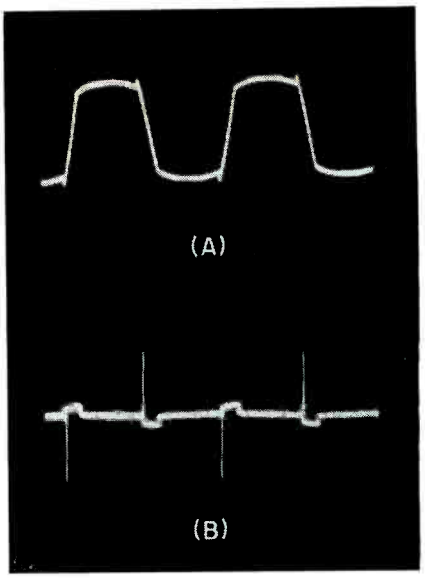


FIG. 4—Trigger waveforms show trapezoidal voltage across neon with sharp discontinuity on leading edge (A) and waveform differentiated to provide trigger (B)

the leading edge of the pulse.

This discontinuity is caused by the neon tube voltage drop suddenly falling from the firing potential to the maintaining potential. The drop is sudden and when differentiated by passing through a small coupling capacitor into the thyratron grid is sufficient to fire the thyratron. Only the positive triggers, Fig. 4B, will be effective.

To get a single triggering pulse, d-c is used for the neon supply. When the normally closed momentary pushbutton S_1 is opened, the voltage across capacitor C_1 rises by being charged through the 220,000-ohm isolating resistor.

This voltage builds up until the neon fires putting a pulse through 10,000-ohm resistor R_1 in series with the neon. Since this voltage drop has an initial discontinuity, it is differentiated and passed to the thyratron for firing.

Energy Burst Source

In the study of electric firing primers and associated ordnance devices it is useful to have available a known amount of energy as a short burst. If the input resistance R is small and of constant value, the energy E in watt seconds delivered to it will be

$$E = \int_0^{t_o} i^2 R\, dt$$

where the pulse width is t_o. Current i is the instantaneous current pulse, a function of time. Under repetitive conditions P, the power in watts in the resistor is

$$P = i_{rms}^2 R$$

If the number of pulses a second is known, multiplying both sides by the repetition period T yields the energy burst E in watt seconds

$$E = PT = i_{rms}^2 R\, T$$

If the half-sine wave pulser is driven from the line and the rms current measured, the energy content of each pulse is known. By switching to the ONE-SHOT position, that amount of energy can be delivered.

Since the current pulse amplitude varies directly as the supply voltage to the thyratron, the energy follows the voltage squared. Similarly, the energy burst varies directly as $C^{3/2}$ or as $1/(L)^{\frac{1}{2}}$.

Frequency Meter

The average pulse current flowing is directly proportional to the number of pulses a second. If an incoming signal is shaped to trigger the generator once a cycle, the average current can be interpreted as a frequency. Accuracies of better than 1 percent of full scale were obtained using this method.

Practical Circuit

Figure 3 is a complete circuit of a half-sine wave pulser used as an energy-burst source. A conventional power supply is stabilized by a v-r tube. A series control tube with an adjustable grid voltage feeds the pulser circuit and controls the pulse amplitude.

The filament winding is rectified to provide 9 v of bias which can be adjusted to set the fixed bias of the thyratron. A trigger circuit provides either 60-cps or one-shot operation. To adjust the pulse width, a tunable inductor is in the discharge circuit.

Using the 2D21 tube, current pulses of peak value equal to $\frac{1}{2}$ ampere were possible with average currents of a few milliamperes. The entire circuit can be scaled up to provide larger pulses.

The author thanks the U. S. Naval Ordnance Labs, Silver Spring Maryland, who sponsored this work under contract NORD-15005 and William C. Schaal who assisted in the development.

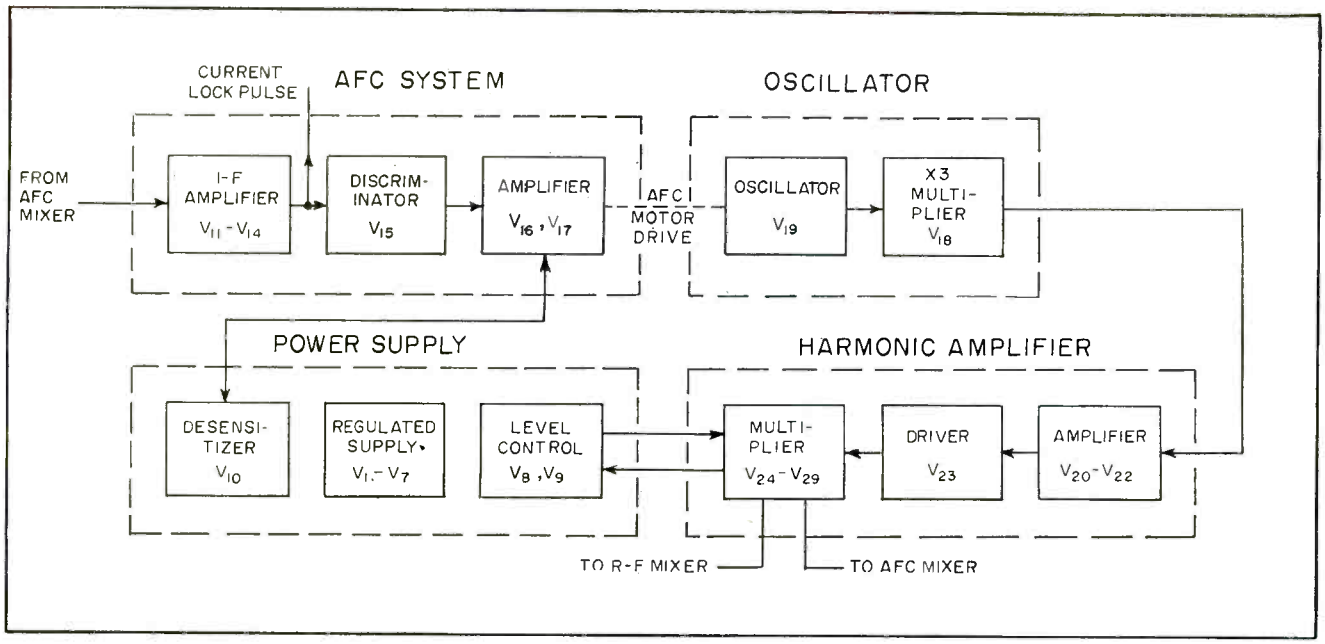


FIG. 1—Block diagram of afc-stalo system. Stalo has 1.93 percent bandwilth and provides minimum of 15 mw at S band

Stable Local Oscillator for S-Band Radar

By W. J. DAUKSHER

Radar and Navigation Department
Airborne Instruments Laboratory
Mineola, New York

SUMMARY — Tunable crystal oscillator, followed by cascade of harmonic amplifiers for output at desired frequency, has excellent short-term stability for mti radar local-oscillator service. Continuous frequency range of 1.3 percent is obtained by using six crystals with motor-driven switching and afc systems. Harmonic-amplifier cascade has sufficient power output to allow for drop-off in efficiency when operated off resonance

MOVING TARGET INDICATION (mti) gives radar the ability to detect moving targets and to discriminate against fixed targets. The most common type of mti uses a phase measurement to establish if the radar return signal is fixed or moving.[1]

Because a phase-measurement method is used, the local oscillator of the radar receiver must have exceptional short-term (pulse-to-pulse) frequency stability. The phase of the signal at the receiver detector is related to the phase of radar return, the phase of the local oscillator of the radar receiver and other fixed phase shifts in the receiver r-f and i-f circuitry. Since a change in the local-oscillator frequency will result in a change in received signal phase and consequently will yield false information from the receiver, the stability of the local oscillator is more important than that of any other oscillator in the mti radar system.

When the local-oscillator stage and associated control circuitry and vibration mounting are packaged, the resulting unit is a stable local oscillator or stalo.

Stalo

The stalo uses a stable crystal oscillator, operating at a low frequency, followed by a cascade of harmonic amplifiers yielding output at the desired frequency, as shown in Fig. 1. This type of stalo offers excellent stability and, by crystal-tuning techniques, has a

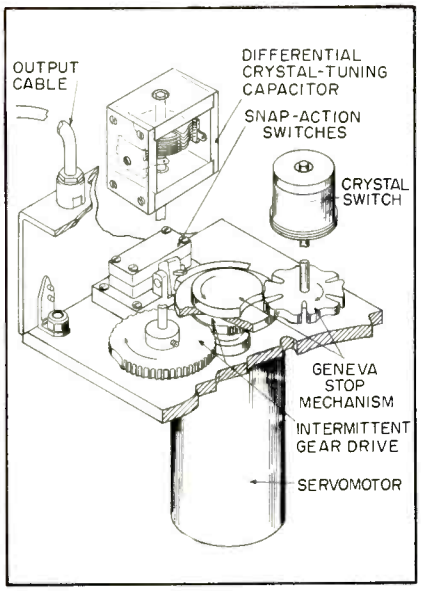
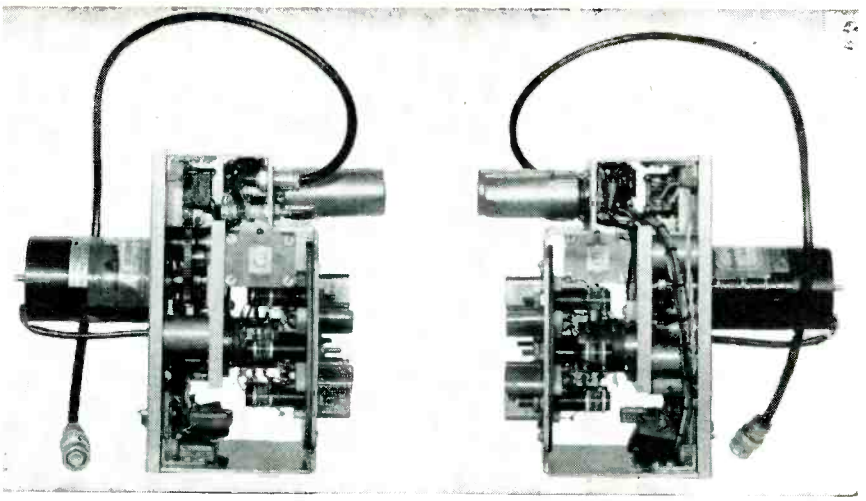


FIG. 2—Mechanical assembly of stalo



Side views of oscillator chassis show optimum component layout for minimum distributed capacitance

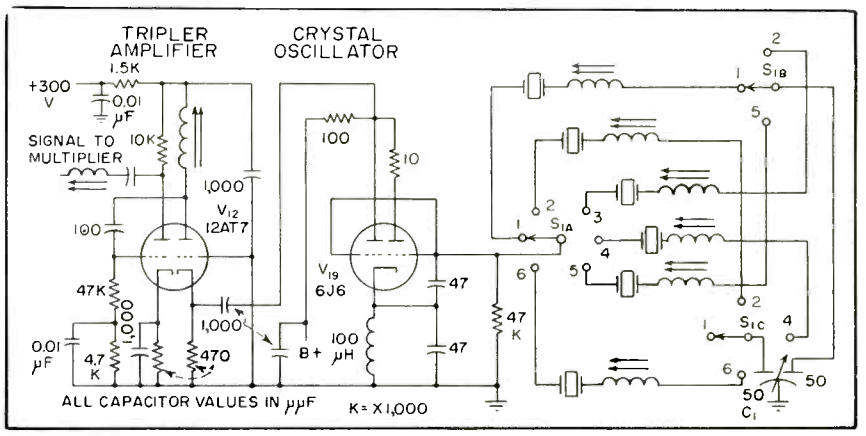


FIG. 3—Oscillator is modified Colpitts type

continuous frequency range of about 1.3 percent for motor-driven afc. Since some frequency overlap is desirable, a total of six consecutively tuned and switched AT-cut crystals are used, each crystal having a 0.25 percent tuning range.

In development, it was established that stray capacitances (coil-to-ground, switch-to-ground, crystal-case-to-ground) were detrimental to the tuning range. The layout shown in the photograph is the best grouping of components consistent with a minimum of distributed capacitance.

Figure 2 shows the mechanical assembly and Fig. 3 is the schematic diagram of the oscillator.

The circuit is a modified Colpitts type that uses the crystal, the associated inductance and tuning capacitor C_1 in series as an inductance.

Capacitor C_1 and the coil associated with the crystal tune the crystal. An individually adjusted coil is required for each crystal because of minor variations in crystal shunt capacitance from crystal to crystal. An afc servo-motor drives both capacitor C_1 and switch S_1, which activates the next crystal in line for continuous frequency coverage.

Figure 4 shows a tuning characteristic of a typical oscillator. Capacitor C_1 must be of the dual-stator differential type because of this characteristic. For example, for constantly increasing frequency, a minimum of capacitance at C_1 is required at the high-frequency end of one crystal range whereas a maximum of capacitance at C_1 is required at the low-frequency end when switching to the next crystal.

Crystals are switched for every 180 degrees of continuous rotation of the tuning-capacitor shaft. Switch S_1 is driven in the proper direction by a Geneva mechanism on the servomotor shaft. During the switching interval, the oscillator is turned off and the afc ceases to function. To keep the servomotor running in the proper direction during this switching interval, two snap-action switches are used; a directional lever actuates the proper switch thereby providing a fictitious error signal for the afc servo amplifier. In addition, during the switching interval when the Geneva mechanism is in motion, C_1 is allowed to rest in the position of maximum or minimum capacitance through an intermittent gear drive.

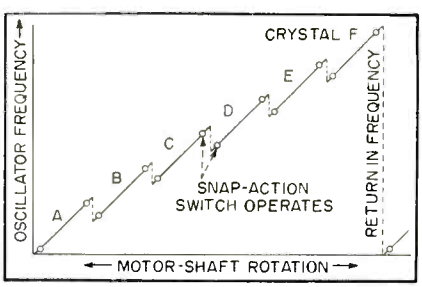


FIG. 4—Idealized straight-line tuning characteristic of oscillator

Crystal Frequency

Choice of crystal frequency is dictated by several requirements. For maximum tuning range, the fundamental mode of AT-cut crystals exhibit best performance. To

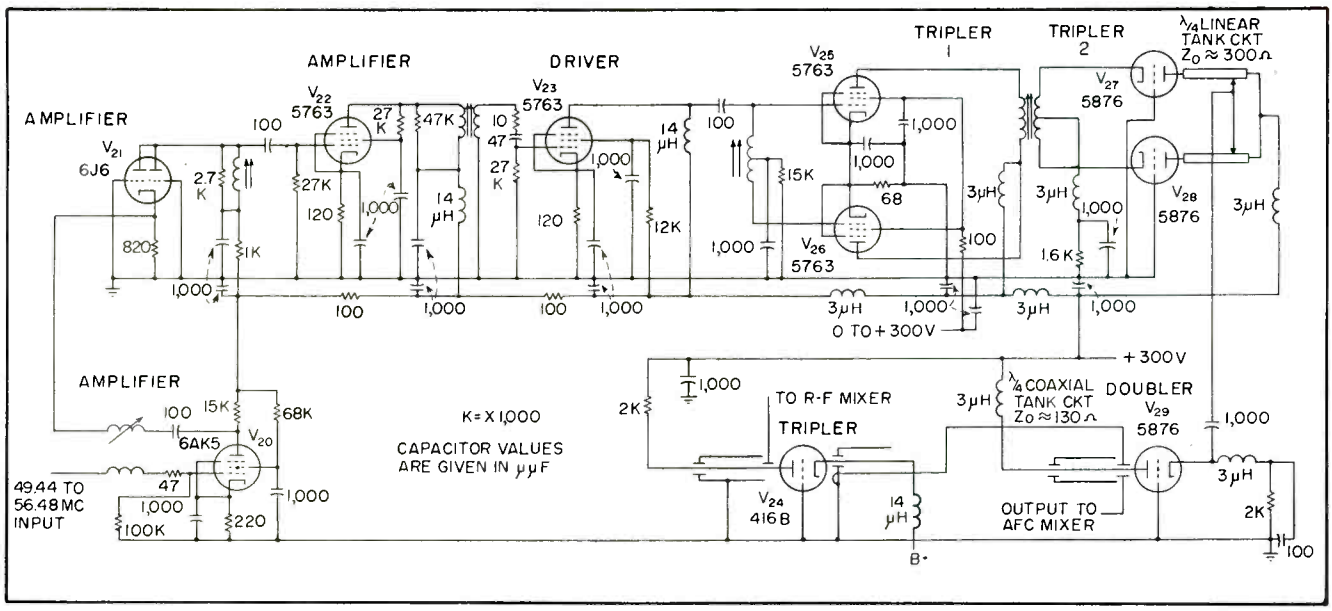


FIG. 5—Harmonic-amplifier cascade gets frequency multiplication of 162 from cascaded frequency double and triplers

minimize the number of sidebands at the output frequency a high-frequency crystal, well above the intermediate frequency of the receiver, should be used. Unfortunately, at present fundamental mode AT-cut crystals are not ground to frequencies above about 20 mc.

If low frequency crystals are used care should be exercised to ensure that harmonics of the crystal frequency fall as far as possible from the intermediate and signal frequencies of the radar receiver. In this unit, the optimum crystal oscillator frequency was found to be nominally 18 mc.

Harmonic-Amplifier Cascade

A frequency multiplication of 162 times is obtained by cascading second-harmonic and third-harmonic amplifiers. To deliver the required output power over a 1.3-percent band without retuning the amplifier after shifting the frequency, it was necessary to build sufficient power capability into the harmonic-amplifier cascade to allow for the drop-off in efficiency when the many stages are operated off-resonance. The coupling between transmission-line resonators is adjusted for maximum power output over a given band and is not set for optimum coupling at the center frequency.

Bandwidth of an amplifier interstage is governed by $\Delta f_{3db} = 1/2\pi RC$ where R is shunt load on the interstage and C is interstage tuning capacitance.

Maximum bandwidth is obtained when the R-C product is a minimum. The harmonic-amplifier cascade shown in Fig. 5 uses interstages that are primarily tuned by parasitic capacitances. Interstages that are inductively resonated are laid out for minimum stray-wiring capacitance.

Interstages with transmission-line resonators use resonators of the shortest physical length and of high characteristic impedence, since the characteristic impedence has a bearing on the bandwidth of the resonator. Some of the inductively tuned interstages are resistance loaded to obtain the proper bandwidth. A push-pull mode of operation is used to further increase the bandwidth of the interstage without resistive loading.

A level control is incorporated to monitor the excitation voltage on the final harmonic amplifier. The control maintains the excitation constant by operating on the screen voltage of push-pull tripler V_{25} and V_{26} in the proper manner to vary the gain of the harmonic amplifier cascade and hold the output power to within 3 db of a 15-milliwatt minimum.

Since the harmonic-amplifier cascade was made broad band, it does not appreciably attenuate side bands that are spaced multiples of the crystal frequency away from the output frequency. A 36-mc side band is attenuated early in the harmonic-amplifier cascade by using many 54-mc interstages to favor the third harmonic of the crystal at the expense of the second harmonic. The side bands most likely to cause trouble in this system are the 54-mc side bands, which are estimated to be about 20 db below the output signal of the stalo.

The author thanks Sheldon Fox for collaborating in the design of the oscillator mechanism and other mechanical parts; Harold Sutherland for his work in fabricating the unit and Abraham Ruvin for his encouragement and guidance during this program. Parts of the work were performed under Rome Air Development Center Contracts AF 28(099)-260 and AF 30(602)-381.

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Operational Amplifier

SUMMARY — High order of zero-offset stability, in conjunction with 0 to 10-kilocycle bandwidth, is obtained for dual-channel computer and control amplifier by combining conventional and chopper amplifiers. Effect of factors such as grid currents, phase-gain stability, chopper choice and filter networks is considered with regard to amplifier design

ANALOG COMPUTERS and a variety of electronic controls include, as an essential building block, a high-gain amplifier with frequency response from d-c to several kilocycles. Where an operational amplifier is used in an integrating circuit, even slight drifts accumulate through the process of integration. Hence the need arises for far greater zero stability than can be obtained in conventional vacuum tube d-c amplifiers.

Counteracting Offset

Several special techniques have been used to achieve the high order of stability required. One circuit, shown in Fig. 1A, consists of a chopper amplifier in which the d-c input is modulated by the moving contact and one fixed contact of the chopper, amplified by a conventional R-C coupled amplifier, demodulated by the other fixed contact and the moving contact of the chopper and finally filtered to provide a d-c output. This amplifier has the advantage of being free of zero drift, but its upper frequency is limited, at best, to half the chopper frequency. For reasons of filter design, the upper frequency limit rarely exceeds 1/10 the chopper drive frequency.

Other methods of modulation and demodulation, such as magnetic or diode modulators, rely upon two bucking voltages that are unbalanced by the d-c so that closely matched components must be used. This limitation leads to some drift and zero offset. Because the chopper is inherently a passive element, it is superior as a modulator and demodulator where zero reference level is to be maintained.

Chopper Stabilization

One way of combining a conventional amplifier and a chopper amplifier is shown in Fig. 1B. Amplifier G is an amplifier such as that shown in Fig. 1A; it passes d-c and a narrow low-frequency band.

Amplifier A is an electron-tube amplifier that passes all frequencies not passed by amplifier G. By adjusting the filter networks R_1C_1 and R_2C_2, the frequency responses of each channel can be mated to produce a flat over-all response from d-c to the upper frequency limit of amplifier A.

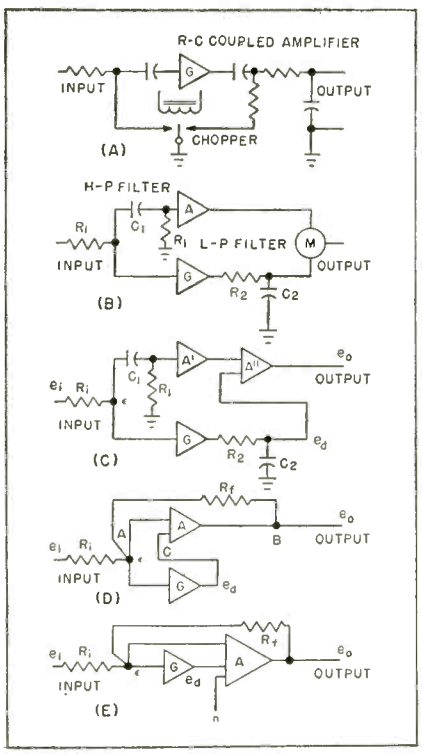


FIG. 1—Carrier-type chopper amplifier (A) can be combined in various ways with direct-coupled amplifier (B through E) to provide stable wide-band amplification with negligible offset

Mixer M at the output passes the entire frequency band of the circuit from d-c up and also presents a low output impedance. The mixer must thus be a direct-coupled electron-tube circuit and may just as well be included in amplifier A. That is, amplifier A can be considered as consisting of an R-C coupled preamplifier A' and a wide band directly coupled power amplifier A'' having two inputs.

This change leads to the circuit of Fig. 1C. Drift and offset arising in stages of amplifier A'' following the mixing point appear in the output. These drifts are small compared to the enormous amount of stable d-c amplification available from amplifier G. Thus, output e_d from the chopper amplifier can be returned to the input of amplifier A' eliminating filter R_1C_1. Of the two inputs presented to amplifier A' input e_d from the chopper amplifier will usually be many thousand times the magnitude of direct input ϵ. Additional feedback is needed around amplifier A' to maintain an overall flat response.

These circuit changes lead to the Goldberg circuit shown in Fig. 1D.

Theory of Operation

In Fig. 1E amplifiers G and A are shown in cascade, as they really are, with amplifier G bypassed for a-c and the feedback loop including both amplifiers.

Has Chopper Stabilization

By DAVID A. ROBINSON
Research Engineer
Airpax Products Company
Baltimore, Maryland

Considering the amplifier at d-c only, offset arising in amplifier A is referred to its input and treated as an unwanted noise, n. The loop equations are

$$\epsilon = e_i R_f/(R_i + R_f + e_o R_i/(R_i + R_f) \quad (1)$$

and $$e_o = -(\epsilon GA + nA) \quad (2)$$

Eliminating ϵ and assuming that

$$\frac{GAR_i}{(R_i + R_f)} >> 1$$

$$e_o = -e_i R_f/R_i - n(R_f + R_i/(GR_i) \quad (3)$$

Replacing feedback gain $R_f R_1$ by A_e

$$e_o = -A_e\left[e_i + \frac{n(1 + 1/A_e)}{G}\right] \quad (3a)$$

The first term of Eq. 3a represents the desired output; the second term is the unwanted offset, which is made negligible by making G large. This is a case of noise in a feedback amplifier. The further along the amplifier chain the noise is introduced, the less its effect on the output. Thus chopper amplifier G provides large gain at d-c with negligible offset. Subsequent stages comprising amplifier A introduce relatively little drift in the output. The circuit of such an amplifier is shown in Fig. 2.

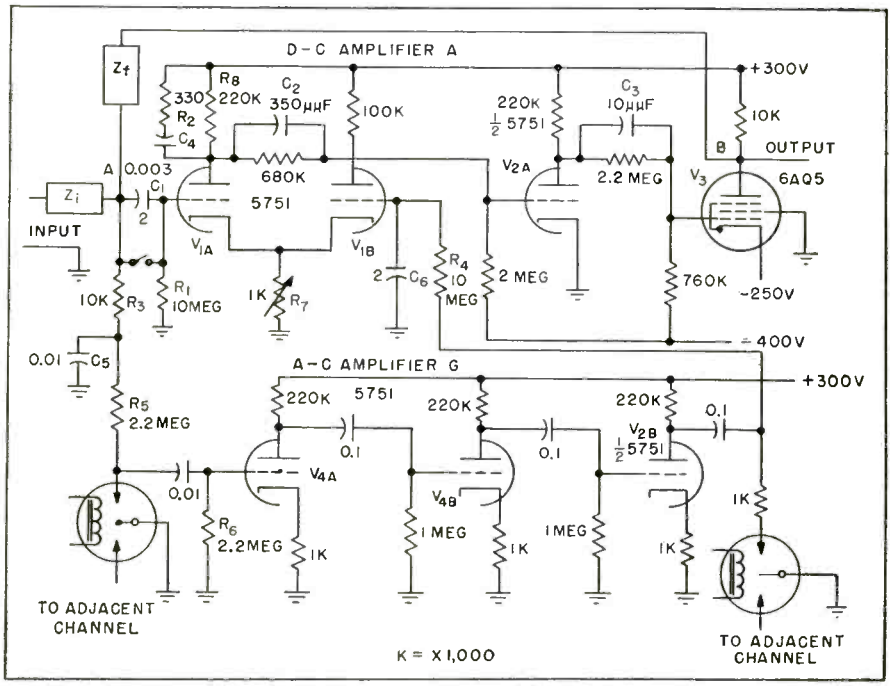


FIG. 2—Complete schematic of one channel of dual-channel amplifier

Phase-Gain Stability

Amplifiers A and G must of themselves be stable. Because d-c amplifier V_1, V_{2A} and V_3 in Fig. 2 is flat to 0 cps, it introduces phase shifts that can cause oscillation only at the high frequency end. Although R_1 and C_1 are in the feedback loop around amplifier A, they constitute only one stage and so have an ultimate roll-off of only 6 db per octave on the low frequency end. By the Bode-Nyquist method, C_2 and C_3 increase the high-frequency response while R_2 and C_4 provide the necessary 10 db per octave roll-off with a step. For greatest stability, maximum feedback should be used ($Z_f = 0$).

The a-c amplifier, V_4 and V_{2B}, must also be stable and although it has no separate feedback directly around it, its a-c gain is high and can lead to oscillation unless the circuit is properly shielded and the components isolated from each other. With a high-μ twin triode such as the 12AX7 ($\mu = 100$) and even with cathode degeneration, it is possible that two stages in a single envelope will break into oscillation. This is especially likely if V_{4A} is one such stage because its grid is about 2 megohms above ground. The ruggedized 5751 provides adequate isolation between triode sections.

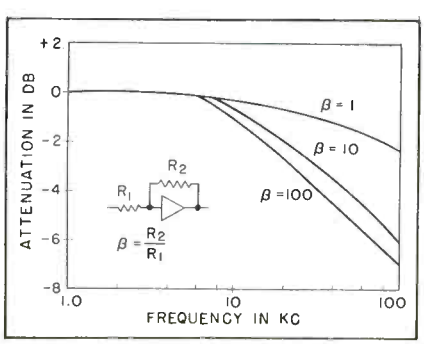


FIG. 3—Response of d-c amplifier A with feedback as parameter

Chopper Choice

Another source of feedback is introduced by the chopper if a single chopper is used to modulate and to demodulate the signal through amplifier G. With one spdt chopper, the output is brought to the chopper socket adjacent to the input. One common practice to avoid this possible path for feedback is to use a make-before-break chopper so at least one end of amplifier G is grounded at any instant. However, if the chopper chatters or if the contacts wear so the action becomes that of a break-before-make chopper, the amplifier will break into oscillation.

In many cases, low-gain operational amplifiers are desired in which the gain of amplifier G may be only a few hundred. In this

Table I—Dual-Channel Operational Amplifier Characteristics

Electrical

Gain of Chopper Stabilizing Amplifier	10,000 at d-c (80 db)
Internal Gain of D-C Amplifier	10,000 (80 db)
Total Internal Loop Gain at D-C	100,000,000 (160 db)
Offset Discrimination at Unity Gain	— 75 db

Operational

Gain	— 3-DB Response	Percent Linearity Over 100-v Range	Percent Linearity Over 200-v Range
1	d-c to 100 kc	0.015	0.5
10	d-c to 30 kc	0.3	1.0
100	d-c to 20 kc	3.0	10.0

case, one can use a break-before-make chopper with impunity. Only when the a-c gain of amplifier G approaches 30,000 will trouble be encountered.

If the chopper fits a septal socket, grounding the center bayonet of the socket and using shielded leads help considerably because most of the coupling capacitance is in the tube socket and not in the chopper. Rolling off the frequency response of the R-C coupled amplifier, just above the carrier frequency by adding shunt capacitance, also helps.

If gains above 30,000 are necessary, two break-before-make choppers are used, one for modulation and the other for demodulation. This arrangement is feasible on the basis that d-c operational amplifiers usually come in pairs. Many applications require multi-channel recording. Hence, operational amplifiers may be packaged in pairs so that one spdt chopper can modulate the input to two amplifiers and the other chopper can demodulate the outputs from both amplifiers.

Filter Networks

Instability also occurs if the amplifier as a whole oscillates with both amplifiers A and G providing the internal loop gain. The two phase shifting networks involved in this loop are the filter networks at the input (R_3C_5) and output (R_1C_6) of amplifier G.

Network R_3 C_5 is usually designed to have time constant as long as 20 seconds, to keep ripple caused by chopping the signal from getting into amplifier A. As a consequence, the high-frequency oscillations are apt to be in the neighborhood of a tenth of a cycle. If the time constants of the two filters are equal an ultimate roll-off of 12 db per octive, which although it may not actually cause oscillation, will cause low-frequency ringing. This ringing can be stopped by making R_1C_6 equal to R_3C_5/G.

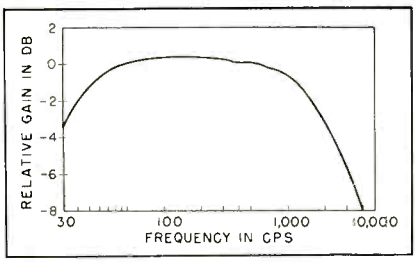


FIG. 4—Response of a-c amplifier G

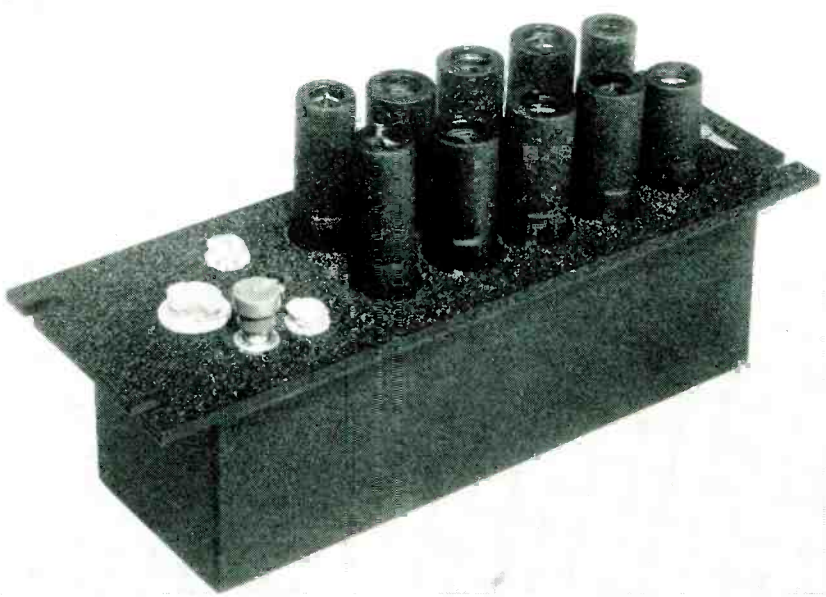
To prevent the chopper modulation frequency from appearing at the input of amplifier A, $1/C_5R_5$ is made much smaller than the chopper modulation frequency. To keep C_5 from grounding the input to amplifier A at high frequencies, it is necessary that R_3 be considerably greater than Z_1A.

Noise

At the input to the d-c amplifier, thermal noise becomes important. With large amounts of feedback, the 60-cps filament pickup is heavily degenerated, but phase shift at the high-frequency end of the d-c amplifier results in the high-frequency components of thermal and shot effect noise being fed back out of phase opposition and, at the upper frequency limit, possibly even in phase. For this reason, feedback cannot be relied upon to reduce high-frequency noise; the noise must be minimized at its source. Well shielded wire-wound precision resistors are preferable in this portion of the circuit; composition carbon resistors may suffice. Deposited carbon resistors suffer from excessive low-frequency pulsation, which usually makes them undesirable.

Grid Currents

If the first grid of amplifier G draws current, a d-c voltage E_c, is established across R_6. If coupling capacitor C_6 has any leakage resistance, the chopper will modulate a small portion of E_c as an error signal. If the leakage resistance of C_6 is m times the resistance of R_6, the chopper will generate a



Dual-channel chopper-stabilized amplifier has 0 to 10-kc bandwidth

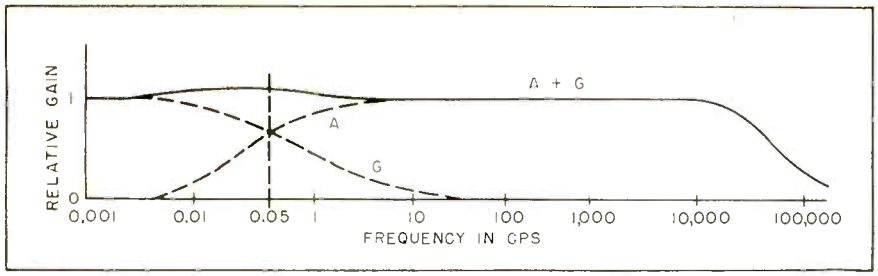


FIG. 5—Response of overall amplifier is flat over wide frequency range

square wave on the grid equivalent to approximately $E_c m$.

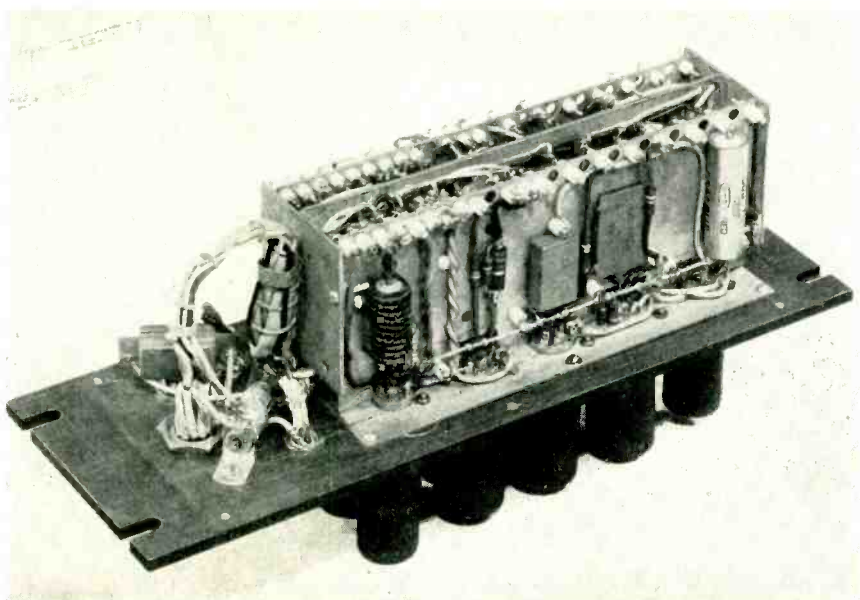
To minimize the effects of this grid current, a high resistance capacitor is used for C_3 and the cathode biasing on this stage is chosen to restrict the grid current to a small value. The grid-current crossover bias for a 12AX7, for example, is −0.85 volts. For this reason, starved pentodes cannot be used in the first stage of amplifier G.

A second source of error owing to grid current is at the input to amplifier A. Coupling capacitor C_1 prevents grid current drawn by the first grid of amplifier A from flowing into the junction of Z_1 and Z_f. If these impedances are purely resistive, this direct current will cause an offset at the output of magnitude $I_g R_f$. Because this offset is an equivalent input noise, the chopper stabilizing amplifier cannot compensate for it.

Considerable care is needed in laying out the circuit around summing point A to avoid stray leakage paths that could cause current injection at this point. Capacitor C_f should be of good quality, well shielded and have high leakage resistance. A reset switch momentarily shorts C_f when the amplifier overloads and saturates.

Performance

Measurement of gain A is straight-forward in the midband range, although considerable d-c drift will be experienced in amplifier A because measurement must be made with no feedback or chopper stabilization. Care must be taken to prevent d-c misalignment in amplifier A from driving the output stage into saturation and so reducing the overall a-c gain. Trim rheostat R_7 can be used for temporary manual alignment or the −250− supply to the output stage can be varied. The response of amplifier A is shown in Fig. 3.



Components and leads of amplifier are isolated along shielding ground planes

If G_1 is the a-c gain of V_4 and V_{2B} the d-c gain of the chopper amplifier from point A to point C will be approximately equal to $G_1/4$.

This is not gain G because it does not account for the transmission loss in differential amplifier V_{1B}. The chopper signal E_2 appears at the grid of V_{1B} and must be referred to an equivalent voltage E_1 appearing at the grid of V_{1A}. This can be done by multiplying E_2 by the gain D of the differential amplifier. This gain G is approximately

$$G = DG_1/4 \qquad (4)$$

Gain D will usually be in the vicinity of 0.3 or less. Although it can be calculated, it is usually easier to measure. Resistance R_8 should be as small as possible to make D large. The response of amplifier G is shown in Fig. 4.

Offset and Drift

After initial warm-up, the long-time drift is negligible compared to the steady component of offset. The value of offset depends on the frequency characteristics of the operational networks. If these are pure resistors, in the order to 1,000 to 100,000 ohms, offsets of 1 mv or less referred to the input may be expected. When the computing resistors enter the megohm range, the offset may increase to 10 mv referred to the input. Offset due to grid current is small; when used as an integrator, the integrating capacitor will retain its charge accurately for long periods of time.

The amplifier has an output range of +200 v d-c from a source impedance of 8,400 ohms with no feedback. Average output noise is about 10 mv of high frequency thermal noise with some chopper switching transients.

With 100 v a-c peak-to-peak in one channel of the amplifier, the pickup in the other channel is below the noise level up to 1 kc and rises slowly to -50 db at 100 kc.

Overall response of the amplifier is shown in Fig. 5; additional characteristics are shown in Table I.

REFERENCE

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One Knob Tunes

SUMMARY — Dual-mode reference cavity and differential amplifiers are combined in feedback loops to provide automatic control of X-band klystron oscillator. Changing cavity frequency produces error signal which drives servo to change klystron cavity size and repeller voltage. Frequency may be directly read with accuracy better than 1 mc within the usual 15-percent band

By JEROME ALTMAN and KINGSLEY CRAFT

Laboratory for Electronics, Inc.
Boston, Mass.

WHEN working with high standing-wave ratios and high-Q cavities the one-knob tuning system, principles of which are applicable to klystrons at all frequency ranges, can advantageously replace the klystron-power supply combinations used where high stability is not required. The ease of operation, coupled with the fact that the frequency is directly calibrated in megacycles, permits an operator to change frequency at will and be positive of oscillation.

The reflex klystron frequency source described herein is electronically stabilized.[1] A portion of the r-f output is fed into a dual-mode reference cavity tuned to the desired frequency. This cavity, a passive element that can be both rigidly controlled and accurately calibrated, is a right circular cylinder. The electrical field induced by the input may be considered vectorially as resolved into two equal components at right angles. These two components are slightly detuned with respect to one another and couple to each one of the two-space orthogonal modes as shown in Fig. 1.

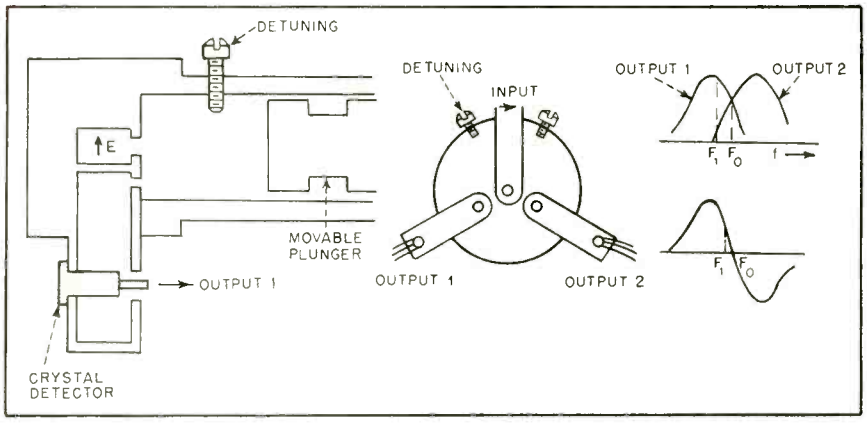


FIG. 1—Cross-sectional view at left shows dual-mode reference cavity and crystal detector. Bottom view showing feed system is at center while curves at right show output as a function of frequency (top) and result after subtraction (bottom)

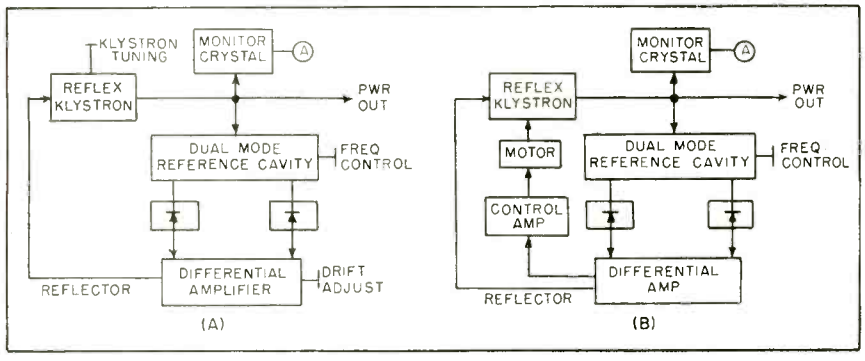


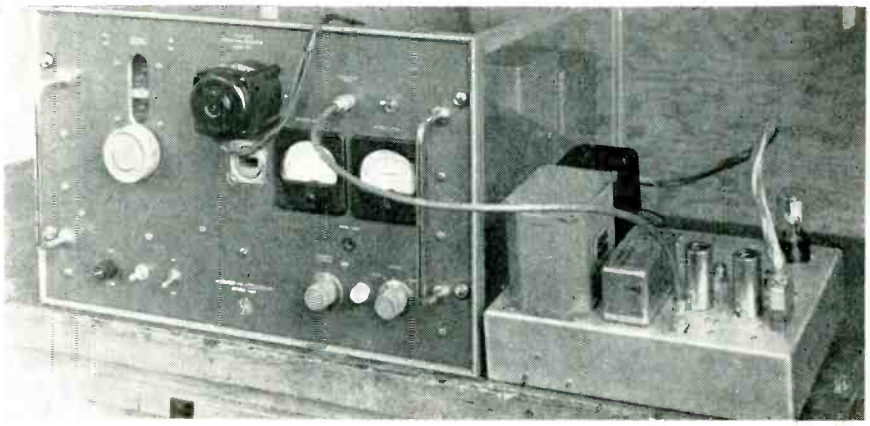
FIG. 2—Block diagram of basic stabilized oscillator (A) and modifications required to provide one-knob control (B)

The outputs are detected and fed to a differential amplifier where the two responses are subtracted. If the klystron frequency is different from that of the reference cavity, a net error voltage is developed at the input to the amplifier. This error voltage is amplified and fed back to the klystron reflector to correct the frequency to that of the reference cavity, except for a small residual error. This error is (error without feedback)/(loop gain +1).

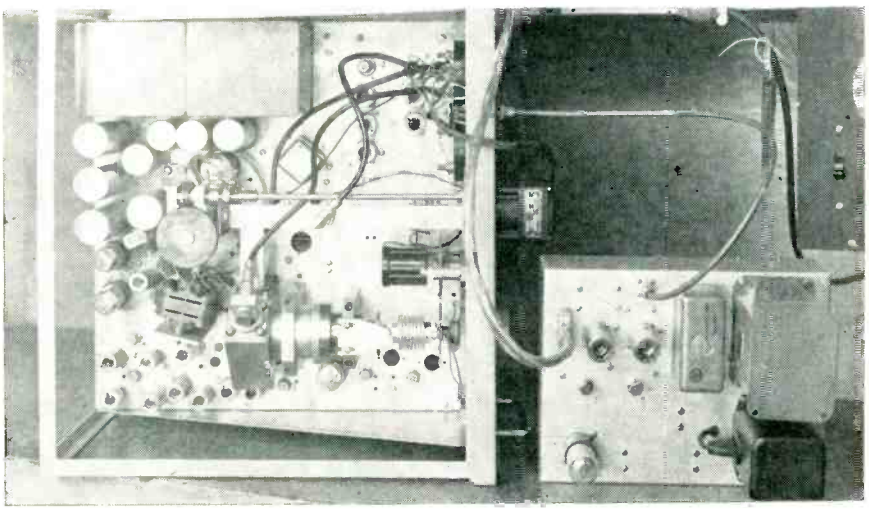
A voltage-level changing stage is included in the differential amplifier and adjusted so that in the absence of any error, the reflector voltage output corresponds to peak power for the klystron mode. The frequency is then practically that of the reference cavity. Figure 2A shows the components of this basic system.

The basic system requires two controls for fixed frequency opera-

KLYSTRON OSCILLATOR



Front view of oscillator showing tuning knob and servo-motor. Smaller chassis at left is the control differential amplifier



Top view of oscillator shows dual-mode cavity at bottom and waveguide connections to klystron oscillator at left

tion and three for tunable operation. Even if the klystron and the reference cavity are mechanically tuned to the same frequency, the reflector voltage may cause the klystron to not oscillate because of drift in the high gain d-c amplifier. A voltage level control is then necessary to initially get the klystron to oscillate and then to lock to the cavity.

Once the system is locked it will remain so, for any internal drift will be corrected by the feedback loop. Over the electronic tuning range, with the system locked, the frequency may be varied by the reference cavity tuning control alone, but as the klystron power output decreases, it must be repeaked by mechanical retuning of the klystron cavity.

If V_R stands for peak power reflector voltage, the range where oscillation is possible is $V_R \pm \Delta V_R$. When the system is turned on however, it is probable that the amplifier output will be outside this range and oscillation or locking impossible until the drift is corrected.

Reflector Voltage Level Control

One method of returning the klystron output to the specified range is to sweep through that range temporarily, at which time a correct reflector voltage will be presented to the klystron reflector. If the klystron is mechanically tuned to the same frequency as that of the reference cavity, the system will begin to oscillate. If the sweep is not turned off, the feedback loop will compensate for the frequency errors that will be caused by the undesired portions of the sweep. There would always be a net residue of error, however, as a result of loop compensation. Therefore, from the standpoint of stability it is preferable to turn off the sweep as soon as locking takes place.

Reliable Method

A simpler and more reliable method is one that uses the circuitry of the amplifier to return the amplifier output to the correct level and eliminates the extra circuitry required to return the amplifier to its normal state once locked. The first stage of the differential amplifier, Fig. 3, is unbalanced by a small cathode potentiometer. During oscillation the voltage input to the amplifier is sufficient to override

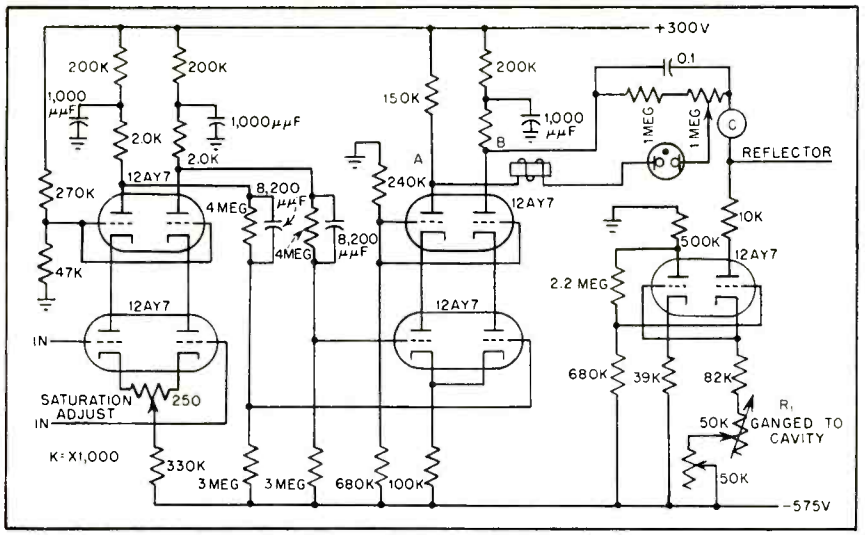


FIG. 3—Differential amplifier provides correct reflector voltage throughout entire klystron range

this unbalance. When the system is unlocked and there is no input to the amplifier the unbalance will produce saturation of the second stage of the amplifier.

The actual amount of the unbalance is unimportant, 0.2 volt being sufficient to result in saturation and still leave a wide margin of safety. When the system is locked, this unbalance means the operating point will be point *P* on the diagram in Fig. 4 rather than point *O*, the operating point for a balanced system. With peak to peak amplitude typically 1 to 2 v, the margin of safety is still adequate.

When saturated, the plates of the second stage, points *A* and *B* of Fig. 3, are at constant positive and negative values, regardless of line voltage, temperature or time. An NE-51 neon lamp conducts and essentially places the potential of point *A* at *C*. This voltage presents the correct reflector voltage to the klystron. The klystron oscillates and, assuming the klystron is mechanically tuned to the same frequency as the reference cavity, locks.

As soon as the system locks a voltage develops at the input of the amplifier and the second stage is desaturated. The NE-51 shuts off, divorcing points *A* and *C*, and visually indicates that locking has been accomplished. The correct reflector voltage level is now maintained by the feedback loop and point *B* becomes a reference point for peak power reflector voltage for any frequency within the electronic tuning range of the klystron.

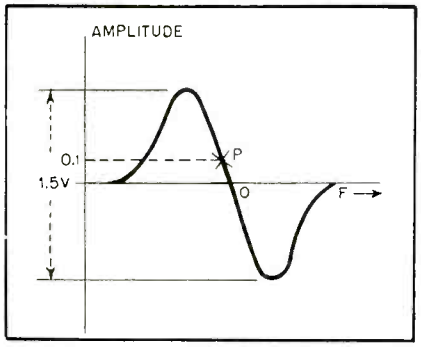


FIG. 4—Dual-mode cavity discriminator curves showing operating point when system is locked on frequency

Any deviation in the desaturated value of point *B* will indicate a deviation from peak power. Point *B*, therefore, has significant saturated and desaturated values for the peak power and unlocked conditions respectively. Negative 75 volts was chosen as the saturated value and −30v for the desaturated or locked condition at peak power.

Since peak power reflector voltage is not constant with frequency, a linear potentiometer, R_1 is mechanically coupled to the reference cavity to regulate the amount of current delivered by the constant-current voltage-level-changing stage.

Mechanical Tuning

The major significance of the −30-v value is that it will be affected by any mechanical misalignment between the klystron cavity and the reference cavity. For example, if the klystron cavity were mechanically detuned under locked conditions, the feedback loop would cause the reflector voltage to change in an effort to electronically correct the klystron frequency and point *B* would also change.

The result, provided the detuning were not extensive enough to unlock the system, would be operation at less than peak power. Any change in the locked value of point *B* would indicate the necessity of mechanically tuning the klystron cavity to match the setting of the

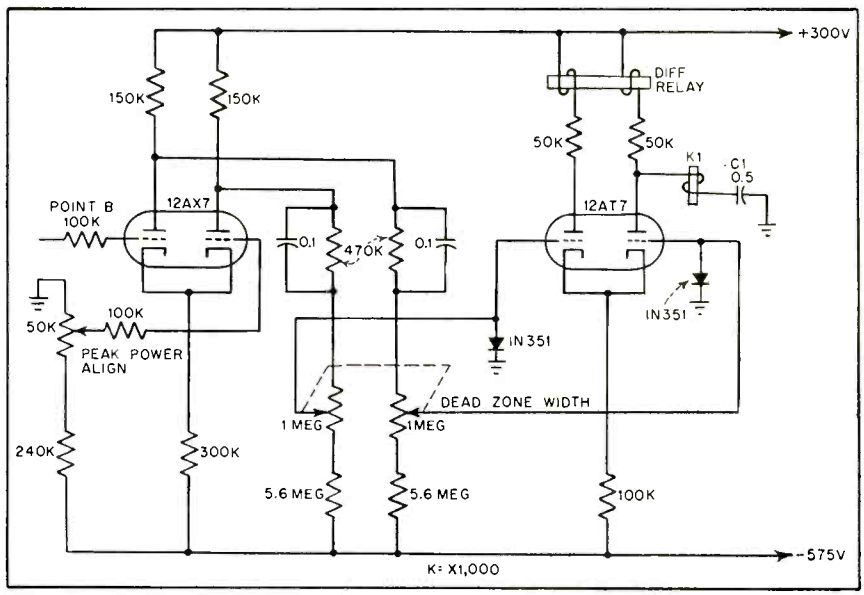


FIG. 5—Control differential amplifier feeds servo motor to change cavity size

reference cavity.

If the klystron tuning characteristics were constant from tube to tube, as they are for external cavity klystrons, automatic tuning could be effected simply by a mechanical coupling between the reference cavity tuning control and the klystron tuning screw. Since the klystron type used is not reliable enough to permit this, a secondary feedback loop is used to motor-drive the mechanical tuning screw as shown in Fig. 2B.

Differential Amplifier

Before it can be applied to the motor, the error voltage must be converted. A differential amplifier, shown in Fig. 5, amplifies only the changes in the −30-v value and the positive or negative voltage output energizes a differential relay. One coil of the relay is energized by a negative output, the other by a positive. A differential relay allows either an a-c or d-c motor to be used.

Although the voltage energizing the motor is eliminated as soon as tuning is accomplished, the motor continues to run for a brief period because of inertia. This problem is solved by the establishment of a dead zone (see Fig. 5 and Fig. 6) at the input to the second stage of the control amplifier. A diode limiter in each grid circuit grounds voltages caused by motor instability. This method eliminates relying on the pull-in or drop-out characteristics of the relay, making accurate and easy setting of the dead zone width possible.

The wider the dead zone, the less precise will be the mechanical tuning of the klystron and the reflector voltage will vary within the $V_R \pm \Delta V_R$ range. As a result, there will be some variations in power output.

Low-Inertia Motor

A compromise between power output constancy and motor stability is achieved by using a motor speed of about 12 rpm. This keeps the dead zone narrow. Because of the relatively low-speed motor, the dead zone produces output power variations of less than 1/2 db for any mechanical setting over the entire tuning range of the klystron.

Running a low-inertia motor at the same speed results in a narrower dead zone. However, its speed will always be limited regardless of inertia, hence it is possible to tune the frequency control so quickly that the motor can not track fast enough to prevent unlocking. This is of no consequence if the motor maintains the proper direction while the system was unlocked, since relocking would take place as soon as the correct setting is found. The time between unlocking and locking is determined by how far the correct setting is from the setting at the time of unlocking. With this distance maximum, the interval with this motor is not more than a few seconds.

Information for a polarity reversing switch is provided by the nature of the change in voltage at point B. When unlocking results from an increase in frequency, the antecedent detuning causes the voltage at point B to swing more negative. When unlocking occurs, the change to −75 v is from a voltage more negative than −30 v. When unlocking is caused by a decrease in frequency, the change is from a value more positive than −30 v. As the diagram in Fig. 6 illustrates there is a greater change in the latter case. By making use of this change, a signal is provided for a polarity reversing circuit.

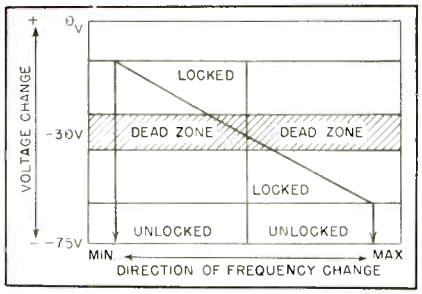


FIG. 6—Voltage changes effecting servo operation. Dead zone appears owing to motor inertia

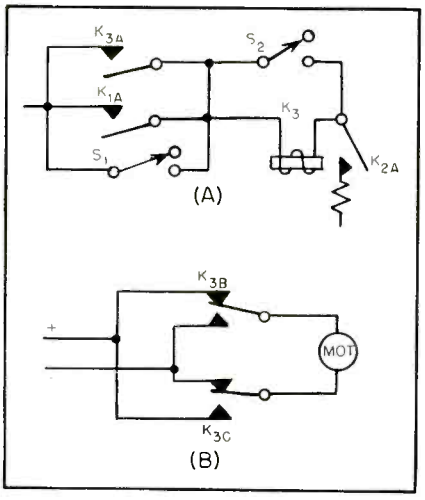


FIG. 7—Relay and limit switch arrangement for servo motor

Polarity Reversing

The polarity reversing circuitry functions as follows: when this type of change occurs in the second stage of the control differential amplifier, plate bypass capacitor C_1 becomes a short circuit and energizes relay K_1. This closes contact K_{1A} of Fig. 7. At the same time, relay K_2 closes, since point B swung to −75 v. Closing the contacts of these two relays energizes relay K_3 which closes holding contacts K_{3A}, K_{3B} and K_{3C}. Contacts K_{3B} and K_{3C} reverse the polarity of the signal and a voltage of the correct polarity is sent directly to the motor. As soon as the system relocks, K_2 and K_3 open, and the circuit is denergized and reset.

When the system is turned on, it may be unlocked and there will be no change at point B to utilize when the −75 v is inadequate for the directional sense required. Thus the motor will run in the wrong direction until the upper limit of the tuning range is reached at which point switch S_1 will close and perform the function of K_1. The motor will reverse and run until the correct setting is found. If the system does not relock, switch S_2 will short out relay K_3 and reverse the motor again to protect the klystron.

Uses

This instrument may be used as a basic unit in a tunable mti radar system. Considering the one-knob oscillator as a basic building block that was complete in itself, the tuning procedure of the entire mti system could be significantly simplified, whether the transmitter were a wide band klystron or a magnetron.

Reference

(1) Altman, J. L. A Technique for Stabilizing Microwave Oscillators, *IRE Trans.*, PGMTT, p 16, July, 1954.

Eccentric-Line Impedance Nomograph

SUMMARY — Chart permits finding characteristic impedance of eccentric coaxial lines in terms of conductor dimensions and amount of eccentricity. Scales may be multiplied by factors of ten to increase useful range of chart

By J. A. HASSE
Staff Member
Sandia Corporation
Albuquerque, New Mexico

DISPLACING the conductors of a coaxial transmission line relative to each other while keeping their axes parallel results in a configuration called an eccentric line because of its appearance in cross-section. The accompanying chart gives the characteristic impedance Z_c in terms of eccentricity.

The chart is based on the relation

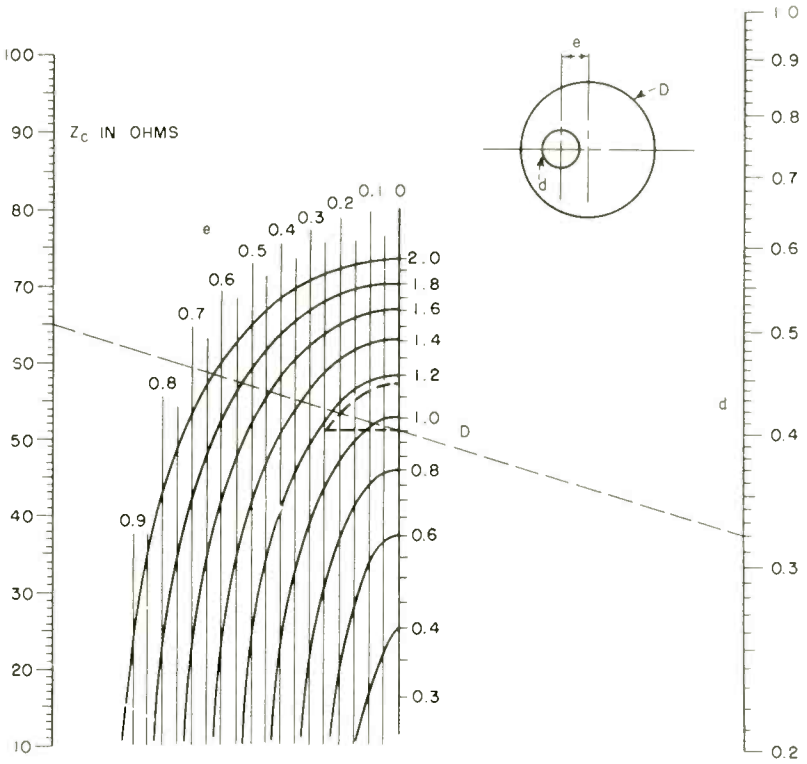
$$Z_c = 60 \ln \frac{D}{d}\left[1 - \left(\frac{2e}{D}\right)^2\right]$$

where d is the diameter of the inner conductor, D is the inner diameter of the outer conductor and e is the axial offset or eccentricity of the conductors. Any consistent set of dimensions may be used.

For zero eccentricity ($e = 0$), the familiar impedance formula is obtained, 60 times the Napierian logarithm of the major-to-minor diameter ratio. This case also appears on the nomograph and may be used where the line is truly coaxial.

All scales except Z_c may be multiplied by the same factor to extend the usefulness of the chart. The common multiplying factor is most conveniently a power of ten so the significant figures are retained.

The chart deals only with transmission lines having air dielectric. To determine Z_c for solid dielectric lines divide the chart value of the square root of ϵ_r, the relative permittivity or dielectric constant.



Example

An example will clarify use of the nomograph. Given: $D = 1.16$, $d = 0.32$ and $e = 0.25$; find Z_c.

Locate $D = 1.16$ along the calibrated line and follow this value in curvilinear fashion to intersect with the eccentricity value $e = 0.25$, which is plotted horizontally. From this intersection return horizontally to the line of zero eccentricity. Now connect $d = 0.32$ and the last point determined with a straightedge, to give $Z_c = 65$ ohms.

If for the same example e were zero, Z_c could be read with a straightedge as 77 ohms.

To illustrate use of a scale multiplication factor, the diameters selected in the example, 1.16 and 0.32, are ten times those for RG-58/U cable expressed in inches. The cable has a dielectric constant of approximately 2.2 and $Z_c = 77/\sqrt{2.2} = 52$ ohms. For an eccentricity of 0.025 inch, referring again to the first example, $Z_c = 65/\sqrt{2.2} = 44$ ohms.

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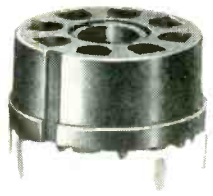
Edge Connector

This 25 contact printed wiring edge connector is designed for 1/16" copper laminates. Contacts are mounted on .150 centers. .125 diameter mounting holes are on 4.33" centers. Contacts are of phosphor bronze, gold plated. Connectors are available in melamine or diallylphthalate insulation. Polarizing contact can be placed in any position.



No. 22743

Octal Stand-Off Type Printed Wire Socket

Designed for 1/16" copper clad laminates. Mounts in eight .1" diameter mounting holes located on a 1.064" pin circle. Insulation—black general purpose bakelite.

Sub-Miniature Hi-Temperature Sockets

Insulation is glass filled silicone resin for high temperature applications. Contacts are of beryllium copper with annealed tails. These sockets are provided with "J" lock shield bases for use with various length shields. The tails can be supplied straight as shown on Part #22021 or with a .04 loop as shown on Part #22377.

No. 22377

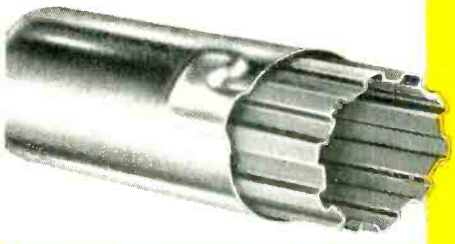
No. 22021

Exp. 9422

Exp. 9421

Jan Type Printed Wire Sockets with Shield Bases

Designed for both 1/16" or 1/8" copper clad laminates. These sockets are of the "Stand Off" type, made of molded mica insulation with silver plated phosphor bronze contacts.



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Slab Line Nomograph

SUMMARY — Design of air-dielectric slab line used as transition or matching section between coaxial and strip transmission lines. Nomograph relates characteristic line impedance, diameter of inner conductor and separation between parallel ground planes

By ELIO SION

Airborne Instruments Laboratory, Inc.
Mineola, New York

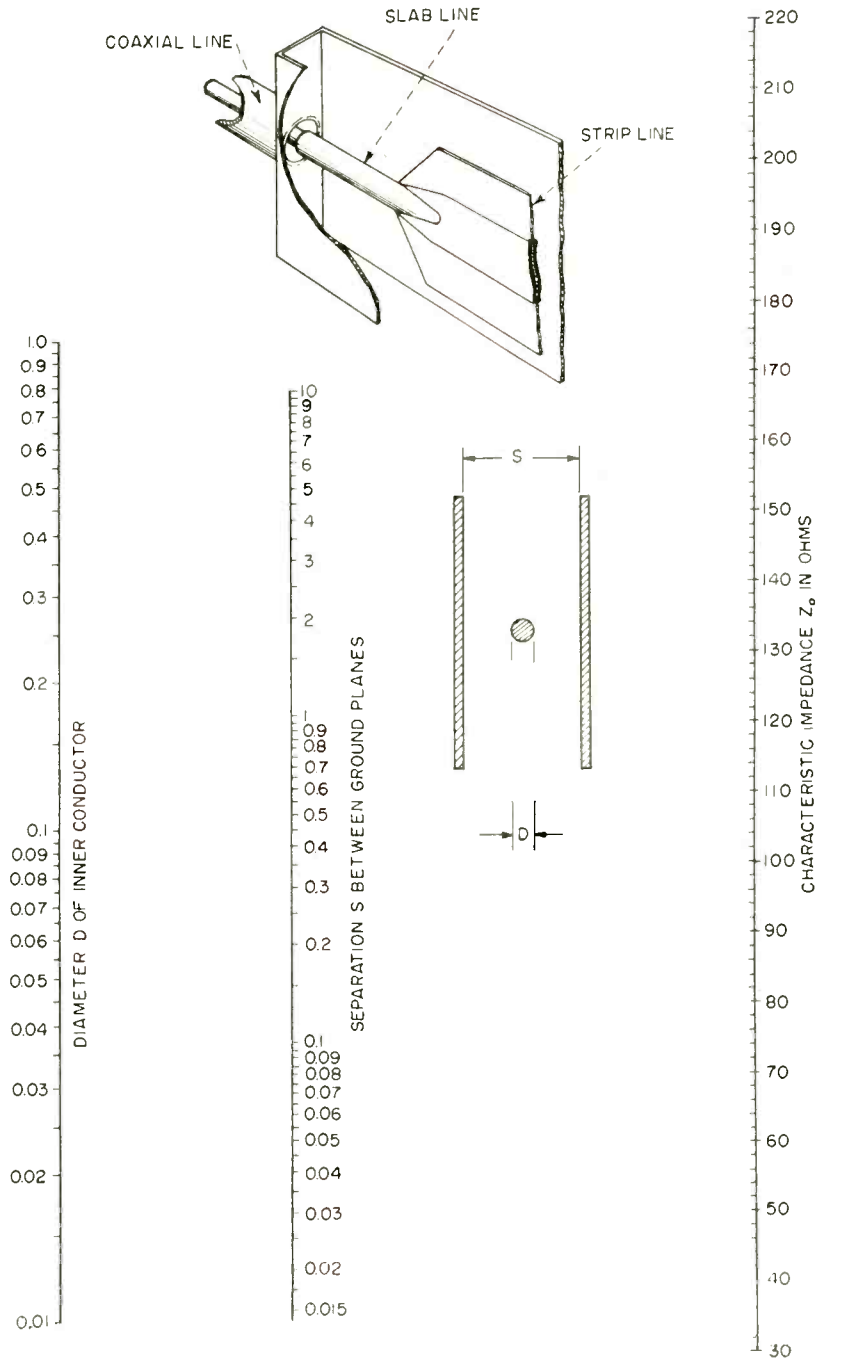
SLAB LINES have numerous applications in microwave transmission circuits.

The slab line is a double-slotted coaxial line whose outer shield has been unwrapped and extended to infinity in both directions. The resulting configuration consists of a round cylindrical conductor between two parallel planes, for which exact impedance formulas have been developed.[1]

The simplified formula[2] $Z_o = 138 \log_{10} (4S/\pi D)$ used in the construction of the accompanying nomograph for such slab lines is accurate to within 2 percent for values of $S/D > 1.5$.

Suppose it is desired to design a slab line of 100 ohms impedance with an inner conductor 0.025 inch in diameter. Enter the left-hand column at $D = 0.025$ and connect that point with a straight line to $Z_o = 100$ ohms on the right-hand column. The center column yields the separation between plates as 0.105 inch.

To prevent radiation the width of the ground plates should be, as a rule of thumb, at least five times the separation between plates. Here $5 \times 0.105 = 0.525$ inch, so make the plates at least $\frac{3}{4}$ inch wide.

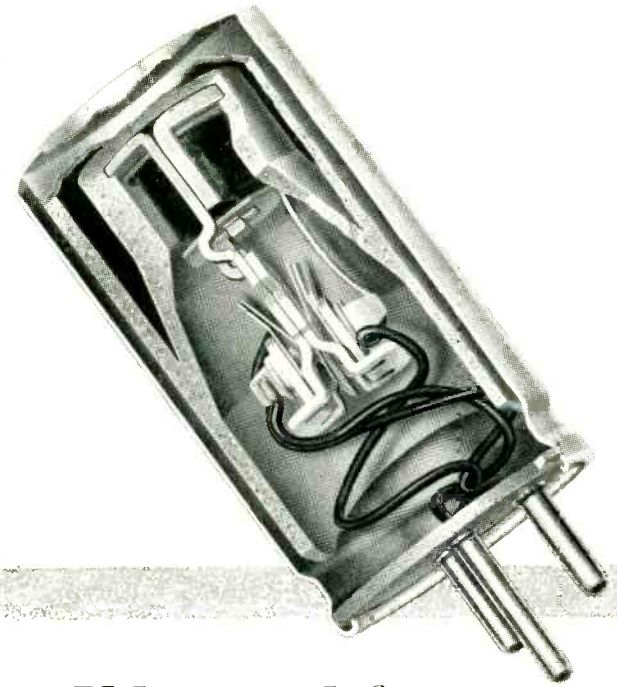


Nomograph for designing slab lines used as transitions or matching sections between coaxial lines and strip transmission lines

REFERENCES

(1) W. B. Wholey and W. N. Eldred, A New Type of Slotted Line Section, *Proc IRE*, p 244, March 1950.
(2) "Reference Data for Radio Engineers," 3rd edition, p 326, Federal Radio and Telephone Corp.

MALLORY



Completely new design concept eliminates usual button contact, provides larger contacting area. New units have far longer life, lowest noise level yet . . . but cost no more.

Vibrator life increased 50 to 100% . . . in

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Sticking of contacts is eliminated.

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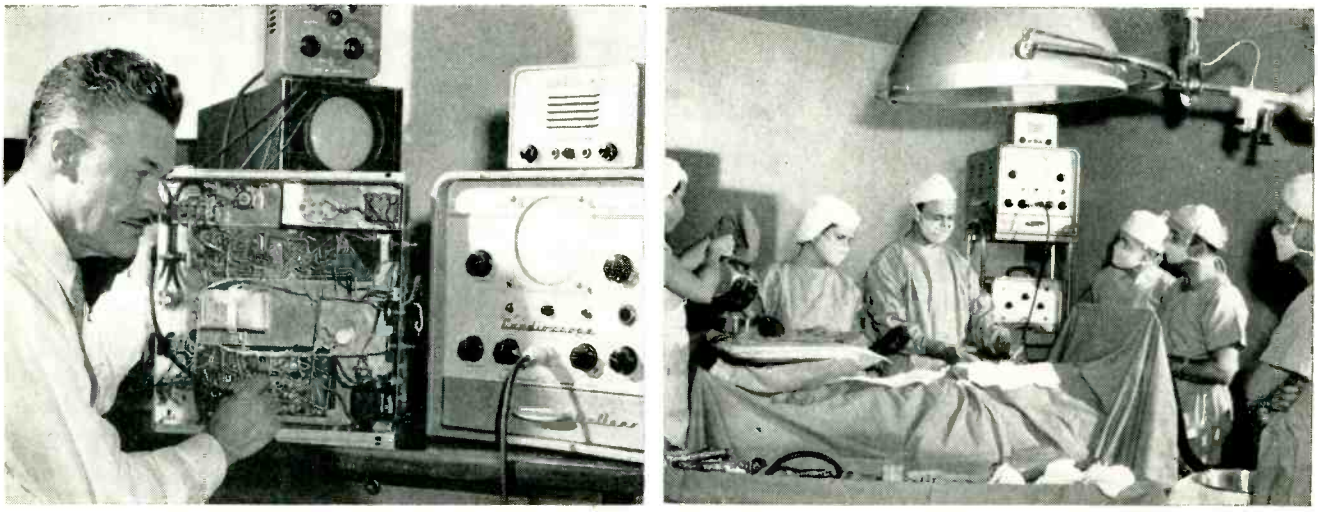
Electrons At Work

Edited by ALEXANDER A. McKENZIE

Cardioscope Checks Heart During Operation



A heart-rhythm monitor developed for use in the operating room gives the surgeons visual and aural indication of the patient's heart condition during an operation. Value of the instrument is in warning surgeon of heart difficulties at the moment they start. Shown here in use in a Los Angeles Hospital, the heart signal is picked up from taped leads on patient's wrists and legs, similar to cardiograph technique. The chassis, shown at left with designer Oscar Dallons, uses printed circuit construction.

Transmission Program for WWV and WWVH

TIME and frequency standards as broadcast by National Bureau of Standards stations WWV (Maryland) and WWVH (Hawaii) are available 24 hours a day in the United States and over much of the world. The broadcast program is shown in Fig. 1.

Transmissions provide standards of r-f and audio signals with accuracies shown in Table I. Two audio frequencies are now transmitted, the 440 cps A above middle C and a 600 cps tone. The latter was chosen as giving the maximum number of integral multiples and submultiples as well as being convenient to use with 60 cps power line frequency.

The standard time pulse marking second intervals consists of 5 cycles of a 1,000-cps tone at WWV and 6 cycles of a 1,200 cps tone at WWVH. Minute intervals are marked by omission of the pulse at the beginning of the last pulse of every minute and commencing the minute with two pulses spaced 0.1 second apart.

Table I—Standard Frequency and Time Transmissions

	WWV	WWVH
R-F Signal Frequency in mc	2.5, 5, 10, 20, and 25	5, 10, and 15
Frequency stability at trans.	1 part in 10^9	5 parts in 10^9
Frequency deviation at trans.	2 parts in 10^{10} per day	4 parts in 10^{10} per day
Time Signal (seconds) Frequency	1,000 cps	1,200 cps
Duration	0.005 sec	0.006 sec
Accuracy	1 part in $10^8 \pm 1$ μsec	
Audio Tones Frequency Accuracy	440 and 600 cps 1 part in 10^9	
Propagation Forecast	19.5 and 49.5 min past hr	9.4 and 39.4 min past hr

When ionospheric conditions are normal and the correct time of day is selected, a frequency standard can be checked with the transmissions to an accuracy of 1 part in 10^9 in a few hours. In general it is best to make the check over a 24-hour period.

Universal Time (equivalent to Greenwich Mean Time) is announced every five minutes in telegraphic code using the 0-to-24 hour system. At WWV a voice announcement of Eastern Standard Time is given before and after the code announcement.

Forecasts of radio propagation conditions are made twice an hour from both stations. A letter and digit are used to classify conditions at time of broadcast and for the next six hours. Letters N, U, and W indicate present conditions of

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RIPPLE: Less than 3 mv. rms.

STABILITY: The output voltage variation is less than the regulation specification for a period of 8 hours.

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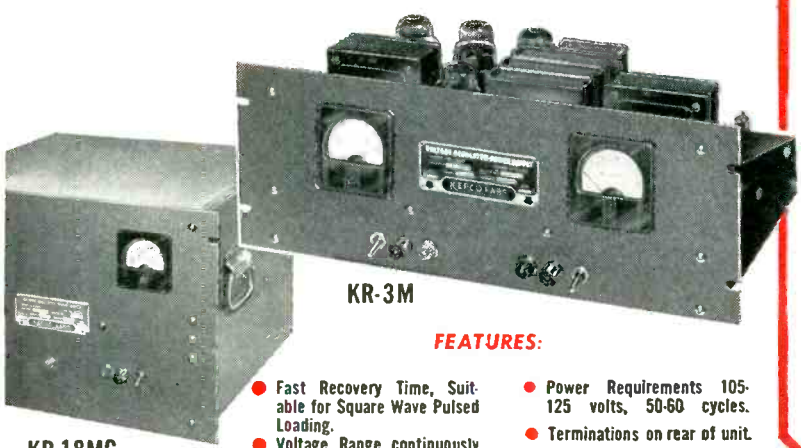
OUTPUT IMPEDANCE: Less than 0.1 ohms from 20 cycles to 100KC. Less than 0.5 ohms from DC to 20 cycles. Many units have very much lower output impedance.



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KR17	100-200	has two	19"	12¼"	17"	$625
KR18	195-325	15 Amp.	19"	12¼"	17"	$695
KR19	295-450	outputs	19"	12¼"	17"	$695

600 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 8	0-150	Each supply	19"	10½"	13"	$330
KR 5	100-200	has two	19"	10½"	13"	$240
KR 6	195-325	10 Amp.	19"	10½"	13"	$240
KR 7	295-450	outputs	19"	10½"	13"	$250

300 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 12	0-150	Each supply	19"	7"	11"	$270
KR 3	100-200	has two	19"	7"	11"	$180
KR 4	195-325	5 Amp.	19"	7"	11"	$180
KR 10	295-450	outputs	19"	7"	11"	$190

125 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 11	0-150	Each supply	19"	7"	11"	$180
KR 1	100-200	has one	19"	7"	7½"	$ 90
KR 2	195-325	3 Amp.	19"	7"	7½"	$ 90
KR 9	295-450	output	19"	7"	7½"	$ 97

To include 3" Current and Voltage Meters, Add M to Model number (e.g. KR 16-M) and Add $30.00 to the Price.
To include Dust Cover and Handles for Table Mounting, Add C to Model number (e.g. KR16-C) and Add $10.00 to the Price.
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normal, unsettled, and disturbed respectively and the digits from 1 to 9 indicate forecast ranging from useless to excellent.

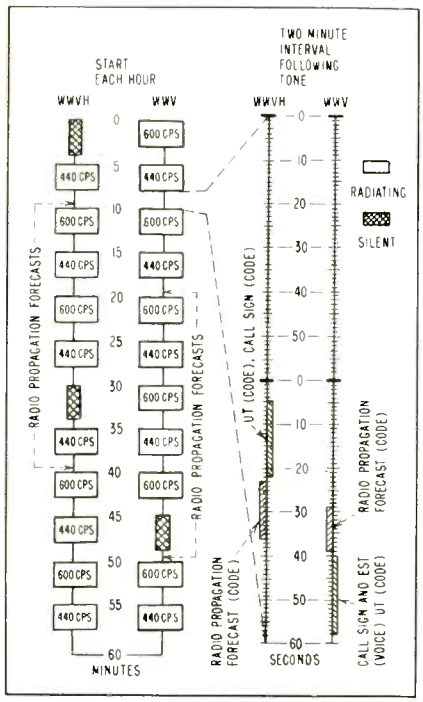


FIG. 1—Division of time for standard signals

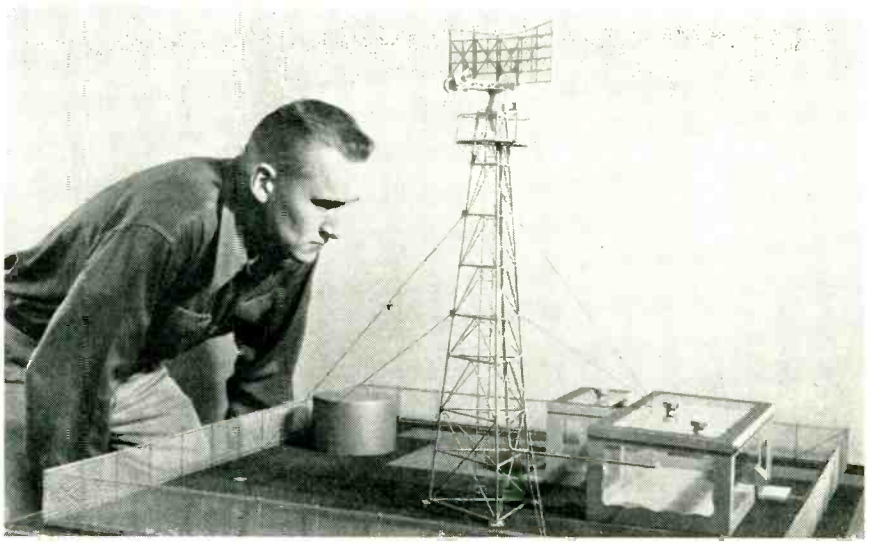
Other time and frequency standards transmissions are made at regular intervals by the U. S. Naval Observatory from four transmitters. The Dominion Observatory in Canada transmits time signals on three frequencies from Ottawa, Canada (ELECTRONICS, p. 182 and 196, June 1955). Previous time-signal information appeared p 190, Jan. and p 192 Apr. 1956.

Other stations broadcasting standard signals are given in Table II.

Table II—Time and Frequency Transmission In Other Countries

Call Sign	Location	Carrier Frequency Mc	Modulation c/s
LOL	Buenos Aires, Argentina	2.5, 5, 10, 15, 20, 25	1, 440, 1000
ZUO	Johannesburg, South Africa	5	1 — —
ZLFS	Lower Hutt, New Zealand	2.5	— — —
—	Moscow, USSR	10, 15	1 — —
MSF	Rugby, England	2.5, 5, 10	1, 1000 —
JJY	Tokyo, Japan	2.5, 5, 10, 15	1, 1000 —
IBF	Torino, Italy	5	1, 440, 1000
—	Uccle, Belgium	2.5	— — —

Model of SAGE Gap Filler



Low-flying aircraft that might come in under the beam of long-range search radar in the continental defense system are detected by installations that require no resident attendants. Model was constructed for MIT Lincoln Laboratory by Atkins and Merrill

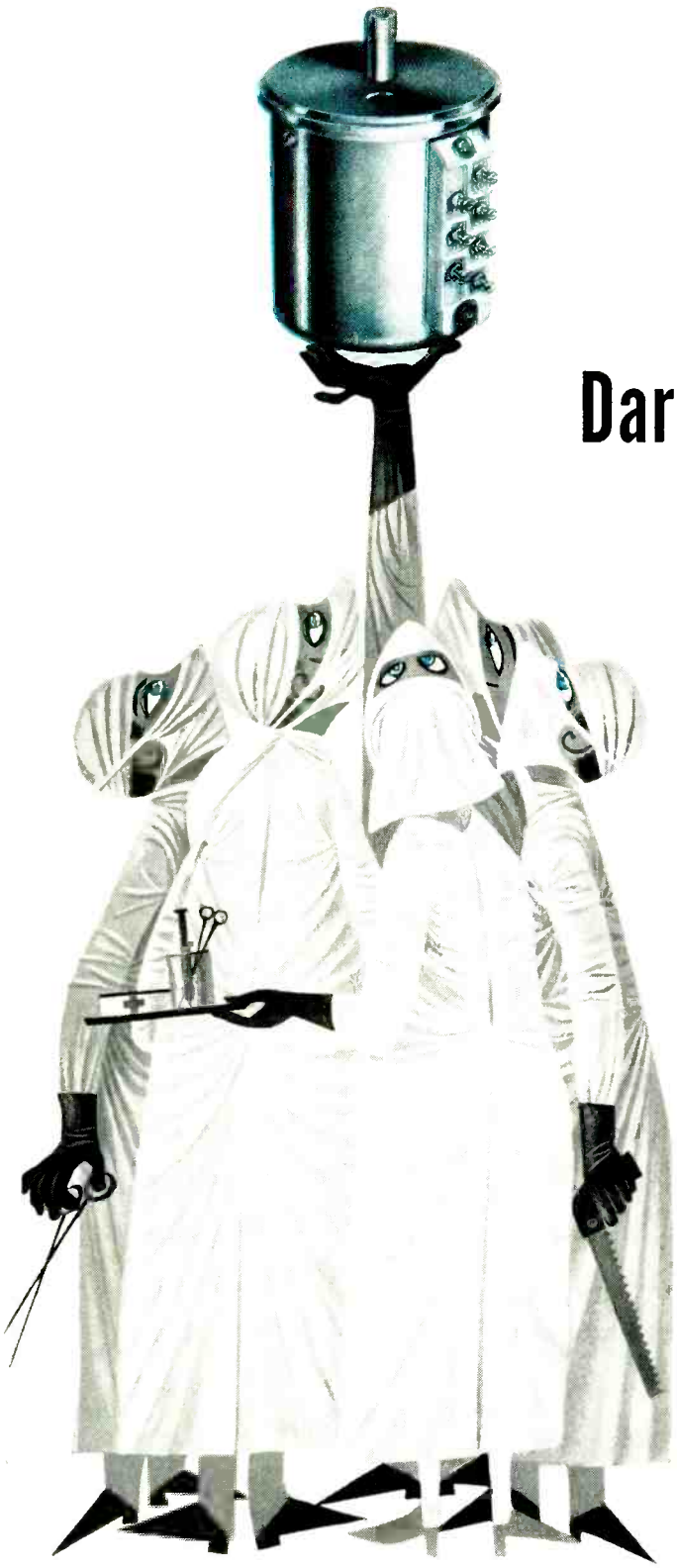
Tubes Run Shake Table

Vibration tests on electronic equipment can be made at frequencies as high as 2,000 cycles using the electromagnetic shaker shown. Primary exciter is an audio-frequency oscillator driving audio-amplifier stages to actuate the vibration device that is not unlike a huge loudspeaker. Demonstrating the effect of shock mounts in their new Teterboro, N. J. laboratory are C. S. Robinson and G. deF. Larner of Robinson Aviation

Automatic Microimage File

MICROIMAGE data storage and retrieval device recently developed provides rapid access to any one of 10,000 information frames recorded in miniature on a 10-sq in. sheet of microfilm. The instrument operates continuously. It automatically searches the microfilm and photographically prints out one frame every 2 seconds.

The machine is applicable where large volumes of data must be assembled in a predetermined sequence from a master random file. Information may be in the form of pictures, drawings, fingerprints,



Another product surprise from Helipot!

Daring operation

Delicate design surgery by the Helipot staff removed the mandrel from our new ten-turn series 7700 . . . and left nothing but fresh air inside the turns of resistance wire!

Startling . . . but so advantageous.

The post-operative picture shows temperature, pulse and pressure normal. Prognosis *excellent* . . . because with air-core winding† linearity approaches the resolution of the unit and phase-shift is less than 0.1° in AC circuitry.

The splendid 7700 . . . 1-13/16" in diameter, with all-metal housing . . . is available for servo or three-hole pilot mounting. Eleven mechanical coil turns provide 180° overtravel at each end. Mechanical stops are standard, with stop-load strength of 50 inch-pounds. Incidentally, air-core winding is used for units with total resistance of 200 to 5,000 ohms . . . copper-mandrel winding, from 5,000 to 200,000 ohms.

The complete clinical records of this fascinating case are presented in data file 901. A copy has been set aside for you.

† *The air-core winding system was developed by Vestal Laboratories of I. B. M.*

Helipot makes precision potentiometers . . . linear and non-linear . . . in the widest choice of sizes, mounting styles and resistances. Many models are stocked for immediate shipment. Our engineers will gladly adapt standard models to your requirements, or design entirely new HELIPOT* precision potentiometers for you.

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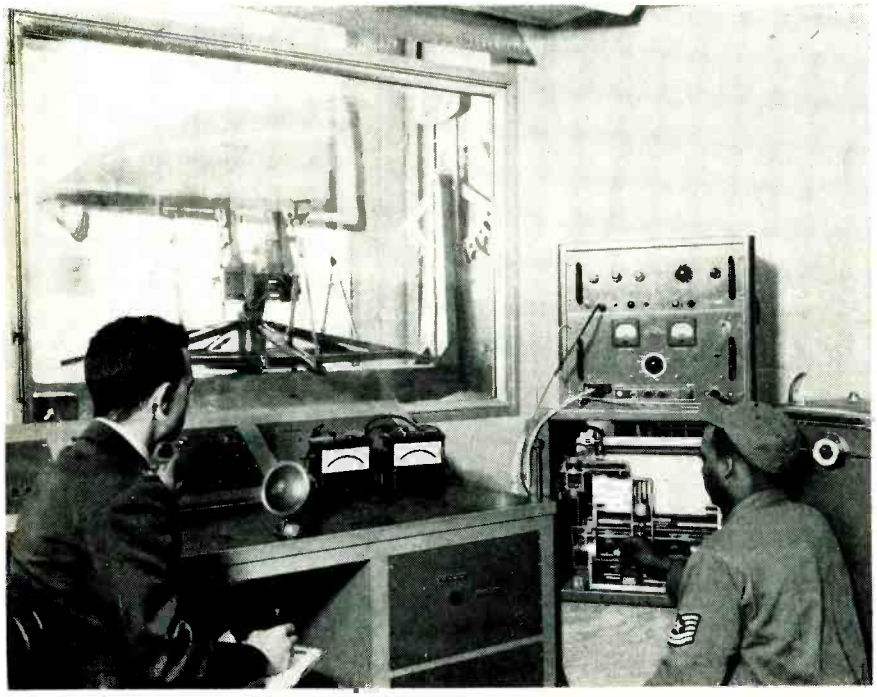
Radome Test Range



To solve problems in transmission-reflection, beam pattern distortion and bore-sight error, Wright Air Development Center is completing construction of an aircraft radome test range. Technical tests are being made on a transmission-reflection unit (left). The test tower (right) is 1,900 feet from the transmitter. Receiving equipment here detects effects caused by radome

sets of numbers, letters, or other symbols, or even single stages of electronic circuit diagrams. Quantity and kind of data is limited only by the size of the individual frame (1/10 sq in.) and the photographic resolution of the film emulsion. Although the basic storage capacity of the machine is for a 10,000-frame matrix, the matrix can be interchanged with others from a static file.

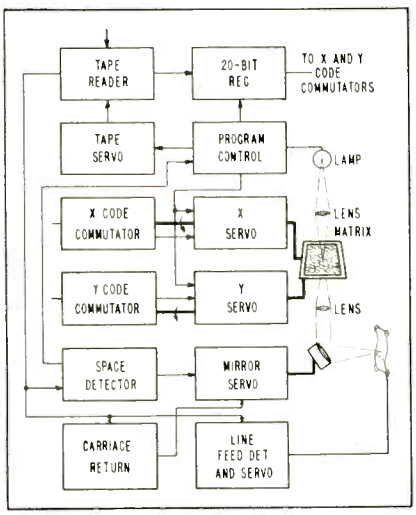


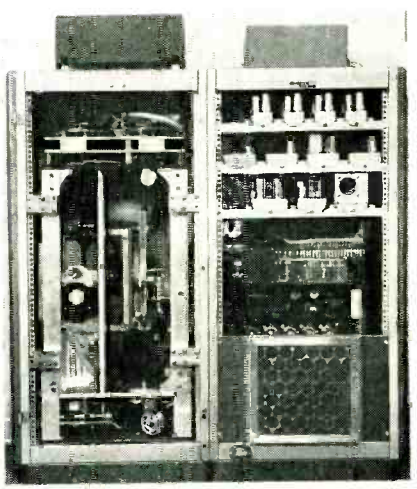
FIG. 1—Block diagram of NBS automatic microimage file system. Instrument searches for and prints out one frame every 2 sec

Machine input is from perforated teletypewriter tape containing coded locations of the desired frames in print-out order. The assembled data comes out on a 10-in wide strip of photosensitive paper of any required length. Individual frames are enlarged to ½-in. squares. Commercial automatic developing equipment processes the paper.

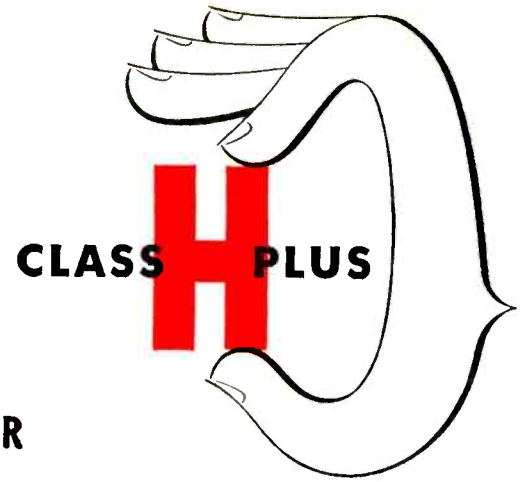
The instrument combines digital computer electronic circuits and a pair of precision servomechanisms that search X and Y axes of the matrix. The location of the desired frame is fed into a 20-bit binary-digit register from the teletypewriter tape. The register consists of capacitor memory and coincidence identification circuitry. The first 10 bits control the Y position selection while the second 10 bits control the X position.

The matrix is supported on a drum 10 in. in diameter and is fastened at one edge with dowel pins to insure accurate location. The drum is servocontrolled in both linear and rotary axes of motion, corresponding to the X and Y axes of the matrix.

The servos that shift the matrix to the chosen coordinates are mechanically coupled to two code commutators associated with each axis. They control the coordinate positions to which the matrix is located. They are photo-etched with 100 ten-bit numbers corresponding to the teletypewriter binary bit code. Two



Rear view of microimage file shows matrixing system at left and electronic control circuits at right

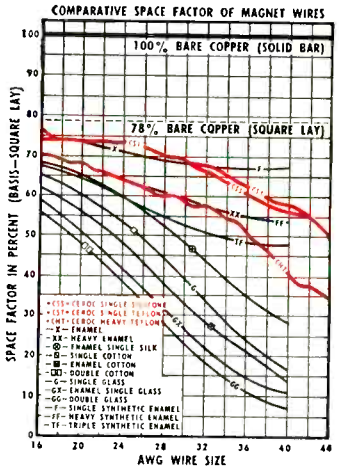


THERE IS ONLY ONE MAGNET WIRE WITH AN EXTREMELY HIGH SPACE FACTOR CAPABLE OF SUCCESSFUL, CONTINUOUS OPERATION AT 250°C

CEROC is an extremely thin and flexible *ceramic* insulation deposited on copper wire. *This ceramic base insulation is unaffected by extremely high temperatures.* Thus, in combination with Silicone or Teflon overlays, Ceroc insulations permit much higher continuous operating temperatures than are possible with ordinary insulations.

There are three standard Ceroc Wires: Ceramic Single-Teflon and Ceramic Heavy-Teflon for operation at 250°C. feature unique characteristics of flexibility, dielectric strength and resistance to moisture. They have been used successfully to 300°C in short time military applications. Ceramic Single-Silicone, for 200°C application, pairs the ceramic with a Silicone reinforcement to facilitate winding.

All three Ceroc Wires have far superior cross-over characteristics to all-plastic insulated wire—all provide an extraordinarily high space factor that facilitates miniaturization with high-reliability standards. ★ ★ ★ ★



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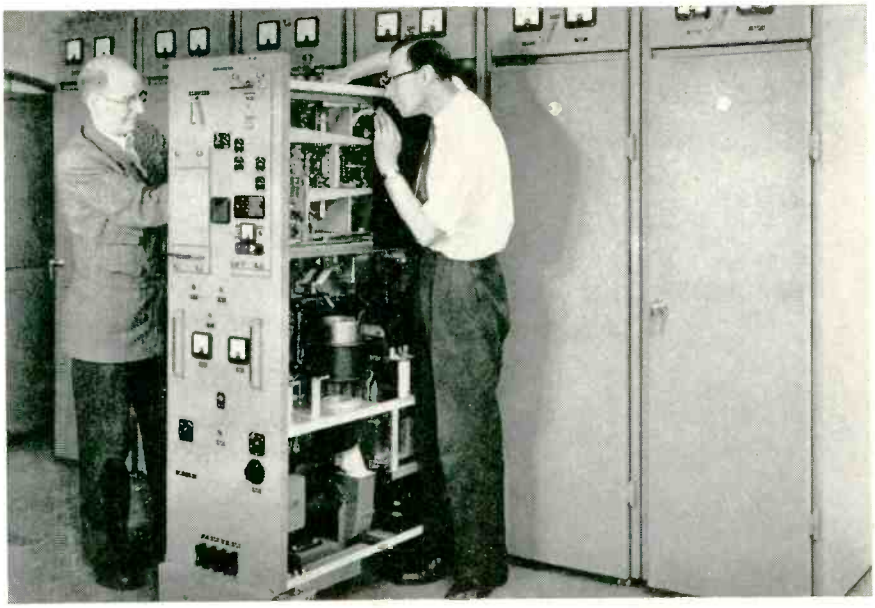
Transpolar Air Routes Get Communications



Three ground-to-air communications links are being installed in Greenland by Marconi Wireless Telegraph Co. for use on the transpolar air routes. One will serve routes between Europe and North America, and the other two will serve the Scandinavian Airlines System route from Scandinavia to Tokyo. The latter installation will be at Nord, Greenland, about 600 miles from the North Pole. Photo shows one transmitter in late stage of assembly.

Helicopter Blade Tracker

To minimize vibration that would otherwise occur if helicopter blades do not follow the same flight path and rotate in the same plane, Chicago Aerial Industries, Inc. has developed an electro-optical device that requires no attachment to the blades. Equipped with a computing analyzer and remote meter, the unit will track from 120 to 1,500 rpm

particular positions are selected by a serial mechanical search with contacting brushes until a code combination is found that matches the binary bits recorded in the 20-bit register.

Magnetic clutches and brakes provide rapid starting and stopping

t/i progress report on silicon rectifiers

NEWEST ADVANCE . . . 1500 VOLT

single junction silicon rectifiers

PRODUCTS SHOWN ACTUAL SIZE

You can now obtain maximum rectifier miniaturization along with nearly *double* the operating voltage previously obtainable from silicon rectifiers – with new TI *single element* grown junction silicon rectifiers. This twofold advance – single element construction plus 1500 volt operating voltage – results in immediate extension of design limits in guided missile and other military applications. Also, these rectifiers are ideal for use in series for cathode ray tube and similar high voltage circuits.

TI miniaturized silicon rectifiers feature forward current ratings to 100 ma . . . have high mechanical reliability . . . and operate stably to 150° C. They require no filament power . . . no warm up time. Five production types give you a choice of axial-lead and stud-mounted half wave and plug-in full wave models.

All these devices in production and available now!

Also, for exacting circuit requirements, select from TI's line of 69 SILICON JUNCTION DIODES, including:

TI — GENERAL PURPOSE	650 — VOLTAGE REFERENCE
1661 — HIGH CONDUCTANCE	TI — UNIFORM FORWARD CHARACTERISTIC

Write today for complete data!

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

of the drum with uniform overtravel in locating every position on the matrix. A single induction motor supplies all motive power to the machine.

At the beginning of the cycle of operation, a teletypewriter tape reader reads a 4-digit number into the 20-bit register in terms of a binary-digit code. A space symbol is customarily inserted in the tape following each 4-digit number. On detecting this space symbol, the machine's program control stops the tape reader, engages the magnetic clutches on the *X* and *Y* servos, and looks for the compatible code on the two coordinate axes. When the compatible code is found, the clutches disengage and magnetic brakes stop the drum. A print lamp is briefly turned on to expose the selected microfilm frame on the photosensitive paper. When exposure is complete, the tape advances to the next instruction, the drum returns to its zero position and the machine proceeds with the next search cycle.

Fifteen successive frames are printed in a row across the width of the print paper by a step-positioning mirror which automatically advances the image one space on the photographic paper for each printout. Upon completion of a line, a line-feed servo advances the paper a fixed amount.

The instrument recognizes two other symbols, the carriage return and the line feed. These symbols instruct the machine to return the step-positioning mirror to its zero position, and to advance the paper one line. Whenever desired, these functions can be inserted into the tape.

Although the machine was primarily designed as an outscriber for obtaining programmed printing, it can temporarily be set up as an inscriber to prepare its own matrices. Using the same machine to prepare a matrix insures that each frame will be accurately located during subsequent use.

The foregoing information was obtained from the National Bureau of Standards, Washington, D. C.

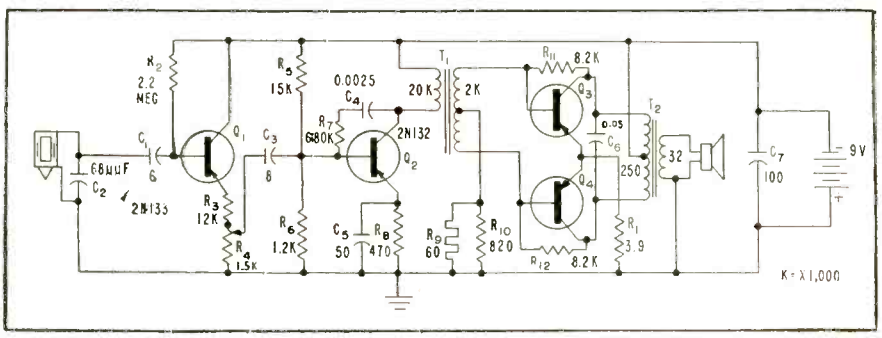
One-Third Watt Phonograph Amplifier

By W. A. McCarthy

Raytheon Mfg. Co.
Newton, Mass.

DESIGNED to be used in conjunction with a small phonograph motor, the combination of transistors and turntable make the record player highly portable. The motor is a 3-volt D'Arsonval type with a current drain of 20 ma. Speed control is attained by series rheostat, feeding from a 4.5-volt battery supply.

The amplifier is operated from a 9-volt supply and has an undistorted power output of 333 milliwatts with an overall power gain of 62 db. It uses four Raytheon *pnp* fusion alloy junction transistors. A high impedance, low-noise-input stage uses



Circuit diagram of the low-power phonograph amplifier

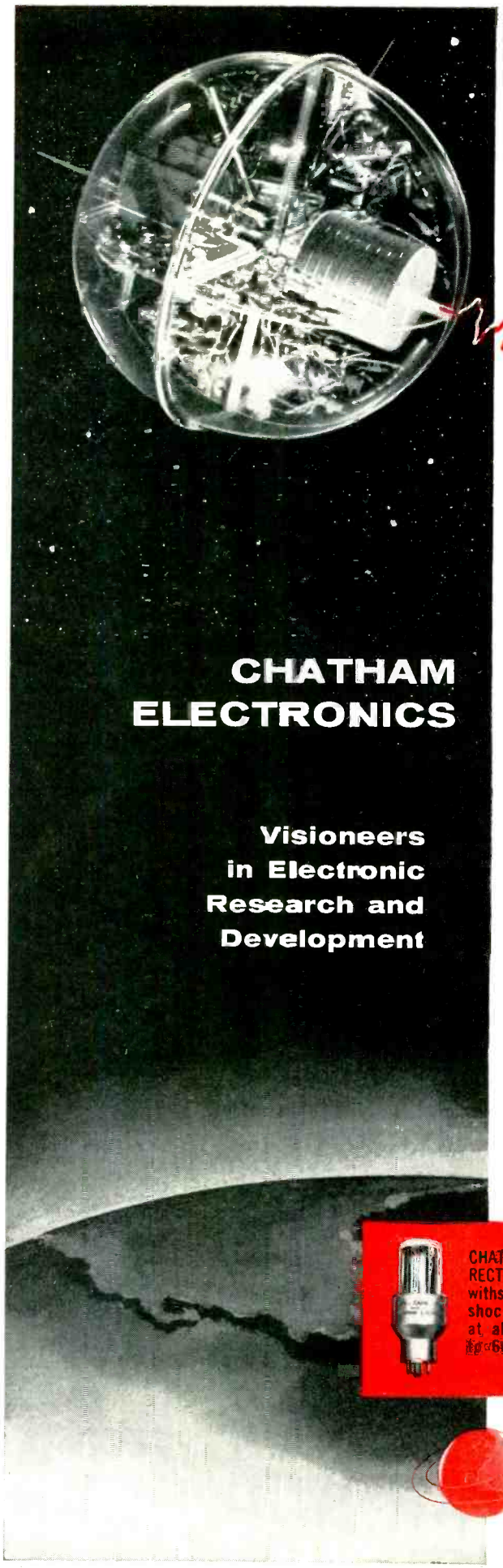


Photo courtesy of Popular Science Publishing Co.

"Echo from Eternity!"

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Visioneers in Electronic Research and Development

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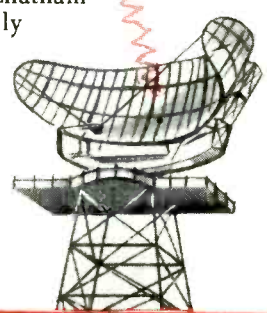
...*CREATING* electronic equipment and components that anticipate and exceed the varied and rigorous requirements of industry, science and the Armed Forces

...*TRANSLATING* these designs into manufactured products of outstanding dependability

...*ANTICIPATING* problems to meet the challenge of the future. These are the functions, and the accomplishments...the every day work of Chatham Electronics—where progress is soundly based on the theory that vision is the foremost factor in research.

Why not consult Chatham on your requirements today? Work on your special problem may be under way as a routine research assignment at Chatham, now!



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CHATHAM'S LIGHTWEIGHT AIRCRAFT CONVERTER —solves space and weight problems

CHATHAM BATTERY-LESS RADIAC DETECTOR CHARGER —an extremely compact design

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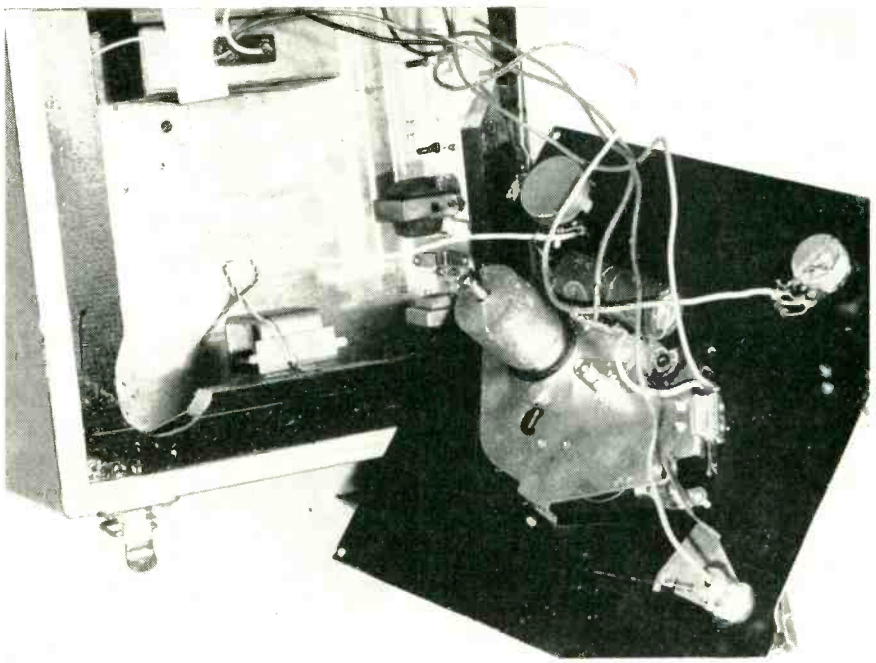


Underside of phonograph shows battery operated motor

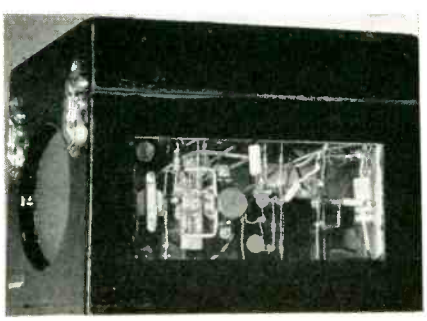
a 2N133, the driver uses a 2N132, and the push-pull output uses a matched pair of CK751A's.

As shown in the circuit diagram the first stage is grounded collector with an input impedance of approximately 500,000 ohms. A transformer having an equivalent input impedance would be prohibitive from a size and economy standpoint. This high-input impedance is necessary to accommodate a ceramic pickup.

▶ **Volume Control**—The input of the second stage is taken from the volume control, R_1, which is, in part, the load of the first stage. Resistors R_3 and R_4 make up the first stage load. But R_3 is a smaller part of the total. This arrangement is necessary to retain high-input impedance. Coupling in this fashion has a much lower gain than transformer coupling but this is made good by the improved frequency response and the lower cost of the elements. The second stage is a class-A, common-emitter driver with negative feedback from collector to base to improve harmonic distortion. This stage is transformer-coupled to the bases of the push-pull output stage. The output stage is common-emitter, push-pull biased slightly class AB for stability and reduced distortion. Total amplifier gain is 62 db. The first stage provides only 3 db of power gain to the amplifier since the input of the second stage is tapped down on the load R_3 and R_4. The driver stage offers an overall power gain of 39 db. This includes about 3 db of negative feedback between collector and base. The output stage delivers 20 db of undistorted power gain to the speaker.

▶ **Stabilization**—Since all of the load (R_3 and R_4) is in the emitter of the first stage and is large, there is no chance of thermal runaway. The driver is current stabilized using a bleeder on the base, R_5 and R_6 and a bypassed emitter resistor R_7. The stability factor for this stage is close to 3. That is, a change in I_{co} to 10 μa will only change I_c by 30 μa or in this stage, 2 percent of the idling current.

Under normal conditions these



Demonstration model has plastic window in side to show audio circuits

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in

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RMC's modern research laboratory is manned by skilled technicians who are continuously at work improving the ceramic dielectrics used in DISCAPS. Increasing leadership in the field of ceramic disc capacitors is due to this continuing research program and improved manufacturing methods.

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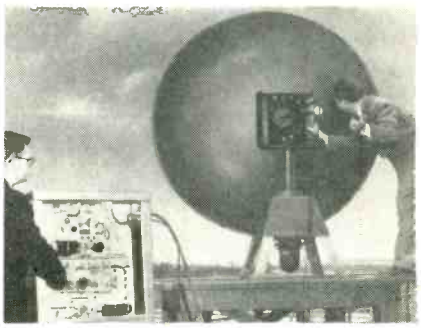
resistance values are adequate without too much battery drain. The output stage uses a combination of current and voltage stabilization plus thermistor action on the base. Resistors R_{11} and R_{12} tend to have a slight voltage stability effect while they also give current stabilization because of R_9 and R_{13}. However, R_9

Prototype transistor phonograph

the thermistor is most effective in keeping the stability factor at a minimum.

The amplifier has an undistorted (10 percent) power output of one-third watt. It has a battery drain of 8 ma with no signal and 72 ma at 333 milliwatts. It is capable of delivering 400 milliwatts of power with only 15 percent harmonic distortion. Using a normal level input signal and a decrease in supply volt-

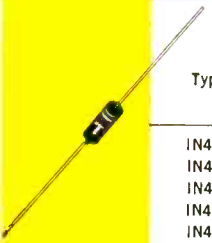
Color TV Relay



Microwave relay system operating at 2 kmc diplexes picture and sound. Frequency control is derived from oven-type crystal unit that eliminates need for long warmup. System developed by GE weighs less than 200 pounds.

Transitron

SILICON DIODES



HIGH CONDUCTANCE

RATINGS AT 150° C

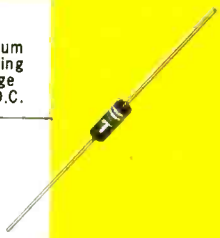
Type	Maximum Average Forward Current ma	Continuous Inverse Operating Voltage Volts D.C.	Minimum Saturation Voltage Volts
IN484B	50	130	150
IN486A	50	225	250
IN488A	50	380	420
IN457	25	60	70
IN458	25	120	135
IN459	25	180	180

HIGH FREQUENCY

SPECIFICATIONS AT 125° C

Type	Forward Current At + 1 V ma	Inverse Current At Specified Voltage ua at Volts	Maximum Operating Voltage Volts D.C.
IN252	10	10 @ - 5	20
IN251	5	10 @ - 10	30
S9G	2	10 @ - 20	40

Typical Shunt Capacitance: 0.8 uufd
Typical Pulse Recovery time: 0.15 usec
Operating Frequency Range: 0-1000 mc

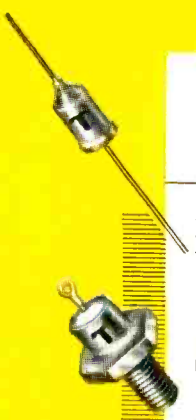


Write for Bulletin TE-1350

THE PROVEN PERFORMANCE of Transitron's silicon rectifiers and diodes has led to their widespread use in critical high temperature applications. The large number of types available allows optimum design for any given circuit.

For low level power supply or magnetic amplifier service, the subminiature diodes or miniature rectifiers are recommended. For higher power requirements, the stud-mounted rectifiers provide up to 30 KW.

SILICON RECTIFIERS

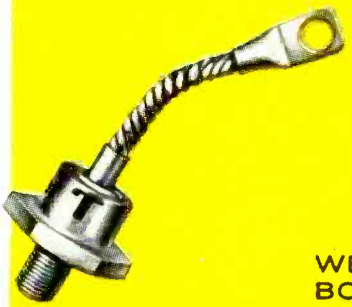


UP TO 35 AMPS AT 150°C

RATINGS AT 150° C

	Maximum Average Forward Current Amps	Peak Recurrent inverse Voltage Volts	RMS Inverse Voltage Volts
Miniature (Pig Tail Leads)			
TJ10A	0.2	100	70
TJ20A	0.2	200	140
TJ40A	0.2	400	280
Military Types			
IN253*	1.0	100	70
IN254*	0.4	200	140
IN255*	0.4	400	280
IN256*	0.2	600	420
Medium Power Types			
IN249A	20	100	70
IN250A	20	200	140
TR352	20	350	250
High Power Types			
IN412A	35	100	70
IN413A	35	200	140
TT352	35	350	250

* JAN types Rated at 135° C



WESCON SHOW
BOOTH 903

Write for Bulletin TE-1351

Transitron

electronic corporation · **melrose 76, massachusetts**

Germanium Diodes · Transistors · Silicon Diodes · Silicon Rectifiers

age from 9 volts to 5.5 volts, the output is reduced to 165 milliwatts and distortion is 15 percent.

If the motor is powered from 3 D cells, or equivalent, the service life of the batteries will be approximately 260 hours. The amplifier, when powered from 6 D cells, or equivalent, will give 175 hours of service. When both motor and amplifier are powered from the same supply, the service life of the batteries is about 110 hours.

The amplifier has an overall signal to noise ratio of 75 db, using a low-noise 2N133 in the first stage. The frequency response of the amplifier is 3 db down at 70 cps and 3,500 cps. The high-frequency portion of the response curve has been intentionally reduced to provide equalization from the record to the output.

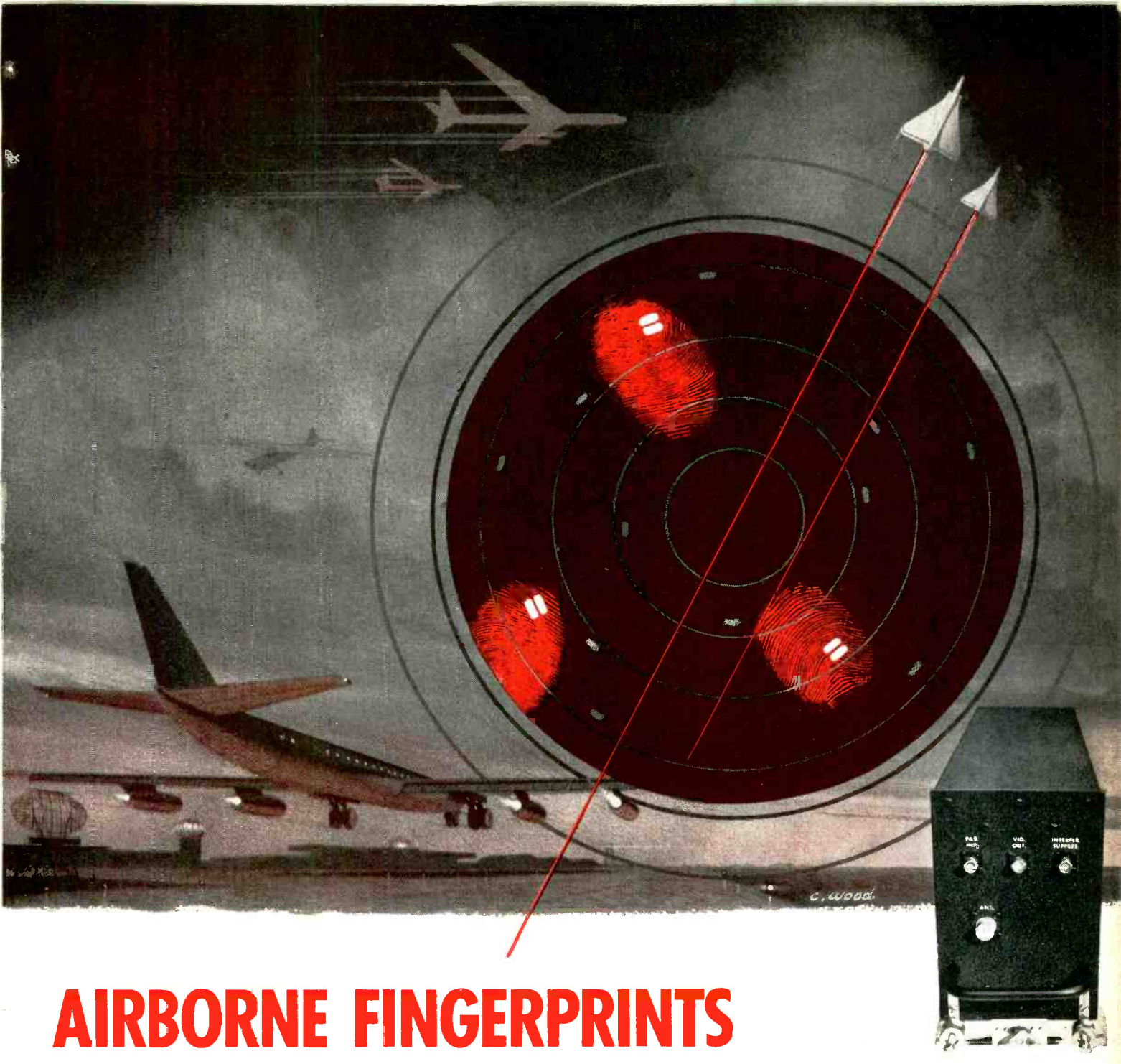
Grainless Coating for CRT Screen

CONVENTIONAL cathode-ray tube screens consist of powder phosphor settled on a surface of glass or other material. Incident light will be scattered from particle to particle, giving diffuse background illumination. If the phosphor is deposited as a uniform, grainless, layer instead of powder, the diffuse scattering is absent and higher contrast and resolution are possible.

Superimposed layers of this kind, with an appropriate activator in each layer, may have application in color television using a system in which penetration is controlled by the voltage of the cathode-ray beam. Continuous sheets of phosphor should give considerably better color separation than layers of granular powder.

Such a continuous-layer phosphor screen also has advantages in applications which depend upon the response of a phosphor to an impressed electrical field, as in the case of the electroluminescent cell. Continuous, uniform thickness layers of material on which electrodes can be deposited make possible uniform fields over large areas.

For a zinc sulfide screen, the basic process is to bring together, at the surface to be coated, an at-



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Now, the new Stewart-Warner Electronics Airborne Safety Beacon makes it possible for every plane in the air to carry identification as positive as your own fingerprints. Stewart-Warner Electronics, the pioneer and builder of the first airborne safety beacons, which were tested by the Air Navigation Development Board and CAA, now offers airline and other aircraft owners automatic identification for greater air traffic safety.

The new beacon combines all the reliability and long-life factors of airborne military equipment supplied by Stewart-Warner Electronics to the services since 1942. This rugged equipment incorporates ARINC tubes and is designed to meet specifically characteristics No. 532-A.

CAA is now planning to install interrogators on ASR radar at all major air terminals to improve air safety. Be sure you take advantage of this program by installing an S-W Electronics Air Safety Beacon. Write today for full details from our Civil Aviation Department 21. Stewart-Warner Electronics, 1300 North Kostner Avenue, Chicago 51, Illinois.

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a Division of Stewart-Warner Corporation

mosphere of hydrogen sulfide and the vapors of zinc or zinc salts, along with an activator.

The glass plate to be coated is supported in a quartz container at a temperature of 400 C to 700 C as shown in the diagram.

The layer of zinc sulfide produced in this way is durable and so firmly bonded to the glass that it can be put through the same polishing operations as the glass itself. The screens will stand temperatures as high as 600 C in a dry atmosphere with essentially no damage.

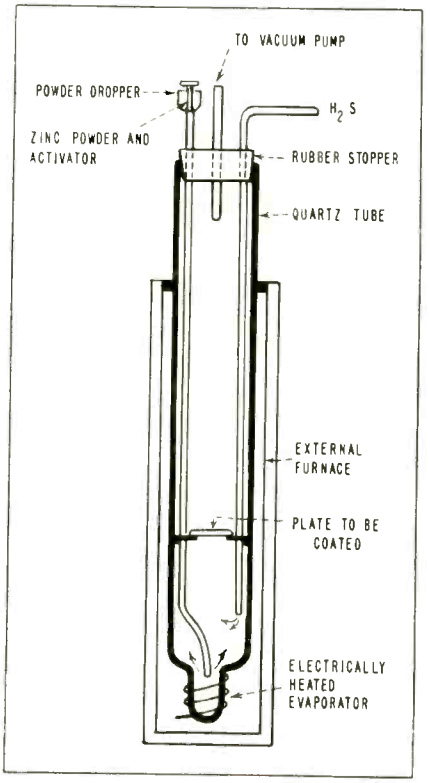


FIG. 1—System for producing grain-free coating on cathode-ray tube screen

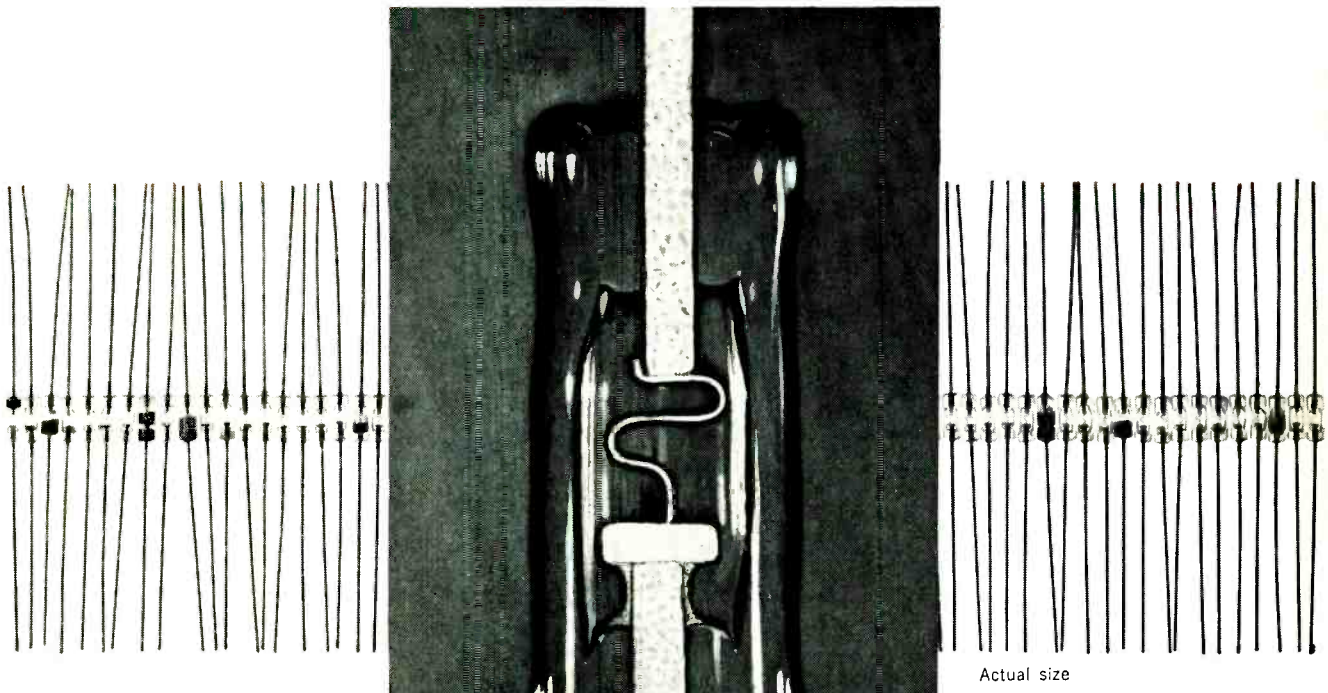
The above information has been abstracted from an article entitled "Grainless Phosphor Screens for TV Tubes and a Light Amplifier" by Frank J. Studer, Jour. SMPTE, April 1956 issue.

Transistorized Magnetic-Core Memory

TRANSISTORS are under investigation to determine their suitability for use in a large coincident-current magnetic core-memory circuits.

Experience to date indicates that

Close-up of a diode



Actual size

Cross section of a Hughes germanium diode photographed at 18 diameters to show structural detail.

Inside, where it counts, a Hughes germanium diode is rigid, sturdy—well able to stand up under conditions of severe shock and vibration. With a microscope, you can see why clearly...the germanium crystal permanently bonded to one lead . . . the whisker firmly welded to the second lead . . . the point of the whisker welded to the crystal . . . the fusion-sealed glass envelope. Such positive mechanical stability (basic to every Hughes diode type) is vital to the achievement of electrical stability—and reliability. Hughes diodes are manufactured, first of all, for reliability. So specify Hughes, and be *sure* of successful application to your electronics and communications equipment.

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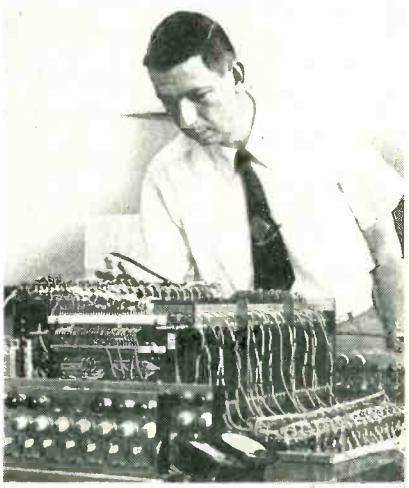
a transistor driven memory of this kind is entirely feasible.

A block diagram of the memory system, developed by Bell Telephone Laboratories, is shown in Fig. 1. It includes the storage array, magnetic-core switches for selecting the desired memory locations, and transistor amplifiers.

Drive amplifiers provide currents for switching the magnetic cores and read amplifiers amplify the signal obtained from a switched core to a level which can drive circuits associated with the memory.

▶ **Drive Amplifiers**—Three drive amplifier designs, known as the digit-inhibit, selection-switch set, and memory-drive, are employed in the system. To switch memory cores, a drive of 320 milliampere-turns lasting four μsec is required. The memory is operated with coincident currents applied to single



Transistorized memory uses 98 low-level and 62 high-level transistors to store 1,024 eighteen-bit numbers

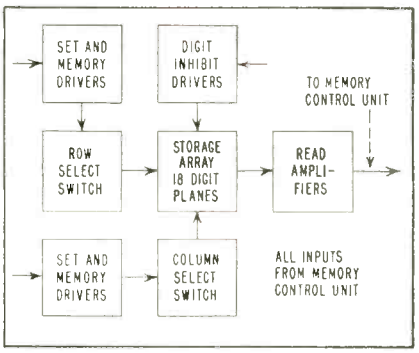
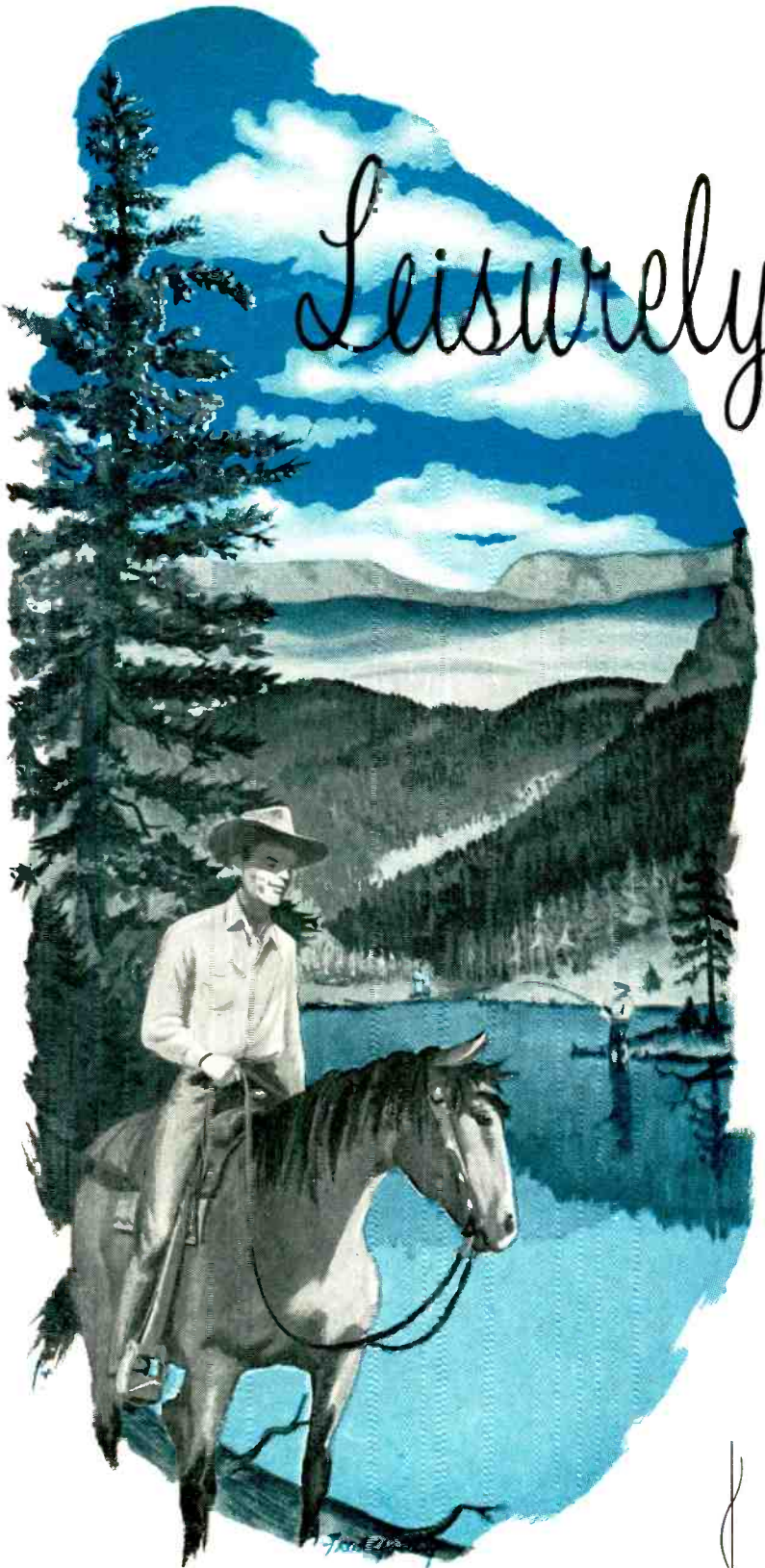


FIG. 1—Block diagram of memory system



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turn windings on the memory cores. Therefore, the digit-inhibit and memory-drive amplifiers must provide current pulses of about 160 ma lasting at least four μsec. The cores in the magnetic selector switch have multiturn windings. The selection switch set amplifier must provide current pulses of about 70 ma lasting for five μsec.

A schematic of the digit-inhibit amplifier is shown in Fig. 2. Two junction transistors, one a low-level (Q_1) and the other a high-level unit (Q_2), are employed. Normally Q_1 is conducting, so that its collector is near ground potential. Thus Q_2 is cutoff and no current flows through the magnetic-core load. When a

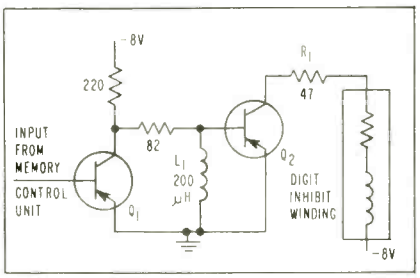


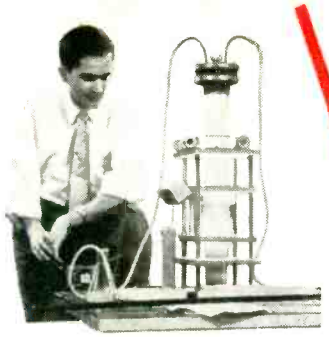
FIG. 2—Digit-inhibit amplifier

digit-inhibit signal is received, Q_1 is cutoff and its collector starts towards −8v. This carries the base of the output transistor negative and it starts to conduct. Collector current quickly reaches a value set

Electronic Plotter

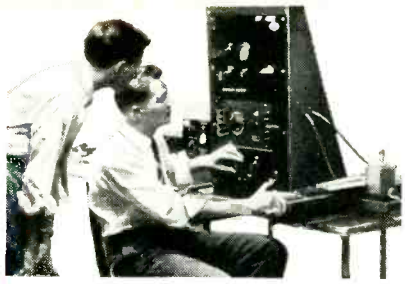
Special cathode-ray display facility is basically a plan-position indicator for a trace-while-scan surveillance radar system. Developed by American Machine and Foundry Co. for the Signal Corps, the unit is necessitated by speeds of modern aircraft

New Production Facilities for Tung-Sol Semiconductors



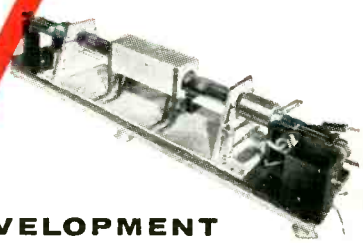
RESEARCH

Solid state devices for not-so-distant future applications command continuous study by Tung-Sol engineers. In this instance the purifying of silicon is under close scrutiny.



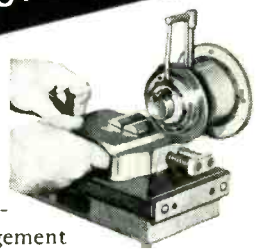
DESIGN

Efficiency and utility are among the foremost considerations of all Tung-Sol semiconductor blue-printing. Here the resistivity of single germanium crystals is being measured.



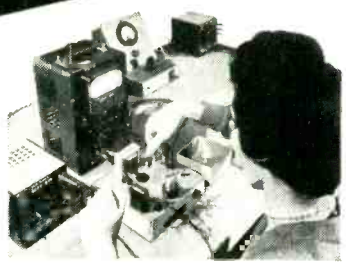
DEVELOPMENT

Ever alert to the intensified and varied demands made by transistorizing, Tung-Sol provides full-scale development of new semiconductor types. Here the latest techniques of germanium diffusion are explored.



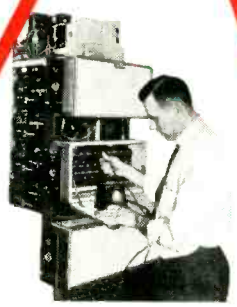
PRODUCTION

A complete manufacturing division—with its own full-time engineering and management staffs—handles every phase of the critical production process from metal refining to finished product. Here germanium ingots are being sliced into 15/1000" blanks.



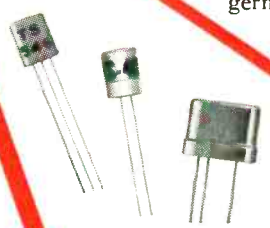
TESTING

100% testing—life, mechanical and electrical—characterizes the Tung-Sol manufacturing program. In this illustration, transistors are 100% checked for noise factor.



QUALITY CONTROL

Every step of Tung-Sol semiconductor manufacture is subjected to intensive quality control that permits no compromise with premium quality. Here transistors are life-tested under conditions in excess of their ratings.



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by limiting resistor R_1. At the end of the digit-inhibit signal Q_1 starts to conduct bringing its collector near ground and turning off Q_2. Current through L_1 is forced into the base of Q_2, resulting in very rapid switching.

The selection-switch set amplifier is quite similar to Fig. 2 except that R_1 is 330 ohms and the applied voltage at the selection-switch set winding is −20v.

The memory-drive amplifier, very similar in general arrangement to Fig. 2, supplies the current which resets the selection switch and flows through the selected address

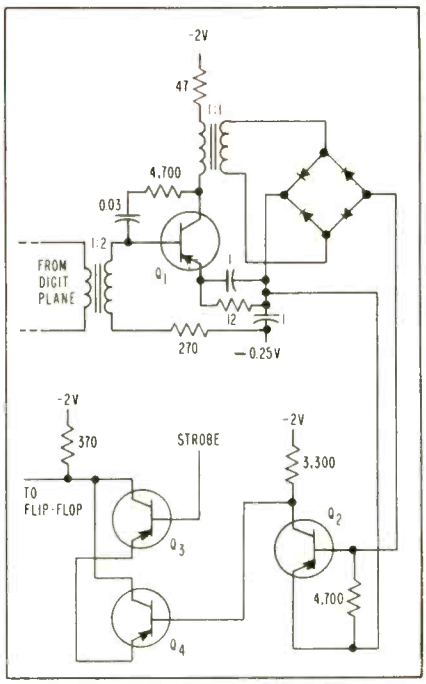

FIG. 3—Circuit of read amplifier

of the memory. The required 200-ma pulses are obtained from a circuit where the collector supply voltage is −20v and R_1 is about 70 ohms.

▶**Read Amplifier**—The read amplifier accepts the output of a digit plane and develops an output which can control a base current of about 1 ma in a memory control unit transistor. The digit plane output may be either a positive or negative pulse, making a polarity-reversing scheme necessary to obtain the same output polarity regardless of input pulse polarity. This can be

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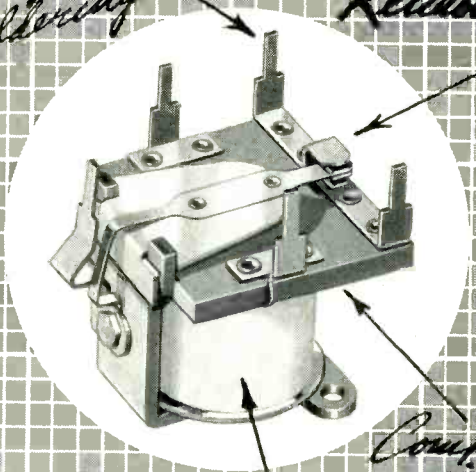

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While not yet in production, extra-sensitive version has been developed. Maximum coil resistance 18,000 ohms, nominal sensitivity .030 watt, maximum sensitivity .020 watt, overall height 1-9/16". All other details same as standard MS relay.

Application—Type MS is an ideal relay for any application requiring a compact, highly reliable single pole D. C. device, where a low cost solution is required because of volume usage and competitive problems.

The fact that industry has already used over a million units of this design is your assurance that the R-B-M Type MS relay will meet your most exacting requirements.

Contacts used in Type MS are of the cross bar type, which offer the ultimate in reliability throughout the life of the relay. Molded bobbin design has eliminated coil failure on sensitive applications under severe climatic conditions.

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Contact Form	S. P. D. T.
Contact Rating	1 amp. 32 V.D.C. non-inductive
Coil Resistance	Up to 10,000 ohms
Nominal Sensitivity (Coil Input)	.060 Watt
Maximum Sensitivity	.040 Watt
Approx. Dimensions	1⅛ x 1 1/16 x 1 1/32"

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done by the circuit shown in Fig. 3.

Transistor Q_1 is biased so that it amplifies both positive and negative pulses. These pulses are fed to a full-wave bridge rectifier so that each input pulse to the bridge produces an output pulse which is further amplified by Q_2.

Output of the read amplifier is combined with an accurately-timed strobe signal in a gate circuit. For the output voltage to change, both Q_3 and Q_4 must be cutoff simultaneously. This occurs when the output of the read amplifier is a 1 at the same time that the strobe signal is applied.

The complete developmental magnetic core memory can store 1,024 eighteen-bit numbers. To accomplish this, 18,432 memory cores and 48 switch cores are employed. Transistor complement includes 98 low-level and 62 high-level units. Total power consumption is less than 50 watts.

Transmitting Tube Manual

COMPANION volume to the well-known receiving tube manual is a new one entitled "RCA Transmitting Tubes—Up To 4 Kw Plate Input". Besides the specific tube data of use to engineers, technicians and amateurs, there are some 80 pages of technical background material, starting with power tube fundamentals.

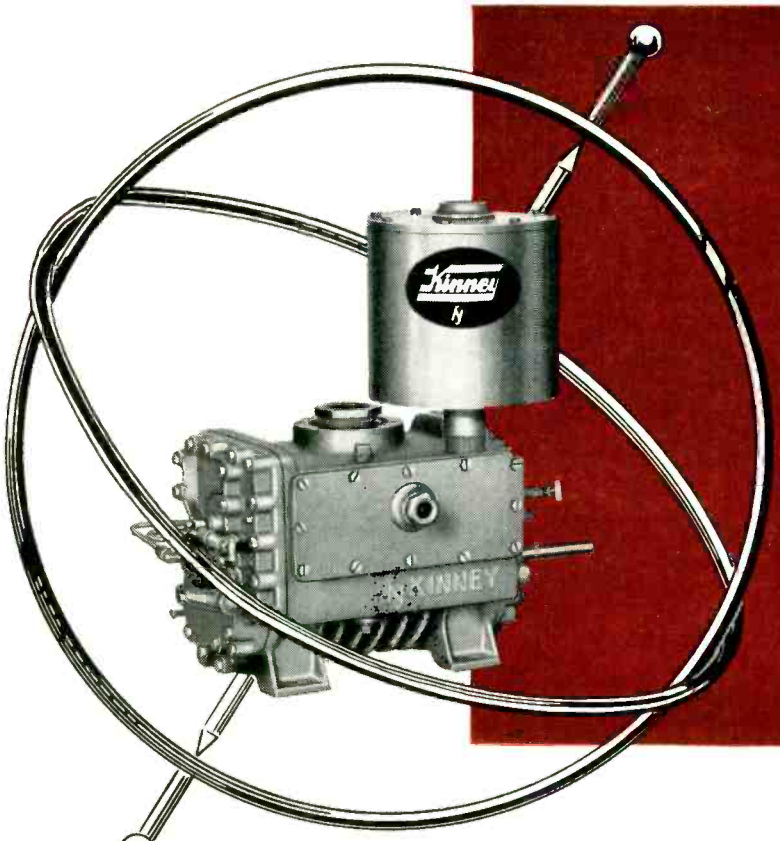
Typical transmitter circuits are given at the end of the data section. Technical Manual TT-4, priced at a dollar, is published by the tube division, RCA, in Harrison, N. J.

Stabilizing V-R Tubes

By ROBERT B. TOMER
Danvers, Mass.

THE TYPICAL glow-discharge, voltage-regulator tube illustrated has a center anode rod surrounded by a cylindrical cathode. The structure is enclosed in a glass container, which has been evacuated and filled with a critical pressure of inert gases.

When a potential of sufficient magnitude is placed across the



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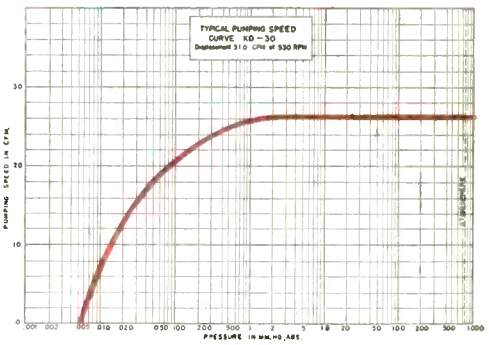

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Free Air Displacement	30.4 CFM
Free Air Displacement	14.4 Liters/sec.
RPM	525
Motor H.P.	1½
Motor RPM	1800
Oil Capacity	2½ qts.
Cooling	Air
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Outlet Connection	1¼" screwed
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anode and cathode, a glow appears on the inside surface of the cylinder. This glow area is usually irregular in shape, but will increase and decrease as the current through the tube is varied.

If the current is allowed to decrease below a certain minimum value, the glow area will disappear. Likewise, if the current is increased sufficiently, this glow area will cover the entire inner surface of the cylinder.

It has been learned that almost the entire drop in voltage, within the tube, takes place immediately in the vicinity of the glow area. Glow area is proportional to the current flowing through the tube, within the limits of what is called the normal operating range of the regulator tube.

Within this normal operating range, the resistance, or tube drop, varies inversely with the applied voltage. This has the effect of compensating for variations in load current and provides voltage regulation for the system across which this tube is placed. A typical regulated power supply, using a glow discharge, voltage-regulator tube as a reference source is shown in Fig. 1.

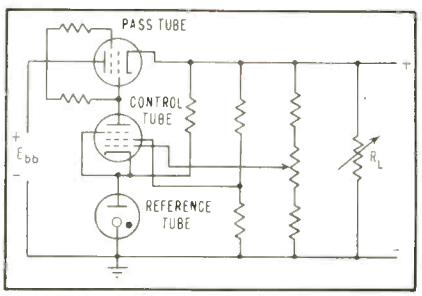

FIG. 1—Typical series-tube voltage regulator

Two forms of instability may result from this arrangement when using conventional voltage-regulator tubes. The first is instability in voltage output of the system when it is alternately cycled on and off many times. The magnitude of the voltage shift will vary with circuit parameters and with individual voltage-regulator tubes. It can assume fairly large values as the voltage across the v-r tube

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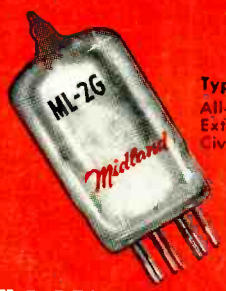

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may vary as much as three or four percent in extreme cases.

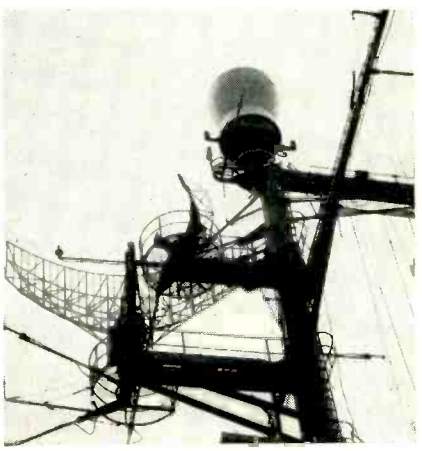
The second form of instability will be observed when the system is operating in a steady-state condition and the output jumps suddenly in discrete increments of several volts; again, the exact amount is a function of circuit values and individual voltage-regulator tubes.

Aging and selection provide only an immediate and temporary solution to the problem. To understand the nature of the solution that has been developed, it is necessary to go into the method by which these tubes regulate voltage and study their behavior more closely.

Voltage drop across the tube is a function of the glow area within the cathode cylinder. As this glowing goes on, there is a continual change taking place on the surface of the metal directly beneath the glowing area. It is not known precisely what this action is; however, it is believed that ions of the inert gas enter into a reaction with the nickel atoms on the surface of the cathode and alter their work function.

Gas ions moving under the force of the field that exists between the anode and cathode cause changes in the energy level of electrons in the outer orbits of the nickel atoms such that they are raised to the necessary level to become free

Modern Barrel Man



Communications antennas and radar structures of the *U. S. S. Saratoga* supplant the old-time crow's nest lookout as eyes for the Navy. Topmost structure is housing for Tacan navigational antenna, a development of IT&T division

NEW 10 STAGE 3/4" multiplier phototube

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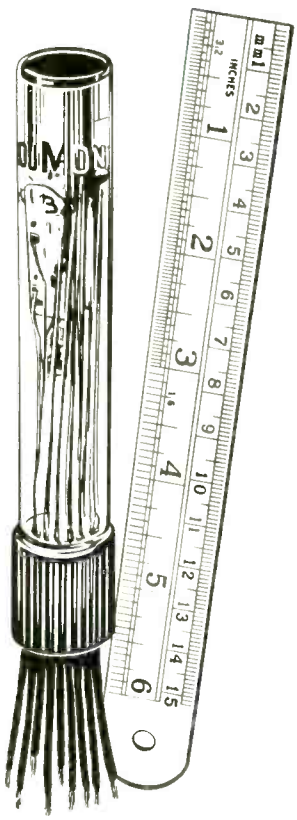

DU MONT Type K1382

In the new Type K1382, Du Mont offers the first ¾" multiplier phototube with the ruggedness of field equipment combined with the performance of a laboratory tube.

The average gain of the Type K1382 of 300,000 at 105 volts/stage exceeds that of many laboratory tubes, with no sacrifice in long-term stability for which Du Mont multiplier phototubes are noted.

In addition to its small size and superb operating characteristics, the Type K1382 is unusually rugged. This tube has been designed for the roughest service under the worst climatic conditions. The tube base is potted and all leads jacketed to permit operation under severest humidity without leakage between leads. **Laboratory performance** can be obtained from this tube even when it is being dropped as a probe into a drill hole far underground.

As in other Du Mont multiplier phototubes, the linear box-type dynode structure is used. This means optimum electron collection greatly improving signal-to-noise ratio. Also, long leakage paths minimize noise and dark current. Dark current is only 0.1 ua at 105 v/stage and 25°C.

The small size and excellent performance of the new Type 1382 mean an extra bonus to users in the geological surveying field where, for example, its extra gain permits much longer signal transmission from underground locations before signal level becomes too low to be useful. It should be exceptionally useful in medical physiological probing. Batteries of these tubes may be used for speedier diagnostic procedure. In addition, the small size will help greatly in the miniature and portable designs that can function at least as well as laboratory equipment.

CONDENSED SPECIFICATIONS

Average gain:	300,000 at 105 v/stage
Maximum dark current:	0.1 ua max. at 105 v/stage and 25°C
Photocathode sensitivity:	40 ua/ lumen
Average anode sensitivity:	12 a/lumen
Maximum outside diameter:	no greater than ¾"
Physical Characteristics:	potted base, jacketed leads

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electrons and enter into the current flowing within the tube. This continuing action actually erodes the surface of the nickel cathode.

For some reason, not fully explained, the ease with which these electrons are raised to the levels necessary to give them freedom alters in certain discrete areas and a condition of instability exists that causes a portion of the glow area to jump to a new place on the nickel surface. Occasionally, this is seen to be a bistable, repeatable phenomena and the glow area will jump back and forth between two discrete areas of the cathode.

When this happens, a sustained oscillation results. More often, the glow will jump to the new area and remain there for an indefinite period of time. The next time some portion of the glow area moves, it will be at another point entirely.

When the glow area moves in these discrete amounts, there is an accompanying shift in voltage drop across the tube, varying from a few tenths of a volt to several volts in

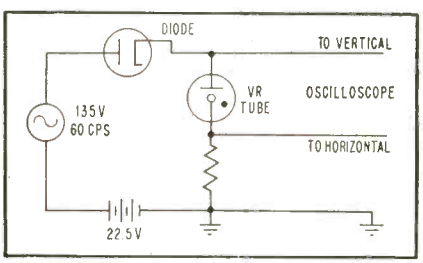

FIG. 2—Voltage-regulator tube curve tracer

magnitude. It is these jumps that cause changes in the output voltage of any system that is referenced to the voltage-regulator tube.

Figure 2 shows a simple test circuit for observing this characteristic in voltage regulator tubes by sweeping them at a sixty-cycle rate. The curves shown in the photograph represent the voltage appearing across the tube as it first rises, then drops abruptly as the tube starts to conduct, remains more or less stable as the current rises to maximum.

It then falls again to the minimum value and finally drops below the point where it will maintain ionization. Observing many dif-

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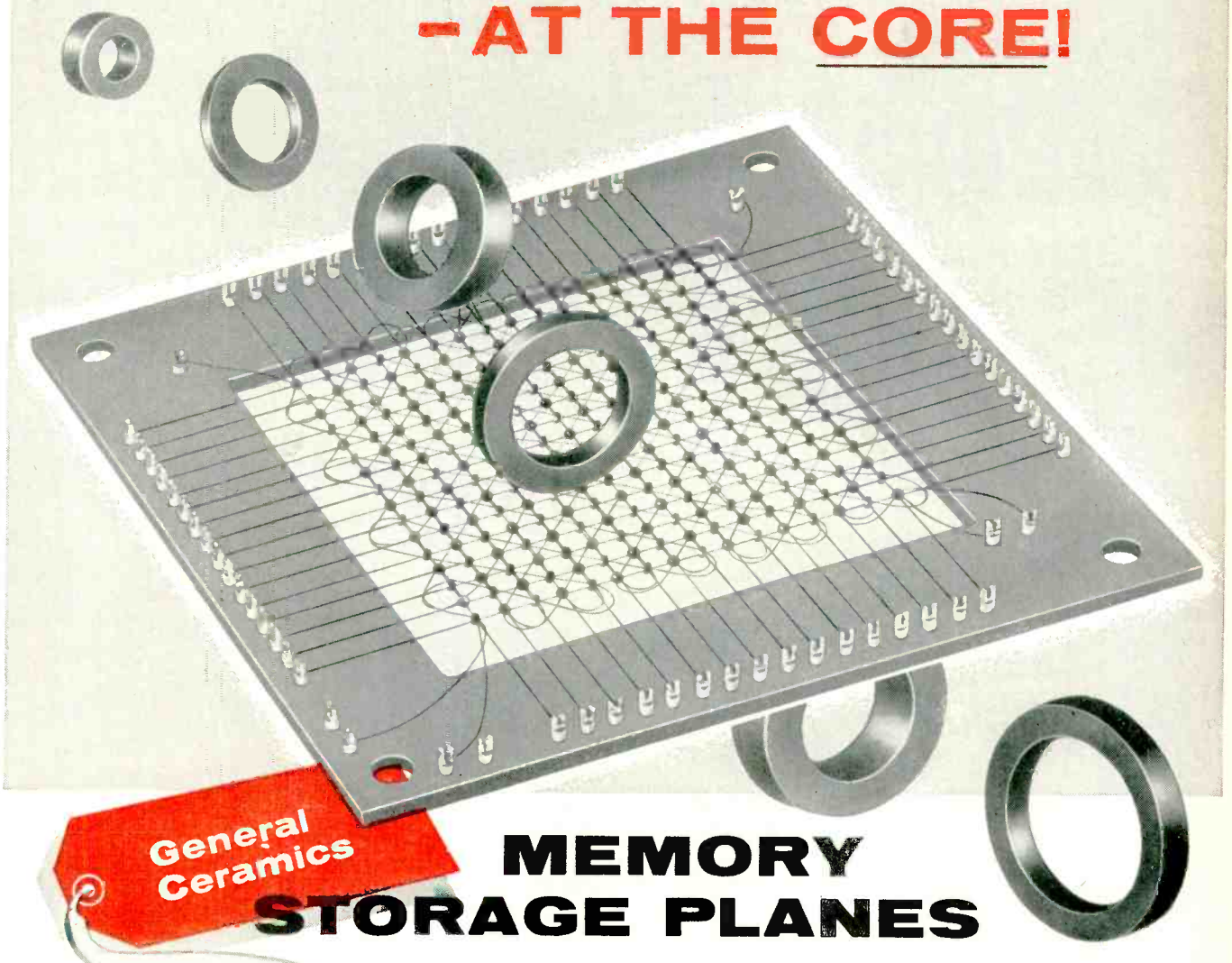

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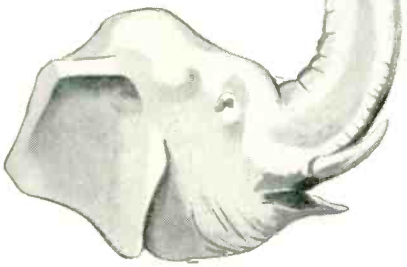

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ferent tubes in this circuit, it will be found that small breaks, or pips, occur at random intervals along the conduction portion of the curve. The pips in the lower curve of Fig. 3 represent sudden jumps in the glow area as it expands and contracts across the cathode surface as a result of the changing current through the tube. These are the points where the tube would have a negative-resistance characteristic.

These pips occur most frequently near the minimum current end of the regulation curve. Few occur near the maximum current end of the curve. Considering the manner in which these changes occur, it is logical that they should be most frequent when the minimum area of the cathode is covered by the glow area and least frequent when it is completely covered.

After the cathode area is covered by the glow, if additional voltage is placed across the tube, the glow area goes into a new mode known

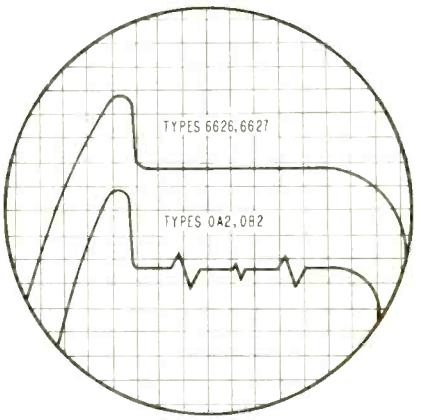

FIG. 3—Regulation curve (lower) shows sharp breaks that are eliminated (upper curve) in new dark-starting tubes

as the abnormal glow condition. The glow area does not now change on the surface of the cathode, but the glow does vary in brightness and density, or depth, extending outward from the cathode.

This abnormal glow mode has a constant voltage drop characteristic that depends upon the gas mixture and anode metal and can be used as a voltage regulating device. Because there is no unused surface area for the glow to choose from, the current can be swept across its operating range without any dis-

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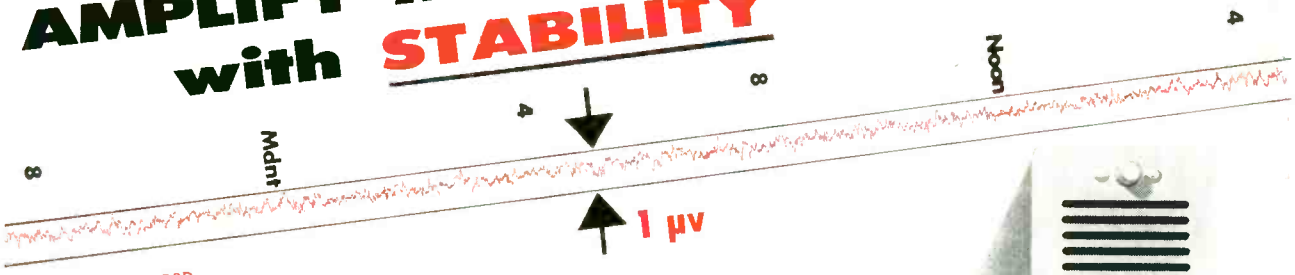

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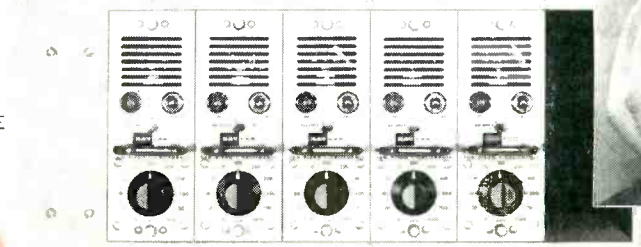

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The Model 111 is available in a single-unit cabinet or in a six-unit rack-mountable module. The amplifiers are extremely compact; the six-unit module occupies only a 19-inch rack width.

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

SPECIFICATIONS

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

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Rack Adaptor for 6 Units	19" wide, 8¾" high, 18¼" deep
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PRICE: Amplifier Unit	$550.00
19-inch Rack Adaptor for 6 amplifier (with fans and connectors)	200.00
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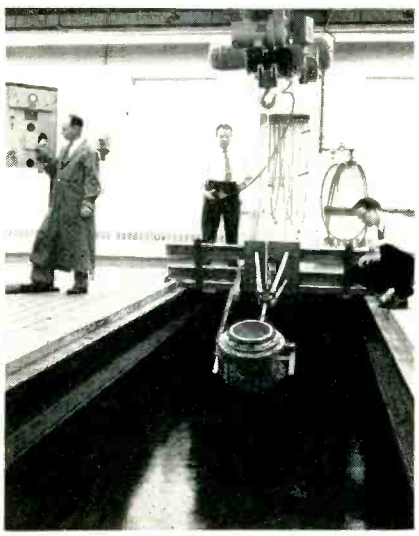
cernable jumps or breaks in the curve. It follows, of course, that repeat starting voltage and the steady state stability are likewise improved as shown in the upper curve of Fig. 3.

If ordinary voltage regulator tubes are stored for a few days, shielded from all radiation by means of a lead-lined, light-proof box, having at least ⅛ inch of lead surrounding the tube and if they are then tested for starting potential, without bringing them out of their radiation proof box, they will be found to be quite erratic and unreliable as to their starting voltage. Some may refuse to start at all. Others will require considerably more than their rated starting voltage to cause them to start.

Typical glow-discharge tube with center anode rod surrounded by cylindrical cathode

The mechanism for starting or firing v-r tubes, is a small probe

Testing Sonar Transducer



New type of sonar transducer employing barium titanate undergoes test in GE tank located at Syracuse, N. Y.

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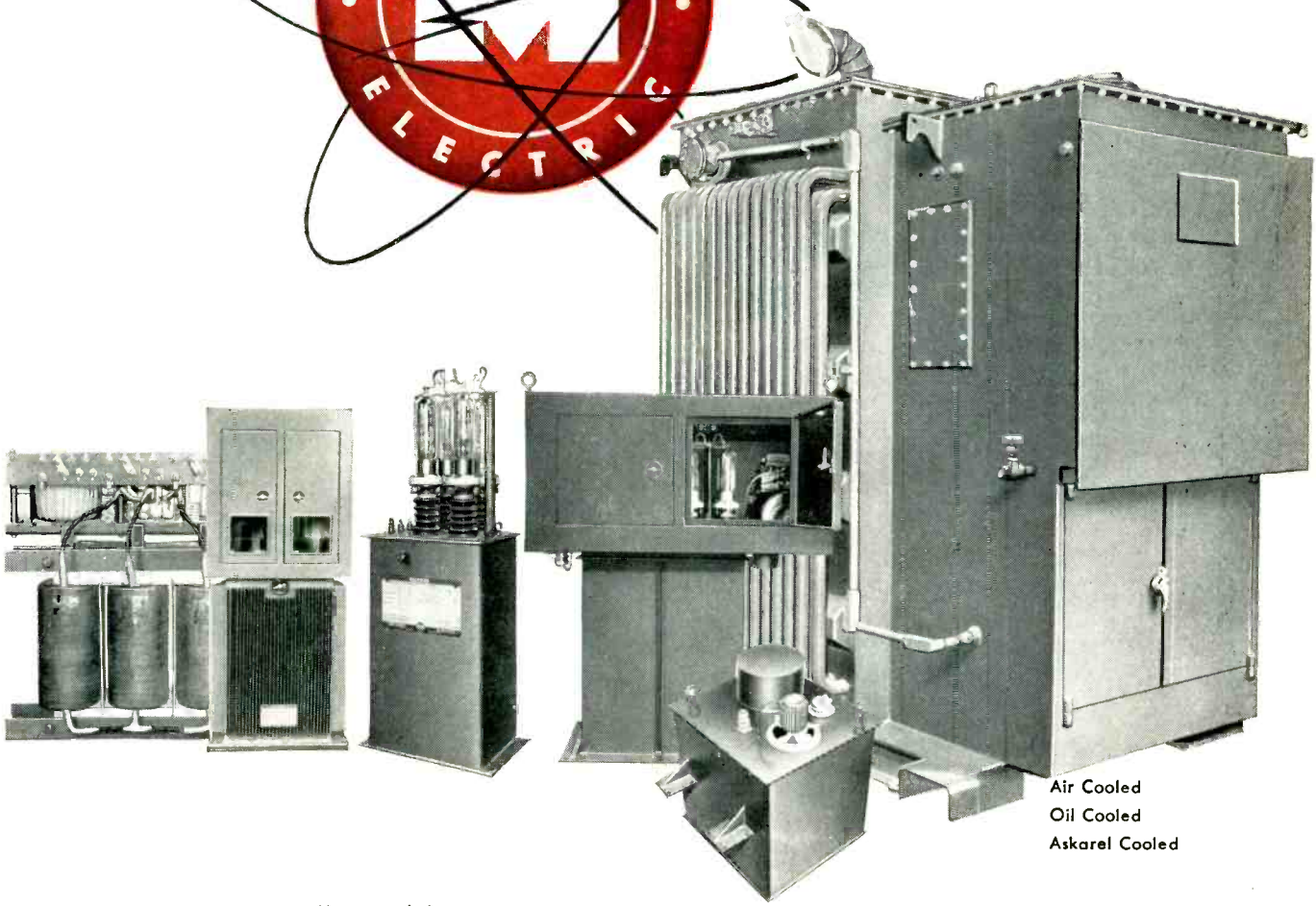

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or gap, which extends out from the anode to a point near the cathode surface. Electrostatic stress, concentrated at this point, is supposed to cause an initial atom to break down and form free electrons that then precipitate a chain reaction.

This results in the glow area spreading out over the cathode.

This reaction is greatly aided by the presence, in normal environments, of stray electrons, or particles of radiant energy, such as photons of light, cosmic rays, or rays from radioactive matter in the earth's crust. These stray particles enter the gap and appear to trigger the ionization process. When these particles are effectively shielded away from the tube, it then appears that ionization occurs only at much higher voltages and is considerably more erratic.

A small amount of radioactive nickel in the starting electrode supplies free electrons in the new tube. Two recently released types, the 6626 and 6627 and their military counterparts, the USN-OA2-WA and the USN-OB2WA, incorporate all of these improvements.

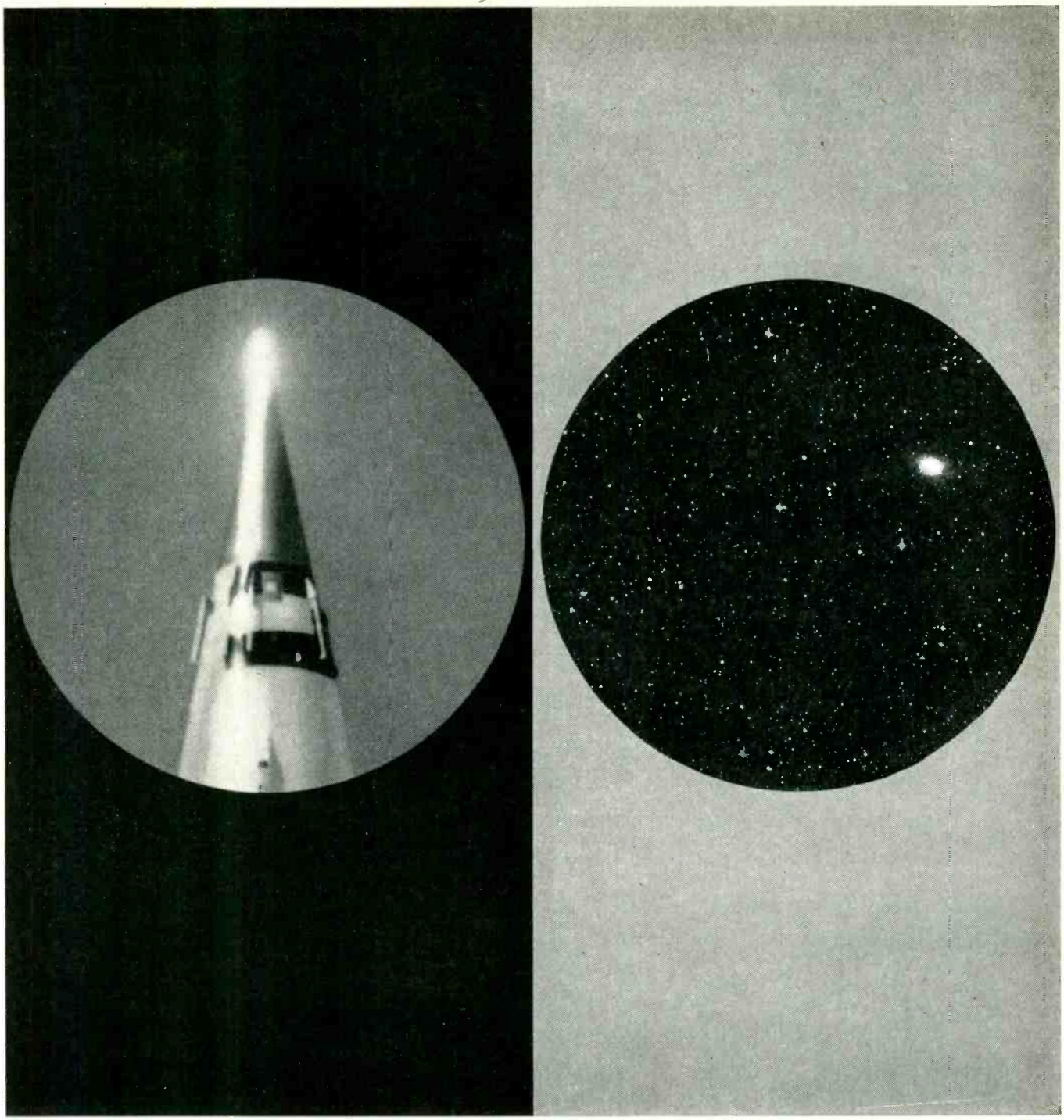
VFO With Near-Crystal Stability

By J. M. SHULMAN

Westinghouse Electric Corp.
Sunnyvale, Calif.

INSTABILITY in *LC* oscillators may be caused by temperature change, loading of the oscillator tube, voltage changes, mechanical shifting of components or intermodulation by self-generated harmonic components. If all these factors are taken into account, stability on the order shown in Fig. 1 can be obtained without specially designed components. This stability can be maintained for long periods of time if necessary by temperature control of the *LC* circuit.

Choice of circuit alone cannot guarantee a stable oscillator. Mechanical constancy of the *L* and *C* components must ultimately determine the stability of any *LC* oscillator. However, assuming a rigid



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and constant LC combination to begin with, the so-called Clapp oscillator[1] can be made highly insensitive to changes external to the LC circuit as compared with other oscillators.

A basic form of Clapp oscillator is shown in Fig. 2. The condition for oscillation can be expressed by the equation

$$\frac{\omega L_1}{Q_1} = g'_m X_2 X_3 \qquad (1)$$

where g'_m is the effective transconductance of the tube and X_2 X_3 the reactance of C_2 and C_3 respectively. Maximum stability with respect to changes caused by the tube occurs when the reactances X_2 and X_3 are as low as they can be made and still sustain oscillation. It is evident that to satisfy both the conditions for maximum stability and for oscillation, X_1 and X_2 can be made only as small as g'_m and the Q of the tuned circuit permit.

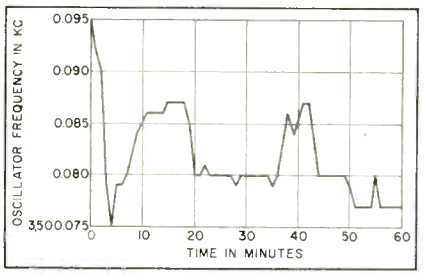

FIG. 1—Frequency stability of oscillator over one-hour period

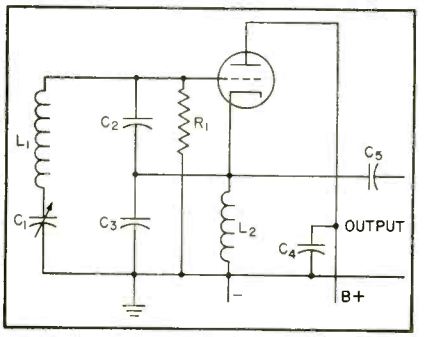

FIG. 2—Basic circuit of Clapp oscillator

However, any given combination of tube and tuned-circuit Q will give better stability in this circuit than in others where the tube is tapped across the entire tuned circuit.

In oscillators that are not linear in operation, frequency change caused by phase shift from the presence of harmonics is lowest

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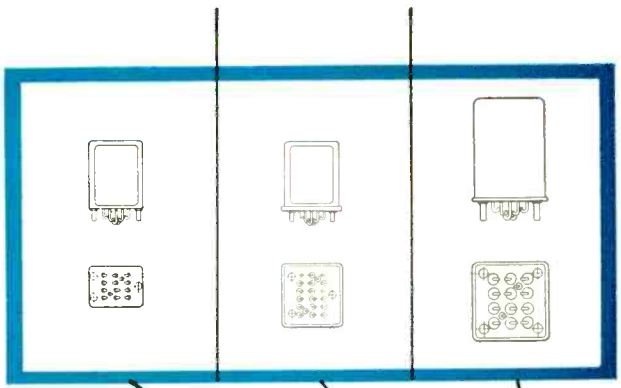

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when L_1 is made as large as possible. Since linearity of operation is a relative quantity and no oscillator operates entirely free from harmonics, the inductance for a stable oscillator should have both high Q and high L. Coil Q increases with diameter and with length. Increase with length is rapid when the ratio l/d is small and slow when the ratio is large.

Since the entire tuned circuit must be fully shielded in a practical oscillator, the shield space is likely to be the determining factor of the coil dimensions and Q. To preserve high Q with a shield, it should be clear of the coil by at least a coil diameter in all directions.

If L is made as large as possible for a given frequency of operation, the variation in L as a function of temperature will likewise be large. This factor alone can cause more drift in frequency if the coil is placed near the tube or any other source of heat than all the other causes of instability together.

Hence it is important that the tuned circuit and its shield be physically isolated from the tube or any other heat source. The Clapp oscillator is particularly well suited to accomplishing this. Because the tube coupling impedances are low, the tuned circuit can be physically isolated from the tube by any desired distance, and the connections between the two made by coaxial cables.

From Eq. 1 the best tube to use for a stable oscillator is one which will give highest g'_m under the operating conditions. In the choice of tube lies the prospect of getting the reactances X_2 and X_3 down to an absolute minimum.

Frequency change is proportional to the changes in interelectrode capacitances of the tube.[2,3] Most tubes which have high g_m also have relatively high input and output capacitances; hence the best tube overall is the one with the lowest ratios of these capacitances to g_m. However, if X_2 and X_3 are made very small, the tube capacitances have so little effect that the advantage of using the highest possible value of g_m tends to offset the dis-

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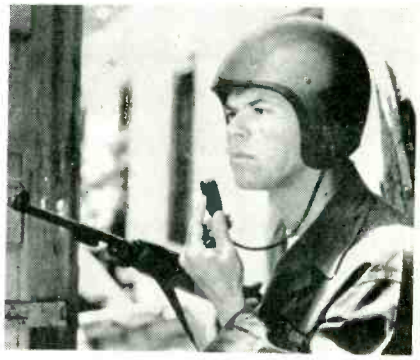
advantage of higher values of tube capacitances.

Of the standard tube types, the 6AC7, 6AG7, 6CL6 and 12BY7 pentodes are typical of those having the highest rated values of transconductance in class-A amplifier operation. At zero grid bias the transconductance is higher but the screen grid and plate dissipation exceed safe ratings.

By reducing screen grid voltage it is possible to operate these tubes at zero bias without exceeding the dissipation ratings. Under these conditions, the 6AC7 operating with lower plate and screen currents than the other tubes can give an operating transconductance of

Talking Hat Combat Radio



A forward scout can quickly remove the thumb-sized microphone from under the helmet and report back to his squad by radio. The equipment above and below has been developed by Signal Corps Engineering Labs. Range of the equipment is normally about a mile. It uses transistors

Weighing less than a pound and about the size of playing cards, the two units shown snap into a special plastic combat helmet to make it a complete transmitting and receiving station. Earphone, switches and batteries are contained in the top unit. The other contains electronic circuits

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No. 9, 1956

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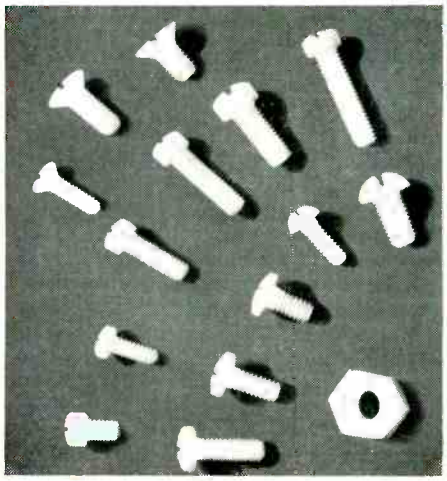

Fastenings made of "Zytel" nylon resin are available in many types and sizes. An example is the "Nylo-Fast" fastenings shown above. These precision-machined bolts are lightweight and durable. The resiliency of "Zytel" permits interference fit which prevents loosening under vibrational conditions. The electrical insulating properties of "Zytel" are good. Temperatures as high as 250°F. will not affect the "Nylo-Fast" parts of "Zytel." Where color coding is desirable, various colors are available. (Manufactured and stocked by Anti-Corrosive Metal Products Company, Inc., Castleton-on-Hudson, New York, from rod stock supplied by The Polymer Corporation of Reading, Pa.)

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An informative free bulletin describing the preparation and uses of laminations and impregnations of glass cloth employing "Teflon" tetrafluoroethylene resin is now available. Specify Bulletin X-64.

Coil forms of "Zytel" for the General Electric AK-4 and AK-5 hook-on volt-ammeters are shown above. The high dielectric strength and easy moldability of this material make it suited for such applications. Photo below shows relative size of easily held volt-ammeter.

Light, molded coil forms of ZYTEL® simplify ammeter design problem

Compact designs, such as the coil form for this G.E. hook-on volt-ammeter, are possible when using "Zytel" nylon resin. This is because "Zytel" can be molded into complex shapes . . . retains its strength even in thin sections. Another important advantage of Du Pont "Zytel" is that it can be injection-molded at low cost per part.

In electronic applications of all kinds, "Zytel" offers many design advantages. Whether it is used for molded components or jacketing for wire and cable, its mechanical strength and heat resistance, coupled with its superior insulating characteristics, give outstanding results. A thin jacketing of "Zytel" nylon resin on electrical wire provides good insulation and abrasion resistance.

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Please send me more information on the Du Pont engineering materials checked: ☐ "Teflon"* tetrafluoroethylene resin; ☐ "Alathon"* polyethylene resin; ☐ "Zytel"* nylon resin; ☐ "Lucite"* acrylic resin. I am interested in evaluating these materials for_____

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about 14,000 within its dissipation ratings. From the standpoint of getting highest transconductance with minimum power dissipation, this tube is the best choice.

If the conditions for oscillation are established with the highest possible values of Q and g'_m and the lowest possible values of X_2 and X_3, a final adjustment for maximum stability of operation is to set the operating point just within the threshold of oscillation. The adjustment may be made either by means of screen grid voltage control or by control of the value of X_3. When so adjusted the tube operates almost as a class-A amplifier, with little grid current.

Because of the relatively large inductance used in the Clapp oscillator for any given frequency, the necessity for rigidly supporting the coil, its series capacitor and the connecting leads assumes great importance. In particular, the junction between the coil and the series capacitor, being the point of highest impedance in the tuned circuit, is a critical region mechanically.

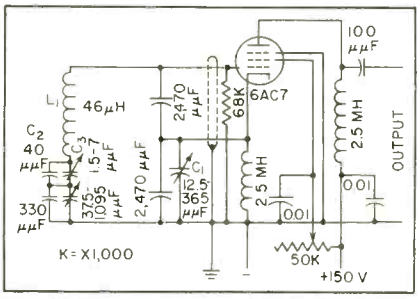

FIG. 3—Circuit of high-stability oscillator

In most practical forms of this oscillator the series capacitor C_1 is used as the tuning capacitor. With L as large as possible, a minute change of stray capacitance in or near the coil side of C_1 causes a relatively large change in frequency. Two-bearing variable capacitors are rigid enough to be used as tuning capacitors in this manner but one small enough to provide a satisfactory tuning range usually requires connecting one or more others in parallel with it. The extra leads involved add that much more chance for instability owing to small change in capacitance.

Using two capacitors in series, with the larger one variable, en-

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ables construction of an oscillator less subject to mechanical instability. Its degree of merit in this respect depends on the choice of values of the two capacitors rather than on the fact that two are used.

The variable capacitor used for tuning the oscillator should be as large as possible consistent with covering the desired frequency range. The small series capacitor should be fixed and mounted rigidly to the coil, directly adjacent to it.

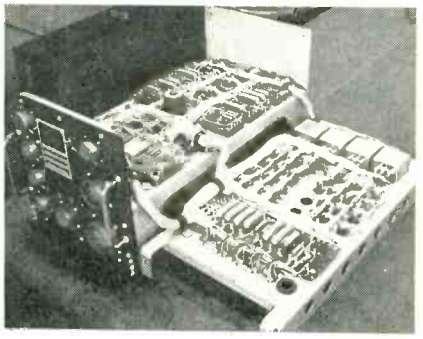
The experimental oscillator incorporating these features, which gave the test result of Fig. 2, is shown schematically in Fig. 3. The tuning range for this oscillator is 3,500 to 3,600 kc. If more tuning range is needed it can be obtained by reducing the value of tuning capacitance.

A preferred method from the standpoint of maintaining maximum stability is to switch in different values of the small fixed capacitance C_1. If such a switching arrangement is used, the individual fixed capacitors should all be permanently attached to the coil and switched on the low-impedance side.

Capacitor C_1 (Fig. 3) is used to lower the plate-circuit coupling reactance to the point where, with an appropriate value of screen grid voltage, oscillations can be made to cease at any setting in its range. In this manner it provides a convenient method of setting the oscillator just within the threshold of oscillation.

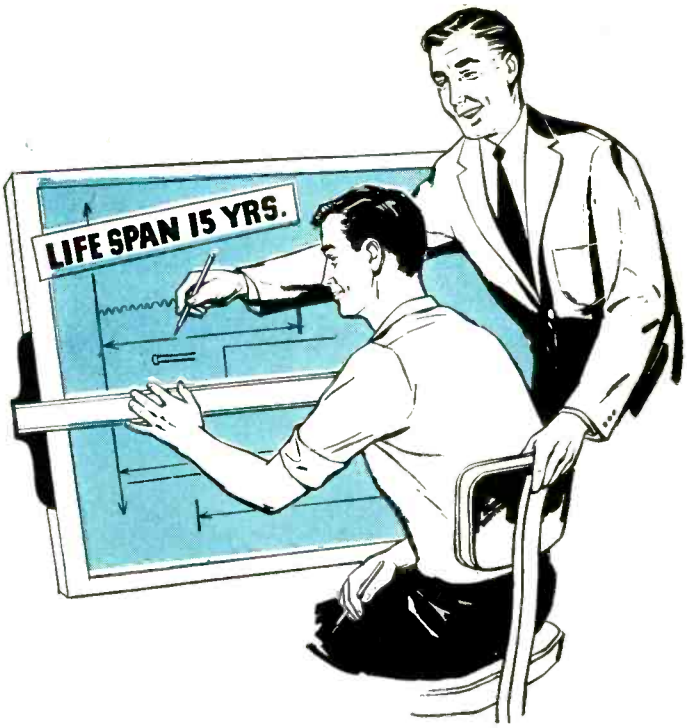
Capacitor C_3 allows the total value of small series capacitance

Drone Brain Remote Control



Built by Temco Aircraft for the Signal Corps, the autopilot shown has been developed for remote control of L-17 drones

planning on LONG LIFE?



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in the tuned circuit to be set exactly for the desired tuning range. Once so set it is considered to be fixed. Capacitors C_2 and C_3 are both mounted on an insulated strip directly next to the coil.

The stability characteristic of Fig. 1 is typical of a number of trials. Ambient temperature was nearly constant at 65 F. Frequency changes after an hour of operation remained within the same limits as during the first hour. For each test the oscillator was initially set to 100 cycles higher in frequency than a crystal oscillator and the beat frequency measured by comparison with the output of an audio-frequency oscillator on an oscilloscope.

Expressed in parts per million, the stability of this oscillator is within 6 parts per million if the first five minutes of operation are included and within 3 parts per million after the first five minutes.

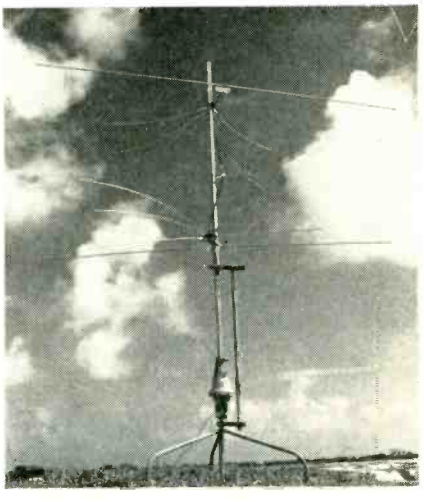
References

(1) J. K. Clapp, An Inductance-Capacitance Oscillator of Unusual Frequency Stability, *Proc IRE*, p 356, Mar. 1948, and discussion, p 1,261, Oct. 1948.

(2) J. K. Clapp, Frequency Stable LC Oscillators, *Proc. IRE*, p 1,295, Aug. 1954.

(3) W. A. Edson, "Vacuum-Tube Oscillators," p 169, John Wiley and Sons, Inc., New York, N. Y., 1953.

Ghost-Free TV



The television receiving antenna illustrated is said to eliminate interference by adjustment of out-of-phase pickup that cancels the interfering component of the undesired signal. One array is oriented on the desired station and the other adjusted or rotated by motor for optimum interference cancellation. The unit is manufactured by Holloway Electronics Corp. of Ft. Lauderdale, Fla.

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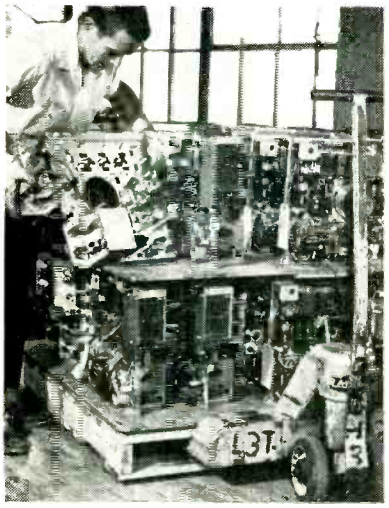
Production Techniques

Edited by JOHN MARKUS

Metal Strap Holds TV Chassis on Plywood Sheet

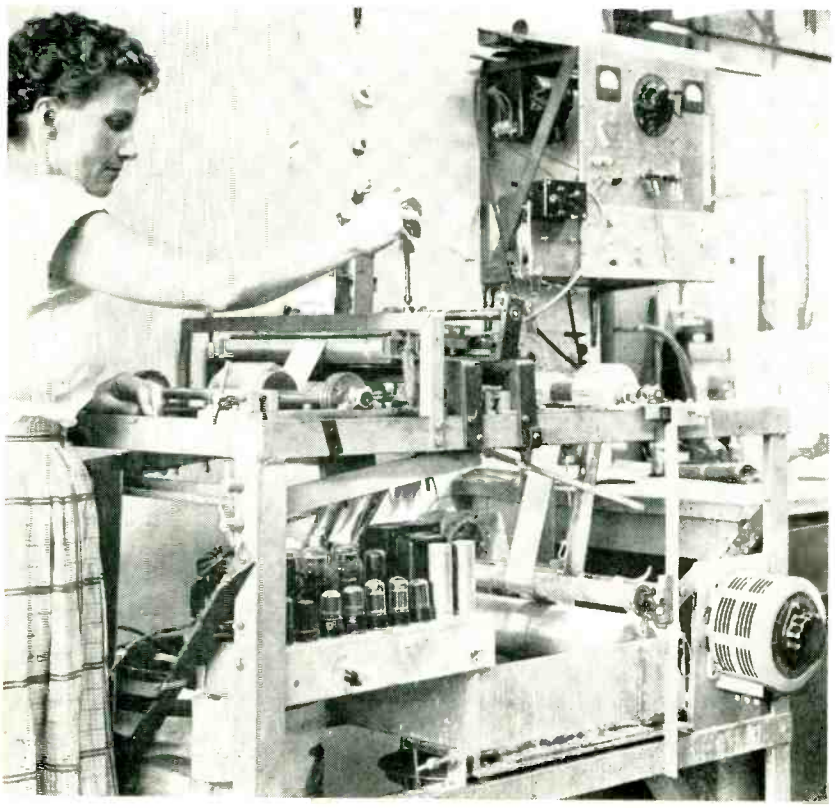


STRIPS of metal formed with a slight offset and fastened to a ½-inch plywood sheet with wood screws hold vertical tv chassis units securely for handling and storage in RCA's Bloomington, Ind. plant. For handling with a fork lift truck, the first sheet of plywood is placed on a standard wood lift truck pallet. The chassis units are then loaded on, one by one, by slipping the edge of each chassis under one of the eight cleats on the board. Another board is then placed on top of the load, resting on the projecting flanges of the chassis and eight more units are loaded on.

With this arrangement, a sixteen-chassis load can easily be transferred from the end of the production line to a temporary storage area while awaiting cabinets or picture tubes. Storage on edge utilizes the strength of the chassis, eliminating the need for storage shelves in the warehouse and giving far greater utilization of space than would an elaborate horizontal-chassis storage system.

Loading vertical chassis on fork lift truck. Chassis is positioned so its bottom edge hooks under metal cleat fastened to plywood sheet

Winding Machine for Oxide-Coated Aluminum-Foil Coils



New machine for winding coils from oxide-coated aluminum foil has automatic regulation of tension and winding speed to reduce operator training time

A MINIATURE winding machine for self-insulated aluminum foil has been developed by Jobbins Electronic Enterprises of Menlo Park, Calif., in continuation of their oxide-coated-aluminum research described on p 244 of July 1956 ELECTRONICS (Winding Focus Coils with Aluminum Foil). Initial experience indicates that cost of such coils can be less than for copper-wound coils. With newly improved coating techniques and increased foil-winding speeds, labor costs per coil are about the same for both. The aluminum-foil coil weighs only about half as much as copper coil, however, and aluminum foil at present costs roughly half as much per pound as copper wire.

▶ **Test Results** — One requirement that has been met with the new aluminum coils is rigorous environmental testing. The coils were able to withstand a 1-kv breakdown test while operating normally at a temperature of 250 C at an altitude of 80,000 feet. Production of these

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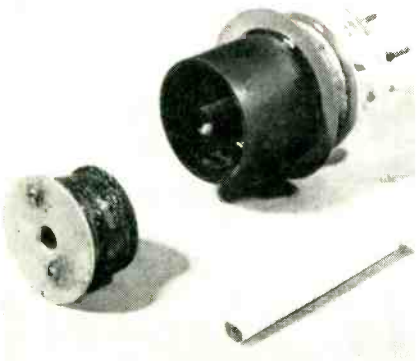
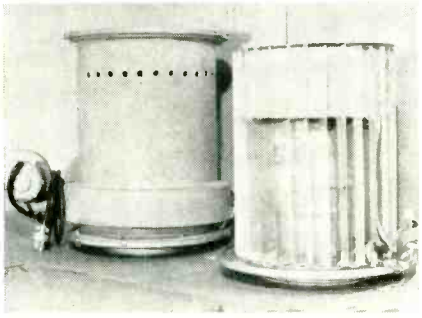


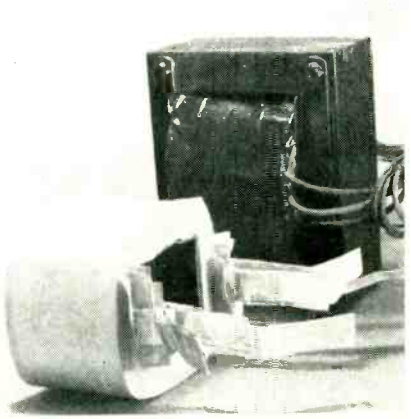
Solenoid coil for operating vacuum relay, using aluminum-foil conductor only 0.00025 inch thick and ⅛ inch wide

high-altitude coils involved winding foil as thin as 0.00025 inch and ⅛ inch wide. Although the speed of this winding equipment is still not high, it does permit building experimental transformers and a-c solenoids. These small-size coils are promising, although the present rather slow production rate makes the cost too high for any but the most exacting requirements.

► **Large Coils** — For larger coils, up to 4 ft in diameter, it is now well established that anodized foil is a highly practical material. However, there has been a continuing demand for coils with holes drilled in them for access to tuning adjust-



At right is large aluminum-foil coil for focussing klystron, with cooling fins attached to outer edges of foil. Housing and air-cooling blower are at left



Transformer coil using oxide-coated aluminum foil, with transformer using equivalent copper wire in background

ments. This was formerly not considered practical because of the extremely thin oxide film. Now, however, coils with radial holes of any size or shape can be produced by punching rather than drilling, then reinsulating the raw edges of the foil.

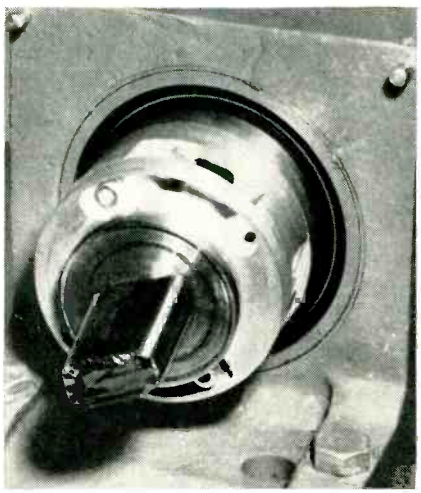
Crystal-Slicing Lathe Reduces Germanium Waste

ROTATION of germanium or silicon crystal ingots while slicing into wafers permits use of thinner diamond saw blades, with correspondingly less waste. This principle is utilized in the new Microtomatic precision slicing machine made by The DoALL Co., Des Plaines, Ill., which also dices the resulting wafers into tiny squares.

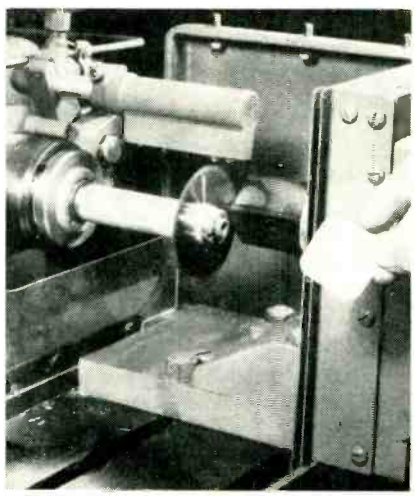
► **Savings**—For most transistors the ingot is first sliced into wafers 0.010 to 0.015 inch thick. For conventional sawing of a 1½-inch-diameter crystal bar the thinnest practical diamond saw cuts a kerf 0.030 inch wide, which means that much more of the $400-a-pound material is reduced to dust than to usable wafers. With the new slicer, it is possible to use a 3-inch-diameter saw that reduces only 0.015 inch of material to dust.

► **Machine Details**—The face plate on the motorized headstock of the machine, to which the end of a germanium crystal can be cemented, is adjustable to bring the crystallographic plane into coincidence with the plane of rotation. The headstock is mounted on the 6 by 18 inch work table, which moves on hand-scraped ways feeding the rotating ingot into the cutting wheel at rates as low as 1/16 inch per minute. The cutting saw need be only large enough to cut to the center of the work.

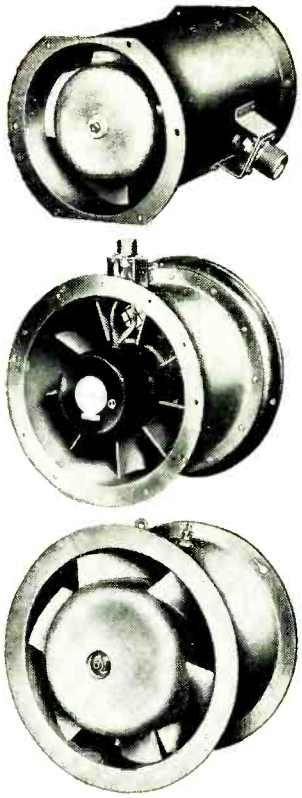
Easily adjusted trip dogs control the length of cutting stroke and provide automatic quick return at speeds up to 50 feet per minute. When slicing, automatic cross-indexing takes place on the return stroke. Cross-indexing can be set at the hydraulic control panel to produce slices of any desired thickness accurate to ±0.0005 inch. Stops are provided so that cross-



Compound headstock permits aligning proper crystallographic plane of germanium ingot to cutting plane of saw after centering ingot to face plate



Close-up of work table with guards removed for visibility and slicing fixture in place. Work piece is rotated so that small-diameter thin circular saws can be



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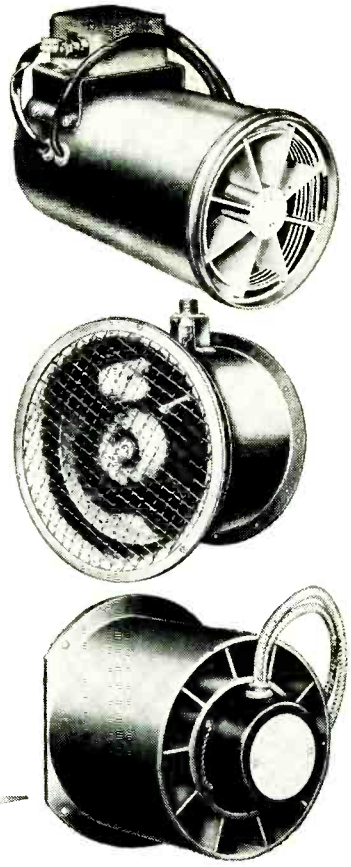

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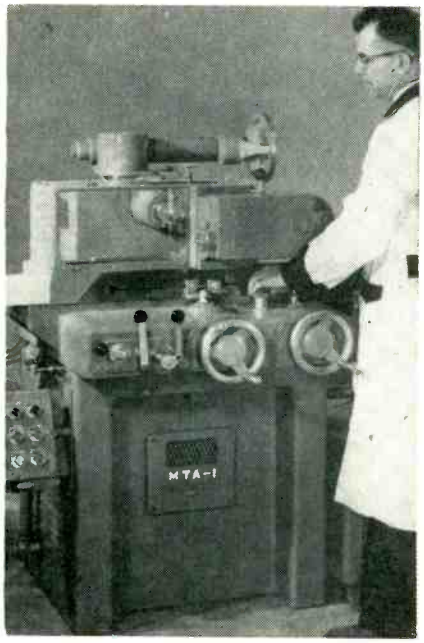
indexing can be adjusted to the length of the ingot or ingots being sliced. The slicing operation is automatic, requiring no attention by the operator until the entire work-load is reduced to wafers.

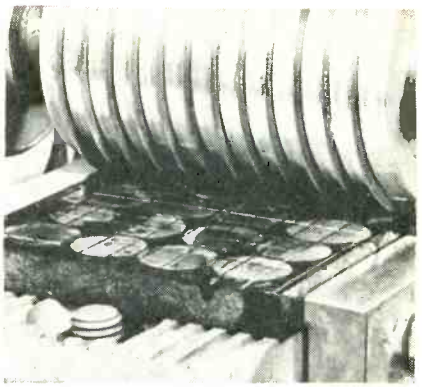
► **Dicing**—Some large power transistors make use of a complete wafer as produced by the slicing operation, but most transistor blanks are made by cutting the thin wafers into tiny squares. The wafers are held for dicing by cementing them to ceramic plates which are, in turn, held by a fixture on the work table. The fixture is a serrated chuck with back stop and clamps to hold up to five 4½-inch-square plates. Each plate can be covered with germanium or silicon wafers, so that a full work-load might be 20 or more wafers.



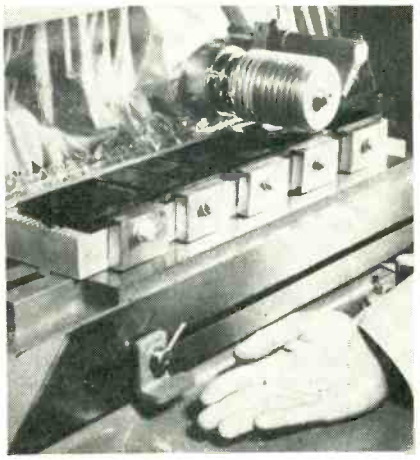
Procedure for dicing 0.250-inch-square blanks

The spindle for dicing has a 3½-inch extension to permit mounting and spacing a number of 3-inch-diameter circular diamond saws. A typical setup might be twelve blades spaced 0.25 inch apart so that the entire width of the fixture is covered at a single pass. Slow table feed is used and the depth of cut is set to cut through the wafers in one stroke.

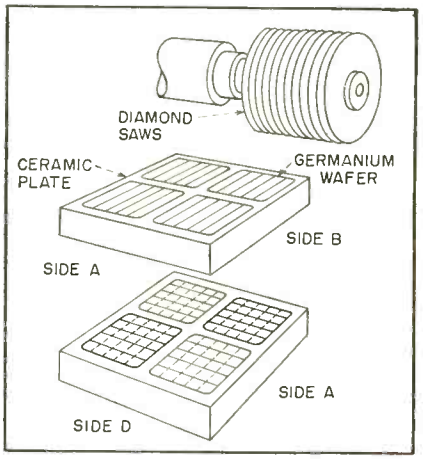
If wheel spacing corresponds to



View of machine arranged for dicing operation on germanium wafers. Spindle shaft extension here carries twelve 3-inch-diameter diamond saws each 0.015 inch thick, spaced 0.250 inch apart. Blanks 0.250 inch square are produced in two passes. Wafers are cemented to ceramic plates and pass is made through these plates. Plates are then turned 90 degrees and another pass taken, dicing wafers into segments of desired size



DoAll Microtomatic precision slicing machine, model MTA-1, equipped with motorized slicing fixture. Operator is adjusting table feed. Cross index, adjustable from zero to 0.250 inch occurs at return stroke



Close-up of dicing operation

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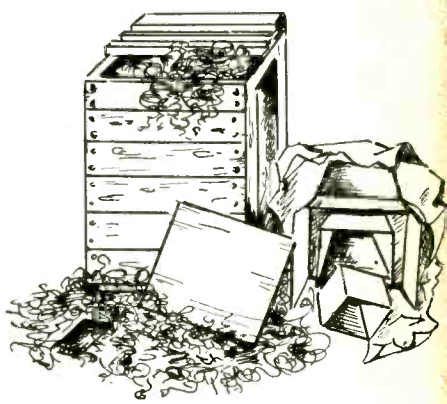

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the desired blank size, the plates are turned 90 degrees and the strips of wafers are diced in a second pass. If small blanks are required, it may be desirable to space the blades two or three times the width of a single blank because the adhesive area on very small blanks is reduced to a point where the force of the blades cutting simultaneously at both edges tends to tear the blanks away from the ceramic mounting plate. Using wider-spaced blades, the accurate cross index is used to position the work for a second cut along the other side of each blank.

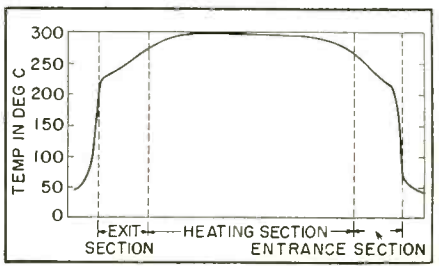
► **Quartz**—The extremely slow and smooth feeding table, coupled with the vibrationless spindle, also permits slicing piezoelectric crystals.

Continuous Furnace Cures Tape Resistors

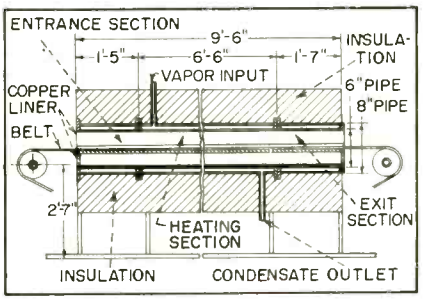
A CONTINUOUS furnace for curing tape resistors has been designed and constructed under the direction of B. L. Davis of the National Bureau of Standards. The furnace uses a liquid heat exchange medium to achieve highly stable temperature control. Curing temperature can be held to ±1 degree C on long-term operations.

The furnace is well suited for a production line facility. It processes each resistor identically and makes possible the manufacture of closer-tolerance tape resistors for module wafers or printed-circuit plates.

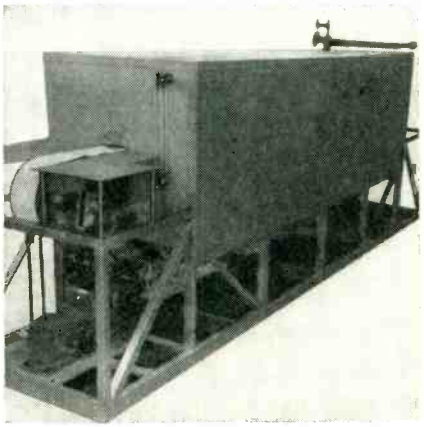
► **Construction**—Resistors move on a continuous belt through a pair of concentric Schedule 40 steel pipes 9½ ft long. The inner pipe is 6 in. in diameter while the outer pipe is 8 in. in diameter. The space between the two pipes is sealed at both ends and at two intermediate positions, thus providing three independent chambers. The two end chambers are each 1½ ft long and the intermediate or heating section is about 6½ ft long.



Temperature distribution curve throughout furnace



Cross-section of furnace



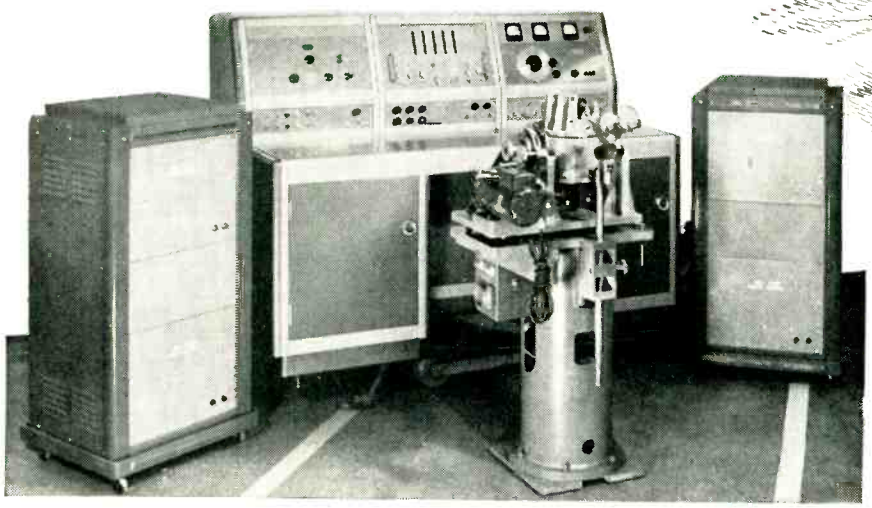
Continuous furnace for curing tape resistors uses a liquid heat exchange medium to achieve highly stable temperature control

An organic heat transfer medium—a eutectic mixture of 26.5-percent diphenyl and 73.5 percent diphenyl oxide (Dowtherm A, available from Dow Chemical Co.)—passes as a vapor into the intermediate section. Here it gives up some of its heat, condenses and returns to the vaporizer. With a condensing vapor, all the heat is transferred at the saturation temperature, thereby maintaining all the heated surface at the same temperature. The condensate returns by gravity, thus providing circulation without pumps.

The two end chambers are filled

ANOTHER FIRST BY Greenleaf

Dynamic Integrating Gyro Servo Table



Greenleaf Manufacturing Company, as a producer of Integrating Gyros, realized the need for a Dynamic Integrating Gyro Servo Test Table. This Test Table was designed and developed to facilitate the evaluation of Integrating Gyros, and Greenleaf now makes this valuable test unit available to industry.

The Gyro Servo Test Table can measure the following characteristics:

1. The drift rate of the gyro unit.
2. The current product angular velocity sensitivity ratio.
3. The characteristic time.
4. The angular velocity input voltage rate output sensitivity.
5. Minimum rate detectable.
6. High limit angular velocity deviation of performance.
7. Low limit angular velocity deviation.
8. Signal generator linearity.
9. Torque generator linearity.
10. Spin motor excitation frequency.
11. Spin motor excitation voltage.
12. Spin motor excitation current.
13. Signal generator excitation current.
14. Signal generator null output voltage.
15. Gyro damping gap temperature.
16. Accurate determination of the input axis.

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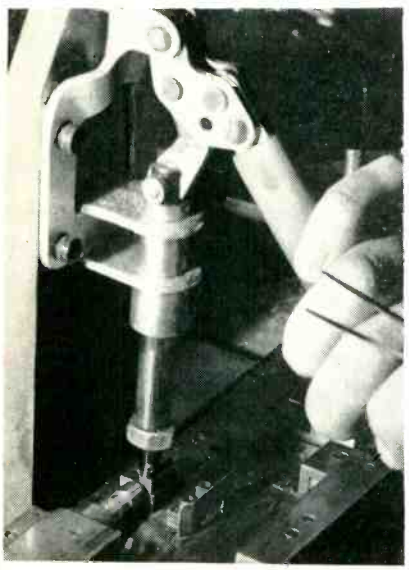
with the liquid heat exchange medium. The themal inertia and the convection currents within the liquid help stabilize the temperature gradients of the end sections. In addition, a heavy copper liner inside the inner pipe helps insure stability in the temperature gradients, from the room temperature at the outer ends of the furnace to the curing temperature that is maintained throughout the intermediate chamber. The center section can be held to within ±1 degree C of its normal operating temperature.

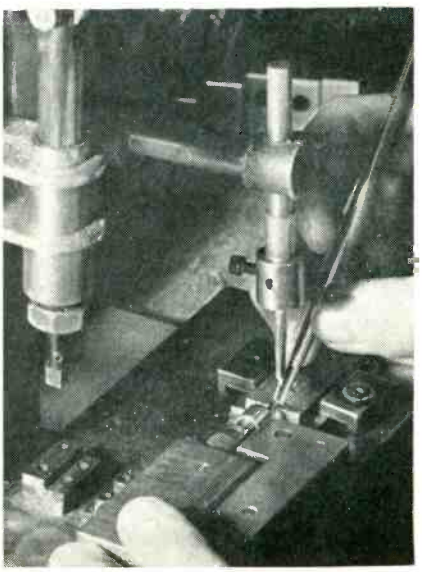
A continuous belt carrying the resistors moves axially through the inner pipe. Belt speed and curing temperatures are adjustable over a wide range. Normally, however, the MBS tape resistors, when mounted on printed-circuit plates, are cured at 300 C and spend 4 hours in transit from cold entrance to cold exit, giving a production rate of 175 resistor wafers per hour.

▶ **Control**—The unusually stable curing temperature of the furnace is maintained by controlling the pressure of the heat transfer medium in its vapor state. Diphenyl-diphenyl oxide was chosen for this application because of its low pressure-to-temperature ratio —20 psi at 300 C. In the region of this temperature, a pressure change of 3.6 psi produces a temperature change of 5.5 degrees C. Such a pressure change is easily detectable with conventional equipment. The pressure-control system maintains the maximum furnace temperature by regulating on an on-off basis the vaporizer electric heater power.

Mounting Germanium Pellets on Transistors



Hand-operated setup for flattening and forming leads of transistor stem in work carrier at bottom center. Downward movement of lever brings down die to give precise positioning



Setup for welding nickel tab to stem lead. Operator is holding transistor work carrier in position against right-angle metal stop with left hand while dropping tab into position with tweezers in right hand

PRECISELY MACHINED metal work carriers make possible the semi-mechanized mass production techniques used in mounting tiny germanium and silicon pellets on the stem leads of surface-barrier transistors in Philco's Lansdale, Pa. plant. These carriers will permit eventual conveyorized assembly closely approximating completely automatic production of transistors.

▶ **Loading**—Assembly starts with insertion of the transistor base or stem in the work carrier. The stem is produced on automatic machinery as a subassembly, much as are the stems for vacuum tubes, with the

Mobile gas turbine power cart

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The AiResearch MA-1A mobile gas turbine compressor, the first unit of its kind qualified by the Air Force to start the intercontinental B-52 bombers of the Strategic Air Command, is now in volume production at the AiResearch Manufacturing Division of Arizona.

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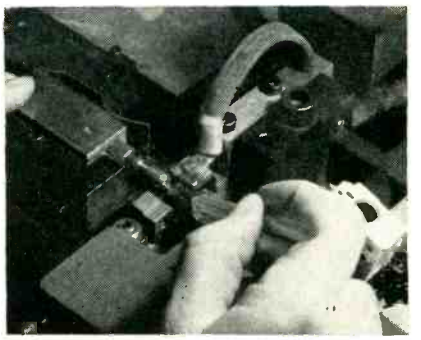
transistor leads projecting down through the base. The chuck of the work carrier is tightened to grip the round stem and give precise centering and positioning.

▶ **Forming Leads**—The first operation on the stem is straightening and flattening the short upper leads, at the same time positioning them accurately for subsequent operations. This is done with a simple hand-operated press. The operator slips the work carrier into a right-angle metal stop bolted to the bed of the press, then brings down the operating lever to push the leads into the die.

▶ **Welding Tab**—After forming the leads, the work carrier is slid over to another positioning block at the same work position, to place one of the stem leads directly under a

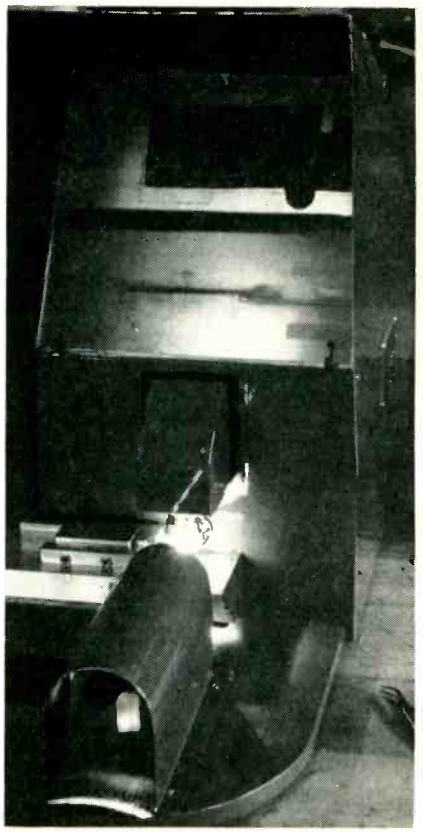


Placing germanium pellet on nickel tab with vacuum lifter at soldering setup. Insulated cable goes to one end of heater strip

welding electrode. The operator places a nickel tab in a recess of this fixture with tweezers, so that it drops accurately into position over the lead, then pushes a foot pedal to operate the automatically timed spot welder. The welder used for this critical operation is a 220-volt, 3-kva unit of the type normally used in the assembly of receiving tubes.

The nickel tab has a 100-percent tin dip at the unwelded end, to permit soldering it to germanium. The blob of tin is put on simply by dipping the end of the tab in a pot of pure molten tin.

▶ **Soldering Germanium** — The work carrier is now transferred to a radiant-heat soldering position. Here spring clips push the carrier



Top and side views of mounted germanium pellet show in greatly enlarged form against tolerance outlines on screen of special shadowgraph

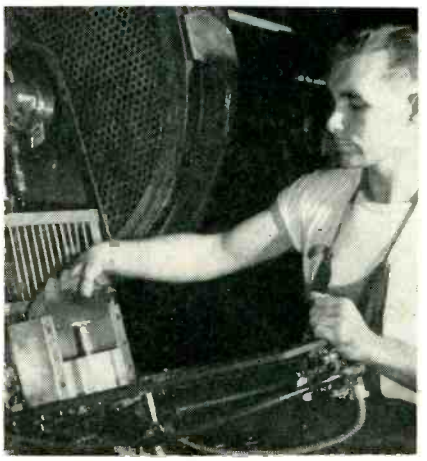
firmly against the metal positioning piece that is bolted to the work table. The operator picks up a previously cut pellet of germanium with a vacuum lifter and drops it into position over the tinned end of the nickel tab. Again a recess in the fixture contributes to precise positioning of the pellet.

A small hinged weight is now flipped over the pellet to hold it down. A lever in front of the fixture is pushed to trigger the 7-second timer which controls a high-current radiant heating element located directly under the nickel tab. This element is a heavy Nichrome strip having a slot milled upward almost all the way through, so heat is concentrated in the remaining portion directly under the tinned end of the nickel tab.

▶ **Shadowgraphing**—At regular intervals, assembled stems are checked on a sampling basis in a double optical-type projector after soldering the germanium, to make sure that all the jigging is working properly. This specially constructed

projector shows two views simultaneously with high magnification on the same screen, each positioned over dotted lines drawn on the screen to show maximum permissible deviation in the positioning of the germanium. The work carrier gives precise positioning of the transistor in the light beam so this inspection can be carried out at high speed even by an unskilled operator.

Automatic Feed for Radio Tuner Punch Press



Method of loading input slide of press. Air cylinder used for automatic feed can be seen under table of press

MATERIAL HANDLING is minimized and more uniform performance is obtained by adding automatic feed to both the input and output of a punch press used for stamping frames for auto radio tuners in the Camden, N. J. plant of Radio Condenser Co. The operator merely loads stacks of plates into the input hopper and removes stacks of punched plates from the lazy-Susan stand just below a conveyor belt at the rear of the press.

► **Input**—Automatic input feed is achieved by an air cylinder that is synchronized with press operations by a snap-action switch actuated by a cam on the shaft of the press flywheel. After each press operation, the air cylinder moves a horizontal plate that pushes a new piece into position from off the bottom of the input stack. At the same time, the finished piece is

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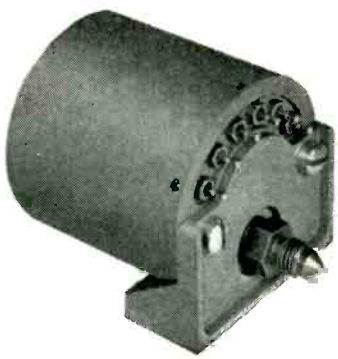

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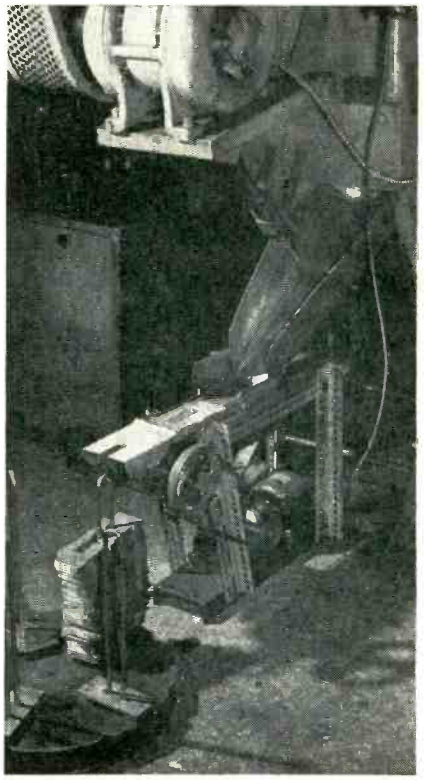
Roller-type switch operated by cam on driveshaft of press controls automatic feed



Output chute, motorized conveyor belt and lazy-Susan rack at rear of press

pushed into a chute running down to the rear of the press.

▶ **Output**—From the chute, pieces slide onto a small motor-driven conveyor belt having side guides for alignment. This belt feeds the stamped pieces onto the vertical projecting rods of a circular floor rack. When one of the rods is filled, the operator rotates the rack a fraction of a turn to bring another rod into position.

Finished pieces are lifted off the rods in bunches at convenient times

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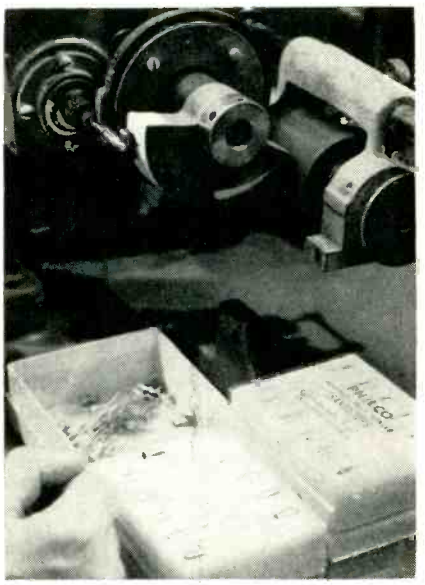
and transferred to conventional tote trays, since a loaded rod section is too heavy for convenient handling by one man. This problem of weight also precludes magazine feed at the input of this and other large punch presses in the plant.

Labeling Transistors

IDENTIFYING NOMENCLATURE is clearly printed on the curved metal cans of tiny hermetically sealed transistors in Philco's Lansdale, Pa. plant with the same motorized printer used for subminiature tubes. The standard Markers Machine Co. unit is simply fitted with the proper chuck to handle each of the various sizes of transistors.

Printed units are placed immediately in individual recesses in

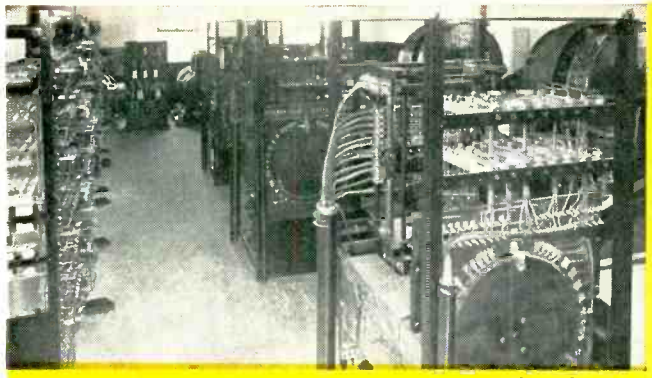


Printing identification on can of transistor held in chuck at upper left. Rubber type is cemented to semicircular sector on output shaft of gear box. Rubberized cam drives shaft of chuck

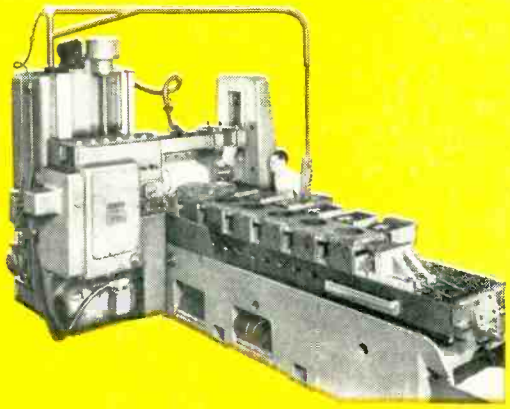
Styrofoam shipping blocks to prevent smearing of the ink as it dries.

The operator loads the printer by pushing back a spring-loaded chuck and inserting the transistor leads as far as they will go. Release of the chuck grips the transistor stem with precise centering.

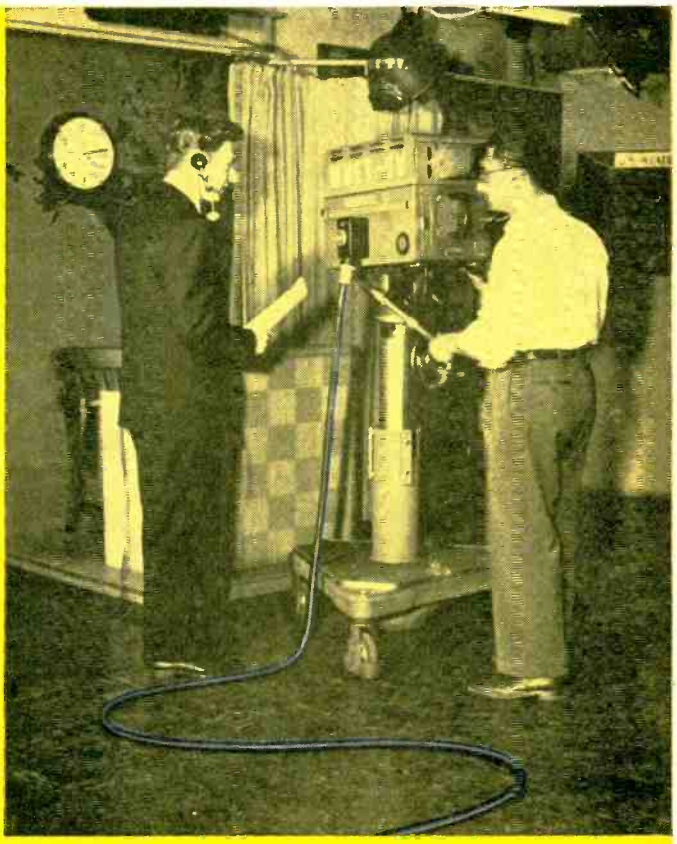
The rubber type is cemented to a half-disk mounted on a gear box output shaft which runs continuously. The type is rotated first



Special cable constructions for a huge variety of applications are the specialty of the house at Rome Cable. Fixture wires for elevator control panels are just one example.



Permanently clear color coding for circuit identification is vital to most modern electronically controlled equipment. Solid colors, spiral markings or colored braids are available.



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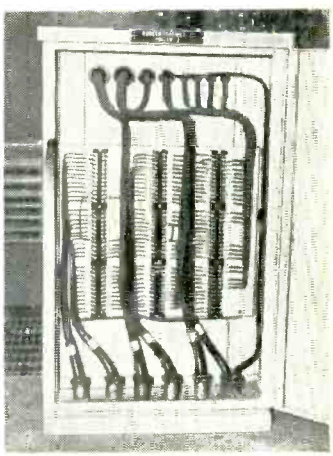

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against an inking roller also driven by the gear box. After picking up ink, the type rotates another 180 degrees to come back to the transistor. Behind the type disk sector is a rubberized cam disk designed to drive the shaft of the chuck by friction for a short period before and after printing. The chuck turns freely on ball bearings. This shaft is the same diameter as the transistor can, so the can surface and the rubber type are moving at precisely the same speeds during the printing operation.

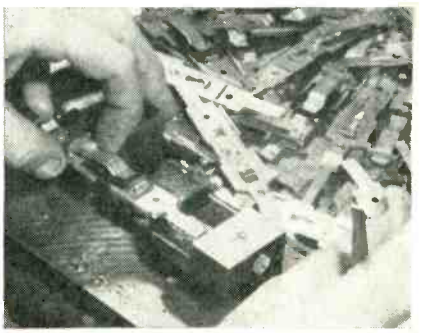
After printing, further rotation brings a notch in the rubber cam over the chuck shaft, stopping the drive of the chuck so the transistor can be unloaded and a new one inserted. The speed of the drive motor is so adjusted that the setup can run continuously, there being sufficient time for unloading and loading while the type is going around for reinking.

The inking roller is itself inked by another roller running in a trough of ink.

Testing Slide Action of Pushbuttons for Tuner

BEFORE INDIVIDUAL pushbutton slides for auto radio tuners are assembled in the tuner frame, each is carefully tested to make sure that locking and unlocking forces of the cam-and-lever action are within tolerance limits, in the Camden, N. J. plant of Radio Condenser Co. Both manual and automatic test setups are currently in use.

▶ **Manual Test**—Test fixtures for bench use are provided with two



Loading slide into manually-operated bench test fixture

in color tv, too

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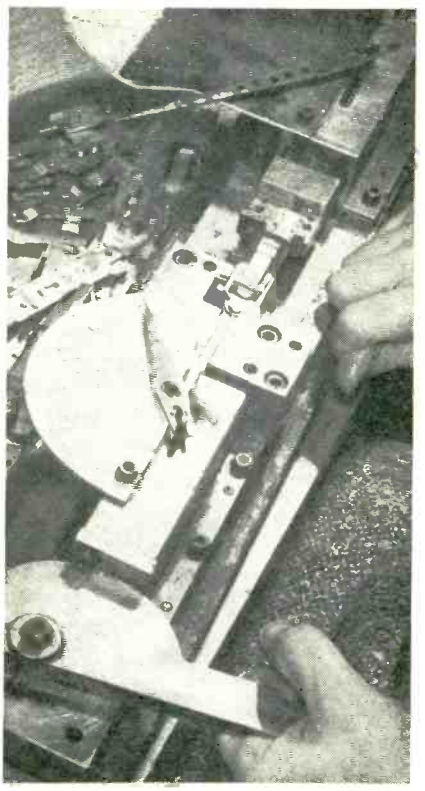
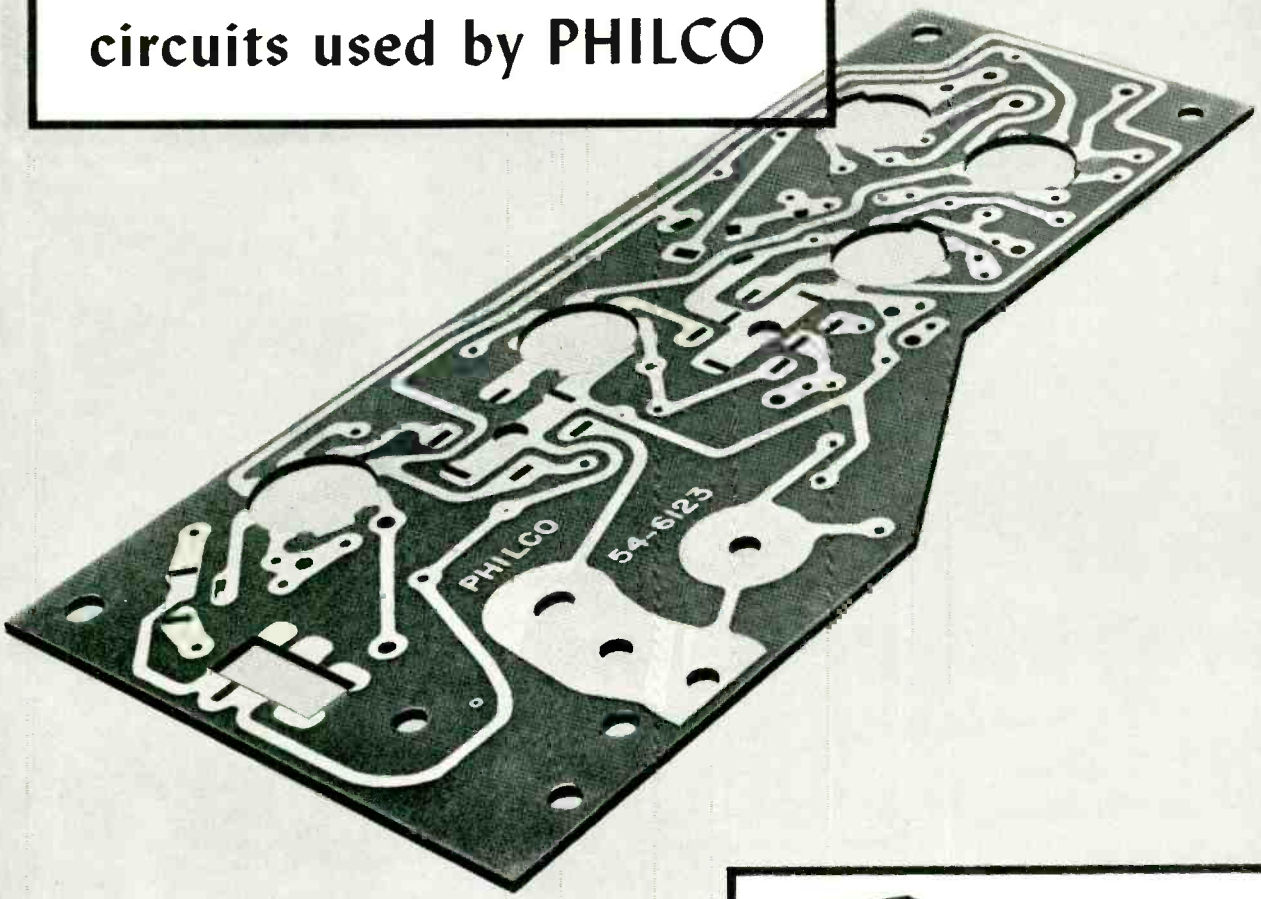
built-in spring scales indicating the action of the slide under test. The operator drops the slide into position, moves the operating lever at the left of the fixture back and forth a few times to simulate op-

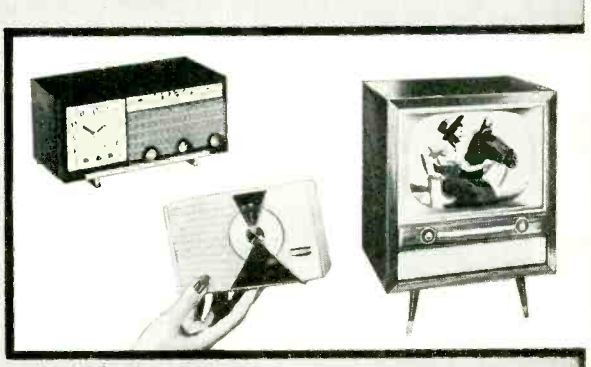


At first step, operator moves left-hand of lever of fixture back and forth a few times to break in slide under test. Right hand is on lever that will later be swung upward to check holding power of cam on slide

Pushing start button of robot tester after loading slide into fixture. Lower air cylinder simulates action of pushbutton, while upper air cylinder applies downward force to check holding power of cam

INSUROK® T-725 printed circuits used by PHILCO





Philco design and production engineers are using Richardson Copper-Clad INSUROK T-725 laminate for printed TV and radio circuits.

Examples are Underwriters approved assemblies for Philco's 21" console TV, Philco's five tube table radio and Philco's transistorized portable radio. All use INSUROK T-725 printed circuits.

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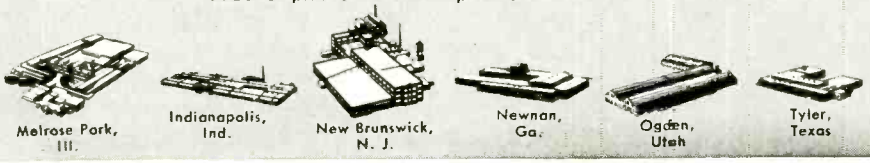

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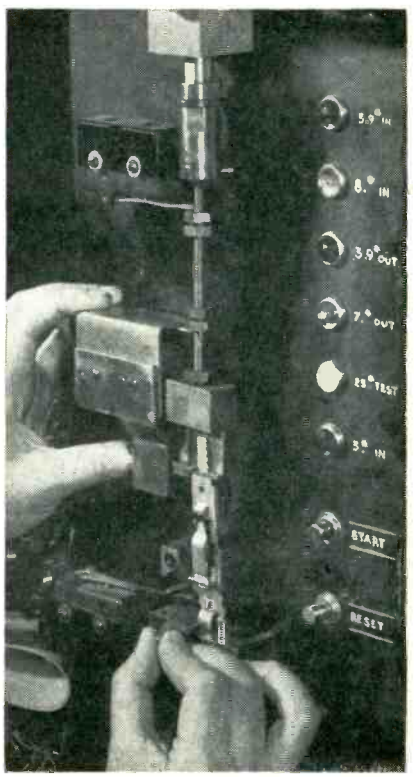
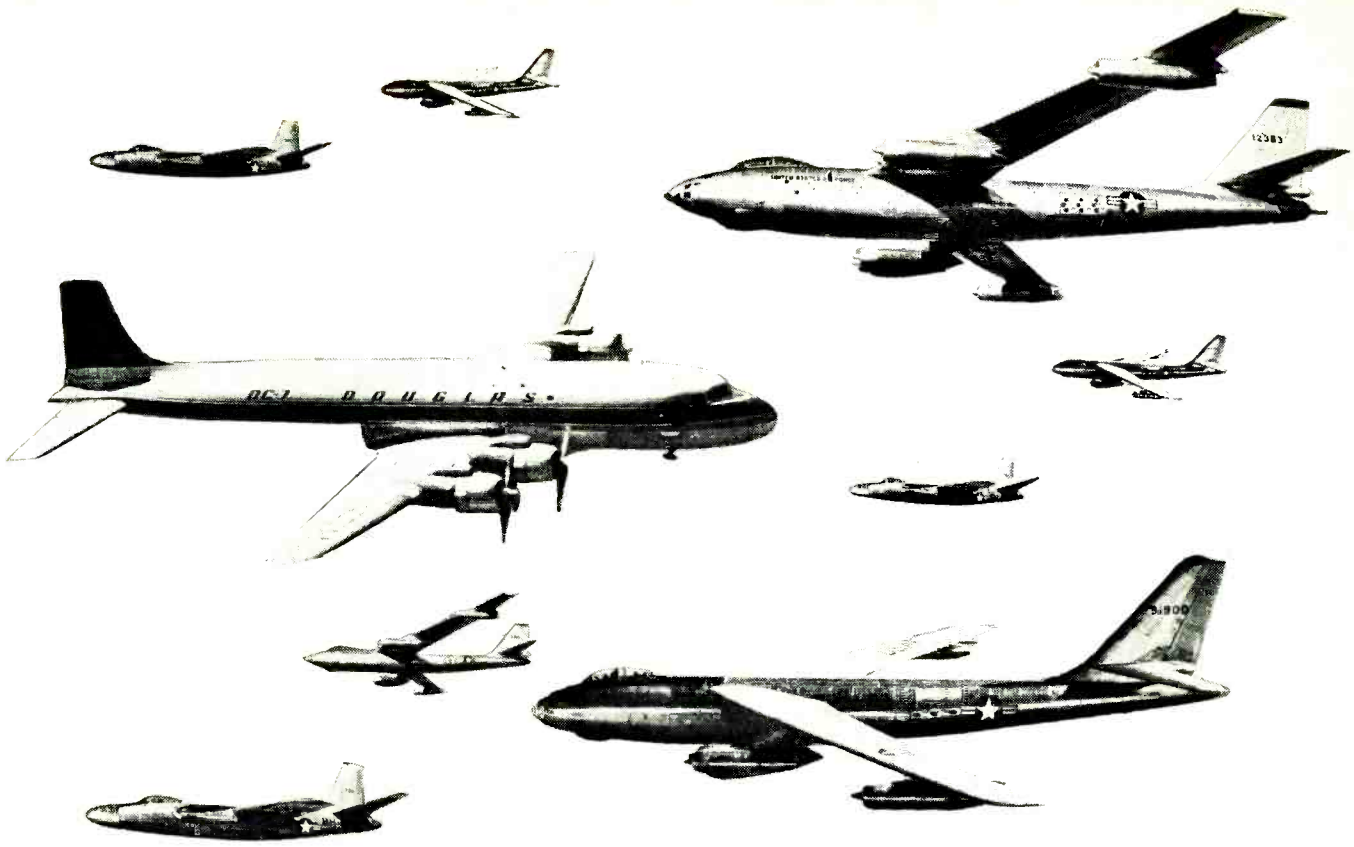
eration of the pushbutton that will later go on the end of the slide, then repeats the locking and unlocking actions slowly one last time while watching the pointer indication on the left-hand scale. This scale is calibrated in ounces of actuating force, with tolerance limits marked.

Next, the operator checks the holding power of the cam on the slide by moving a lever that applies 30 lb of pressure to the cam. The pointer on the right-hand scale, graduated in pounds, indicates applied pressure. If there is no slipping of the cam at 30 lb pressure, the slide is satisfactory.



Closeup view of slide in fixture. Operator has just moved pivoted metal tab with right hand to lock slide in position. Snap-action switches monitor performance of tester

► **Robot Tester**—A more recent development requires only that the operator load the slide into vertically mounted jaws of the tester, then push a start button. Cycling for the required sequence of tests is then automatically provided by air cylinders working in conjunc-



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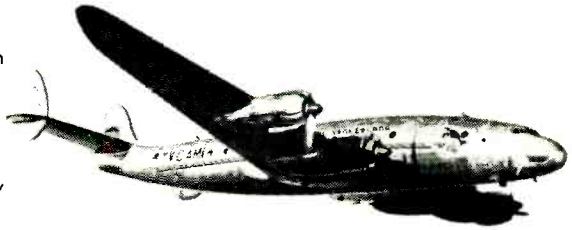
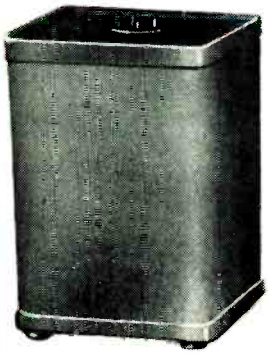
Use the world's smallest, lightest, most reliable, magnetically regulated power supplies — now available from Engineered Magnetics, each one JAN approved and each one rugged enough to withstand the great extremes demanded by modern missile and aircraft instrumentation. MAGNAPACK miniaturized power supplies are hermetically sealed units with no moving parts or filaments, eliminating maintenance and assuring stability under adverse conditions of shock and vibration.

These precision power supplies can now be obtained in the range of 5 to 200 volts — 0 to 200 ma. For individual specifications: custom designs involving mounting, mechanical construction and desired voltage range can be manufactured.

If you have an airborne instrumentation power supply problem . . . where reliability, size and weight are important considerations, a MAGNAPACK power supply will solve your problem more efficiently, more economically.





MAGNAPACK AIRBORNE MODEL EM 4-100-2B

SIZE	2.9/16 INCHES X 3 INCHES X 4.3/16 INCHES
WEIGHT	2 LB. 8 OZ.
OUTPUT	100 VOLTS DC; 0 TO 200 MA.

ENGINEERED MAGNETICS DIVISION

GULTON

INDUSTRIES, INC.

METUCHEN, NEW JERSEY

GULTON INDUSTRIES, INC.

Side view of tester with door open to show use of electric valves, current regulator tubes, stepper switch and other control components

tion with a stepper switch, relays and solenoid valves. Six pilot lamps light up or stay dark to indicate the test results.

Soldering Whiskers on Transistor Pellets

A NEWLY DEVELOPED Philco automatic machine cuts and forms tiny whisker wires, plates one end with indium, then solders the whisker automatically at precisely the correct position in the etched and indium-plated hole of a germanium transistor. The equipment is now being used for mass production of uniform high-reliability transistors in the firm's Lansdale and Spring City, Pa. plants.

Before development of the machine, separate hand-operated fixtures were used for the whisker-producing and whisker-soldering operations. These illustrate the sequence of steps involved in the automatic technique.

► **Hand Soldering** — When hand-soldering jigs were used for attaching whisker wires to the collector and emitter electrodes, flux was ap-

our leadership protects yours...

When you specify Cornell-Dubilier capacitors, you can be sure that nothing is left to chance. Production procedures, test and inspection operations and quality control are in full compliance with Cornell-Dubilier high-quality standards and *your* specifications. Quality and Reliability are talents we have cultivated since 1910. That's why you can count on the consistently dependable facilities of C-D's 16 plants!

Typical C-D paper tubulars:

TIGER CUB*®: Cardboard-cased paper tubular with Polykane[1] end-fill. Vikane-impregnated for excellent capacitance stability. High moisture resistance. Operating temperature range: –55°C to +100°C.

TINY CHIEF*®: Small, all-purpose paper tubular, molded in extra-hard thermosetting plastic for long-lasting all-around satisfaction. Available with high temperature wax impregnant for operating temperature range –40°C to +90°C and Vikane or Polykane* impregnant for –55°C to +100°C operation.

ROYAL CUB*®: Cardboard-cased paper tubular with Polykane* end-fill. Tough, durable, withstands rough handling, vibration, shock, soldering iron heat. Operating temperature range: –55°C to +100°C.

BUDROC*®: Steatite-cased paper tubular. Polykane* end-fill for extra protection against heat and humidity. High temperature wax impregnant for operating temp. range –40°C to +90°C and Vikane impregnant for –55°C to +100°C.

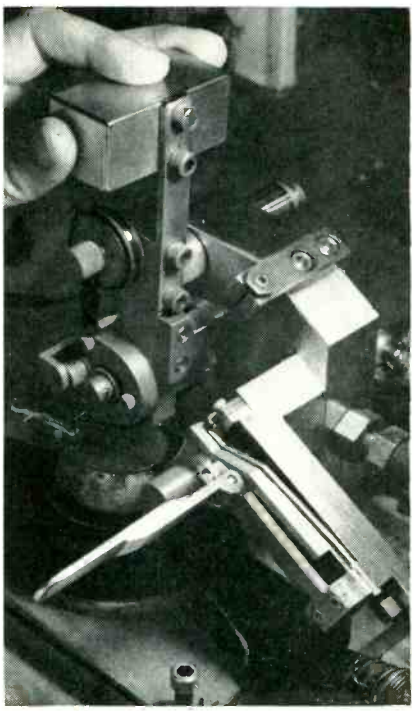
[1] Polykane: A development of the C-D laboratories. A solid thermosetting compound will not crack, soften or flow.

Write for catalog to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

CONSISTENT HI-EPENDABILITY
CORNELL-DUBILIER CAPACITORS

*® SOUTH PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER & CAMBRIDGE, MASS.; PROVIDENCE & HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD, FUQUAY SPRINGS & VARINA, N. C.; VENICE, CALIF.; & SUB.: THE RADIART CORP., CLEVELAND, OHIO; CORNELL-DUBILIER ELECTRIC INTERNATIONAL, N. Y.

plied with a strip of polyethylene dipped in liquid rosin while watching the operation through a bioncular microscope. The previously prepared whisker wire was then held in position against the indium-plated emitter hole with tweezers and an adjacent heater wire was energized by a foot pedal to solder the whisker in place by radiant heat



Whisker-plating fixture, with pivoted lever in vertical position. Reel of nickel wire is under thumb, and plating bath is directly below. In foreground is lever that operates whisker-bending part of fixture

with a blob of indium eutectic on its end. Under radiant heat, this fuses readily to the indium previously plated on the germanium.

The collector whisker was similarly soldered to the other side of the germanium.

▶ **Automatic Whiskering** — The newly developed automatic whisker attacher combines preparation and soldering of whiskers into one precise mechanized operation. The operator merely inserts and removes the holding fixtures and monitors the operation. Eventually even this can be mechanized by combining feed mechanisms with a conveyor.

The 0.002-inch whisker wire is fed from a reel through feed jaws that lower it into the heated plating

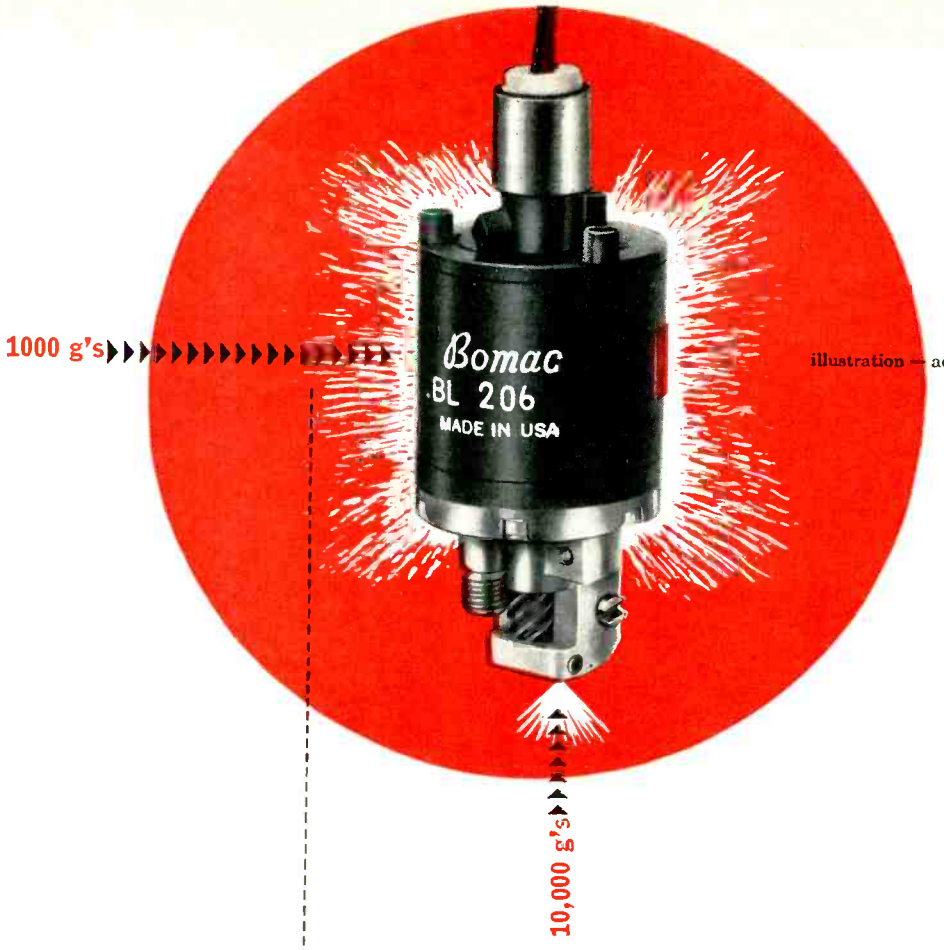


illustration — actual size

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miniature C band magnetron . . .

UNERRING RELIABILITY *in performance under severe stress — 10,000 g's longitudinally, 1,000 g's laterally . . .* **HIGH PRECISION, ADJUSTABLE TUNING** *from 5400 to 5900 mc. by worm drive with set screw lock on tuner . . .* **FREQUENCY DRIFT** *— less than 0.05 mc/°C . . .* **COMPLETE PACKAGE UNIT** *— no accessory equipment or accessory fittings are required . . .* **WARM-UP TIME** *— 7 seconds . . .* **WEIGHT** *— 6.5 oz . . .* **DIMENSIONS** *— 3 1/8" high, 1 3/16" diameter*

For complete specifications, write (on your company letterhead) to Dept. E-9

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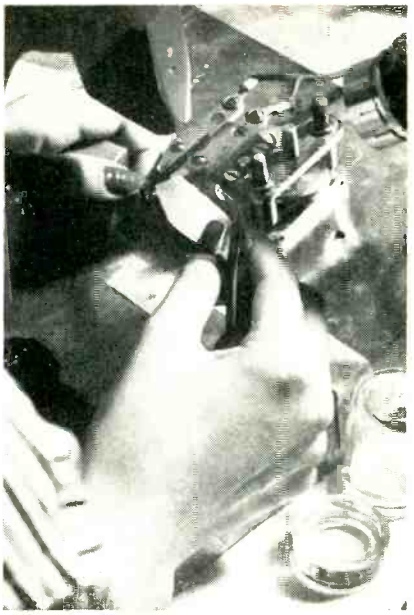
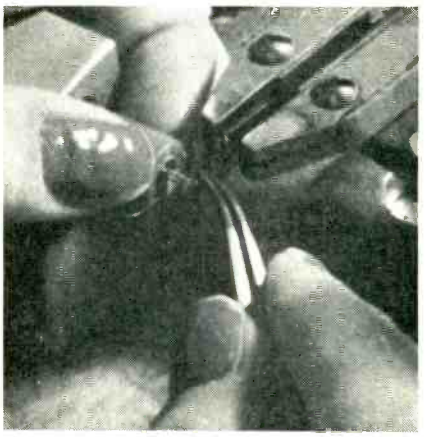
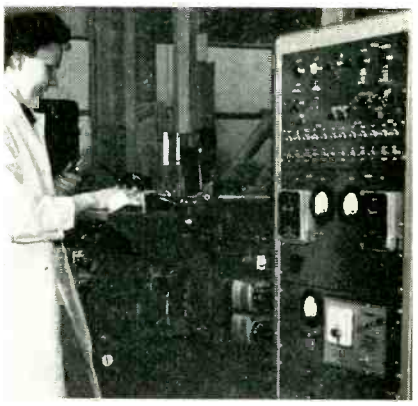
Offices in major cities:—Chicago • Kansas City • Los Angeles • Dallas • Dayton • Washington • Seattle • San Francisco • Toronto Export:—Maurice I. Parisier, 1860 Broadway, N.Y.C.



Applying flux to whisker wire in hand-soldering jig



Soldering whisker wire to emitter with radiant heat in hand soldering jig



Automatic whisker attacher for surface-barrier transistors. Rack at right holds associated controls

tank. The required ball of indium is built up on the end of the whisker in 5 seconds, controlled by a timer. After this plating operation, jaws move in to grip the whisker, cut

Family Portrait

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It's a good family to know, too!
Many of you already know us by our former name — Central Sales and Manufacturing, Inc. — because for many years leading design engineers have relied on our precision products and "personal" services to help solve their most difficult electronic problems.
CENTRAL'S exclusive quality control techniques have earned an industry-wide reputation for dependable product performance. And CENTRAL'S creative engineering capabilities are now meeting the challenges of tomorrow's industrial horizons.

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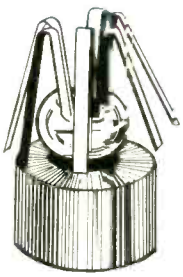

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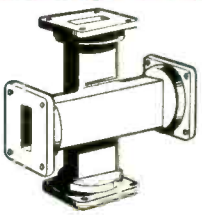
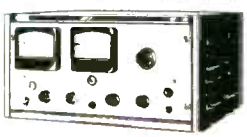


MICROWAVE COMPONENTS



TEST EQUIPMENT

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DENVILLE, NEW JERSEY

central electronic MANUFACTURERS, INC.

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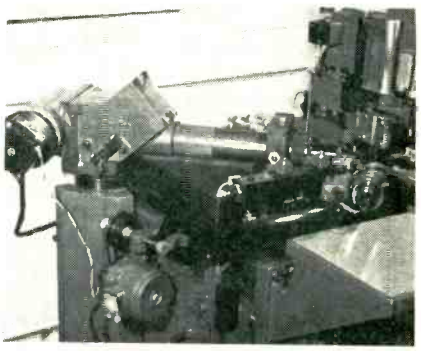
it off, bend it to shape and move it into position for soldering to the germanium. Servos are used in combination with a split-chopper photoelectric system to achieve precise positioning of the whisker. Radiant heat soldering is used just as in the hand assembly procedure.

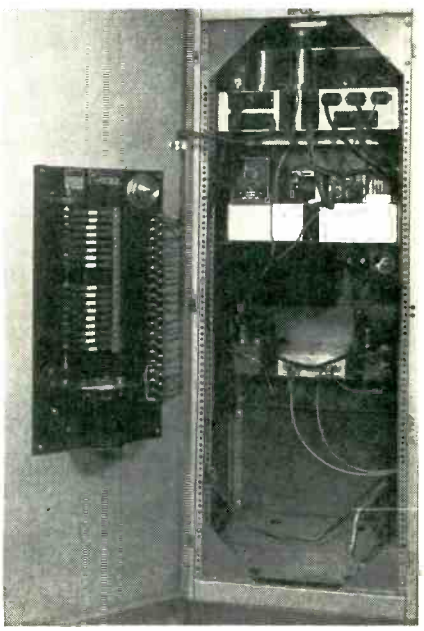
After soldering, the other ends of the whiskers are welded conventionally to the leads projecting up through the transistor stem.

▶ **Whisker Plating**—Before whiskers are soldered to the pellet of a surface-barrier transistor, the tiny wires must be plated with a yellow indium eutectic alloy in a precisely controlled manner. The fixture developed initially for this purpose does the plating automatically under control of a timer.

The spool of 1.5-mil or 2-mil nickel wire used for the whiskers

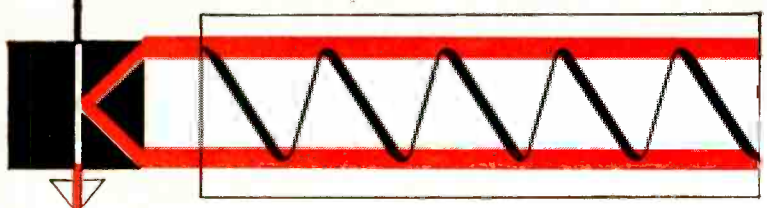


Whisker-forming and attaching mechanism



Control equipment for automatic whisker attacher

A REPORT FROM KELLOGG ON



KEL-F® GRADE Plastic 500

Results of electrical tests on Grade 500	
VOLTAGE BREAKDOWN	VOLTS
Initial volts	13,500
at 150°C.—1 week	13,000
2 weeks	14,600
at 175°C.—1 week	13,500
2 weeks	14,500
at 190°C.—1 week	11,300
2 weeks	9,600

New Fluorocarbon Plastic Formulation Provides Wire Insulation that can withstand Continuous Operating Temperature up to 175° C.

KEL-F PLASTIC, Grade 500—like all the molding compounds in the KEL-F fluorocarbon series—is notable for its extreme resistance to high temperatures, chemical attack, humidity and abrasion.

Of special interest to the electrical field is the higher heat-aging level of wire coatings with the new Grade 500. Tests on wire insulation indicate a continuous operating range of temperatures up to 175°C. Samples of coated wire exposed to temperatures as high as 190°C. for extended periods of time (2-3 months) still maintain relatively high voltage breakdown values.

Results of these electrical performance tests are summarized in the table above. An examination of the breakdown voltages after continuous exposure to high temperatures points up the high heat-aging level reached by KEL-F PLASTIC Grade 500 coated wire.

TWO TYPES AVAILABLE

KEL-F PLASTIC GRADE 500 is produced in two distinct types:

GRADE 500-F, a less crystalline type that resists embrittlement by high temperatures. Recommended for general wire and cable insulation, hook-up wire, thin wall tubing, and spaghetti.

GRADE 500-R, possesses same general properties as F type, only a slightly more rigid formulation. Recommended for use in connector insulation and for coil forms.

MOLDABILITY

The new Grade 500 permits extrusion of high molecular weight coatings and thin wall tubing that resist embrittlement when exposed to higher temperatures. Less crystalline in structure, Grade 500 can be fabricated without danger of splitting or crazing when heated. The flexibility of Grade 500 coated wire is also slightly improved.

TECHNICAL SERVICE

KEL-F PLASTIC Grade 500 is a result of Kellogg's comprehensive research in the field of fluorocarbon chemistry. Our technical staff will be happy to work with you in developing specific applications for the new Grade 500.

REPORT ON KEL-F PLASTIC, GRADE 500

Kellogg's TECHNICAL CUSTOMER Service Staff has prepared a technical report on KEL-F PLASTIC, Grade 500. It contains information on properties, extrusion techniques and operating conditions, electrical tests, and field evaluation of the new 500 Grade. To get your copy, just clip and mail coupon below.

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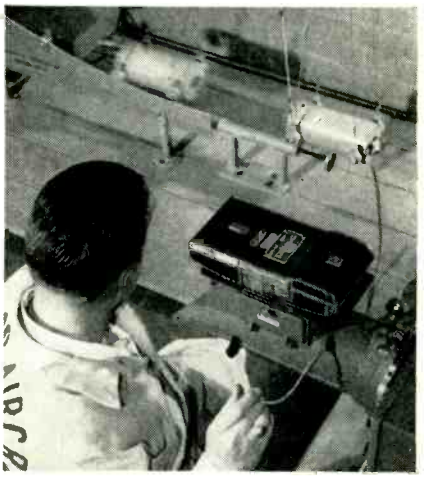
is mounted on a hinged arm of the plating fixture. When this arm is moved from the 4 o'clock position to the vertical, the correct amount of wire is fed down into the plating bath below by a ratchet. The wire serves as one electrode for plating; the other electrode is in the electric solder pot that holds the plating solution at high temperature. The operation produces a blob of indium about 6 mils thick on the end of the wire.

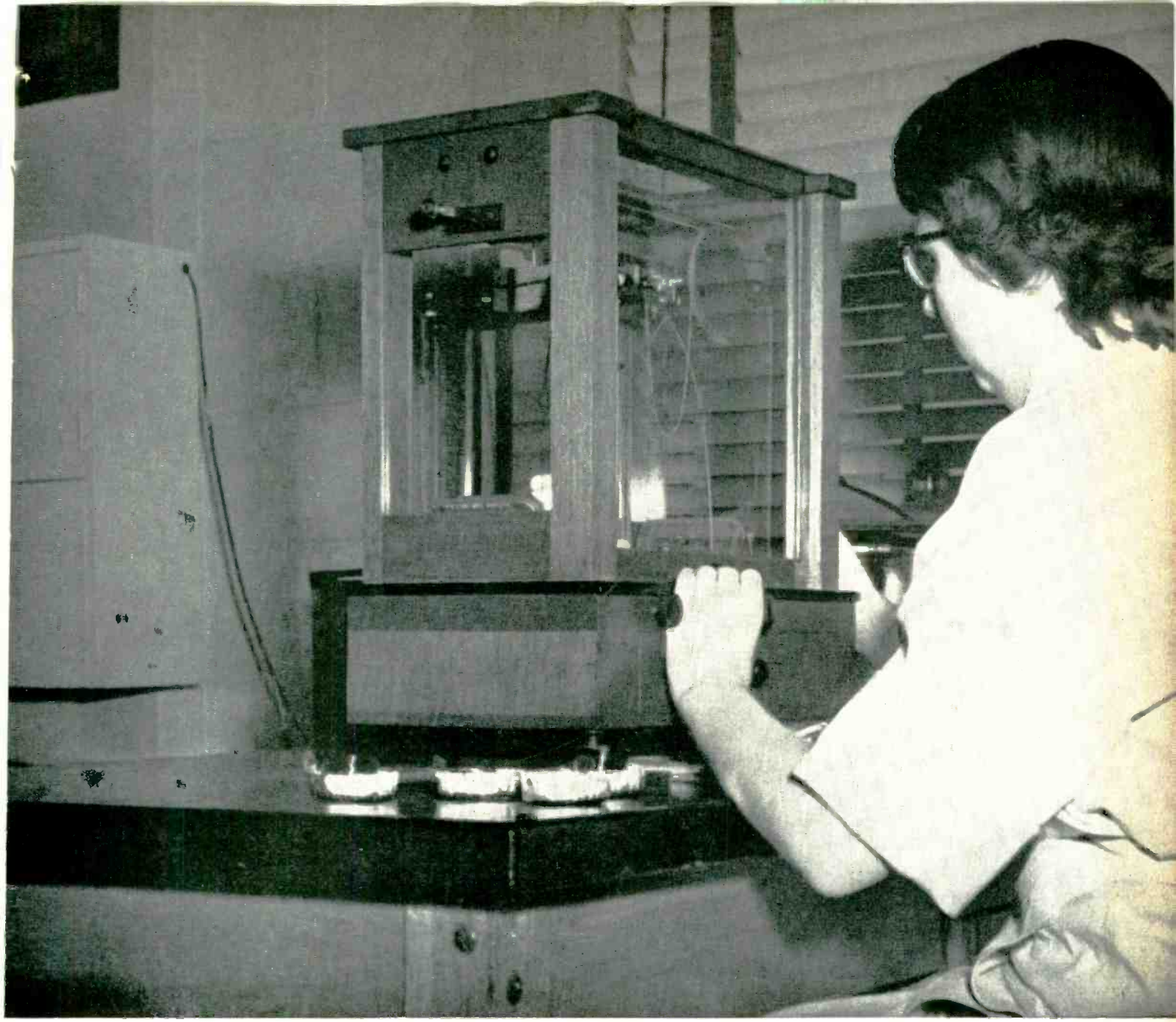
When plating times out, the operator swings the wire holder down to cut off the plater whisker, then pushes in a lever at the front of the fixture to bend the cut piece to the desired shape and trim it precisely to final length. After releasing the lever, she picks up the finished whisker with tweezers and drops it into a glycerol bath on a hot plate.

Matching Accelerometers with Ballistic Pendulum



Pendulum in motion (blurred at upper left) is about to strike cylindrical mass suspended at upper right, while operator holds camera shutter open to photograph traces on scope at right

STANDARD AND UNKNOWN ACCELEROMETERS are mounted at opposite ends of a suspended resonant-mass test device that is hit with 600-g force by a ballistic pendulum, to give a unique missile instrumentation comparison test in the Hawthorne, Calif. plant of Northrop Aircraft, Inc. The accelerometers are connected to the



LABORATORY TECHNICIAN carefully measures quality of sample of enamel before it is allowed on the production floor. Results of these tests are recorded and checked against rigid specifications.

This worker can help you cut rejects in winding

This technician and her co-workers check the quality of all raw materials received at Anaconda mills. Only after they are sure that Anaconda's rigid raw materials specifications are met is the material released for production.

This same rigid control is exercised over Anaconda Magnet Wire *throughout* its entire manufacture — even into shipping.

The result is the finest magnet wire on the market today. A production run will show you how this insistant demand for quality pays off in your winding room — in fewer rejects, longer break-free runs. Many customers are able to eliminate incoming inspection, too.

The Man from Anaconda will be glad to cooperate. Offices in 27 cities — see "Anaconda" in your phone book. Or write: Anaconda Wire & Cable Company, Magnet Wire Headquarters, Muskegon, Michigan.

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two inputs of a dual-beam oscilloscope and the traces at impact are photographed with a Polaroid camera.

If the pattern produced on the film shows a uniform pulse pattern from both components the test item is considered suitable for use on the USAF SM-62 intercontinental Snark missile. These components must necessarily be rugged and precise to withstand the extreme acceleration of missile flight and operate without error until the pilotless craft reaches its distant target.

Corona Resistance Test for TV Anode Cups

By R. D. SCHWARTZ

Standardizing Section
The Magnavox Co.
Fort Wayne, Indiana

ORDINARY HOME-TYPE ozone generators form the basis for a quick and inexpensive corona resistance test, used to select anode connector cups which will exhibit good resistance to the effects of corona when used on color picture tubes where voltages as high as 25,000 volts are common.

No attempt has been made to interpret the test on a quantitative basis. It provides a quick means of comparing an unknown with a part that is considered satisfactory or of comparative evaluation of a series of materials.

▶ **Setup**—The ozone generating fixtures, available in most appliance stores, were placed in a General Radio standard capacitor wooden case. A piece of hardware cloth was pressed into the upper portion of the box for specimen mounting.

▶ **Results**—In the actual tests, the material under test was mounted on the mesh under stress. It is important that stress be applied to more readily show up the corona effects. The box cover was closed, except for the small gap caused by the fixture line cords. The ozone generators were left on continuously for the test duration, which is usually several days. The heat from the fixtures produces an

TAYLOR
Laminated Plastics
Vulcanized Fibre

Shop Talk

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

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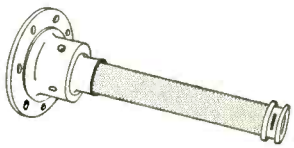
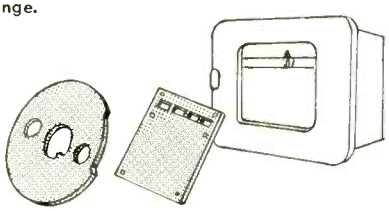
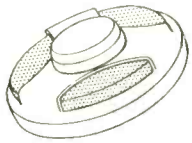
Tips for designers



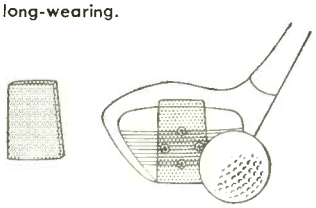
Aircraft fuel gage tank unit uses a tube of Taylor Epoxy Glass Base Laminate . . . an unusual material noted for excellent corrosion resistance and electrical insulation over a wide humidity range.



Cam and terminal board for recording instrument, made of Taylor Grade XP Laminate . . . noted for its electrical insulating properties and ease of machining.



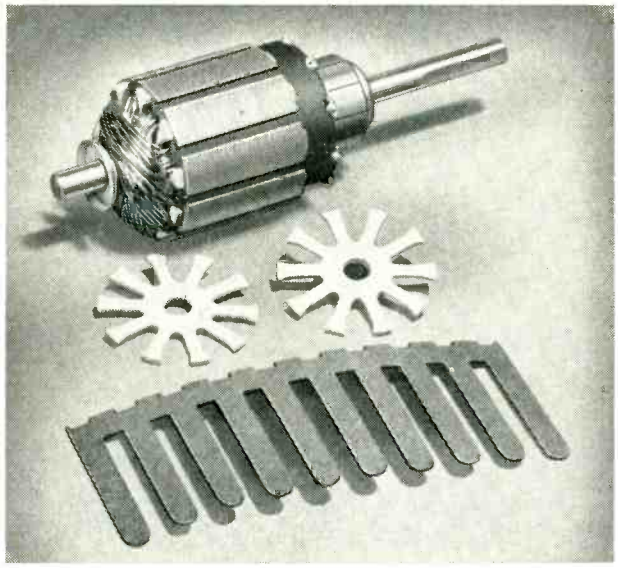
Fuel pump valve seat . . . Taylor Grade LE phenol laminate resists attack by gasoline . . . tough, long-wearing.



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

TAYLOR FABRICATING FACILITIES

Your production can be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts to your specifications. Efficient, modern facilities are ready to serve you. Get in touch with Taylor about your requirements.



Toughness, flexibility and dielectric strength are required for insulation for motor armature windings. Taylor Insulation and Commercial Grade Vulcanized Fibre serve ideally for slot wedges, topsticks and end laminae . . . and paper-base tube for the thrust bushing.

For tough, pliable insulation -try Taylor Vulcanized Fibre

You probably have a product design job on hand right now that could gain from the economy, machinability, and performance advantages of Taylor Vulcanized Fibre. In the application shown above, Taylor Vulcanized Fibre was chosen for its high impact strength, excellent bending qualities, and outstanding insulating properties. Designers are putting its wide range of properties to work in new, demanding applications every day.

It's a rugged material—tough enough to withstand heavy wear and abrasion, yet resilient enough to take heavy pounding. You can use it to advantage in gaskets, washers, cams, workbench tops, abrasive discs, and structural parts.

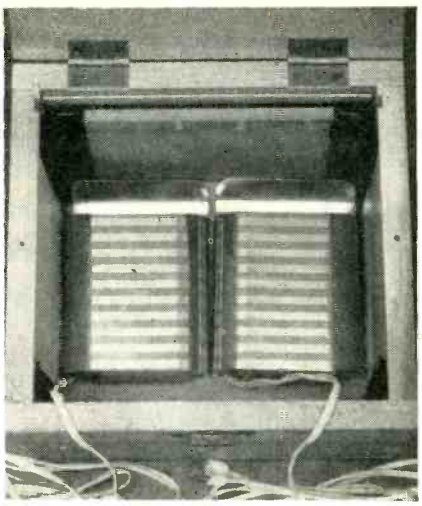
It has high arc resistance and dielectric strength—an ideal material for use in electric motors, transformers, appliances, circuit breakers, and switches.

In any of its applications, Taylor Vulcanized Fibre brings important savings in fabricating. It's readily formed . . . easily punched, stamped, drilled, cut.

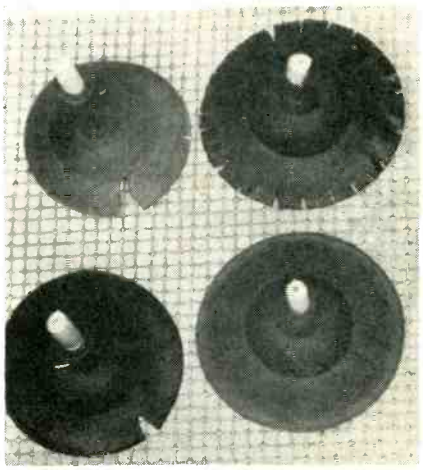
From the many grades of Taylor Vulcanized Fibre, you can choose the properties needed for your job. It's supplied in various colors . . . in rolls, strips, and turned rods . . . and in the largest sheet size in the industry.

Check with your Taylor representative for help in gaining the many benefits of this versatile material for your own products.

Want more information? Use post card on last page.



Ozone generators in box



Appearance of caps after four-day test. That at lower right, used as standard of comparison, is still in good condition whereas all three others show cracks

ambient of approximately 55 C in the test chamber.

In one four-day test the part used as a standard because of satisfactory field experience was in good condition at the end of the test, while the other parts showed definite deterioration.

Motorized Tester for Waveguide Components

By JOHN MOYTA

Test Engineer
Convair (San Diego)
Division of General Dynamics Corp.

NEED FOR QUICKER means of obtaining acceptance testing information became apparent in the course of producing waveguide components for K_u-band radars. The method of

A triumph of over 3 years' research!

New Westinghouse Rectox® Industrial Selenium Stacks

Westinghouse research developed the unique evaporation process of applying selenium which gives better contact area, lower forward drop, and less leakage than any other selenium stack available.

Here's how Westinghouse selenium stacks give outstanding performance—

- Lowest forward aging rate in the industry
- Up to 90% conversion efficiency
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Get all the information you need from your Westinghouse Sales Engineer—*The Man With The Facts.* J-21927

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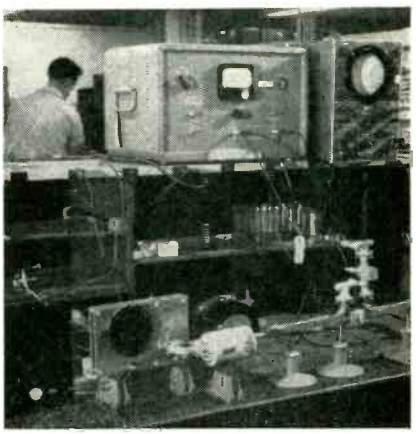
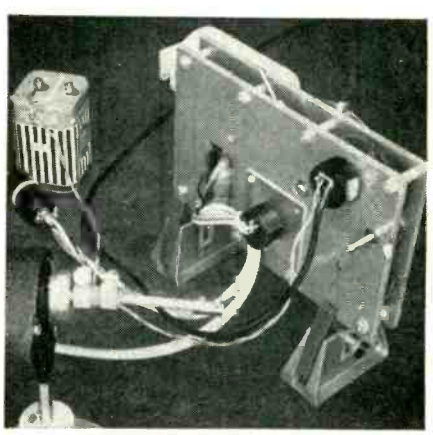
obtaining testing information by the point-by-point plotting of vswr as a function of frequency is particularly slow where tuning component is involved. To tune one rotating joint, for example, might require that 100 sets of points be plotted before the bandwidth requirements are met. Also, the effect of adjustments made is uncertain until after about 20 points are plotted.



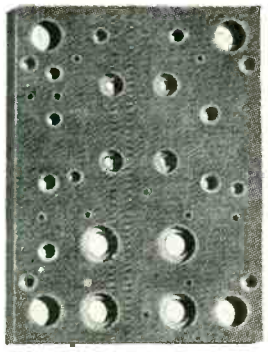
Complete production test setup for waveguide components, with reflector power supply at left on bench and motor-driven klystron on vertical plate assembly at its right. Hewlett-Packard ratio meter and DuMont oscilloscope on shelf are used in tests

▶ **Klystron**—An investigation was made into the feasibility of converting an existing test-bench klystron to a mechanically-driven

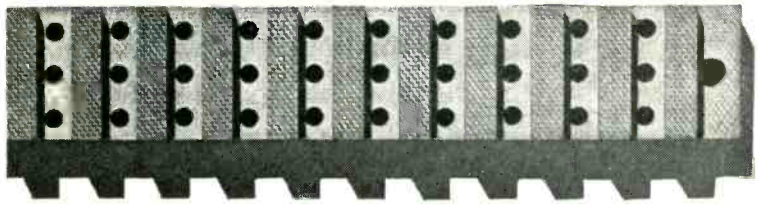


Components to be tested are inserted in waveguide system supported by adjustable stands. System uses quick-disconnect flanges. Calibrated dial on klystron frame serves for adjusting reflector tracking

FOR CRITICAL APPLICATIONS, specify self-extinguishing, high-strength C-D-F DILECTO® MELAMINE LAMINATES

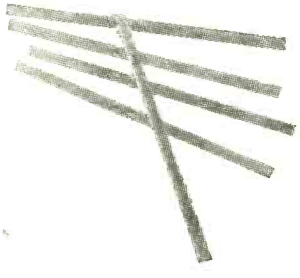


AIRCRAFT PANEL BOARD — GB-28-M, ¼" laminate machined by C-D-F at one of its well-equipped plastics fabricating shops.



TERMINAL BLOCK—C-D-F machined it from standard GB-28-M sheet stock, by sawing, milling, sanding, drilling, counterboring, and stamping characters.

RF COIL FORM—GB-112-M rolled tubing; sawed, drilled, and burred at C-D-F machine shops next to the presses that produce Dilecto.



ARMATURE SLOT WEDGES — Standard GB-28-M sheet; sawed, beveled, and cut off by C-D-F production machining methods.

GLASS-BASE MELAMINE grades of Dilecto are particularly suitable for electro-mechanical parts requiring high flame- and arc-resistance, flexural and impact strength. C-D-F offers the following melamine grades in sheet, tube, and rod form, *or as completely manufactured components to your specifications:*

GB-28-M (NEMA grade G-5)—Medium-weave glass cloth laminated with high-purity melamine resin. Highest mechanical strength of the three grades listed. *Will not support combustion.* Dimensionally stable over wide temperature and humidity range.

GB-112-M (NEMA grade G-5)—Fine-weave glass-cloth laminate, generally used in thicknesses less than 1/32". Substantially same characteristics as GB-28-M.

GM-1 (NEMA grade G-8)—Glass-mat laminate supplied in sheets only or as finished parts. A lower-cost grade suitable for many applications requiring arc- and flame-resistance and good mechanical strength.

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

CDF **CONTINENTAL DIAMOND FIBRE**

CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.

NEWARK 16, DELAWARE

sweep oscillator which would cover the required band and give a visual presentation of the required information either on an oscilloscope or X-Y plotter. With the availability of commercial reflectometers and ratio meters, the problem remained solely with the mechanically driven r-f source.

A type VA-94 klystron was investigated as to tuning rate, repeller characteristics versus tuning rate, and power output over the required band. This information is plotted in Fig. 1. Since this tube is an external-cavity klystron, it lends itself to modification to mechanical operation. The tuning

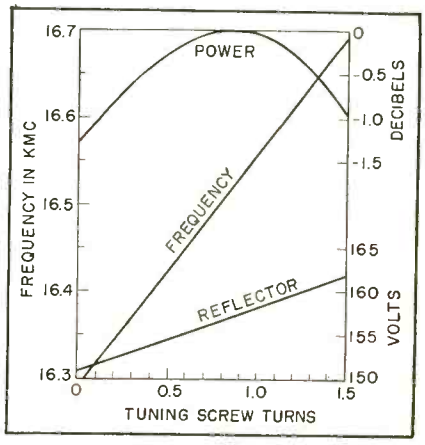
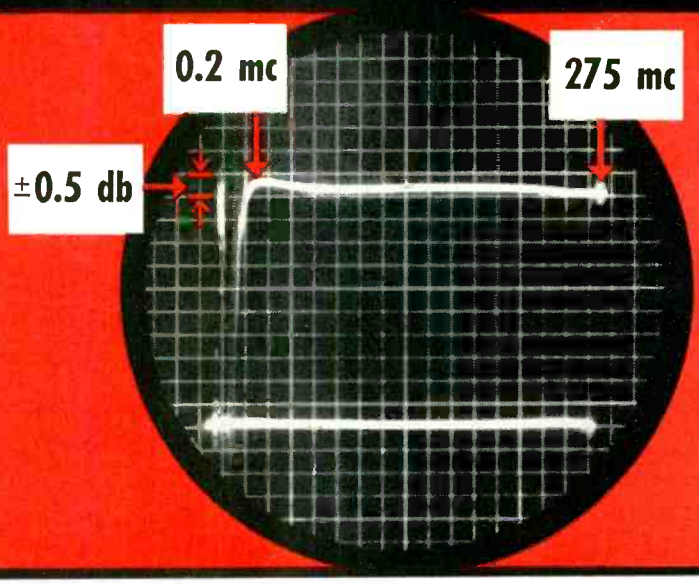


FIG. 1 — Characteristics of VA-94 klystron. Linear tuning-rate curve permits adaptation for mechanical drive

mechanism in the tube, as supplied by the manufacturer, consists solely of a plunger pin on the end of a No. 10-56 screw. The conversion to accept mechanical drive consists of converting the screw to a bushing carrying through it a pin with a comfortable sliding fit and of the same diameter as the original pin, as in Fig. 2.

▶ **Mechanical Drive**—To insure a long life, the bushing is made of bronze and the plunger or pin of polished stainless steel. The desired plunger motion information was translated from the turn-versus-frequency information in Fig. 1. Since the required motion is relatively small, approximately 0.018 inch per turn, operation directly from a cam was deemed inadvisable

SWEEP Wide Bands In One SWOOP



with

JERROLD'S NEW W-I-D-E BAND SWEEP GENERATORS

MODEL 900

For laboratory or production tests where unusual versatility, high stability and extreme constancy of output are essential in accurate sweep frequency measurements.

Supplies a sweep signal at any frequency from 0.2 mc to approximately 1000 mc with sweep widths as high as 300 mc or as low as 0.1 mc.

SPECIFICATIONS:

	VHF Range	UHF Range
Center Frequency:	Continuously Var. 0.2 mc to 275 mc.	Continuously Var. 275 mc to 1000 mc.
Sweep Width:	Continuously Var. 0.1 mc to 275 mc.	Continuously Var. 0.1 mc min. to max. of 100 mc at 275 mc cent; 300 mc at 1000 mc cent.

Source Impedance: *75 ohms—VSWR less than 1.2

Output Voltage:	0.3 V rms	0.3 V rms
Max. Output Voltage Variation at Max. Sweep	±0.5 db	±3.0 db

Frequency Modulation: 60 Cycle Sinusoidal

(50 ohm Model available on special order)

Model 900

- Internal Detector
- Internal Oscilloscope Preamplifier
- Internal Filter
- Internal Marker Amplifier
- Output AGC controlled

price $1120.00 f.o.b. plant

Models 95 and 220

price $375.00 f.o.b. plant

MODEL 220

A rugged portable unit that supplies a sweep signal at any frequency from 50 mc to 225 mc with sweep widths as high as 175 mc and as low as 2.0 mc. Output voltage is 0.7 volts rms (into 75 ohms) with a variation at maximum sweep widths of ±0.5 db.

MODEL 95

Same mechanical features as 220. Frequency range from 22 mc to approximately 110 mc. A high voltage output of 1.5 volts rms is maintained across this band to within ±0.5 db.

Ideal for laboratory or field use

SPECIFICATIONS OF MODELS 220 and 95:

Frequency Range: Model 95—22 mc to 95 mc; Model 220—54 mc to 220 mc — Continuously Variable

Sweep Range: Continuously var. from a min. of 2.0 mc to max. Sweep deviation approx. 5 to 1 range.

RF Output Response (75 ohms load): Model 95—1.5 Volts flat across a 70 mc—AGC controlled; Model 220—0.7 Volts flat across a 165 mc—AGC controlled

Horizontal Sweep Output: Sine voltage of 60 cps. Complete phasing over a range of 360 degrees is provided. Internal blanking provided.

This model available on special order covering any frequency range from a minimum of 1.0 mc to a maximum of 220 mc with maximum sweep deviation of approximately 5 to 1.

For detailed information write to

JERROLD ELECTRONICS CORPORATION

23RD and CHESTNUT STREETS • PHILADELPHIA 3, PENNSYLVANIA

in view of the extremely close tolerance involved in making a linear cam with such a small deviation. Therefore, a cam with a larger deviation with a bell crank of the proper ratio in the arms was decided upon as the best solution. The mechanical schematic of this

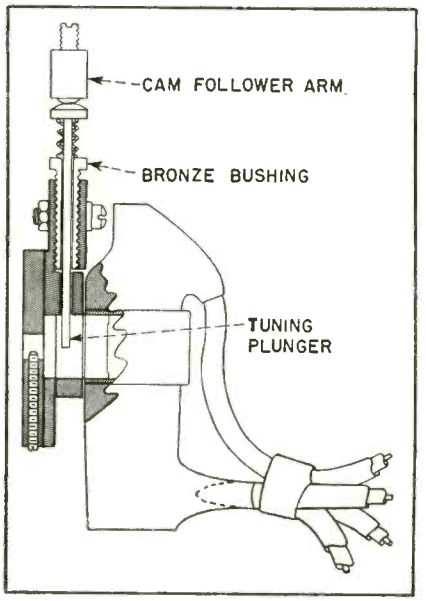


FIG. 2—Method of replacing tuning screw of klystron with spring-loaded plunger pin that can be pushed in and out by cam arm

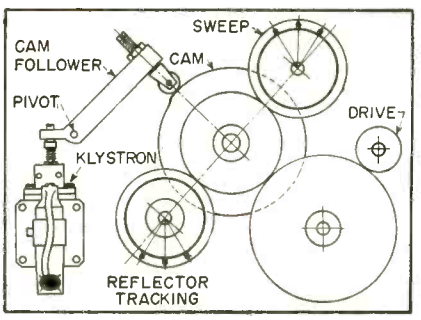
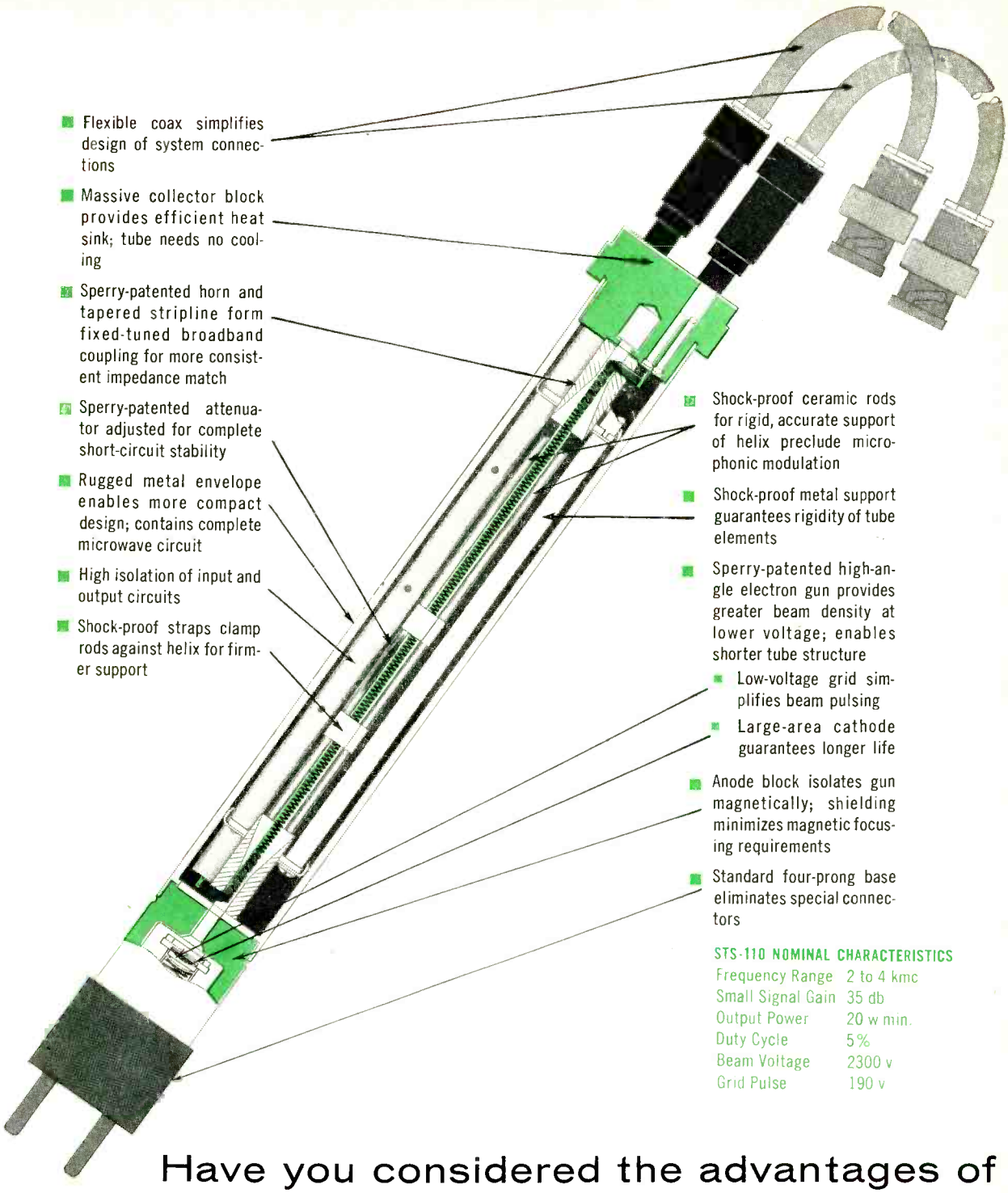


FIG. 3—Arrangement of gears between motor drive and cam used for moving tuning plunger in and out of klystron at desired sweep rate

arrangement is shown in Fig. 3.

▶**Tracking**—The problem of reflector tracking was solved by replacing the original reflector supply bleeder network with the one shown in Fig. 4. The operating point is selected by inserting the reflector tracking potentiometer between the arms of dual potentiometer R_1; the range of tracking potentiometer R_2 is adjusted by varying the current through the



STS-110 NOMINAL CHARACTERISTICS

Frequency Range	2 to 4 kmc
Small Signal Gain	35 db
Output Power	20 w min.
Duty Cycle	5%
Beam Voltage	2300 v
Grid Pulse	190 v

Have you considered the advantages of Sperry ALL-METAL travelling wave tubes?

The new Sperry *all-metal* travelling wave tube shown here in cutaway form was produced to provide the driving power for multi-megawatt klystrons used in defense radars. Its characteristics, however, open the door to unlimited new applications. Being made of metal, this Sperry travelling wave tube is *rugged*—withstands far greater shock and vibration than any previous tube. *Electrical characteristics are better,* providing excellent phase stability. And from the system engineer's standpoint, *application is simpler.* Sperry's all-metal travelling wave tubes conform to your design, eliminating the necessity of designing to conform to the tube. A new data sheet on the STS-110 is yours for the asking and our Electronic Tube Sales Department will gladly give you information relating this new development to your specific projects.

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network by changing R_3.

Synchronized sweep is provided by a potentiometer across a small battery. Both sweep and tracking potentiometers are of the continuously rotating servo type, linear and with the resistance element covering as much of 360 degrees as possible. These two potentiometers are connected to the cam with gears of 1:1 ratio and synchronized by rotating them in their mountings. An idler gear between the cam and drive gear was selected

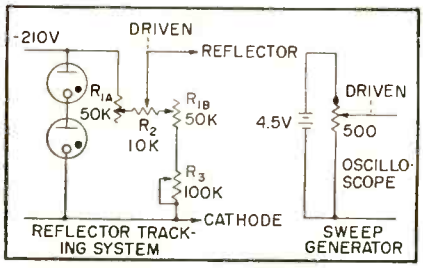
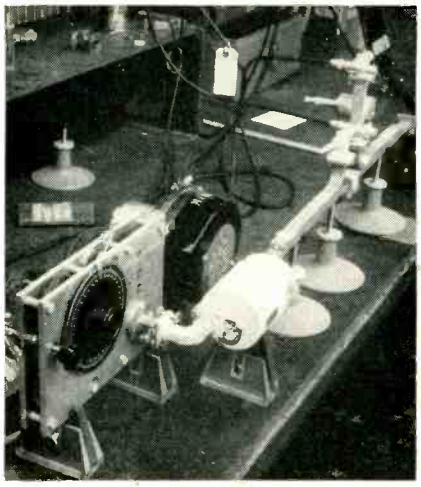


FIG. 4—Reflector tracking and sweep circuits as modified for mechanical drive of sweep oscillator



Rear view of klystron frame, with drive motor at left. Klystron can be seen in opening near left end of frame

to give some fineness when turned manually. A 60-rpm gear reduction motor is ideal for oscilloscope presentation; about 1 rpm is satisfactory for X-Y plotter operation.

▶ **Performance**—The klystron is isolated by a ferrite isolator to insure maximum power output with minimum load effect. Cavities can be inserted in either or both ratio arms to provide reference marks. The oscilloscope should have d-c inputs to both axes and a long-per-

NEW!

MICROWAVE SWEEP GENERATOR

1,000 to 15,000 mc

- *7 Bands...*
- *Interchangeable Units...*
- *Stable Backward Wave Oscillators...*

- Sweeps full frequency range of unit
- Rapid sweep or fixed frequency operation
- Direct reading frequency dial
- Power monitor and attenuator
- High power output, from 10 mw to one watt
- Pulse rise time less than 0.15 microsecond (external modulation)
- Provision for amplitude modulation from external source
- Internal 1000 cps and 456 kc square wave modulation
- No moving parts, assuring long equipment life and reliable operation

Polarad **Model ESG** Microwave Sweep Generator makes possible rapid, dynamic testing of broadband and narrowband microwave systems and components. Its operation is completely electronic, eliminating the need for point-by-point measurement. An integral variable r-f attenuator is provided with each microwave oscillator unit, and the r-f power output level is continuously monitored. This versatile instrument may be used for fixed frequency measurements. Frequency is read directly on face of meter.

Model ESG can be used with the Polarad Rapid Scan Ratio-Scope for direct and instantaneous measurement of reflection or transmission coefficients.

TEST:
receivers, amplifiers, preselectors, jammers, intercept equipment, beacons, antennas, T/R tubes, crystal mounts, fixed and tunable filters, as well as complete radar and microwave systems.

SPECIFICATIONS

Basic Unit: Model E-B

MODEL	FREQUENCY RANGE	POWER OUTPUT
Model E-L1	1000 to 2,000 mc	80 to 1000 mw
Model E-L2	1600 to 3,200 mc	80 to 1000 mw
Model E-S1	2000 to 4,000 mc	80 to 800 mw
Model E-C1	3600 to 7,200 mc	25 to 400 mw
Model E-C2	4800 to 9,600 mc	20 to 150 mw
Model E-X1	6500 to 11,000 mc	20 to 100 mw
Model E-X2	7500 to 15,000 mc	15 to 40 mw

Sweep Width: Continuously adjustable to full frequency range of Microwave Oscillator Unit in use.

Sweep Rate: 60 cps

Internal Modulation Rate, during Sweep Operation:
(a) 1000 cps square wave. (b) 456 kc square wave.

Modulation capabilities, during non-swept Operation:
(a) 1000 cps square wave. (b) 456 kc square wave.
(c) External modulation.

Output when modulated with external pulse:
(a) Pulse rise time less than 0.15 microsecond.
(b) Minimum pulse width less than 0.3 Microsecond.

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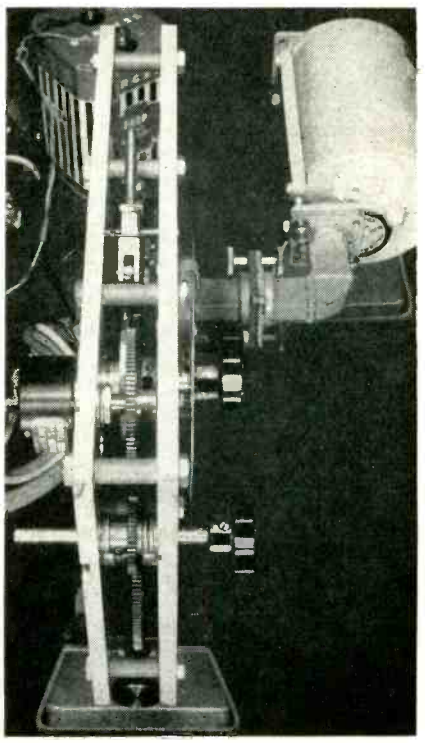
sistence screen. Absolute measurements in vswr are not to be expected because of the frequency dependence and nonsquare-law characteristics when crystal detectors are used. Some improvements in this respect can be expected with the use of bolometers. However, as a go—no-go and minimizing type of testing operation, this system is an invaluable time saver. Having available vswr standards of the nonfrequency-dependent type is a valuable adjunct to this equipment, making its use by unskilled personnel more reliable.

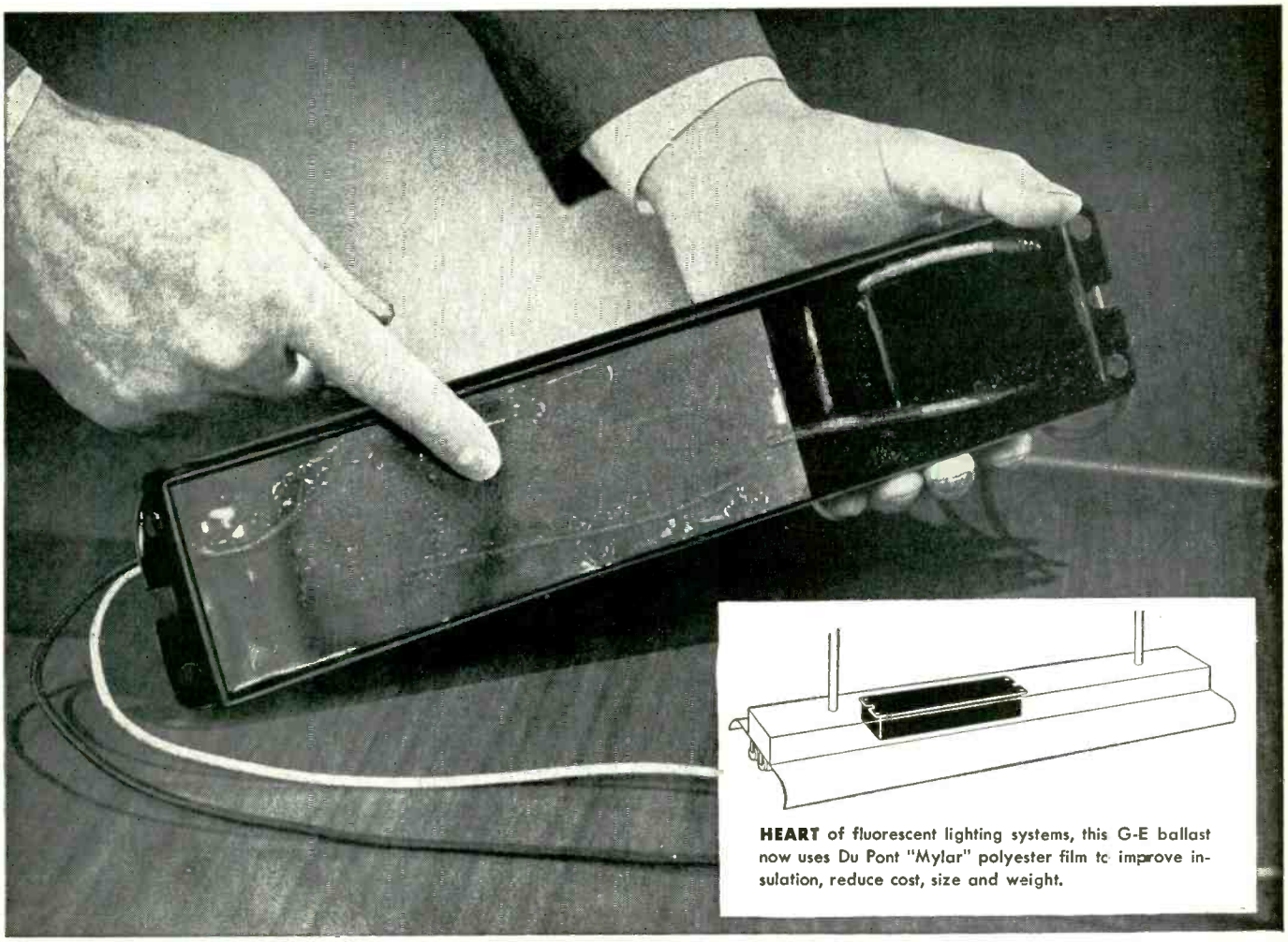
The unit just described is a prototype. Some improvements in future units could include such features as an integral motor and cooling fan for the tube, over-riding clutch for driven or manual operation, and complete packaging of the unit.



End view of klystron frame, showing gear train used between drive shaft in foreground and cam at rear between plates

The present unit has withstood a change of klystron and hundreds of hours of operation with a minimum of adjustments, and has satisfactorily served its intended purpose.

MYLAR* provides improved insulation...



HEART of fluorescent lighting systems, this G-E ballast now uses Du Pont "Mylar" polyester film to improve insulation, reduce cost, size and weight.

G. E. reduces cost and weight by using Du Pont MYLAR® in ballast

General Electric selected "Mylar" as the insulating material for many of its fluorescent lamp ballasts.

Reasons? First, they needed a tough material with high dielectric strength. Next, it had to be easily applied and economically feasible.

Because of the hot potting compounds, the insulating material had to resist heat and chemicals. Lastly, it had to be thin and lightweight in order to provide compactness for reducing ballast space in fluorescent fixtures.

This successful application is only one of the many ways that versatile "Mylar", used alone or in combination with other materials, is making possible superior performance in capacitors, coils, motors and a host of other electrical products.

Perhaps "Mylar" can help *you* solve a knotty development problem or improve product performance. For more information on this unique polyester film and its applications in your field, send in the coupon for a fact-filled booklet. Be sure to indicate the type of application you have in mind.

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Application_____
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New Products

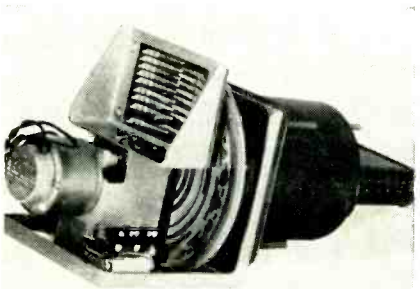
Edited by WILLIAM P. O'BRIEN

74 New Products and 45 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

CONVERTER

analog-to-digital

BENDIX AVIATION CORP., Pacific Division, 11600 Sherman Way, N. Hollywood, Calif., has available an analog-to-digital converter designed for accurate long-distance transmission of data representing voltage, current and power. It uses a conventional pointer-type meter without modification of the movement or loading of the output shaft.

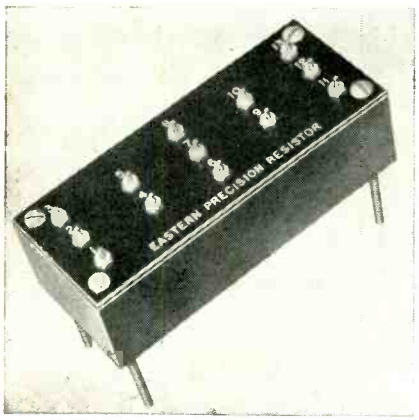


▶ **Components**—The basic elements of the meter-reader are: a photocell and light source assembly; a pointer path length mirror; a small motor; a code disk; a sensitive relay; and a group of digit storage relays, one for each digit of the code disk.

Digital readings of electrical power may be taken at 3-second intervals and transmitted with an accuracy of better than 1 percent over long distances. **Circle P1 inside back cover.**

VOLTAGE DIVIDER

a network of 11 resistors



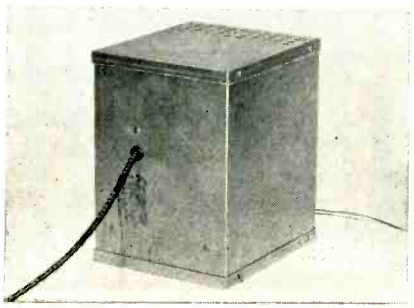
EASTERN PRECISION RESISTOR CORP., 675 Barbey St., Brooklyn 7, N. Y. A recent development in precision resistor manufacture, involving internal cushioning and the application of synthetic resins during winding, resulted in a precision voltage divider which conformed to these specifications: A network of 11 precision wire-wound resistors of values ranging from approximately 7,000 to 171,000 ohms and matched to 0.005 percent at both d-c and 400 cps over a temperature range of 50 degrees C.

The network was mounted on an anodized engraved aluminum face plate containing Teflon feedthroughs to minimize leakage problems. Four studs were provided for mounting. The network was then encapsulated in thermosetting resin with zero percent shrinkage characteristics to avoid external pressure effects on the resistors, and to meet the MIL-R-93 Government specification. The same method of construction can be furnished in a variety of sizes and configurations. **Circle P2 inside back cover.**

R-F POWER SUPPLY

with 7.5 to 12 kv output

SPELLMAN TELEVISION CO., 3029 Webster Ave., Bronx, N. Y., now manufactures a new r-f type power supply with a voltage output of approximately 7.5 to 12 kv. One ma of current may be drawn throughout the voltage range. To obtain an output of 7.5 kv at 1 ma, low voltage input requirement is 300 v d-c at 50 ma. By varying the d-c input, the output voltage can be increased. Maximum input voltage of 425 v at 100 ma will give an output of 12 kv at 1 ma. Net price of model 7512 is $42.50. **Circle P3 inside back cover.**



MINIATURE RELAY

for low cost equipment

COMAR ELECTRIC CO., 3349 W. Addison St., Chicago 18, Ill., has an-

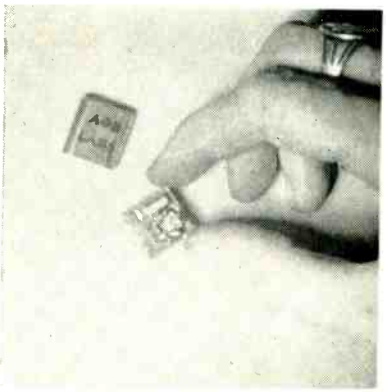
nounced the type S miniature d-c relay which measures only $\frac{7}{8}$ in. wide, $1\frac{3}{16}$ in. long and 1 in. high overall. It is particularly suitable for use in low cost electronic equipment, radiosonde, expendable devices and printed circuits.

▶**Technical Data** — Additional specifications stated are: sensitivity rated at 40 mw; coil resistance up to 7,500 ohms, standard; contact rating $1\frac{1}{2}$ amperes at 115 v a-c, for spdt; cross-bar contacts available; choice of two mounting styles, single stud 6/32 by $\frac{5}{8}$ in. or insulated base. **Circle P4 inside back cover.**

TRANSISTOR CIRCUITS

are potted and sealed

DOTY ACOUSTICAL ELECTRONIC LABORATORIES, 557 Broome St., New York 13, N. Y., has available potted and sealed transistor circuits such as flip-flop, multivibrators, d-c amplifiers, audio and r-f oscillators, saw tooth generators, gates, inverters and similar units. The units can be used as a plug-in or may be soldered into bails to form computers or allied electronic circuits. Their versatility makes it possible to break any existing electronic equipment into separate component stages.

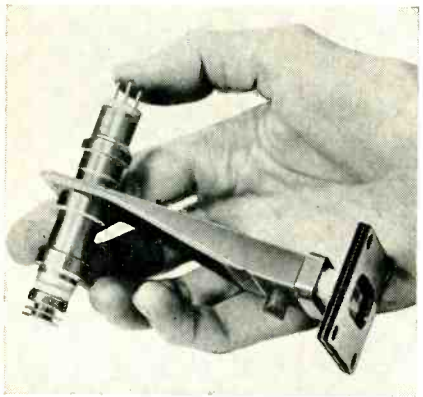


▶**Dimensions** — Minimum size is 0.313 long by 0.717 wide by 0.312 high; average—0.750 by 0.717 by 0.312; maximum—1.500 by 0.717 by 0.312.

National Bureau of Standards circuitry is used, or special circuits can be made to user specifications. Any existing circuit can be assembled into these units, or units can be added to an existing circuit now being used. **Circle P5 inside back cover.**

B-W OSCILLATOR

miniature type, light in weight



VARIAN ASSOCIATES, 611 Hansen Way, Palo Alto, Calif., has developed a miniature backward-wave oscillator. Model VA-161 combines low power requirements, small, compact size and light weight with rugged construction. The new tube is instantaneously tuned by changing voltage.

▶**Application**—Used for radar systems, signal generators, search receivers and related microwave equipment, the VA-161 tube operates over the normal 8.5 to 9.6 kmc radar band on less than 300 v, making possible the use of existing radar system power supplies.

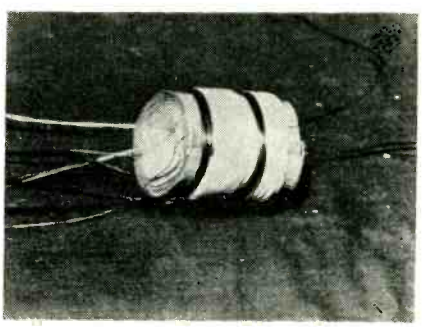
It involves a permanent magnet which weighs less than 5 lb, eliminating the need for an electromagnet and its associated power supply. Overall size of the tube is approximately 4 in. long by $\frac{3}{4}$ in. diameter. Because of its metal and ceramic construction, it will withstand severe shock and vibration. Power output is smooth across the entire tuning range, with relatively minor fluctuations. **Circle P6 inside back cover.**

TEFLON INSULATION

miniaturizes transformers

THE POLYMER CORP. OF PENNA., 2140 Fairmont Ave., Reading, Pa. A new line of h-v transformers developed by Goslin Corp., Burbank, Calif., use Polypenco Teflon tape to meet aircraft requirements for smaller, lighter and more rugged units. The transformers are used for airborne radar and electronic applications.

The high dielectric strength and high heat resistance of the Teflon tape insulation permits producing

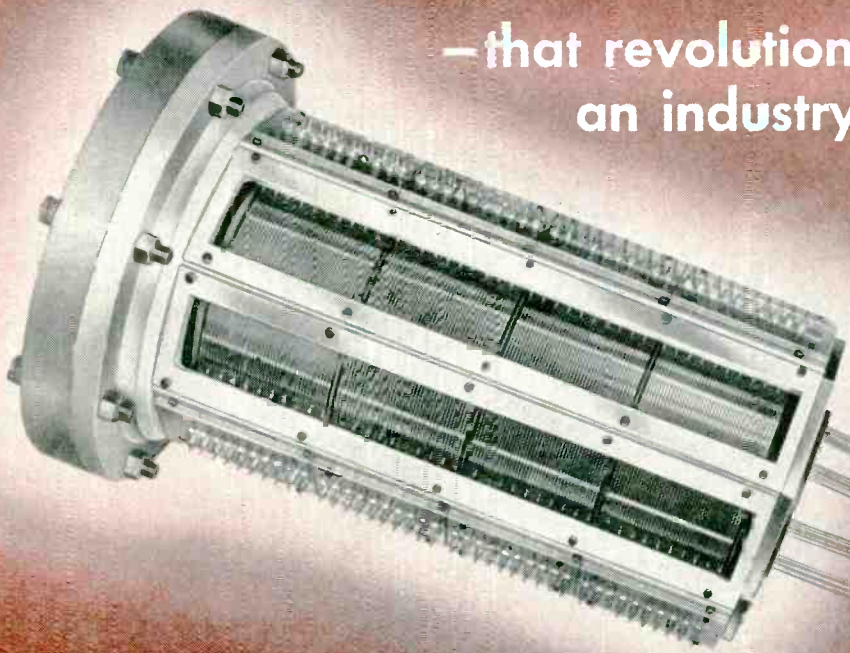


a 42,000 v transformer weighing only 14 lb. A 20-lb minimum weight was required using other insulation. With a smaller transformer, weight is reduced from 11 to 3 lb. The tape can be continuously used up to 550 F.

▶**Properties**—It will not generate a conducting carbon path due to arcing. It has a volume resistivity of 10^{15} ohm-cm and a surface resistivity of 10^{13} ohms at 100-percent relative humidity. It has zero water absorption and is fungus resistant. A thermosetting fiber glass wrapping is used over the Teflon to permit liquid resin im-

A DESIGN CONCEPT*

—that revolutionized an industry!



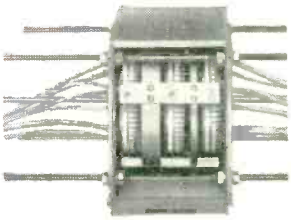
ELECTRO TEC

PRECISION MACHINED ONE-PIECE CONSTRUCTION

SLIP RING & COMMUTATOR ASSEMBLIES

Diameters of multi-ring assemblies from .035" to 36"

Individual components or complete assemblies to precise electrical, mechanical, and environmental specifications.



Uniformly hard rings, low noise, minimum friction and dimensional stability.

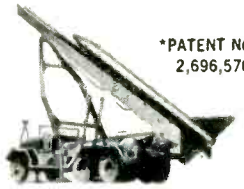
An Unmatched Record of Performance

Today, Electro Tec Slip Ring and Commutator Assemblies are the choice of leading aircraft, instrument, and component manufacturers throughout the world. Our units are selected for Gyro and Servo applications, for Telemetering and Radar devices, for Guidance systems, and Automation equipment... where sustained and reliable performance is a requisite.

Facilities Available to Serve You

Plants in South Hackensack, N. J., Blacksburg, Va., and Ormond Beach, Fla., are currently producing a wide variety of Slip Ring, Commutator, and Brush Block Assemblies, Precision Selector Switches, and Miniature Relays. Complete Engineering Facilities and Branch Sales Offices in Los Angeles, Minneapolis, Chicago, and Waltham, Mass. are geared to service your requirements.

Write for fully illustrated literature.



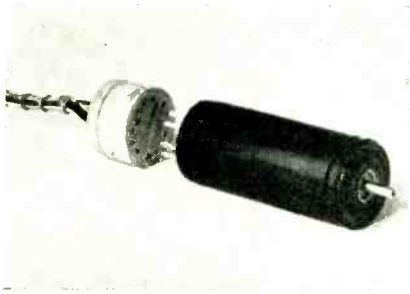
*PATENT No. 2,696,570

ELECTRO TEC CORP.

SOUTH HACKENSACK, NEW JERSEY

PRODUCTS OF PRECISION CRAFTSMANSHIP

pregnation of the units. **Circle P7 inside back cover.**



INDUCTANCE POT
has ±0.1 percent linearity

DIEHL MFG. CO., Somerville, N. J., has announced a new size 11 induction potentiometer with a linearity of ±0.1 percent over a range from 0 to 75 deg. An important feature is the placement of the input windings on the stator. This relieves the brushes and collector rings from the necessity of carrying current. In addition, the unit is completely machine wound. It operates at 70,000-ft altitude without pressurization.

▶ **Key Specifications** — Input impedances are up to 750 ohms; phase shift, ±5 minutes with rotor position; maximum null voltage, 1 mv per volt of input; and weight, 4.7 oz. **Circle P8 inside back cover.**

PHOTOTUBE
with 7½-in. cathode

CONTINENTAL ELECTRIC CO., Geneva, Ill. Number XR-673A photocell features a 7½-in. cathode which opens up many new appli-

a case history of airborne electronic equipment temperature control

*PAT. NO. 2,690,002

Some of the most delicate and vital electronic equipment in the Boeing B-47 is supplied by the Raytheon Manufacturing Company and protected by Roll-Bond cases. Made of single homogeneous sheets of aluminum containing a tubing design within the metal itself, these cases offer foolproof, leakproof cooling or heating equipment that must be right, every time.

Take advantage of this entirely new heat exchanger concept when you plan new products. Let our engineers work right with you. Often their suggestions will show you the way to better, more efficient products built at lower cost. Write for a new folder explaining the Roll-Bond process in detail.

Olin ROLL-BOND

WESTERN BRASS MILLS DIVISION

OLIN MATHIESON CHEMICAL CORPORATION

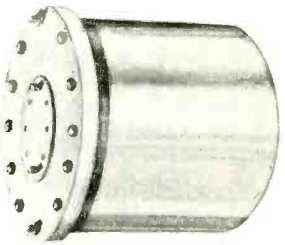
EAST ALTON, ILLINOIS

* THE ORIGINAL PATENTED PROCESS

cations. The long cathode eliminates the use of a bank of smaller phototubes, cuts down on circuitry and assumes stability of output over its entire length.

Sensitivities (average of readings taken at top, center and bottom of cathode) are as follows: minimum, 75 μa per lumen; nominal, 120 μa per lumen; and maximum 200 μa per lumen. Maximum operating temperature is 75 deg. Projected cathode area is 4.68 sq in.

The phototube can also be supplied in vacuum. **Circle P9 inside back cover.**

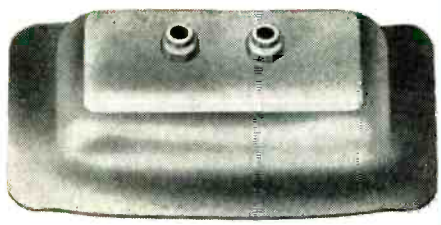


CAPACITORS
low inductance type

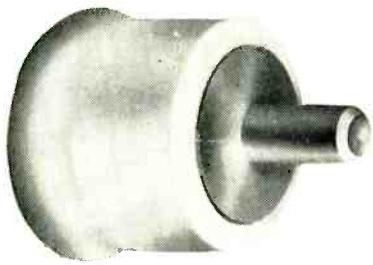
AXEL ELECTRONICS DIVISION, Axel Bros., Inc., 134-20 Jamaica Ave., Jamaica 18, N. Y., has available a line of low inductance capacitors designed for applications requiring high peak energy within a short time constant. They can be used for such applications as a precision light source for nuclear research, energy sources for linear accelerators, or as pulsed r-f tank circuit capacitors. Low inductance is achieved through a design which reduces magnetic flux to a minimum. The result is a unit of not only high voltage and high capacitance but also high ringing frequency.

▶ **Insulation** — The capacitors are hermetically sealed in a heavy-gage welded steel case. Insulating creepage distance is provided by an insulating cover, which provides terminal access and keeps size to a minimum.

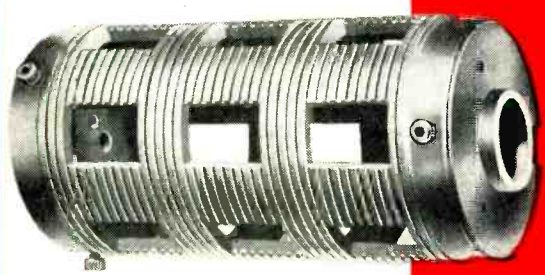
Electrodes are made of dead-soft, dry annealed aluminum foil,



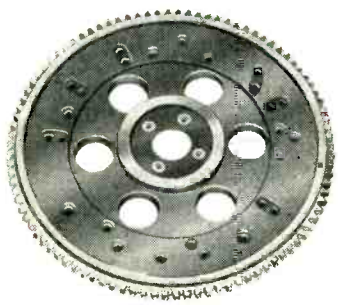
APPLIANCE SEAL . . . insures absolute physical seal — permanent bonding to inserts



BRUSH HOLDER STUD . . . maintains correct gapping under extreme conditions



COIL FORM . . . achieves dependable high speed, high frequency performance



SPUR GEAR . . . matching thermal expansion eliminates distortion and corona

Moldable

SUPRAMICA® 555

VERSATILE CERAMOPLASTIC

. . . MAKES COMPLEX INSULATED PARTS — BETTER!

SUPRAMICA* 555 ceramoplastic offers an unbeatable combination of properties . . . *absolute* dimensional stability, high thermal endurance, every desirable electrical characteristic . . . plus precision moldability to permanent tolerances of ±.001".

Think how your projects can be improved by this *unique* ceramoplastic's ability to hold fragile inserts . . . expansion coefficient that matches steel . . . and distortion-free performance under widely varying conditions. Here's a single material with all the features you need . . . extremely low electrical loss . . . unexcelled arc resistance . . . complete freedom from carbonization and imperviousness to radiation effects, water, oil and organic solvents.

The secret of this superiority: SUPRAMICA 555 ceramoplastic's exclusive formulation of top grade electrical glass and SYNTHAMICA* synthetic mica. Send to Department 336 for an *Engineering Data File* on SUPRAMICA 555 ceramoplastic insulation and MYCALEX custom molding services.

SUPRAMICA DIVISION

MYCALEX

CORPORATION OF AMERICA

THE FIRST SUPRAMICA® CERAMOPLASTIC

SINCE 1919 MYCALEX® THE INSULATOR

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MINNEAPOLIS
WASHINGTON

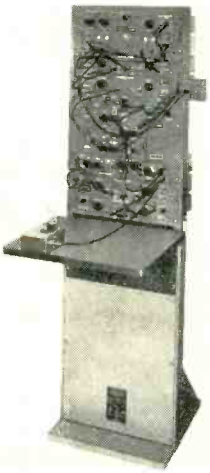
*SUPRAMICA is a registered trademark of MYCALEX CORPORATION OF AMERICA for ceramoplastic material.

SYNTHAMICA is a trademark for synthetic mica manufactured by SYNTHETIC MICA CORPORATION, a subsidiary of MYCALEX CORPORATION OF AMERICA.

WORLD'S LARGEST MANUFACTURER OF GLASS-BONDED MICA AND CERAMOPLASTIC PRODUCTS

held to the closest tolerances. Dielectrics used are high quality capacitor tissue and polyester film, with a stable, highly purified oil impregnant having high dielectric constant and strength.

Stock ratings are available from 500 joules at 25 kv with 0.025 μh inductance to 8,000 joules at 125 kv with 0.065 μh inductance. Other ratings and sizes are available to customer specifications. **Circle P10 inside back cover.**



CORE TESTER
performs varied functions

BURROUGHS CORP., Electronic Instruments Div., 1209 Vine St., Philadelphia 23, Pa. The newly developed magnetic core tester, BCT 301, designed expressly for testing tape wound bobbin cores, provides precise control over the frequency pattern, amplitude, and rise time of the core driving signal, and allows extremely accurate measurement of the switching time of the core as well as the amplitude of the output voltage.

▶ **Makeup**—Mounted on a single 6-ft relay rack, the BCT 301 consists of: (1) a core mounting jig designed to minimize not only pickup by the secondary but also other disturbances caused by air flux. (2) A pattern generator. (3) Two current drivers that convert the voltage pulses from the pattern generator into the positive and negative constant current pulses used for driving the cores. (4) A calibrator designed to measure the currents and voltages associated with the evaluation of

RCA "SPECIAL RED" AND "PREMIUM" TUBES

Optimum performance of electronic equipment, particularly when it involves critical applications, often depends on the quality of the tubes installed in the equipment. *Premium-quality* tubes minimize early failures and inefficient or unreliable equipment performance.

The ability to design and manufacture a *premium-quality* tube comes only with the accumulation of many years of experience in the development and production of tubes of all types. RCA's special knowledge of tube design, manufacture, inspection, and quality control is diligently applied in producing RCA PREMIUM TUBES. This special knowledge is your assurance of electron tube dependability and optimum performance of your equipment.

Design for dependability. In critical applications, *specify* "SPECIAL RED" and "PREMIUM" TUBES—available through your RCA TUBE DISTRIBUTOR. For technical data on RCA "Special-Red" and "Premium" tubes, write RCA, Commercial Engineering, Harrison, N. J.

RCA®

TUBES FOR INDUSTRIAL-ELECTRONICS

Radio Corporation of America, Harrison, N. J.

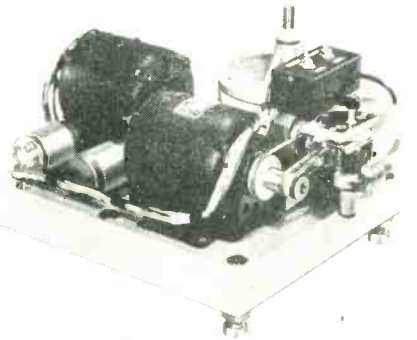
Prototype	RCA "Special-Red" and "Premium" Types
0A2	0A2-WA*
0B2	0B2-WA*
2D21	2D21-W*
6AC7	6AC7-W*
6J4	6J4-WA*
6AK5	5654
6AK5	5654/6AK5-W*
6AK5	5654/6AK5-W/6096*
2C51	5670
—	5686
—	5690†
6SL7-GT	5691†
6SN7-GT	5692†
6SJ7	5693†
—	5718
5718	5718-A*
—	5719
5719	5719-A*
6AS6	5725
6AL5	5726
6AL5	5726/6AL5-W*
6AL5	5726/6AL5-W/6097*
2D21	5727/2D21-W*
6BA6	5749
6BE6	5750
12AX7	5751
12AX7	5751-WA*
12AU7	5814-A
12AU7	5814-WA*
—	5840
5840	5840-A*
6AQ5	6005
12AY7	6072
0A2	6073
0B2	6074
6AS7-G	6080-WA*
6J6	6101
6J6	6101/6J6-WA*
6AU6	6136
6AG5	6186/6AG5-WA*
12AU7	6189/12AU7-WA*
12AT7	6201
5840	6205*

NOTE: Since the "Special-Red" and "Premium" types can not always be used as replacements, check tube data before replacing a type in the prototype column with the listed "Special-Red" or "Premium" type.

†Special-Red Tubes

*Built to the military specification applicable at the time of production.

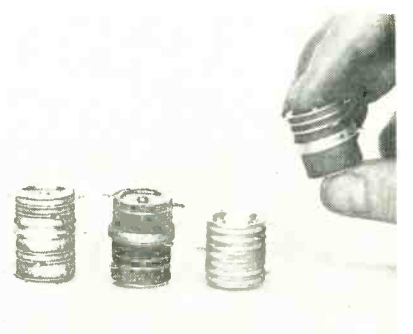
magnetic cores under pulse conditions. (5) A power supply which provides seven regulated d-c voltages. **Circle P11 inside back cover.**



RECORDER DRIVE
nine-speed type

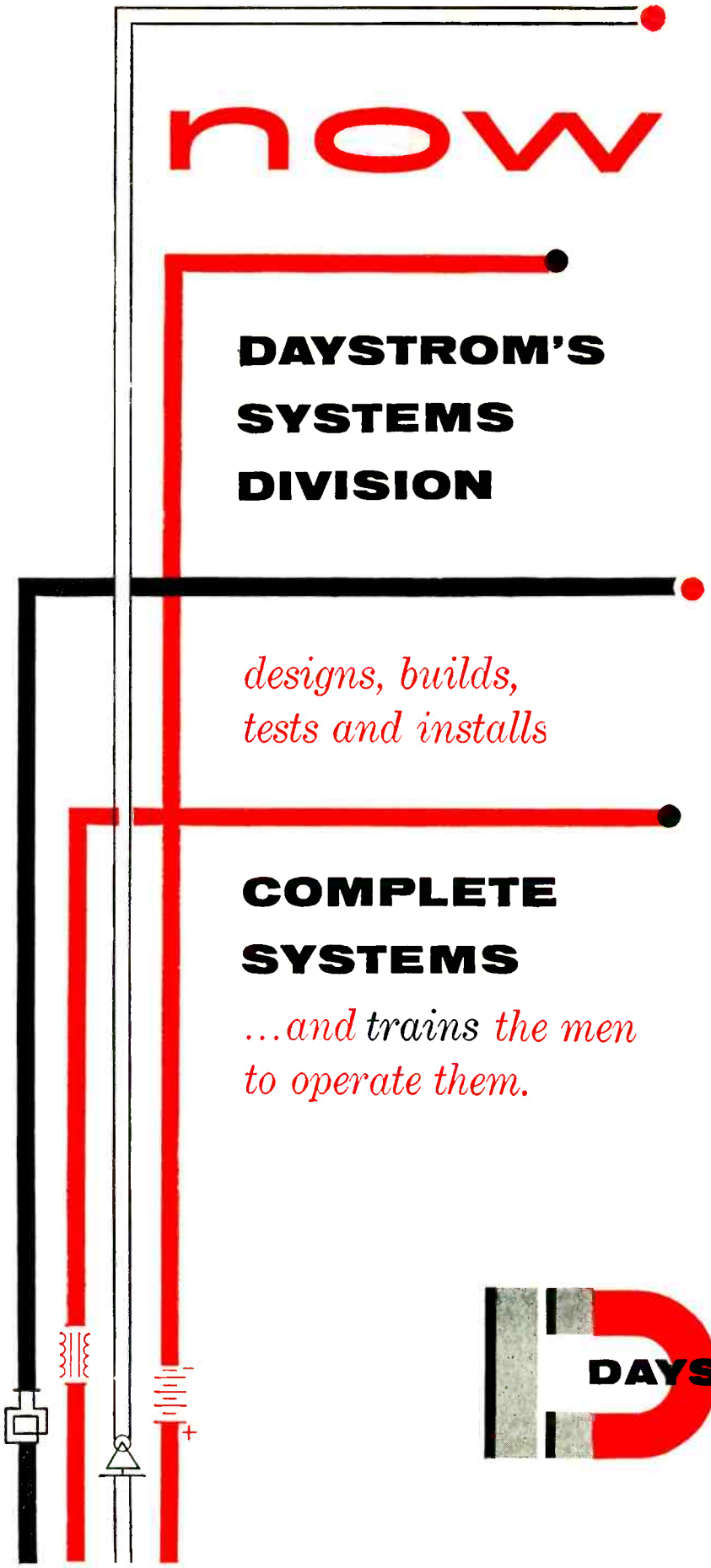
DAMON RECORDING STUDIOS, INC., 117 W. 14th St., Kansas City 5, Mo. New design permits disk recording and duplication either from disks or tape at smooth precise standard speeds of 16⅔, 33⅓, 45 and 78.22 rpm, plus exactly double speed for each when desired, plus additional speeds helpful in laboratory recording work. Two hysteresis-synchronous motors are used and efficiently isolated. A filtered coupling shaft is included incorporating a protection clutch.

▶ **Users**—These machines are recommended to those who use direct drive type disk recording lathes, dubbing turntables and associated equipment having a wide frequency range. Price is $850. **Circle P12 inside back cover.**



RECEIVING TUBES
stacked ceramic design

EITEL-MCCULLOUGH, INC., San Bruno, Calif., has developed rugged and small stacked ceramic re-



now

DAYSTROM'S SYSTEMS DIVISION

designs, builds, tests and installs

COMPLETE SYSTEMS

...and trains the men to operate them.

To serve the needs of the systems field more effectively, Daystrom, Inc. announces the formation of a new Systems Division at La Jolla, California, which will coordinate the experience and background of all other Daystrom companies.

The Systems Division will call upon the combined efforts and resources of Daystrom's engineers, physicists, production experts and administrators.

The Division will integrate the information and techniques from many fields—electronic, electrical, optical, hydraulic, pneumatic and mechanical—and take full advantage of Daystrom's experience with controllers, servo-mechanisms, aircraft systems, instrument mechanisms, memory devices, magnetics, gyros, computers, telemetering equipment, digital systems and special systems.

Daystrom is now prepared to provide total responsibilities for *completely-engineered* systems for both industry and the military.

You are cordially invited to visit the Daystrom exhibit at the Instrument Society of America Show, New York Coliseum, Booth 102.

DAYSTROM, Inc.
Elizabeth, N. J.

Daystrom Electric Corporation • Daystrom Instrument Division • Daystrom International Division • Daystrom Nuclear Division • Daystrom Pacific Corporation • Daystrom Systems Division • Heath Company • Weston Electrical Instrument Corporation • Daystrom Furniture Division

ceiving tubes. Life of the new tubes is so long that they will be wired directly into electronic airborne and missile equipment, thereby eliminating the need for tube sockets. They can withstand heavy accelerative forces from shock or vibration, while suppressing noise output.

Their metal-ceramic construction inhibits deterioration of electrical characteristics even when operating continuously with envelope temperatures of more than 300 C.

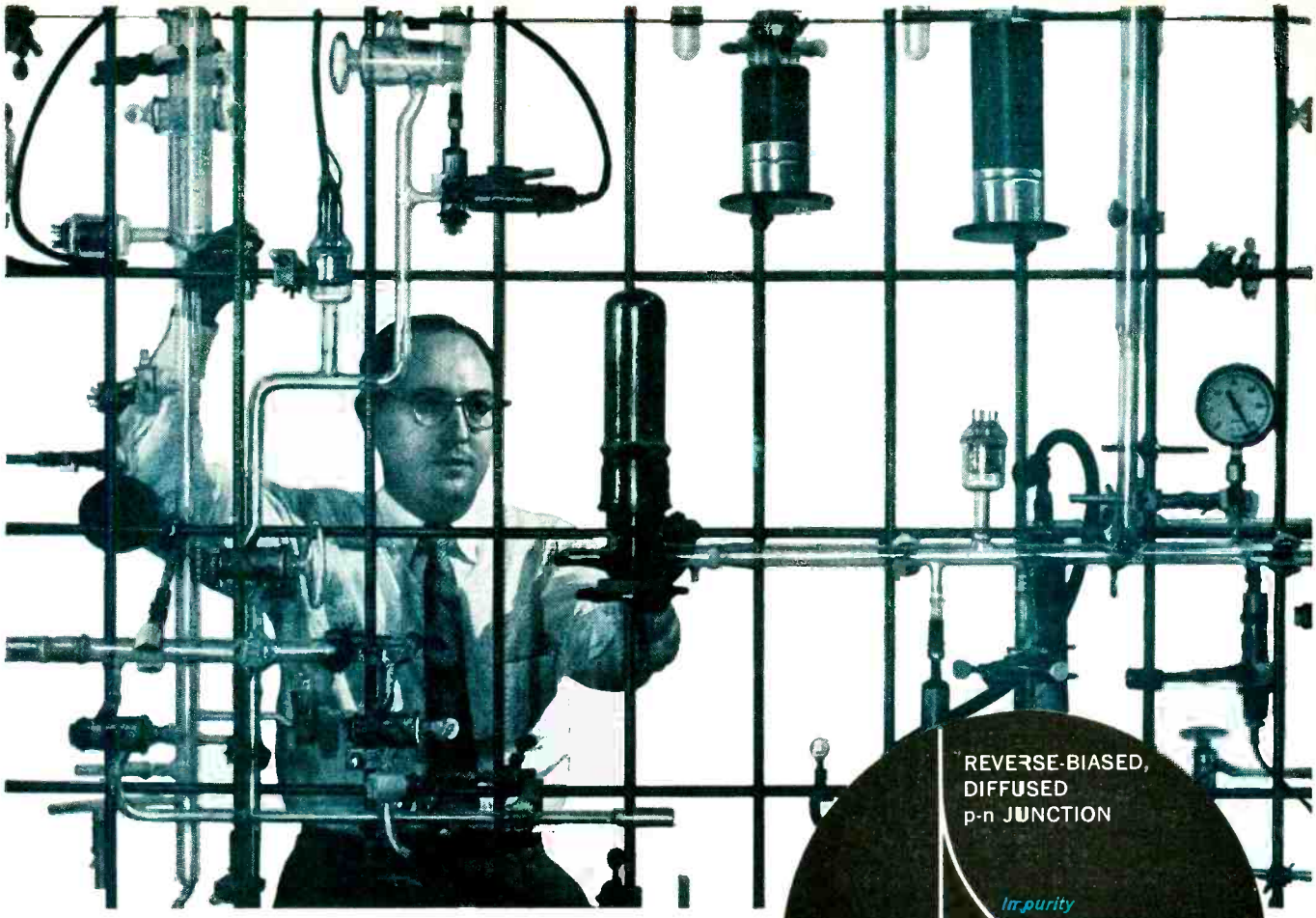
▶ **Types**—The company is in production on four of these new tubes. They include the 33C3A2, a twin-triode amplifier; the 5C2A, a sharp-cutoff pentode; and two developmental tubes: the CD-19, a medium-mu triode; and the CD-22, a beam power amplifier.

A four page descriptive brochure contains specifications. **Circle P13 inside back cover.**

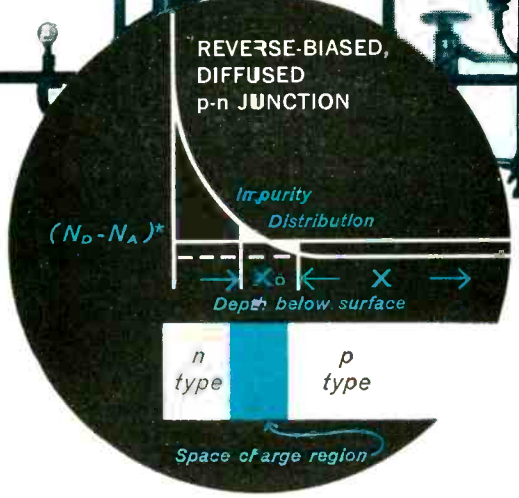
FREQUENCY CONVERTER
low-cost, lightweight

TEL-INSTRUMENT ELECTRONICS CORP., 701 Garden St., Carlstadt, N. J., has announced model 400A, a new and improved low-cost, lightweight frequency converter delivering 100 v-a of 400-cycle power. It occupies little more than a cu ft of space in either bench or rack-mounted design and weighs only 60 lb.

The unit has no moving parts, uses standard components and has only eight tubes. Voltage regulation, no load to full load, is 0.25 percent; frequency regulation, no load to full load, is better than ±1 cps; total harmonic distortion is better than 3 percent and all three performance characteristics are



T. J. La Chapelle supervises the development of silicon diffused junction devices within the Research and Development Department of PSI.



*No. of donors less No. of acceptors

Diffusion: the promise of improved performance in semiconductor circuitry

The formation of p-n junctions by solid state diffusion can result in significantly improved semiconductor devices. Research and development at Pacific Semiconductors, Inc. is concerned with translation of this advantageous technique into products having performance not available today.

PRECISE TOLERANCES WITH SUPERIOR PERFORMANCE—The sketch, above right, illustrates the diffusion of n-type (donor) impurity into a p-type (acceptor) material, to a depth which is controllable in microns. Junction slope can be precisely controlled. The graded change from "n" type to "p" concentration widens the space charge region. Junction capacitance is reduced and higher reverse voltage breakdowns are achieved, because of the greater distance (X_D) across which the field is developed.

VOLUME PRODUCTION—LOWER COST—Because of the precise tolerances which can be maintained with diffusion, product quality and uniformity can be more easily controlled. Diffusion is a high-volume production technique. Ultimately, lower equipment and labor costs will result in lower costs per p-n junction produced.

We believe that PSI products made by diffusion will be significantly superior in range of performance, reliability and uniformity.

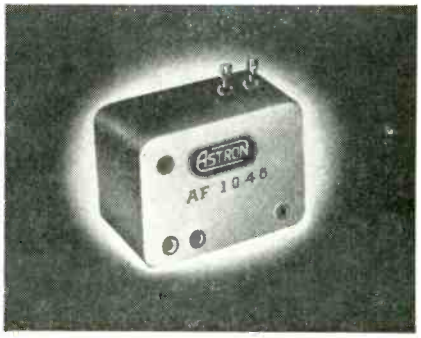
PSI offers new standards of reliability in fusion-sealed germanium and silicon diodes with four basic lead arrangements.

Pacific Semiconductors, Inc.

10451 WEST JEFFERSON BOULEVARD, CULVER CITY, CALIFORNIA

independent of power factor.

Frequency of oscillation is completely determined by the resonant frequency of a tuned circuit. Amplitude of oscillation is limited by nonlinear elements in a bridge circuit. **Circle P14 inside back cover.**

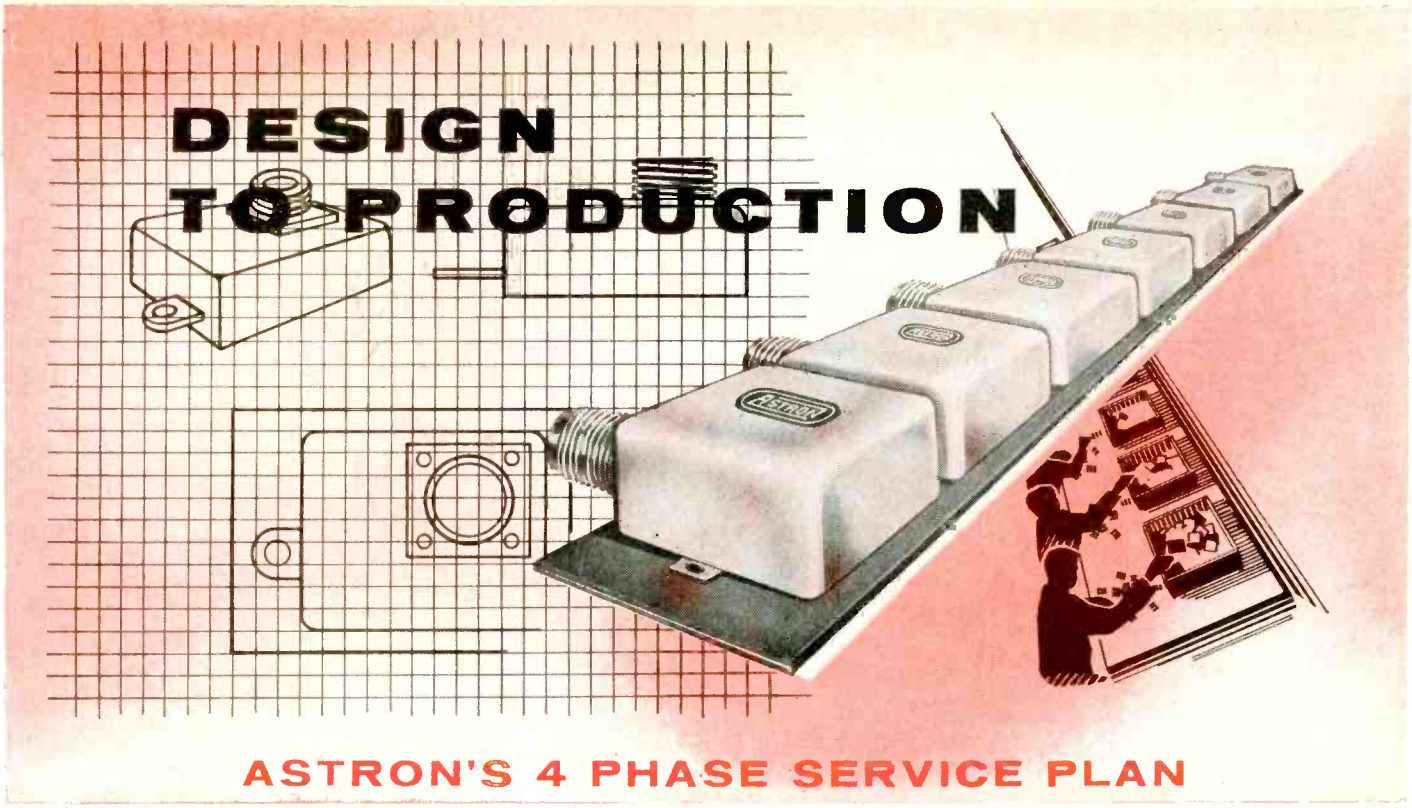


LITTLE FILTER
is hermetically sealed

ASTRON CORP., 255 Grant Ave., East Newark, N. J., has announced a new miniaturized r-f noise suppression filter, style No. AF1046. This hermetically sealed filter surpasses the requirement of specification MIL-1-11748. The 2-section filter incorporates four toroid coils and a capacitor section. The rugged construction enables it to withstand great amounts of shock and vibration as well as severe climatic conditions. **Circle P15 inside back cover.**

PRECISION POT
is 1 7/16 in. in diameter

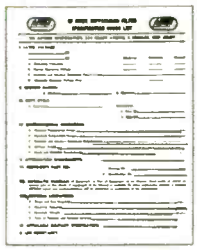
HELIPOT CORP., 916 Meridian Ave., South Pasadena, Calif. Series 5000 precision potentiometer is a new unit developed to fit A.I.A. di-



ASTRON'S 4 PHASE SERVICE PLAN

. . . solves thousands of industry's R. F. filter problems

Since the inauguration of this unique engineering and production service, Astron has produced more R. F. Filters for military and commercial electronic equipment than ever before. This special service is designed to custom-engineer and then mass produce a filter specifically for your equipment to meet and surpass government and commercial specs.



If you have a filter problem — write for "Filter Specification Check List".

HERE'S HOW IT WORKS!

1. **PROBLEM IS DEFINED**
   An experienced staff of filter engineers undertakes a complete examination of your equipment. An intelligent definition of the problem is then made.
2. **EQUIPMENT TESTED**
   An equipment analysis is conducted in Astron's modern screened R. F. noise suppression laboratory. Every piece of testing equipment used in the analysis is government specified and approved.
3. **PROTOTYPE FILTER DESIGNED**
   Results from equipment analysis are tabulated. A Prototype filter of minimum size & weight is then custom-engineered for the equipment under examination.
4. **FINAL EQUIPMENT ANALYSIS MADE**
   Another equipment analysis is made with the inclusion of the filter. Governmental procedures are strictly followed. Temperature and other environmental conditions are simulated, shock and vibration tests are conducted. The final report is made, ready for customer approval in order to proceed in production.

You can put your trust in Astron — pioneers in filter miniaturization, leaders in filter design . . . highest quality filters at an economical price.

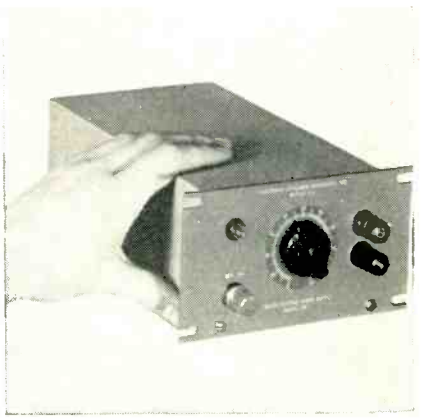
ASTRON
CORPORATION
255 GRANT AVE., E. NEWARK, N. J.

SKOTTIE ELECTRONICS CORPORATION
QUALITY CERAMIC CAPACITORS
A Wholly-owned subsidiary of ASTRON CORPORATION

Want more information? Use post card on last page.

mensional standards. Housed in a dimensionally stable one-piece plastic cup, the single-turn, continuous-rotation unit can have 8 sections ganged on a common shaft at the factory . . . each with a maximum of 12 taps.

▶ **Specifications** — Standard range of resistance is from 25 to 51,000 ohms. Best practical linearity tolerance is ±0.15 percent at 10,000 ohms and above. It is available with or without ball bearings, for servo or bushing mounting. Power ratings are 2.8 w at 25 C ambient and 2 w at 40 C ambient. Operating range is from −55 to +80 C. Electrical rotation is 354 deg ±2 deg. **Circle P16 inside back cover.**



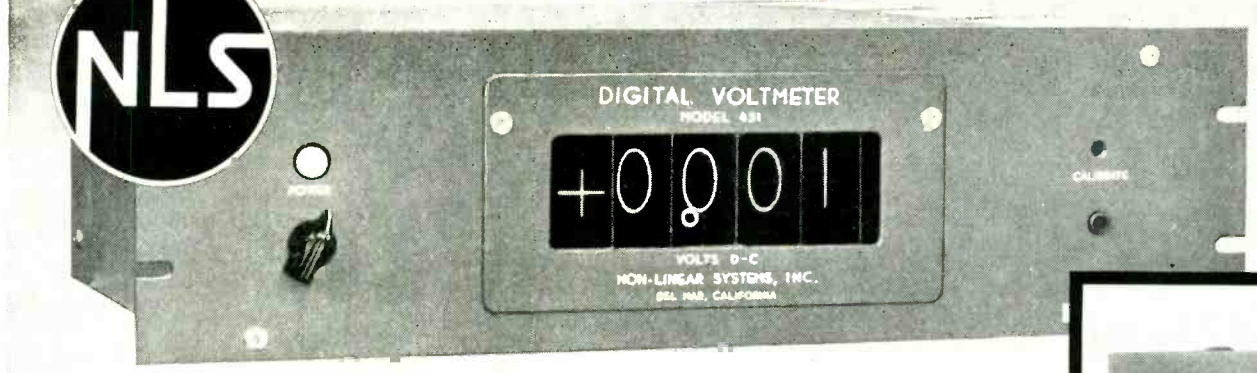
D-C POWER SUPPLIES
utilizing transistors

ELECTRONIC RESEARCH ASSOCIATES, INC., 67 East Centre St., Nutley 10, N. J., announces a new line of semiconductor, transistor-regulated d-c power supplies. Intended for all low and medium voltage applications, these supplies feature high conversion efficiency, low heat dissipation, small size, light weight, instant warmup time, nonmicrophonic operation, fast transient response, and output continuously adjustable Zero-Max.

Semiconductor rectification is used in the design and germanium junction power transistors operating with low collector-emitter voltage drop replace the conventional electron-tube regulator. An additional transistor is incorporated into the circuit to obtain increased sensitivity in the feedback control loop.

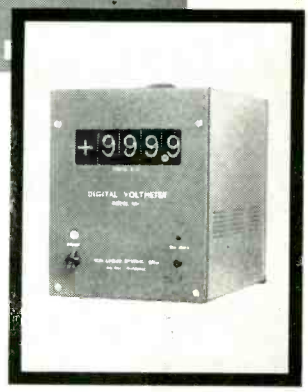
Models are available in several

MODEL 451



RACK MOUNT STYLE—5¼" high by 18" wide by 15⅛" deep

PORTABLE STYLE—10⅞" high by 8⅜" wide by 15⅛" deep



Now! Accurate automatic measurements for varied industrial applications...

NOW EVERY FEATURE you want in a precise, automatic Digital Voltmeter is available in these new Non-Linear Systems models. Their *performance* features automatic measurement from zero to ± 999.9 volts DC with high accuracy and resolution. *Fast readings* are presented in a brilliant, in-line luminous numerical display. *Automatic features* simplify operation, enable you to use non-technical employes. Assured *long life* results from exclusive NLS *oil-sealed* stepping switch system, plus top-quality components. Thorough *quality control* ensures reliable operation. And unitized construction means *simplified maintenance*, saving you time and money.

Yet NLS Model 451 Digital Voltmeters are priced far below instruments offering only a fraction of these advantages! These low costs are possible because NLS, as originators of the Digital Voltmeter, has the advantage of pioneering design and production techniques. Furthermore, NLS quantity production results in additional savings.

You can save time and money, and assure automatic accuracy in precision measuring, with an NLS Digital Voltmeter. Mail coupon today for more information on how these quality instruments can assist your operations.

YOU GAIN THESE ADVANTAGES

Automatic operation — Simple operation plus brilliant numerical readout and recording allows use of non-technical personnel.

Exhaustive quality control — Sustained accuracy assured by systematic testing procedure throughout all engineering, production phases.

Unitized, standardized construction — Each instrument can be quickly disassembled into three functioning subassemblies.

Quality components, including mercury-cell reference standard, stepping switches built to NLS specifications, precision resistors and other high standard components.

Oil-sealed stepping switch subassembly cuts maintenance, boosts switch life, ensures reliability under all operating conditions.

Long-life stepping switches — Life tests corresponding to 21,000,000 readings completed, with switches still operating!

Simplified maintenance, resulting from unitized construction, saves you time and money.

No-lost-time service — Interchangeable subassemblies and complete instruments available promptly.

Automatic recording by electric typewriter, printer, summary punch.

Low initial cost, based on NLS integrated, efficient production methods, and on advanced engineering developments.

New! Automatically-standardized reference power supply eliminates manual adjustment; available instead of internally-mounted mercury-cell battery pack.

APPLICATIONS

Automatic measurement, digital display and recording of DC voltages for:

Manufacturing — Development, production and process control testing.

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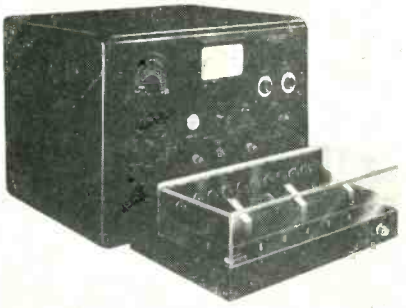
voltage and current ranges, extending from low voltage to 300 v d-c at current ratings up to 200 ma. Line regulation is better than 0.5 percent and load regulation is better than 0.5 percent. Ripple is less than 0.02 percent. Included in most models is a 6.3 v a-c output. **Circle P17 inside back cover.**

PULSE GENERATOR
with 0.01-μsec rise time

RADIO CORP. OF AMERICA, Camden, N. J. Type LG-30 pulse generator features a rise time of 0.01 μsec, produces either positive or negative pulses, and functions also as r-f pulse modulator.

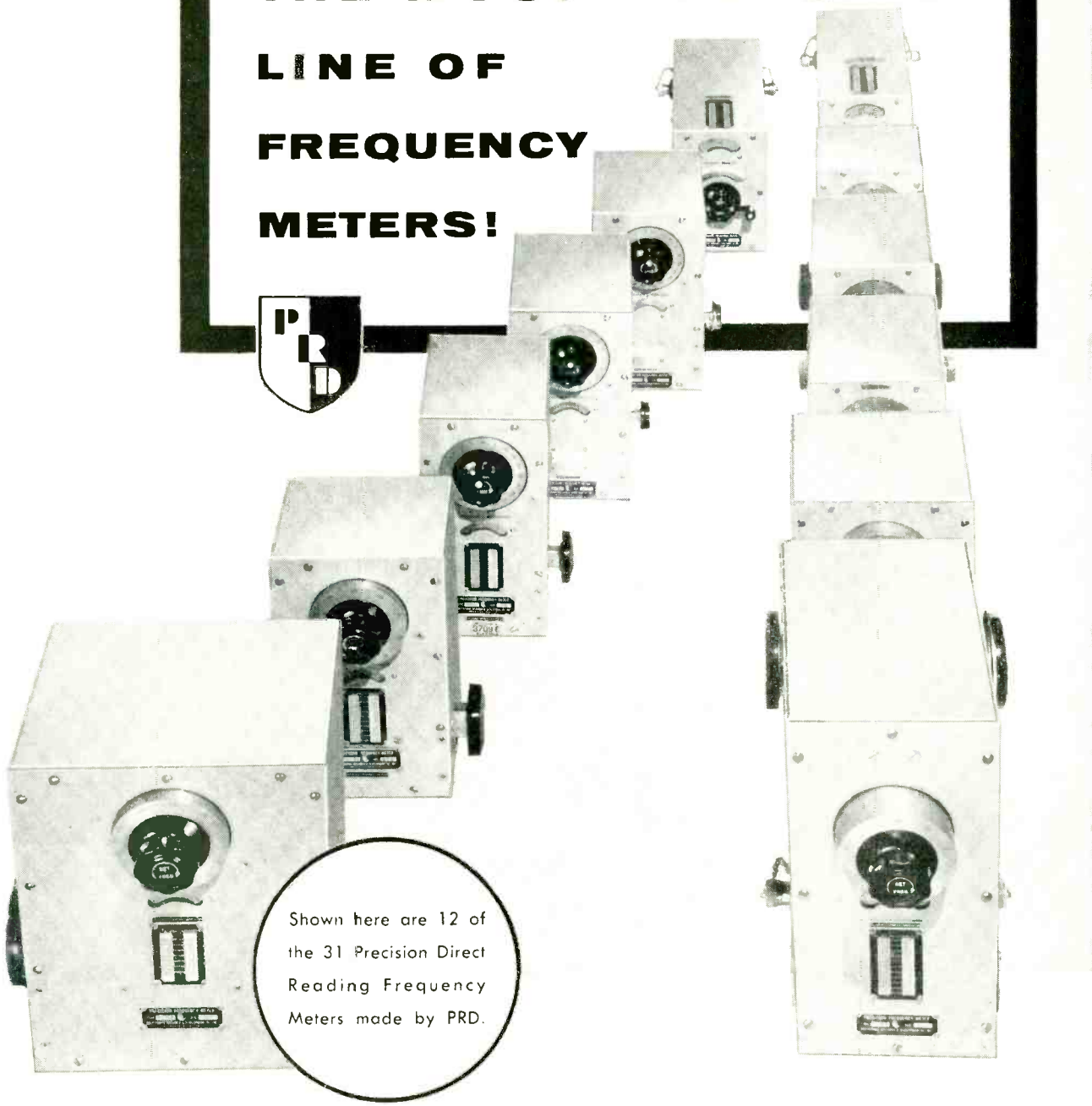
The LG-30 generator produces steep-front pulses whose amplitude, length and recurrence are variable, and will modulate r-f wave with these pulses to approximately 100 percent. **Circle P18 inside back cover.**



BREAKDOWN TESTER
for high speed inspection

THETA INSTRUMENT CORP., 204 Market St., E. Paterson, N. J. This automatic high potential tester is a GO, NO-GO instrument intended for high speed inspection of slip ring assemblies, relays, electron tubes, synchros and motors. Each electrode of the specimen is successively energized at high potential with respect to the others. Deteri-

THE MOST COMPLETE LINE OF FREQUENCY METERS!



Shown here are 12 of the 31 Precision Direct Reading Frequency Meters made by PRD.

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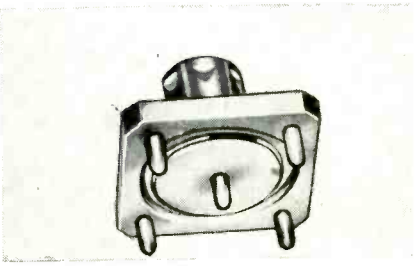
oration of the dielectric causes a current to flow which is monitored by a sensitive relay. The test is nondestructive and indicates the source of the breakdown.

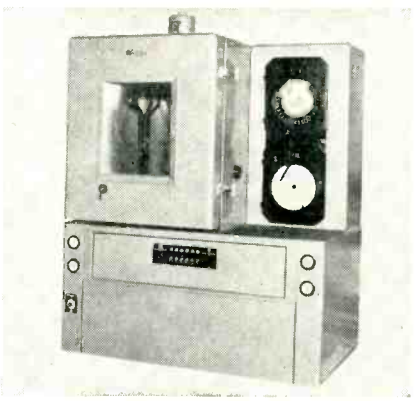
Applied voltage to the specimen is adjustable from 0 to 2,000 v, 60 cps. Full voltage is applied to each electrode for a period of time selected by panel adjustment. The basic equipment design allows certain parameters to be altered to customer requirements. **Circle P19 inside back cover.**



LITTLE CONNECTORS
for printed circuit use

NUGENT ELECTRONICS CO., INC., New Albany, Ind., is producing a miniature connector for printed circuit application N530. The connectors presently in production have 0.040 diameter pins with 0.312 spacing and are for $\frac{1}{16}$ thick printed circuit boards.

Also available are printed circuit connectors having 0.200, 0.300 and 0.400 pin spacing. The pins can be furnished with 0.030, 0.040 and 0.050 diameters for $\frac{3}{32}$, $\frac{1}{16}$ and $\frac{3}{32}$ thickness boards. **Circle P20 inside back cover.**



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for humidity, temperature

CONRAD INC., subsidiary of Crampton Mfg. Co., 141 Jefferson St.,

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What are you striving for—product improvement?—better equipment performance?—a more economical process? A product made of "Teflon" by R/M could well be the missing link you're seeking. For R/M has been working with this wonder plastic ever since it was produced and, with it, has solved some of the very toughest problems encountered in recent years by electrical and electronics engineers.

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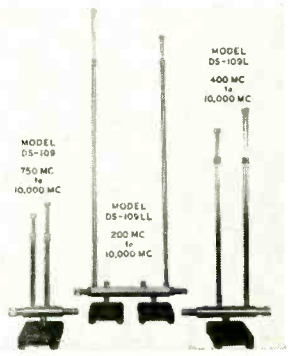
Holland, Mich. Model No. FD-8-2-2 self-contained environmental test chamber has a temperature range of 250 F to −100 F. It uses Freon 13-Freon 22 cascade systems which permit numerous advantages to the designer as well as to the user, allow for more compact installations, application of hermetically or semihermetically sealed refrigerating systems, improved cooling rates, and colder temperatures with less total horsepower required. A 3-page article on Freon 13-Freon 22 cascade systems is available for the asking. **Circle P21 inside back cover.**



DOUBLE STUB TUNERS
cover 200 to 10,000 mc

WEINSCHEL ENGINEERING, 10503 Metropolitan Ave., Kensington, Md., has available three new double stub tuners covering the 200 to 10,000-mc frequency range. Their sliding contacts are placed outside of the high current region and permit smooth, low-noise adjustments. Each sliding contact is machined from a solid phosphor bronze rod. Collet locks have been added to each stub, permitting quick locking of the tuning position. The relative position of the two studs is readily adjustable to any one of three positions.

► **Applications** — (1) To match loads such as bolometer mounts. (2) To match r-f sources for maximum power transfer. (3) To make direct measurements in a 70-ohm system using a 50 ohm slotted line, matching a 70 ohm load to 50 ohms. Generally low loss double stub tuners can be used to transform a slotted line to make end measurements in a system having a different impedance. (4) To provide a d-c return. (5) To suppress

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S. E. C. products have proved the answer to many tough engineering problems by such leading *analog computer manufacturers as;* Electronic Associates, Reeves Instrument, Beckman Instrument, Mid-Century Instrumatic, Goodyear Aircraft, Donner Scientific, Boeing Airplane Company and such *military contractors* as Northrop Aircraft, Gilfillan Brothers, North American Aviation, Convair, Motorola, Farnsworth Electronics, Bendix Aviation, Federal Tele-Communications and many others.

R. & D. establishments as M.I.T., Jet Propulsion Labs, Cornell Aeronautical Labs, Battele Memorial Inst., Sandia Corp., and many others have chosen S. E. C. engineered components for their prototypes.

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- Tolerances as close as 0.1%
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- Dissipation Factor as LOW as .0002
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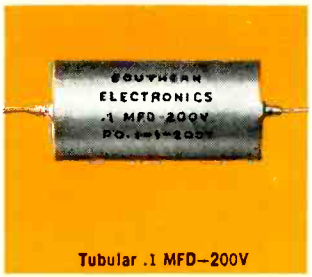
- Stability as close as .05% drift in 1 yr.
- Voltage derating . . . none to 170°F.
- *Hermetically sealed for enduring accuracy!*



Tubular .1 MFD–200V

.1 MFD–200V


10 MFD ±1% 200V
4-7/16 x 3-1/16 x 2-1/8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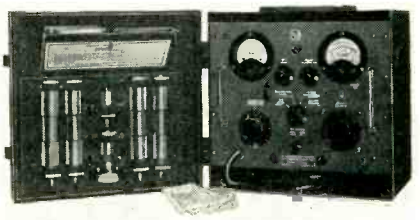
PIONEERS IN CUSTOM PRECISION CAPACITOR ENGINEERING

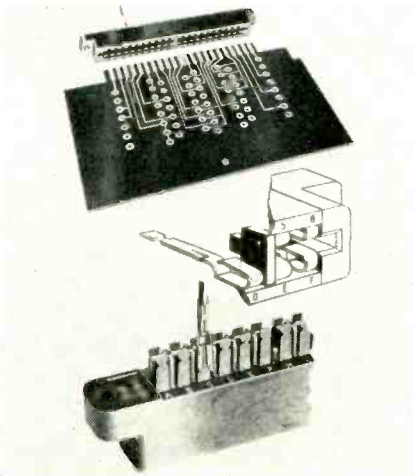
2nd harmonics. **Circle P22 inside back cover.**



R-F POWER METER
power range is 5μw to 5 w

RADIO CORP. OF AMERICA, Camden, N. J. Type LP-90 r-f power meter provides continuous wave or pulse power measurements over the frequency range of 20 to 1,000 mc.

▶ **Other Features**—The instrument has a power range of 5 μw to 5 w, incorporates an r-f power bridge and complete set of broadband calibrated r-f accessories, and features bolometer mount and interchangeable low-power and high-power bolometer elements for use where either high sensitivity or high power is desired. **Circle P23 inside back cover.**



CONNECTORS
used with printed circuits

ELCO CORP., M Street below Erie Ave., Philadelphia 24, Pa., has announced a new improved line of Varicon connectors for use with printed circuit boards. Five sizes are available: 12, 20, 30, 36 and 44 contacts, individually located on both sides of the board. The contacts make good connections with the printed circuitry regardless of normal warpage or variation in

Admiral® lends a hand to the Atomic Airplane

Radiation effects being studied in special laboratory

The flight date of the first atom-powered airplane may well be advanced as the result of a study being conducted by Admiral for the U.S. Air Force. The problem is to determine the effects of nuclear radiation on electronic components.

All types of electronic components . . . such as tubes, resistors, condensers, capacitors and coils . . . are first bombarded by neutrons to make them radioactive prior to observation and testing.

Admiral has equipped a special nucleonics laboratory to make this study. Test equipment is set up within heavily shielded "hot cells" and operated by remote controls outside each room. One of the "hot cells" contains environmental chambers for testing the radioactive components under extreme temperature and altitude conditions. The laboratory also contains shielded underground storage facilities and a cobalt 60 source of gamma radiation as powerful as some atomic reactors.

Working with radioactive materials is not new to Admiral. For the past seven years the company has been engaged in designing, manufacturing and testing radiation measurement equipment. In this connection Admiral engineers have contributed much to the combined nucleonic-electronic sciences.

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thickness inherent in the boards. This is accomplished by the double spring action incorporated in the contact form.

Contact terminals are designed for use with either taper tab or conventional soldered connections. The polarization or keying system used is unique in that it does not require a substitution or loss of contacts, thereby effecting additional economy.

Bulletin 103 contains further data and specifications. **Circle P24 inside back cover.**

THYRATRON CONTROL
uses inert circuit elements

ORTHO FILTER CORP., 196 Albion Ave., Paterson 2, N. J. A simplified, fast response, grid control circuit producing a steep wave front grid firing potential which can be varied in phase from 0 to 180 deg is available for applications such as high power fast response servos, regulated power supplies with variable frequency inputs and motor controls. Units are supplied in matched sets for full-wave or three-phase applications. Where extremely small levels of control power are available the unit can be driven by a transistor. **Circle P25 inside back cover.**

ANTENNA SYSTEM
for 450 to 470 mc

ANDREW CORP., 363 E. 75th St., Chicago 19, Ill., has developed a new antenna system for the 450-470 mc communication system. The basic part is the type 201 base-station antenna which provides a

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...it's worth engineered cable

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Belden quality built to exacting specifications for black-and-white or color cameras. Harmonizing color—lightweight for easier handling.

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A type for every requirement, designed for highest efficiency, easiest use, longest service life.

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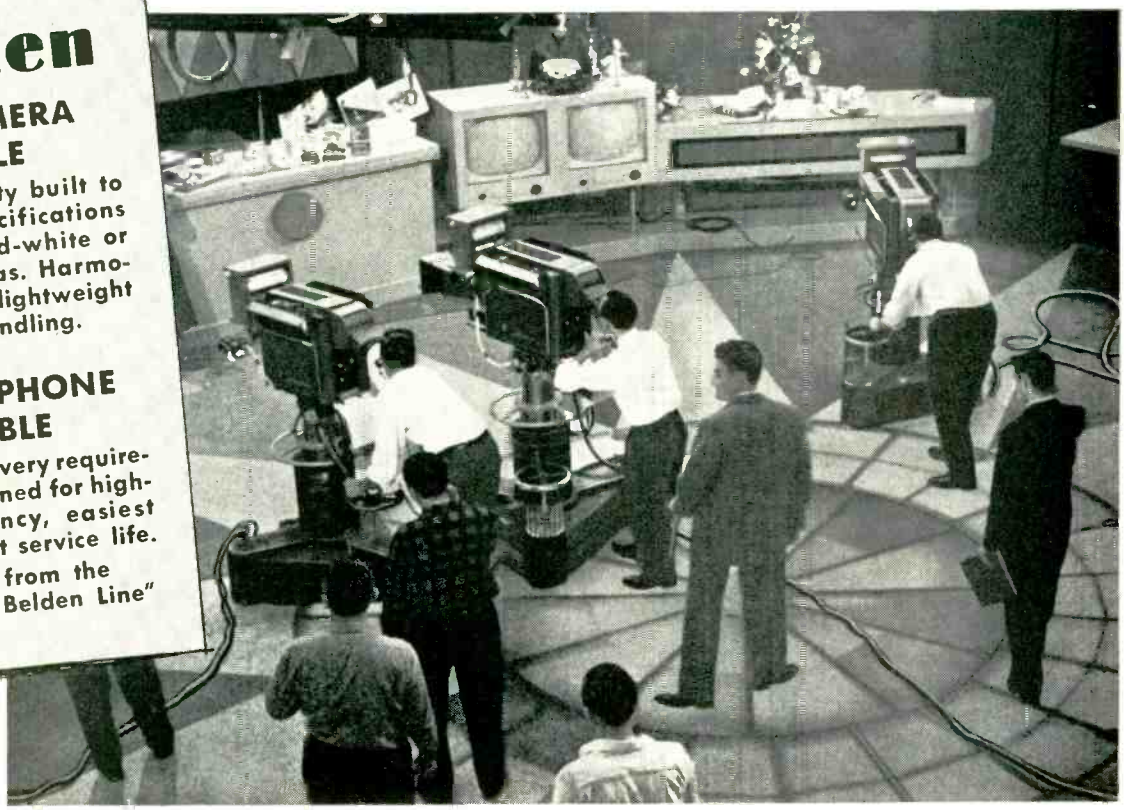

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Welding Cable • Electrical Household Cords • Electronic Wires • Automotive Wire and Cable

measured gain of 10.8 db over a half wave dipole in the direction of maximum radiation, while still providing gain considerably higher than unity in all directions. The base-station antenna is fed by a flexible air dielectric cable, Heliax, which can save as much as 2 db over less efficient cable.

Complementing this installation is the type 233 mobile antenna, which will add 1.8 db gain to the system. Gain of type 233 is relative to 0 db gain of ¼-wave whip with RG-58/U, and includes allowance for lower loss of RG-8/U feed cable.

Additional engineering specifications and performance details are given in bulletin 8417. **Circle P26 inside back cover.**

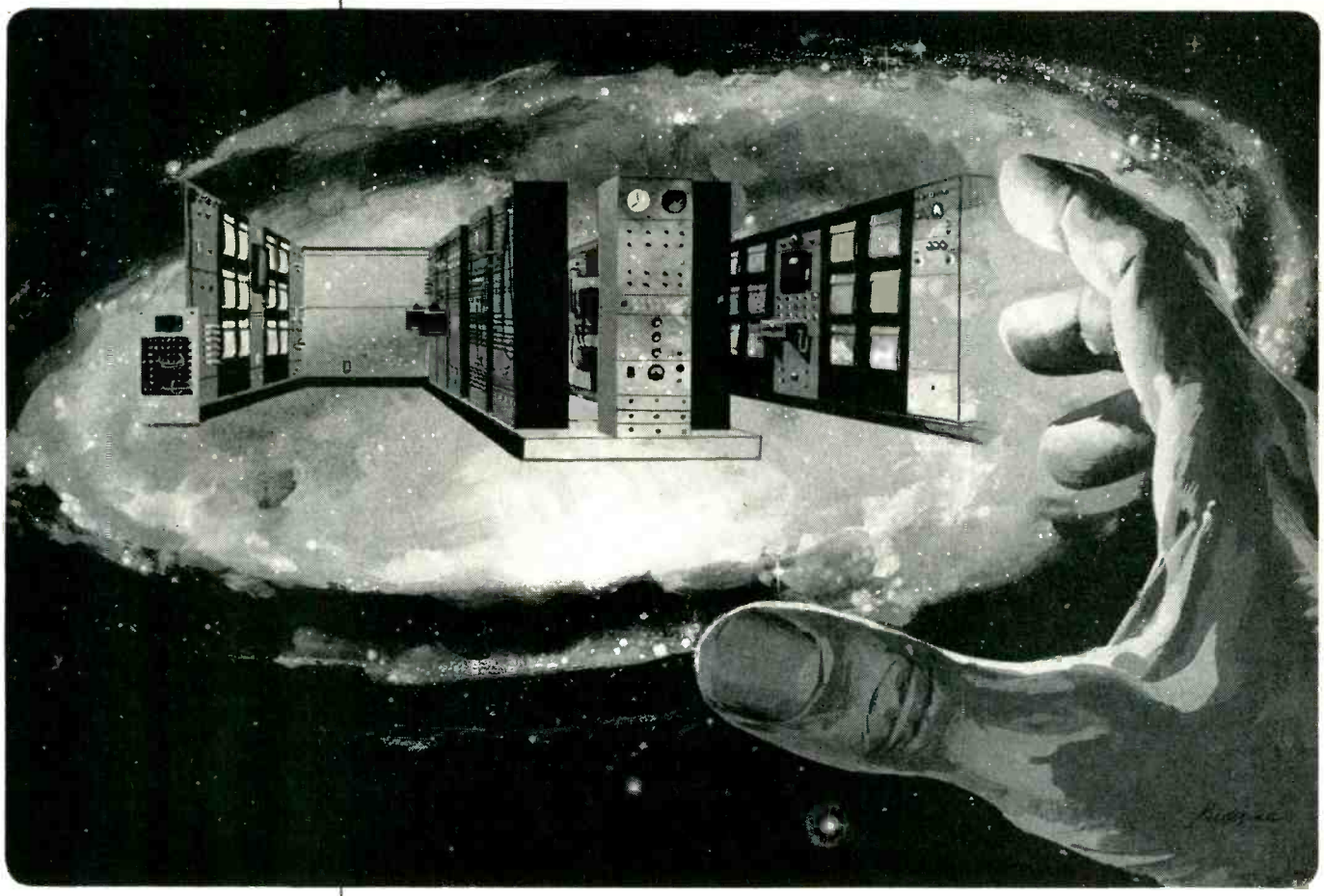
RANDOM NOISE GENERATOR may be operated from 6 v

STARR INSTRUMENT CO., 44 Starr Lane, Jamaica Plain 30, Mass. Model 1 random noise generator is designed to supply a random noise signal up to 100 db for testing the attenuation of screened enclosures and for performing susceptibility tests to military specifications. It may be operated from a 6-v storage battery or any 6-v d-c power supply delivering from 5 to 10 amperes. Signal strength may be varied from 60 db to 100 db by varying the voltage from 4 to 6 v d-c.

The signal source is an autotransformer fed into a spark plug enclosed in a ventilated dome. The circuitry is designed to prevent shock to the operator by being enclosed in a nonconducting fire-resistant box. An off-switch is provided.

► **Other Uses**—Additional applications are: checking radio and tv

IMPORTANT DEVELOPMENTS AT JPL



The Jet Propulsion Laboratory is a stable research and development center located to the north of Pasadena in the foothills of the San Gabriel mountains. Covering an area of 80 acres and employing 1450 people, it is close to attractive residential areas.

The Laboratory is staffed by the California Institute of Technology and develops its many projects in basic research under contract with the U.S. Government.

Inquiries leading to employment of qualified personnel are now invited.

Central Recording Systems for Rocket Engine Tests

The Jet Propulsion Laboratory pioneered in central recording of rocket engine measurements when in 1948 the Laboratory established its first system serving five engine test cells.

From this early beginning involving but a few instruments, central recording systems both at the Laboratory and elsewhere have expanded to the complex multi-channeled systems now required for modern-day development of missile systems.

The central recording system combines recorders, transducers, amplifiers, carrier systems, control networks, calibrating standards, wired-telemetry channels, and special devices into an integrated complex to measure the multiplicity of variables of a rocket engine test. Through flexible interchanges of communications channels the entire system becomes available for engine tests progressing at any one of many rocket engine test cells accomplishing an economy of instrumentation investment and operation with improved reliability.

Among the special devices, the Laboratory introduced high-speed encoding of instrumentation-level voltages, on-line computation of rocket-engine performance parameters, and rotary-element flowmeters for hazardous fluids. The Laboratory is in the forefront of the development of missile-system instruments such as transducers, recorders, standards, controls, data-transmission and data-handling systems, and computers.

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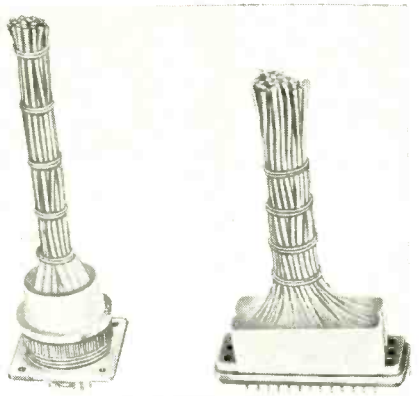
receivers; as source of noise to determine effectiveness of filters used in electronic equipment; as a source of energy for testing measurement equipment when other sources are not available in a laboratory.

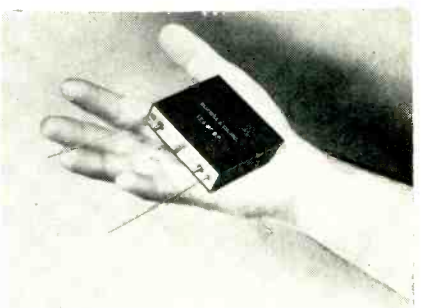
Price is $21.50. **Circle P27 inside back cover.**



POTTING SHELLS
for miniature connectors

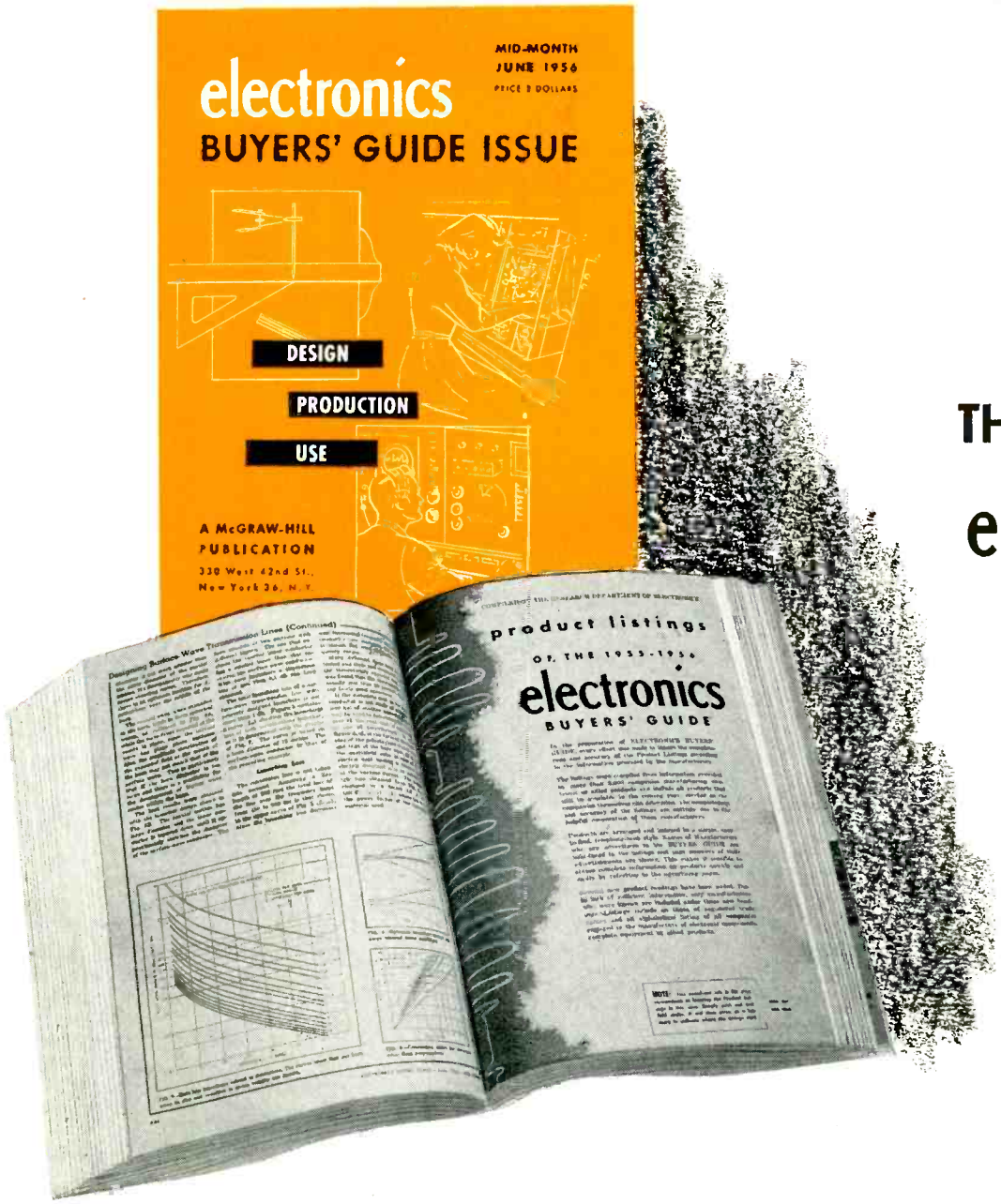
DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y., has announced potting shells for several types of its electrical connectors.

A sealing compound applied in a molded plastic potting shell after wiring the connector contacts, provides complete protection of solder cups and wires. It seals the connector against moisture and prevents cable strain under extreme vibration and repeated connect and disconnect of plug and receptacle. **Circle P28 inside back cover.**



TINY FILTERS
used in printed circuits

BURNELL & CO., INC., 45 Warburton Ave., Yonkers 2, N. Y., announces a new line of subminiature filters designed for i-f amplifiers for



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electronics

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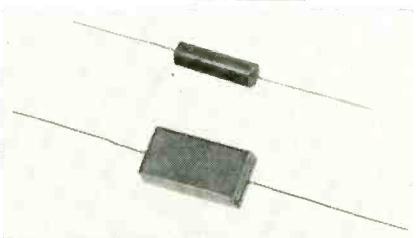
printed circuit use. The units are temperature compensated to 0.15 percent from −55 C to + 85 C.

▶ **Further Data**—Specifications are as follows: for operation at 1.3 mc—100 kc bandwidth at 6 db, 200 kc bandwidth at 60 db; for operation at 12.5 mc—300 kc bandwidth at 6 db, 1,100 kc bandwidth at 60 db. Size of the new filters is $\frac{13}{16}$ in. by $2\frac{1}{2}$ in. by 2 in. high. **Circle P29 inside back cover.**

MULTIMETER
features high sensitivity

RADIO CORP. OF AMERICA, Camden, N. J. Type LM-1 multimeter features sensitivity of 20,000 ohms per volt for both a-c and d-c; one range-selector switch; and built-in overload protection device which can be reset to protect meter from accidental burnout. The compact instrument is designed for wide range of industrial and laboratory applications requiring highly accurate measurement of a-c and d-c voltages, d-c current and resistance. **Circle P30 inside back cover.**



CAPACITORS
molded polystyrene type

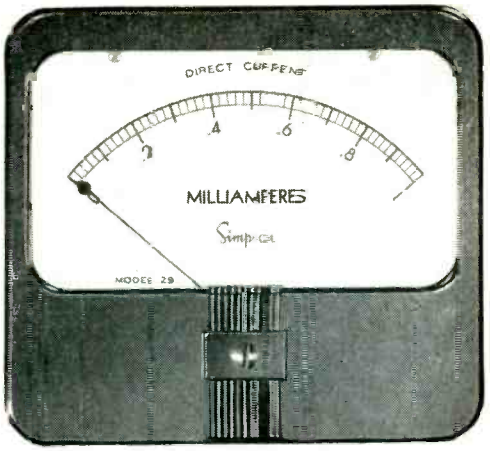
CONDENSER PRODUCTS CO., 140 Hamilton St., New Haven, Conn., has introduced a line of molded polystyrene capacitors in both round molded and flat molded configura-

why companies find it

GOOD BUSINESS

to specify panel instruments

by **Simpson...**



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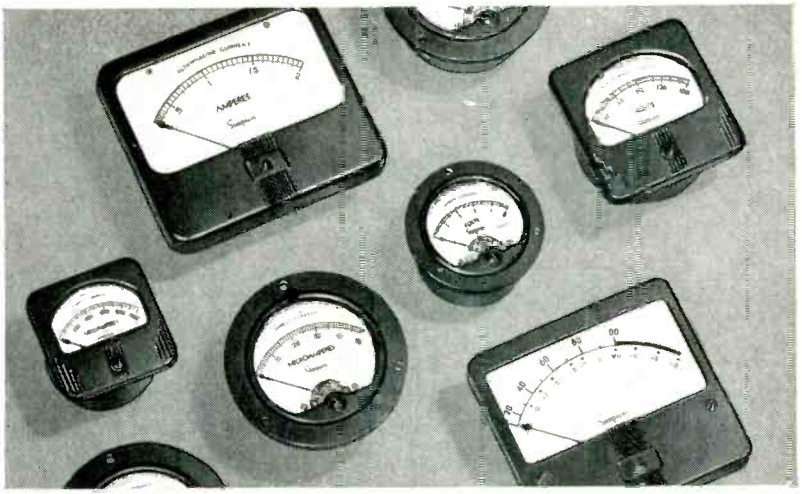
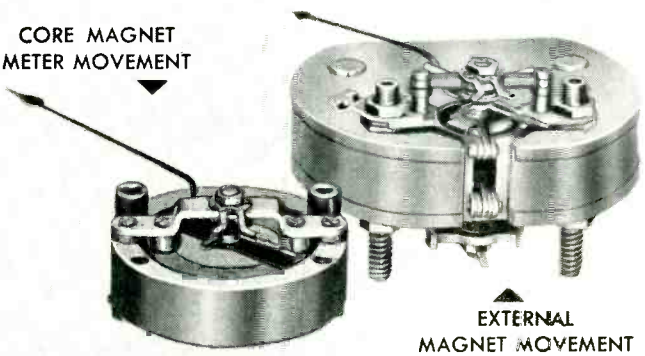
Over 50,000 stock units, in 800 sizes and types, are available for *immediate delivery* through 1,500 electronic distributors in the United States, Canada, and abroad. This wide distribution can save you time and prevent expensive delays.



...EXACT NEEDS

CUSTOM BUILT!

Many meters quickly built from *standing tools*. Others designed to your specifications. Delivery schedules on which you can rely. Movements include three sizes of Simpson's superb Core Magnet Meter Movement—*self shielded* and exceedingly rugged.



Ask your Simpson representative or write on letterhead for new Catalog now available.

Whatever your needs in panel instruments, you, too, will find it makes good business sense (and design sense) to specify "Simpson." Simpson instruments have established a reputation for laboratory accuracy . . . yet they have the ruggedness to stand up under years of service and severe shocks. Why not send us your panel instrument problems today?

Instruments that stay accurate

SIMPSON ELECTRIC COMPANY

5200 W. Kinzie St., Chicago 44, Illinois • Phone: EStebrook 9-1121

In Canada: Bach-Simpson Ltd., London, Ont.

tions. They have been designed for all phases of the electronics industry with particular emphasis on radio and tv equipment.

The molded polystyrene capacitor offers the design engineer high insulation resistance, low dielectric absorption, good stability, a linear temperature coefficient and a Q of greater than 2,000. Both the flat and round models are of extended foil construction, molded in a thermosetting alkyd resin and have axial leads. Inserted tab construction and special lead configurations also are available.

▶ **Other Specifications**—Dielectric absorption is 0.05 percent with insulation resistance at 25 C being 1×10^{12} ohms. Power factor at 1 kc is a maximum of 0.05 percent. Temperature range is −55 to +85 C with a coefficient of −100 parts per million per deg C. Capacitance range is 0.0001μf to 1 μf. **Circle P31 inside back cover.**

HIGH Q COILS
for low-frequency uses

UNITED TRANSFORMER CO., 150 Varick St., New York 13, N. Y., has announced coils employing special laminated Hipermalloy structures to provide high Q and stability for l-f (10 to 400 cps) applications. Laboratory adjusted to 2 percent accuracy at 1 v 60 cps, stability is such that inductance change is less than 1 percent for a 10 times voltage change. The temperature stability is excellent, total inductance change being less than 3.5 percent from −55 C to +85 C.

Heavy Hipermalloy shielding

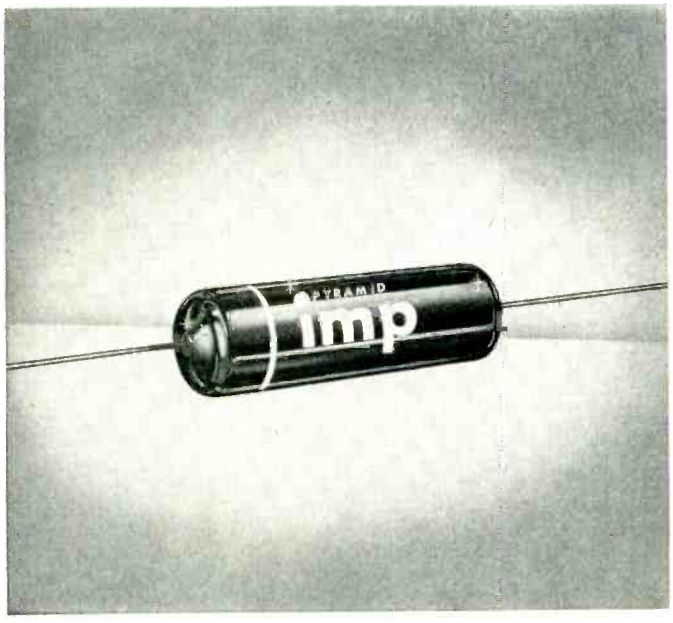
PYRAMID technical bulletin

NO.57

THERE IS MORE TO A CAPACITOR THAN ITS DESIGN FORMULA:

$$C = \frac{A}{K\,D}$$

Pyramid's production and life tests of their capacitors are among the most stringent in the industry. Production test for voltage breakdown, capacitance, power factor, insulation resistance and seal are performed on 100% basis. In consisting of life, temperature and immersion cycling, vibration, and corrosion where applicable. These serve to guarantee that the capacitors you purchase are consistently as represented to be.



Pyramid capacitors also owe their exceptional performances to the type of materials used in their manufacture and the production methods which Pyramid engineers have devised. For example, in the new Pyramid IMP capacitor, a new, exclusive plastic molding technique was developed which bonds casing, impregnated element, and tinned copperweld leads into one compact assembly capable of withstanding severe physical abuse. In addition, this unit is heat and moisture resistant withstanding the RETMA humidity-resistance test to a remarkable degree. In another capacitor, type MT metallized paper units, vacuum impregnation is employed and the ends of the capacitor are sealed with plastic. Then, as a final step, the entire unit is completely coated with a highly moisture resistant wax. It is production techniques such as these which, in conjunction with high quality papers, impregnants (such as Halowax, Mineral Oil, or Silicone Base Synthetic Oil), and metals, that account for the excellent stability and long life that Pyramid capacitors exhibit.

Pyramid capacitors, particularly electrolytic capacitors, are specifically designed for long shelf life. To achieve this goal requires that the various materials and chemicals used in the manufacture of these units possess a high quality and long term stability. Another contributing factor to long shelf life is the care which is taken to provide maximum protection against the corrosive effects of chemicals in the atmosphere. This necessitates a container which is well insulated against the intrusion of moisture, i.e., one which is air tight and hermetically sealed.

* * * *

The number of different types of capacitors that Pyramid manufactures is extensive. Included in this line are the following:

1. Electrolytic capacitors, type TD, with each unit sealed in a metal tubular case. Available in single sections, dual sections, and triple sections.
2. Electrolytic capacitors in screw base metal containers, type MC. Available in single and dual sections.
3. Twist-Mount electrolytic capacitors, type TM. Available in single, dual, and triple sections. Different sections may have different working voltages.
4. HI-TEMP Twist-Mount Electrolytic capacitors, type TWH. Designed for 100°C operation.
5. Dry Electrolytic capacitors in wax-filled, impregnated cardboard tubes, type CDB. Available in single, dual, and triple sections. Sections may possess individual leads or share a common negative terminal.
6. Plug-in Electrolytic capacitors, type DO, provided with 4 pins on standard octal base.
7. High-capacitance, low voltage electrolytic capacitors, type PFB.
8. Molded tubular paper capacitors, type IMP.
9. Miniature tubular paper capacitors. Type 85LPT.
10. Ceramic-cased tubular paper capacitors, type CT.
11. Bathtub-Type Oil-Paper Capacitors, types PDM, PDMT, PDMB.
12. Metal-tubular Oil-Paper capacitors, types PTIM, PTDMV, 4PTIM, 4PTIMV, 7PTIM.
13. Small-base oil-paper capacitors, types PKM, PKMF, PKMS, PKMT, and PKMB.
14. High-voltage oil-paper capacitors, types PLM, PLMF, PLMS, PLMU, PLMR.
15. Kraft-tube metallized paper capacitors, type MT.
16. Metal-can metallized paper capacitors, types MPGK, MPGM.
17. Metal-tube metallized paper capacitors, types MPTIK, MPTIM.
18. "Glasseal" subminiature paper tubular capacitors, and many others.

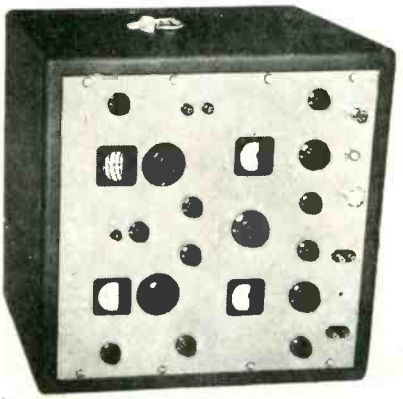
Pyramid capacitors are competitive in price because of the modern production methods that are empolyed throughout every phase of capacitor production. Whenever possible, automation techniques are being applied so that more uniform high quality may be achieved. Much of Pyramid's success is due also to the aggressiveness of Pyramid engineers in pioneering new products.

FOR COMPLETE DATA SEND FOR ENGINEERING BULLETIN—FORM IMP-2

PYRAMID ELECTRIC CO. North Bergen, New Jersey

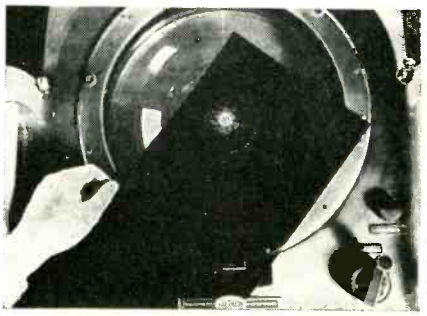
PYRAMID IS THE BIG NAME IN CAPACITORS AND SELENIUM RECTIFIERS TODAY!

assures low hum pickup—240 mv/Gauss for typical unit. Two identical windings are employed which are brought out to four terminals for series, parallel, or transformer connection. Four standard types provide for eight inductance values from 215 to 400 henrys. **Circle P32 inside back cover.**



SIGNAL GENERATOR
tests ssb equiment

CROSBY LABORATORIES, INC., Box 233 Robbins Lane, Hicksville, N. Y., announces a new single-sideband signal generator, model 160. The unit is specifically designed for alignment and test of single and double-sideband receiving equipment. Providing continuous tuning from audio frequencies to 50 mc, together with several crystal-controlled outputs, this generator features a low distortion modulation source for all available single and double-sideband modulation systems. **Circle P33 inside back cover.**



OPTICAL FILTERS
for radarscopes

POLAROID CORP., 730 Main St., Cambridge, Mass., announces a new light filter that kills reflections on a radarscope or any c-r tube in-

A friend in need...

A bomber pilot, homing on a tanker when his fuel is low, might well thank, not his lucky stars, but his AN/APN 69 . . . a radio beacon built by Stromberg-Carlson.

To perform its military mission, guiding fuel-hungry aircraft to airborne tankers, reliability in all kinds of weather, in darkness as in daylight, is imperative.

Our company has been privileged to manufacture this radio beacon, both as a sub-contractor and as a prime supplier. This is a far cry from our founders' 1894 magneto telephone, but it is evidence that our skills have grown with the world's needs.

P.S. *Engineers . . . excellent career opportunities in electronics, telecommunications. Write now.*

STROMBERG-CARLSON COMPANY

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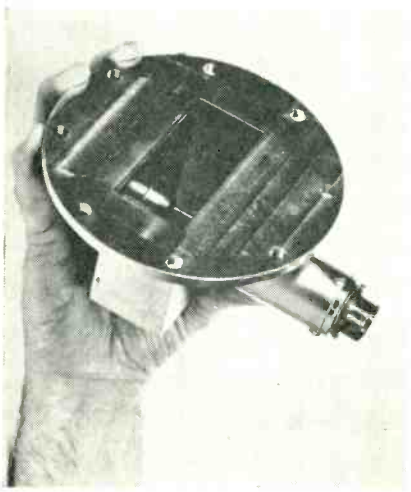
General Offices and Factories at Rochester, N. Y.—West Coast plants at San Diego and Los Angeles, Calif.

S-C

strument. By removing reflections, it makes the image sharp and easy to read, eliminating the need for bulky hoods or other light shielding.

The filter gets its one-way properties through circular polarization of the light striking it from outside sources. Lightweight and sturdy, it can be laminated in either glass or plastic, for easy mounting or any size scope.

The new reflection-trap filter can also be combined with a linear-polarizing filter so the observer can vary the brightness of the display, simply by pushing a knob, without readjusting the scope. **Circle P34 inside back cover.**

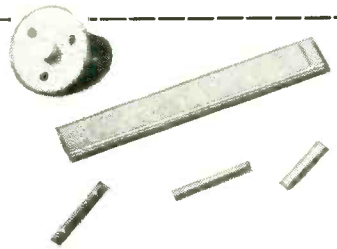


GAS TUBE NOISE SOURCES
for airborne applications

ROGER WHITE ELECTRON DEVICES, INC., 96 Fourth Ave., Haskell, N. J., has announced development and production of compact, gas tube noise sources for airborne microwave applications. Already finding wide use for the calibration and test of radars, and microwave equipment and communications systems, the devices feature extreme compactness; the unit for the S band being only 3⅛ in. long, and units for higher frequencies are correspondingly smaller.

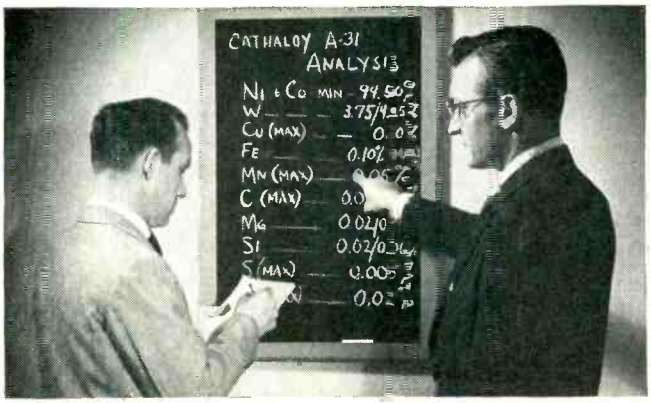
▶ **Other Features** — These noise sources pass all environmental military specifications for shock, humidity, vibration and temperature cycling. They will provide an excess noise ratio of 18 db ±0.5 db. They will fire and operate at conventional airborne power sup-

How Superior guards cathode quality to insure uniformly excellent performance



NEWEST CATHODE ALLOYS: THE CATHALOYS[1]

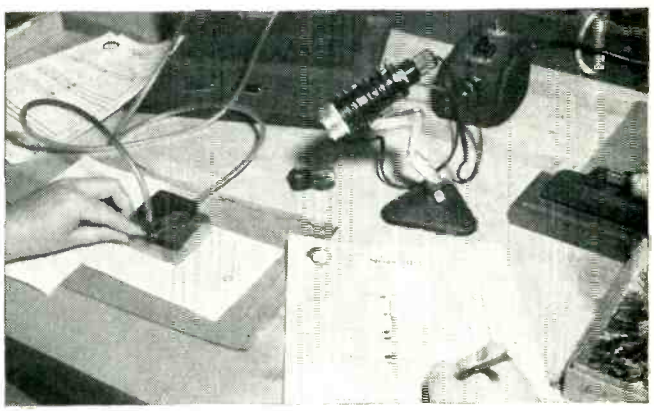
Most versatile alloys. Available in both active and passive types. Promoted by, controlled by, and available only from Superior. Samples shown include seamless, Lockseam,[2] and WELDRAWN[3] cathodes.



1. FIRST STEP: ALLOY SPECIFICATION. For each of the Cathaloys, Superior engineers specify precise percentages of constituent metals in order to give good control to the emission, sublimation, and interface impedance characteristics.

2. ANALYSIS OF EACH HEAT. Samples of each heat of the alloys are sent to Superior's metallurgical laboratory for extensive chemical and physical analysis. Metal must conform with rigid specifications before acceptance.

3. TESTED IN ELECTRON TUBE. Samples of each heat of Cathaloy are fabricated into cathodes and assembled into ASTM standard diodes. They are operated under controlled conditions. These tests evaluate each heat for emission and sublimation characteristics. Satisfactory results approve the heat for production.



4. CHECKING OF MECHANICAL DIMENSIONS. Rigid quality control inspection standards assure constant checks on the finished cathode dimensions: length, diameter, bead position, etc. Must fall within close tolerances specified. The very latest precision measuring instruments are employed.

[1] Cathaloy is a trademark of Superior Tube Co., Reg. U.S. Pat. Off.
[2] Manufactured under U.S. Patents
[3] T.M. Reg. U.S. Pat. Off., Superior Tube Co.

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The big name in small tubing

NORRISTOWN, PA.

JOHNSON & HOFFMAN MFG. CORP., Mineola, N.Y.—an affiliated company making precision metal stampings and deep-drawn parts

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ply voltages. Operating effectively from 2.6 to 26 kmc, the noise sources require no warmup time, and correction for ambient temperatures is unnecessary. **Circle P35 inside back cover.**

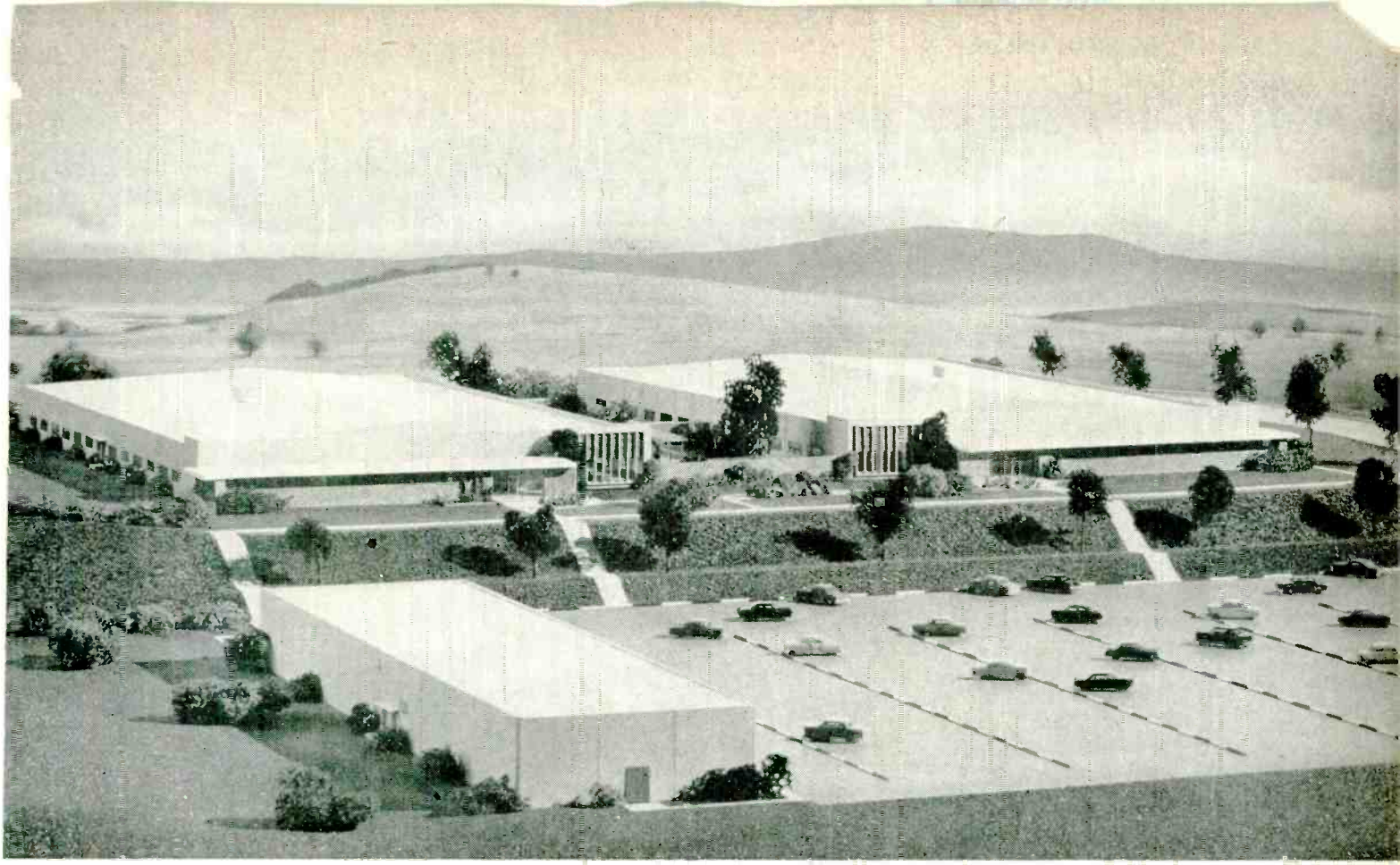
BATCH COUNTER
for use on production line

SPELLMAN TELEVISION CO., 3029 Webster Ave., Bronx, N. Y., announces an electronic batch counter for use in production line predetermined counting in the range of 0 to 99 counts. It will count speeds up to 4,000 per sec.

Model 99 incorporates a mechanical indicator on the front panel which is limited to counts of 1,000 per minute and shows batch counts up to 999,999. The unit also has spacing adjustment control on the front panel which will control an internal relay or external relays and solenoids with delays up to 60 sec. The relay in the unit has two sets of spst contacts; one set normally open and one set normally closed. **Circle P36 inside back cover.**

TEST INSTRUMENT
measures magnetic fields

MAGNAFLUX CORP., 7300 W. Lawrence Ave., Chicago 31, Ill. The Magnatest FM-200 (precision magnetic field meter) is an extremely



SCALE MODEL, NEW LOCKHEED RESEARCH CENTER AT PALO ALTO, CALIFORNIA
Here scientists and engineers are now working in modern laboratories on a number of highly significant projects.

LOCKHEED DEDICATES NEW RESEARCH CENTER

Scientists and engineers are now performing advanced research and development in their new Lockheed Research Center at Stanford University's Industrial Park, Palo Alto, California. In recent ceremonies marking its completion, the Research Center was dedicated to scientific progress.

First step in a $20,000,000 expansion program, it provides the most modern facilities for scientific work related to missiles and space flight. Significant activities are already being carried on in more than 40 areas, including upper-atmosphere problems, nuclear physics, hypersonic aerodynamics, use of new and rare materials, propulsion and advanced electronics.

Lockheed's expansion program has created positions on all levels for scientists and engineers in virtually every field of missile technology. Inquiries are invited from those possessing a high order of ability.

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MISSILE SYSTEMS DIVISION

research and engineering staff

LOCKHEED AIRCRAFT CORPORATION

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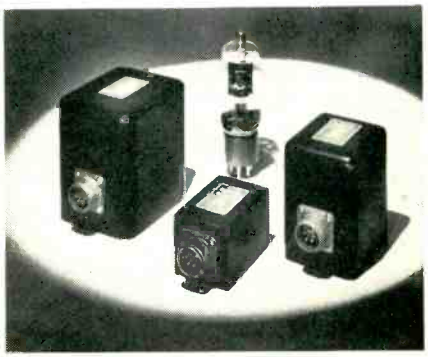
precise instrument for measuring static d-c magnetic fields as small as 0.01 millioersted with an accuracy of ±1 percent of the scale reading. The instrument has 10 ranges, from 1 to 1,000 millioersteds full scale.

The FM-200 is equipped with several different types of probes which expand its usefulness to many applications including both absolute and differential measurements. When used with a recording instrument the speed of response is on the order of 0.001 sec. Model FM-300 has similar characteristics. **Circle P37 inside back cover.**



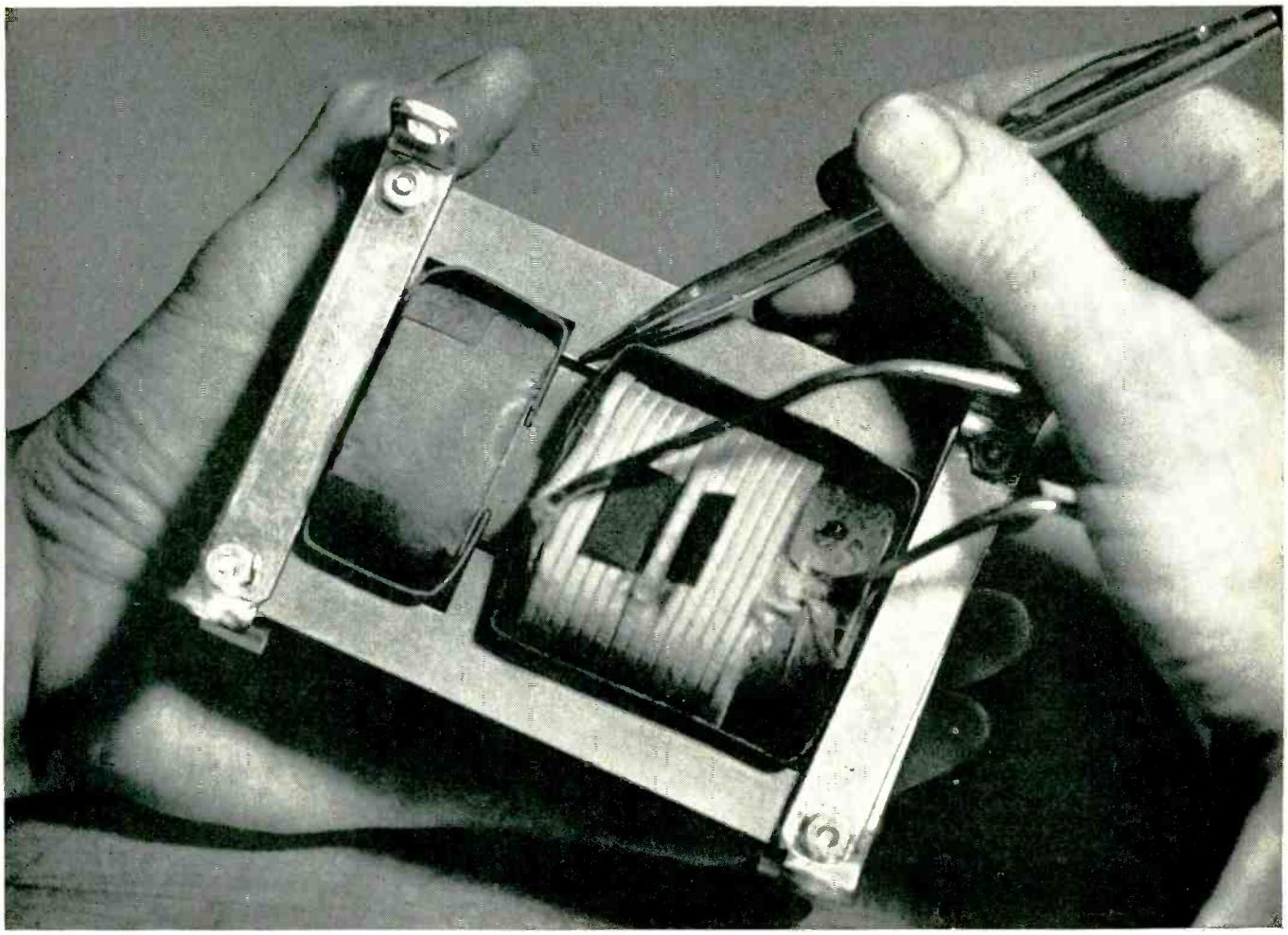
D-C POWER SUPPLIES
magnetic amplifier type

ARNOUX CORP., Box 34628, Los Angeles, Calif. Subminiature, highly-regulated, magnetic amplifier type d-c power supplies are rugged and stable enough for missile use. Units are available in many sizes and ratings from 5 v for strain gage and transducer operation to 550 v regulated plate voltage supplies.

Designed for maximum reliability, these units contain no vacuum tubes or transistors. **Circle P38 inside back cover.**

GRID PULSER
for firing thyratron tubes

HANSON-GORRILL-BRIAN, INC., 85 Hazel St., Glen Cove, N. Y. This universal grid pulser generates voltage spikes as high as 150 v to fire thyratron tubes at accurate phase points in response to low level input signals. The unit has two floating inputs to provide greatest freedom in circuit design. Although it provides very fast half



PHYSICAL ISOLATION OF INPUT AND OUTPUT CIRCUITS *of the Sola Constant Voltage Transformer is indicated in the core-and-coil assembly shown above. At pencil-point is one of two magnetic shunts which separate the input from the output sections of the windings.*

YOU GET VOLTAGE REGULATION AND MORE FROM A SOLA:

Isolation of Input and Output Circuits in Sola Constant Voltage Transformers Generally Eliminates Need for Static Shields

A fixed level of input voltage to today's complex electrical and electronic equipment is virtually essential for adequate performance. The Sola Constant Voltage Transformer, a static-magnetic stabilizer, combines automatic, instantaneous voltage regulation with other desirable electrical functions.

One of these functions is both electrical and physical isolation of the input circuit from the output circuit. In general, this isolation is sufficiently effective to eliminate the need for additional line filtering. Static shields, often required with regulators having a common connection between input and output circuits, are rarely necessary.

Sola Constant Voltage Transformers are available in stock models, or in custom designs to meet the exact requirements of many load devices or service conditions. Your Sola representative will be happy to provide you with information on your particular application.

SOLA *Constant Voltage* **TRANSFORMERS**

Write for Bulletin 7I-CV170D
SOLA ELECTRIC CO.
4633 W. 16th Street
Chicago 50, Illinois

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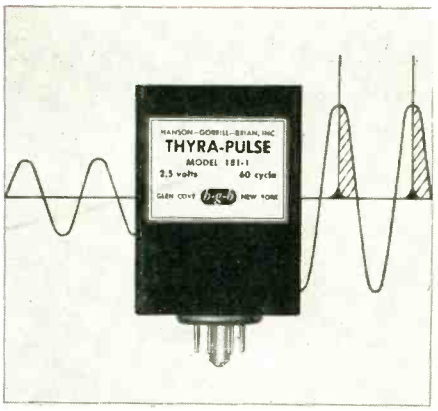
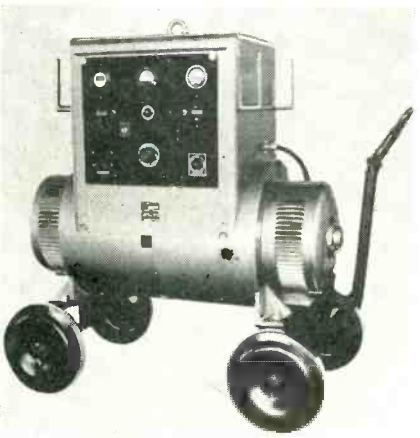


cycle response, it also minimizes thyratron misfiring due to pickup from relays or other random noise.

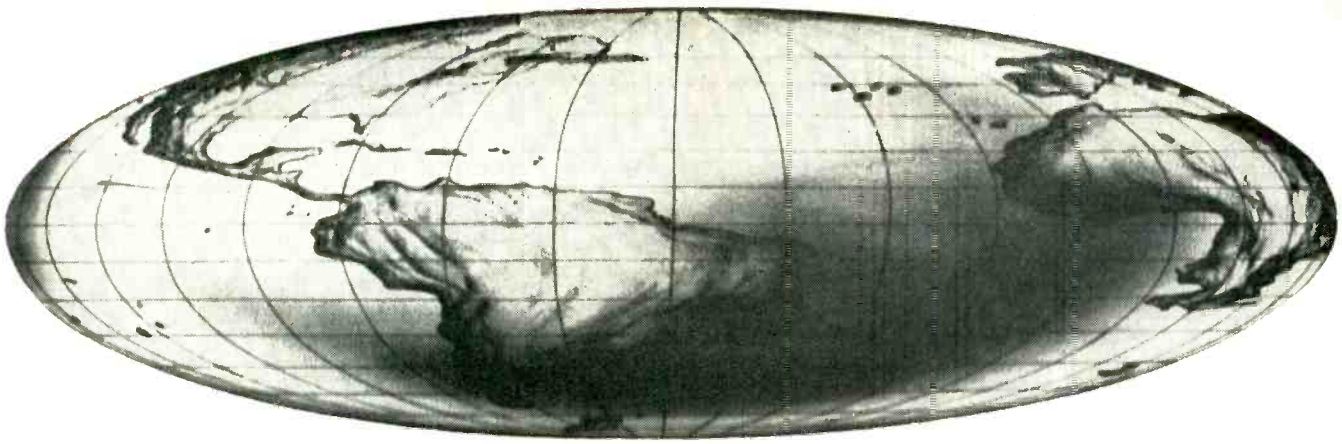
It can be controlled by either a-c or d-c input signals, or by a variable resistor. The grid pulser will control any size thyratron without additional bias supply. It provides extremely long life and trouble-free operation for industrial applications. **Circle P39 inside back cover.**



GENERATORS
for frequency changing

MOTOR GENERATOR CORP., Hobart Square, Troy, Ohio, has placed on the market a new line of synchronous motor driven frequency changing generators, to convert 60 cycle current into a 400-cycle power source accurate enough for the most exacting application in aircraft and missile test work.

► **Uses**—The sets, in 5, 10, 15, 30, 45, 60 and 75-kw capacities, can be used for operating test instruments, functional testing of radio and radar systems, fire control navigation aids, and detection equipment; for supplying power to



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Same

RELIABLE PERFORMANCE

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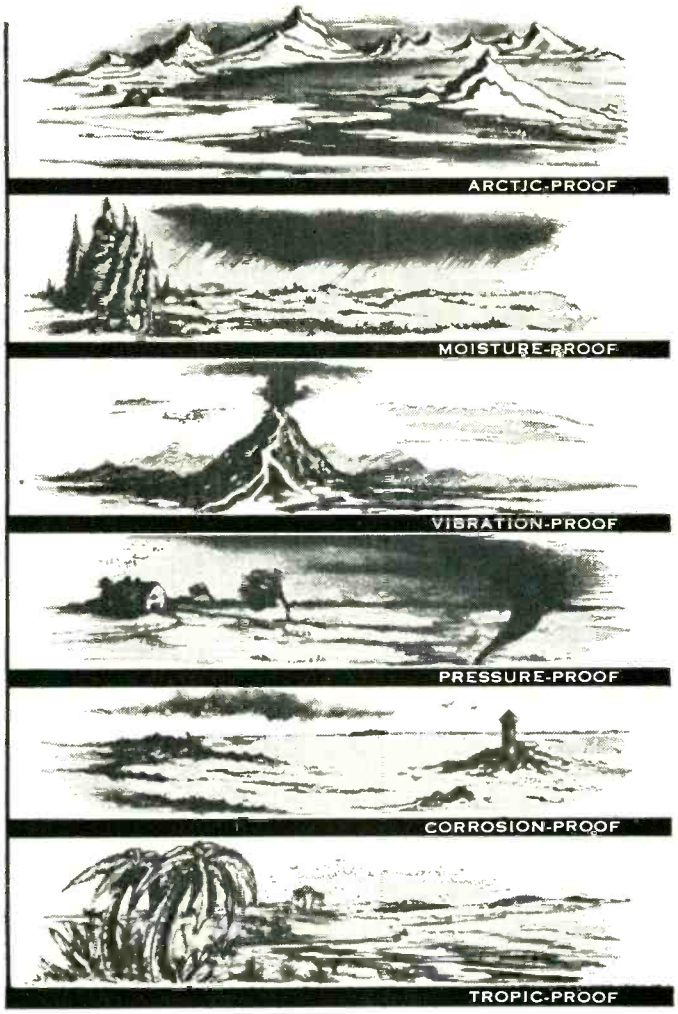
GLASS-TO-METAL SEALS

Constantin's pre-testing assures quality glass-to-metal seals that stand up under climatic extremes . . . and **any** one of the thousands of different Constantin seals will improve your present project, no matter what your particular requirement may be.

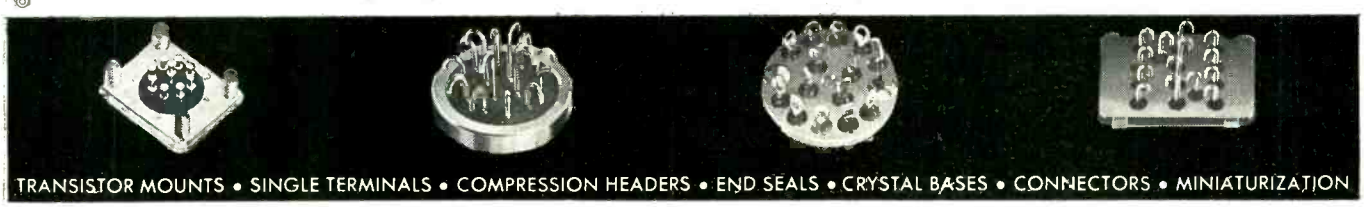
Constantin has long been noted in the electrical and electronic industries for its rigid inspection of **all** parts, from start to finish. They have pioneered in unique and difficult designs in such diversified items as multi-headers, all-in-one assemblies, transistor mounts, single terminals, end seals, crystal mounts, and other superior fabrications.

Constantin's experienced staff of design engineers are ready to help you with **any** glass-to-metal sealing problem. Write today for complete information.



L. L. Constantin & Co. **MANUFACTURING ENGINEERS**

Route 46, Lodi, N. J. • 187 Sargeant Ave., Clifton, N. J.



control systems of missiles and rockets, or for any similar operation where 400-cycle current is needed. **Circle P40 inside back cover.**

CONVERTERS
feature long life

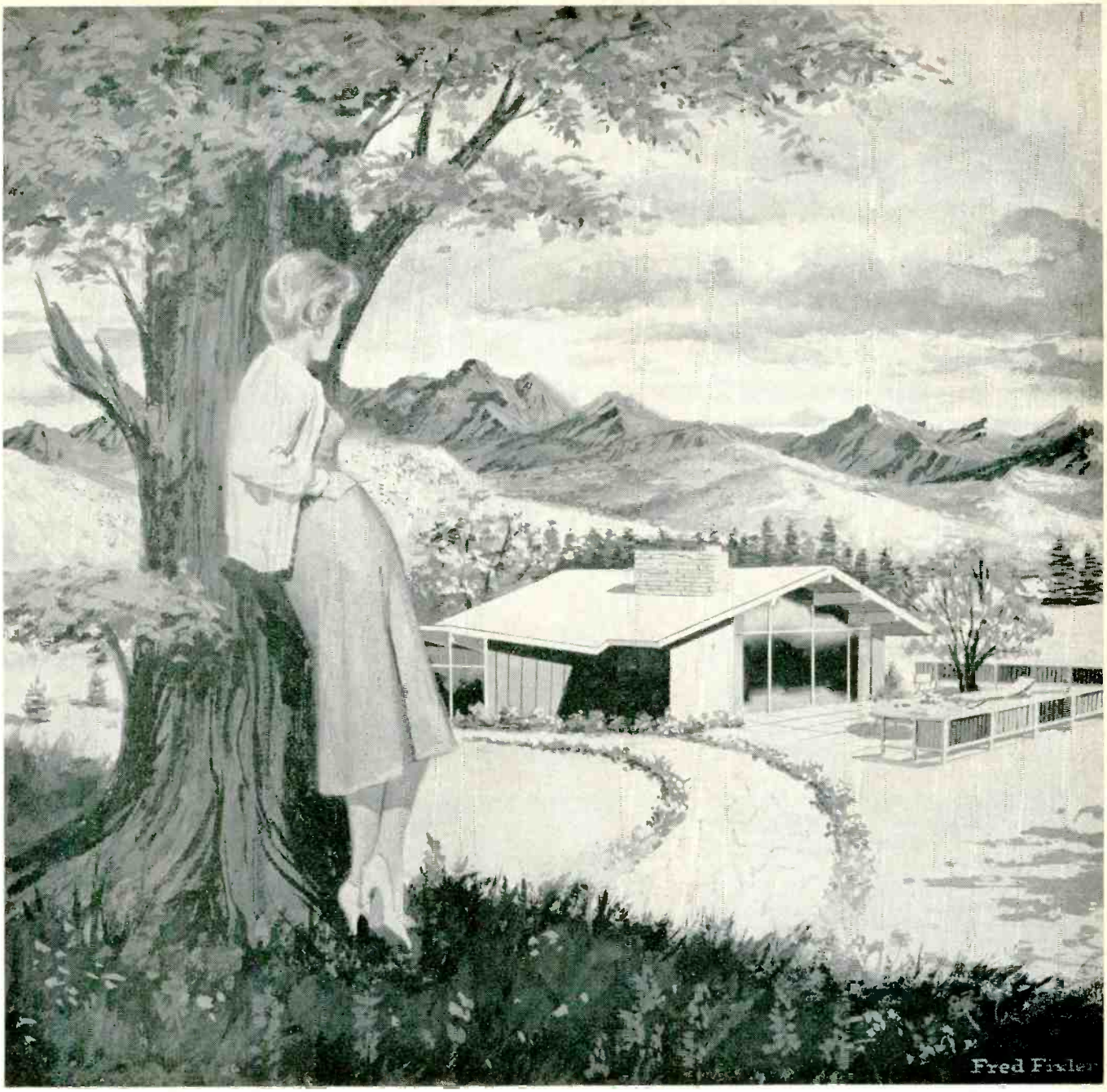
NORDEN-KETAY CORP., 99 Park Ave., New York, N. Y. The new analog-to-digital converters are available in a complete range of counts up to 543,288. These units are conservatively estimated to operate for 4 million revolutions, or better than 500 million counts at 200 rpm before cleaning is required.

▶ **Features** — All converters have number and complement available simultaneously, rapid readout, increasing count available in either direction, low torque and inertia, easy reading while shaft is in motion, d-c or pulse input, unambiguous natural binary output, parallel readout and accuracy with complete design.

More complete information is available in bulletin 372. **Circle P41 inside back cover.**

RECORDER
used with analog computers

REEVES INSTRUMENT CORP., 215 E. 91st St., New York 28, N. Y., has developed a new 6-channel REAC recorder designed specifically for use with analog computers. Among its new features is the introduction of automatic recording of reference data. Pen zero, attenuator setting and electrical offset for each channel, as well as paper speed, are recorded on the chart at the start of each run. This reference data is recorded at a speed independent of the actual paper speed setting. As soon as



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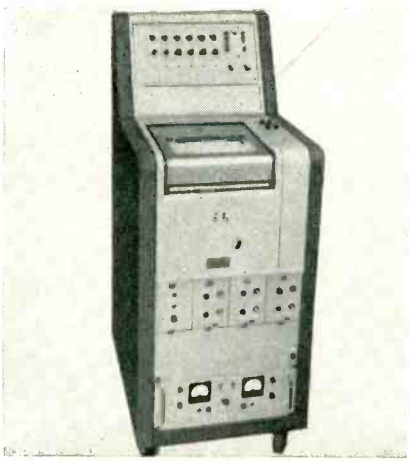


the reference data is entered, the computer and recorder are both switched automatically to "operate," and the run is thereafter recorded at the rate to which the speed switch is set. A zero-time marker indicates the point at which the run began.

►**Technical Information** — Eight paper speeds are available, ranging from 1 to 250 mm per sec. Frequency response is uniform to 60 cps. Full scale voltage ranges from ±1 to ±200 v, with 8 attenuator settings providing voltage control between the ranges of 0.05 to 10 v per mm. **Circle P42 inside back cover.**

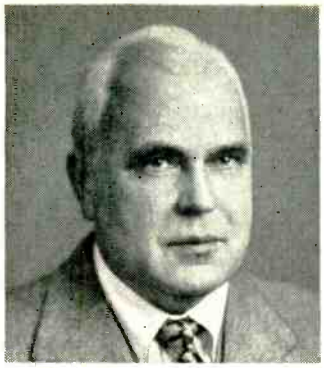
McLEAN Model 1E200 Blower Unit

LITTLE BLOWER
cools electronic equipment

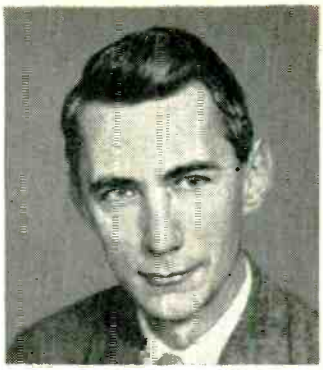
McLEAN ENGINEERING LABORATORIES, Princeton, N. J., is producing a new subminiature blower designed specifically for cooling electronic equipment. Model 1E200 is designed to fit into a 3¾-in. cubic area. Operating on 115 v, 60 cps and drawing 0.12 ampere, the motor is a continuous-duty permanent capacitor type totally enclosed, with ball bearings. Operating at a speed of 3,400 rpm the

WARREN A. MARRISON. Tompion Gold Medal, Worshipful Company of Clockmakers of the City of London, for pioneer work on development of quartz crystal oscillators as precision standards of time.

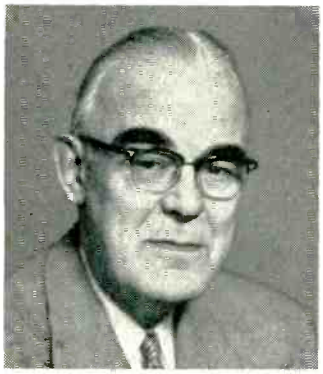
W. G. PFANN. Mathewson Gold Medal, American Institute of Mining and Metallurgical Engineers, for discovery of and pioneering research in zone melting.



H. T. FRIIS. Medal of Honor, Institute of Radio Engineers and Voldemar Poulsen Gold Medal, Danish Academy of Technical Sciences; important work in application of short and ultra-short radio waves.

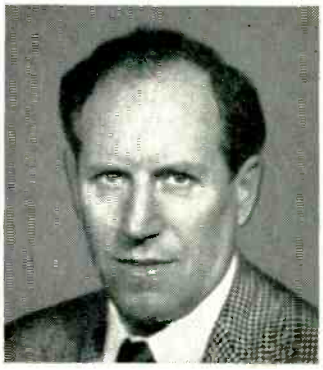


CLAUDE E. SHANNON. Stuart Ballantine Medal, Fronklin Institute of the State of Pennsylvania, for contributions to a comprehensive theory of communication.



AXEL G. JENSEN. David Sarnoff Gold Medal, Society of Motion Picture and Television Engineers, for technical contributions to television; G. A. Hagemann Gold Medal for Industrial Reseorch, Royal Technical College, Copenhagen.

H. F. DODGE. Shewhart Medal, American Society for Quality Control, for original contributions to the art of statistical quality control.



R. KOMPFNER. Duddell Medal, Physical Society of England, for his original work on the traveling wave tube.

WALTER H. BRATTAIN. Co-winner with Dr. John Bardeen of John Scott Medals, City of Philadelphio, for invention of the transistor.

PIONEERS OF PROGRESS

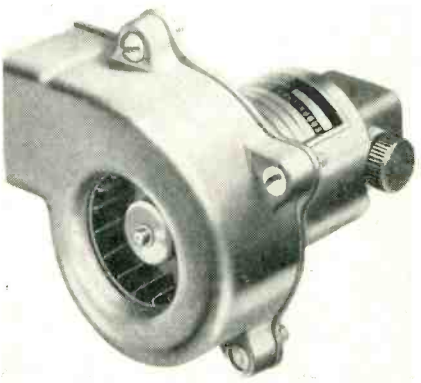
These are some of our recent medal winners at Bell Laboratories. The awards they have won symbolize recognition for outstanding achievement in the many sciences that bear on telephony. Bell Labs is extremely proud of them—and of the thousands of scientists and engineers who work with them to keep the American telephone system the greatest in the world.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

Want more information? Use post card on last page.

2-in. centrifugal blower wheel provides 10 cfm free air delivery. The unit meets rigid specifications. **Circle P43 inside back cover.**



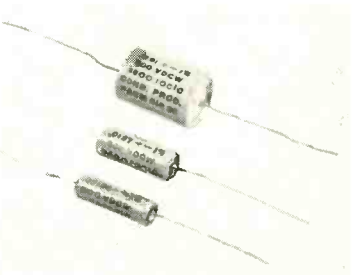
CENTRIFUGAL BLOWERS

permanent-magnet type

BARBER-COLMAN CO., Rockford, Ill., has available a p-m centrifugal blower designed for dissipating the heat generated by electron tubes, circuit components and other similar equipment mounted in confined enclosures.

▶ **Ranges**—Voltages range from 6 to 115 v d-c; air volume (at 0 static pressure and 70 F) for a typical unit is 20 cfm.

Catalog F4344-3 describes the company's p-m centrifugal blowers, motors, gearheads and generators. **Circle P44 inside back cover.**

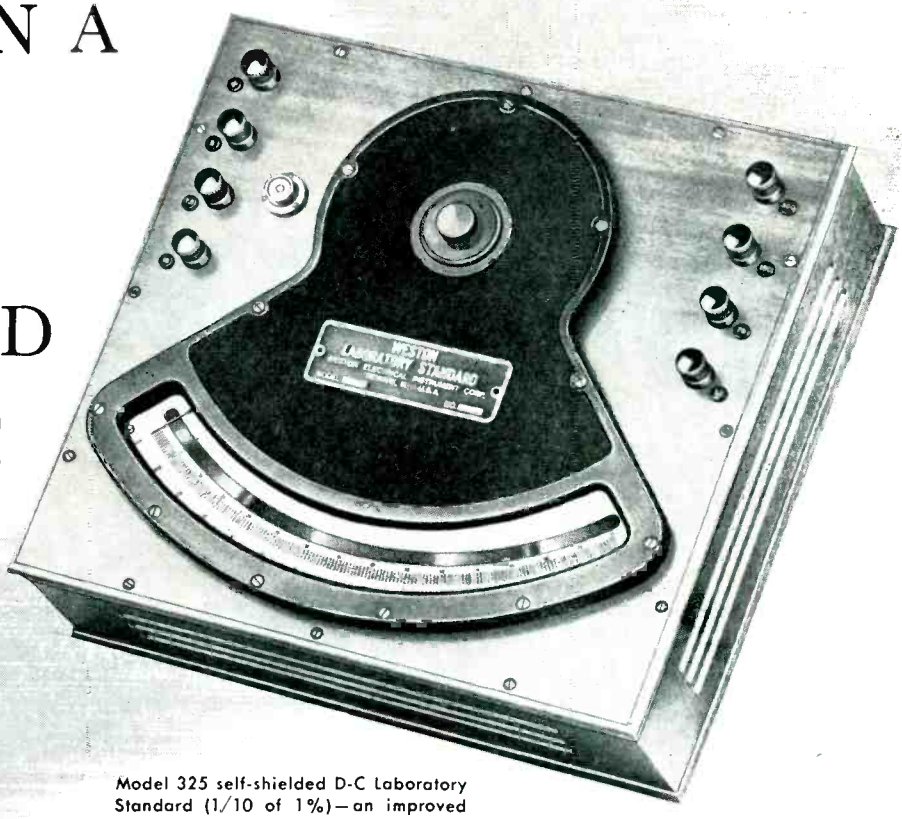


METAL TUBULARS

miniature polystyrene type

CONDENSER PRODUCTS CO., 140 Hamilton St., New Haven, Conn. High insulation resistance and excellent capacitance stability have been designed into the new precision miniature metal tubular polystyrene capacitors recently introduced. Built for use in various types of military computers and

NO MEASURABLE ERROR IN A 5 OERSTED FIELD!



Model 325 self-shielded D-C Laboratory Standard (1/10 of 1%)—an improved instrument now replacing the world renowned Model 5.

The new Weston model 325 provides a new STANDARD of laboratory measurement

Another WESTON first... a self-shielded primary instrument standard that is unaffected by magnetic fields normally encountered in the modern laboratory. While the new Model 325 incorporates a special CORMAG® mechanism, the overall design provides an even far greater degree of shielding than that inherent in the basic core-magnet mechanism. In fact, tests show absolutely no measurable error in a 5 oersted field. Thus there is no need for positioning or mounting the instrument with reference to the earth's field; nor to take undue precautions when using it in close proximity to current carrying conductors. In addition, Model 325 is well compensated for normal room temperatures; and a vernier type corrector is provided for precise and rapid zero adjustment. This improvement in primary instrument standards is another example of the *forward thinking* and *continuous development* which have kept WESTON the instrument leader since 1888. For complete data on Model 325, or on other Weston instruments consult your nearest Weston representative, or write... *Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.* A subsidiary of Daystrom, Incorporated.

WESTON
Secondary Standards
(¼ of 1%)

A DAYSTROM UNIT

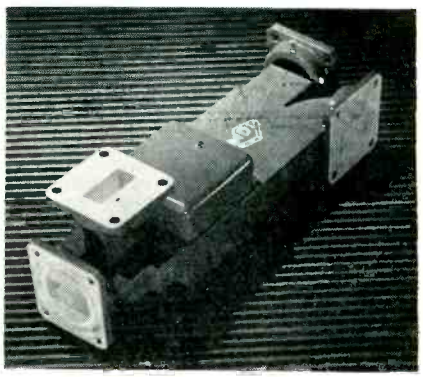
WESTON *Instruments*

other electronic devices, the new miniatures are particularly suitable in radiation type batteries. Capacitance range is from 0.0001 to 1 μf and voltage range is from 100 to 1,600 v d-c.

▶ **Advantages**—Both inserted tab and extended foil construction are offered and various circuit styles and bracket arrangements in accordance with MIL-C-25A are available. The units also can be supplied with a vinyl sleeving.

A principal advantage is that all of the elements of polystyrene as a dielectric are provided in the small sizes of CP-04 through CP-11 case styles of MIL-C-25A.

Dielectric absorption is 0.05 percent and insulation resistance at 25 C is 1×10^{12} ohms. Power factor at 1 kc is a maximum of 0.05 percent. Stability is to 0.1 percent per cycle. Temperature range is −55 to +85 C with a coefficient of minus 100 parts per million per deg C. **Circle P45 inside back cover.**

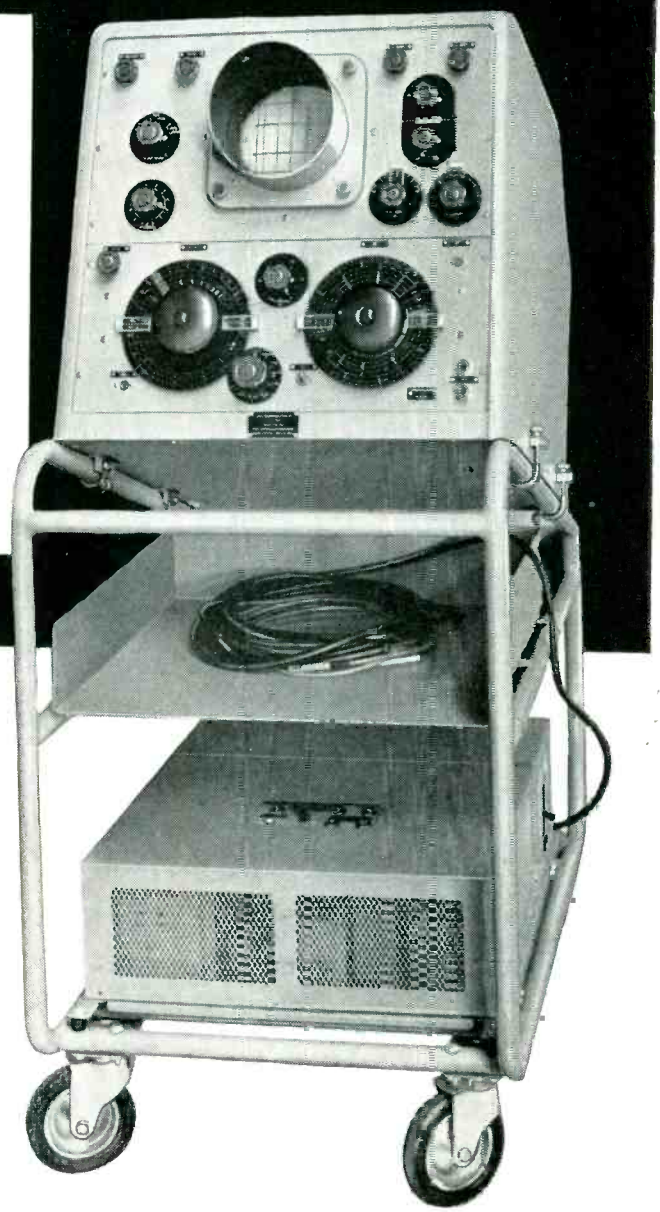


FERRITE CIRCULATOR
for X-band use

MICROWAVE DEVELOPMENT LABORATORIES, INC., 92 Broad St., Wellesley 57, Mass., announces a new X-band Ferrite circulator with a front-to-back ratio approaching 300 to 1. Model 601 circulator is a medium power microwave component developed around the nonreciprocal differential phase shift principle. Power entering the circulator is transmitted in sequence from one terminal to another. That is, power entering at *A* leaves at *B*, while power entering at *B* leaves at *C*. Power entering at *C* leaves at *D*, while that entering at *D* returns to *A*. The component is ideal for such uses as a low-loss, broad-

MARCONI'S SPEED SSB CHECKS

HF SPECTRUM ANALYZER
TYPE OA 1094



The Marconi OA 1094 Analyzer gives an immediate panoramic display of the frequency spectra of signals in the band 3 to 30 MC. It brings speed and convenience to the alignment of SSB communication transmitters and drives. Intermodulation distortion, hum level and carrier compression, the bandwidth of FSK and on/off keyed signals—these can all be seen at a glance and evaluated directly against the CRT graticule. A crystal-controlled first local oscillator insures a drift-free display at sweep widths as low as 100 cps. Highly-selective IF crystal filters provide 60 db discrimination between components as little as 60 cps apart.

ABRIDGED SPECIFICATION

Frequency Range: 3 to 30 MC in 9 bands with separate fixed drive-frequency input.
Sweep Width: Continuously variable up to 30 KC.
Sweep Duration: 0.1 to 30 sec in 6 steps.
Amplitude Measurement Range: 0 to -30 db and -30 to -60 db relative to reference signal.
IF Bandwidths: 6, 30, and 150 cps.
CRT: 6-inch diameter with long-persistence phosphor.

Designed and developed by communication engineers of the British General Post Office for use at their HF point-to-point transmitter stations, the OA 1094 is manufactured by Marconi Instruments under GPO authority.

MARCONI INSTRUMENTS

Marconi - since 1897

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MONTREAL 9, CANADA.

HEAD OFFICE: MARCONI INSTRUMENTS LTD · ST. ALBANS · HERTS · ENGLAND

TC 85

band isolator, or in passive duplexing applications.

► **Typical Characteristics** — Frequency range is 8,500 to 9,600 mc; isolation, 30 db minimum; insertion loss, less than 0.2 db; return loss, 30 db minimum; input vswr, 1.2 maximum; waveguide, RG-52/U-RG67U; flanges, UG-39/U, 135/U at B, C and D; input terminal, UG-40 A/U, UG-136A/U. **Circle P46 inside back cover.**

KLYSTRON OSCILLATOR
for 8,500 to 10,500 mc

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y. A new X-band, waveguide output, two-cavity klystron oscillator features excellent frequency stability and low microphonics.

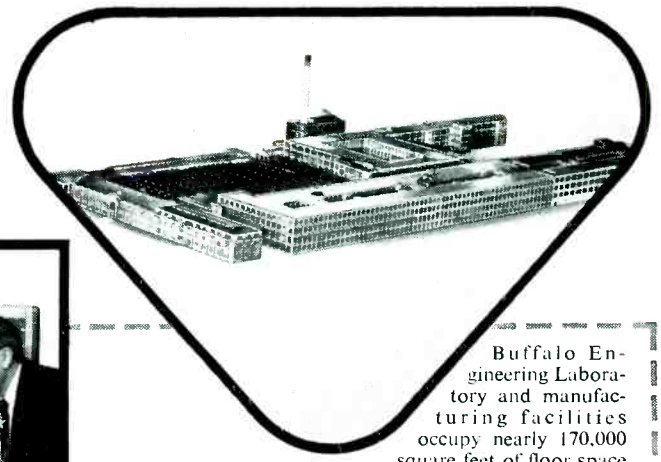
► **Power and Uses**—The new tube design is available in any of three power classes—the type DX 122 for 5 w, type DX 123 for 20 w and type DX 124 for 150 w minimum. It covers any fixed frequency in the 8,500 to 10,500 mc range, and, as such, satisfies the application requirements of guided missiles, radar, telemetering devices and microwave relay links.

It is electrostatically focused with easily modulated a-m or f-m and has a new dispenser type cathode for long life. **Circle P47 inside back cover.**

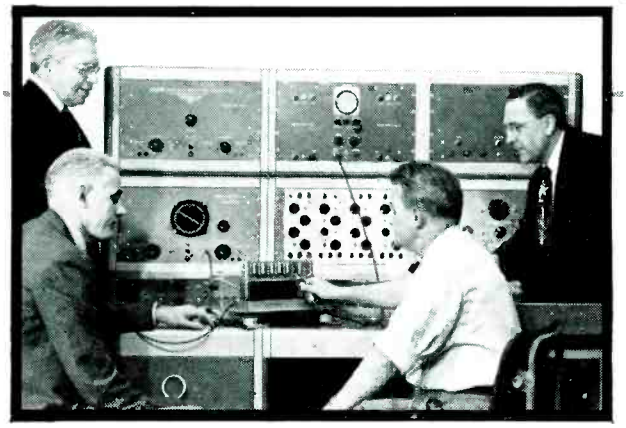
SIGNAL GENERATOR
covers 4,200 to 11,000 mc

POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N. Y. The MSG-34 signal gener-

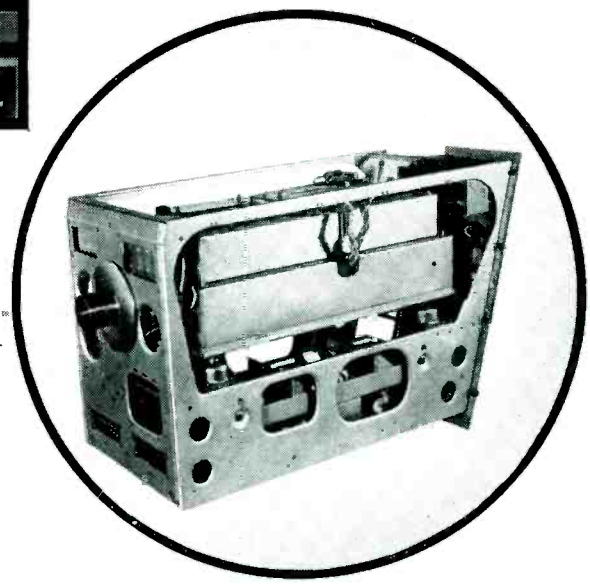
The right people with the right facilities produce the right solutions



Buffalo Engineering Laboratory and manufacturing facilities occupy nearly 170,000 square feet of floor space in this industrial center at 175 Great Arrow Ave., Buffalo 7, New York.



Observing measurement of circuit parameters in the Electronic Systems Division's Buffalo Engineering Laboratory. From left: *H. C. Tittle*, Manager—Buffalo Operations; *M. C. Scott*, Manager—Buffalo Engineering Laboratory; *R. W. Ferry*, Assistant Product Engineering Manager and *A. W. Puttick*, Product Engineering Manager.



Component of Airborne Countermeasure System.

"Packaged"

to deliver top performance—anywhere

THIS "PACKAGE" CAN GO anywhere, any time, in modern, high-performance aircraft, and deliver effectively in America's defense. It is an electronic countermeasure system. Designed, engineered, and "packaged" for minimum weight, the equipment provides maximum reliability and top performance under extreme conditions of humidity, altitude, shock, vibration, and temperature differential.

Engineered in the Buffalo Engineering Laboratory of Sylvania's Electronic Systems Division, this highly advanced electronic system employs subminiature tubes, transistors, and printed circuits in a package which is itself subminiaturized. Despite its complexity of design and purpose, it is engineered for quantity production in the Division's Buffalo plant.

In all of Sylvania's Electronic Systems Division installations, the right people work with the right facilities, within a sound managerial environment. That is why they have produced the right solutions to a variety of problems, and have made such important contributions in the fields of aviation electronics, guided missiles, countermeasures, communications, radar, computers and control systems. Whether the problem is military or industrial, Sylvania's business is to come up with electronic solutions that are *producible*.

In addition to its Buffalo Engineering Laboratory and manufacturing facilities, the Electronic Systems Division has installations at Waltham, Mass., and Mountain View, Calif., staffed with top-ranking scientists and engineers, and backed by Sylvania's extensive resources in the electronics field.

SYLVANIA IS LOOKING FOR ENTERPRISING ENGINEERS

Sylvania has many opportunities in a wide range of defense projects. If you are not now engaged in defense work, you are invited to contact Edward W. Doty, Manager of Personnel, Electronic Systems Division, Sylvania Electric Products Inc., 100 First Avenue, Waltham 54, Mass.

SYLVANIA

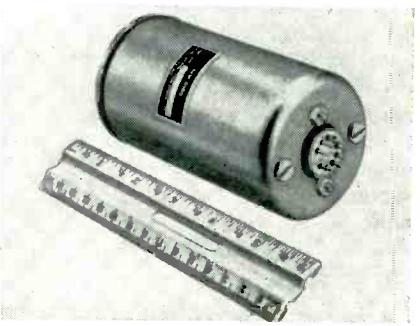
SYLVANIA ELECTRIC PRODUCTS INC.

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

ator cover S, C and X band frequencies—4,200 to 11,000 mc—with a power output of 1 mw.

► **Features**—It is equipped with Polarad's Uni-Dial construction which provides complete integration and simple operation. Large, direct-reading dials indicate frequency and attenuation. Other features are: provision for external modulation by multiple pulses; automatically tracked power monitor; and noncontacting oscillator choke.

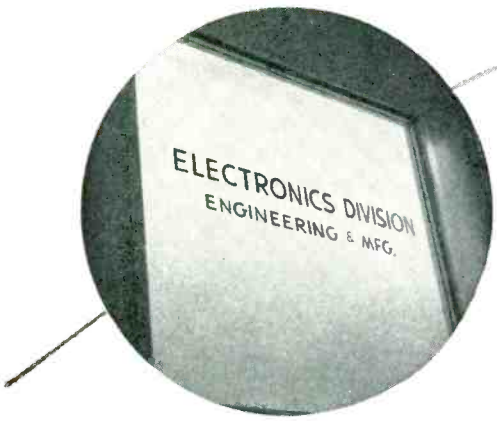
The modulator, utilizing printed circuit techniques, permits internal pulse and square-wave modulation from 10 to 10,000 pps at pulse widths of from 0.2 to 10 μsec. **Circle P48 inside back cover.**



RATE GYRO
a rugged unit

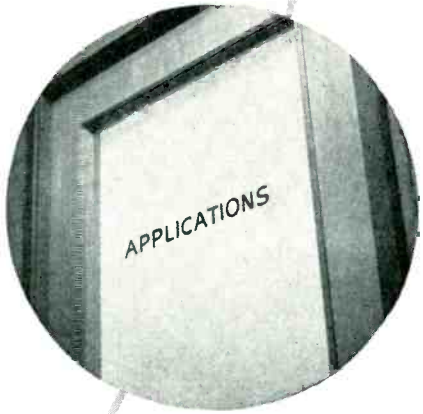
GLOBE INDUSTRIES, INC., 1784 Stanley Ave., Dayton 4, Ohio, has introduced a new rate gyro. The motor is d-c powered and governor controlled so that output is independent of line voltage. The size is 2⅜ in. diameter by 4 7/16 in. long and weight is 1.7 lb.

The case is designed to provide hermetic sealing. Standard units incorporate a potentiometer pickoff and also adjustable switches



BEHIND THESE DOORS...

The formula for success in the field of electronics might be resolved to the equation, "Scientific ability plus engineering skill plus modern plant facilities equals achievement." You will find all three behind these doors of Marvelco Electronics. Scientific ability represented by some of the finest electronic scientists in the nation . . . dedicated scientists whose research not only has produced such achievements as the Tandem Transistor, but practical scientists who have the ability to apply the fruits of their research to industry. They are backed up by skilled engineering technicians working with modern production facilities to make their formulas a finished product. If you have an electronics problem or a research and development project why not query Marvelco today?



MARVELCO

(Electronics Division)

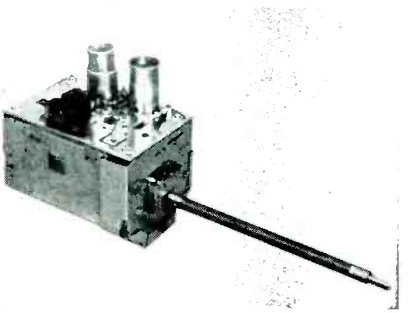
NAC

NATIONAL AIRCRAFT CORPORATION

3411 Tulare Avenue Burbank, California

Want more information? Use post card on last page.

which can be set to close at any desired rate within the range of the unit. The standard unit also incorporates a dashpot for damping, and the natural frequency of the gyro is in the range of 5 to 10 cps. The gyro is well suited for rate stabilization, position control, telemetering and rate switching. **Circle P49 inside back cover.**



TV TUNER
with neutralized triode

STANDARD COIL PRODUCTS CO., INC., 2085 North Hawthorne Ave., Melrose Park, Ill. The Neutrode television tuner features lower noise figure, better sensitivity and many other improved qualities.

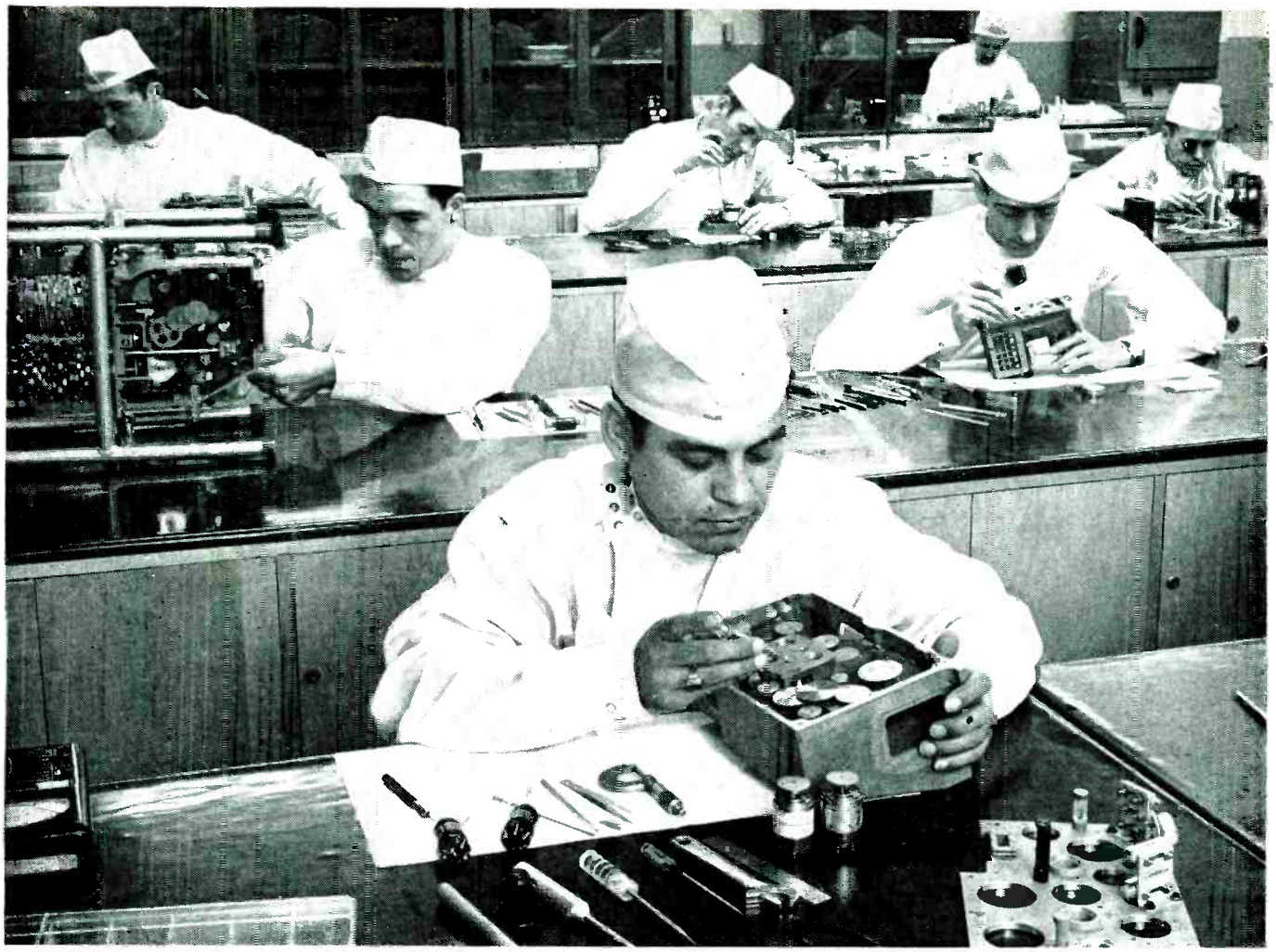
▶ **Typical Values**—Field tests have revealed more than 32 db gain and less than 7 db noise (channels 2 through 6), and more than 28 db gain with less than 8 db noise (channels 7 through 13). These figures are for the tuner as a whole of which the neutralized triode is a prime stage.

By employing printed circuitry, the tuner has consistently better wiring, greater uniformity, improved performance and lower inspection costs. **Circle P50 inside back cover.**

RESISTORS
for limited space uses

PRECISION, INC., 730 Lyndale Ave. North, Minneapolis, Minn. Ideal for printed circuitry or for use in limited space application, precise-ohm AW and BW resistors measure only ½ in. in diameter, approximately ½ in. in length. Type AW is rated at 0.25 w; type BW, at 0.5 w.

▶ **Specifications**—Tolerances of 1, ½, ¼ and 1/10 percent are stand-



Operating room conditions for

Inertial Instrument Development Engineering

The work in this 5000 square-foot room at AUTONETICS is surgical in its precision, clinical in its standards of cleanliness. Here are assembled the precise mechanisms devised by the engineers and physicists engaged in the new field of INERTIAL NAVIGATION SYSTEMS. Among the units are highly-specialized types of Gyros and Accelerometers as delicate as a living organism.

Each cubic inch of air in this room contains fewer than 6 dust particles whose diameter exceeds 0.3 micron. Temperature variation is held to plus or minus 1°; humidity to less than 50%. AUTONETICS provides these ideal conditions, comparable with the standards attained in primary laboratory instrument work, to insure optimum results in the function of the tiny components, so painstakingly designed. The men who create them are reaching the highest levels of professional skill, as they obtain definitive answers to the problems of miniaturization and reliability under environmental extremes.

This facility is soon to be doubled. The hitherto unpublicized program is already ahead of the rest of the field. Prime need of the current expansion is for men who can make a *creative* contribution.

You Can Participate In This Work. Act Now: Here are the fields in which your individual contribution can bring you distinction in your profession:

Mechanical Engineering: Analysis, Development, Design and Test of ultra-precision inertial sensing and measuring instruments.

Physics: Solution of unique instrumentation problems far beyond the scope of routine design or mere extrapolation from existing knowledge.

Electrical Engineering: Design and development of miniature, continuously-rotating and servo motors, and special transducers of extreme precision.

Electronic Engineering: Development of transistor and vacuum tube circuits as integral parts of instrument systems, and the electronic equipment for the unique and elaborate testing demanded by inertial systems.

Response to your inquiry will be prompt.

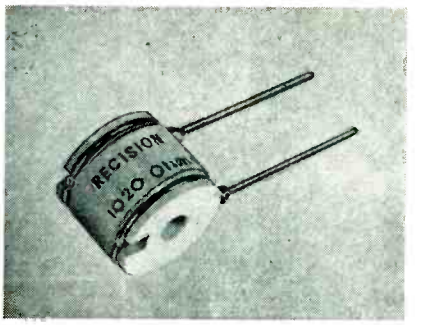
Write: Mr. A. Brunetti, Autonetics Engineering Personnel, Dept. 991-9EL, P.O. Box AN, Bellflower, California.

See us at booths 626 and 627 at the Instruments and Automation Conference and Exhibit, New York, September 17-21.

Autonetics

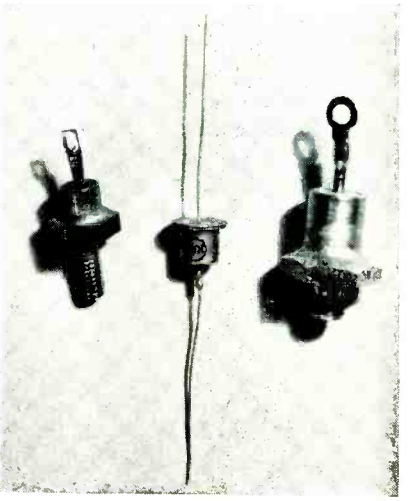
A DIVISION OF NORTH AMERICAN AVIATION, INC.

AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE



ard; however, tolerances of 1/20 and 1/50 percent may be obtained on special order. Both types are noninductively wound, equipped with No. 20 tinned annealed copper or high copper-content alloy pigtail wire leads.

In applications requiring matched resistors, such as in analog computers or bridge networks, types may be matched to 1/50 percent. **Circle P51 inside back cover.**



SILICON RECTIFIERS
for airborne equipment

FEDERAL TELEPHONE AND RADIO Co., 100 Kingsland Road, Clifton, N. J. A new line of silicon power rectifiers is ideally suited for airborne power supplies and other airborne electronic equipment. They may also be applied wherever minimum size, high operating temperature and resistance to vibration and shock are required.

Electrically, the rectifiers exhibit very low forward voltage drop when passing full rated forward current. The negligible leakage current is most appealing to design engineers. Stud-type mounting available per government specifications assures reliable service under

*12 weeks ago 4 Engineers Said...

ENGINEERS:

Take our word for it...

Your career will be better at

Westinghouse

BALTIMORE DIVISIONS

YOUR FUTURE WILL BE BETTER

"In 1938, I joined the Westinghouse Graduate Student Program and continued on through its Advanced Design School and Graduate School at Westinghouse expense, earning both my M.S. and Ph.D. Degrees. My experience gained in working with Edison Medal winner J. F. Peters and others, as well as with the outstanding facilities the company provided to do advanced development, led to a series of promotions culminating in my present position as Engineering Manager of the Air Arm Division."

Dr. S. W. Herwald

YOUR WORK WILL BE BETTER

"I appreciate the wide range of projects available to an engineer at Westinghouse. After joining the company as a student engineer, my work included airborne radar, as Project Engineer for X and K Band Spectrum Analyser, Project Engineer for 50 kilowatt Broadcast Transmitters and Project Engineer for 500 kilowatt, 100 kilocycle military transmitters. In this challenging field, my work covered a wide scope from theoretical analysis to design and development work, including tests and systems. At the present time, I am Section Manager for microwave engineering. So, I have covered the spectrum from 100 kilocycles to 20,000 megacycles, and a power range from milliwatts to 500 kilowatts. As an engineer, you can look forward to the same kind of broad experience working at Westinghouse." Take my word for it your work will be better at Westinghouse.

Nelson Tharp

YOUR EXPERIENCE WILL BE BETTER

"For the past six years, I've been working in advanced control techniques in fire-control computers, radar antenna servos and turret servos. With this extensive experience, I was able to organize evening classes for engineers and teach classes in servo-mechanisms. It has meant a great deal to me to associate every day with established leaders in the electronics field men who have pioneered developments from radio to radar. And the research facilities here at Westinghouse Baltimore are immense. Take my word for it . . . you'll like working for Westinghouse."

Adam O. Kegel

YOUR OPPORTUNITIES WILL BE BETTER

"After four years of military life, with its constant moving around, the feeling of job stability that I have with Westinghouse is of special importance to me. As an individual with a family, I appreciate the opportunities given to me here opportunities for developing my engineering talents and abilities to the fullest extent. And, I can't overemphasize the value of friendly, cooperative associates. There are many reasons that a person can give for choosing a particular company for which to work, but I feel that these two, job stability and friendly, cooperative associates, have meant the most to me at Westinghouse in Baltimore. Take my word for it . . . your opportunities will be better at Westinghouse."

Jim Baech

NOW...One of these men DR. HERWALD has been named Manager of the Air Arm Division

When Dr. Herwald was advanced recently to Manager of the Westinghouse Air Arm Division it was proof again that Westinghouse values highly the career engineer and gives him a vital role to play in its far-reaching activities. Dr. Herwald's growth at Westinghouse, since joining the company in 1938 in the Graduate Student Program, is most significant to engineers looking for challenging careers with real opportunities for advancement.

ADVANCED EDUCATION AT COMPANY EXPENSE

Dr. Herwald received his M.S. and Ph.D. Degrees in the Westinghouse Graduate Education Program. This program pays tuition expenses for work on graduate degrees—and it is open to you!

This Illustrated Brochure sent to All Applicants

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TO APPLY: Send letter outlining your education and experience to:

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WATCH BALTIMORE WESTINGHOUSE DIVISIONS

WHERE BIG THINGS ARE HAPPENING IN ENGINEERING CAREERS

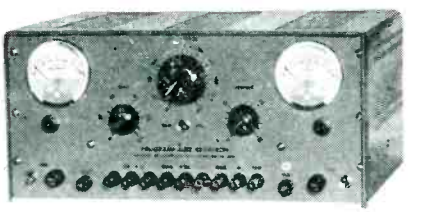
the most adverse conditions.

Ratings of the different models at various temperatures are available on request. **Circle P52 inside back cover.**

DELAY LINES
in matched multiple units

ANDERSEN LABORATORIES, West Hartford, Conn., announces a new series of very long delay lines in matched multiple units. The assembly shown comprises three 20-mc, 2,780-μsec lines matched within 0.25 μsec of one another. Spurious responses are 45 db or more below the main delayed signal.

These lines can be supplied in dual or triple assembly, with or without temperature control. At the present time, matching of delays can be specified as close as 0.25 μsec. **Circle P53 inside back cover.**

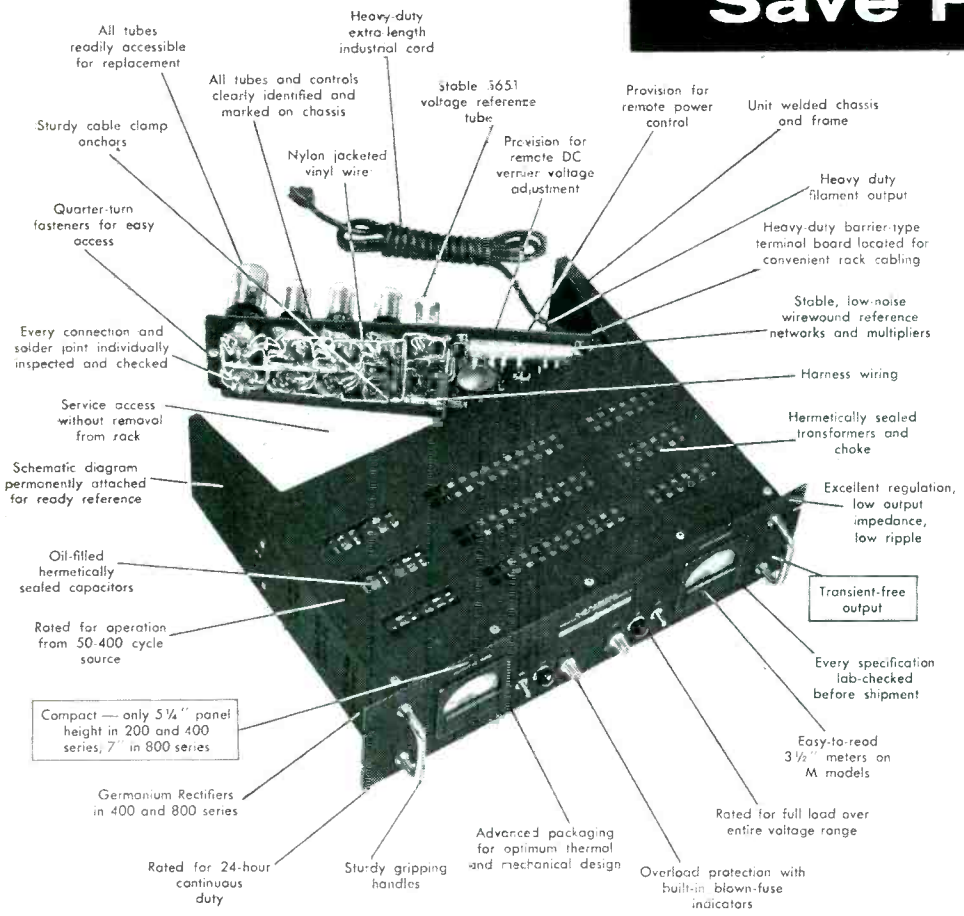


POWER PACKS
for programming uses

ELECTRONIC MEASUREMENTS CO., INC., Lewis St., Eatontown, N. J. The circuit design of these newly developed power supply units is intended for applications requiring remote control and/or programming according to commands from an operator or control system—such as in tube-test programming, automatic production testing, and

LAMBDA 200, 400, 800 MA SERIES

New Power Supplies Save Panel Space!



New! **HERMETICALLY-SEALED TRANSFORMERS**

New! **TRANSIENT-FREE**

New! **FUSE FAILURE INDICATORS**

New! **GERMANIUM RECTIFIERS IN 400 AND 800 MA SERIES**

These new, compact, regulated Lambda D.C. power supplies are precision engineered, designed to displace minimum panel space. Wiring and tubes are easily accessible for maintenance and replacement. Hermetically-sealed transformers and chokes, protected from moisture, assure long trouble-free service. Meters optional.

Germanium rectifiers in 400 and 800 MA series for higher efficiency, compact design, longer life.

200 AND 400 SERIES ONLY 5¼" HIGH

	800 MA SERIES	400 MA SERIES	200 MA SERIES
	MODEL 881 125-325 VDC **$315.00***	**MODEL 481** 125-325 VDC **$244.50***	**MODEL 281** 125-325 VDC **$149.50***
	MODEL 882 325-525 VDC **$350.00***	**MODEL 482** 325-525 VDC **$259.50***	**MODEL 282** 325-525 VDC **$159.50***
INTERNAL IMPEDANCE	less than 1.5 ohms	less than 3 ohms	less than 6 ohms
AC OUTPUT 6.5 VAC (unregulated)	20 amp.	15 amp.	10 amp.
SIZE	7"Hx19"Wx14⅜"D	5¼"Hx19"Wx14⅜"D	5¼"Hx19"Wx14⅜"D
WEIGHT (net)	75 lbs.	53 lbs.	53 lbs.

REGULATION:

(line) . . . Better than 0.15% or 0.3 Volt (whichever is greater). For 105-125 VAC.

(load) . . . Better than 0.25% or 0.5 Volt (whichever is greater). For 0 to full load.

TRANSIENT RESPONSE:

(line) . . . Output voltage is constant within regulation specifications for step-function line voltage change of plus (+) 10 volts or minus (−) 10 volts rms within the limits of 105-125 VAC.

(load) . . . Output voltage is constant within regulation specifications for step-function load change between 0 to full load or full load to 0 MA.

OVERLOAD PROTECTION:

External . . . AC and DC fuses, front panel, with built-in fuse-blown indicator.

Internal . . . Fuse, rear of chassis.

*Metered models identified by letter "M", add $30 to base price.

LAMBDA Electronics Corp.

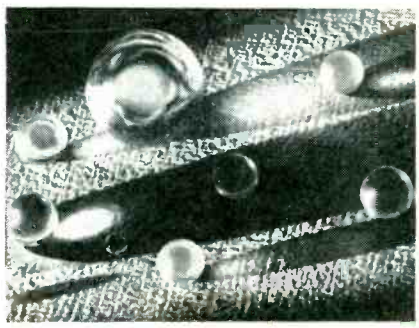
THE FIRST NAME IN POWER SUPPLIES

11-11 131 STREET, COLLEGE POINT 56, NEW YORK

other automated processes.

Also useful for general applications, all three models feature main and vernier controls, auxiliary bias and filament outputs, as well as super-regulation over full range and for all load conditions.

Designated models 231-A, 232-A and 233-A, all units have an output range of 0 to 300 v, regulation of 0.1 v, and ripple of only 1 mv. Current outputs for the various models respectively are 0 to 100 ma, 0 to 200 ma and 0 to 300 ma. **Circle P54 inside back cover.**



PYREX BALLS
highly precision ground

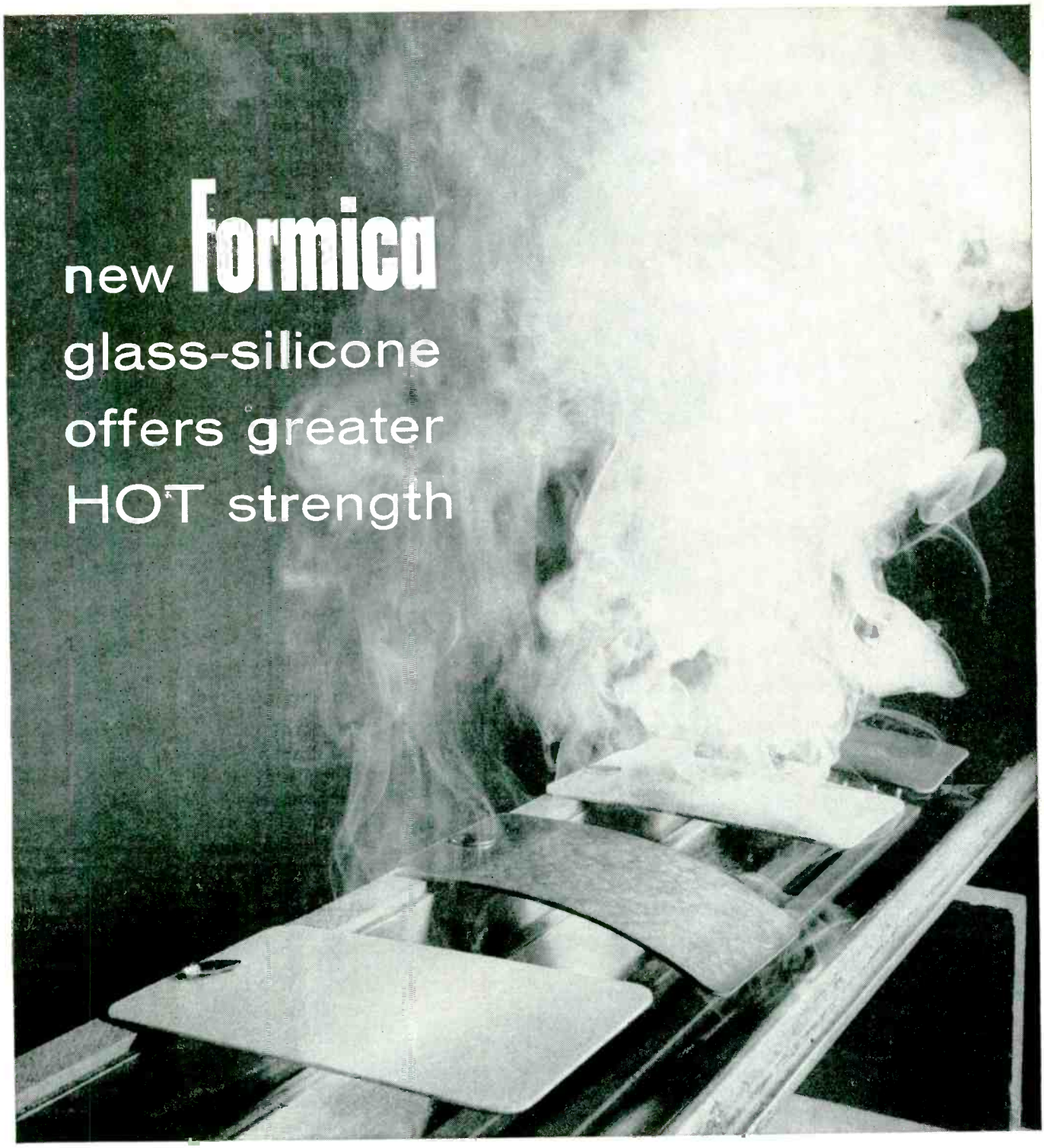
THE HARTFORD STEEL BALL CO., INC., West Hartford, Conn. Nonconductive and unaffected by heat and cold, these precision Pyrex balls offer a wide application in the electronic field and in applications where resistance to a variety of corrosives is an absolute must. They are light in weight, heat and shock resistance and have a high load capacity.

► **Uses**—They are recommended for viscosity tests, in developing films, with acids and liquids, flow meters, pump, radio and electronic equipment.

The balls are availabe from stock in sizes from $\frac{1}{8}$ in. to 1 in. diameter. Special sizes may be had on order. Accuracy is maintained within ± 0.001 in. on diameter, and 0.0005 in. on sphericity. **Circle P55 inside back cover.**

Q-METER JIG
with instruction book

RADIO INSTRUMENT LABORATORIES, 12-05 Sumner Place, Fair Lawn, N. J., announces the new model 10-B series jig for low impedance



New Formica G-7-2 silicone offers five characteristics for broader application:

1. Greater hot strength.
2. Lower moisture absorption.
3. Lower wet power factor.
4. Larger and thicker sheets (up to 36″ x 72″ x 2″).
5. Uniform creamy white color.

The photo above dramatically demonstrates the outstanding hot strength property of Formica's new G-7-2. A withering blast from the lab heater causes three ordinary laminated plastics to smoke, char, blister and bend. But G-7-2 comes through this grueling test unmarked, its mechanical and electrical properties virtually unaffected.

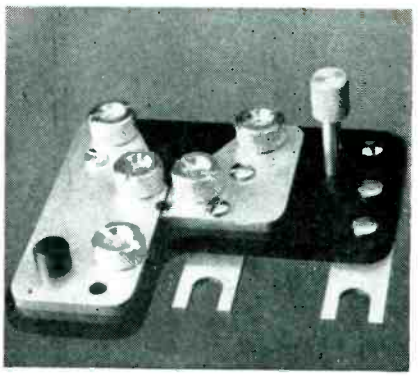
G-7-2 is approved under military spec MIL-P-997-B, type GSG.

The unusual properties of G-7-2 are especially useful in guided missiles, radar, radio and tv, motors and generators and other electrical/electronic applications. Recommended for printed circuitry. For complete information, send today for free G-7-2 data sheets. Formica Corp., Subsidiary of American Cyanamid, 4640 Spring Grove Av., Cinti 32, O.

FORMICA

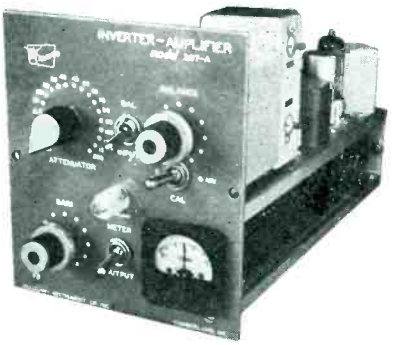
FI-1153 1st choice in laminated plastics

Application engineering • Fabricating
Research • Customer stock service



measurements with Boonton 160-A or 260-A Q-meters. This jig facilitates measurements of inductance and Q of small coils, large capacitors, transistor parameters, transmission line characteristics, resonant by-pass capacitors, vhf and uhf tuner parameters, r-f impedance of electrolytic capacitors, antenna impedance, and other low impedance components. Price is $25.

A comprehensive instruction book is supplied with each jig. **Circle P56 inside back cover.**



D-C AMPLIFIER
for galvanometers

ALLEGANY INSTRUMENT CO., INC., 1091 Wills Mountain, Cumberland, Md. Model 307-A is a low-drift, trouble-free amplifier for use with wire strain gages, transducers, thermocouples and the like. It will drive most galvanometers, including the low sensitivity h-f types, and provides excellent linearity over a wide range of input voltage.

▶ **Highlights**—The instrument features balanced input, high gain, high output, phase sensitivity, stability, long inverter life, low noise level, an overload indicator and protection device, and no operational delay when overloaded. The 307-A will give fine resolution

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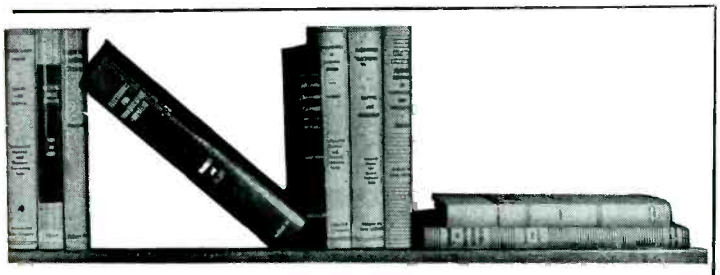

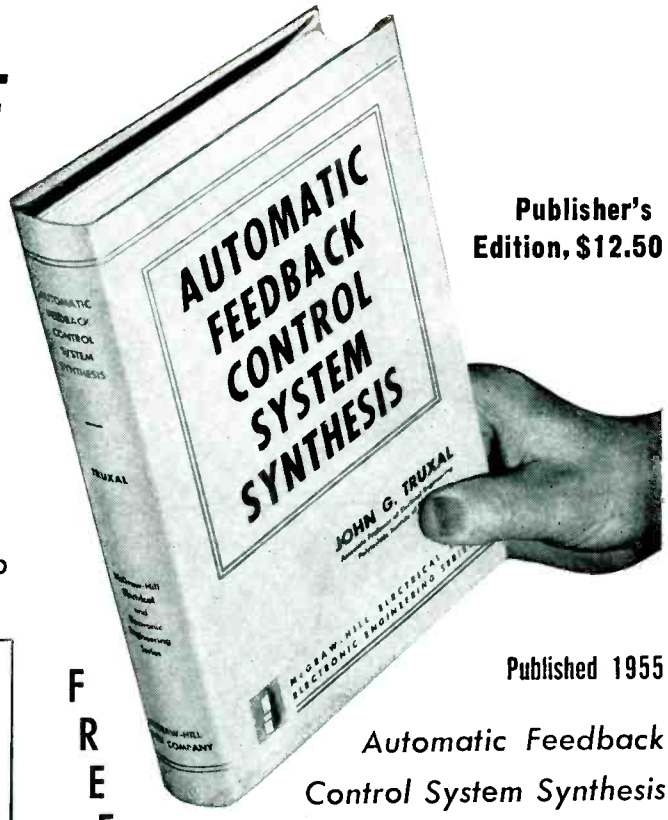

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Published 1955

F R E E

Automatic Feedback Control System Synthesis

by John G. Truxal

Associate Professor of Electrical Engineering
Polytechnic Institute of Brooklyn

A notably complete and current compilation of methods useful in the design of feedback systems. This graduate-level account of modern feedback theory, with emphasis on the synthesis of feedback control systems, includes an abundance of worked examples and concise summaries which make it invaluable for both advanced students and practicing engineers.

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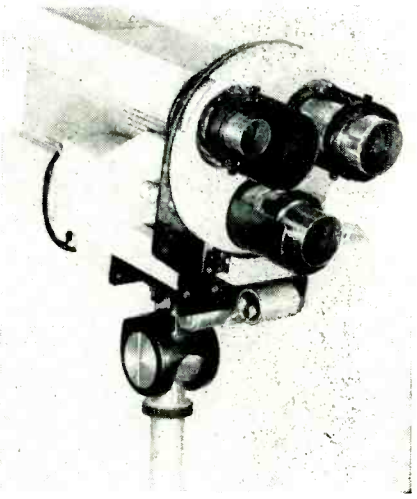
with a 20-step attenuator and a gain control which permits full-scale galvanometer deflection adjustment for input voltages between adjacent attenuator settings. **Circle P57 inside back cover.**



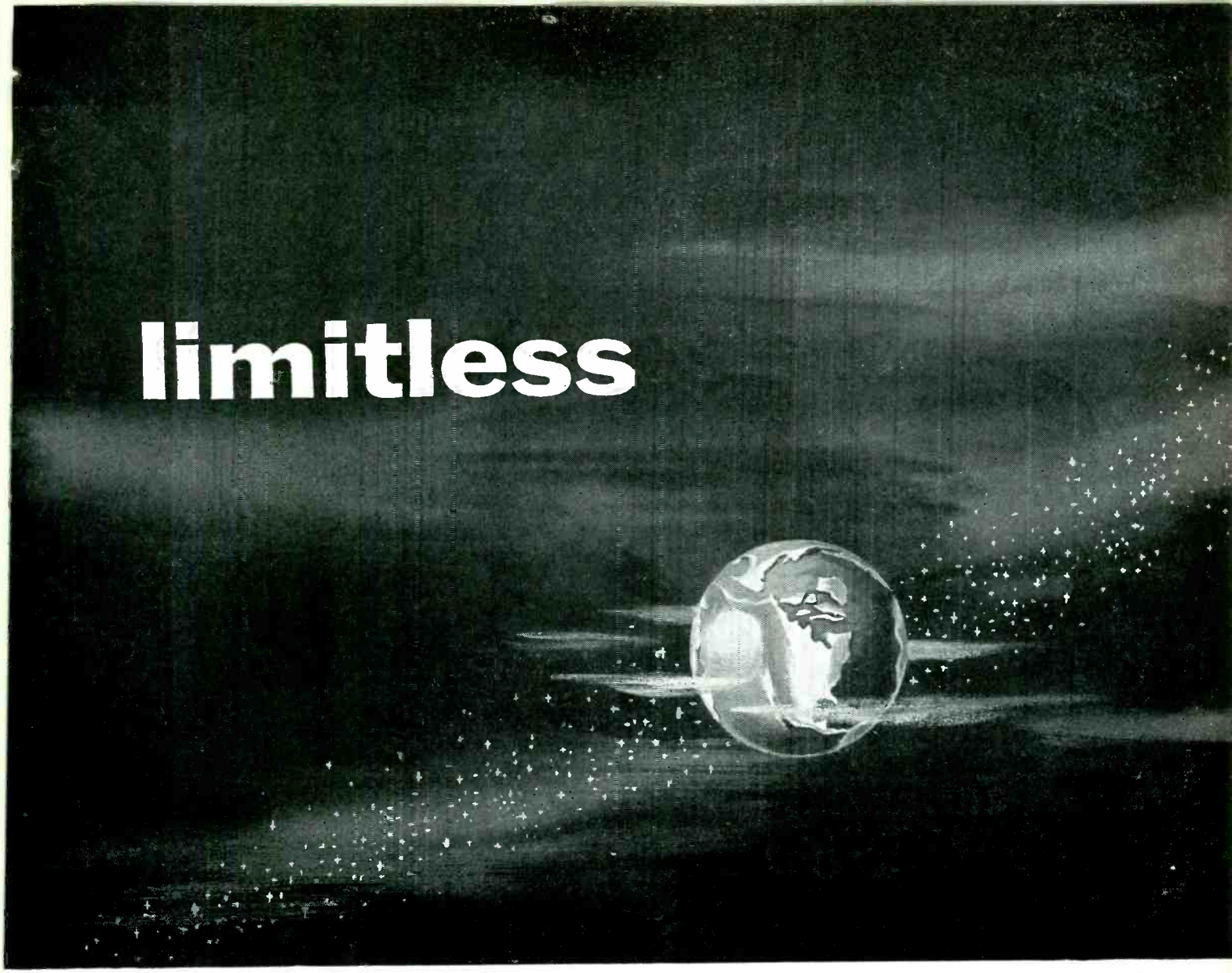
THREE-LENS TURRET
ultimate in flexibility

KAY LAB, 5725 Kearney Villa Road, San Diego 12, Calif. Model ARC-4 remote 3-lens turret provides the ultimate in flexibility. The turret, designed for use with the company's industrial tv systems, provides remote selection of any one of 3 lenses and remote iris and focus adjustment.

The unit is ideally suited for applications where a wide field of view is required and where variable focal length lenses are inadequate because of their slow speed. By utilizing fixed lenses in the turret considerably increased overall system sensitivity and utility are achieved. The 3-lens remote turret is designed to mount on the Kay Lab pan and tilt unit and industrial camera mounts. **Circle P58 inside back cover.**

TIME INTERVAL METER
indicates in milliseconds

ELECTRO-PULSE, INC., 11861 Teale St., Culver City, Calif. Model 7440A time interval meter, using cold-cathode glow-transfer tubes, provides a reliable, compact and economical instrument for the measurement of time intervals, periods and velocity. The instru-



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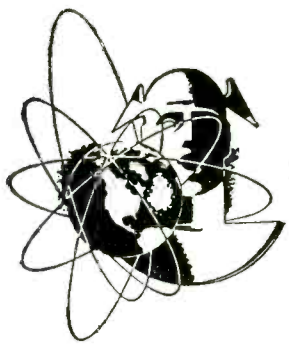

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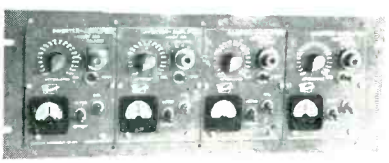
ment utilizes electrical impulses defining the interval to be measured to start and stop a gate. It then counts the number of cycles of an internally generated, crystal controlled frequency occurring during this gate.

Indication is directly in milliseconds, ranging from 1 to 9,999 milliseconds. Automatic recycling is provided, or the measurement may be held and indicated until a manual reset is operated.

The unit provides a time base of 1 kc or 10 kc, or may be operated with an external time base. Accuracy is crystal stability ±1 count. The instrument is also available with print-out. **Circle P59 inside back cover.**



AMPLIFIER PACKAGE
for galvanometers

ALLEGANY INSTRUMENT CO., 1091 Wills Mountain, Cumberland, Md. Model 309 d-c amplifier is a 4-channel, low-drift, trouble-free package for use with wire strain gages, transducers, thermocouples and the like. It will drive even low-sensitivity, h-f galvanometers, and provides excellent linearity over a wide range of input voltages.

▶ **Highlights**—Features include: balanced input, high output (±60 ma), high gain, phase sensitivity, high stability, low noise level, overload indicator and protector, and no operational delay when overloaded. The 309 will give fine reso-

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High specialization sometimes makes it difficult for a good all-around engineer to find a kind of work that satisfies the many facets of his aptitudes and abilities, and at the same time fulfills his financial requirements. Specialization in electronics has gone so far that often an engineer has difficulty in changing from the field of specialty assigned by his company to one more to his liking. To make this change, an engineer must frequently throw away much of his hard gained experience and start at or near the bottom of a new field. All too seldom does the opportunity for major advancement come to an engineer having a broad engineering knowledge, rather than a specialization in any particular field.

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McGraw-Hill is preparing under Air Force contracts several engineering handbooks on the application techniques of electronic component parts and tubes. The contents will be on a par with that of other well known McGraw-Hill engineering handbooks. The editorial staffs, on which there are several high level openings, will be responsible for the technical contents they will do through original writing as well as work with top level engineering contributors. The work offers both challenge and opportunity to the engineering writer who, if he is a specialist at all, is a specialist in everything electronic.

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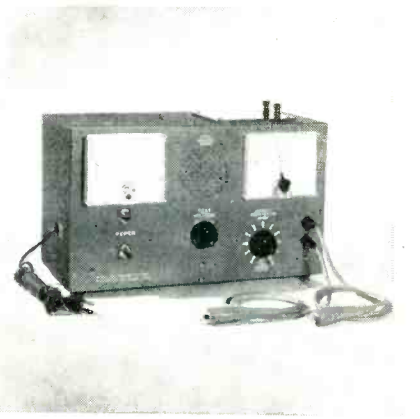
lution with a 20-step attenuator and a unique gain control which permits full-scale galvanometer deflection for input voltages between adjacent attenuator settings. Detailed literature is available. **Circle P60 inside back cover.**



H-V LEAKAGE TESTER
audibly signals defects

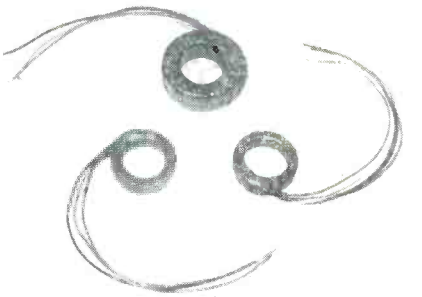
SLAUGHTER CO., Young & College Sts., Piqua, Ohio. Used for the high-voltage a-c breakdown testing of equipment when a maximum leakage current is specified, the model 103 cancels current due to the electrostatic capacity of the tested article and checks insulation leakage only.

Adjustable, the unit will cancel up to 0.005 $\mu\mu$f capacity, and has external binding posts for adding greater correction on the job. The leakage limit can be set between 0 and 5 ma.

High leakage and grounds are signalled by a buzzer, and arcing above 20 μa by a speaker. Test voltages from 400 to 2,100 v a-c are provided by the unit, which has a momentary contact on-off switch, pilot light, voltmeter and milliammeter. **Circle P61 inside back cover.**

VIDEO TRANSFORMERS
offer simplified circuitry

ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J., has available toroidal transformers covering wide bandwidths. The doughnut-shaped components allow application of transformers in video-frequency circuitry as found in digital computers, for-



ward scatter transmission and color tv.

More reliable than tubes in impedance matching, video mixing and wide-band coupling, the video transformers offer simplified circuitry, a decrease in power and space requirements, and they assure highly stabilized performance.

The wide-bank toroids are designed for low-level power operation, all with 1-to-1 turn ratio. They are available with pigtail leads or solder-lug terminals, and the outer protective cover can be furnished as a varnish-covered tape wrapping, resin-dipped coating or casting.

▶ **Frequency Bands**—Type 22193 covers from 1 kc to 1 mc; the 22227, from 375 cps to 2.8 mc; and the 22228, from 120 cps to 800 kc. **Circle P62 inside back cover.**

POWER TUBES
two new types

CENTRAL ELECTRONIC MANUFACTURERS, INC., Danville, N. J., is now producing types 7C25 and 7C23 Nucor three-electrode power tubes, specifically designed to give superior performance in a wide range of military and industrial applications. They feature an extra mar-

General Plate

ROLLED FORM STOCK

- **Cuts Production Costs**
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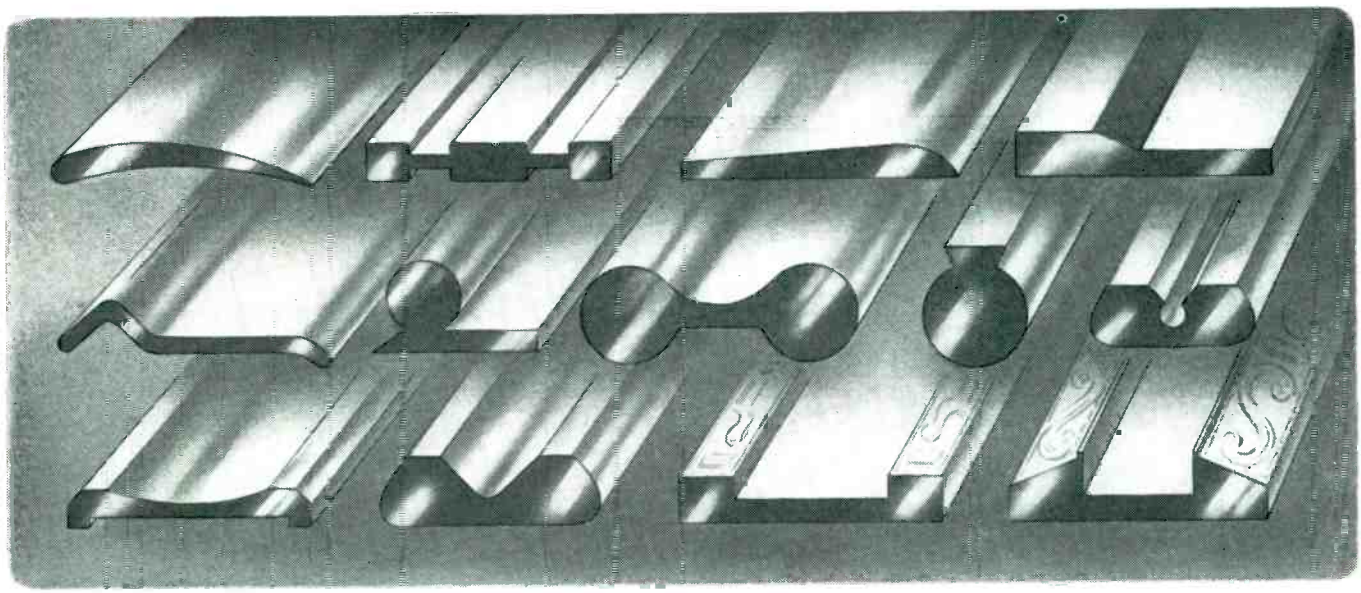

General Plate craftsmanship can mean substantial production and assembly savings to you, and at the same time minimize your rolled stock inventory problems. Here are some of the advantages available to you in General Plate rolled form stock:

1. Close tolerances in dimensions, contour, and composition.
2. Wide diversification of available metals and shapes.
3. Excellent surface finishes.
4. Heat treating facilities available.
5. Size range from .025″ to 3½″ wide.

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We'd like to figure on your rolled form stock requirements — if you'll send information to help us quote, we'll be glad to estimate tool and material costs without obligation. The information we need is: (1) cross-sectional sketch or drawing and dimensional tolerances, (2) length of strip and tolerances, (3) material specifications, (4) permissible edge curvature and flatness, (5) surface finish required, (6) hardness, and (7) quantities involved.

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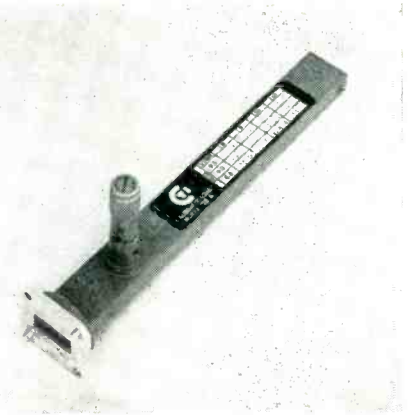
Metals & Controls Corporation

GENERAL PLATE DIVISION

1309 FOREST STREET, ATTLEBORO, MASS.

gin of safety, a sturdily supported, double spiral filament of thoriated tungsten, and conservative ratings for long life. Both the grid and filament seals are precision-formed of strong Kovar. The special design employed eliminates the conventional internal insulators. Widely spaced elements are a further protection from shorts. Both types are supplied with flexible ofhc copper leads. Custom modifications of both styles are available.

▶**Specifications**—The 7025 is a forced air cooled tube with anode dissipation of 2,500 w and plate input of 7,000 w. These performance figures are calculated at 30 mc where full ratings apply. Type 7C23 is especially recommended for pulse-type operation because its peak power output is 120 kw, maximum pulse width is 90 μsec and maximum duty cycle, 0.005. **Circle P63 inside back cover.**

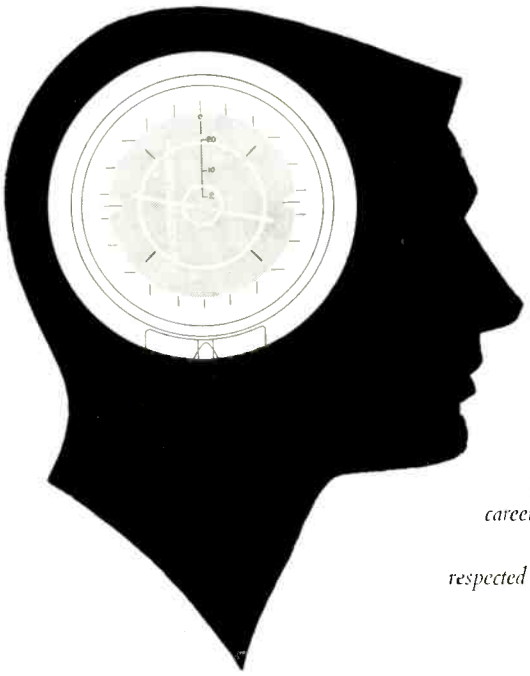


CALIBRATED LOAD
for X-band use

COLOR TELEVISION INC., 935 E. San Carlos, Calif. Offered as a convenient reference for equipment calibration, the new X-band calibrated load provides an adjustable mismatch using a micrometer probe calibrated at 8,600, 9,000 and 9,500 mc for vswr's of 1.10, 1.16, 1.4 and 1.8 at each of these frequencies. Model 128A has an accuracy of ±1.0 percent of calibrated value.

Special units can be provided with calibrations to other frequencies and vswr's as required. Fitting UG-39/U waveguide, the load is accurately aligned by

Systems Career: a laboratory for learning



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HUGHES

Some extra advantages for Field Engineers include:

Training at full salary for 3 months before assignment.

Generous moving and travel allowance between present location and Southern California (Culver City).

Additional compensation plus complete travel and moving on assignments away from Culver City.

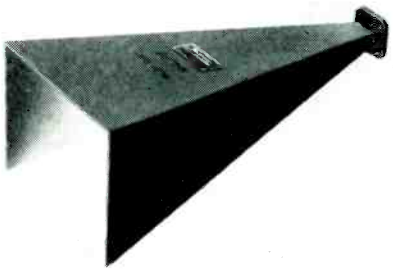
Ideal living conditions in the unsurpassed climate of Southern California.

Reimbursement for after-hours courses at UCLA, USC, or other local universities.

Employee group and health insurance paid by company, retirement plan, sick leave, and paid vacations.

Scientific Staff Relations
RESEARCH AND DEVELOPMENT LABORATORIES
HUGHES AIRCRAFT COMPANY
Culver City, California

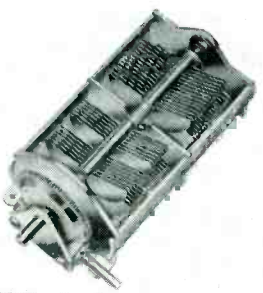
means of two locating guide pins in the flange which mate with UG-39/U cover flange or equivalent. Overall length is 8¾ in. **Circle P64 inside back cover.**



WAVEGUIDE HORNS
with 1.10 maximum vswr

MICROWAVE ASSOCIATES, INC., 22 Cummington St., Boston, Mass. A complete series of precision standard horns for use in antenna design and measurement in the range from 8.2 through 75.0 kmc are now available. Nominal gain of the RG-52/U X-band model MA-647 is 15 db. In the 50 to 75 kmc millimeter range, gain of standard horn model MA-627 is 25 db.

Low-loss pressurized standard horns are also being designed and will be available for use in high power or airborne applications. **Circle P65 inside back cover.**



VARIABLE CAPACITOR
worm-driven, 2-section unit

JOHANSON MFG. CORP., Boonton, N. J. Type 2100 variable air capacitor is a 100-to-1 ratio, worm-driven, two-section unit. Low expansion nickel-steel alloys are used in the frame, rotors and stators, resulting in a temperature coefficient of practically zero. Insulation is of high-strength pink alumina ceramic held under compression for

If you're not in the book *you're a man without*

. . . . . a country
. . . . . a state
. . . . . a county
. . . . . a town
. . . . . a party
. . . . . a street
. . . . . a school
. . . . . a *vote*

Look at all the things you can lose, if you're not a registered voter.

If you're not in the book, you lock yourself out of the elections. The polls are closed to you. You can't vote on streets, or schools, councilman or mayor (not to mention congressman, senator or president). You don't even have the right to *complain* about your government and the way things are run!

But more than that, you cut yourself apart from your neighbor next door, your friends at the shop, your fellow members in union or club.

You lose the right to look that boy of yours in the eye when he wants to know if you're doing your part.

And you lose the self-respect that comes from knowing you can walk into the polls on Election Day—the one place in the world where all free men are really equal. Isn't it too much to risk for the little time that registering takes?

Get your name in the book
—and do it now!

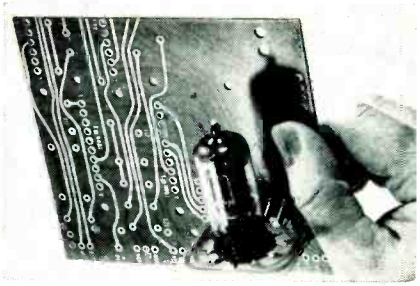
PUBLIC SERVICE ADVERTISING COUNCIL

THE AMERICAN HERITAGE FOUNDATION

Is your name in the book?

greatest resistance to fracture.

The front section features split stator construction with 70 $\mu\mu$f maximum capacitance across stators and 10 $\mu\mu$f minimum. The rear section is conventional with a maximum capacitance of 220 $\mu\mu$f and a minimum of 16 $\mu\mu$f. Capacitance variation of both sections approaches straight line frequency. **Circle P66 inside back cover.**



ANGLE SOCKET
used with printed circuits

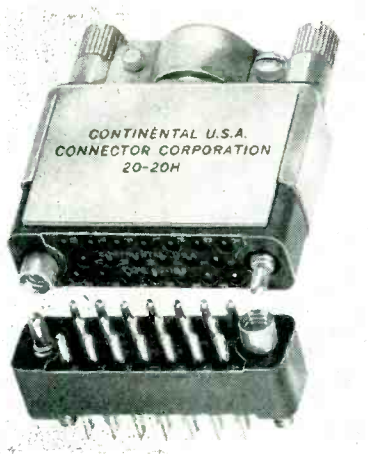
CLEVELAND METAL SPECIALTIES, 1783 E. 21st St., Cleveland 14, Ohio. The angle socket provides for the mounting of tubes in units where there is limited height, and for maintenance and servicing accessibility where circuit boards are plugged vertically into larger units or terminal strips.

▶ **Structure**—Extreme structural rigidity is provided to the socket by the specially designed supplementary buttress ribs which maintain the angle position of the socket to the printed circuit. Structurally, the ribs will withstand great pressure so that the socket cannot be bent out of position or torn from the circuit board. **Circle P67 inside back cover.**

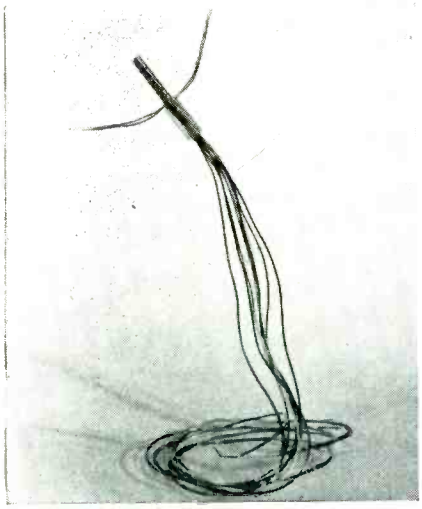
SMALL CONNECTORS
in 20 and 27 contacts

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y., announces a new series 18 precision Continental connector available in 20 and 27 contacts. The 0.053 in. diameter solder cup can accommodate two No. 20 wires, if necessary.

▶ **Highlights** — Outstanding features include nonrotating, floating contacts that assure self-alignment



of each individual contact. This reduces the engagement and disengagement force normally encountered when using connectors with fixed contact. Clear anodized, aluminum hoods provide positive cable support and strain relief. Positive polarization is achieved through the use of a reverse type guide pin and guide socket arrangement. A unique polarizing screw-lock guide pin and guide socket are also available in this series connector. **Circle P68 inside back cover.**

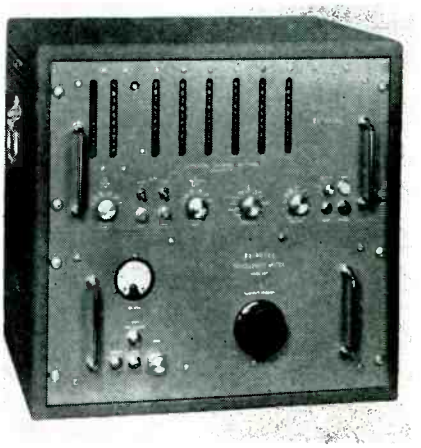


TEFLON LEAD WIRE
of the subminiature type

HITEMP WIRES, INC., 26 Windsor Ave., Mineola, N. Y., has made commercially available the DQT high-temperature subminiature Teflon lead wire. It is available in sizes from No. 34 Awg to No. 20 Awg, in 8 solid colors.

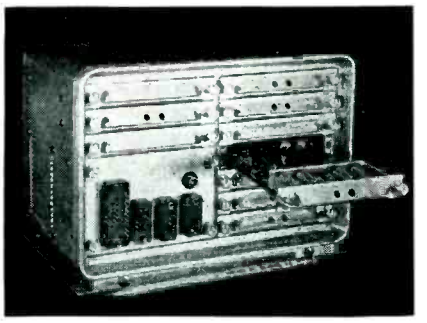
Because of its reduced diameter it is an excellent lead for slip-ring assemblies. The Teflon insulation

is not affected by the high molding temperatures encountered during the fabrication of the slip-ring assembly. **Circle P69 inside back cover.**



FREQUENCY METER
for standard broadcasts

BERKELEY DIVISION, Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif. Model 5571 frequency meter permits direct digital frequency reading from 1 cps to 42 mc, and also functions as a frequency ratiometer, 0-1 mc period meter, μsec to 10-million sec time interval meter, 0-2 mc eput meter, and a high-speed straightforward counter. **Circle P70 inside back cover.**



DIGITAL ENCODER
is all-electronic

RADIATION, INC., Melbourne, Florida. Model R-1047-40-1 advanced digital encoder is designed to accept 0 to 10 v input levels and generate 24,000 8-bit binary code groups per second defining the input at an overall accuracy of one part in 256. Designed to operate in either air or ground systems, the coder's all electronic circuitry, in-

cluding solid state components, is mounted on etched circuit plug-in cards to provide for increased operational reliability and ease of maintenance.

Weighing only 8 lb, the overall dimensions of this piece of equipment are only 6 13/16 in. high by 9⅛ in. wide by 6¾ in. deep. **Circle P71 inside back cover.**

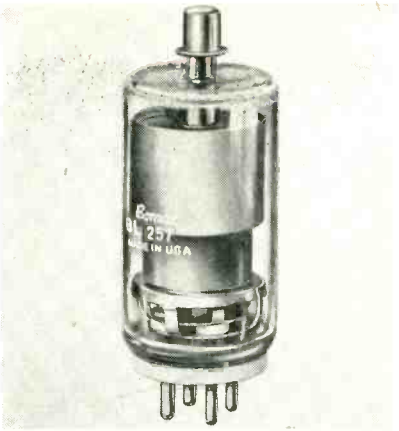
BEAM PENTODE
1,000-w plate dissipation

PENTA LABORATORIES, INC., Santa Barbara, Calif., has available the new PL-172 external-anode beam pentode transmitting tube. It is 4 in. in diameter and 5 in. high. It has a maximum plate dissipation rating of 1,000 w, a maximum allowable plate voltage of 3,000 v and a maximum current rating of 1 ampere.

▶ **Uses**—In addition to serving in ordinary class B and C applications, the PL-172 is designed to meet the critical requirements of linear amplifier operation, and will deliver a useful power output of over 1.5 kw as a low-distortion class AB, linear amplifier. The suppressor and screen grid terminals are ring contact surfaces, which provide isolation between circuits and contribute to the high overall stability of r-f amplifier stages using the new tube. **Circle P72 inside back cover.**

HYDROGEN THYRATRON
for vibration, high impact

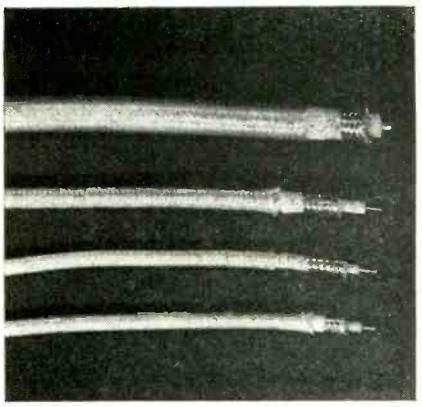
BOMAC LABORATORIES, INC., Beverly, Mass. The BL-257 is a new hydrogen thyratron ruggedized for vibra-



tion and high impact service.

The tube is conservatively rated for 5 g vibration from 60 to 500 cps and 3 g from 500 to 1,200 cps, and also for 60 g high impact shock in any direction.

▶ **Ratings**—Electrical ratings are 8.0 kv peak anode voltage, 90 amperes peak current and 100 ma, maximum anode current. It is rated for ambient temperature range of −50 C to 90C and for an altitude of 10,000 ft in air. The tube may be immersed in oil for high altitude application. **Circle P73 inside back cover.**



COAX CABLES
are extra rugged

FEDERAL TELEPHONE AND RADIO Co., 100 Kingsland Road, Clifton, N. J., has available a new line of extra-tough Teflon coaxial cables which will operate successfully in environmental temperatures from −100 to +500 F. The rugged cables are designated as types RG 87A/U, RG 140/U, RG 141/U and RG 142/U. Their electrical characteristics and physical specifications are available on request. **Circle P74 inside back cover.**

New Literature

Microwave Silicon Diode. Microwave Associates, 22 Cummington St., Boston, Mass. A useful 8-page microwave silicon diode brochure is available. Catalog 56S is intended to bridge the gap between the specification and application of microwave diodes and is directed to the designer of microwave receivers and test equipment as well as production, maintenance and purchasing personnel.

The brochure is extensively illustrated with performance curves and data of mixer and video diodes for operation over the 1,000 to 75,000 mc range.

Subjects discussed include: factors in silicon diode selection; silicon versus germanium, diodes as video detectors; mixer diode considerations; reversible polarity diodes; diodes for high level modulator use; diode pairs for balanced mixer use; broader bandwidths; and pricing. **Circle L1 inside back cover.**

Electronic Components. Keystone Electronics Corp., 423 Broome St., New York 13, N. Y. A 28-page catalog, No. 56, will prove most helpful as a guide in choosing the following components: Terminals, terminal boards, diode holders, battery holders and radio electronic hardware. Technical information, dimensional drawings and descriptive wording accompany each item. **Circle L2 inside back cover.**

Mass Spectrometers. Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif. Bulletin 1824B is a 16-page booklet illustrating and describing types 21-610 and 21-620 process-monitor mass spectrometers designed for continuous or individual sample analysis. The electronic system is completely covered. Price lists and ordering information are included. **Circle L3 inside back cover.**

Silicon Rectifiers. Sarkes Tarzian, Inc., Rectifier Division, 415 N. College Ave., Bloomington, Ind., has published a 20-page silicon rectifier handbook. Included is information on theory of operation, manufacturing process, characteristics, construction, electrical ratings and mechanical dimensions, and engineering data. Price is $1. **Circle L4 inside back cover.**

Test Instruments. Beckman Instruments, Inc., Shasta Division, P. O. Box 296, Richmond, Calif., has available a 4-page, 2-color catalog describing its line of electronic test instrumentation including expanded scale voltmeters and frequency meters, vtm's, oscillators, resistance bridges, power supplies, wide-band amplifiers, WWV receiver and decade inductor. **Circle L5 inside back cover.**

Pulse Oscillator. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif., has available a new 2-page bulletin on the model 3420B pulse oscillator. The model described produces pulses at repetition rates from 100 cps to 3.3 mc. It is useful as clock pulse generator, for flip-flop resolving time studies, and high speed circuitry development. **Circle L6 inside back cover.**

Resistor Engineering Guide. International Resistance Co., 401 North Broad St., Philadelphia, Pa. Comprehensive data on IRC's complete line of resistors and special products is listed in the revised 1956-1957 official Resistor Engineering Guide. Data given include JAN or MIL equivalent, rated wattage, standard tolerances, temperature rise, temperature coefficient, maximum operating temperature, ohmic values available, dimensions and approximate prices. **Circle L7 inside back cover.**

Transformer Catalog. Chicago Standard Transformer Corp., 3501 W. Addison St., Chicago 18, Ill., has available a new Stancor transformer catalog with new design format and new readable type face. Selection is simplified through a cross index of part numbers and by type of application. The 570 transformers for tv, radio, communication, industrial and other elec-

tronic applications are listed. It is listed as catalog No. S-102. **Circle L8 inside back cover.**

Navigator System. Bendix Aviation Corp., Pacific Division, 11600 Sherman Way, N. Hollywood, Calif. A 20-page, 4-color brochure covers the Bendix-Decca Navigator system. The system gives accurate, reliable and continuous position fixing for helicopters, fixed-wing aircraft, ships and land vehicles, and is ideally suited for terminal area traffic control and landing approach procedures. **Circle L9 inside back cover.**

Electronic Counter. U. S. Engineering Co., 40-24 22nd St., Long Island City 1, N. Y. A recent brochure illustrates and describes the Feed-A-Matic, a hopper for feeding, orienting and counting up to 200,000 items per hour. Included are chief features, operation information, a long list of possible items handled, and applications to production and to packaging. **Circle L10 inside back cover.**

Transformers. Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif., has available the 1956 edition of the company's general Catalog. The catalog illustrates and describes nearly 700 items; 76 of which are new to the line. **Circle L11 inside back cover.**

Transistorized Power Supplies. Electronic Research Associates, Inc., 67 E. Centre St., Nutley, N. J. A single-sheet bulletin covers a line of transistorized regulated d-c power supplies. Included are tabular data (including prices) on adjustable voltage, laboratory and industrial types, as well as fixed voltage, miniaturized types. **Circle L12 inside back cover.**

Laminates. Dow Corning Corp., Midland, Mich., has issued a 4-page illustrated brochure on glass cloth laminates bonded with the company's silicone resins. It features case history descriptions of a wide range of specific electric and electronic applications. Typical physical and dielectric properties are detailed. A list of current manufacturers and fabricators of sili-

cone-glass laminates is also included. **Circle L13 inside back cover.**

Microwave Catalog. Microwave Associates, Inc., 22 Cummington St., Boston, Mass., has available an illustrated 4-page brochure listing all of its products. Catalog 56BG provides useful microwave silicon mixer and video diode performance data and operating characteristics of pulse and c-w magnetrons, TR and ATR radar switch tubes, reference cavities and narrow and broadband waveguide pressure windows.

In addition, a complete list of waveguide components and test equipment conveniently arranged by function and waveguide frequency range is included. **Circle L14 inside back cover.**

Relay Catalog. Ohmite Mfg. Co., 3637 Howard St., Skokie, Ill. Catalog R-29 gives complete information on the four popular Amrecon relay models—DOS, DOSY, DO and CRU, which are available from stock in 65 different types.

Models DO and DOS described fill many industrial needs for a compact, lightweight relay that handles power loads usually requiring much larger, heavier units. They are particularly adaptable to aircraft and mobile equipment where severe shock and vibration are encountered.

The increased operating sensitivity of the model DOSY described, equipped with twin coils, make it adaptable to a wide range of electronic control circuits.

Model CRU relay discussed is noted for its wide range of available contact combinations. Additional information is given in catalog R-29. **Circle L15 inside back cover.**

Testing Cores. Burroughs Corp., 1209 Vine St., Philadelphia 7, Pa. A new technical bulletin, number 136, gives the latest helpful information on how both manufacturers and users of tape-wound or ferrite cores can benefit from using pulse control systems to test cores by digital techniques.

The booklet shows how reliable testing procedures are a must,

points out the need for equipment which not only tests how a core will meet specifications within all necessary ranges of tolerance, but also how it will eventually operate in the system for which it is intended. It is illustrated with block diagrams and timing diagrams. **Circle L16 inside back cover.**

Microphones. The Astatic Corp., Conneaut, Ohio, has released a fully illustrated 14-page catalog covering a complete line of microphones and microphone accessories. An entire section of catalog S-442 is devoted to the Futura series of dynamic microphones, their specifications, features, performance, accessories plus architect's and engineer's specifications. All microphones in the line are illustrated with photographs and line drawings showing various applications and uses. List price for each microphone is included. **Circle L17 inside back cover.**

Plastic Products. Raybestos-Manhattan, Inc., Manheim, Pa., has released a new brochure covering plastic products made of Teflon and Raylon. In addition to furnishing complete information on the chemical, electrical and mechanical properties, it also provides complete specifications on the various sizes in which sheets, tape, molded and extruded rods and tubes of Teflon and Raylon are available. Typical applications for the products are also suggested. **Circle L18 inside back cover.**

Data Handling. Berkeley Division, Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif. Newly developed systems for data handling and a new series of analog computers are described in short form catalog C-703. Engineered systems described include those for data reduction, data handling, data logging, industrial measuring and recording and industrial process control.

Three new analog computers, plus four components for control systems are outlined in the new catalog. Components include amplifiers, electronic multipliers, and function generators.

The catalog also describes newly

developed frequency meters, decimal counting units, events-per-unit-time meters, time interval meters, nuclear scalers, and nuclear sample changers. **Circle L19 inside back cover.**

Industrial Laminates. The Improved Seamless Wire Co., 775 Eddy St., Providence, R. I., has published a 12-page, 2-color catalog containing information on the manufacture of improved laminated sheet, wire and tubing for industrial use. Comparative tables of weight and other technical information will also be found in the catalog.

Copies will be forwarded upon receipt of requests on company letterheads. **Circle L20 inside back cover.**

Spray-Clean Technique. Cobehn, Inc., Passaic Ave., Caldwell, N. J., has issued an 8-page booklet describing the Spray-Clean technique. The booklet describes and illustrates the ultimate in chemical cleanliness for the components of such units as transistors, diodes, vacuum tubes, miniature slip ring assemblies, potentiometers and other precision parts.

Actual applications of the method are illustrated in the booklet, and illustrations are also shown of the equipment and the solvent used. **Circle L21 inside back cover.**

Retractile Cords. Koiled Kords, Inc., Box K, New Haven 14, Conn., has issued a new, 2-color catalog showing the company's complete line of retractile cords for industry and communication application. More than 25 illustrations picture as many different uses for these springlike cords that extend to approximately six times their retracted length and when released return to their neatly coiled normal size. **Circle L22 inside back cover.**

Components Brochure. Thordarson-Meissner, Seventh and Bellmont, Mt. Carmel, Ill., has available a 4-page brochure with technical information on 59 new components for use in transistor circuits. Included are data on 36

audio transformers, 10 i-f transformers, 7 ferrite antenna coils, 5 oscillator coils and a midget variable capacitor. **Circle L23 inside back cover.**

Bathtub Capacitor Cans. Northern Metal Products Co., 9599 W. Grand Ave., Franklin Park, Ill., has available a new catalog illustrating a complete line of bathtub capacitor cans and covers. Northern features a line of triangular ear and regular bathtub-type cans, available in lake copper or steel, and with hot solder coating and extruded holes, as desired. A line of transformer housings and lids is also available.

The company's modern facilities are available for producing chassis and other large and small electronic parts to specifications in production quantities or in small run lots. **Circle L24 inside back cover.**

Potting Shells. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y., has available free a data sheet illustrating various shapes and sizes of potting shells. Dimensions and specifications are included. **Circle L25 inside back cover.**

Services and Facilities. National Scientific Laboratories, Inc., 2010 Massachusetts Ave., N. W., Washington 6, D. C., has prepared two illustrated brochures describing the activities of its field engineering division, and the laboratory facilities of its research and development division.

The ability to furnish engineering services and personnel at all technical levels is emphasized. The service described is world-wide and available to both industry and government.

Skills and lab facilities available are described as broad fields of interest covering electronic devices, transistor applications, radio interference measurement, electro mechanical study and analyses. **Circle L26 inside back cover.**

VSWR Measurement. Color Television Inc., 935 E. San Carlos Ave., San Carlos, Calif. Band-sweeping equipment for continuous display or recording of vswr in the region 8,500 to 9,600 mc for laboratory

research or production-line testing applications is described in a new leaflet, identified as Form 125-256. The system illustrated in the literature is of the instant-reading, ratiometer type.

Description of the unit points out that the continuous display independently adjustable as to both center frequency and sweep width anywhere across the rated spectrum, provides an ideal facility for observation of adjustments made on broadband microwave components while undergoing measurement.

Specifications listed in the sheet cover details on the meter scales, the c-r indicator, the klystron oscillator, the bidirectional coupler, the calibrated load, and the output arrangements for use with an Esterline-Angus recorder. System accuracy of ±2 percent is indicated, physical arrangements and dimensions are given. Price of the complete system described is $4,950. **Circle L27 inside back cover.**

Power Supplies. Kepco Laboratories, 131-38 Sanford Ave., Flushing 55, N. Y. Bulletin B356 is a 4-page folder covering a line of 33 voltage regulated d-c power supplies. Features and specifications are included. **Circle L28 inside back cover.**

Pressure Pickup. Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif. Bulletin CEC-1539B deals with the type 4-311 pressure pickups which are especially suited for measurement and control applications that involve severe vibration, acceleration and ambient-temperature variations. Complete specifications are given. **Circle L29 inside back cover.**

Variable Transformers. Standard Electrical Products Co., 2240 E. Third St., Dayton, Ohio, has issued a new 22-page catalog, No. A56, on its expanded and redesigned line of Adjust-A-Volt variable transformers in auto, isolated and metered models for bench and panel mounting.

All single and ganged units are illustrated and described with

photographs, dimension drawings, wiring and circuit diagrams. Included for the first time are the 9 new basic motorized variable transformers. A complete specification and application index is also included. **Circle L30 inside back cover.**

Oil Impregnated Tubulars. General Electric Co., Schenectady 5, N. Y. Mineral oil impregnated metal-clad tubular capacitors, designed for workhorse applications in military electronic circuits, are described in a recent 12-page bulletin, GEC-1390. The Kovar glass-to-metal process is used to seal the capacitors described, which are highly resistant to oil leakage and moisture penetration. The units are built to MIL-C-25A specifications. **Circle L31 inside back cover.**

Test Chamber. Tenney Engineering, Inc., 1090 Springfield Road, Union, N. J., has published a 4-page folder discussing its TR chamber especially designed for accurate controlled low or high-temperature and relative humidity testing. The 2-color folder contains informative details regarding applications, performance, construction and specifications data about the TR line. The chambers described are designed to meet temperature and humidity test requirements of several military specifications. **Circle L32 inside back cover.**

Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Bulletin P-2b covers types PW-5, PW-7 and PW-10 resistors. Comprehensive data on construction, design, applications, ranges, ratings, tolerance temperature coefficient identification and dimensions are given. Charts and graphs are included. **Circle L33 inside back cover.**

Electric Insulation Products. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill. An illustrated, informative 20-page catalog on electrical slot insulations, wedges and fabricated parts, with selection guides and ordering data, is now available.

A handy table of contents guides

the user quickly to electrical insulating papers, plain, cuffed, creased or crimped; dispenser packaged paper coils; paper and plastic film combinations; asbestos base plastic wedges; and hard fiber washers. Catalog 19 also includes dimension tables and up-to-date prices. **Circle L34 inside back cover.**

Leak Detector. Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif. Bulletin 1830 is a 4-page folder illustrating and describing the type 24-210 leak detector for the testing of evacuated or pressurized systems. Features, specifications and a price list are included. Accessory and associated equipment are also shown. **Circle L35 inside back cover.**

Recorders. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. Concise information about Speedomax G recorders for precise measurement of rotational and linear speeds, and about the tachometer generators used with them, is available in an illustrated 4-page data sheet.

The sheet completely lists the features and specifications of both round and strip chart recorders, and tabulates the characteristics and speed ranges of both standard and explosion resistant tachometers. It is designated as data sheet ND46-27(1). **Circle L36 inside back cover.**

Waveguide Components. Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass., has available a 4-page catalog of waveguide components for use in the 26.1 kmc to 39.5 kmc (8-10 mm) band. The units described are being introduced in this country by the company, U. S. representatives for Hilger & Watts Ltd., London, England. **Circle L37 inside back cover.**

Photoelectric Shaft-Position Encoder. Electronics Corp. of America, 77 Broadway, Cambridge 42, Mass., announces bulletin 4605 describing type 309-13 shaft-position encoder. The unit discussed is a precision photoelectric analog-to-digital converter for direct read-

ing of shaft positions to an accuracy of one part in 8,192. It is used in mechanical testing, missile guidance, radar, optical tracking and other applications in which the angular position of a rotating shaft expressed as digital information is required.

The bulletin describes and illustrates the principle of operation and gives full specifications as to accuracy, readout rate, size and mounting. Also described are other ECA shaft-position encoders with nonlinear readouts and accuracies up to one part in 65,536. **Circle L38 inside back cover.**

Modular Enclosure Systems. Amco Engineering Co., 7333 W. Ainslie St., Chicago 31, Ill., has available a 4-page folder illustrating and describing a line of low-cost modular enclosure systems. Included is information on flexibility, construction, accessories and general specifications. For complete descriptive literature and price list, send for catalog No. 101. **Circle L39 inside back cover.**

Precision Potentiometers. The Gamewell Co., Newton Upper Falls 64, Mass., has released a new 1956 precision potentiometer catalog.

There is an introductory section giving details on Gamewell engineering, laboratory and production facilities and five separate product sections. These product sections cover the redesigned RL-270A series, the RVG miniatures, sine-cosine potentiometers, the new low-cost G-20 model and the RL-257 toroidal unit.

Detailed description, technical data, dimensional drawings, specifications alternates and power rating curves are included. **Circle L40 inside back cover.**

Laminated Tubing. Lamtex Industries, Inc., 51 State St., Westbury, L. I., N. Y. A 4-page illustrated brochure describes TUFF-TUBE, a new laminated fiber glass-epoxy tubing. The brochure contains information on high temperature characteristics, electrical properties, weight and strength, plus detailed technical data in accordance with ASTM testing procedures.

Also included is an illustrated section dealing with suggested ap-

plications of this material, of interest to designers in the aircraft and electronics field. **Circle L41 inside back cover.**

Soldering Equipment. Phillips Mfg. Co., Inc., 2816 Aldrich Ave., S., Minneapolis, Minn., has issued 5 illustrated literature sheets on its line. Three of the sheets present the heavy-duty models 250 and 500 Versa-Tool and the SF-100 Flash. The other two illustrate the lightweight quick-heating models 75 and 300.

Complete specifications and servicing information are given and the tools are shown in operating position. The Versa-Tool is also shown open for servicing. **Circle L42 inside back cover.**

Miniature Tube Shielding. The Fred Goat Co., Inc., 314 Dean St., Brooklyn 17, N. Y. A 4-page folder illustrates and describes (with dimensional diagrams) the Uni-Shield, designed for use with both 7-pin and 9-pin miniature tubes, and available in a full range of sizes. The tube shields described were especially designed to aid in the solution of assembly and operational problems that have arisen through the development and use of the printed circuit, the vertical chassis, the hot chassis. **Circle L43 inside back cover.**

Vibration Meter. Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif. Bulletin 1566 is a 4-page folder illustrating and describing type 1-128 vibration meter. Chief features, operation information, data on controls and specifications are given. **Circle L44 inside back cover.**

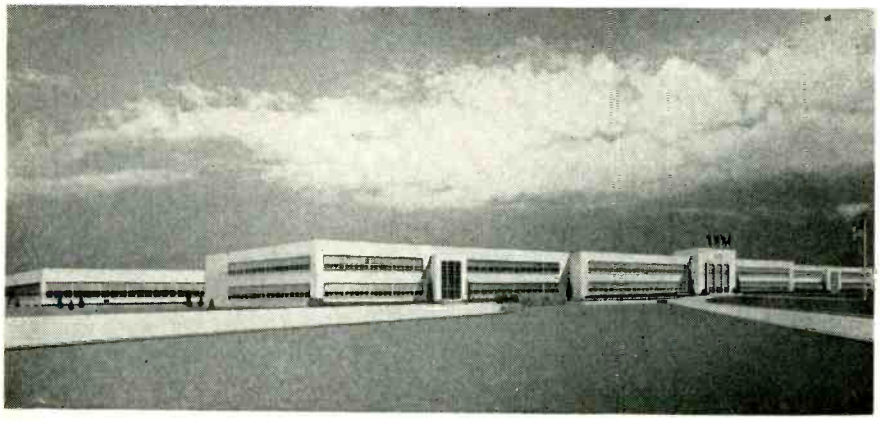
Galvanometric Recorder. Houston Technical Laboratories, 3701 Buffalo Speedway, Houston 6, Texas. Bulletin R-501 contains complete specifications and engineering data on the new Recti-Riter, a galvanometric recorder which writes a truly rectilinear trace. The unit described, priced from $385, enables one to view a recorded sine, square or other shape signal in true form without curvilinear distortion. **Circle L45 inside back cover.**

Plants and People

Edited by WILLIAM G. ARNOLD

Electronics manufacturers plan new factories, expand present facilities and acquire additional plant space through mergers. Engineers and executives in the industry are promoted, move to new positions. Technical societies elect officers for 1957

IBM To Build Military Electronics Laboratory In New York



IBM's new Kingston, N. Y. plant for military electronics and other products

INTERNATIONAL BUSINESS MACHINES CORP. plans construction in Lexington, Ky. of additional manufacturing facilities for the company's electric typewriter division and construction of a laboratory in Kingston, N. Y. for the military products division.

Charles F. McElwain, general manager of IBM's military products division, which was reorganized late last year as an autonomous unit of the company, said his division's new laboratory would be built on presently owned land opposite the Kingston plant. Construction on the 150,000-sq ft building will begin in the fall of 1956. It will accommodate 700 employees now employed elsewhere on research and development in connection with the giant computers being produced for SAGE, the Air Force's continental air defense system.

Presently, IBM employs approximately 4,900 people in its new Kingston operations, 3,100 in defense work and 1,800 in the typewriter plant. The plant provides 780,000 sq ft of floor space. Total of 439,000 sq ft of the present Kingston plant is used for military electronics.

Sylvania Opens Computer Center, Expands Tube Plant

SYLVANIA ELECTRIC is now operating its nationwide 18,000-mile private communication network and data processing system. Focal point of the system and network is a new 50,000-sq ft data processing center in Camillus, N. Y.

The leased Western Union network consists of 71 Sylvania stations linking various facilities in 61 cities and towns in 20 states. Heart of the system is a Remington Rand Univac computer.

New Sylvania Data Processing center in Camillus, New York

▶ **Tubes**—The company also announced that a 50,000-sq ft addition to its television picture tube plant in Fullerton, Calif. has been completed.

The addition doubles the size of the plant, originally a 51,000 sq ft facility completed in 1954. The new addition provides space for warehousing, a function now performed in the original section of the plant. The space released in the main plant will be devoted to increased manufacturing capacity.

▶ **Appointment** — Herbert Bandes has been appointed to the newly created post of chief engineer, semiconductors, of the electronics division of Sylvania.

Dr. Bandes is responsible for the development and engineering of transistors, diodes and other semiconductors devices manufactured at

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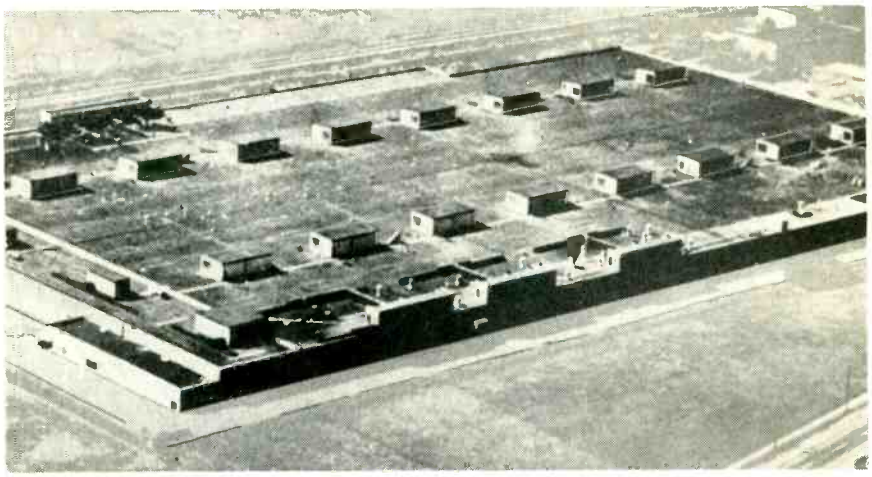
the division's plants in Woburn, Mass. and Hillsboro, N. H.

He had been engineering manager—semiconductors. He came to Woburn last year, having previously been manager of the chemistry laboratory at Sylvania's corporate research center at Bayside, N. Y.

Magnavox Plans Computer Plant

Plans have been approved for a new Magnavox plant to be erected in Urbana, Ill. It will have a minimum of 47,000 sq ft of space and may be expanded to 83,000 sq ft. The initial construction will include offices, laboratories and manufacturing space for computers and business machines for industry. Ground is to be broken almost immediately. About 200 people will be employed upon completion of the plant. Eventually 500 to 700 may be employed.

American Bosch To Operate U. S. Plant



American Bosch Arma plant in Chicago for defense output

AMERICAN BOSCH ARMA has received a facilities contract from the U. S. Air Force to operate a government-owned factory in Chicago which covers nearly 750,000 sq ft of floor space.

The plant is to be acquired to support the company's defense production program. It would be operated as the Chicago division of American Bosch Arma Corp.

Manufacturing operations will involve highly classified projects for the U. S. Air Force.

Kaar Joins Hoffman As V-P And Engineering Director

IRA J. KAAR has been elected to the newly created position of vice-president and engineering director for Hoffman Electronics Corp.

Since 1949 he has been manager of the engineering department for General Electric's electronics division. He has been with G.E. since 1924.

"We feel indeed fortunate to have Mr. Kaar join our company," H. Leslie Hoffman, president, stated, "particularly in view of the company's plans of tripling its engineering and research activities within the next two years. In addition to expanding the specialties which the company has already established, it is planned to set up several new distinct sections of engineering approach that will have significance, both from a military electronics and a commercial electronics viewpoint."

Kaar's most recent assignment with G.E. was manager of the color systems technical project. Prior to his appointment as head of the engineering department in 1949, he was manager of the receiver division of the electronics department with responsibility for engineering, manufacturing and sales.

Consolidated Acquires Company, Sells Computer Division

CONSOLIDATED ELECTRODYNAMICS CORP. acquired Electronic Industries of Burbank, Calif.

Electronic Industries, specializing in etched circuitry development and production, will become a wholly owned Consolidated subsidiary.

But it will retain its present name and activity. Hugh F. Colvin, CEC president, will be president of the new subsidiary and George B. Clark will serve in the capacity of vice-president and general manager.

The company also announced that John J. McDonald has been appointed assistant director of the systems division of the firm.

James R. Bradburn

For the past three years he has been manager of the company's central regional sales office in Chicago. He joined Consolidated in 1951 as a field engineer.

▶ Buy—Electro-Data Corp. was acquired by Burroughs from Consolidated Electrodynamics.

Burroughs plans to produce and sell electronic data processing systems in the division.

Consolidated's James R. Bradburn, who was president of Electro-Data, has been named a vice-presi-

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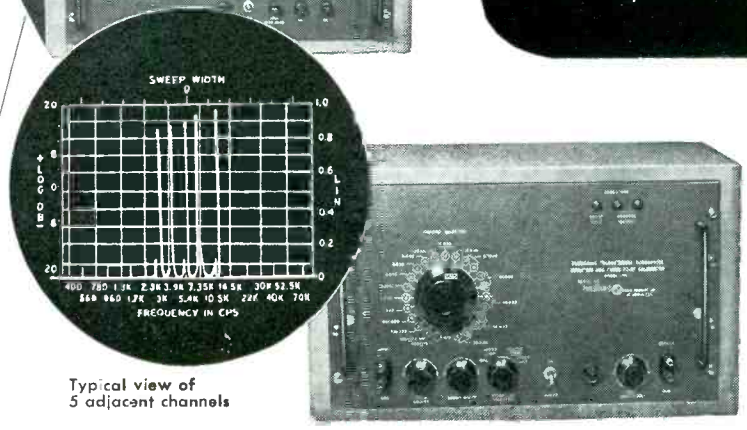

Typical view of
5 adjacent channels

The Panoramic Telemetering Indicator, Model TMI-1, and Panoramic Telemetering Subcarrier Deviation and Three Point Calibrator, Model TMC-1, are designed specifically to provide a high speed yet reliable method for checking system operation and subcarrier deviation limits of FM/FM telemetry systems.

Model TMI-1 Panoramic Telemetering Indicator offers a directly read overall visual analysis of the frequency distribution and level of subcarriers oscillators from 350 cps to 85 kc. Magnified views of individual channels, or groups of adjacent channels, are readily obtained with front panel controls. This facilitates minute analysis and measurement of distortion products, noise, signal spillover and other spurious effects, down to magnitudes insufficient to disturb system operations. Cost-saving routine inspections can be made with the telemetry system in full operation.

By comparing subcarrier frequencies with precise markers generated by the TMC-1 or TMC-211, the TMI-1 also enables rapid calibration of subcarrier deviation limits well within a 1% tolerance.

USES FOR MODEL TMI-1 • Analysis and measurement of cross modulation, harmonic distortion, noise interference, hum, microphonics, etc. • High speed adjustment of subcarrier levels • Monitoring overall subcarrier spectrum • Analysis of switching transients • Calibration of subcarrier deviation limits (when used with TMC-1 or TMC-211).

Model TMC-1 Panoramic Telemetering Subcarrier Deviation and Three Point Calibrator is a source of accurate, crystal derived center, upper and lower limit frequencies for all 18 channels. Frequency accuracy is ±0.02%. Limit frequencies are ±7½% or ±15% on five optional channels. Other limit frequencies are available on request.

USES FOR MODEL TMC-1 Three point calibration of subcarrier discriminator linearity.

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Model TMC-211 Panoramic Simultaneous 11-Point Calibrator is an instrument especially designed to calibrate the FM/FM Telemetering Subcarrier Discriminator linearity simultaneously, accurately, quickly and conveniently. Eleven equally spaced frequency points are provided within the ±7½% or the ±15% limits.

A TMC-211 consists of compact individual chassis, each incorporating wherever possible, two compatible subcarrier channels and a self contained power supply. A master control unit is also provided for linear mixing and simultaneous switching of all channels. By combining various subcarrier channel chassis, it is a simple matter to assemble a system to suit specific needs.

For each channel there are 11 calibrating frequencies provided which are at equal frequency differences. Calibrating frequencies are generated from frequency standards which have an inherent long-time stability of 0.002%. The linearity error is guaranteed to be not more than .002% of the total band-width for any one channel. The calibrating frequencies of all channels are controlled synchronously by solenoids provided in each rack and the synchronization can be turned off and the calibrating frequencies may be selected manually. An automatic timer is provided which can be adjusted from ¼ to 8 seconds per switching step. Warm up time is less than 5 minutes.

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dent of Burroughs and general manager of the new division with headquarters in Pasadena, Calif.

Parts Group Elects Officers

A. N. HAAS, JR. of Bud Radio in Cleveland was elected chairman of the Association of Electronic Parts & Equipment Manufacturers.

Helen S. Quam of Quam-Nichols Co. in Chicago was named vice-chairman; Kenneth A. Hathaway of Ward-Leonard Co. was named treasurer, and Kenneth C. Prince was reelected executive secretary.

Haas also was named to the board of directors of the Radio Parts & Electronic Equipment Shows, the annual trade show which EP&EM co-sponsors. Haas succeeds Wilfred Larson of Switchcraft in Chicago as head of EP& EM. Mrs. Quam succeeds Wayne Cargile, formerly of Permo in Chicago, as vice-chairman.

Texas Instruments Promotes Engineers

HARRY L. OWENS has been appointed chief engineer of the semiconductor-components division of Texas Instruments. Promoted to assistant chief engineers are: Boyd Cornelison, semiconductor products; Charles E. Earhart, contract projects; John R. Pies, resistors and transformers; and Lawrence Congdon, meters, applications, qualifications and evaluation, and automation. Charles T. Mankus has been appointed administrative engineer. Cecil P. Dotson has been appointed manager of manufacturing for the semiconductor-components division.

GE Establishes Computer Lab

GENERAL ELECTRIC has established a computer laboratory at Menlo Park, Calif.

It is part of the industrial computer section and will be known as

the ERMA Systems Laboratory. Headquarters will be temporarily located in 8,000 sq ft of rented facilities at the Stanford Research Institute, Menlo Park, until permanent arrangements are completed.

About 15 scientists and engineers will begin work at the new laboratory immediately and more will be added by the end of the year.

George Jacobi has been named manager of the laboratory. He was formerly supervisor of engineering for the general engineering lab's analog computer unit.

Engineering work at the new laboratory will initially be devoted entirely to the development of the ERMA data-processing system.

At the conclusion of the ERMA program in about three years, the new laboratory will broaden its development activities to include a wide variety of allied electronic computer problems.

The ERMA systems laboratory will be responsible for engineering phases of the program. Manufacturing operations will be carried out in Syracuse, N. Y., headquarters for the industrial computer section, and at other plants.

Atlas Missile Plant Construction Planned

CONSTRUCTION of a $40-million plant for Convair division of General Dynamics devoted to research, development, manufacturing and preliminary testing of the Atlas intercontinental ballistic missile as well as related projects will get under way later this summer and is scheduled for completion in 1957. Cost of the land, buildings and some equipment will be borne by Convair. Special equipment, including machine tools, will be paid for by the U. S. Air Force. The facility will be known as Convair-Astronautics.

The plant will be on a 252-acre site on Kearny Mesa, adjacent to San Diego's Montgomery Field.

It will consist of a one-story-high bay factory building of approximately 500,000 sq ft; two six-story office buildings, each having almost 107,000 sq ft of working area; a 147,400-sq-ft engineering

laboratory; a cafeteria-auditorium; a 75,000-sq-ft instrument and computer center and several special-purpose test and utility buildings. In all, the plant will have about a million sq ft of floor space.

More than 6,600 engineering, production and administrative personnel will be employed at Convair-Astronautics by 1958.

Aerovox Appoints Chief Physicist

Howard I. Oshry

HOWARD I. OSHRY has been appointed chief research physicist for Aerovox Corp.

Dr. Oshry was previously senior chemist with Koppers, with Mellon Institute and was director of research with Erie Resistor Corp.

Emerson Names Engineer Head

LOUIS G. PACENT, JR., vice-president in charge of manufacturing at Emerson Radio, has been named vice-president in charge of engineering and manufacturing of the company's radio-tv-phonograph division.

Pacent has been associated with the Emerson organization since 1944 when he became the company's chief industrial engineer. He subsequently served as manager of production services, manager of production engineering, assistant to the executive vice-president and

assistant to the vice-president in charge of manufacturing.

From 1946 to 1949, Pacent was works manager and then vice-president in charge of manufacturing of Radio Speakers, Inc., an Emerson subsidiary.

Thordarson-Meissner Acquires Mark

THORDARSON-MEISSNER of Mt. Carmel, Illinois, manufacturers of transformers and coils, has bought, for cash, all the assets and goodwill of the transformer division of Mark Electronics of Bloomfield, N. J. Mark designs and produces flybacks for original equipment manufacturers. All of Mark's transformer production facilities will be moved into the Thordarson-Meissner plant in Mt. Carmel.

Several of the Mark engineering and production staff have joined the T-M organization as part of the move.

California Firm Changes Name

MORAND ELECTRONICS CO. in Los Angeles will change its name to National Electronics Corp.

The firm recently purchased El Ray Motors of North Hollywood, manufacturer of fractional horsepower motors.

Hycon Eastern Adds Space

HYCON EASTERN of Cambridge, Mass. acquired an additional 7,000 sq ft of production space.

This provides the firm with more than 57,000 sq ft of space at its present location. An additional 11,000 sq ft is expected to be added shortly.

The new area will allow increased production of crystal filters.

Daystrom Appoints Two Engineers

DAYSTROM PACIFIC CORP. appointed Robert Hodges as vice-president of engineering and Frederick J. Har-

rison as vice-president of manufacturing.

Hodges was formerly general manager of the electronics division of Fairchild Controls Corp., and previously spent 19 years with Arma Corp., starting as a junior development engineer and becoming technical assistant to the president.

Harrison was formerly factory manager of the west coast division of Lear, and previously operated his own business.

Sterling Precision Names Chief Engineer

SOL LEVINE has been appointed chief engineer of the instrument division of Sterling Precision Corp. of Port Washington, N. Y.

He was previously chief engineer of Edo Corp. where he was associated for the past ten years. Prior to joining Edo, he was a senior engineer with Bendix Aviation Corp. and a physicist with the Signal Corps Laboratory, Fort Monmouth, N. J.

Sol Levine

The instrument division of Sterling designs, develops and manufactures a wide variety of precision electronic and electro-mechanical devices and components.

In addition to its production plant at Flushing, N. Y. and its Port Washington engineering department, the division maintains a 72-acre radar antenna test site for special antenna testing and calibrations for radar equipment and

guided missiles. Its Cambridge, Mass. engineering laboratory specializes in the development of high precision gyros and related instrumentation under the direction of J. J. Jarosh.

Other major divisions of Sterling Precision Corporation include American LaFrance Corp. manufacturer of fire-fighting apparatus and fire-protection equipment; Yawman & Erbe Manufacturing Co. manufacturers of steel office equipment; the Prescott Co. manufacturer of heavy duty sawmill machinery, pumps and heavy industrial machinery components; Sterling Engine Co., manufacturer of gasoline, gas and diesel engines, and a fiber glass plastics division which produces reinforced fiber glass plastic products.

IT&T Promotes General Lanahan

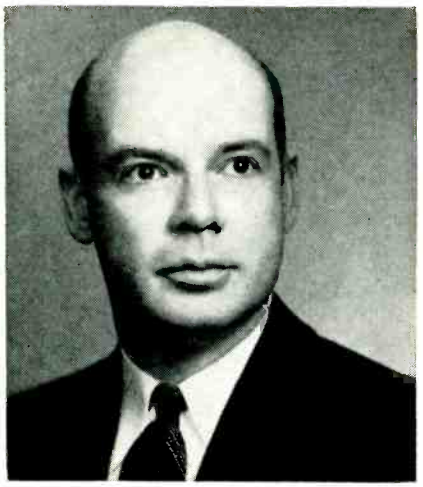
MAJOR GENERAL FRANCIS H. LANAHAN, U.S.A. (Ret.), has been elected executive vice-president of IT&T's Federal Electric Corp. He became vice-president and general manager of the division in 1955 upon his retirement as deputy director of logistics for the U. S. Army.

Since he joined the company it has entered its period of greatest growth, having been awarded contracts by the U. S. Air Force for the maintenance and operation of the DEW Line, distant-early-warning radar network guarding the northern approaches to the North American continent, and for similar responsibilities in connection with the WHITE ALICE communications network in Alaska. The latter currently is under construction to improve older facilities and add new radio links in some of the more remote areas.

Stromberg Forms Electroacoustics Group

AN ELECTROACOUSTICS RESEARCH GROUP has been formed in the research and advanced development department of Stromberg-Carlson division of General Dynamics Corp.

Manager of the new group is



Frank H. Slaymaker

Frank H. Slaymaker, formerly chief engineer of the special products division of Stromberg-Carlson.

The electroacoustics research group will consolidate existing research programs in this field and will implement expansion of Stromberg-Carlson research into other related areas not previously covered. In addition to investigations of magnetic recording techniques and improved sound reproducing equipment, studies will be made of underwater sound, ultrasonics, application of information theory to the analysis of speech sounds and other related subjects.

Slaymaker joined the firm in 1941 as a research engineer.

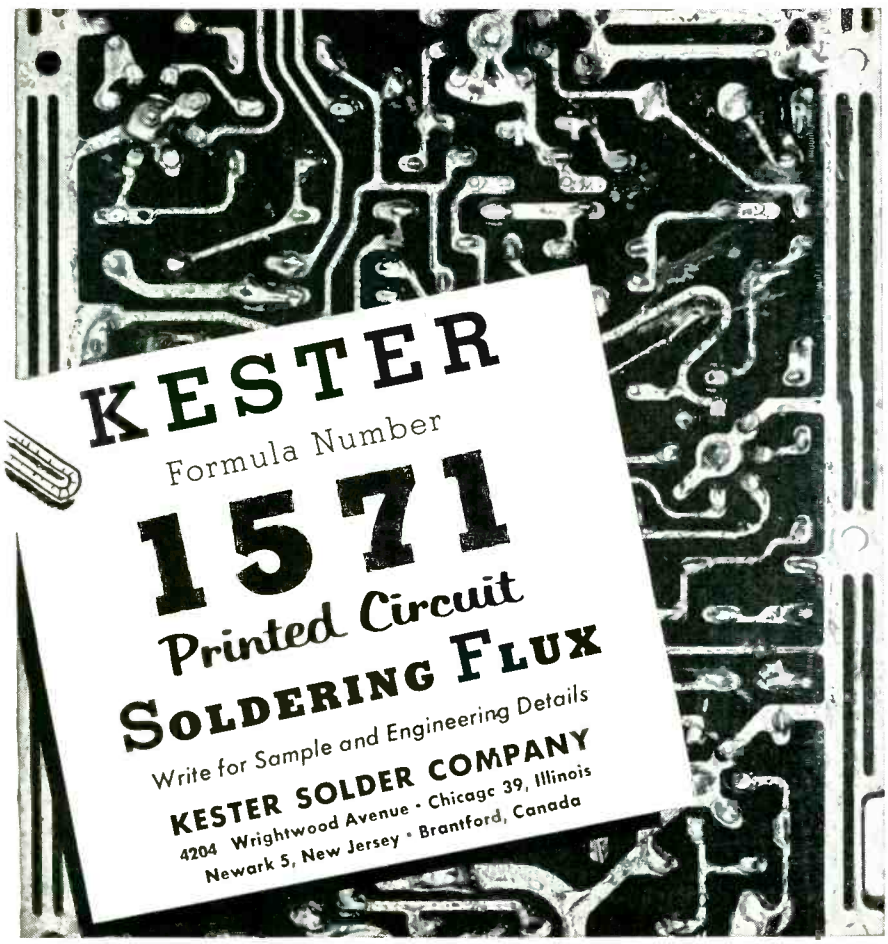
Gulton Acquires Allegany, Adds Engineers

ALLEGANY INSTRUMENTS Co. of Cumberland, Md., has been acquired by Gulton Industries.

Allegany manufactures precision electronic equipment primarily for the aircraft, rocket, metal fabricating, automotive and paper industries. The addition of the company adds a completely equipped plant of 17,000 sq ft to the Gulton organization.

Gulton also announced that Bernard Bernstein, formerly in charge of nuclear instrumentation development at GE, has joined the engineering staff of the firm.

Other new personnel that have joined Gulton include Abraham Soble, a physicist previously a private consultant in the fields of piezoelectricity, transistors, atomic



physics and applied mathematics; Edward Weinberg, production supervisor, formerly division superintendent of Automatic Mfg. Corp. and president of Gem Radio and Television Corp.; Miss Eleanor Ullman, chemist, previously associated with Vitro Corp. of America and Victory Engineering Co.; and Gunther Fenner, an electrical engineer who served with Blonder Tongue Laboratories.

General Ceramics Sets Foreign Plant

GENERAL CERAMICS CORP. of Keasbey, N. J. and Ducon Condenser Ltd. of Sydney, Australia, have formed a joint company known as Ducon-General Ceramics Pty Ltd. that will start operation in Sydney, Australia. It will manufacture ferrites, steatite, and other electronic ceramics in a new plant set up for these purposes for the Australian market.

RCA Appoints Missile Head

Harry R. Wege

HARRY R. WEGE has been appointed manager of the RCA missile and surface radar department.

He has been operations manager of the department since its establishment last November to coordinate engineering, design, production and marketing activities for RCA electronic surface radar equipment, missile launching systems and surface display and infor-

mation handling systems for military use.

Wege joined RCA in 1929 and for nearly a decade was engaged in engineering special radio receivers for commercial and government applications.

In 1940, he was appointed supervisor of a newly created radar engineering group. Within 10 years, increasing radar development activities resulted in the reorganization of the expanding group as a separate engineering section, with Wege as manager.

Warwick Forms Research Unit

A NEW RESEARCH and development department has been established at the Warwick Manufacturing Corp. in Chicago.

Edward S. White, formerly chief electronics engineer at Warwick, has been promoted to the newly created post of director of research and development to head the department.

Penn State Selects President

ERIC A. WALKER has been named president of the Pennsylvania State University, succeeding Milton S. Eisenhower, who has resigned after heading the institution since 1950.

Dr. Walker, dean of the college of engineering and architecture since 1951, was appointed vice-president of the University last year. From 1945 to 1951, he held the dual position of professor and head of the department of electrical engineering and director of the ordnance research laboratory at Penn State.

Collins Appoints Foreign Chief

JOSEPH R. PERNICE, chief of the electronics section of NATO's production and logistics division, has been appointed managing director of Collins Radio Co. of England. The company was organized last year as a subsidiary of Collins Radio Company in Cedar Rapids, Iowa.

The subsidiary has functioned as

a sales office for the United Kingdom and the Continent and as a maintenance facility for Collins equipment used by international air carriers and other commercial customers. Pernice will have charge of all Collins operations in Europe.

In his NATO post, which he had held for the past six years, Pernice directed the activities of the international groups on electronics. Their purpose has been to exchange technical information, aid in the development of production plans and further standardization among member nations.

Alliance Adds Three Buildings

ALLIANCE MANUFACTURING CO. subsidiary of Consolidated Electronics Industries, has announced the lease, with option to buy, of three buildings formerly occupied by the McCaskey Register Co.

Alliance has been using the 81,000 sq ft McCaskey plant for storage. The firm plans to spend approximately $50,000 in expansion and remodeling.

Ampex Organizes For TV Tape

Charles P. Ginsberg

AMPEX CORP. has formed a video engineering department, in addition to the audio engineering department. Charles P. Ginsberg who was project engineer for the development of the Videotape recorder since its conception over three years ago, has been appointed chief engineer of the new department. Named as senior project en-

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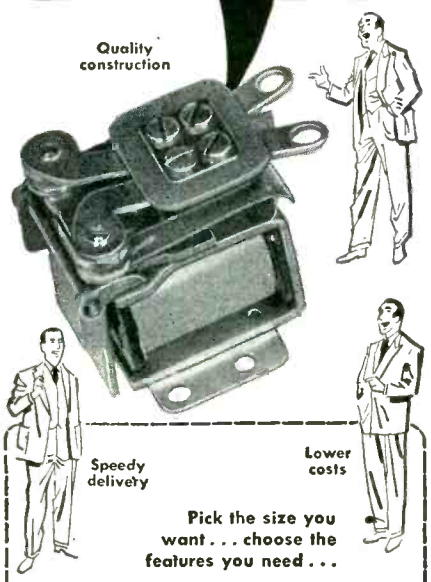

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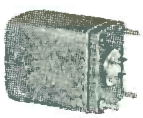

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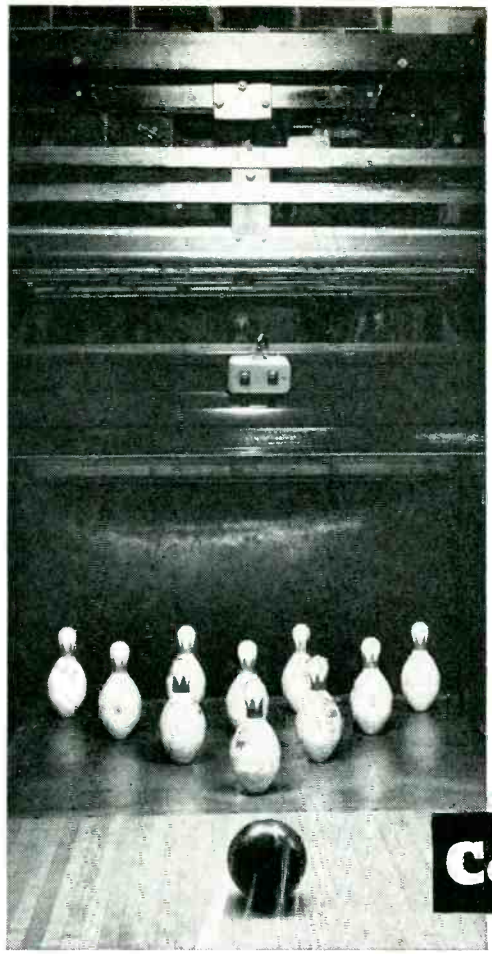

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gineer for video is Charles E. Anderson.

Ross H. Snyder has been named manager of the video sales section of the company. He has been with the firm since 1952 and will continue in his previous capacity as manager of theatre equipment and custom products sales for the audio division. Previously he was chief audio engineer for KJBS in San Francisco and a consultant on audio investigation for Consumers' Research.

PCA Moves To New Quarters

PCA ELECTRONICS has moved its Santa Monica factory to new, enlarged quarters in Sepulveda, Calif. The new plant has approximately 15,000 sq ft for production use, representing a total investment of over $200,000.

Marchant To Build New Plant

MARCHANT CALCULATOR plans to build a $4 million factory in Oakland, Calif.

The new home office and plant will have 500,000 sq ft of office and factory work space. It is anticipated that the initial moves from present facilities will be made in midsumer of next year.

At the present time, the Oakland operations of the firm are conducted in two large factories and ten other buildings.

All of these widely scattered actvities will be consolidated in the new building.

Society To Honor Burns

ROBERT M. BURNS has been selected to receive the Edward Goodrich Acheson Gold Medal and Prize of The Electrochemical Society. Presentation of the medal and prize of one thousand dollars will be made at a dinner to be held on October 2, 1956, at which Dr. Burns will deliver the Acheson Medal Address, at the 110th Meeting of the Society in Cleveland, Ohio, September 30-October 4, 1956.

The Acheson Award is made once

every two years for conspicuous "contribution to the advancement of the objects, purposes, or activities" of the Society.

Dr. Burns, formerly chemical director of Bell Telephone Laboratories, is now a scientific advisor to Stanford Research Institute and to the Sprague Electric Co.

General Quesada Heads Topp Industries

General E. R. Quesada

LT. GEN. ELWOOD R. QUESADA (Ret), former head of the missile systems division of Lockheed Aircraft Corp., has accepted the position of chairman of the board of Topp Industries, of Los Angeles, and State College, Pa.

He will serve as board chairman and chief executive officer.

General Quesada retired from the Air Force with the rank of Lieutenant General in 1951. Prior to joining Topp Industries, he was a director of the Olin Mathieson Chemical Corp. and later vice-president and director of Lockheed Aircraft Co. and general manager of its missile systems division.

Filtron Opens Another Plant

A COMPLETELY EQUIPPED NEW PLANT for the manufacture of radio frequency interference filters, capacitors, pulse-forming networks and delay lines has been built by the Filtron Co., in Culver City, Calif. The new facilities have some 14,000 sq ft of floor space. The

plant is expected to employ 200 additional people, and will be used to supplement the firm's original west coast factory, built last year. William Lana will be general manager of both units.

Ford Motor Leases Space

FORD MOTOR COMPANY'S new subsidiary, Aeronutronic Systems, has leased the Grand Central Terminal buildings in Glendale, Calif.

The terminal buildings will house the firm's administrative offices and equipment for a product program. The activation of electronic, nucleonic, computer and control, and aerophysics laboratories will begin immediately.

Consideration is now being given to the selection of a permanent building site for Aeronutronic in the vicinity of Los Angeles.

Bell Aircraft Goes Automatic

BELL AIRCRAFT CORP. formed the Bell Automation Corp., a new wholly owned subsidiary in Rochester, N. Y., which will specialize in the field of automatic controls and systems.

First product to be introduced is the Electro-Way, an electronically controlled, continuous weighing system for the conveyor belt handling of bulk materials.

Officers of the new corporation are president, Leston P. Faneuf, vice-president and general manager of Bell Aircraft; vice president, Terence M. Nolan, manager of product planning of Bell; and secretary and treasurer, William G. Gisel, who is secretary and comptroller of the parent company.

Frank S. McCullough has been named general manager of Bell Automation. He has been with the parent company since 1952 as an electronics engineer in charge of a product design group. Previously, he was president of the Buffalo Electronics Corp. and was employed in various supervisory engineering capacities by the Frederic Flader Co., Cornell Aeronautical Laboratory, Aviola Radio Corp., Vega

Aircraft Co. and Bendix Aviation.

The new firm has leased 10,000 sq ft of floor space in Rochester.

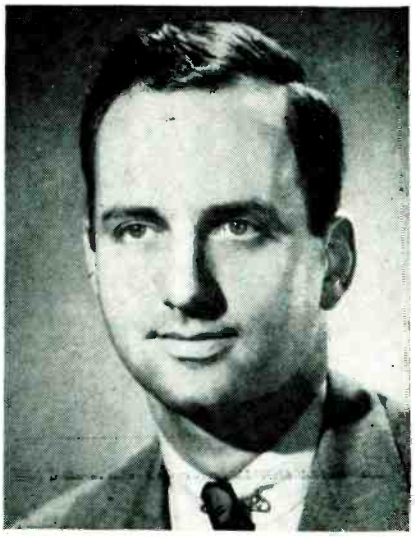
Sprague Moves Two To New Posts

GEORGE H. L. NORMAN has been appointed sales manager of the Pacific division of the Sprague Electric Co. at Los Angeles, Calif. He joined Sprague in 1954. He was previously with Corning Glass. He succeeds George S. Kariotis, who has resigned.

Gilbert B. Devey has been appointed to Norman's former post of company coordinator of computer activities.

Frederick J. Nichols was named manager of filter operations at the Sprague Pacific division. He will have charge of the manufacture of radio interference filters in addition to his present responsibilities as head of the field engineering radio interference laboratory.

Chromatic Selects Vice-President



Morgan A. Gunst, Jr.

MORGAN A. GUNST, JR., has been named vice-president of Chromatic Television Laboratories and general manager of the company's west coast development laboratory in Emeryville, Calif.

He joined the Paramount Pictures affiliate in 1951 as manager for military contracts. Until his appointment as general manager, he served as product manager. The

company is engaged in research and development in the color television and radar fields utilizing the Lawrence color picture tube.

From 1946 to 1951 Gunst was associated with the radiation laboratory of the University of California as assistant executive in the director's office. He was a staff member at the Radiation Laboratory of MIT from 1943 to 1945, one year of which was spent with the British branch. From 1940 to 1943, Gunst was a senior engineer for Lockheed Aircraft.

Acoustical Society Elects Officers

RICHARD K. COOK of the National Bureau of Standards was named president-elect of the Acoustical Society of America. He will take office in 1957.

R. Bruce Lindsay, chairman of the department of physics of Brown University and director of the Brown ultrasonic laboratory, is currently president.

Leo P. Del Sasso, of the University of California at Los Angeles, was elected vice-president of the society for the coming year. Wallace Waterfall, secretary of the American Institute of Physics, was re-elected secretary and Herbert A. Erf, of the H. A. Erf Acoustical Co. of Cleveland, Ohio, was re-elected treasurer.

Leeds & Northrup Names Engineering Head

LEEDS & NORTHRUP CO. appointed G. Lupton Broomell, Jr., as assistant director of engineering, acting head of engineering and inspection departments, and member of the executive operating committee. He succeeds John W. Harsch, director of engineering, who is retiring.

Broomell, who has been chief engineer, joined L&N in 1937.

Appoint Schwartz To New Doelcam Post

GEORGE J. SCHWARTZ has been appointed vice-president and general manager of the Doelcam division of Minneapolis-Honeywell Regula-

tor Co. He had been divisional vice-president.

He will be responsible for the direction and coordination of operations in all departments of the Boston division.

Schwartz joined Doelcam in 1947 after a period as a research assistant at MIT and, later, a member of the engineering department at American Bosch Arma Corp.

Packard-Bell Promotes Unger

WILLIAM L. UNGER has been named assistant to Richard B. Leng, vice-president of the technical products division at the Packard-Bell Co.

Unger has been with the firm since 1955 as assistant chief engineer, administrative.

Olympic Acquires Presto Recording

OLYMPIC RADIO & TELEVISION of New York purchased Presto Recording Corp. of Paramus, N. J.

Presto, manufacturer of tape and disc sound recording and playback equipment, will operate under its present management but as a wholly-owned subsidiary of Olympic. The new division also makes blank recording discs, direction-finders, antennas, transmitters and radar equipment.

George J. Saliba, president of Presto, will continue to direct the operation as vice-president and general manager.

Under the new arrangement, the David Bogen Co., a subsidiary of Olympic, will transfer part of its manufacturing activities to an 80,000 sq ft plant adjoining the Presto factory. Present Bogen facilities in New York will be retained.

Presto, which continues as a separate manufacturing entity, will remain at its present plant.

Maxson Fills Plant Manager Post

OSCAR E. HOLT has been appointed manager of the W. L. Maxson Corp. plant at Old Forge, Pa.

He has been assistant plant manager since 1955, and manager of the research and development division, electromechanical engineering

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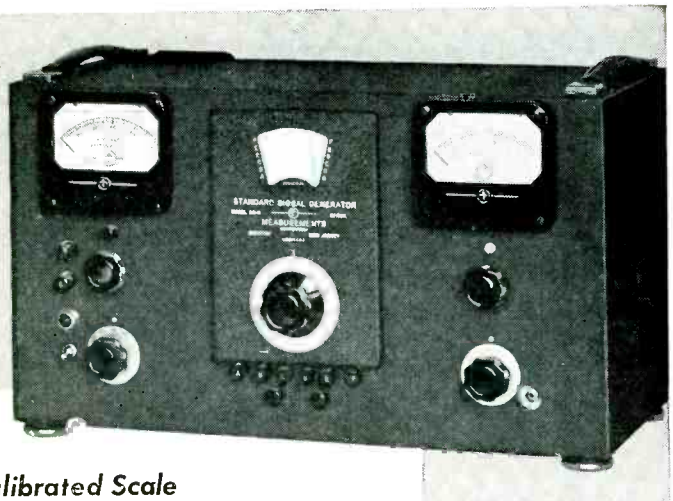

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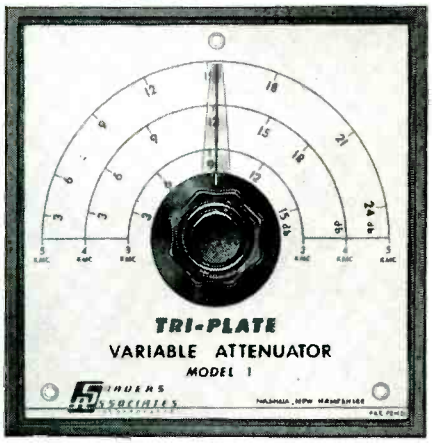

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Maximum Attenuation — linear function of frequency (20 db at 4,000 mc)

Insertion Loss — less than 1.5 db

Maximum VSWR — less than 1.25 at 4,000 mc.

Characteristic Impedance — 50 ohms

Average Power Rating — 2 watts

Dimensions — 5" x 5" x ¼"

Weight — 8 ounces

Other Tri-Plate products such as transitions, directional couplers, hybrid rings and special antennae can also be supplied.

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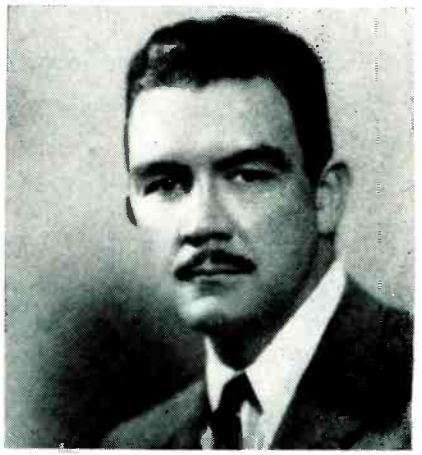
department located in New York. Before joining Maxson, Holt was chief physicist and chief test engineer at Reaction Motors in Rockaway, N. J. Earlier he served as a chief flight test engineer with the Curtiss-Wright Corp. at Columbus, Ohio. He replaces A. J. Westmaas, who resigned.

Gabriel Elects Executive V-P



Thomas J. Riggs

THOMAS J. RIGGS, JR. has been elected executive vice-president and general manager of the Gabriel Co.

He comes to Gabriel from the F. L. Jacobs Co. Detroit manufacturer of automotive parts and metal stampings. He had been president of that company since 1954. At Jacobs he served successively as general sales manager, executive vice-president and president.

New Company Formed In Florida

A NEW COMPANY, Dbm Research Corp. has been formed at Cocoa Beach, Florida. The primary objective of the new corporation is to coordinate the research and development capabilities of private industry with the requirements of the Department of Defense, particularly in guided missile instrumentation.

Officers of the company are Cliff E. Mattox, president; A. R. Beach, vice-president and treasurer; and David Gordon, vice-president.

Mattox was head of the Signal Corps Engineering Laboratories

electronic control and guided missile test range instrumentation division and later was the chief engineer and range director of the Air Force guided missile test range in Florida.

Beach was deputy technical director of the Air Force missile test center and guided missile test range in Florida until recently.

Westinghouse Names Baltimore Managers

B. M. BROWN has been appointed manager of the Baltimore, Md., divisions of Westinghouse.

Brown, manager of the Baltimore air arm division since 1953, replaces F. W. Godsey, Jr., who has resigned.

S. W. Herwald will succeed Brown as manager of the air arm plant. He has been manager of engineering there. N. V. Petrou, who has been manager of development engineering, is the new engineering manager.

Food Processor Goes Electronic

ARCHER-DANIELS-MIDLAND CO. of Minneapolis, has purchased half-interest in the Applied Radiation Corp., a producer of linear electron accelerators and other electronic equipment.

ADM processes agricultural crops and marine oils, and is a producer of chemicals. The Applied Radiation Corp., known as ARCO, is located at Walnut Creek, Calif.

Applied Radiation will remain a separate corporation. Completion of new lab and manufacturing facilities are scheduled for this fall.

Levinthal Promotes Project Engineer

JOSEPH SWANSON, previously senior project engineer, has been advanced to the post of assistant to the chief engineer at Levinthal Electronic Products of Redwood City, Calif. The firm specializes in medical electronic equipment, microwave communications and control apparatus, and scintillation crystals. Swanson has been working primarily in the fields of high-power modulators and medical

electronics. Previously a research associate in the systems-study and -development group, electronic research laboratory, Stanford University, he has also been a staff member in the Moore School of Electrical Engineering at the University of Pennsylvania.

New Transformer Company Formed

FORMATION of a new manufacturing entity, known as Utrad Corporation, to continue operation of the transformer manufacturing business of Utah Radio Products Company Incorporated, is announced by Arnold R. Kaufman, president of Utrad.

The new operation will continue with the manufacture of specialty electronic transformers. Personnel is essentially the same as that of the Utah transformer operation. Utrad has purchased all the machinery, equipment and engineering data of Utah.

The new company is located in Huntington, Indiana.

Marvelco Sets Research Center

AN ADVANCED ELECTRONIC RESEARCH and development center has been established in San Diego by the Marvelco electronics division of National Aircraft Corp.

Immediate work in electronics systems encompassing telemetering, data-handling and display, guidance-navigation, and computer research and development will be undertaken by a staff of 20 research and development engineers and scientists at the new facilities.

The San Diego operation will function as a separate department of the electronics division with James W. Browder, manager and John P. Day, technical director.

Mosler Safe Buys Electronics Firm

RESEARCH PRODUCTS of Danbury, Conn., manufacturer of electrical and electronic monitoring and security devices, has been purchased by the Mosler Safe Co.

Earlier this year, Mosler bought

a 7½-acre industrial tract in Danbury for construction of research and development facilities.

Research Products, Inc., will remain in Danbury. Kenneth H. Schmidt is president of Research Products.

I-T-E Appoints R-F Design Head

DAVID F. BOWMAN has been appointed to head a new r-f design department within I-T-E Circuit Breaker Company's special products division in Philadelphia.

He was formerly chief engineer with Developmental Engineering Corp. of Washington, D. C. Earlier he was associated with Airborne Instruments Laboratory.

Servomechanisms Leases Space

THE EASTERN DIVISION OF SERVOMECHANISMS in Westbury, L. I., has leased 17,000 sq ft of space.

The company has signed a two-year lease on the additional space.

At the termination of this two year period, the company expects to have new Long Island facilities ready for occupancy by the entire eastern division.

The company also announced the appointment of Clement Joseph Savant, Jr., to the position of chief engineer of the western division.

He will be responsible for all phases of western engineering operations. He has been with the company in an engineering capacity since 1955.

Since 1954, Savant has been a member of the teaching staff at the University of Southern California in Los Angeles.

Before joining Servomechanisms, he had served as senior research engineer at North American Aviation, and research engineer for the Jet Propulsion Laboratory at California Institute of Technology.

Mid-Century Selects Division Head

NORMAN L. IRVINE has been appointed director of sales, western division, of Mid-Century Instrumatic Corp. of New York City.

He previously headed the com-

putation laboratories at Aerojet-General in California.

Irvine's duties will include supervision and coordination of all sales efforts of the twelve state western division, as well as directing the research and development activities of Mid-Century on the west coast.

Norden-Ketay Promotes Schaefer

Carl F. Schaefer

CARL F. SCHAEFER has been appointed to the post of technical director of the Norden laboratories division, Norden-Ketay Corp.

Schaefer, who joined Carl L. Norden in 1942, assisted in the formation of the laboratory staff at the Naval Ordnance plant, Indianapolis at that time and in 1943 was one of the key personnel of Carl L. Norden, Inc. selected to organize the Norden Laboratories Corporation as a research and development company.

New Environment Firm Formed

TROP-ARCTIC of Muncie, Indiana is a new corporation formed from the partnership firm of Trop-Arctic Temperature Products of Muncie which was established in 1954. It brings together several men in the environmental test equipment field.

A. M. Andrews, Walter Tranbarger, Earl Dresbach and Vere Robinson together have been associated

with the sales and engineering of temperature products for many years.

The company has increased its capital and plans to expand on a modest basis with the help of several manufacturer's representatives in the north-east quarter of the USA and Canada.

The national sales office in Mishawaka, Ind. will be under the supervision of A. M. Andrews.

GPL Names Division Engineers

DONALD S. KELLOGG has been named chief engineer of the avionic engineering division of GPL. William H. Heath has been appointed assistant chief engineer. The new post of director of research has been assumed by Dr. George R. Gamertsfelder and that of chief product engineer by Otto J. Kolb. A special planning staff has been formed under Donald S. Basim.

Department heads are Frances B. Berger, L. Raymond Chapman, Arden H. Frederick, Everett B. Hales, Harry J. Reed, John C. Duffy and Harold D. Decker.

Titeflex Consolidates And Expand Plants

THE $1.5-million move consolidating the facilities of Titeflex at Springfield, Mass., is completed.

The plant now comprises over 300,000 sq ft, having been enlarged by 40,000 sq ft during the consolidation. There remains approximately 16 acres for further expansion.

Edison Buys Infra Facilities

THOMAS A. EDISON has acquired the Roseland, N. J. plant, equipment and inventory of Infra Electronic Corp.

The new facility will be operated as plant two of the instrument division and will make and market the same precision instrument system components now being produced. The factory makes servo and synchro motors and other components.

The Roseland plant includes a

total of 26,000 sq ft of floor space.

William H. Balentine, who has been named assistant division manager, will be the general manager of the plant. He was previously manager of plant operations for the Edison instrument division.

Armour Research Establishes In The West

BRANCH LABORATORIES have been established at Tucson, Ariz., by Armour Research Foundation of Illinois Institute of Technology.

Alfred J. Hoehn, assistant manager of the electrical engineering research department, will head the branch facility.

He currently is directing work on two projects for the Army Electronic Proving Ground at Ft. Huachuca, Ariz.

Bendix Fills Transistor Post

HOWARD OSTRAN has been appointed to the new position of factory superintendent of the recently opened semiconductor products plant of Bendix Aviation's Red Bank division.

He joined Bendix 10 years ago, and was on the staff of the Eclipse-Pioneer division as a wage administrator. Prior to his new appointment he was chief industrial engineer at the electron tube plant of the division.

Before joining Bendix he was an industrial engineer for RCA.

Electric Regulator Acquires Products

ELECTRIC REGULATOR CORP. of Norwalk, Conn., has acquired from Texas Instruments of Dallas, Texas, the regulator business formerly handled by the Burlington Instrument Co. of Burlington, Iowa.

Principal product involved is a voltage regulator which has been manufactured by Burlington for a number of years and, since last February, by Texas Instruments. It is now being produced by Electric Regulator.

Manufacturing plans for other Burlington products have not been announced, though it is likely that

Electric Regulator's Regohm will be substituted for several types of regulators, including the Ward-Leonard line, which use the same mounting chassis as Regohm.

Raytheon Elects Vice-President

CARLO L. CALOSI has been elected a vice-president of Raytheon. He will serve as a consultant and participate in the management of the company's microwave and power-tube operations.

Dr. Calosi recently returned from a leave of absence in Italy where he served with Finmecanica and its subsidiary electronics company, Microlambda, which is one of Raytheon's manufacturing licensees abroad. In 1948 he organized Raytheon's research division and served as its manager for three years.

He joined the Submarine Signal Co. in 1944, two years before its merger with Raytheon. After the merger he worked on numerous projects at Raytheon including the industrial applications of ultrasonics before becoming manager of the research division.

In addition to his responsibilities in connection with microwave and power-tube operations he will serve as consultant in connection with Raytheon's foreign license and export program.

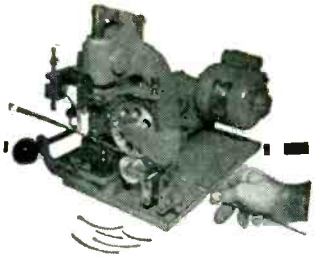
Du Mont Names Control Head

FRED WALZER has been appointed as quality control manager of the technical products division of Allen B. Du Mont Laboratories. Prior to his new position, he served as a section head in quality control for the cathode-ray tube division.

Previous to joining Du Mont in 1949, Walzer was associated with the quality control department of National Union Radio.

Instruments Adds Engineering Executive

ROBERT D. BILLHIMER recently joined Instruments for Industry of Mineola, N. Y. as an engineering



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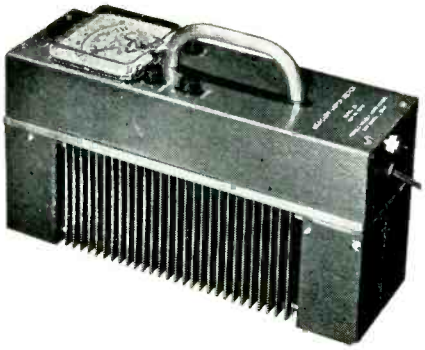

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administrator. In his new position he will be responsible for coordinating and scheduling of the electronic research and development activity which is presently being carried out by the firm for the Department of Defense.

Billhimer has been associated with the Otis Elevator Co., Airborne Instruments Laboratory, and Federal Manufacturing.

Sanborn Builds New Plant

CONSTRUCTION is underway on the Sanborn Company's $1,500,000 plant with some 128,000 sq ft of manufacturing and office space. It is being built on 16.3 acres of land in the Waltham, Mass. Research and Development Park.

ECA Appoints Chief Engineer

ELECTRONICS CORPORATION OF AMERICA has promoted Ernest Jellinek from assistant chief engineer, Photoswitch division, to chief engineer, Fireye division, heading up the development and design of electronic fire and explosion detection and extinguishing systems for aircraft.

Prior to his association with ECA, he was with the General Electric Co. in various phases of electronic development and design.

Major Armstrong Foundation Established

THE NAME and works of the late Major Edwin Howard Armstrong will be perpetuated in the Armstrong Memorial Research Foundation, established by his friends and associates.

Besides G. E. Burghard, president, the incorporating members of the Foundation include vice-president, Harry W. Houck, who is president of Measurements, Inc.; secretary, Thomas J. Styles, who was a laboratory research associate of Major Armstrong, and treasurer, Joseph Stantley, who is president, Continental Sales Corp.

The expressed purposes of the Foundation include aiding in the continuation of basic research that

was carried on by Armstrong as professor of electrical engineering at the Marcellus Hartley Laboratory at Columbia University and to contribute to the education and training of engineers and scientists capable of doing basic applied research in electronics and related fields of science.

The Foundation will make grants of money or of property to the school of engineering of Columbia University for research in electronics and related sciences and to other schools, components or affiliates of Columbia to promote or assist in the research or study of fields or subjects in which Major Armstrong was interested in his lifetime and specifically, to make grants to the school of law of Columbia for the purpose of continuing work of courts and administrative tribunals in passing upon questions of scientific fact and other studies along the same line in which the Foundation may approve on recommendation of the Dean of the Law School.

Further, the Foundation will make grants of money or other property to such institutions, persons or groups, not associated with Columbia University, for such educational or scientific purposes, including the preservation or commemoration of the inventions and research of Armstrong.

Simons Joins NRC Research

JOHN C. SIMONS, JR. has joined the staff of National Research Corp. He will serve as director of the applied physics department in the company's research division and he will be responsible for long range product development for the equipment division as well as special projects for research.

Dr. Simon's background includes four years at MIT where he was project engineer in charge of research on analogue computers and fire control systems. Earlier he served for three years with the atomic power division of Westinghouse where he was in charge of work on control systems and techniques for nuclear power reactors including the one installed on the U. S. S. Nautilus.

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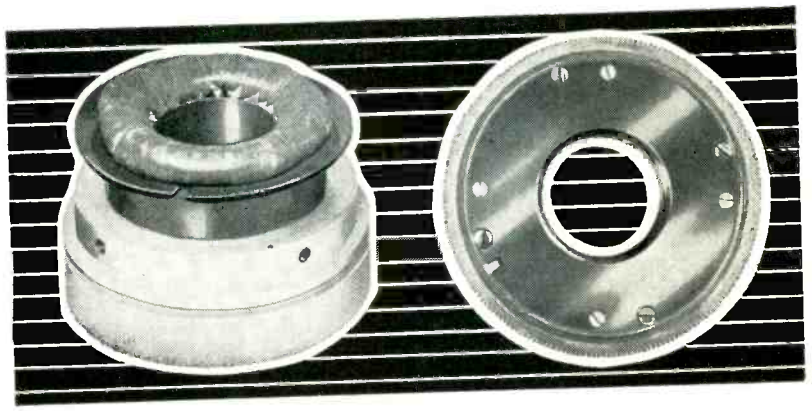

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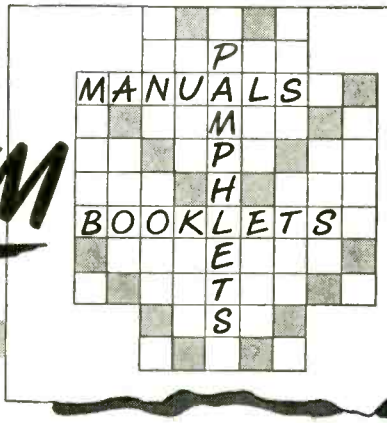

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Macmillan Co., New York, 1956, 582 *p*, $8.00

THIS book is a third edition of an introductory treatment of electron devices and their underlying physical principles. In addition to the material usually presented in textbooks of this sort, chapters on semiconductor devices, wave shaping and control circuits, and magnetic amplifiers are also included.

▶ **Format**—The objective that the author sets for himself is "to provide a textbook for junior and senior college and university courses on basic electronics and electron devices." However, the result falls short of this mark. Most of the treatment is superficial consisting mainly of qualitative discussion coupled with many diagrams and illustrations. Although the number of topics covered is fairly large, any detailed explanation of a particular subject is avoided by referring to a fairly complete bibliography that is included at the end of each chapter. Thus, in many cases, the reader is left in a position of having been introduced to the name of a particular theory or device without having the opportunity of understanding it if he confines his attention to this textbook alone.

▶ **Formulas** — Furthermore, any mathematics beyond that of the simplest algebra is generally avoided with only an occasional use of the most elementary calculus. Many of the formulae are simply stated without derivation and some conclusions are not justified by the preceding discussion. A notable exception to this is the discussion of transistor amplifiers where the analysis is more detailed. However, several errors in the text were noted such as the one on p 396 where the author states that if "$I_c = -E_g (r_b + r_m)/\Delta$ and if the impressed voltage E_g equals zero, then, for I_c to equal zero, Δ must also equal zero."

▶ **Magnetics**—Another notable improvement over the rest of the text is the chapter on magnetic amplifiers which was written by J. J. Wittkopf. Within the limitations set by the length of the chapter, a fairly clear discussion suitable for undergraduate students is presented, although here again the analysis could have been more detailed.

A set of rather simple problems is given at the end of each chapter which are supplemented by a group of questions requiring short essay type answers.

Although this book is too elementary for the college student, it may find use as a descriptive introduction to modern electronic devices for readers having some familiarity with elementary algebra and who wish to obtain a passing acquaintance with this subject.—Armen H. Zemanian, *College of Engineering, New York University, New York, N. Y.*

Color Television

By DONALD G. FINK
Philco Corporation, Philadelphia, 1956, 154 *p*.

THIS book was written "to introduce and simplify the basic theory of color television, and to quickly train the reader (one who now enjoys a working knowledge of monochrome television) to master the techniques of trouble-shooting and servicing color television circuits regardless of their manufacture".

After a brief review of the philosophy of black-and-white television in Chapter 1, the author introduces the basic concepts of colorimetry in Chapter 2. Such physical color fundamentals as hue, brightness and saturation are clearly explained; however, the physiological and psychological aspects of color are not covered.

▶ **Signals** — Chapter 3, Transmission and Reception Methods and Standards, discusses the signals necessary to convey color and brightness information. Starting with a review of vector theory, suppressed carrier modulation is covered in some detail. Frequency in-

terlacing is also looked into.

Chapter 4 describes the various circuits of a typical shadow-mask crt color receiver. The crt and its directly associated circuits are taken up in detail in Chapter 5.

Chapters 6 and 7 are concerned with crt and receiver adjustments and alignment. Chapter 8 discusses troubleshooting methods and show typical waveforms for different parts of a receiver.

Installation of a color receiver, including the antenna and transmission line are covered in Chapter 8.

▶ **Questions**—The end of the book contains a series of review examinations, one for each chapter, which will test the readers understanding of the subjects covered.

Written primarily for the service technician, this book will also be of interest to the engineer who wants to learn the essentials of color tv without getting into the details of colorimetry.—H.A.M.

International Dictionary Of Physics and Electronics

D. Van Nostrand Co., Princeton, N. J., 1956, 992 *p*, $20.00

CONTRIBUTED definitions of some fifteen scientists and educators have been combined in one monumental volume that emphasizes the terminology of pure science while at the same time presenting the working language of those concerned more with practical applications. Laws, basic principles, equations and concepts are presented along with the definitions of instruments, apparatus and components. Wherever possible, definitions established or recommended by professional groups have been included.

▶ **Coverage**—The major subject divisions are listed by the publisher as: units and dimensions; general principles; mechanics; the gaseous state; the liquid state; the solid state; heat and thermodynamics; acoustics; optics; electricity; electronics; meteorology; atomic and nuclear physics; mathematical physics; quantum mechanics; relativity. Radio and television terms are included as well, though of course they constitute only a small per-

centage of the total terms in a dictionary having such broad coverage.

▶ **Contributors**—The following are listed as contributors to the volume: Professor Walter C. Michels (Pres. Amer. Assoc. of Physics Teachers) Bryn Mawr College; Professor N. F. Beardsley, Wright Field, Dayton Ohio (formerly of University of Chicago); Professor R. T. Beyer, Brown University; Professor H. C. Corben, Carnegie Institute of Technology; Dr. Robert Lindsay, Southern Methodist University; Dr. Robert B. Lindsay, Brown University; Professor J. C. May, Yale University; Dr. K. Mendelssohn, Clarendon Laboratory, Oxford University; Professor George Murphy, New York University; Dr. Chester H. Page, National Bureau of Standards; Dr. Rudolph Sher, Brookhaven National Laboratory; Dr. Benson R. Sundheim, New York University; Dr. A. A. Townsend, Cambridge University; Dr. A. D. Yoffe, Cambridge University; Professor S. M. Ziman, Cambridge University.

▶ **Commentary** — The publishers and contributors deserve commendation for tackling this publishing venture and bringing it to a successful conclusion, in a scientific field where the language and terminology is expanding so fast that the work will be out of date before it is a year old. With Weld's "Glossary of Physics" long out of print, there has been a real need for such a work.

With such a large staff of contributors, however, it is inevitable that there be a wide variation in the style and quality of definitions. Some approach the encyclopedic style in length, while others are so terse as to be almost worthless. Fortunately the majority of the definitions, particularly those in the field of physics proper, are excellent.—J.M.

Taschenbuch der Hochfrequenztechnik

Edited By H. MEINKE and F. W. GUNDLACH
Springer—Verlag, Berlin, Germany, 1956, 1,408 *p*

A TECHNICAL handbook should serve two purposes; (1) it should

provide an easily accessible technical survey of the subject and (2) it should serve as a starting point for further investigation of any particular application. Both of these functions are admirably fulfilled for the field of high-frequency electronics by the handbook edited by Professors Meinke and Gundlach. With the assistance of more than 30 contributors, a thorough survey of high-frequency techniques has been prepared. Its accessibility to the reader is facilitated by a detailed index. For further information extensive bibliographical references to books and periodical literature are attached to each of the 26 chapters.

The book is almost evenly divided between electronic components and electronic circuits. The components described and analyzed include both passive elements in their special high-frequency forms and active elements such as magnetrons, traveling wave tubes and transistors. Generally, the term high-frequency technique has been applied rather loosely and the subjects of interest to the electronics engineer engaged in present day developmental work have been included. There are extensive treatments of antennas, propagation, tubes and transmission lines, to give a few examples of the components treated. Among the circuit subjects there are chapters on amplifiers, mixers, relaxation oscillators and modulators.

► **Techniques**—The editors have limited themselves to a discussion of techniques and have not treated applications at all. It is obvious that some limit had to be placed on the subject matter and it would appear that this separation line is a logical one. Thus there is no discussion of systems construction or other devices incorporating high-frequency elements.

The publishers have accomplished no mean feat in compressing all this subject matter into a single volume which is readable. The drawings and graphs are particularly good. The text is compressed but clear. However, the equations are well spaced. The resultant effect is that the book does not appear at all crowded except for the bibliog-

raphies. The high quality of typography is much in evidence.

▶ **Tradenames** — The American reader will probably be surprised by the advanced technical level of the European work which is presented. However, in addition to the language handicap, which we should learn to overcome, the American engineer will find the component portion not as useful as might be desired. This is due to the references to European trade names for glasses, ceramics and alloys for which information here is not generally available. This is hardly a valid criticism since the handbook is primarily intended for use in Germany. From another point of view, this handbook will probably be the most easily accessible collection of whatever information there is available on such European materials. The bibliography and the authors of the various section might then be used to obtain further details on the subject. Unfortunately, the few photographs of actual structures have not reproduced well in their reduced size. This has apparently been recognized and drawings are used much more extensively than photographs.

This handbook will serve to remind the American electronics engineer that we are hardly alone in advanced technical development and that there may be know-how we should import as well as export.—M. ETTENEERG, *Electronic Tube Research Dept., Sperry Gyroscope Co., Great Neck, N. Y.*

Thumbnail Reviews

Part 7, Volume X, Proceedings XI General Assembly U. R. S. I. General Secretariat U. R. S. I., Brussels, Belgium, 140 p, $3.00 (paper). Reports on reading held at The Hague during August and September, 1954, and concerns work of commission on radio electronics. Book includes list of reports and papers submitted to the Commission and Reports of the National Committees.

Proceedings of the Ninth Annual Conference on the Administration of Research. New York University Press, New York, 1956, 107 p, $4. Collection

of papers delivered at a conference held September 7-9, 1955 at Northwestern University. Subjects include research interrelationships of Government, universities and industries; sources of research operations; means for improving research relationships and the future of research.

World of Atoms. J. J. G. McCue. The Ronald Press, New York, 1956, 660 p, $6.50. Introductory course to science considers mechanics, chemistry, electricity, radioactivity, quantum mechanics and nuclear physics. Provides a broad survey of the field of natural science.

Theory of Photons and Electrons. J. M. Jauch and J. Rohrlich. Addison-Wesley Publishing Co., Cambridge, Mass., 1956, 487 p, $10. Presents uniform radiation theory in conformity with principles of relativity and quantum mechanics. The book is on the advanced graduate level.

Government-Industry Cooperation In Standardization. American Standards Association, New York, 1956, 94 p, $3. Proceedings of Sixth National Conference of Standards sponsored jointly by National Bureau of Standards and American Standards Association. Contains numerous papers by representatives of industry, government and the armed forces.

Worldwide Radio Noise Levels Expected in the Frequency Band 10 Kilocycles to 100 Megacycles. W. Q. Crichlow, D. F. Smith, R. N. Morton and W. R. Corliss. Government Printing Office, Washington, D. C., 1955, 36 p, $0.30. Level and variability of atmospheric, celestial and man-made noise measurements made at Boulder, Colorado, Front Royal, Va. and Tatsfield, England.

The Radio Amateur's Handbook. American Radio Relay League, West Hartford, Conn., 1956, 156 p, $3 (paper). Enlarged theory section includes new chapter on semiconductors. Material has likewise been added in the high-frequency sections to include a series of simple converters and construction data on vhf beam antennas. Additions have been made to the chapter on measurements and lists of vacuum tubes and semiconductors.

Peaceful Uses of Atomic Energy, Vol. 4—Cross Sections Important to Reactor Designers. Columbia University Press, New York, 1956, 356 p, $7.50. Part of proceedings of Geneva Conference held August 8 to 20, 1955. Collection of papers from Canada, U. S., Great Britain, France, U. S. S. R. and Scandinavian countries containing recently declassified data on cross sections of fissionable and fertile materials.

World Radio-Television Valve Handbook. Lund Johansen. Gilfer Associates, New York, 1956, 195 p, $2.50. Tube manual listing receiving tubes, crt's, crystal diodes and transistors with data, uses and interchangeability. Covers U. S. and foreign types.

Backtalk

Allocation Problem

DEAR SIRS:

A PRESS announcement last week regarding the FCC study of a plan to "deintermix" television vhf and uhf, with the recommendation that eventually all tv broadcasting be placed in the uhf band, is exceedingly interesting to those engaged in the engineering profession.

It is about time that the engineers made their voice known to the FCC and to their representatives in the Senate and House of Representatives in this regard. Although many engineers agree that the uhf television broadcast band is eventually the proper answer, many engineers will simply "let Charlie do it". Only politics would rule unless the engineers make the facts known to their representatives.

There is no point here in discussing the engineering reasons why uhf television broadcasting is the right direction to move. Any engineer who has read the pages of ELECTRONICS and the other trade publications knows the reasons well enough. The real point, and the deciding factor, will be what the senators and representatives believe their voters want. Actually, the voters want one thing, and that is certain, more tv stations. Not understanding the engineering reasons, they would obviously recommend to their representatives vhf frequencies, not realizing that this would eventually lead to the same hopeless mess that exists in the a-m broadcast band.

It is up to the engineers, not only those who are interested in tv broadcasting, but those who want additional frequencies for other uses, to write their representatives to accept the uhf band for tv broadcasting, and reassign the existing vhf bands for other commercial purposes. Any engineer who has studied the situation will realize that this is the only real answer in the United States, where radio frequencies are at a premium, and the FCC must assign to the best of their ability to serve the most of us with adequate services.

This letter is an appeal to the thousands of engineers to write their representatives their feelings in the matter. Don't let the politicians have a chance to make this issue a political one without engineering approval. Give them the engineering facts first, before they go to their homes and get the laymen to approve an unworkable and illogical plan of frequency allocation.

CHARLES R. MADUELL, JR.
President
Della Electronics, Inc.
New Orleans, La.

MTJ Reliability

DEAR SIRS:

WITH reference to the article on reliability in your column *Cross Talk*, page 121, June, 1956 issue; you posed the question of—"what to call parts with a higher degree of reliability than 'Tel. Qual.'"

I have a suggestion which may or may not be the answer, but how about using "MTJ", taken from the first letter of each of the customary specifications, *MIL*, *TEL*, *JAN*?

RICHARD PAULSON
Engineering Representative
Convair
Div. of General Dynamics Corp.
San Diego, Calif.

Editor's Note: Seems reasonable, but we wonder if some people might conclude that the three specs implied are additive. In any event, it will be many years before the term "Inf. Qual." will be reached.

Proposed Junction Symbol

DEAR SIRS:

I WOULD like to propose a new symbol for junction transistors as follows:

The present symbol does not show in any way whether the transistor is the junction or the point-contact type. As vacuum tubes of a different structure were developed (diode, triode, tetrode, beam, gas, photoelectric) different symbols were added, and it is just as reasonable that new symbols should be added as different transistor structures are developed.

Since the conventional symbol resembles the physical structure of

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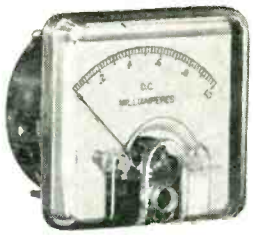

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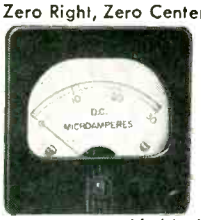

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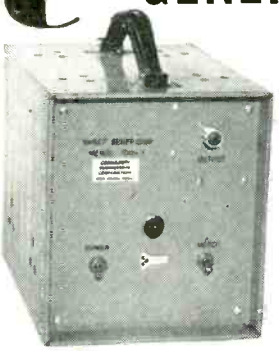

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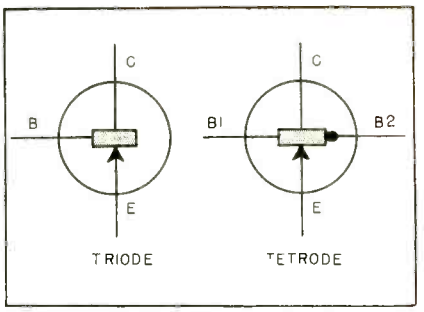

the point-contact transistor it is suggested that it be used only for the point-contact type, and since the above symbol resembles the physical structure of the junction transistor it is suggested that it be adopted for that type.

JAMES E. PUGH, JR.
Menominee, Michigan

Credit

DEAR SIRS:
MY ARTICLE, "Variable Delay Line Simulates Radar Targets", which appeared in the June 1956 issue of ELECTRONICS, was based on work sponsored by the U. S. Air Force under Contract No. AF 30(635) 2807.

This equipment was described in Technical Report T-1/124, "An Ultrasonic Variable Delay Line", Electronics Research Labs., Columbia University, Jan. 25, 1956.

S. A. GITLIN
Staff Engineer
Columbia University
Electronics Research Labs
New York, N. Y.

Transistorized Telemetering

DEAR SIRS:
THERE are some corrections in the illustrations for my article appearing on page 145, July issue of ELECTRONICS. On page 145 two illustrations at the top of the page are reversed.

Of greater importance is the fact that circuit 1-B on page 146 has been changed from a common collector connection to a common base connection. The circuit as shown cannot possibly operate, since the entire bias voltage appears between the emitter and base connections and the collector is essentially floating.

C. M. KORTMAN
Sr. Scientist
Lockheed Aircraft Corp.
Van Nuys, California

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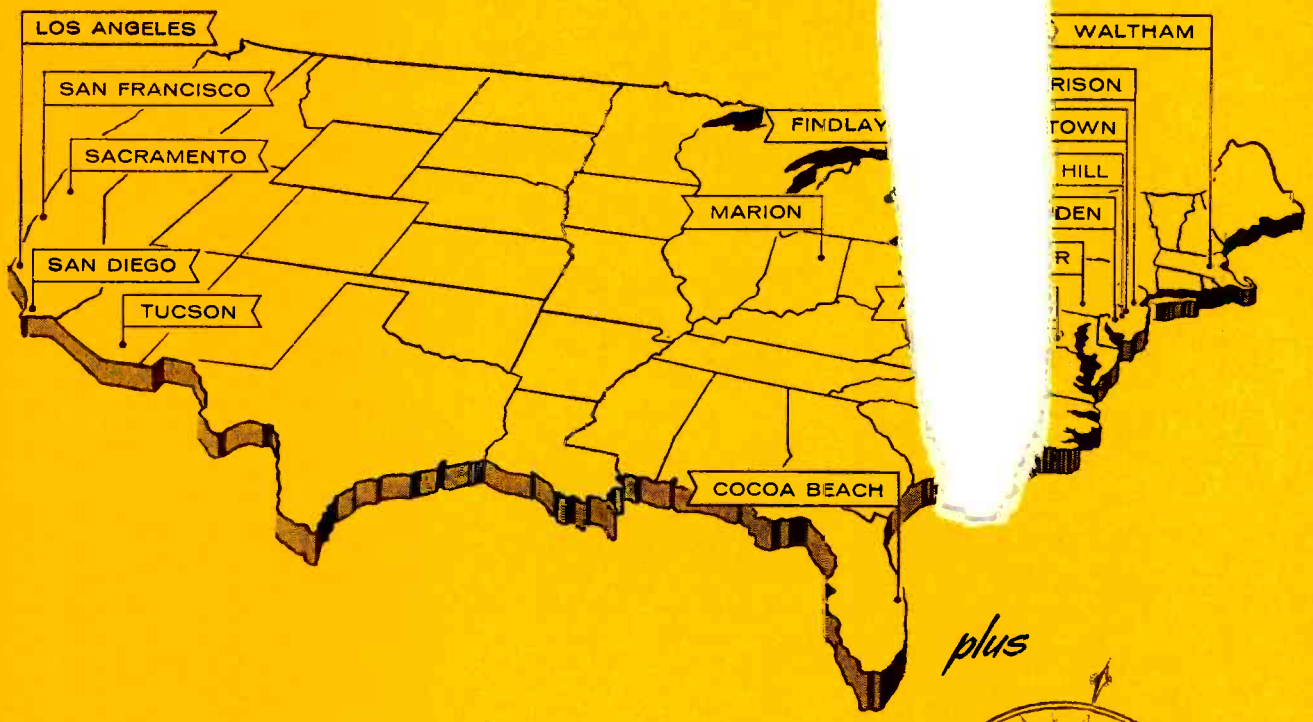

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FIELDS OF ENGINEERING ACTIVITY	MANAGERS	TYPE OF DEGREE AND YEARS OF EXPERIENCE PREFERRED											
		Electrical Engineers			Mechanical Engineers			Physical Science			Chemistry Ceramics Glass Technology Metallurgy		
		0-2	2-3	4-15	0-2	2-3	4-15	1-2	2-3	4-15	1-2	2-3	4-15
• SYSTEMS (Integration of theory, equipments and environment to create and optimize major electronic concepts.) — **AVIATION ELECTRONICS • CONTROLS**			W	W M			M		W	W M			
DIGITAL DATA HANDLING DEVICES	M C		M C	M C		C	C		C	C			
MISSILE ELECTRONICS • RADAR	M W		M W X	M W X		M W	M W		M W	M W			
INERTIAL NAVIGATION	W			W			W			W			
COMMUNICATIONS				C						C			
• DESIGN • DEVELOPMENT **KINESCOPES (B & W and COLOR), OSCILLOSCOPES**—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photosensitive Materials and Glass to Metal Sealing)		L	L Y	L Y	L	L Y	L Y	L	L	L	L	L Y	L Y
RECEIVING TUBES—Tube Design—Test and Application Engineering—Chemical and Physical Development—Methods and Process Engineering—Advanced Development		H	H	H		H	H		H	H		H	H
SEMI-CONDUCTORS—Transistors—Semi-Conductor Devices—Materials		H	H	H	H	H	H	H	H	H	H	H	H
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave—Magnetron)	H		H	H		H	H		H	H		H	H
GAS, POWER AND PHOTO TUBES—Photosensitive Devices—Glass to Metal Sealing—UHF and VHF—Power		L	L	L	L	L	L	L	L	L	L	L	
AVIATION ELECTRONICS—Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Automation—Transistorization	W C	W C X	W C X	W C X	W C	W C X	W C X	W C X	W C X	W C X			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming		C	C X	M C X	C	C X	M C X	C	C	M C			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control—Information Handling—Displays	M C	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X			
COMMUNICATIONS — Specialized Military Systems — Microwave — Aviation—Audio—Propagation Studies		C	C	C		C	C	C	C	C			
MISSILE ELECTRONICS—Systems Planning and Design—Radar—Fire Control—Shock Problems—Servo Mechanisms	M	M X	M X	M X	M	M	M X	M	M X	M X			
COMPONENTS—Transformers—Coils—TV Deflection Yokes (Color or Monochrome)—Resistors—Ferrites (Material and Parts)		C	Z C	Z C	C	Z C	Z C	C	C	C		Z C	Z C
• SYSTEMS APPLICATION (Evaluation and Planning—Design and Development—Modification—Specification)													
MISSILE TEST INSTRUMENTATION (Data Acquisition and Processing) — Radar — Telemetry — Timing — Communications — Optics — Computers	F	F S	F S	F S	F S	F S	F S	F S	F S	F S			
RADAR—Airborne—Surface—Shipboard—Sonar—Fire Control	F	F S	F S	F S	F S	F S	F S	F S	F S	F S			
COMMUNICATIONS — Radio — HF — VHF — UHF — Microwave — Telephone — Teletype — Telegraph Terminal Equipment — Wave Propagation	F	F S I	F S I	F S I	F S	F S	F S	F S	F S	F S			
• MACHINE DESIGN Mechanical and Electrical—Automatic or Semi-Automatic Machines		L	L		L	L H Y	C H Y		L	L			

Locations: **C**—Camden, N.J. **F**—Cocoa Beach, Fla. **H**—Harrison, N.J. **I**—International Div. **L**—Lancaster, Pa. **M**—Moorestown, N.J. **S**—RCA Service Co. (Cherry Hill, N.J.; Alexandria, Va.; Tucson, Ariz.; San Diego, Sacramento, San Francisco, Calif.; Foreign Assignments). **W**—Waltham, Mass. **X**—Los Angeles, Calif. **Y**—Marion, Ind. **Z**—Findlay, Ohio

Please send resume of education and experience, with location preferred, to:

Mr. John R. Weld, Employment Manager
Dept. A-15J, Radio Corporation of America
30 Rockefeller Plaza, New York 20, N.Y.

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The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

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CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)
LOS ANGELES: 1125 W. 6th St. (17)

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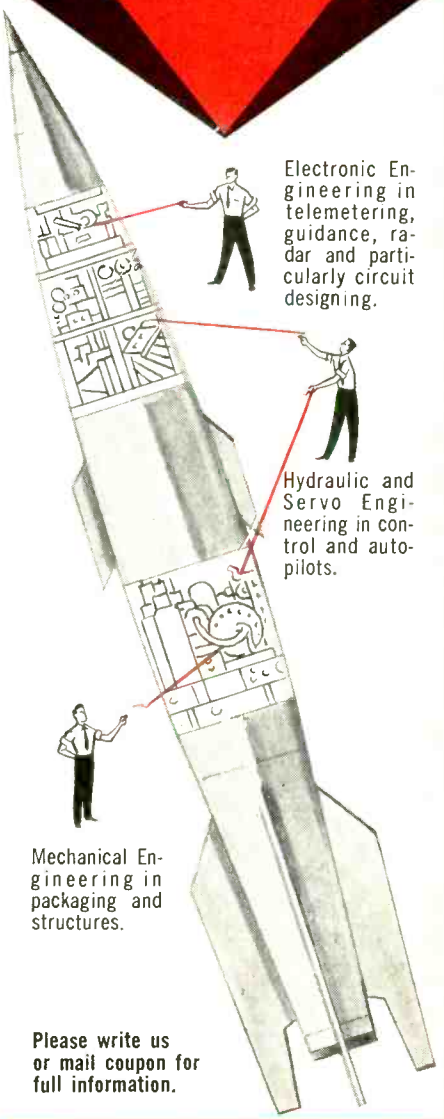

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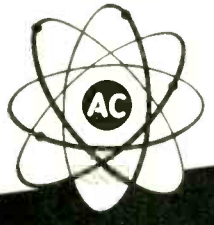

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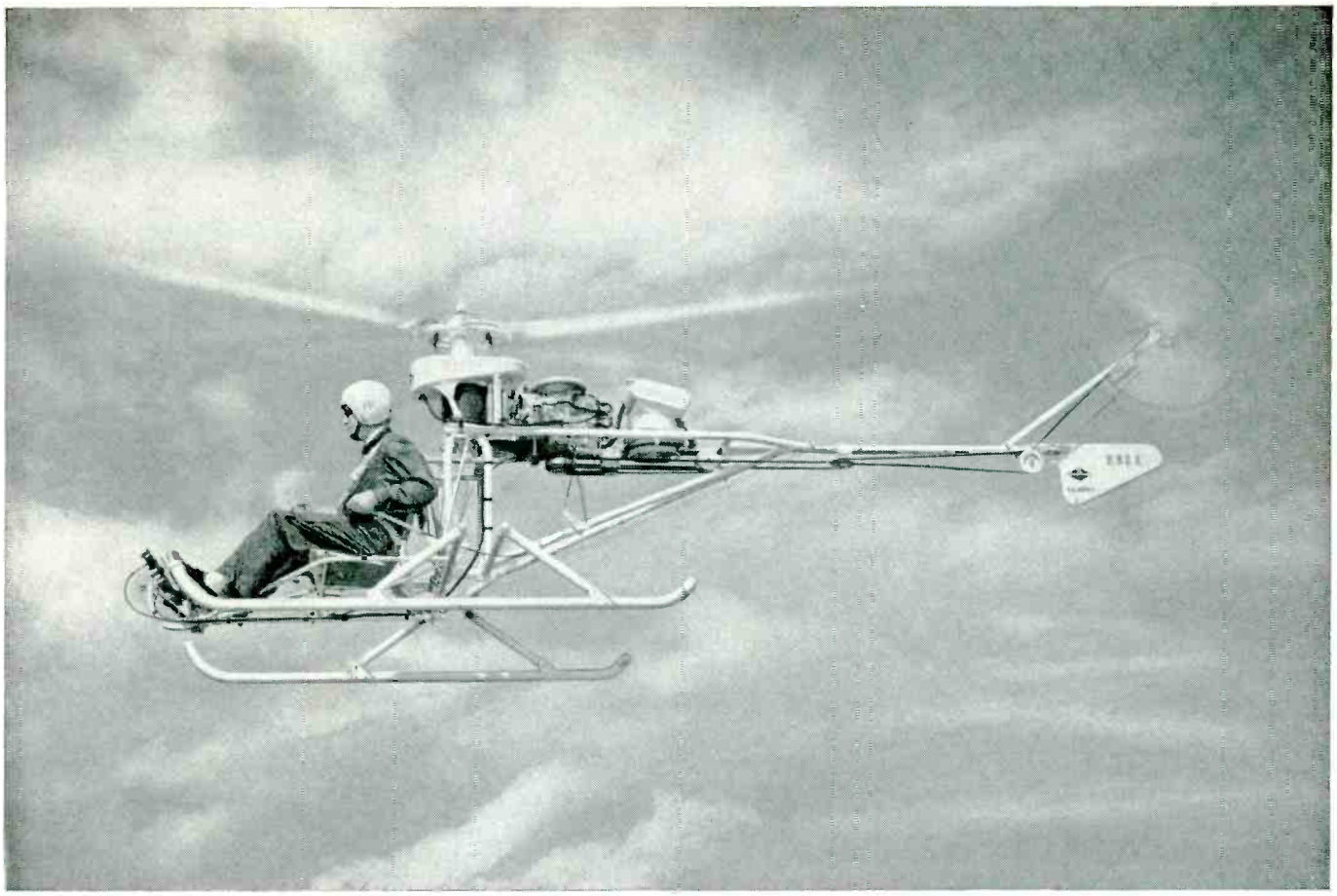

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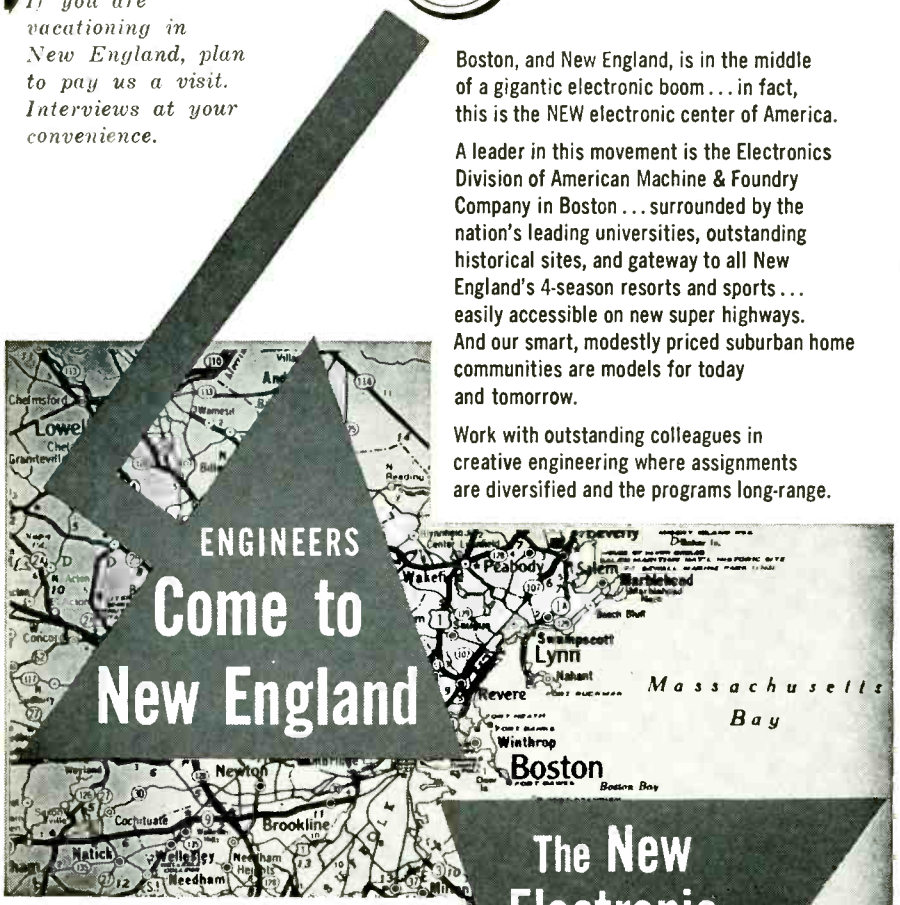
Work with outstanding colleagues in creative engineering where assignments are diversified and the programs long-range.



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to work on the development of Digital Data Processing and Display and Radar Training Equipment

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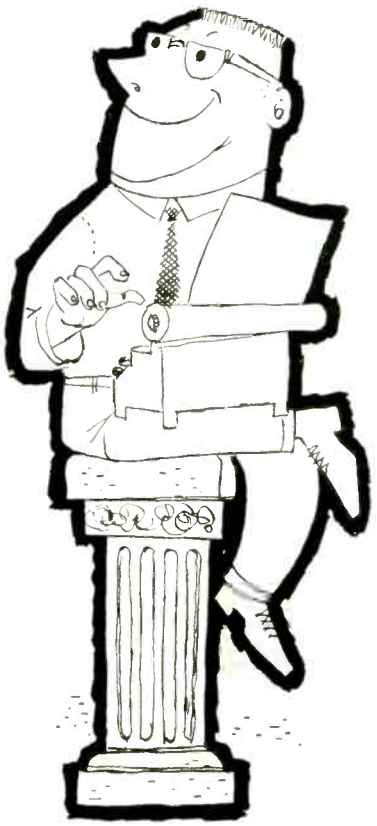
the electronics engineer who can WRITE

is one of our favorite people



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Collins Radio Company

Cedar Rapids, Iowa
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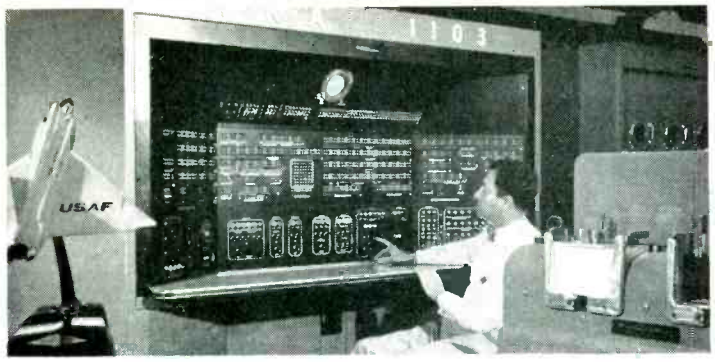

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Motorola Research Laboratory
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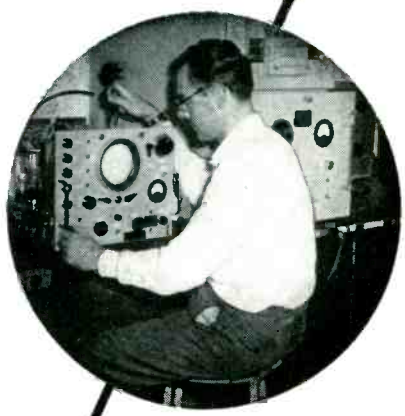
ELECTRONIC ENGINEERS!



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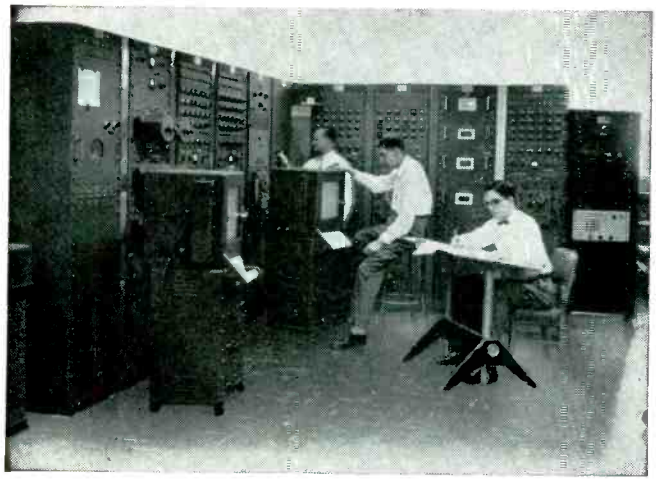

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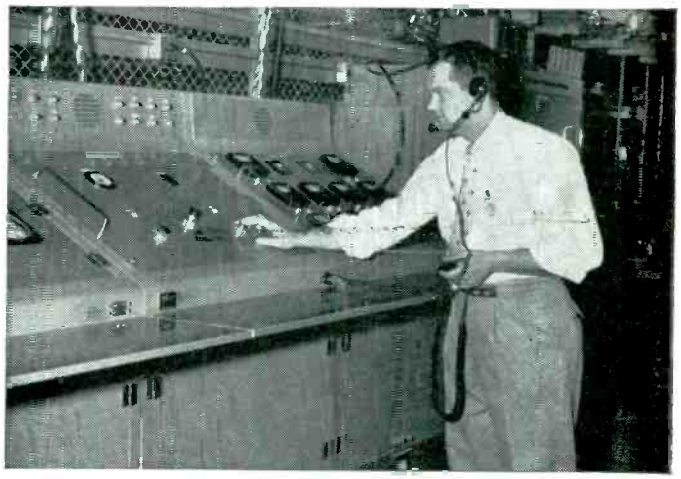
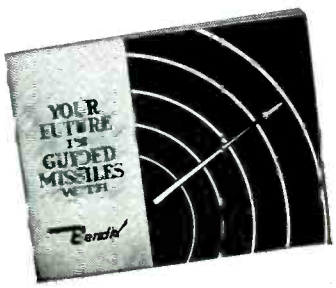


TEST EQUIPMENT—Experienced engineers required for design of precision electronic and electro-mechanical automatic test equipment and instrumentation. Programming, signal generation from low frequency to microwave, analogue and digital data handling, and go-no-go comparators and indicators are involved.

Bendix Guided Missiles also offer interesting job opportunities for Senior Engineers, Assistant Engineers, Junior Engineers and Technicians.

A thirty-six-page book, "Your Future in Guided Missiles", describing in detail the many phases of our guided-missile operation and the job opportunities available to you, will be sent to you on request. Write for your copy today.—BENDIX PRODUCTS DIVISION—MISSILES—403B Bendix Drive, South Bend, Ind.



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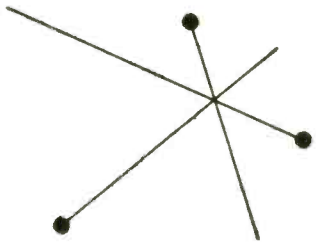
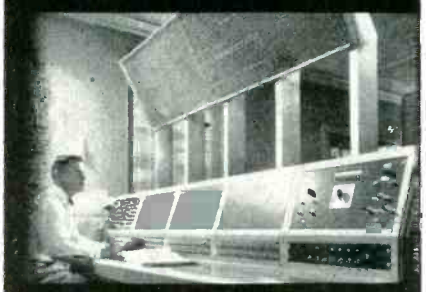
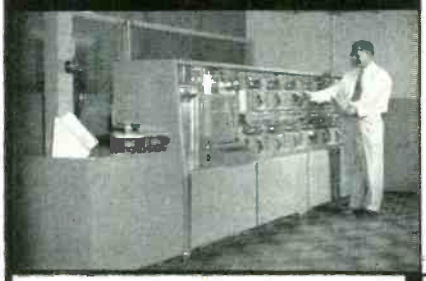
Arlington 74, Massachusetts



ERMA

electronic recording machine accounting





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- COMPUTER CIRCUIT ENGINEERS
- DESIGNERS ELECTRO MECHANICAL DEVICES
- ELECTRONIC PACKAGING ENGINEERS

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Technical Assignments available in Palo Alto, California and Syracuse, New York.

FIRST *industrial data processing system designed to solve entire checking account bookkeeping.*

FIRST *such system ordered into quantity production. (The Bank of America to convert to ERMA.)*

FIRST *production computer designed with modern solid state components.*

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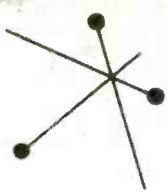

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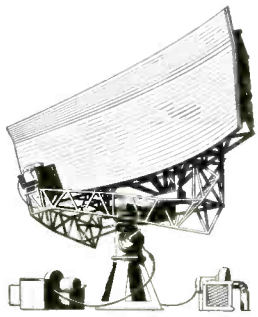
Antenna Systems Engineering Challenging Opportunities

RADAR

MISSILE GUIDANCE

COMMUNICATION

R-F MECHANICAL
SERVOS CONTROLS



Well established, medium sized division specializing in antenna systems—backed by a large company—here you will find professional recognition and broader responsibilities. Project assignments without excessive specialization.

The Philadelphia area is famed for its pleasant suburban living, its excellent housing and all the facilities of a large city.

Please send a resume to Mr. R. S. Roberts—Personnel Dept., I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Phila., Pa.

Project Leader

We have an opening for a graduate mechanical engineer with several years' experience in drive assemblies, structures and electro-mechanical apparatus, as well as strong interest in supervision and administration to head up a group of mechanical engineers. Some background in electrical engineering (especially R-F) highly desirable. You will be responsible for entire antenna systems and have extensive customer and supplier contact.

Microwave and Antenna Engineers

If you have a B.S. or M.S. in electrical engineering and experience in R-F development (2 years minimum) here is your finest opportunity to further your career in antennas. You will work on radar antennas, scanners, scatter communication antennas, countermeasures antennas, waveguides and related components. You will add to a newly formed R-F development group. You will have superb mechanical engineering support for your tricky R-F devices.

Servo and Control Engineers

If your chosen field is in servo and control engineering and you have a minimum of two years' experience, we're sure antenna systems will open excellent opportunities for interesting and rewarding problems. Well qualified mechanical and R-F engineers are eager to welcome your help.

Mechanical Project Engineers

New challenging problems in the mechanical design of radar and guided missile pedestals, antennas and associated drive and control systems require men of experience (minimum—2 years) and ability. If you are a mechanical engineer with a desire to work on precision gear trains and/or mechanical systems intimately related to R-F and servo systems, this is your meat.

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Under supervision of the sales manager—calls on assigned accounts, prepares proposals, makes quotations. Services accounts and solicits new business from government agencies and major electronic manufacturers.

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Experience: 3 years with one year in sales. General experience in electro-mechanical or electronic industry desirable. Should be conversant with major electronic manufacturing concerns and with military type electronic or electro-mechanical equipment. Must be well suited for industrial selling.

I-T-E CIRCUIT BREAKER COMPANY

ENGINEERS

AC needs

SERVO ENGINEERS

...Electrical
...Mechanical

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Milwaukee 2, Wis.

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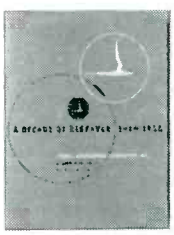

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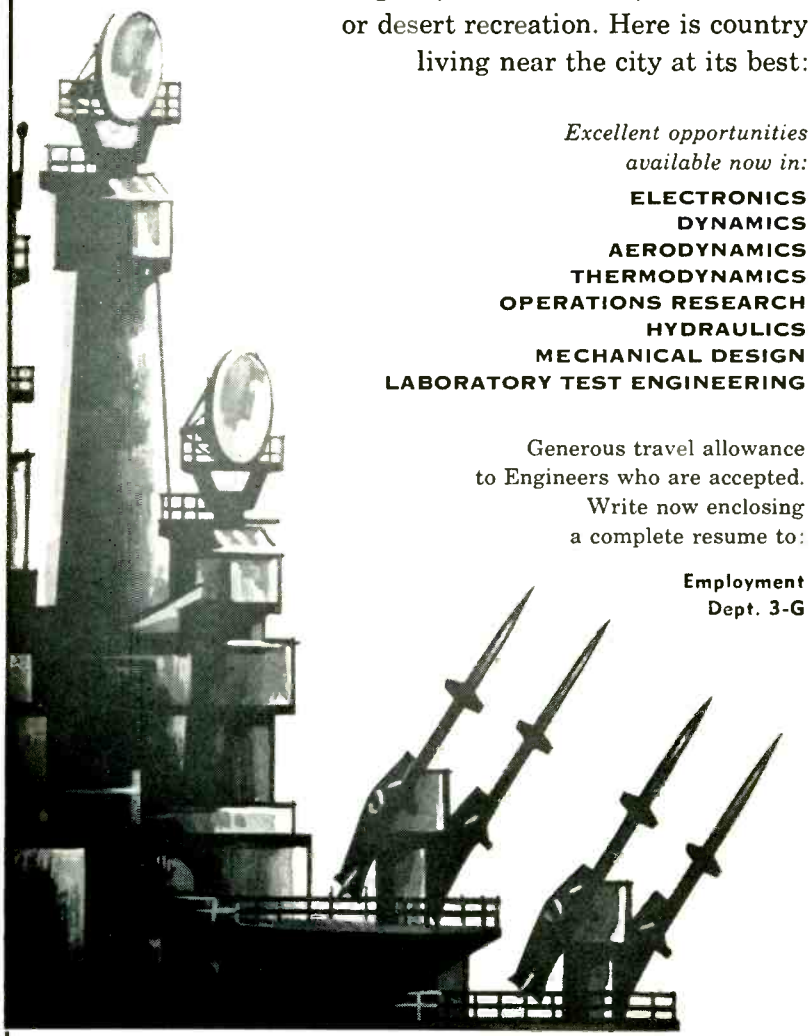

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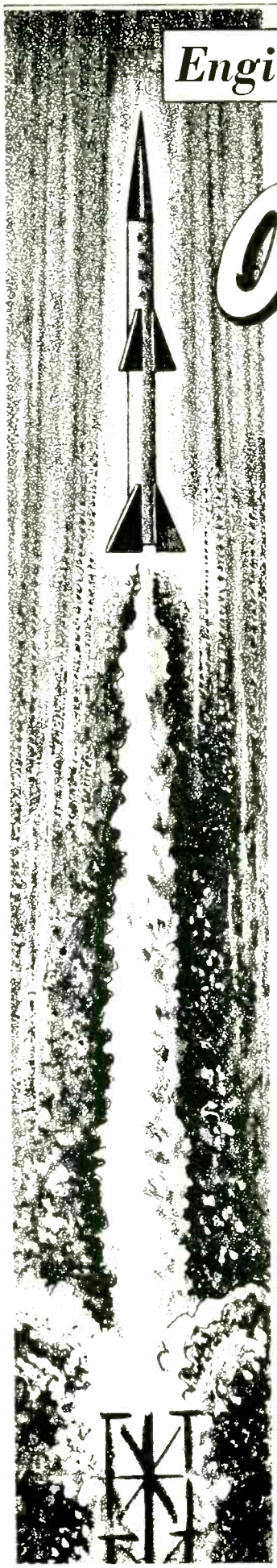

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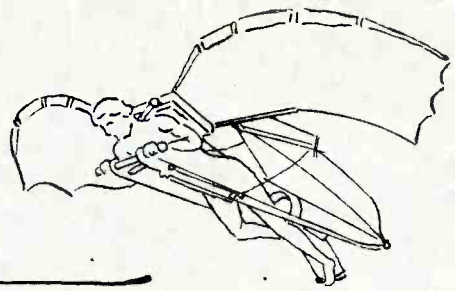
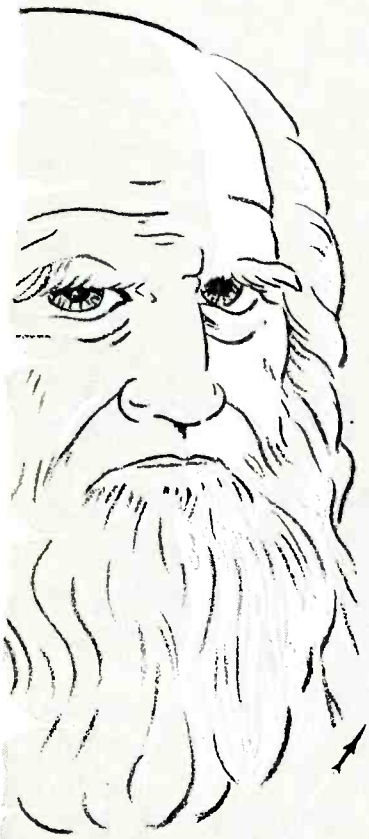


Leonardo Da Vinci's experiments in flight and his insight which approached prophecy, are revealed in manuscript notes, written by him in reversed mirror-image writing. (To read inscription place mirror upright above top line.)

A child is an instrument
moving according to mathe-
matical laws, which instru-
ment it is within the capacity
of man to reproduce with
all its movements.



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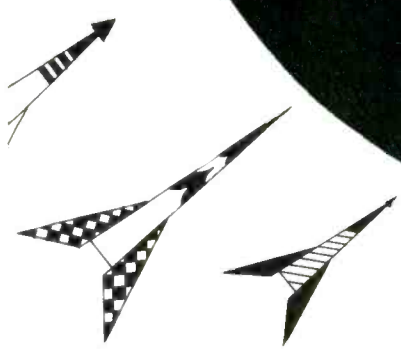

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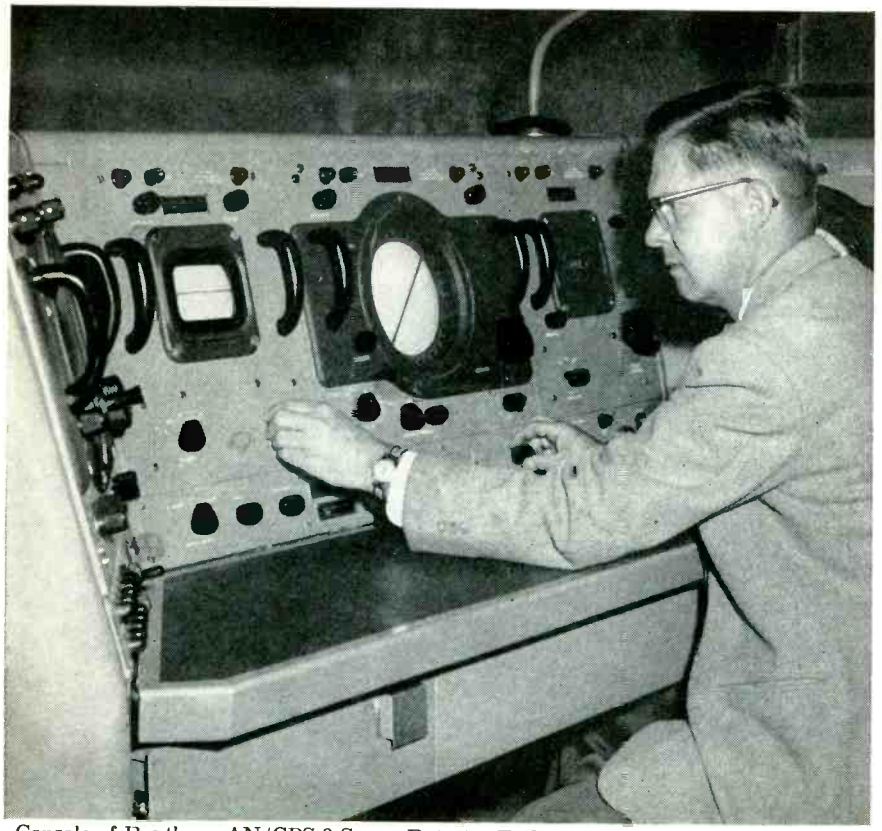

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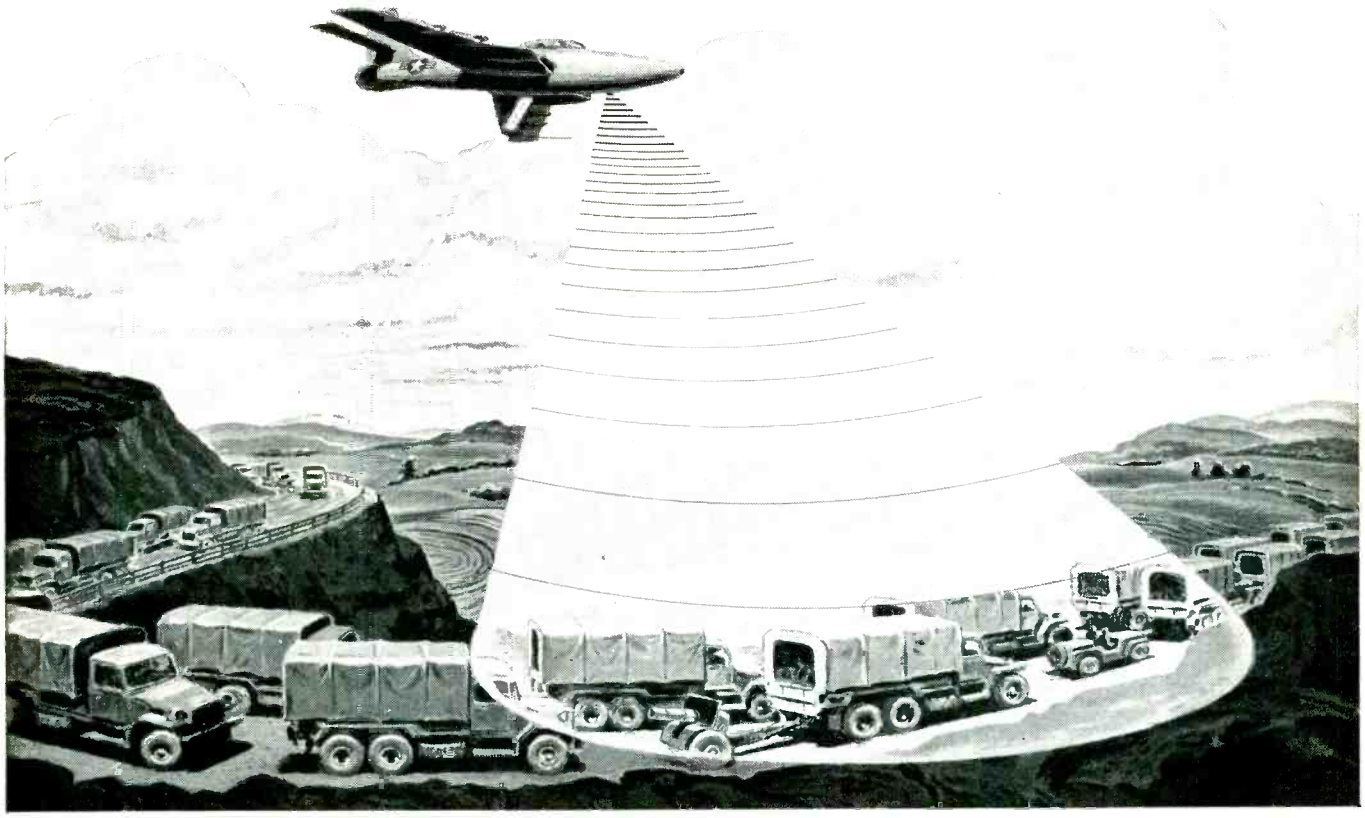

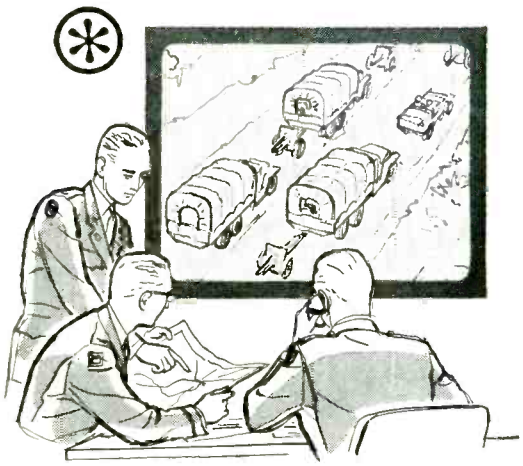

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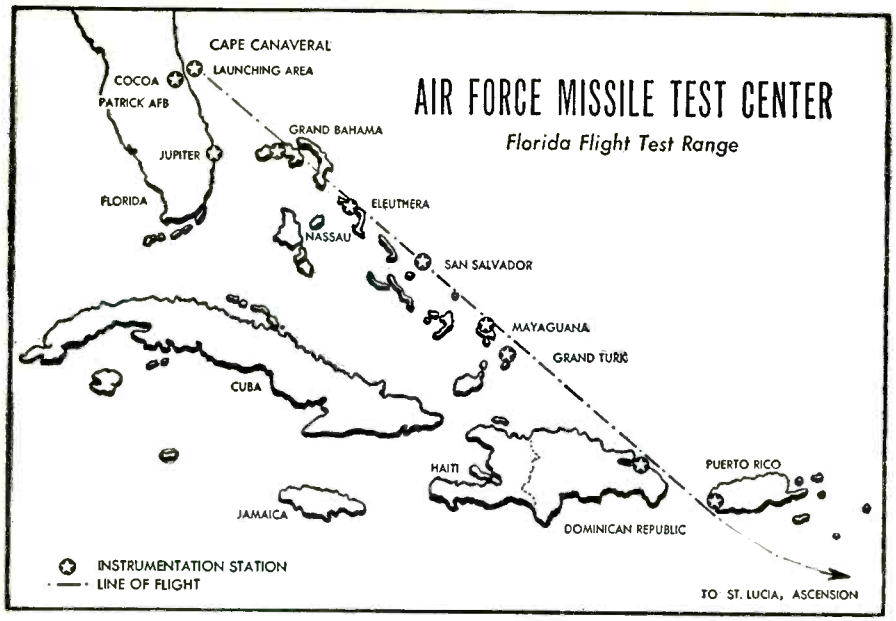

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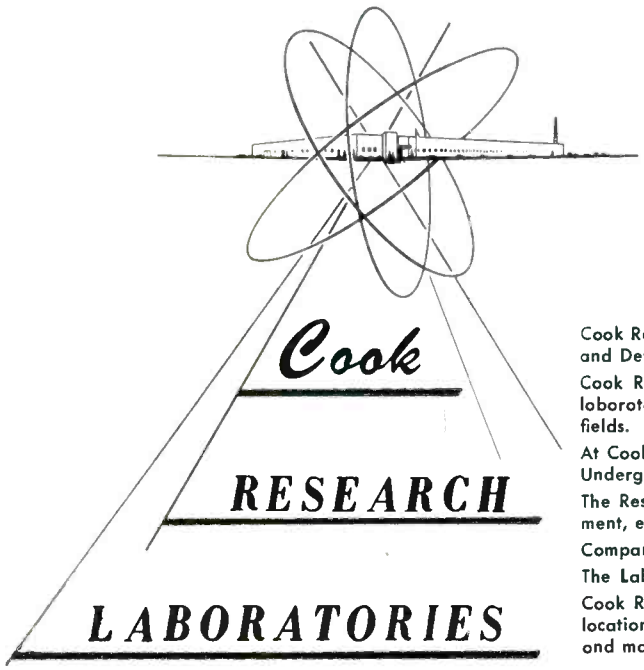

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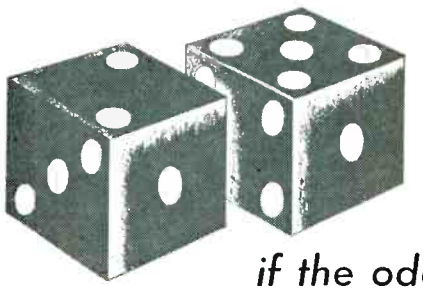

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1B35	4.25	NS-4	1.00	RK-47	18.00	832A	6.00	5647	4.75	5995	7.50
1B35A	7.50	4B25	8.00	RK-75	2.50	836	1.25	5645	6.00	5998	4.00
1B40	2.00	4C27	5.00	V-82 Klys.	POR	837	1.65	5651	1.50	6005	1.75
1B63A	20.00	4E27	8.50	FG172	19.95	838	1.00	5657	125.00	6021	4.50
1B58	42.00	4J21	68.00	41	.20	843	.50	5663	1.20	6032	POR
1B98/151N	1.00	4J34	35.00	100R/8020	7.50	845	5.00	5670	1.10	6044	30.00
1N21C	12.00	4J42	35.00	100TH	6.00	849	17.50	5670W	4.50	6045	1.75
1N23	.60	4J50	80.00	1001G	12.50	851	15.00	5678	.90	6080	4.75
1N23B	1.50	4J58	100.00	FG105	10.00	852	4.00	5680	115.00	6098CT	5.50
1N25	3.00	4J64	250.00	121A-WE	1.95	858	275.00	5687	2.50	6100	2.25
1N32	8.00	4J26	45.00	VT127	1.00	860	3.00	5691	4.75	6110	7.50
1N38	.60	4X150A	21.50	FG-154	15.00	864	.35	5692	6.00	6112	6.75
1P30	1.00	4X150G	10.00	VT-98BR	POR	866A	1.45	5693	4.75	6116 Klys.	250.00
1V	.90	5N5	1.00	VT-158	12.00	872A	1.15	5702	1.65	6147	3.00
2AP1	4.00	5B	1.00	203A	2.50	876	.75	5702WA	6.00	6159	5.50
NR2A	1.00	EL5B	7.00	250R	2.00	878	.50	5703WA	6.00	6161	60.00
NS2A	.75	5BP4	1.00	250TL	15.00	880	250.00	5718	2.50	6189	3.00
2A6	1.40	5CP1A	7.50	FG32	3.75	889RA	100.00	5719	1.75	6201	3.00
2C27	1.00	5CP11	8.00	FG172	16.00	892	165.00	5722	1.25	6211	1.35
2C39	4.75	5FP7A	2.50	FG-271	37.50	892-R	225.00	5726	.60	6236	250.00
2C39A Sealed	11.00	5JP1	10.00	QK-284	95.00	902P1	2.50	5744	1.25	6263	10.00
2C39A Bulk	8.50	5JP1A	25.00	314A	80.00	922	1.85	5749	1.50	6293	POR
2C42	9.00	5J26	100.00	ML-322	10.00	931A	2.50	5751WA	3.50	6326	POR
2C43	9.00	5NP1	2.00	327A	3.50	957	.30	5762	125.00	6328	POR
2C46	6.00	5RP11	25.00	349A	5.75	1500T	75.00	5763	1.15	6364 Phot.	
2C51	3.85	5Y3WGT	1.90	351A	7.00	1611	2.50	5780WE		Mult.	40.00
2D21	.75	5Z22	26.00	371A	1.00	1616	.50	MAG	300.00	6386	5.50
2D21W	1.20	5J26	140.00	RT-434	25.00	1619	.35	5783	4.50	6392 Phot.	
2D29	1.00	5R4GY	1.35	417A	2.00	1624	1.00	5784	4.75	Mult.	30.00
2E27	1.00	5R4WGY	4.00	450TH	40.00	1625	.30	5784WA	7.50		
2E24	2.25	5X4G	.40	450TL	35.00	1630	.60	5787	4.85	8005	5.00
2E25	4.75	5Y3GT	.44	464A	2.15	1631	1.75	5794	6.00	8014A	60.00
2E29	1.00	524	.68	471A	3.00	1633	1.25	5799A	POR	8020/100R	7.50
2E30	1.95	C6L/5528	10.00	508	275.00	1961	1.00	5814	.75	9002	.65
2E36	1.65	C6M	7.00	526AX	1.70	2050	1.00	5814WA	3.50	9003	1.35
2AF1	1.65	6AN5	22.50	527	5.00	2050W	2.00	5840	4.25	9006	.45
2G22	1.20	6AN5WA	3.75	531	200.00	5517	1.60	5844	2.00	AX9903	19.00
2J22	4.50	6AQ5W	1.70	560A	10.00	5528/C6L	10.00	5845	5.00	0164696	POR
2J26	4.50	6AR6	1.25	575A	17.50						
2J27	4.50	6AS6W	2.75	592A	10.00						
2J32	12.50	6AU6WA	1.55	KU627	30.00						
2J34	15.00	6BA7	1.00	HK-654	1.25						
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2J62	5.50	6A3	POR	706CY							
2K25	18.50	6AL7G	1.50	708A	.75						
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2K55	15.00	6Y6G	.58	722A	1.00						
2X2	.50	6-4 Regl	1.00	723A/B	9.00						
3AP1	2.85	6-7 Regl	1.00	724B	.70						
3CP1	5.00	6-11 Regl	1.00	726A	6.00						
3FP7	3.00	7CP1	4.99	726B	20.00						
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249B	3.50	337A	6.00	422A	8.50				
252A	17.00	338A	10.00	423A/6140	8.00				
253A	3.50	345A	6.00	431A	200.00				
254A	4.75	350A	2.75	436A	55.00				
259A	14.00	350B	2.75	703A	1.00				
262B	5.50	359A	2.00	704	.85				
274B	1.00	368A	2.00	705A	.75				
276D (Relay)	8.75	371B	1.00	708A	.75				
282A	7.00	373A	5.00	709A	.65				
282B	7.50	374A	4.75	713A	.65				
293A	12.25	388A	1.00	715B-WE	7.00				
300B	5.00	394A	8.00	717A	1.00				
315A	3.00	395A	POR	719A	9.50				
310A	4.50	400A	4.00	724B	1.00				
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WECO: D-163247 For Modulator of SCR 720....$22.50

GE #K-2449A

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Secondary: 28 KV, 450 ohms.
Pulse length: 1.05/5 usec @ 635/120 PPS. PK Power Out: 1,740 KW. Bifilar: 1.5 amps.....$62.50

GE #K-2748-A, 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well.....$24.50

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68G711: Ratio: 4:1 Pri: 200V, Sec. 53V, 1.0 usec Pulse @ 2000 PPS, 0.016 KVA.....$4.50

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7-5E3-3-200-67P, 7.5 KV. "E" Circuit. 3 microsec. 200 PPS, ohms imp. 3 sections.....$12.50
H-616 10KV, 2.2 usec., 375 PPS, 50 ohms imp..$27.50
H-615 10KV, 0.85 usec., 750 PPS, 50 ohms imp..$27.50

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TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	PRICE
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35X-059	19	3.8	405	.095	4.35
DM33A	28	7	540	.250	3.95
B-19	12	9.4	275	.119	6.95
			500	.050	
DA-3A*	28	10	300	.260	3.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	1000	.350	17.50
BD 69	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.50
BDAR 93	28	3.25	375	.150	5.75

‡ Less Filter. * Replacement for PE 94.
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MICROWAVE ANTENNAS

AT49/APR—Broadband Conical, 300-3300 MC. Type N Feed (as shown).....$8.95
3 CM ANTENNA ASSEMBLY: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan: over 160 deg. at 35 scans per minute. Elevation Scan. over 2 deg. Tilt. Over 24 deg..$35.00
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Discone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" Connector.....$14.50
AS14A/AP, 10 CM pick up dipole assy, complete w/ length of coax and "N" connectors.....$4.50
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SPECIAL VALUES

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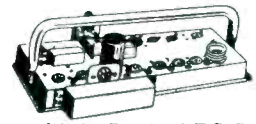

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GE #CR2791B106C3

SPDT, Dual Contacts will handle 20 Amps. Coil: 18-28 VDC 125 Ohms DCR.....$1.25

*THESE RELAYS AVAILABLE IN MFRS. QUANTITIES

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Complete R.F. Head and Modulator delivers 50 KW Peak R.F. at 3000 MC. Pulser delivers 12KV pulse at 12 Amp. to magnetron of .5, 1, or 2 microsec. duration at duty cycle of .001. Unit requires 115V, 400-2400 Cycles, 1 phase @ 8.5A. Also 24-28 VDC @ 2A. External sync. Pulse of 120V Req'd. Brand New, Complete with magnetron, magnet, plumbing and all tubes.....$375.00

MICROWAVE EQUIPMENT

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AT-68/UP 3 Cm Horn with type N. feed for receiver measurements, etc. New.....$7.45
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ROTARY JOINT (AIS-6) Sperry PT #658275, 180 deg. rotation, choke to choke. Has "Built-in" Di-Coupler, 20 DB with "N" Takeoff.....$22.50
3 CM. DIPOLE FEED, 15" L. for APS-15.....$14.50
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Directional Coupler. UG-40/U Take off 20db.....$17.50
MAGNET AND STABILIZER CAVITY For 2J41 Magnetron.....$24.50
90 degree elbows. "E" Plane 2½" radius.....$8.50
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10 CM.—RG48/U Waveguide

10CM ECHO BOX: Tunable from 3200-3333 Mc. For checking out radar transmitters, for spectrum analysis, etc. Complete with pickup antenna and coupling devices.....$17.50
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PLATE—115/60~INPUT

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PT-913	2500V12 MA H'SLD	4.95
PT-38-2	37.5/40V AT 750 MA	2.15
PT-87P	860VCT/230MA DC	4.75
PT-876	1500-0-1500V./400MA	12.75
PT-151	2060VCT/0.175A	18.50
PT-403	Autotrans.—70V/1.0 AMP	1.75
PT-078	300V/.05MA	1.85
PT-823	220VCT/75 WATT	2.95
PT-973	160V/100MA	2.15

COMBINATION—115V/60~INPUT

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CT-875	1600V/2MA., 6.3V/.6A, 2.5V/1.75A	4.95
CT-127	900V/25MA PK, 5V/2A, 2V/7.5A	2.79
CT-006	350-0-350V/120MA, 5VCT/3A, 2.5VCT/12.5A, 2.5VCT/3.5A	3.49
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CT-479	7090V/.018A, 2.5V/5A/17,800V. T	22.50
CT-403	350VCT .026A 5V/3A	2.75
CT-931	585VCT .086A 5V/3A, 6.3V/6A	4.25
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OB2	.60	2K25	11.00	6BM6	25.00	250-TL	12.50	403B/5591	2.75	721A	.75	5634	6.50
OB2WA	3.00	2K26	45.00	6BM6A	30.00	WE-251A	49.50	WE-403A	1.50	721B	7.00	5636	3.00
OB3VR90	.85	2K28	25.00	6D4	1.75	WE-252A	7.95	WE-404A	12.00	722A	.75	5639	7.00
OD3	.65	2K33	85.00	6F4	2.50	QK253	Q	WE-408A	2.75	723A/B	8.50	5639A	7.00
1AD4	1.25	2K33A	60.00	6J4	1.75	WE-254A	3.00	WE412A	4.50	725A	3.50	5644	7.25
ELC1B	1.50	2K33B	85.00	6J4WA	2.50	FG-258A	90.00	GL-414	63.00	726A	7.00	5647	5.00
1B22	1.10	2K34	85.00	6J6W	1.50	V-260/		WE-416B	40.00	726B	17.50	5651	1.40
1B23	2.75	2K35	175.00	6K4	2.25	VA-6310	Q	417A	1.75	726C	15.00	5654	1.30
1B24A	12.50	2K39	100.00	6SK7W	1.50	V-262	Q	WE-417A	12.00	730A	7.50	5656	7.00
1B26	1.25	2K41	100.00							750TL	35.00	5657	125.00
1B27	10.00	2K42	110.00							801A	.35	5663	1.50
1B29	2.50	2K43	110.00							802	2.00	5665	35.00
1B32	1.00	2K44	110.00							803	2.00	5667	125.00
1B35	3.50	2K45	30.00							804	9.00	5670	2.00
1B36	4.00	2K46	200.00							807	1.20	5675	7.00
1B40	2.00	2K47	75.00							807W	2.00	5683	5.75
1B42	4.00	2K48	55.00							808	1.25	5687	3.00
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1B47	5.00	2K54	5.00							811	2.90	5692	5.00
1B51	6.75	2K56	50.00							812A	3.50	5693	4.50
1B62	4.00	2X2A	1.00							813	10.00	5702	1.50
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1N21B	1.25	3B22	3.00							828	8.50	5719	2.50
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1N23BM	3.50	3B26	3.50							830B	.50	5726/6AL5W	.60
1N23C	2.50	3B29	4.75							832A	5.00	5744	1.90
1N25	2.20	3C22	60.00							834	5.00	5750	2.50
1N26	3.50	3C23	4.00							836	1.50	5763	1.30
1N28	6.00	3C24	2.50							838	.70	5768	30.00
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1N63	1.40	3FP7A	2.50							861	15.00	5840	4.50
1N69	.40	3J30	35.00							865	.90	5844	1.50
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2B24	.80	4C35	13.50							931A	2.50	5932	4.00
2C33	.75	4E27	7.50							935	4.00	5933/807W	4.00
2C35	2.50	4J32	45.00							957	.35	5956	35.00
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2E26	3.25	5JP4	6.00							1631	1.25	6111	6.00
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2J54	25.00	6AR6	1.25							5517	1.50	8012	1.00
2J55	29.50	6AS6W/5725	2.70							5551/FG271	35.00	8025A	2.00
2J56	40.00									5553/		9001	.85
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C3J	6.35	OA2	.74	2K23	16.50	5BP1A	8.99	12AT7	.85	274A	5.95	706A	6.75	814	2.49	1619	.92
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C6J	7.99	1B22	1.69	2K-28	29.50	5C22	25.00	12GP7	12.95	276A	7.25	706C	17.50	816	1.05	1626	.29
CK-551AX/2E41	1.79	**1B24**	**5.99**	**2K33A**	**59.95**	5CP1	3.99	15E	1.25	282A	6.49	706DY	35.00	826	.75	1629	.29
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EC1	1.99	1P30	1.99	2K45	32.50	5CP7	9.99	26A7/GT	2.99	286A	7.50	**707B**	**3.95**	830B	2.99	1632	.59
EF-50	.80	2A4/G	1.10	**2K54**	**8.95**	5CP11A	14.99	26C6	1.19	304TH	10.00	708A	2.99	832A	7.49	1641	1.88
E1148	.29	2AP1	3.99	**2K55**	**9.50**	5D21	6.99	28D7	.89	304TL	13.95	709A	1.69	833A	31.50	1642	.39
EM-3GA	39.50	**2AP1A**	**6.44**	2V3/G	1.39	5FP7	3.99	7BP7	6.25	**307A**	**1.85**	713A	.96	836	1.99	1644	.48
F123A	**5.99**	2B22	1.89	2X2	.34	5HP4	2.49	9LP7	5.00	310A	3.99	714AY	24.95	837	1.99	1806P1	4.99
FG17	4.50	**2BP11**	**7.99**	2X2A	.89	5JP1	16.99	10Y	.39	316A	.69	715A	2.65	838	3.50	2050	.95
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HK-24	3.69	2C26A	.49	3B23	3.25	5JP19	13.99	35TG	7.25	354C	14.95	718AY/CY/EY/DY	29.75	851	16.50	5654	1.40
HK-54	3.99	2C33	.69	3B24	2.99	5LP1	13.99	53A	2.29			719A	14.65	860	3.49	5656	3.25
HY-65	1.20	**2C39**	**4.99**	**3B24W**	**4.99**	5NP1	6.99					720CY/DY/EY	29.75	861	19.00	5670	2.20
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KU-610	3.49	**2C40**	**10.99**	3B27	3.49							721B	8.45	865	.49	5687	2.69
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		2C43	**10.99**	3BP1	2.99							723A/B	8.99	869B	30.00	5702WA	3.10
		2C44	1.35	3BP1A	6.35									872A	1.29	5703	1.19
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1N21A	.55	1N26	3.55	
1N21B	.99	1N27	.69	
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1N23A	.49	1N34A	.64	

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RK-60	**1.99**	2E27	.95	3C24	1.50	6AC7W	1.50	203A	5.99	GL-434A	6.66	726A	9.50	884	1.00	5814	1.39
RK-61	**3.50**	2D21	.79	3C28	5.95	6AG7	.79	205B	1.99	446A	1.49	726B	25.00	885	1.10	5851	3.25
RK-65/5D23	14.99	2D21W	1.39	**3C33**	**8.99**	6AJ5	1.19	205D	3.99	446B	1.79	726C	24.50	9-3	.69	5879	1.10
RK-73	.49	2G22	2.29			6AK5	.64	207	49.50	**WL-460**	**8.99**	728AY/BY/CY/DY/FY/GY	35.00	902P1	2.99	5933	2.95
RX-233A	.69	2J21	2.99	3C45	6.25	6AK5W	1.35	211	.72	**WL-464A**	**4.25**	**730A**	**7.95**	918	1.99	5963	1.19
VT25/10	.49	2J21A	4.95	3CP1	2.25	6AN5	2.12	215A	3.25	471A	1.25	800	1.29	927	1.45	5964	.74
VT25A/10Y	.39	2J22	4.99	3C23	4.99	6AR6	1.49	217A	2.99	CK-508AX	1.10	801A	.42	931A	2.99	5977	3.89
VT67/30 Spec.	.26	2J26	2.50	3DP1	1.88	6AS6	1.19	217C	4.99	CK-521AX	1.10	802	2.89	954	.19	6080	2.99
VT-158	17.50	2J27	5.99	3E29	10.25	6AS7/G	2.49	221A	3.99	527	14.50	803	2.69	955	.29	6080W	3.90
VU-111	.19	2J30	14.50	3EP1	1.88	6BM6	39.50	233A	1.19	**WL-530**	**19.50**	804	9.99	956	.25	8002R	18.50
1B32/532A	.99	2J31	14.50	3FP7	2.95	6C4	.49	242C	8.00	WL-531	6.25	805	4.90	957	.33	8005	4.50
QK-59	**29.50**	2J32	13.50	3GP1	3.95	6D4	2.99	249B	2.99	532A	.99	807	1.25	958A	.39	8012	1.85
QK-61	**32.00**	2J33	13.50	3HP7	2.95	6F4	2.99	249C	3.99	700A/B/C/D/E	10.99	807W	3.25	959	1.40	8013	2.50
QK-185	99.00	2J34	13.50	3J21	49.95	6J4	2.50	250TH	24.95	703A	4.99	808	1.79	991	.39	8013A	3.49
VR-78	.89	2J38	14.00	4A-11	.49	6J4W	3.75	250TL	13.95	702A	2.25	809	3.15	CK1005	.46	8020	2.99
VR-90	.89	2J39	11.00	4B36	4.69	**6J6W**	**1.29**	250R	4.99	703A	1.90	810	9.95	CK1006	1.97	8025	1.99
VR-105	.79	2J49	39.50	4C27	8.95	6K4	3.99	253A	3.39	704A	1.59	811	3.19	1500T	94.50	9001	.79
		2J61	16.40	4C28	35.50	6X4W	1.49	259A	5.99					1603	2.99	9002	.69
		2J62	**9.60**	4E27	9.95	7BP1	9.95	264C	3.90					1613	.95	9004	.19
				5AP1	3.95			269A	13.50					1614	1.49	9006	.19

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M359A 15¢ 831AD

115 V. 60 CYCLE BLOWERS:

At left: 115 VAC 60 Cycle SINGLE TYPE — 100 CFM — 2-¾" intake; 2" outlet. Complete size: 5" x 6" — No. 1C939 ..... **$8.95**

115 VAC 60 Cycle DUAL TYPE —100 CFM—4" intake; 2" Dis. Each Side. Complete size: 8" x 6" — No. 1C880 ..... **$13.95**

115 VAC 60 cycle COMPACT TYPE—108 CFM; Motor built inside squirrel cage; 4-½" intake; 3-⅝" x 3" Dis. Complete size 4-½" W x 8-⅝" H x 8-⅛" D—No. 2C067 ..... **$14.95**

115 VAC 60 cycle FLANGE TYPE—140 CFM; 3-½" intake; 2-½" Dis. Complete size: 7-½" W x 7-¼" H x 6-¾" D—No. 1C807..... **$13.95**

115 VAC 60 cycle FLANGE TWIN—275 CFM; 4-¾" intake; 3-¼" x 3" Dis. Complete size: 11-¾" W x 2-¾" H x 8-1/16" D— No. 2C069 ..... **$21.95**

115 VAC 60 Cycle BLOWER 200 CFM; 4" intake; 3" x 5" outlet. Overall size: 8" x 7" x 6". Bodine Motor NSI-33. Removed from New Equipment. #BOD-200 ..... **$14.95**

115—VAC 60 Cycle BLOWER—100 CFM; 3-¾" intake; 2" outlet; Rd. Flange with Flap Director. Overall size with bracket: 8" L x 6-½" W x 7" H. Removed from New Equipment. Diehl Motor FB-2106-6 No. FDBL-2106..... **$6.95**

Same as above, but with 12-Curved Director. No. CDBL-2106 ..... **$7.95**

OTHER BLOWERS:

12/24 VDC—AC CAST ALUMINUM BLOWER—100 CFM—3" intake; 2" outlet. Shunt Motor 4" x 2". 3000 RPM @ 24 VDC..... **$5.95**

6 VDC SINGLE—100 CFM—No. 6100—USED: **$4.95**

24 VDC DUAL—20 CFM—Min—No. 2420..... **$7.95**

10 CFM BLOWER 27.5 VDC:1/100 HP; 7000 RPM; Oster Motor C2BP-1A; L-R Mfg. Co. Bakelite Blower #2—Overall Size: 3½" x 4½". Price **$5.95**

Same as Above, 12 VDC operation — Price **$5.95**

115 V. 400 CYCLE—10 CFM—Eastern Air Devices Motor J31A—7200 RPM. 1/100 HP. L-R #2 Blower Assy. Overall Size: 4-⅛" x 3-½". No. 3110.....**$5.95**

10 CFM BLOWER—28 VDC. 6A; 5000 RPM. Pioneer Motor SS 2345. Aluminum Blower Housing overall Size: 4-½" x 3-¼". Price **$5.95**

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DYNAMOTORS:

INPUT VOLTS:	OUTPUT VOLTS:	MA:	STOCK No.	PRICES USED:	NEW:
12 VDC	220	80	DM-34	$2.95	$4.95
12	625	225	DM-35	9.95	
12	230	90	PE-133	4.95	6.95
12 or 24	540	450	DA-12		14.95
12 or 24	230	100	DA-14		8.95
14	220	70	DM-24	4.95	7.95
14	375	150	BD-83	3.95	4.95
14 VDC	330	150	BD-87	3.95	5.95
14	250	50	DM-25	6.95	8.95
14	1000	350	BD-77	14.95	
24	250	60	PE-86		8.95
28	1000	350	PE-73	8.95	

RECEIVER-TRANS. — FM 20 — 28 MC

BC-603 RECEIVER: 20-28 MC variable tuning. 10 Pre-Set push button channels, squelch circuit, 4" speaker; 10 Tubes: 2/12SG7, 2/6SL7, 1/6V6, 1/6J5, 3/AC7, & 1/6H6. Price..... **USED: $29.95**

PLUG for rear of Receiver..... **$1.00**

DYNAMOTOR: 12 V input; Output 220 V 80 MA. #DM-34 ..... **NEW: $4.95** ..... **ReISSUE: $2.95**

BC-604 TRANSMITTER: 20-28 MC, 30 Watt, companion to BC-603 Receiver. Crystal control, 10 Pre-Set channels, interphone communication; 8 Tubes: 7/1619 & 1/1624 ..... **USED: $18.95**

PLUG for rear of Transmitter..... **$1.00**

DYNAMOTOR: 12 V input; Output 625 VDC 225 MA. #DM-35 ..... **NEW: $12.95** ..... **ReISSUE: $8.95**

FT-237 BASE for mounting Receiver & Transmitter (No plugs required) ..... **USED: $9.95**

BC-500 RECEIVER—TRANSMITTER: FM Crystal Control on 5 channels. 100 KC separation 20-28 MC. Transmitter: 25 Watt output, 7 Tubes: 1/6625, 1/12A6, 3/12SJ7, & 2/12SA7. Receiver: 11 Tubes: 1/12SL7, 2/12A6, 3/12SA7, 3/12H6, 2/12K8, & 1/12SJ7, Dynamotor Supply: Receiver 28 VDC 1.2 A input; output 250 VDC 60 MA. Transmitter 28 VDC 4.1 A input; output 550 V 120 M.A. Control Panel: For Local Control & outlets for Remote also. Heavy duty 5" speaker. Size: 12" x 25" x 9½". With Schematic and Conversion. Weight: 65 lbs. Price..... **New: $59.50**

TELEPHONE EQUIPMENT

EE-8 Field Telephone—Ideal for private telephone system for two or more phones, up to 17 miles, hand ringer generator with handset, carrying case, uses two flashlight batteries.....Used. Checked: **$14.95**
New Equipment. Used Cases: **$18.95**

SOUND POW'D Head & Chest Sets. U: Checked: **$3.95**

TS-9 HANDSETS .....NEW: **$6.95**—USED: **$3.95**

TS-13 HANDSETS w/PL-55 & PL-68..USED: **$5.95**

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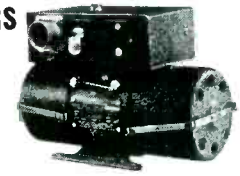


10042-1-A Bendix
DC Input 14 volts; output: 115 volts; 400 cycles. 1-phase; 50 watt **$35.00**

12116-2-A Bendix
Output: 115 VAC; 400 cyc; single phase; 45 amp. Input: 24 VDC, 5 amps. **$35.00**

12117 Bendix
Output: 26 volts; 400 cycles, 6 volt amperes, 1 phase. Input: 24 VDC; 1 amp. **$15.00**

12121 Bendix
Input: 24 volt D.C. 18 amp. 12000 r.p.m. Output: 115 volts, 400 cycle, 3-phase, 250 volt amp, 7 pf. **$49.50**

12123 Bendix
Output: 115 V; 3-phase; 400 cycle; amps .5 Input: 24 VDC; 12 amp. **$49.50**

12126-2-A Bendix
Output: 26 volts; 3 phase; 400 cycle; 10 VA; 6 PF. Input: 27.5 volts DC; 1.25 amps. **$24.50**

12130-3-B Bendix
Output: 125.5 VAC; 1.5 amps. 400 cycles single phase, 141 Va. Input: 20-30 VDC. 18-12 amps. Voltage and frequency regulated **$49.50**

12133 Bendix
Input: 26/29 volt D.C., 28 amps. Output: 115 volt, 3 phase, 400 cycle, 250 volt amp., .8 pf. **$59.00**

12147-1 Pioneer
Output: 115 VAC 400 cycles; single phase. Input: 24-30 VDC; 8 amps. **Price $39.50 each**

778 Bendix
Output: 115 volt 400 cycle; 190 VA; single phase and 26 volt, 400 cycle, 60 VA, single phase. Input: 24 VDC. **$37.50**

10285 Leland
Output: 115 volts AC; 750 VA, 3 phase, 400 cycle, .90 pf and 26 volts. 50 VA single phase, 400 cycle, .40 pf. Input: 27.5 VDC 60 amps. cont. duty, 6000 rpm. Voltage and frequency regulated. **$59.50**

10339 Leland
Output: 115 volts; 190 VA; single phase; 400 cycle, .90 pf. and 26 volts; 60 VA; 400 cycle, .40 pf, Input: 27.5 volts DC, 18 amps cont. duty, voltage and freq. regulated. **$49.50**

10486 Leland
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 pf. Input: 27.5 DC; 12.5 amps; cont. duty. **$70.00**

10563 Leland
Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 pf. Input: 28.5 VDC; 12 amps. **$35.00**

PE109 Leland
Output: 115 VAC, 400 cyc; single phase; 1.53 amp; 8000 rpm. Input: 13.5 VDC; 29 amp. **$50.00**

PE218 Leland
Output: 115 VAC; single phase pf 90; 380/500 cycle; 1500 VA. Input: 25-28 VDC; 92 amps; 8000 rpms; Exc. Volts 27.5 BRAND NEW **$30.00**

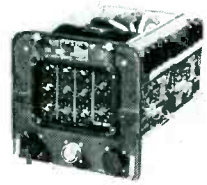
MG149F Holtzer-Cabot
Output: 26 VAC @ 250 VA; 115 V. @ 500 VA; single phase; 400 cycle; Input: 24 VDC @ 36 amps. **$40.00**

MG153 Holtzer-Cabot
Input: 24 VDC; 52 amps. Output: 115 volts —400 cycles, 3-phase, 750 VA. Voltage and frequency regulated. **$95.00**

DMF2506M Continental Electric
24-30 volts input; 5.5-45 amps; cont. duty. Output: 115 volts; .44 amps; 400 cyc; 1 phase; pf 1.0; 50 watts. **$39.50**

940702-1 Eicor, Class "A"
Input: 27.5 volts at 9.2 amps AC Output: 115 volts 400 cycles; 3 phase 100 voltamp; continuous duty **Price $39.50 each**

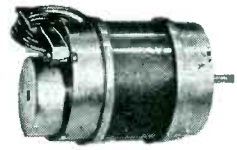
3-AXIS LEAR AUTOPILOT GYRO AND AMPLIFIER



component control type W-2 mfr's part No. 82455

This is the famous autopilot used on the F-86 aircraft. Unit contains two gyros: a vertical and a directional mfgd. by Minneapolis-Honeywell. Unit also contains 5 plug-in Servo amplifiers, with a total of 30 tubes. Unit is in excellent condition, removed from the aircraft. Approximate Government cost $8,000.00. Limited quantity available at **$400.00** each.

SELSYNS-SYNCHROS



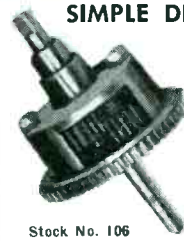
1CT Cont. Trans. 90/55V 60 cy.	$37.50
1DG Diff. Gen. 90/90V 60 cy.	37.50
1F Syn. Mtr. 115/90V 60 cy.	37.50
1G Gen. 115V 60 cy.	37.50
1SF Syn. Mtr. 115/90V 400 cy.	12.50
2J1F1 Gen. 115/57.5V 400 cy.	7.50
2J1F3 Gen. 115/57.5V 400 cy.	10.00
2J1FA1 Gen. 115/57.5V 400 cy.	7.50
57.5/57.5V 400 cy.	5.00
2J1H1 Diff. Gen. 57 5V 400 cy.	7.50
2J5D1 Cont. Trans. 105/55V 60 cy.	17.50
2J5F1 Cont. Trans. 105/55V 60 cy.	17.50
2J5H1 Gen. 115/105V 60 cy.	17.50
2J15M1 Gen. 115/57.5V 400 cy.	17.50
5CT Cont. Trans. 90/55V 60 cy.	34.50
5D Diff. Mtr. 90/90V 60 cy.	34.50
5DG Diff. Gen. 90/90V 60 cy.	34.50
5F Syn. Mtr. 115/90VAC 60 cy.	34.50
5G Syn. Gen. 115/90VAC 60 cy.	34.50
5HCT Cont. Trans. 90/55V 60 cy.	42.50
5SDG Diff. Gen. 90/90V 400 cy.	12.50
6DG Diff. Gen. 90/90V 60 cy.	25.00
6G Syn. Gen. 115/90VAC 60 cy.	34.50
7G Syn. Gen. 115/90VAC 60 cy.	42.50
R110-2A Kearfott Cont. Mtr. 115V 400 cy.	17.50
R200-1-A Kearfott Cont. Trans. 26/11.8V 400 cy.	15.00
R210-1-A Kearfott Trans. 26/11 8V 400 cy.	15.00
R220-T-A Kearfott Receiver 26/11.8V 400 cy.	20.00
R235-1A Kearfott Resolver 26/11 8V 400 cy.	22.50
C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
C78249 Syn. Diff. 115V 60 cy.	5.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 22V 60 cy.	7.50
403 Kollsman Autosyn Mtr. 32V 60 cy.	7.50
FPE-25-11 Diehl Servo Mtr. FPE-25-11 Diehl Servo Mfr. 75/115V 60 cy	22.50
FPE-43-1 Resolver 400 cy.	25.00
FJE-43-9 Resolver 115V 400 cy.	25.00
999-0411 Kollsman 26V 400 cy.	15.00
13770410 Kollsman 26V 400 cy.	10.00
1515B-0410 Kollsman 26V 400 cy.	20.00
10047-2-A Bendix 26V 400 cy.	12.50
2900 Transicoil 115 V 400 cy.	15.00

SIMPLE DIFFERENTIAL

Size: 2-5/32" long x 1¼" dia.; bearing one end ½" O.D.; Shaft Size: 1" long, threads 8-32-¾" long, with bearing shaft ⅛" dia. x ¼" long. Gear on shaft end 1-7/16" dia., gear on bearing end 1¼" dia. Drive gear 25/32" dia.

Stock No. 101 **$3.95 ea.**

SIMPLE DIFFERENTIAL



1:1 reverse ratio, 60 teeth on large gear; ¼" shaft. Size: 3" long with 1-15/16" dia.

Stock No. 106 **$3.95 ea.**

SIMPLE DIFFERENTIAL

size 2-$\frac{3}{32}$" long, 1-$\frac{1}{16}$" diameter, ¼" shaft each end 1-1 reverse ratio 32 teeth on input and output gear price.....**$3.50 each**

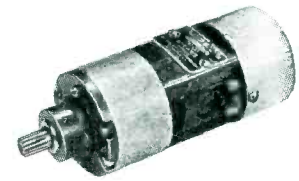
stock no. 149

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. 110 **$7.50 ea.**

SMALL DC MOTORS



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

5069600 Delco PM 27.5 VDC 250 rpm	12.50
5069230 Delco PM 27.5 VDC 145 rpm.	15.00
5068750 Delco 27.5 VDC 160 rpm w/brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069625 Delco 27.5 VDC 120 rpm w/governor	15.00
MM A-11 Globe PM 24 VDC	7.50
5BA10A118 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
806069 Oster series reversible 1/50 h.p. 10,000 rpm 27.5 VDC 1⅝" x 3½"	5.00
C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm	3.00
7100-B-PM Hansen 24 VDC 160 rpm	7.50
SSFD-6-1 Diehl PM 27.5 VDC 10,000 rpm	4.00
6-volt PM Mtr. by Hansen 5,000 rpm 1¼" in dia. 2" long overall	4.00

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New Advertisements

received by Aug. 31st will appear in the October issue subject to limitations of space available.

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TUBES

Special Purpose Tubes

OA2	$ .90	217C	2.00
OB2	.70	218	18.50
OB3/VR90	.95	RX233A	.70
OC3/VR105	.74	244A	15.00
OD3/VR150	.74	249C	2.25
1B22	1.75	250R	5.90
1B23	6.00	250TH	24.00
1B26	3.10	250TL	14.00
1B27	20.00	253	20.00
1B37	7.00	258B	4.50
1B40	2.00	262B	5.50
1B41	50.00	274B	2.00
1B47	7.50	275A	10.00
1B56	30.00	283A	11.00
1B63A	22.00	297A	18.00
1D21	6.00	305A	13.00
1P22	14.00	307A	1.00
1P23	2.25	311A	.40
1P25A	75.00	313CD	5.00
1P30	1.50	324A	3.00
1P40	1.80	336A	5.00
1P41	1.63	339A	7.50
1Y2	6.50	347A	4.90
1Z2	2.75	350B	2.00
2AS15A	6.25	356B	8.50
2B22	1.95	359A	1.60
2C22	.70	371A	.75
2C26	.30	371B	1.50
2C26A	.40	393A	4.50
2C39	6.00	399A	6.00
2C40 **	9.00	400A	2.95
2C43 **	9.00	MX408U	.50
2C44	.50	417A	2.50
2C51	3.80	434A	3.00
2C52	4.00	446	.60
2D21	1.00	446A	.70
2D21W	1.80	446B	1.50
2E26	3.25	464A	2.25
2E36	2.15	471A	1.25
2J21	3.00	CK503AX	.90
2J22	4.30	531	10.00
2J31	12.50	WL532	.95
2J32	12.50	532A	3.75
2J36	34.00	559	.45
2J39	9.00	HY-615	.45
2J47	65.00	627	10.00
2J48	35.00	701A	1.85
2J51	225.00	703A	1.75
2J55	40.00	705A	.68
2J59	59.00	706C	12.00
2J61	15.00	706CY	12.50
2J62	30.00	707A	3.00
2J67	220.00	707B	6.00
2K29	28.85	703A	.70
2K54	15.00	715B	3.00
2K55	15.00	715A	1.50
2X2	.38	717A	.35
2X2A	.85	721A	.65
3A5	.55	721B	11.00
3B21	3.50	722	2.00
3B22	1.45	724A	.75
3B23	3.50	724B	.75
3B24	1.00	725A	3.00
3B24W	5.00	726A	4.50
3B28	3.70	750TL	40.00
3C25	5.00	800	.90
3C31	1.50	801	.45
3C33	7.00	801A	.50
3C45	5.90	802	2.00
3D6/1299	.39	803	1.40
3D21A	6.50	807	1.20
3E29	8.50	811	3.20
4B22	8.50	814	1.50
4B24	6.25	815	1.50
4B28	3.00	816	1.00
4C27	3.50	826	.65
4C28	20.00	827R	110.00
4C35	19.00	829	6.00
4E27	8.50	830B	.50
4J23	200.00	831	.7
4J30	30.00	832	3.50
4J42	30.00	836	1.50
4X150A	29.00	837	.95
4X150G	54.00	838	1.00
5A6	2.25	842	1.85
5C22	34.00	843	.35
5D21	6.50	845	4.00
5J29	7.50	849	75.00
6AC7W	1.20	852	4.00
6AJ5	1.45	861	12.00
6AK5W	1.10	864	.30
6AR6	1.50	865	.75
6AS6	1.20	874	.50
6AS7G	3.88	876	.75
6C4W	5.75	878	.45
6J4	2.50	884	.95
6C21	17.00	885	.95
6J4WA	3.50	899A	2000.00
6J6W	1.25	918	2.15
6SC7GTY	2.25	927	1.60
6SH7L	1.50	929	1.10
6SJ7WGT	6.00	930	1.48
6SL7WGT	1.80	954	.25
6SN7WGT	2.00	955	.40
7F8W	4.30	957	.35
12LGT	.75	58	.35
26A7GT	5.50	CK1005	.30
28D7	1.75	E1148	.63
C1B	1.50	1201	.63
KFG1	2.05	1203A	.07
C5B	1.00	1274	1.00
10	.29	1291	.50
10Y	.31	1294	.81
SCR12	155.00	1615	.50
15E	1.30	1619	.30
15R	.25	1620	4.00
T-20	2.75	1625	.30
RX21	5.00	1626	.25
HK24	5.00	1629	.25
HK24G	2.00	1630	.40
CE25A/B	3.20	1636	.75
RK25	2.25	1638	1.49
30 SPECIAL	.70	1641	4.00
RK34	.65	1642	.40
REL36	3.10	1810P1	5.00
EF50	.80	1960	.50
T55	5.50	1961	1.00
QK59	22.00	5528	23.00
QK60	22.00	5603	5.25
QK61	22.00	5635	10.00
QK62	22.00	5636	4.00
RK62	1.75	5636A	Q
RK65	7.50	5639	8.50
RK73	.75	5641	6.00
FG81A	12.00	5651	1.30
VR92	1.65	5654	1.75
100TH	6.50	5656	7.00
114B	1.25	5670	3.00
149B	.7	5676	1.00
FG154	35.00	5718	3.00
FG166	65.00	5719	3.00
203A	5.50	5744	.90
211	.50	5794	9.00
211D	16.00	5814	1.74
215A	2.90	5814A	2.78

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2A6	.59	7G7	.85
3A5	.39	7H7	.59
3CB6	.75	7W7	1.10
3D6	.68	7Y4	.59
3Q4	.55	7Z4	.55
3Q5GT	.81	10	.75
4A1	.95	12A6	.55
5T4	1.45	12AH7GT	.98
5U4G	.58	12AT6	.49
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5Y3GT	.49	12AU6	.56
5Z3	.69	12AV7	.90
6A3	.95	12AW6	.85
6A4	.97	12AX7	.72
6A6	.88	12B4A	.92
6A7	.89	12BA6	.63
6A8GT	.78	12BA7	.68
6AB7	.95	12BE6	.63
6AC7	.75	12BH7	.83
6AG5	.63	12BY7	.78
6AG7	1.05	12C8	.50
6AK5	.69	12H6	.63
6AK6	.72	12J5GT	.62
6AL5	.53	12J7GT	.86
6AM8	.92	12K8	.69
6AS8	.98	12L6GT	.82
6AU6	.59	12SQ7GT	.67
6B4G	.95	12SA7	.81
6B7	1.05	12SA7GT	.81
6B8	.95	12SC7	.75
6B8G	.67	12SF5	.65
6BC5	.67	12SF5GT	.65
6BF6	.68	12SF7	.73
6BJ6	.63	12SG7	.75
6BZ7	1.12	12SH7	.60
6C4	.88	12SJ7	.53
6C5GT	.61	12SK7	.62
6CD6G	1.68	12SK7GT	.59
6D6	.63	12SL7GT	.66
6D8G	.86	12SQ7	.62
6E5	.75	12SR7	.60
6F5	.45	12SR7GT	.58
6F6	.89	12Z3	.54
6F7	1.18	14A4	.78
6F8G	.48	14A7	.72
6G6G	.89	14Q7	.82
6H6	.49	14R7	.78
6H6GT	.49	14S7	.92
6J5	.48	14W7	.89
6J6	.63	14X7	.79
6J7	.95	19	.75
6J7GT	.78	19BG6G	1.95
6K6GT	.62	19C8	.98
6K7	.55	19J6	.65
6K7G	.45	19T8	.82
6L5G	.85	19V8	1.08
6L6	1.55	24A	.70
6L6G	1.12	25AV5GT	1.12
6L6GA	.98	25AX4GT	1.04
6L7	.95	25L6GT	.63
6L7G	.86	25Z5	.61
6N7	.99	26	.58
6N7GT	.72	27	.54
6P5GT	.72	30	.65
6P7G	1.30	32L7GT	.85
6Q7GT	.68	33	.84
6R7	.78	34	.69
6S4	.60	35	.38
6S7	.98	35L6GT	.63
6SA7	.63	35WA	.43
6SA7GT	.63	35Z3	.56
6SB7Y	.98	35Z4GT	.54
6SD7GT	.98	12Z5GT	.49
6SF5	.73	36	.82
6SF7	.83	37	.50
6SG7	.72	39/44	.05
6SH7	.55	41	.62
6SJ7	.59	45	.48
6SJ7GT	.63	45Z3	.52
6SK7	.54	45Z5GT	.72
6SK7GT	.54	46	.82
6SL7GT	.76	49	.86
6SN7GT	.72	50B5	.68
6SQ7	.54	50C5	.63
6SQ7GT	.54	50L6GT	.67
6SR7	.69	56	.59
6SS7	.78	75	.60
6T8	.75	76	.52
6U8	.85	77	.55
6V6GT	.59	78	.55
6W4GT	.65	84/6Z4	.52
6W6GT	.80	89	.45

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2AP1	$5.75	5CP1	4.00	7BP7	6.50
3AP1	5.00	5CP7	7.00	9GP7	8.50
3EP1	3.00	5FP7	2.58	9LP7	12.50
3HP7	3.50	5HP1A	36.00	902	5.50
5BP1	4.00	5LP1	12.00	902P1	5.00
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1N21	$ .50	1N27	5.00	1N69	.65
1N21B	1.75	1N31	6.48	1N70	.75
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1N23	.50	1N38	.75	CK705	.50

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OA3/VR-75	1.00	4-65A	15.00	VX-33A	5.00	WE-421A	7.00
OA4G	1.00	4B22	6.50	35T	3.00	GL-434A	10.00
OA5	3.75	4B23	5.00	351G	2.00	446A	.40
OB2	.60	4B24	5.00	VX-41	5.00	446B	.85
OB3 VR-90	.75	4B25	7.00	FP-54	35.00	450TH	40.00
OC3/VR-105	.60	4B27	2.25	HK-54	2.00	450TL	40.00
OD3/VR-150	.60	4B31	20.00	T-55	3.00	464A	1.50
EL-C1B/3C31	1.00	4C27	7.50	VX-55	6.00	CK-510AX	.59
1AD4	1.15	4C33	85.00	RK-60/1641	1.25	527	25.00
1AE4	1.00	4C35	17.50	RK-61	2.50	WL-530	20.00
1AF4	2.50	4E27 8001	7.50	HY-65	.75	GL-546	2.00
1AG5	2.00	4J34	25.00	RK-65/5D23	6.50	559	.45
1B22	1.25	4J38	100.00	FG-67	9.00	575A	6.00
1B24	5.00	4J39	100.00	HY-69	2.25	631-P1	5.00
1B35	4.50	4J61	175.00	RK-72	.50	WL-632A	17.50
1B38	25.00	4X100A	12.50	RK-73	.75	WL-652/57	40.00
1B46	1.75	4X150A	20.00	RK-75/307A	.75	WL-655/58	80.00
1B47	5.00	EL-C5B/5C30	1.00	75TL	7.50	WL-681/86	25.00
1D21/SN4	5.00	5AP1	5.00	FG-81A	3.50	WE-701A	2.50
1D85	2.50	5BP1	2.00	FG-95	17.50	703A	1.25
1P22	5.50	5BP1A	5.00	100R	3.50	WE-705A	.70
1P28	7.50	5BP2A	5.00	100TH	5.00	706AY-GY	7.50
1P29 & 30	1.50	5BP4	2.00	100TL	12.50	707B	2.50
1P36 & 37	2.00	5C22	25.00	WE-122A	1.50	WE-714A	7.50
2AP1	4.00	5CP1	2.00	F-123A	5.00	715B	3.00
2AP1A	6.00	5CP1A	7.50	WE-123A	2.50	715C	10.00
2BP1	7.50	5CP7	6.00	F-128A	10.00	717A	.35
2C38	6.50	5CP7A	8.00	VXR-130	1.65	WE-719A	7.50
2C39	3.75	5CP11A	9.50	HK-154	4.00	720AY-EY	35.00
2C39A	10.00	5CP12	10.00	VT-158	10.00	721A	.75
2C40	12.00	5FP7	1.50	FG-166	7.50	721B	7.00
2C42	8.50	5FP14	7.50	FG-172	20.00	723A/B	7.50
2C43	9.00	5GP1	4.00	QK-181	12.50	WE-725A	3.00
2C44	.45	5HP1	2.00	FG-190	7.50	WE-726A	5.00
2C46	5.00	5J23	20.00	HF-200	8.50	WE-726B	20.00
2D21	.75	5J29	10.00	CE-203	3.50	WE-726C	20.00
2D21W	1.00	5J30	10.00	203A	3.50	WE-730A	6.50
2D29	1.00	5J31	15.00	207	50.00	750TL	50.00
2E22	3.00	5J32	7.50	WE-211C	10.00	SA-728B	2.00
2E24	2.50	5JP1	10.00	WE-211D	8.00	801A	.35
2E26	2.85	5JP2	5.00	WL-218	15.00	802	2.00
2J21A	2.50	5JP4	5.00	WE-222A	100.00	GL-803	2.00
2J26	2.50	5JP5A	5.00	232CH	150.00	804	8.50
2J29	10.00	5JP11A	9.50	CE-235A	5.00	805 (RCA)	7.50
2J30	50.00	5LP1	7.50	WE-242C	7.00	807	1.20
2J31-40	10.00	5NP1	2.00	WE-244A	7.50	807W	2.00
2J51	125.00	5R4GY	1.25	WE-245A	7.50	808	1.00
2J52	50.00	5R4WGY	3.50	WE-249B	3.00	809	2.25
2J54	25.00	5X3	2.75	WE-249C	2.50	810 (RCA)	10.00
2J55	35.00	5X3P1	75.00	250R	3.50	811	2.75
2J56	50.00	5Z2P7	50.00	250TH	20.00	811A	3.50
2J61	15.00	5Z4P11	100.00	250TL	12.50	812	2.75
2J62	5.00	EL-C6J	10.00	WE-251A	75.00	813 (RCA)	12.00
2K25	10.00	EL-C6L	5.00	WE-252A	7.50	814	1.25
2K30	100.00	EL-6C/4B25	8.00	WE-253A	2.50	815 (RCA)	1.00
2K33A	50.00	6AC7W	1.00	WE-254A	3.50	816	1.00
2K34	85.00	6AD4	2.50	WE-257A	2.00	826	.50
2K39	100.00	6AK5W	1.00	FG-258A	80.00	SD-828A	6.50
2K41	85.00	6AL5W	.75	WE-262B	5.00	SD-828E	6.50
2K45	30.00	6AN5	1.90	267B	5.00	828	8.50
2K47	75.00	6AR6	1.25	WE-268A	5.00	829	4.00
2K54	5.00	6AR6WA	3.75	FG-271	40.00	829B	8.50
2K55	5.00	6AS6	1.25	WE-271A	7.50	830B	.50
2V3G	1.25	6AS6W	1.75	WE-274B	.90	832	2.50
2X2	.25	6AS7G	3.00	WE-276A	7.50	832A	5.00
2X2A	.90	6BA5	2.50	WE-282A	5.00	833A	30.00
3A4	.50	6C21	15.00	WE-283A	3.50	SD-834	3.75
3A5	.60	6J4	1.75	WE-285A	5.00	834	7.50
3AP1	1.50	6J4WA	2.50	WE-286A	6.00	836	1.25
3AP11A	5.00	6J6W	1.25	287A	2.50	837	1.00
3B21	3.50	6L4	3.50	WE-300B	5.00	838 (RCA)	2.00
WE-3B24	1.00	6SK7W	1.00	304TH	7.50	842	1.50
3B24W	4.85	6SN7W	1.50	304TL	10.00	845	3.50
3B25	3.50	6SK7WA	2.00	307A	.75	845W	7.50
3B26	3.00	6SU7GTY	2.00	WE-310A	4.00	849	17.50
3B27	2.50	6X4WA	2.00	WE-313C	3.00	850	15.00
3B28	4.50	6X5W	1.25	316A	.50	851	7.50
3BP1	1.50	7BP7A	7.50	WE-323A	10.00	860	2.50
EL-3C	5.00	7C24	100.00	323B	6.00	866A	1.15
EL-3CJ	8.50	7CP1	10.00	WE-328A	3.50	866 JR	1.00
3C23	4.50	7EP4	10.00	WE-337A	6.00	869B	50.00
3C24	3.00	7F8W	2.50	WE-339A	7.50	872A (RCA)	2.50
3C33	7.50	7HP7	10.00	WE-347A	3.00	884	.95
3C45	6.50	10KP7	25.00	WE-350A	2.50	885	.95
3D22	7.50	12AP7	50.00	WE-350B	2.00	902A/P1	2.00
3DP1	3.00	12DP7	15.00	WE-352A	15.00	913	17.50
3DP1A	7.50	12GP7	15.00	WE-355A	12.00	SD-917A	3.75
3E29	8.50	FG-17	3.50	WE-356B	3.50	917	1.75
3EP1	2.00	RK-20A	6.75	WE-368A/AS	1.25	918	1.50
3FP7	1.50	TZ-20	1.50	371B	1.50	922	2.00
3FP7A	2.50	RK-23	2.50	WE-388A	1.50	923	1.40
3GP1	2.00	HK-24	3.00	WE-393A	4.50	927	.75
3GP1A	10.00	HK-24G	3.00	394A	3.00	931A	2.50
3HP7	3.00	RK-25	2.25	WE-396A	3.00	SN-947C	6.50
3HP14	2.50	25E6WG	3.00	WE-404A	12.50	SN-947D	8.50
3J21	50.00	FG-27A	12.00	WE-409A	1.25	SN-948B	6.50
3J31	45.00	28D7W	1.50	GL-415	25.00	SN-948D	6.50
3JP12	10.00	FG-32	5.00	WE-417A	12.50	SN-956B	1.00
3K27	150.00	VX-32B	7.50	WL-417A	2.50	958A	.35
						959	1.25
						SN-974B	6.00
						SN-976D	8.50
						991/NE-16	.30
						CK-1005	.25
						CK-1006	2.50
						SN-1006	6.50
						CK-1007	.45
						SN-1007A	6.50
						SN-1007B	8.50
						CK-1009/BA	3.00
						SC-1016C	6.50
						SC-1017C	6.50
						CK-1026	2.90
						SN-1039A	6.50
						SC-1156A	6.50
						1500T	100.00
						1614	1.85
						1619	.30
						1624	1.00
						1625	.30
						1846	50.00
						1945	50.00
						2000T	150.00
						2050	1.00
						ZB-3200	100.00
						R-4330	7.50
						5528	7.50
						5550	25.00
						5551	40.00
						5553	80.00
						5556/PJ-8	6.75
						5557	3.50
						5558	5.00
						5560	17.50
						5610	1.00
						5632	8.50
						5634	6.50
						5637	3.75
						5638	6.50
						5640	8.50
						5642	1.00
						5644	6.50
						5645	6.00
						5650	85.00
						5651	1.35
						5654	1.00
						5656	5.50
						5670	1.45
						5672	1.15
						5676	1.25
						5678	1.00
						5687	2.75
						5691	4.50
						5692	5.00
						5693	4.50
						5696	1.00
						5703	1.00
						5720	15.00
						5725	1.75
						5726	.75
						5727	1.25
						5728	9.00
						5734	12.50
						5740	35.00
						5750	2.50
						5763	1.25
						5771	275.00
						5800	7.50
						5801	5.00
						5803	6.00
						5819	30.00
						5827	5.00
						CK-5829	1.00
						5842	12.50
						5847	12.50
						5915	.75
						5932	3.75
						5933	2.00
						5948/1754	200.00
						5949/1907	50.00
						5962/BS-101	5.00
						5963	1.40
						5979/BS-1	10.00
						5980/BS-2	8.50
						5981/5650	75.00
						5998	7.00
						6098	3.75
						8002R	15.00
						8005	4.75
						8012A	3.50
						8013	2.50
						8013A	3.00
						8020	1.50
						8025	1.00
						8025A	2.00
						9001	.85
						9002	.50
						9003	1.25
						9005	1.40

ALL TUBES ARE NEW, INDIVIDUALLY CARTONED, FULLY GUARANTEED

Prices are F O B shipping point

western engineers
ELK GROVE, CALIFORNIA
GEORGE WHITING, OWNER

Orders for less than ten dollars cannot be processed

"TAB" THAT'S A BUY

New Variable Voltage X-fmrs

SUPERIOR-GR-STACO-UTC	
0-132V-1.25A	$7.23
0-135V/3A	10.63
Cased 0-135V/7.5A	19.55
Uncased/0-135V/7.5A	15.30
Cased/0-270V/3A	22.10
Uncased/0-270V-3A	17.00
Cased/0-135V/15A	39.10
Cased/0-270/9A	39.10
Uncased 0-27V/7.5A	51.64
Cased 0-270V/9A	81.60
Cased 0-270V/12A	107.10
Cased 0-270V/15A	124.95
Cased 0-270V/30A	154.70
GR50B 0-270V/31A/LN	115.00

BUY AS YOU NEED AT FACTORY DISCOUNTS

WRITE FOR NEW RECTIFIER AND POWER SUPPLY CATALOG PR156-B

"TABTRAN" Rectifier Xfmrs

Sec'd Volts (DUAL † 0-9-15-18 & 0-9-15-18 Series Sec'ds 0-3-6-9-12-15-18-21-24-27-30-33-36 Volts

TR5007 1 Amp†	$5.25
TR5008 2 Amp†	6.35
TR5001 5 Amp†	8.65
TR5002 12 Amp†	16.65
TR5003 24 Amp†*	35.65
TR5004 50 Amp†*	59.95
TR5005 100 Amp†*	108.65

18 Volt 2 Amp ..... $1.98; 2 for $3.50
† Wndgs in Series at Ratings shown; Parallel 2X Current; Voltage 0-9-15-18.
* Dual Pri 115 & 220V 60 cy

NEW "TABTRON" SELENIUM RECTIFIERS

ENGINEERED FOR AUTOMATION & INDUSTRY

"Technical Apparatus Builders" mfgrs. Power Rectifiers to your specs. From one amp up to and above 1000 amps, convection or fan cooled, single or 3 phase. "NEMA" & JAN. Specs.

* FULL WAVE BRIDGE ● DATED & ONE YEAR GTD

Max Amp	18VAC* 14VDC	36VAC* 28VDC	45VAC* 42VDC	72VAC* 56VDC	130VAC* 100VDC	226VAC 217VDC	Ctr Tap AC/DC	3 Phase 120VAC	Bridge 240VAC
								150VDC	300VDC
1	$1.40	$2.80	$3.70	54.45	$7.40	$25.00	$2.40	$17.10	$33.25
2	2.00	3.40	5.30	5.85	10.25	29.00	2.70	18.25	45.00
3	2.90	4.10	5.75	7.80	12.70	37.00	3.05	20.00	49.50
4	3.50	6.40	11.25	14.30	25.00	45.00	3.40	21.70	55.75
6	3.95	7.70	12.75	17.25	29.65	59.00	3.70	24.00	59.90
10	5.85	11.35	19.40	24.75	41.25	85.00	5.45	42.40	94.25
12	7.20	14.25	22.00	29.50	43.85	100.00	6.80	48.15	113.50
20	13.00	25.00	37.00	48.00	78.00	161.00	9.15	68.50	164.75
24	15.00	28.50	44.25	57.50	80.65	191.00	11.45	103.35	241.00
30	17.85	34.25	56.25	70.50	108.00	236.00	14.90	135.55	289.00
36	22.35	42.00	64.75	86.50	133.65	296.00	17.20	155.10	368.00
50	29.40	54.00	105.00	115.00	173.00	405.00	27.50	206.85	496.00

RETURN YOUR OLD DUD RECTIFIER—DEDUCT 5% FROM PRICE

FILTER CAPACITORS

CE156M 6000MFD 15V ..... 98c; 2/$1.50; 10/$5
CE502M 2000MFD 50V ..... 50; 10 for $20
CE603M 3000MFD 60V ..... $3.98; 2 for $7

230 to 115 V Autoformers

For 220v/50cy Input. To 110-120V or Step up. † With Cord, Plug & Receptacle.

TPA050/50W.*	$2.55
TPA075/75W.†	3.65
TPA100/100W.†	4.00
TPA200/200W.†	5.75
TPA250/250W.†	6.75
TPA500/500W.†	8.25
TPA750/750W.†	11.79
Model TPA1000 Watts 1 kw.†	16.95

TPA1500/1500W.†.. $22.50; TPA2000/2KW .. $34
*Less Cord, Plug & Receptacle.

Heavy Duty Battery "Fast" Charger Rectifier

13-0-13V (CT) 100 Amp Fan Cooled or 34 Amp Air Cooled. Rep'mt 6V Booster Charger.
Model CR16 ..... $12.00
16-0-16V (CT) Fan Cooled for 12V/60A and 6V/100A Booster Chargers.
Model CR30 ..... $17.20

"TABTRAN" Rectifier Chokes

CR6001/1 Amp/0.1 HY/1.4 Ohm	$3.95
CR6002/2 Amp/0.1 HY/.67 Ohm	5.95
CR6003/5 Amp/.07 HY/.6 Ohm	7.95
CR6004/12 Amp/.01 HY/.1 Ohm	14.95
CR6005/24 Amp/.001 HY/.025 Ohm	29.95
CR6006/50 Amp/.001 HY/.001 Ohm	52.00

High Current Power Supplies

ONE YEAR GUARANTEE

Variable 0-28VDC. Completely Built. Ready to go. Full Wave Selenium Rectifier. Transformer Variac. 4" Volt & Amp Meters. Swith. Terminals & Fuse. Hvy Duty Steel Cabinet Std 115V/60 cy Input or 220V † (3 phase) to order.

Stock NUMBER	Continuous Rating	With Meters
T28V5A*	0-28 WVDC at 5 Amp	$50
T28V5ACC	5 Amp (1 % Ripple)	$85
T28V5A2CC	5 Amp 0.01 % Ripple	$145
T28V12A	0-28 VDC at 12 Amp	$125
T28V12ACC	12 Amp (1 % Ripple)	$160
T28V12ACC	12 Amp 0.01 % Ripple	$220
T28V24A†	0-28 VDC at 24 Amp	$155
T28V24ACC†	24 Amp (1 % Ripple)	$225
T28V24A2CC†	24 Amp 0.01 % Ripple	$310
T28V50A†	0-28 VDC at 50 Amp	$285
T28V50ACC†	50 Amp (1 % Ripple)	$410
T28V100A†	0-28 VDC at 100 Amp	$500
T28V100ACC†	100 Amp (1 % Ripple)	$700

Variable 75 to 135 VDC Completely Built. Ready to go. Includes F. W. Selenium Bridge Rectifier 4" Rectangular Volt & Ammeter. Specify for 115 or 230 VAC 1 phase, 60 cy Input.

T120V5AC	75 to 135 WVDC at 5 Amp	$190
T120V5ACC	5 Amp (1 % Ripple)	$240
T120V10AC	75 to 135 VDC at 10 Amp	$245
T120V10ACC	10 Amp (1 % Ripple)	$295

*2" Meters; All Others 4" Meters

POWER SUPPLIES TO YOUR SPECS. WRITE US YOUR REQUIREMENTS

New Variable 0 to 6 & 12 Volt 12 Amp DC Power Supply

Battery Eliminator Charger Model RR Plater Aircraft Marine or any DC Reg. Extra Hvy. Duty Selenium Rectifier, 2 Meters V. & A. Dsgnd for Cont. Service and up to 20 Amp Intermittent overload. New Model T612V12AC SPECIAL $33.00

Regulated Lab or Hi Fi Power Supply

Uses "SOLA" Constant Voltage Filament & Power Transformer W/Rectifier Tubes, Low Resistance Brute Force Filter. Furnishes 400VDC @ 250MA from Filter System & 5V/6A 3% Regulated & 12 Volts @ 6 Amps Filtered DC for Filaments. Wgt. 45 lbs.

Special @ $39

GENUINE SANDVICK STEEL WOOD SAW. dble cutting edge $15. Reg.@$2.99

WRITE FOR MONTHLY BONUS CATALOG

IN23B Crystal Diode

"TAB" SPECIAL 75¢ ea; 8 FOR $5

IN21 ..... 6 For $1

DE JUR-AMSCO 3" Meter. 0-800MA. 3" Rd. New Reg. $12.50. "TAB" @ $2.95

MICA CONDENSERS

MFD	WVDC	Price
.03	600	45c: 100/$40
.01	1200	35c: 100/$30
.001	1200	20c: 100/$15
.002	1200	35c: 100/$30
.015	2500	95c: 100/$80
.002	2500	45c: 100/$40

MICRO-POSITIONER. Barber-Colman AYLZ3522-S polarized DC relay Dble coil, differential current sens. 50v max for remote control position $3.50
2 for $6

WE BUY, SELL and SWAP AS WELL

BANDPASS FILTER TRANSFORMERS. Sharp cutoff HiQ individually cased & shielded for 60 or 90 or 120 cycle Each $1.95. Set 3 Asstd Freqs. $5

MICROSWITCH

B-1, SPNC, 30 Amp Cased Hvy Duty Industrial Type Incl. Suppressor.

25¢ Ea., lots of 4 Single each 39¢

NEW CONDENSER #BT-14

.012 Mfd/25000 WVDC tubular mica, axial stud terminals ea. end, 13/16" x 1 3/4" Dia $4; 6/$20

HI-FI RECORDING TAPE

Sold on Money Back Guarantee

7" REEL, 1200 FOOT High-est Quality Precision Coated & slit, FERRO-SHEEN processed quality controlled, constant output. Noise Free. Plastic tape. Splice Free. Freq. 7½ I.P.S. 40-15kC. Oxide Wnd In. "TAB" SPECIAL @ $1.59 EA; 3 @ $1.50 EA; 12 FOR $1.45 EA ..... 1000's SOLD

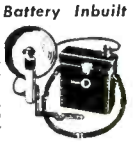
TUBES

"TAB" TESTED INSPECTED GUARANTEED!!!

OA2	$ .74	3C45	7.00	394A	1.85	1201	.75	5819	33.00
OA3	.89	3D21A	2.95	434A	2.75	1612	1.25	5820	45.00
OB2	.64	3D23	5.09	446A	.69	1613	1.00	5829	.99
OB3/VR90	.84	3K23	125.00	446B	1.85	1616	.49	5841	7.98
OC3/VR105	.74	3X2500A	100.00	450TH	65.00	1619	.25	5842	11.00
OD3/VR150	.65	4-65A	16.50	512AX	1.35	1620	3.00	5844	.85
1AD4	1.24	4-125A	19.09	531DX	1.89	1625	.30	5851	3.50
1AG4	1.35	4B23	6.00	536AX	1.55	1626	.15	5879	1.15
1AX2	1.25	4B27	2.50	538DX	.98	1629	.30	5881	2.70
1B3	.65	4C35	15.00	439DX	2.50	1632	.63	5910	.43
1B22	1.25	4J52	50.00	544DX	2.50	1633	.98	5932	3.95
1B24	4.94	4X150A	22.25	571AX	4.45	1642	.50	5965	1.50
1B32	2.94	5C22	29.45	608CX	.97	1644	.99	6080	5.99
1B35	3.49	5D21	7.45	HY615	.46	1680	2.00	6082	4.50
1B46	1.88	5U4G	.45	703A	1.20	1850A	65.00	6099	1.55
1B63A	21.95	6AG5	.45	704A	.74	2050	.98	6146	4.87
1D21	3.49	6AN5	2.61	705A	.74	2050W	2.48	6199	45.00
1LN5	.70	6AS6	1.20	707B	3.95	2051	.68	7193	.25
1Q23	150.00	6AS7G	2.35	710A	1.68	5514	4.69	8005	3.85
1X2A	.60	6BQ6	.90	715A	3.85	5516	5.51	8008	3.50
2C22	.25	6J6	.45	717A	.23	5517	2.10	8012	1.09
2C26	.20	6SN7	.55	721A	72.00	5651	1.40	8013	2.70
2C39A	7.95	6X4	.40	722A	1.05	5654	1.25	8020	2.95
2C40	7.22	6BZ1	79.00	724A	.84	5656	6.00	9025A	2.00
2C43	6.90	12AU7	.50	724B	.80	5663	1.06	9001	.80
2C51	2.85	12AX7	.55	725A	2.00	5670	2.24	9002	.57
2D21	.59	FG17	2.70	726A	4.25	5672	1.55	9003	1.25
2E22	1.89	15BG6	1.35	801A	.42	5686	2.99	9006	.15
2E26	3.25	24G	2.70	807	1.19	5687	3.59	3BP1A	5.55
2E32	.99	HK24	2.70	807W	4.98	5691	4.65	3CP151	5.98
2G21	1.95	REL26	.49	814	2.48	5692	5.00	3DP1	2.75
2J30	15.00	RK34	.24	815	1.90	5693	4.75	3DP1A	6.50
2J42	59.00	35Z5	.45	826	.70	5694	3.70	3EP1	2.40
2K22	14.00	TZ40	3.33	829B	8.49	5697	3.70	3FP7	1.91
2K23	17.50	50L6	.55	832A	5.00	5702	2.50	3FP7A	3.00
2K28	28.00	HY69	5.49	836	1.49	5704	2.25	3GP1	1.91
2K29	29.50	QK15S	250.00	837	1.95	5718	3.00	5BP1	1.95
2K30	100.00	QK202	250.00	864	.34	5719	2.50	5CP1A	9.00
2K33	100.00	203A	3.50	866A	1.25	5727	1.77	5HP1	3.55
2K39	100.00	215	10.35	872A	1.29	5732	2.85	5JP1	14.95
2K41	90.00	233A	2.92	874	.59	5744	1.85	5JP2	5.00
2K42	125.00	250R	10.95	884	1.38	5749	1.49	5LP1	7.00
2K43	118.00	250TH	35.00	885	1.19	5750	3.10	5SP7	50.00
2K48	80.00	304TH	15.00	927	.90	5751	1.45	7BP4A	7.50
2K50	125.00	304TL	15.00	954	.10	5783	4.25	7BP7	4.50
2P23	89.00	316A	.48	955	.34	5787	4.95		
3B24W	5.00	349A	5.00	956	.29	5794	5.99	WRITE FOR FULL LIST	
3C22	75.00	371B	.90	957	.34	5812	1.49		
3C24	3.98	388A	1.15	1005	.35	5814	.79		

NEW "TABLITE" ELECTRONIC PHOTOFLASH KITS

Portable Units—AC & Battery Inbuilt In One Camera Case



Uses new lo cost lo voltage super circuit constant bright light output; light duration 1/600 sec'd; color K 6800°; cost per flash less than ¾ c. 1000 to 2000 flashes per set of batteries. All kits with inbuilt AC pack. (Kits do not include batteries*.)

Model 400B, 60W Sec color 75 +; B&W 225 +. Recycles 2 sec'd, less than 4 lbs. $29.95
Model 600B, 120W Sec, color 100 +; B&W 300 +. Recycles 5 sec'd, less than 5 lbs $44.95
Model 1000B, 240W Sec color 150 +; B&W 450 +, Recycles 10 sec d, less than 6 lbs $54.95
Kits ASSEMBLED, additional ..... @ $10
*Two (2) 240V BATTERIES ..... @ $10
SOLD WITH "TAB" MONEY BACK GUARANTEE

PHOTOFLASH & STROBE LAMPS

"TAB" No.	Replaces	W-Sec Max	Each
TWL	FA 104/FT118	150	$5.98
THL	Amglo 5804X	100	10.98
23ST	GE FT 210	200	9.98
THVA	SYLV. 4330	200	9.98
V4X4	X400	200	10.98
TLX	DX & FA100	150	9.00
TDX	DXC/250-350	150	10.00
353GTQ	FT 503	2000	49.98

TRIGGER COIL TO VOLT FLASH $1.67
COND-525MFD/450VDC/53 ... Watt ... see/da.
NEW low leakage famous mfgr. .58; 2/15; 6/$38
Send 50c for "TAB" Photoflash Data

INFRARED SNOOPERSCOPE

SEE IN DARK TUBE

Selected, GTD & Tested for resolution. 1st class image converter viewing tube. Hi-Sensitivity simplified design 2" dia. Willemite screen. Resolution up to 450 lin/in. Tube & Data "TAB" SPECIAL ..... @ $4.75; 2/$9

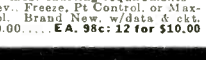
New Snooperscope Power Supply

MODEL PS2001—4500VDC. Using Dual Doubler Circuit, Housed in Metal Cabinet $21.95
KIT, Same as above, Less Cabinet $13.95

NEW HI Q PHONE CW FILTER

USN, Mfgr UTC. Radio, Air, Range, Ship & Ham Hi Q Filter. 3 Positions—Switches 1020 cycle filter for CW in Hi pass circuit cutting out background noise & QRM. For Speech Lo pass with cut off for phone. Or non-band-pass, filter out. Plugs into output jack. Complete ready to operate. Cost $85 @ "TAB" @ $2.98; 4/$10

MERCURY THERMO REGULATOR



DUAL CKT, 105° F. & 32° F. Extremely sensitive & accurate for most exacting requirements—Research, Fire Prev., Freeze, Pt Control, or Max-Min Temp Control. Brand New, w/data & ckt. Regularly over $20.00 ..... EA. 98c; 12 for $10.00

New Diehl Miniature PM Motor

Hi efficiency, ball bearing, type FD6-21, RPM 10,000/27.5VDC, operates on 12 to 27.5VDC. Excel for Models, HR & experimenters. 1" H x 1" W x 2" D. $20 Reg. "TAB" $1.85

PRECISION RESISTORS

1% ACCURACY GTD
SPECIAL 15c EA
10 OF ONE VALUE 10c ea
100 of One Value $8.00
100 Asst'd Values $10.00
WRITE FOR FULL LISTING

HI-MEG HI-VOLT RESISTORS

2 MEG 5W/10KV	89c; 12/$ 9.00
7 MEG "MVP" 10W/10KV	1.00; 12/$10.00
12 MEG 10W/10KV	1.50; 12/$16.00
20 MEG "MVO" 15W/50KV	$2.00; 12/$20.00
60 MEG "MVE" 25W/40KV	$2.50; 12/$25.00
10 MEG "MVP" 10W/10KV	$2.00; 12/$20.00

SELSYNS—SYNCHROS

AY1 & AY5, Autosyn/26V/400CY @ 2/$3.95
2J1H1-Syn Diff/57.5/57.5V/400CY ... @ $5.98
344968-Syn Rptr/115V/60CY ..... @ $12.98
C78248-Syn Trans/115V/60CY ..... @ $8.98

PLANETARY DRIVE

5:1 & 1 to 1 RATIO
Reg. $5.20 ..... "TAB" @ $2
SPECIAL ..... 3 For $5

New Xmitting Mica Condenser

.00015MFD/10,000WVDC, CM75, Ceramic cased, Special ..... $5; 3/$12

PUT HI-FI IN YOUR HOME NOW!

Speakers, Amplifiers, Tuners, Changers and Component Parts—

GET OUR PRICE B-4-U-BUY

NEW G.E. PHONO CARTRIDGES
Original Boxed—Money Back Gtd

RPX050A .001 & .003	$6.75
RPX052A Gold Treasure	19.25
RPX053A Gold Treasure	28.00
RPX040A Single (S) .003	5.08
RPX041A Single (S) .001	5.08

STEVENS ARNOLD DC-AC CHOPPER. 0-500 cps Type CH365 SPDT Coil, DC 26V/800Ω imp 60cy/830 ohm, 400 cy/1100 ohms. Electro-Mech. Vibrator used as Chopper, rectifier, demodulator, sq wave generator. Ideal Servo Applications Reg $20 SPECIAL ..... @ $3; 4 for $10

CIRCUIT BREAKER

Heinmann Magn. Bkrs. Amps: 3, 5, 9, 10, 12, 15, 20 @ $1.85 EACH; 12 FOR $20 ..... 50 FOR $75
Sq. G. & CH. Toggle Sw. Bkrs. Amps: 5, 10, 15, 25, 70 ..... 79c EA
Klixon Therma Push Button Bkrs. Amps: 5, 10, 15, 25, 30, 35 @ 79c ea; 6/$4 ..... 20 FOR $10

THOR 201J ¼" Electric Speed Drill w/Jacobs chuck 2400RPM 115VAC/DC $13.95
THOR 400J ¼" Electric Speed Drill w/Jacobs chuck 650 RPM 115VAC/DC $27.50

THAT'S A BUY "TAB" THAT'S A BUY

Dept. 9E6 111 Liberty St., New York 6, N. Y., U.S.A. PH. RECTOR 2-6245 CABLE: "TABPARTS"

Money Back Guarantee (Cost of Mdse. Only) $5 Min. Order FOB N. Y. C. Add shpg. charges or for COD 25% Dep. Prices Subject to Change Without Notice.

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F. J. Eberle, Business Mgr.

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electronics READER SERVICE CARD

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Here is How to Use the Card!

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For more information on an advertisement, check page number of advertisement in section A on the reader service card (below).

If there is more than one advertisement on the page, the position of the ad will be indicated by letters following the page number. The letters following the page number will indicate the ad's positions: R-Right, RT-Right Top, RB-Right Bottom, L-Left, LT-Left Top, LB-Left Bottom, M-Middle, MT-Middle Top, MB-Middle Bottom (i.e. 230L). Diagrams on back of this page show how to use the key.

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Remember to carefully print your name, title, company and address and check the numbers on the card carefully. Then tear off the reader service card and mail. We are unable to process cards where the name and address is illegible.

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FILL IN NAME, POSITION, COMPANY & ADDRESS HERE

• Please Print Carfully •

SEPT 1956
CARD EXPIRES DEC • 1ST

• electronics • READER SERVICE CARD

Please Print Carefully

NAME POSITION

COMPANY

ADDRESS

FOR ADDITIONAL INFORMATION ON AN ADVERTISEMENT CHECK CORRECT NUMBER IN SECTION A

SECTION A

4	37	62	80	99	121	195	219	241	265	286	310	330	350	374	398	412L	421RB	428T	438LT
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9	39	64	82	101	123	199	221	243	267	288	312	332	352	376	400	413R	422T	429RT	487
11	40	64A	83	102	124	200	222	245	268	289	313	333	353	377	401R	413LT	422B	429LB	488T
13	41	64B	84	103	125	201	223	247	269	290	314L	334T	354	378	401LT	413LB	423RT	429LT	488B
15	42	64C	85	104	126	202	224	248	270	291	314R	334B	355	379	401LB	414T	423LT	430	489
17	43	64D	86	105	127	203	225	249	271	292	315	335	356	380	402	414B	423RM	431T	490T
19	44	65	87	106	128	204	226	250	272	293	316	336	357	381	403	415R	423RB	431B	490B
21	45	66	88	107	129	205	227	251	273	295	317	337	358	382	404	415L	423LB	432T	491
23	46	67	89	108	130	206	228	252	274	297	318	338	359	383	405L	416R	424R	432B	492
25	47	68	90	109	131	207	229	253	275	298	319	339	360	384	405RT	416L	424L	433T	
27	48	69	91	110	132	208	230	254	276	299	320	340	361	385	405RB	417RT	425RT	433B	
29	50	70	92	111	133	209	231	255	277	300	321	341	362	386	406	417RB	425LT	434T	
30	51	71	93	112	134	210	232	256	278	301	322	342T	363	387	407	417L	425RM	434B	
31	52	72	94	113	135	211	233	257	279	302	323	342B	364	388	408L	418T	425RB	435R	
32	53	73	95	114	136	212	234	258	280	303	324	343	365	389	408R	418B	425LB	435L	
32A	54	74	96	115	137	213	235	259	281	304	325	344	366	391	409RT	419T	426T	436	
32B	55	75	96A	116	138	214	236	260	282	305	326L	345	367	393	409LT	419B	426B	437TR	
33	56	76	96B	117	139	215	237	261	283	306	326R	346	368	394	409LB	420T	427R	437TL	
34	57	77	96C	118	140	216	238	262	284T	307	327	347	369	395	409RB	420B	427LT	437RB	
35	60	78	96D	119	191	217	239	263	284B	308	328	348	370	396	410	421RT	427LM	437MB	
36	61	79	97	120	193	218	240	264	285	309	329	349	372	397	411	421LT	427LB	437LB	

NEW PRODUCT INFORMATION? USE SECTION B

SECTION B CHECK FOR NEW PRODUCTS HERE!

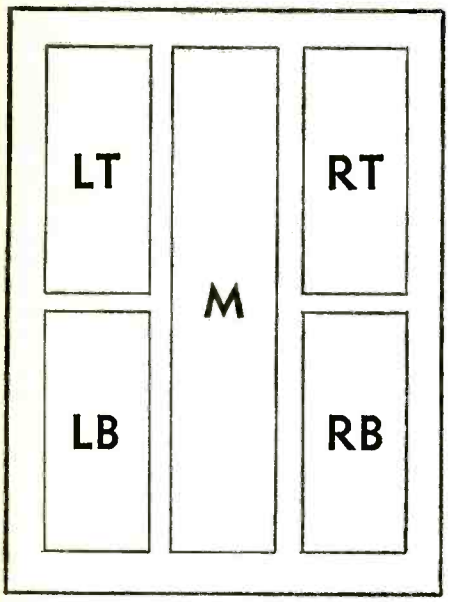
P1	P6	P11	P16	P21	P26	P31	P36	P41	P46	P51	P56	P61	P66	P71	P76	P81	P86	P91	P96
P2	P7	P12	P17	P22	P27	P32	P37	P42	P47	P52	P57	P62	P67	P72	P77	P82	P87	P92	P97
P3	P8	P13	P18	P23	P28	P33	P38	P43	P48	P53	P58	P63	P68	P73	P78	P83	P88	P93	P98
P4	P9	P14	P19	P24	P29	P34	P39	P44	P49	P54	P59	P64	P69	P74	P79	P84	P89	P94	P99
P5	P10	P15	P20	P25	P30	P35	P40	P45	P50	P55	P60	P65	P70	P75	P80	P85	P90	P95	P100

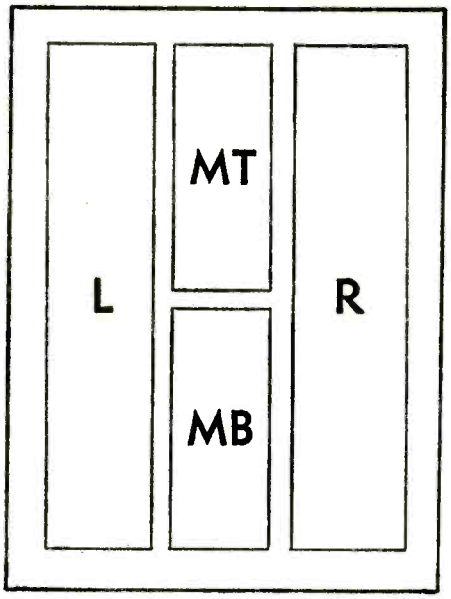
LITERATURE? USE SECTION C

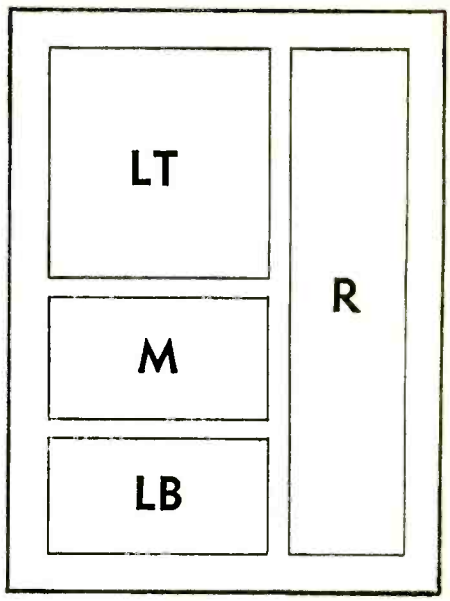
SECTION C CHECK FOR LITERATURE HERE!

L1	L6	L11	L16	L21	L26	L31	L36	L41	L46	L51	L56	L61	L66	L71	L76	L81	L86	L91	L96
L2	L7	L12	L17	L22	L27	L32	L37	L42	L47	L52	L57	L62	L67	L72	L77	L82	L87	L92	L97
L3	L8	L13	L18	L23	L28	L33	L38	L43	L48	L53	L58	L63	L68	L73	L78	L83	L88	L93	L98
L4	L9	L14	L19	L24	L29	L34	L39	L44	L49	L54	L59	L64	L69	L74	L79	L84	L89	L94	L99
L5	L10	L15	L20	L25	L30	L35	L40	L45	L50	L55	L60	L65	L70	L75	L80	L85	L90	L95	L100

DIAGRAMS BELOW SHOW HOW TO USE THE KEY
ON PAGES WITH MORE THAN ONE ADVERTISEMENT







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NEW YORK, N. Y.

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Reader Service Dept.

330 West 42nd Street

New York 36, N. Y.

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USE THIS KEY:

R—RIGHT

RT—Right Top

RB—Right Bottom

L—Left

LT—Left Top

LB—Left Bottom

M—Middle

MT—Middle Top

MB—Middle Bottom

electronics READER SERVICE CARD

FOR ADDITIONAL INFORMATION ON ADVERTISEMENTS, NEW PRODUCTS AND LITERATURE

Here is How to Use the Card!

WANT MORE INFORMATION ON ADVERTISEMENTS?

For more information on an advertisement, check page number of advertisement in section A on the reader service card (below).

If there is more than one advertisement on the page, the position of the ad will be indicated by letters following the page number. The letters following the page number will indicate the ad's positions: R-Right, RT-Right Top, RB-Right Bottom, L-Left, LT-Left Top, LB-Left Bottom, M-Middle, MT-Middle Top, MB-Middle Bottom (i.e. 230L). Diagrams on back of this page show how to use the key.

On pages with no number such as bleed pages, count from last numbered page to find the number. Inserts are numbered using last numbered page plus A, B, etc. If you are not sure of a page number, consult the advertisers index.

WANT MORE INFORMATION ON NEW PRODUCTS?

Each New Product item in ELECTRONICS has a number (P1, P2, etc.) Check the corresponding number in section B of the Reader Service Card (below).

WANT AVAILABLE LITERATURE?

Each Literature item in ELECTRONICS has a number (L1, L2, etc.) Check corresponding number in section C of the Reader Service Card (below).

YOUR ACCURACY ASSURES CORRECT REPLIES

Remember to carefully print your name, title, company and address and check the numbers on the card carefully. Then tear off the reader service card and mail. We are unable to process cards where the name and address is illegible.

See Fractional Page Diagrams on Other Side of This Page!

FILL IN NAME, POSITION, COMPANY & ADDRESS HERE

• Please Print Carefully •

SEPT 1956
CARD EXPIRES DEC • 1ST

• electronics • READER SERVICE CARD

Please Print Carefully

NAME _____ POSITION _____

COMPANY _____

ADDRESS _____

FOR ADDITIONAL INFORMATION ON AN ADVERTISEMENT CHECK CORRECT NUMBER IN SECTION A

SECTION A

4	37	62	80	99	121	195	219	241	265	288	310	330	350	374	398	412L	421RB	426T	438LT
5	38	63	81	100	122	197	220	242	266	287	311	331	351	375	399	412R	421LB	428B	438LB
9	39	64	82	101	123	199	221	243	267	288	312	332	352	376	400	413R	422T	429RT	487
11	40	64A	83	102	124	200	222	245	268	289	313	333	353	377	401R	413LT	422B	429LB	488T
13	41	64B	84	103	125	201	223	247	269	290	314L	334T	354	378	401LT	413LB	423RT	429LT	488B
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P5	P10	P15	P20	P25	P30	P35	P40	P45	P50	P55	P60	P65	P70	P75	P80	P85	P90	P95	P100

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L2	L7	L12	L17	L22	L27	L32	L37	L42	L47	L52	L57	L62	L67	L72	L77	L82	L87	L92	L97
L3	L8	L13	L18	L23	L28	L33	L38	L43	L48	L53	L58	L63	L68	L73	L78	L83	L88	L93	L98
L4	L9	L14	L19	L24	L29	L34	L39	L44	L49	L54	L59	L64	L69	L74	L79	L84	L89	L94	L99
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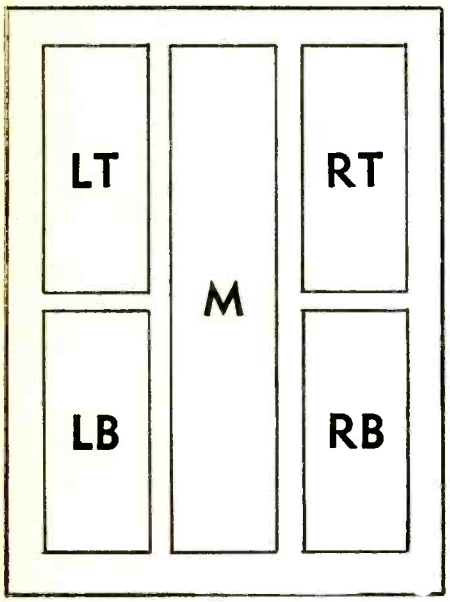
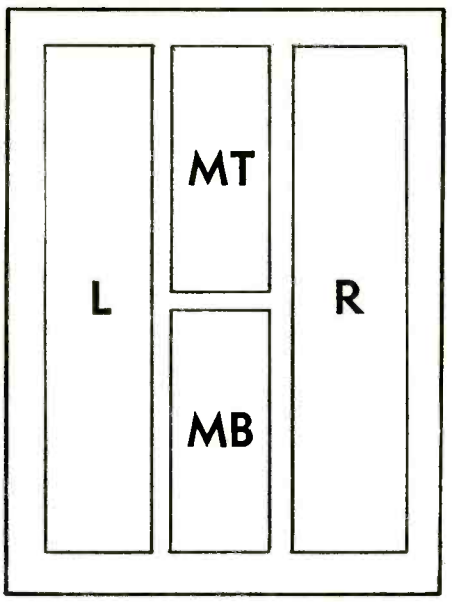
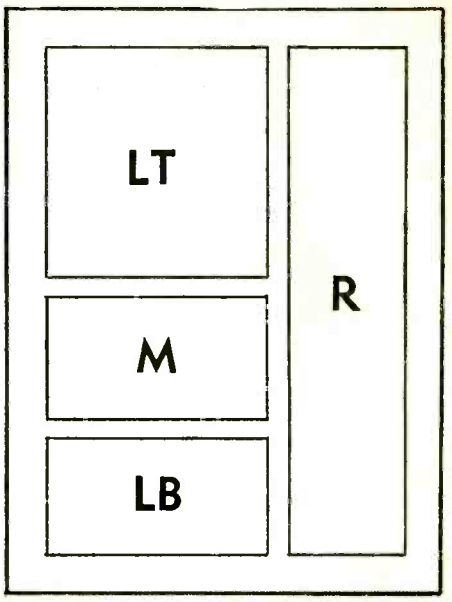
ON PAGES WITH MORE THAN ONE ADVERTISEMENT







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LB—Left Bottom

M—Middle

MT—Middle Top

MB—Middle Bottom

write for

DAVEN'S NEW ENCAPSULATED RESISTOR CATALOG

. . . a 12-page catalog on Daven's complete encapsulated wire wound line

Based on the results of an intensive research development program designed to improve encapsulated wire wound resistor performance, advance miniaturization, and reduce cost, the new DAVEN catalog places vitally important data at the command of the engineer and will prove to be an indispensable reference guide.

Newly developed products, new plastic formulations, new encapsulating techniques, in addition to many, many other design features, are embodied in DAVEN's new line of encapsulated resistors and are presented, in detail, in this new reference catalog.

Briefly, the catalog includes: temperature-sensitive resistors; new products: card-type resistors—miniature DC voltage dividers and DC networks—"toothpick" resistors; miniature resistors; sub-miniature resistors; axial lead types; lug types; MIL-TYPES—in short, all of DAVEN's new contributions to the field of encapsulated resistors.

Write, Today, For Your Copy of this 12-page supplement to **Daven's** Precision Wire Wound Resistor Catalog!

THE DAVEN CO.

530 West Mt. Pleasant Ave.
Livingston, N. J.

TODAY, MORE THAN EVER, THE DAVEN STANDS FOR DEPENDABILITY!

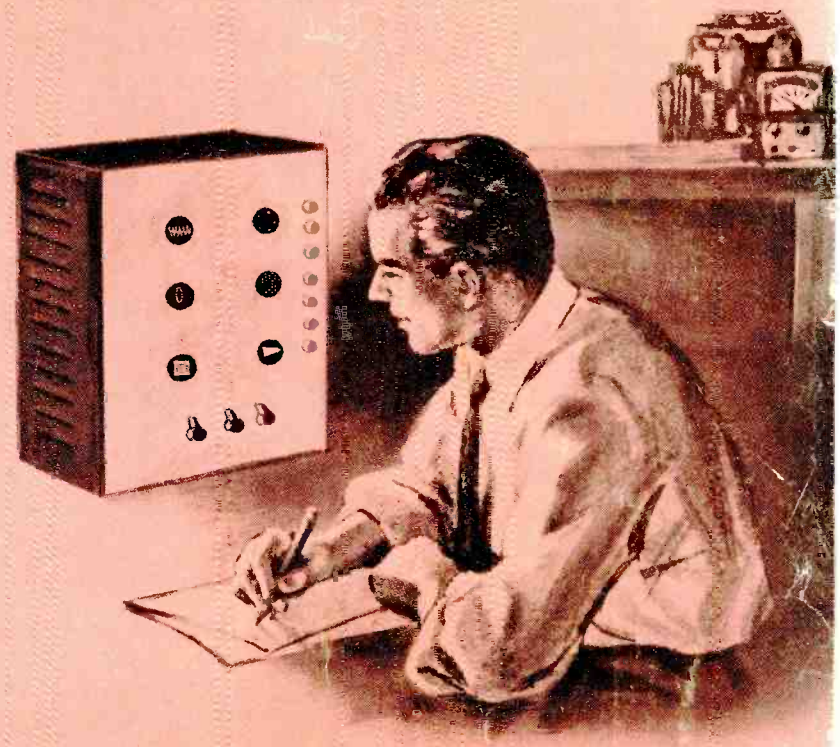
RCA-1EP1...-1EP2...-1EP11

1 1/16"-screen, 2-ounce

OSCILLOGRAPH TUBES

...new additions to the comprehensive line of RCA oscillograph tubes for commercial and military electronics.

The versatile RCA-1E-series affords engineers new opportunities in the design and development of compact airborne electronic equipment, portable test apparatus, and devices for continuous circuit-monitoring. These are but *three of the many* types constantly being added to RCA's broad line of oscillograph tubes. In addition to the new 1EP1, 1EP2, and 1EP11, the following 3" and 5" types have been recently announced to electronic-equipment designers: 3WP1, 3WP2, 3WP11, 5AHP7, 5AHP7-A, 5FP14-A, 5FP15-A.



For sales information on these and the *many* other RCA OSCILLOGRAPH TUBES, contact the RCA DISTRICT OFFICE nearest you:

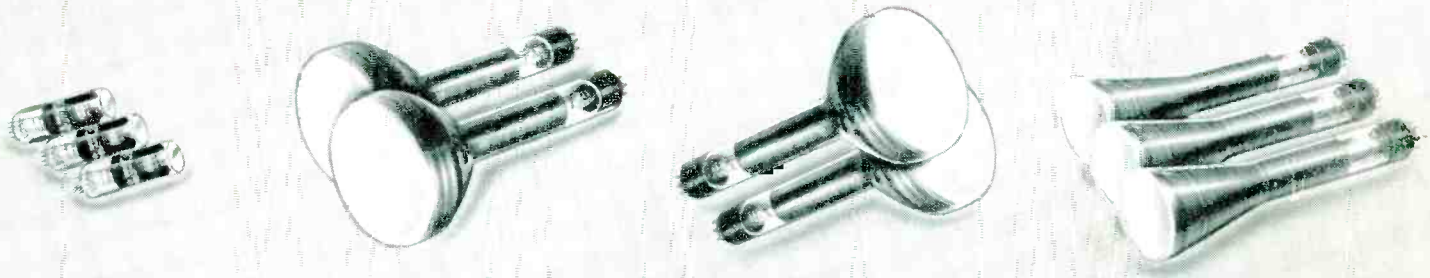
EAST: HUmboldt 5-3900
744 Broad Street
Newark 2, N. J.

MIDWEST: WHitehall 4-2900
Suite 1181, Merchandise Mart Plaza
Chicago 54, Ill.

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

For technical data on Oscillograph Tubes, write RCA, Commercial Engineering, Section 1-19-Q Harrison, N. J.

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



RCA-1EP1, -1EP2, and -1EP11... Medium-, long-, and short-persistence types, respectively, utilizing electrostatic focus and electrostatic deflection. Each has flat face...maximum outside diameter of only 1-1/4" with minimum useful screen diameter of 1-1/16"...maximum overall length of 4-1/16"...weighs only 2 ounces!

RCA-5FP14-A and -5FP15-A... 5FP14-A intended particularly for radar-indicator service and 5FP15-A for photographic recording of electrical phenomena including radar signals—both types feature high-resolution capability. Employing magnetic focus and magnetic deflection each has deflection angle of 53° and minimum useful screen diameter of 4-1/4".

RCA-5AHP7 and -5AHP7-A... For radar-indicator service and general oscillographic applications. Feature low-voltage electrostatic-focus guns to assure good uniformity of focus over entire screen and to permit automatic maintenance of focus with wide range of line-voltage variation and image-brightness adjustment. 5AHP7-A has aluminized screen for increased brightness and improved image contrast.

RCA-3WP1, -3WP2, and -3WP11... Medium-, long-, and short-persistence types, respectively, for oscillographic applications requiring extremely high deflection sensitivity. Each has flat face and minimum useful screen diameter of 2-3/4". Maximum overall length is 11-5/8".