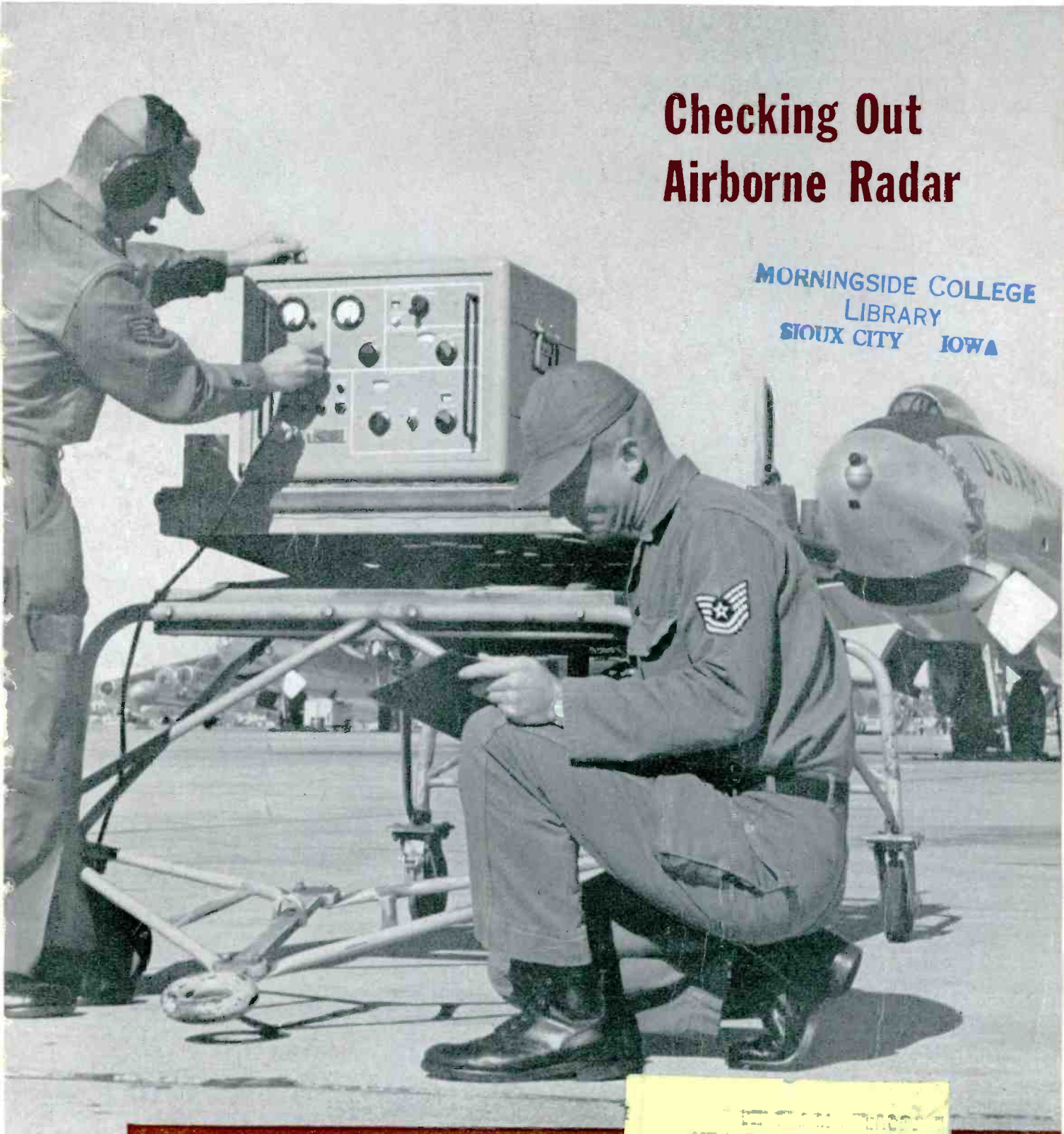
JUNE 5, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 23 PRICE SEVENTY-FIVE CENTS



Checking Out Airborne Radar

What Happens to Its I[illegible] Out?

Creative Microwave Technology

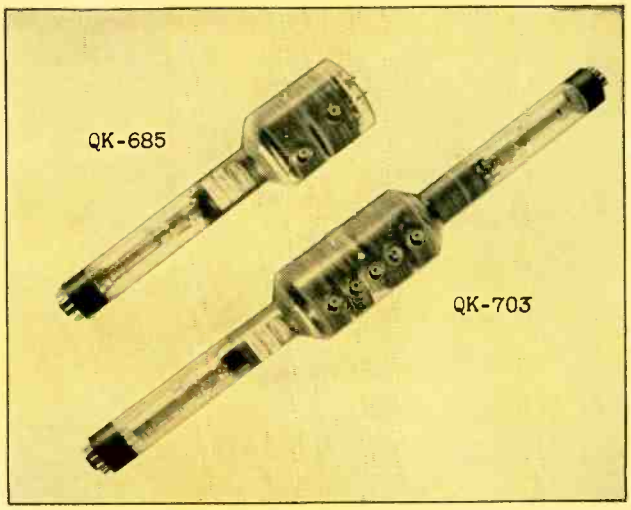
Published by Microwave and Power Tube Division, Raytheon Manufacturing Company, Waltham 54, Mass., Vol. 1, No. 4

NEW KILO-LINE RECORDING STORAGE TUBES SPECIALLY DESIGNED FOR SCAN CONVERSION

To meet the need for low-noise, high-resolution devices for frequency and scan conversion, Raytheon scientists and engineers have developed two new storage tubes: the single-gun QK-685 and the dual-gun QK-703. These tubes are now available in production quantities.

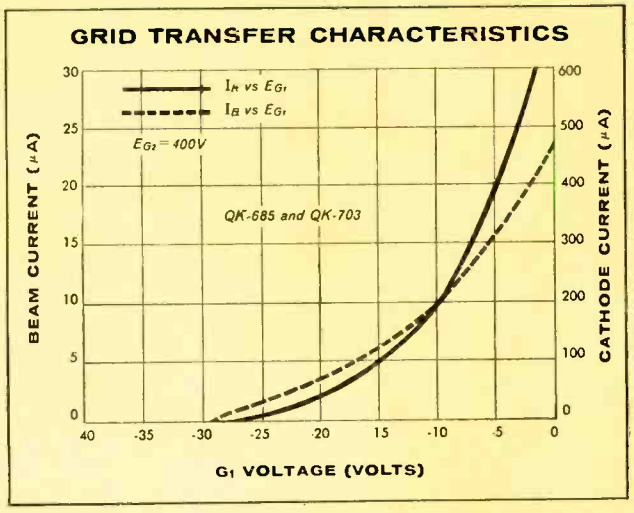
Both types incorporate a specially designed tetrode electron gun for higher resolutions — 1,000 TV lines at 50% modulation — and better control over beam cut-off than conventional triode guns. A new multiple collimating lens improves background uniformity and results in shading-to-signal ratios of less than 10%.

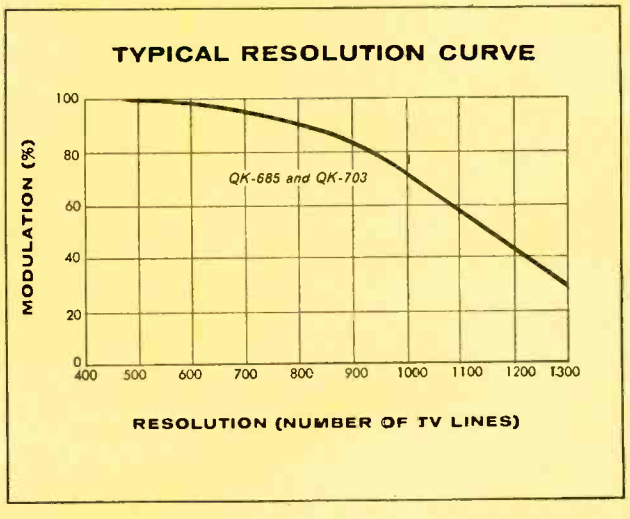
The ability of the dual-gun type to read and write simultaneously makes this tube particularly applicable to slow-down video and conversion from PPI to TV scan patterns for "Bright Display."



Typical Operating Characteristics

	QK-685 and QK-703
Anode Voltage	4,000 Vdc (Max.)
Resolving Power	
Magnetic Focus	1,000 Lines (Nom.)
Electrostatic Focus	700 Lines (Nom.)
Output Capacitance	QK-685—10 μμf (Nom.)
	QK-703—20 μμf (Nom.)
Maximum Deflection Angle	30°





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electronics

JUNE 5, 1959

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A McGRAW-HILL PUBLICATION
Vol. 32 No. 23

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Eliminates servo hunting. Improves dynamic response of feedback systems.

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In a one-turn unit, Linearity to .01%! Sine-Cosine to .025%!

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Typical *field* experience: 30,000,000 revolutions at 500 rpm.

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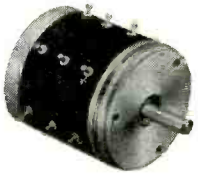
SUPERCON Film Pots are "FAIL-SAFE"; integrity of winding does *not* depend on single hair-like wire.

SUPERCON FILM POTS consist of a non-metallic resistance film permanently bonded to a high temperature plastic base with a precious metal wiper riding on its polished-finish surface. This sturdy one-piece shock, vibration and wear resistant construction has proven superior, during 10 years of field use, to the loose-wire, glued-assembly, wiper-bouncing-from-turn-to-turn construction of wire-wound pots. No longer do you have to compromise the accuracy or reliability of your system by the limitations of wire-wound pots. SUPERCON Film Pots easily meet the requirements of the space age.



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Three voltage ranges:
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(metered)		(unmetered)	
MODEL C-1580M:	0-200 VDC, 0-1500 MA. **580.00**	**MODEL C-1580:**	0-200 VDC, 0-1500 MA. **550.00**
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MODEL C-1582M:	325-525 VDC, 0-1500 MA. **680.00**	**MODEL C-1582:**	325-525 VDC, 0-1500 MA. **650.00**

800 MA MODELS **NEED ONLY 7" OF PANEL HEIGHT!**

(metered)		(unmetered)	
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400 MA MODELS **NEED ONLY 5¼" OF PANEL HEIGHT!**

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C- 400 Series . . . . . Less than 3 ohms.
C- 800 Series . . . . . Less than 1.5 ohms.
C-1500 Series . . . . . Less than 0.75 ohms.

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AC OUTPUT
(unregulated) . . . . . 6.5 VAC (at 115 VAC Input).

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C- 800 Series . . . . . 20 AMP
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electronics

June 5, 1959 Vol. 32, No. 23

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SHOPTALK . . . editorial

REDS AND RED INK. In club cars, hotel suites and board rooms many an inquiry into the state of business is concluded with the remark, "What would our firm do without the government?" A fitting observation these days when military electronics accounts for more than half our industry's factory-door sales.

You can bet the Russians are just as aware of how dependent our economy is on military spending. And there is a 50-50 chance the next Soviet offensive will be an economic one, replete with dulcet tones to lull us into complacency. This offensive would have a double-barreled effect: to denude our national defenses and to wreak economic havoc at home.

New York financial expert Casper Bower is one man who thinks this Communist economic threat is a real and present one. And he faces up to the unpleasant truth that such a Red peace offensive could splash deep red ink on the ledgers of many U.S. electronics firms heavily engaged in military work. There are lots of other complications, too. Read about it as one industry expert speaks his mind in our story "What If Peace Breaks Out?" on p 32.

MARKET RESEARCH. Our Market Research department, which appears on p 24, is prepared weekly by Ed DeJongh, who heads up ELECTRONICS' Market Research staff. DeJongh has an MBA from Harvard's Graduate School of Business, is a graduate of Oberlin College. He is ably assisted by Marilyn Koren, a Syracuse graduate who received her Master's from the University of Minnesota.

The market research department collects and develops market data about the electronics industry, not only for our editorial columns but also for this magazine's internal planning and guidance.

This wealth of hard-to-come-by marketing facts about our industry is likewise available to ELECTRONICS' friends in industry.

Coming In Our June 12 Issue . . .

COOLING FIN DESIGN. Since the advent of semiconductor devices, electronic circuit designers have become more concerned than ever with heat dissipation in circuit components. Temperature dependence of semiconductor devices is well known, and this has resulted in new burdens on the designer to create and maintain the proper environment within his equipment package.

Happily, as often emphasized in ELECTRONICS, graphical methods can illuminate areas where engineers ordinarily fear to tread. W. Luft, a Product Analyst Engineer with the International Rectifier Corp., has assembled a useful and pertinent article which utilizes charts, graphs, and nomograms for designing cooling fins for such devices as power transistors, power diodes, zener diodes, others.

STATIC PRESS CONTROL. Static control devices for machine tools are becoming commonplace in industrial plants. However, incorporation of static switching for the control of a press presents problems of safety not ordinarily present in other machine tools. Reliability of the control circuits must be unusually high.

S. A. Zarleng, Development Engineer for the Clark Controller Co. in Cleveland, has devised an anti-repeat control for a press which makes it impossible for the operator to work the ram while his hands are in the danger zone. Furthermore, the operator cannot bypass any of the safety restrictions. The control is built around a *pnp* transistor, a pulse transformer consisting of three windings on a small toroidal core, and two specially-designed magnetic amplifiers.

SPRAGUE® RELIABILITY in these two dependable wirewound resistors

MINIATURE

Blue Jacket®

VITREOUS-ENAMEL POWER RESISTORS

Sprague's new improved construction gives even greater reliability and higher wattage ratings to famous Blue Jacket miniature axial lead resistors.

A look at the small *actual sizes* illustrated, emphasizes how ideal they are for use in miniature electronic equipment with either conventional wiring or printed wiring boards.

Get complete data on these dependable minified resistors, **write for Engineering Bulletin 7410.**

TAB-TYPE BLUE JACKETS: For industrial applications, a wide selection of wattage ratings from 5 to 218 watts are available in Sprague's famous Tab-Type Blue Jacket close-tolerance, power-type wirewound resistors. Ideal for use in radio transmitters, electronic and industrial equipment, etc. **For complete data, send for Engineering Bulletin 7400A.**

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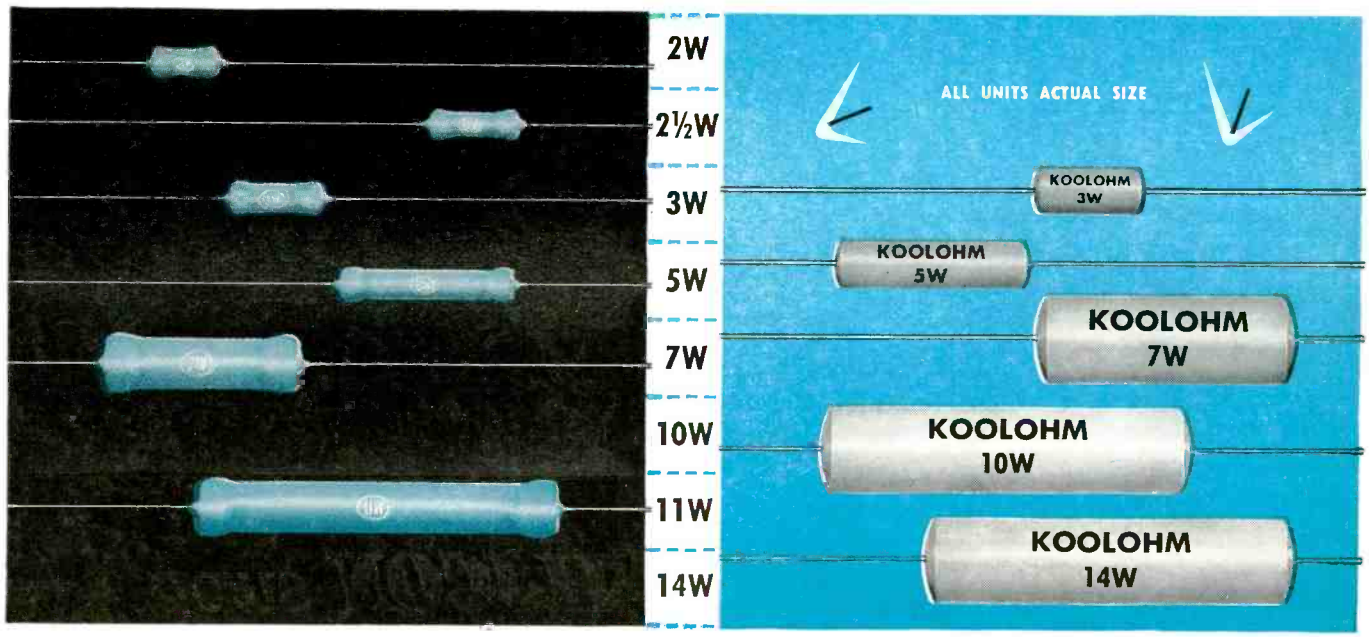
KOOLOHM®

INSULATED-SHELL POWER RESISTORS

New Koolohm construction features include welded leads and winding terminations—Ceron ceramic-insulated resistance wire, wound on special ceramic core—multi-layer non-inductive windings or high resistance value conventional windings—sealed, insulated, non-porous ceramic outer shells—*aged-on-load* to stabilize resistance value.

You can depend upon them to carry maximum rated load for any given physical size.

Send for Engineering Bulletin 7300 for complete technical data.



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a new concept in ***SILICON*** *supply!*

Right off the bat you start doing things the way they *should* be done.

You pick *men* who know — a top-flight manager from the process field, and a well-versed gentleman from the semiconductor field. Then add experienced semiconductor men who understand the device manufacturer's problems. That's your management group.

Next provide a plant. Select a site where conditions are particularly favorable — as they are near the Allegheny National Forest.

Then, devote your efforts *exclusively* to the production of ultra-pure silicon in every form.

This . . . is Allegheny Electronic Chemicals Co. And this is for you — a *new* concept in silicon supply, a new service for the semiconductor industry.

Your inquiries are invited. Write to Allegheny Electronic Chemicals Co., 207 Hooker-Fulton Bldg., Bradford, Pennsylvania, or 252 North Lemon St., Anaheim, California.

Silicon polycrystalline bulk, cast billets and rods, single crystals, slices, seeds and dope.

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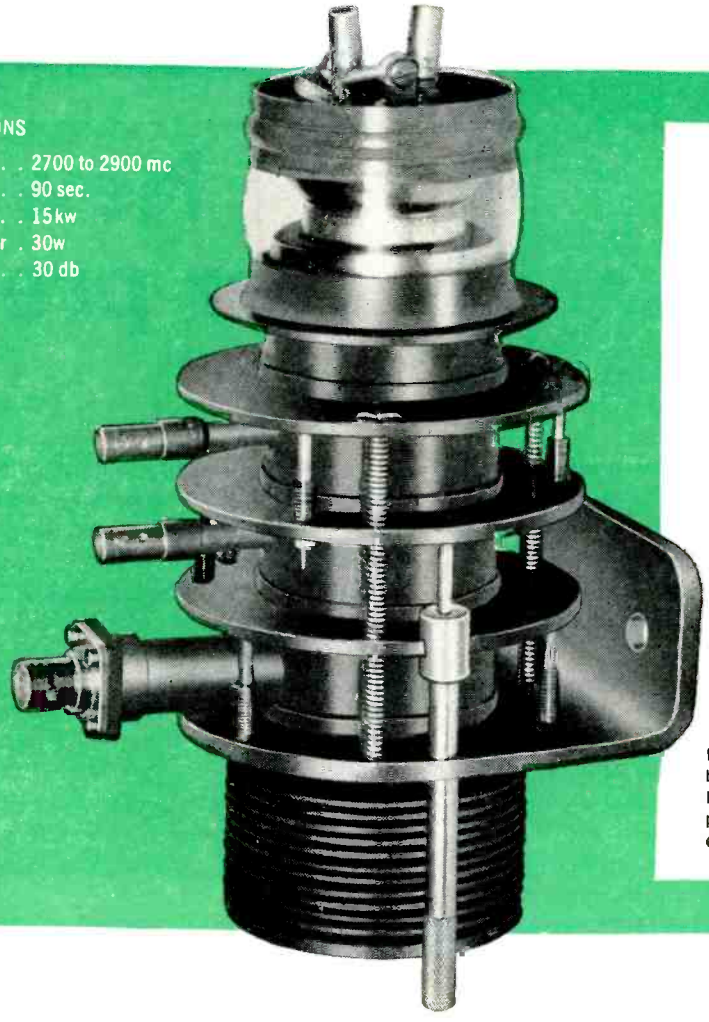
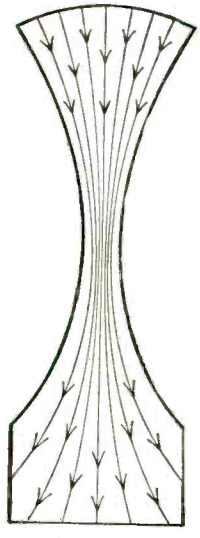
15kw S-Band Amplifier Klystron has **no heavy magnets**

Exclusive Space-Charge Focus cuts weight to only 6½ lbs.

SAS-61 SPECIFICATIONS

Frequency Range . . . . 2700 to 2900 mc
Heating Time . . . . . 90 sec.
Peak Power Output . . . 15kw
Maximum Drive Power . 30w
Power Gain . . . . . 30 db





New Space Charge Focus principle of beam control is shown in diagram. New Sperry tube design utilizing this principle reduces size, weight, power consumption and cooling needs.

AVAILABLE FOR IMMEDIATE DELIVERY. Sperry's new S-band transmitting tube is a 3-cavity pulse amplifier of high gain and extra-long service life.

EXCLUSIVE SPERRY SPACE-CHARGE FOCUSING design eliminates heavy, cumbersome magnetic structures — a feature of prime importance in equipment design. Although the SAS-61 weighs only 6½ lbs., its sturdy construction withstands extreme vibration and environmental conditions.

MAIN APPLICATIONS for the SAS-61 are as an output tube in low-power radars, or as a driver for higher-powered klystrons in radar and linear accelerator systems. Its unusually long service life, however, makes it highly desirable for any application requiring 15 kw in the S-band. The SAS-61 with its internal tunable cavities is a *complete* microwave unit. No external equipment is required.

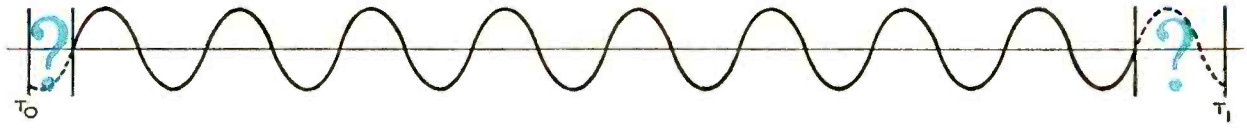
SPERRY CAN DELIVER SAS-61 tubes in quantity at once. Write or phone your nearest Sperry district office.

SPERRY

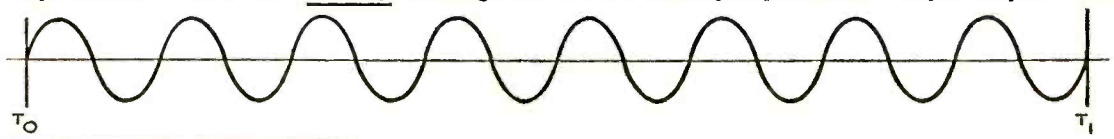
ELECTRONIC TUBE DIVISION, *SPERRY GYROSCOPE COMPANY, GREAT NECK, NEW YORK, DIVISION OF SPERRY RAND CORPORATION*
Address all inquiries to Great Neck or Sperry offices in Brooklyn, Boston, Philadelphia, Los Angeles and Montreal. Export Dept., Great Neck, New York

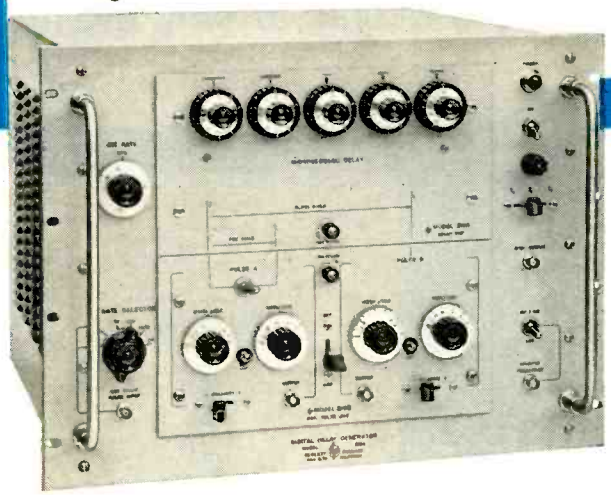
± 1 COUNT AMBIGUITY ELIMINATED!

OLD WAY X counts ± 1 count due to unknown phase at start and stop.



NEW -*hp*- 218A X counts *exactly*—timing wave starts with sync pulse and only full cycles counted!





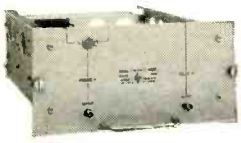
New ease, for precision

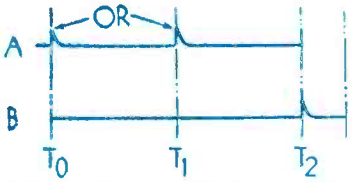
Time measurement and pulse simulation in radar, loran, Tacan, DME, oscilloscopes, computers, fast gates, pulse code systems —almost any fast circuit double pulse measurement with any kind of delay may now be made quickly and accurately with the new -*hp*- 218A Digital Delay Generator.

Constructed along rigid military standards, the -*hp*- 218A is basically a pulsed crystal oscillator synchronizable *in constant phase* with an initial trigger pulse (zero time) and two positionable terminating pulses. Time is counted with a 1 MC preset counter, and two independent output pulses (T_1 and T_2) are available in any relationship. For utmost present and future versatility, output pulses are generated through -*hp*- 219A series plug-in units.

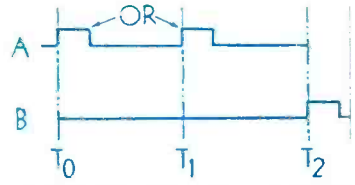
Model 218A is a direct slave to an external trigger, 0 cps to 10 KC, or may be triggered internally over a 10 cps to 10 KC range. A push-button manual trigger is also provided. The two delay pulses are *separately and digitally adjustable* from 1 to 10,000 μsec with interpolation 0 to 1 μsec. Timing accuracy is ± 0.1 μsec ± 0.001%; time interval and pulse characteristics are directly selected on front panel controls.

Brief specifications appear alongside; for complete details see your -*hp*- representative or write direct. Also request -*hp*- Journal, Vol. 9, No. 8.





-*hp*- 219A Dual Trigger Unit contains two blocking oscillators supplying positive polarity trigger pulses to control auxiliary equipment. Pulse A available at T_0 or T_1; pulse B at T_2. Pulse characteristics identical to sync output pulse of -*hp*- 218A. (See "Specifications") $100.00.



-*hp*- 219B Dual Pulse Unit contains two pulse generators providing digitally delayed, fast rise time, high power pulses. Positive or negative polarity, amplitude variable 0 to 50 v, pulse width variable 0.2 to 5 μsec, rise time 0.06 μsec. Pulse A available at T_0 to T_1, pulse B at T_2. Internal impedance is 50 ohms. $450.00.

hp offers the world's most complete

This new -hp- 218A Digital Delay Generator produces pulses accurately spaced in time, with spacing controlled by a crystal oscillator. The 218A is a perfect slave to any beginning or synchronizing pulse, even though random, and locks in constant phase during each counting period.

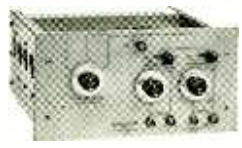
speed and 0.1 μsec accuracy time measurements

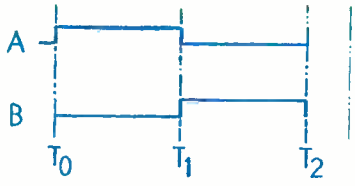
SPECIFICATIONS

-*hp*- 218A DIGITAL DELAY GENERATOR
(Plug-in necessary to operate)

Time Interval Range: 1 to 10,000 μsec, T_0 to T_1 and T_1 to T_2. Accuracy: ± 0.1 μsec ± 0.001% of time interval selected.
Digital Adjustment: 1 μsec steps, 1 to 10,000 μsec.
Interpolation: Continuously variable, 0 to 1 μsec.
Input Trigger: *Internal*, 10 cps to 10 KC, 3 decade ranges. *External*, 0 to 10 KC. Pos. or neg. pulses 2 to 40 v peak. Delay between external trigger and T_0 is 0.25 μsec ± 0.05 μsec.
Jitter: 0.02 μsec or less.
Recovery Time: 50 μsec or 10% of selected interval, whichever is larger.
Sync Output: 50 v pos. pulse, 0.1 μsec rise time (from 50 ohm source). Available at T_0, T_1 or T_2.
1 MC Output: 2 volt 1 MC pulses (from 500 ohm source) available at panel connector when counting on internal 1 MC oscillator.
Power: 115/230 v ± 10%, 50/60 cps, 525 watts.
Size: 14" high, 19" wide, 24" deep. Weight 75 lbs.
Price: -*hp*- 218A (cabinet) or -*hp*- 218AR (rack mount), $2,000.00.

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





-*hp*- **219C Digital Pulse Duration Unit** produces a high power pulse with digitally controlled delay and duration. Pulse duration either T_0 to T_1, or T_1 to T_2. Both polarities available simultaneously; amplitude variable 0 to 20 v (from 90 ohms impedance) or 100 v (from 500 ohms). Rise or decay time 0.03 μsec (90 ohms). $350.00.

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Cable "HEWPACK" • DAvenport 5-4451
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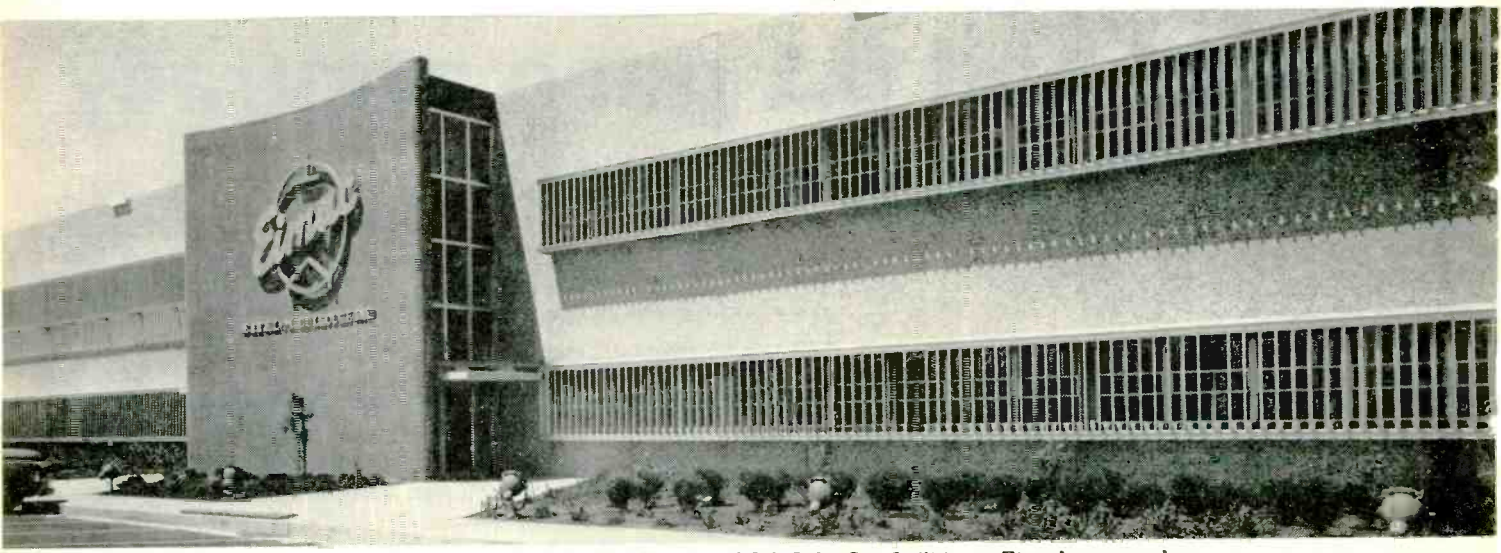
selection of precision electronic counters

EIMAC TUBES
NOW IN PRODUCTION
IN AMERICA'S NEWEST, MOST MODERN TUBE PLANT

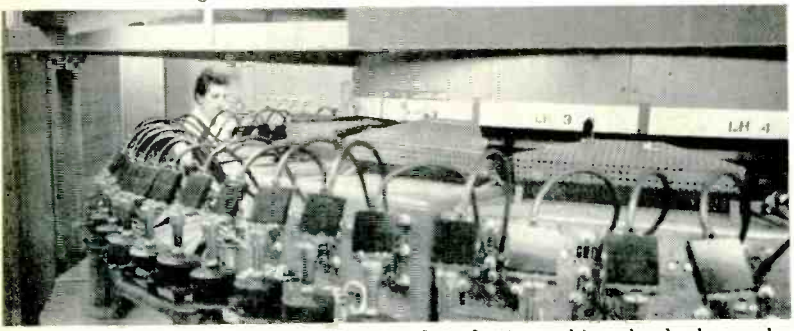
In San Carlos, California, Eimac's third and largest plant is nearing full production to meet the great demand for many popular Eimac electron tube families. Never before have so many advanced techniques and processes been applied to vacuum tube manufacture. Eimac's leadership in new processing methods has brought a new era of quality to electron tubes.

Ready for shipment, these Eimac ceramic tetrodes are just one of more than a hundred different tube types manufactured by Eitel-McCullough, Inc., including negative grid tubes, power amplifier klystrons, reflex klystrons and traveling wave tubes.



Eimac, San Carlos, greatly increasing production capacity, joins San Bruno and Salt Lake City facilities as Eimac's newest plant.

Final tube assembly in near-sterile "clean rooms" assures exceptional tube reliability. These rooms are pressurized with filtered, conditioned air to prevent the tiniest dust particles from entering. Even shoes are automatically vacuum cleaned as personnel enter the room through double-door air locks.



Eimac designed rotary vacuum pumps speed production, achieve hard, clean tube vacuums. Pumping Eimac tubes at high voltages and ambient temperatures assures long life and reliability. These giant rotary pumps are typical of production equipment custom designed by Eimac for transmitting tube manufacture.

Every tube meets rigid Eimac specifications before shipment. On test consoles like this, dozens of electrical characteristics are patiently tested and recorded for each Eimac tube produced. Environmental testing equipment is also available for testing for severe applications.

Eimac

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

ELECTRONICS NEWSLETTER

MICROWAVE POWER IN SPACE for uses other than for radar and communications—such as propulsion—is quietly getting military study and support. USAF is studying a Raytheon proposal for platforms in the stratosphere that would derive propulsion power from microwave energy transmitted from the ground in narrow beams (ELECTRONICS, p 11, May 29). Now comes word that Varo Mfg. Co., Garland, Tex., with contract commitments believed to be in excess of $5 million, has set up a microwave power laboratory division to "exploit many neglected concepts and applications of very high microwave power outside the radar and communications fields." The firm, which has built precision static power conversion equipment for missiles and aircraft, could give no further details of the new program. But Varo says it has completed negotiations with Carrier Corp.'s Elliott Co. division for subcontract work.

Electronic countermeasures spending by the Air Force may be on the wane, with $127.1 million requested for ecm in the 1960 budget compared to $196.5 million for 1959. USAF also hopes to buy 1,232 missiles in '60, which is 230 less than in '59.

RADIOTELESCOPE FOR MILITARY USE is being built by the Navy near Sugar Grove, W. Va. The 600-ft, $79-million facility was first touted as "one of the foremost scientific tools available." Then Congressmen demanded to know why the radiotelescope was being built only 30 mi from a smaller National Science Foundation telescope. Now the Navy reveals the equipment "is primarily intended to handle Navy problems, which are not following stars through the sky." Defense officials say the new unit may be used for basic space research only 10 percent of the time. The radiotelescope will have a reach of 38 billion light years, 19 times as far as the reach of the Mt. Palomar, Calif., telescope. Although the Navy doesn't say what the facility's main military research uses will be, it does admit the station will be able to bounce radio signals off the moon and manmade satellites for communication, navigation and tracking. U. S. Steel's American Bridge division has a $19.3-million subcontract to build the 600-ft dish and supporting structure.

TRANSISTOR DIODE POWER LEVELS will go 10 to 100 times higher than related transistors with comparable frequencies and efficiencies in two to three years. Prediction comes from William Shockley, a co-inventor of the transistor and president of Shockley Transistor Corp., a subsidiary of Beckman Instruments. He said space and cost economies will mean wider use of the diodes in many types of electronic circuitry.

DEW-LINE EXTENSION called DEW-East, which will run 1,200 mi east of the Canadian terminal on Baffin Island to Iceland, will get under construction soon. Greenland survey has just been completed for Western Electric by Page Communications Engineers, confirming suitable locations for radar and communications stations previously selected by the Air Force. WE manages the communications and electronic phases of DEW-East, including engineering, procurement, logistical support, installation and testing.

CONTROL OF 50 MACHINE TOOLS at once by one machine is just reported by the Soviets. It uses fewer tubes, has faster speed than control machines shown at the Brussels Fair last year. Another machine, for automatic control of electric-arc furnace processes, uses transistors. It now operates on an experimental basis at the Elektrostal works near Moscow. Soviets say the machine can also be used for control of blast and open hearth furnaces.

MIDAIR COLLISION AVOIDANCE SYSTEM that uses passive airborne detection and ranging will be flight tested for the Federal Aviation Agency under a $28,000 award to Fairchild Astrionics, the developer. The system, known as PADAR, is said to permit a pilot to detect aircraft without transmitting a signal, to determine its range and to assess collision danger. System does this by receiving direct and reflected electromagnetic waves from a transmitter in the nearby plane. Time difference between the two signals combined with known altitude provides range and rate of closure.

SEARCH SONAR for use against submarines by destroyer leader class ships is being developed by GE's heavy military electronics department under a $2-million Navy contract. The new sonar, designated AN/SQS-26, incorporates new and improved techniques including advanced signal processing and detection methods.

Atomic space clock operating with cesium vapor, one of three types under study for possible tests of Einstein's theory of relativity, is being developed by MIT under a $50,000 NASA contract.

ANTIJAM SHIPBOARD COMMUNICATIONS gear using transistors will be produced by Westinghouse under a $7-million Navy follow-on contract. The transmitters, resembling six-foot-high file cabinets, are designed for ships and subs.

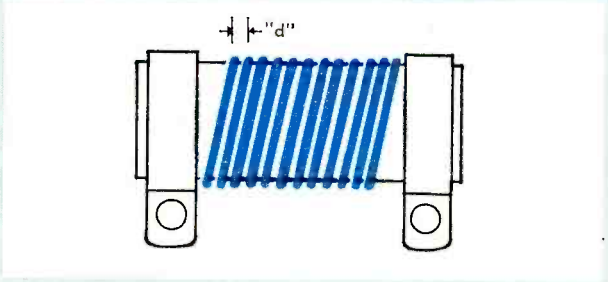
CENTRAL AIR DATA SYSTEM for the Air Force B-70 intercontinental bomber will be developed and manufactured by the Garrett Corp.'s AiResearch manufacturing division, Los Angeles. Same firm last year won a contract for a similar system for the F-108 interceptor.

IRC INFORMATION FILE

What everyone should know about Power Wire Wound Resistors

Since power wire wound resistors are essential elements of many circuits an explanation of their behavior and performance may be found helpful.

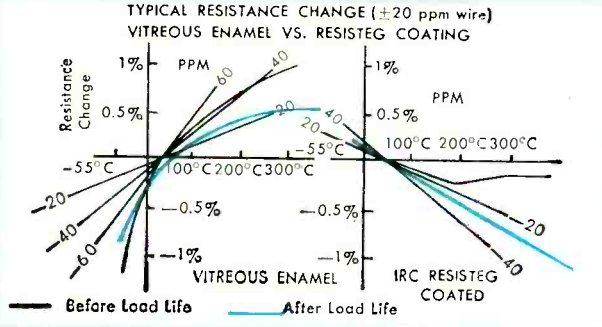
There are two basic types of power wire wound resistors: 1.) vitreous enamel coated and 2.) cement coated. These types differ externally but it is with internal differences affected by the choice of coating that you should be most concerned.



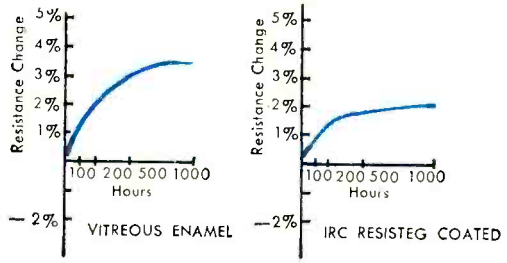
1 For example, in the illustration above, MIL-R-26C permits a pitch "d" of as much as 5 x wire diameter. The maximum is desirable with a vitreous enamel coating because at the high (1200°F. or more) curing temperature the turns tend to loosen and move toward each other. The result may be either an actual short or an imminent one, prevented only by the oxide film on the wire. High voltages could easily pierce and short or arc-over the turns.

The low temperature (205°F. or less) at which the IRC Resisteg Coating is cured permits a minimum "d" in IRC Power Wire Wound Resistors of 1.8 x wire diameter and a maximum of 2.8 x wire diameter, assuring the use of the largest wire diameter and the maximum number of turns on any given size of core.

The use of fine wire, required with many vitreous enamel resistors—to allow sufficient spacing—does not provide a margin of safety for mechanical abuse, and taxes reliability. Fine wire cannot withstand surges such as are common in aircraft applications.



TYPICAL RESISTANCE CHANGE DURING LOAD LIFE AT RATED LOAD. VITREOUS ENAMEL COATED VS. IRC RESISTEG COATED RESISTOR.



2 The high temperature vitreous enamel cure changes the temperature coefficient and the resistance of the wire. Actually, the temperature coefficient of resistance wire furnished by the wire manufacturer is only 20 ppm. By the time IRC Resisteg Coated Resistors are cured the average TC is about 25 ppm. By comparison, vitreous enamel units are not TC guaranteed for less than 80 ppm and then only on special order.

3 To prevent shifting of turns during curing of vitreous enamel coated power wire wound resistors, the turns must be wound at high tension. This, of course, work-hardens the wire which increases the temperature coefficient and lowers the resistance. These disadvantages are not completely offset by firing and cooling in vitreous enamel coated resistors.

4 Because of the low temperature at which IRC Resisteg Coated Power Wire Wound Resistors are cured, there is no tendency for turns to shift during cure, no necessity therefore for tight windings, no appreciable change in the TC or resistance.

5 The ability to use heavier wire in IRC Power Wire Wound Resistors increases the transfer of heat from the interior of the resistor to the terminals, minimizes the necessity for derating at high ambient temperatures.

6 Vitreous enamel coating being inherently brittle is subject to cracking and crazing from aging, thermal shock, or internal stress; the coefficients of expansion involved are critical and must be carefully matched.

WRITE FOR THE NEW POWER WIRE WOUND RESISTOR BULLETIN C-1C

INTERNATIONAL RESISTANCE COMPANY • Dept. 377, 401 N. Broad Street, Philadelphia 8, Pa.

WASHINGTON OUTLOOK

TOUGH RULES on recovery of profits under the Renegotiation Act will probably be continued for four years.

The House Ways and Means Committee turned down pleas of defense producers for an exemption for contracts with incentive clauses. Such contracts are involved in most of the current aircraft company appeals against renegotiation rulings that ordered some $72 million returned to the U.S. The committee also voted against a provision for a guaranteed rate of defense profit on individual contracts.

The controversial law expires the end of this month. A four-year extension, if enacted, is two years longer than the administration sought—and continues the rugged rules on recovery of profits determined excessive by the independent Renegotiation Board.

But some balm for contractors did come from the committee. It inserted two important amendments to ease the right to appeal Board decisions.

The new law will require the Board to spell out precisely how "excessive" profits are calculated in individual cases, thus making it easier for contractors to plan their appeals. It will also allow contractors to go to the U.S. Court of Appeals to protest tax court decisions on Board rulings.

- **Latest Pentagon** figures show up the military procurement trend toward cost-reimbursement-type contracts in general, and the use of incentive clauses when fixed-price-type contracts are still negotiated.

  Of the $22.2-billion worth of procurement contracts let last year, almost 40 percent of the total were cost-reimbursement types—mostly with fixed-fee provisions. The year before, about 33 percent of the total dollar volume was covered by such contracts. Defense experts say the rate is increasing this year and will continue next year.

  Of the remaining 60 percent—all fixed-price types—the largest chunk was still with firm price provisions. But an increasing percentage contained incentive clauses, under which the contractor is allowed to increase his profit by trimming costs, speeding delivery, or boosting performance characteristics of the equipment.

- **Odds against passage** of the much-heralded Saltonstall bill to revamp military buying laws are rising sharply. This is the bill, backed by Electronic Industries Association and most other spokesmen for defense contractors, which would: (1) extend the use of "weapon system management" to strengthen a prime contractor's authority on a major development project, and (2) make it easier for the military to award negotiated contracts (as opposed to formal advertised bids).

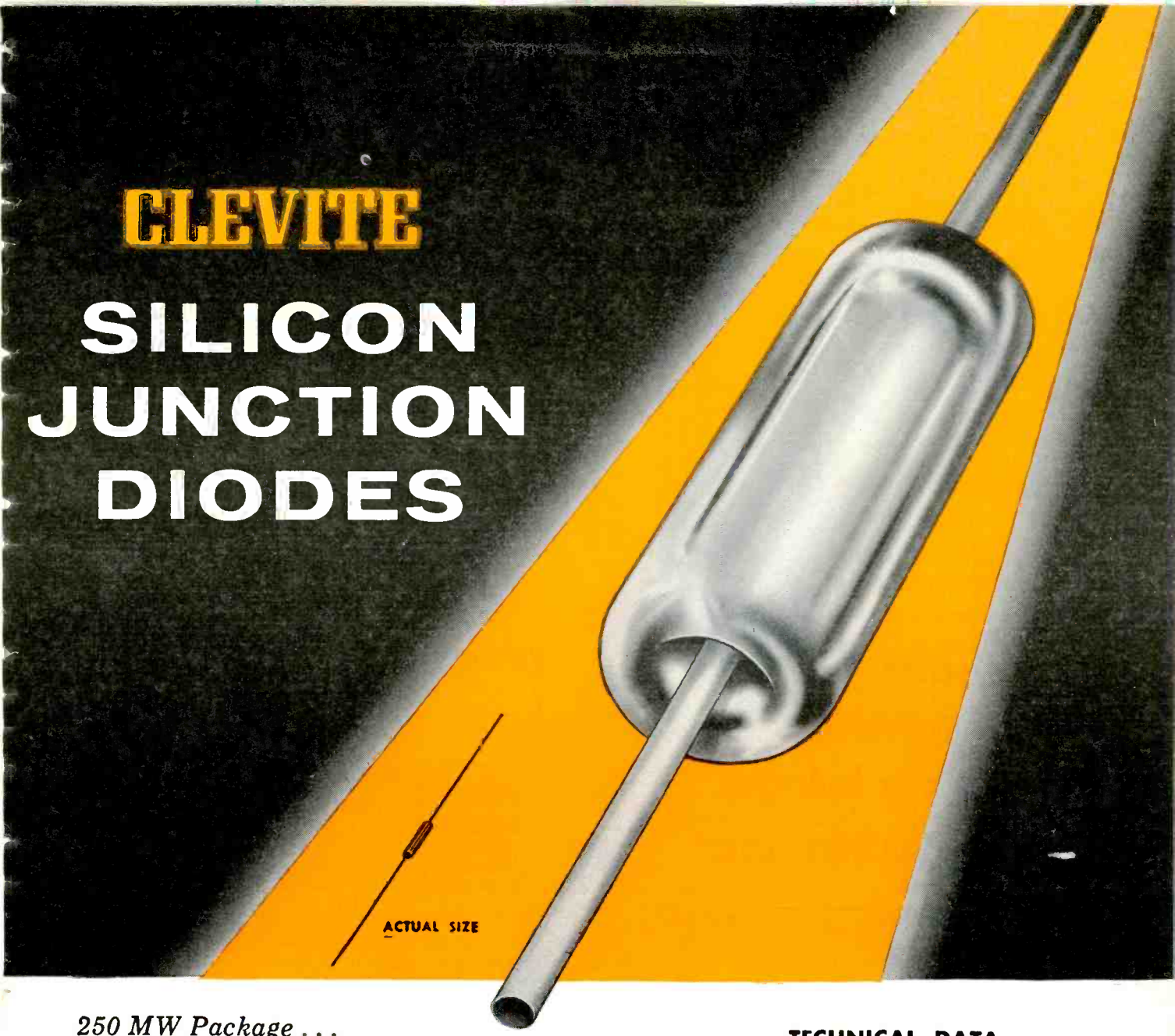
  Says Defense Dept. general counsel Robert Dechert: "No single method or formula provides an answer to the management of procurement of weapons systems. . . . To emphasize a single weapon system manager, on one hand, and a single prime contractor, without recognizing capability within government itself, or of other contractors, is unduly restrictive."

  Reflecting the views of many lawmakers, Rep. Gerald R. Ford (R., Mich.), ranking Republican on the House Defense Appropriations Subcommittee, now says smaller firms fear that when a larger company gets a prime weapons system contract, it takes "a larger and larger share (of the project) directly or by some closely tied affiliate."

CIRCLE NO. 15 READER SERVICE CARD→

CLEVITE

SILICON JUNCTION DIODES



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For details, write for Bulletin B217A-1 B217A-2

TECHNICAL DATA

Type	Max. DC Inver. Oper. Voltage	Forward Current @ Specified Voltage	Max. Inverse Current @ 25°C	Max. Inverse Current @ 150°C	Test Volts
1N457	60 V	20 ma @ 1.0 V	0.025 μa	5.0 μa	60 V
1N458	125 V	7 ma @ 1.0 V	0.025 μa	5.0 μa	125 V
1N459	175 V	3 ma @ 1.0 V	0.025 μa	5.0 μa	175 V
1N662	90 V	10 ma @ 1.0 V	20 μa	100 μa (@ 100° C)	50 V
1N663	90 V	100 ma @ 1.0 V	5.0 μa	50 μa (@ 100° C)	75 V
1N778	100 V	10 ma @ 1.0 V	0.5 μa	30 μa (@ 125° C)	100 V
1N779	175 V	10 ma @ 1.0 V	0.5 μa	30 μa (@ 125° C)	175 V

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for detection and measurement of oxygen or hydrogen impurities in other gases

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SUPER-SENSITIVE DEOXO INDICATOR . . . measures oxygen or hydrogen present as impurities in other gases—from 2 to 200 parts per million oxygen and 4 to 400 parts per million hydrogen. Dual range permits measurement up to .25% oxygen or .50% hydrogen. Send for literature.

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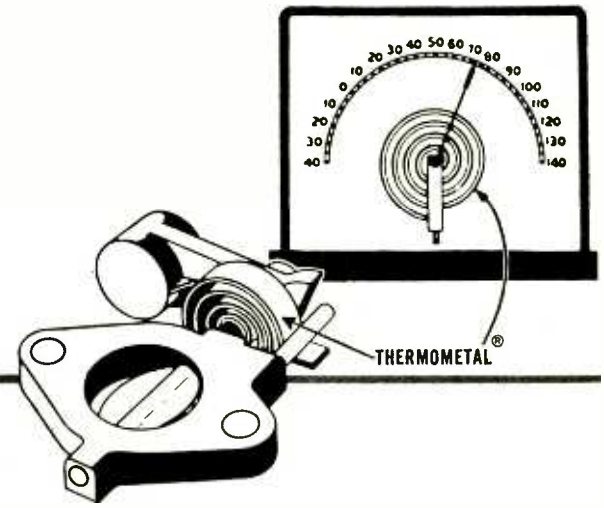

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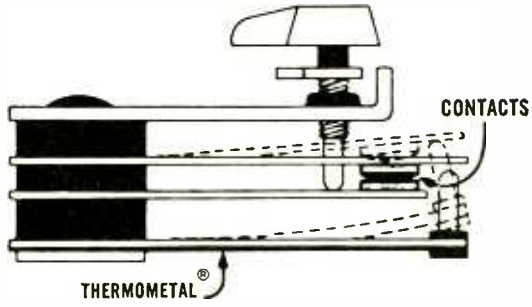

Leading manufacturers depend upon the outstanding performance of Thermometal in electrical appliances, thermal cutouts, heating controls and many other applications involving the indication and accurate control of temperatures, electrical currents, voltages, etc. Thermometal is supplied in strip form, rolled and slit to close tolerances and tempered to specification. Thermometal elements and sub-assemblies are also supplied to specifications, with or without contacts attached. Send for literature.

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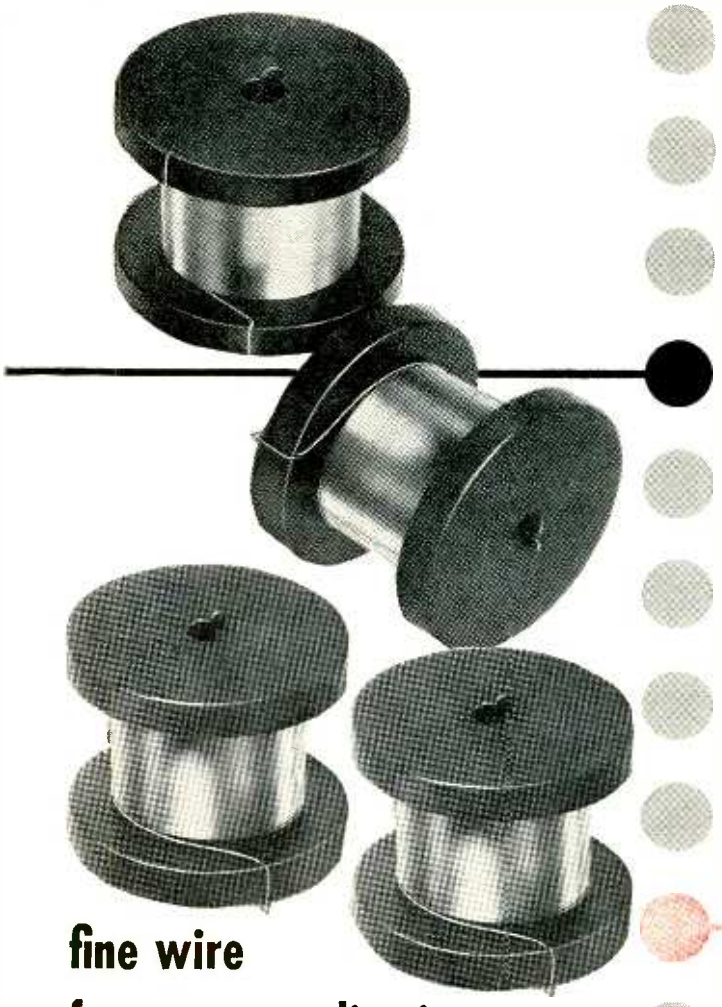

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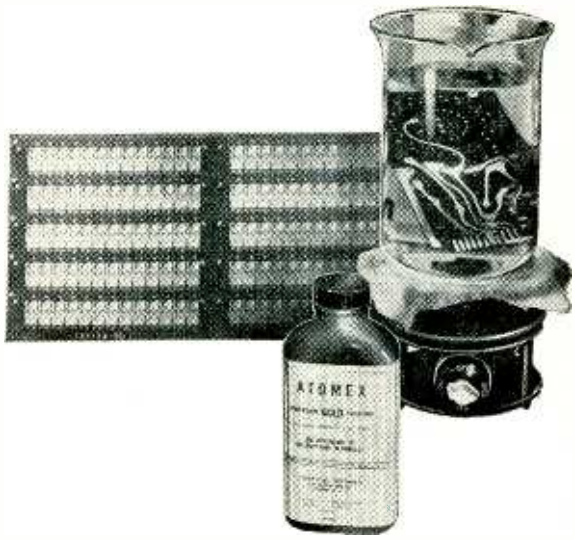

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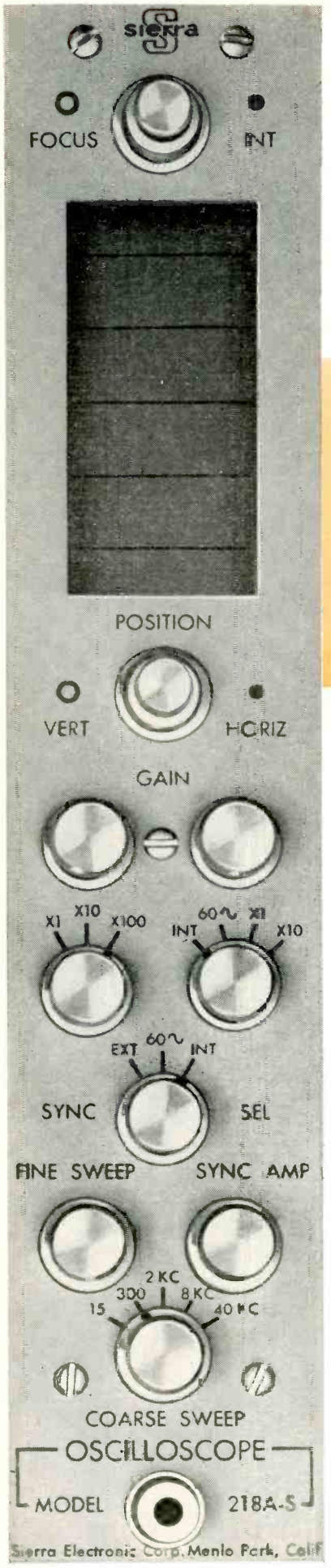

NEW MONITOR OSCILLOSCOPES

View up to 7 circuits simultaneously!

New Sierra Model 218 Monitor Oscilloscopes provide, in the smallest possible package, a convenient and practical means for viewing and evaluating complex voltages. Up to seven oscilloscopes can be mounted side by side in a standard relay rack —units measure only 10½" high x 2⅛" wide (front panel). Thus seven circuits can be monitored simultaneously.

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Unusual design features include printed circuitry, broad bandwidth, smooth high frequency rolloff without overshoot and minimum heating (only 20 watts dissipation per scope unit, including filaments!) Request bulletin and demonstration.

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Record-Setting Continues

SALES PREDICTIONS of $250 million for one company and more reports of continued expansion are financial news elements this week. Here are details:

• **Motorola Inc.** reports first-quarter sales up 56 percent over 1958 for a total of $63 million, with earnings at $2.6 million or four times greater than 1958's first quarter. Highest score was made by radio and tv sales which rose 100 percent. Automotive products went up 60 percent, and two-way radio gear improved 30 percent. Similar increases are predicted for the second quarter, with a year-end expectation of over $250 million total sales volume.

• **American Bosch Arma Corp.,** Hempstead, N. Y., and **Ensign Carburetor Co.,** Fullerton, Calif., announce groundwork has been laid for a merger of the two firms, subject to action by boards of directors. No changes in management or distribution patterns are expected, according to executives of the companies.

• **Electronics Engineering Co.,** Santa Ana, Calif., plans to issue 100,000 shares of common stock. A total of 78,750 will be offered initially to employees. The firm is engaged in the design, development and engineering of range instrumentation systems and specialized data-processing equipment.

• **Victoreen Instrument Co.,** Cleveland, O., has voted to issue one share of common stock for each four now held. Distribution will be made on June 16 to holders of record as of May 25. A special stockholders meeting slated for June 25 will vote on a proposal to increase authorized capital of $1 par stock from 2 million to 3 million shares.

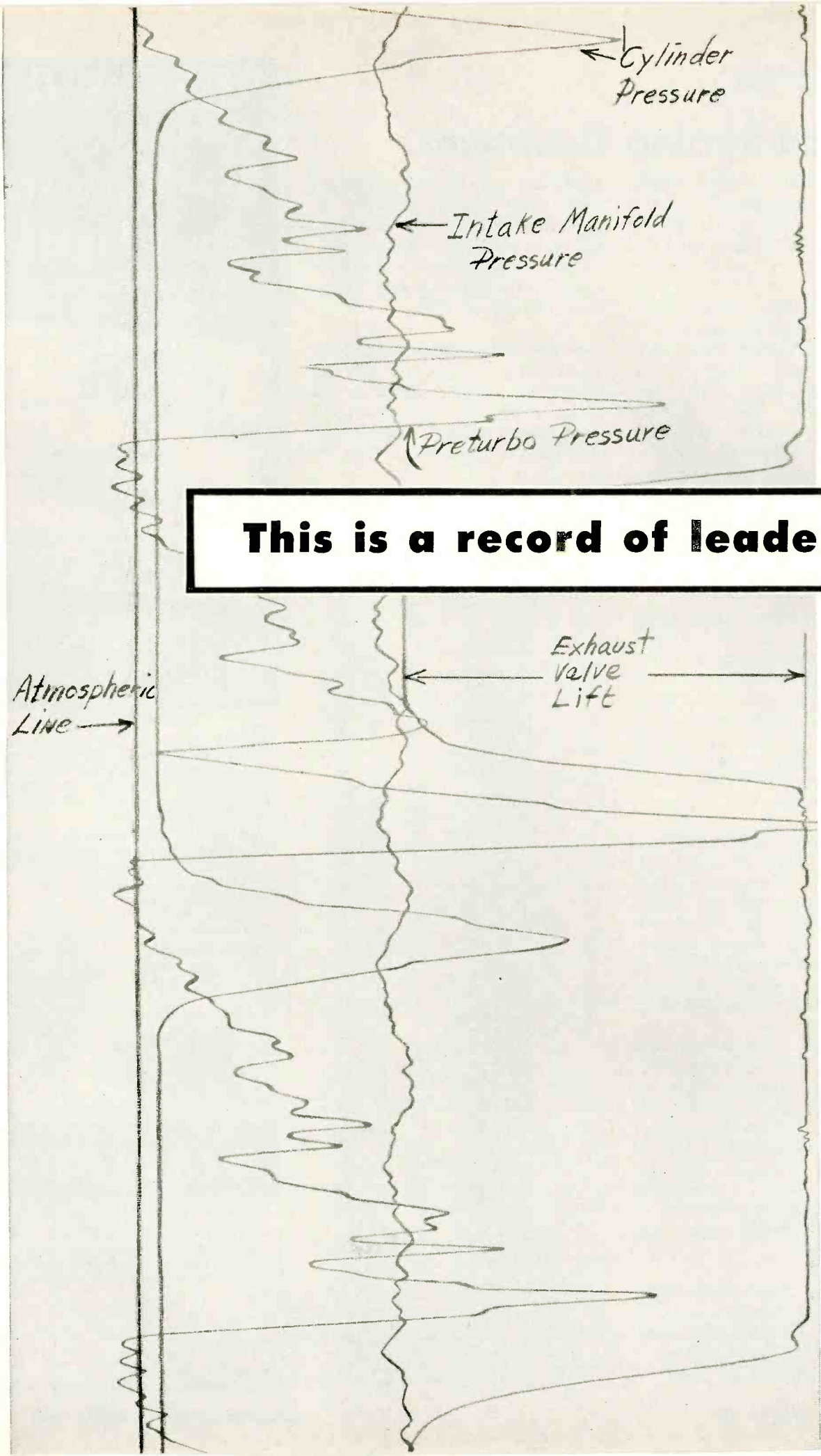
• **Transonic Inc.,** Bakersfield, Calif., reports record sales and earnings for the fiscal year ended February, 1959. Net profit for the period was $84,430 on sales of $1,876,237. During the preceding year, profit came to $66,624 on sales of $1,507,345. The company, which manufactures wave filters, magnetic amplifiers and other components, made its first public stock offering in 1958.

• **General Dynamics Corp.,** New York, plans to register 400,445 shares of common stock to be offered under the firm's restricted stock option plan to officers and employees of the company and its subsidiaries.

OVER THE COUNTER

1958 BIDS LOW	1958 BIDS HIGH	COMMON STOCKS	WEEK ENDING May 15 BID	WEEK ENDING May 22 BID	WEEK ENDING May 22 ASKED
3¾	20½	Acoustica Assocs	34½	31	36⅜
1⅝	3	Advance Industries	2¾	2¾	3⅜
3⅛	6⅝	Aerovox	10½	10¼	11⅜
5½	15	Appl'd Sci Princet	9½	10¼	12¼
1⅛	8⅞	Avien, A	10	10¼	11¾
6¾	24	Baird-Atomic	32	32½	38¼
9¾	13⅜	Burndy	17¼	17½	19
6¾	9	Cohu Electronics	7⅛	7⅞	8½
11	22½	Collins Radio	36	33¾	38½
32½	49	Cook Electric	46½	42	49¼
4	7	Craig Systems	10½	10½	12
17⅝	25⅜	Eastern Industries	18½	18	19⅞
1¾	8⅜	Elco Corp	8	7¼	9⅛
10½	21	Electro Instr	28½	28	30⅜
34	49	Electronic Assocs	45	41	48¼
5	11	Electronic Res'rch	18	18	20⅜
8½	12¾	Electronic Spec Co	16	16	19⅝
15¼	49½	Epsco, Inc	38	39	45⅝
5½	9⅜	Erie Resistor	10⅛	10	11⅛
10	17½	Fischer & Porter	13½	14¾	16¾
5½	10½	G-L Electronics	12¼	11	13⅞
12	27	Giannini Controls	33	30¼	35⅝
...	...	Haydu Elec Prod	5¼	5	6⅝
30	39½	Hewlett-Packard	48	44¾	50⅞
23¼	48	High Voltage Eng	62	65	70½
1¾	3	Hycon Mfg	3¾	3½	4⅜
1⅛	5⅛	Industro Trans'tor	5⅞	6	6⅞
...	...	Internat'l Rec'f'r	26	27½	31½
...	...	Interstate Engin'g	24½	21¼	26¼
1½	4¾	Jerrold	6¼	6	6¾
21	30	D. S. Kennedy	27	28¾	33
33¾	29	Lab For El'tronics	36¼	35	39
19¼	28	Leeds & Northrup	31¼	33¼	36⅜
2	3⅛	Leetronics	3½	3⅜	4
5	18¾	Ling Electronics	25⅝	28½	32⅛
3¼	8¼	Magnetic Amplifiers	9½	9⅞	10¾
2⅞	4½	Magnetics, Inc.	6¼	6⅛	6¾
4⅝	12	W. L. Maxson	14⅝	13⅞	15¾
10⅝	29	Microwave Assocs	24¼	20	25⅝
5¼	11¾	Midwestern Instr	11¾	11⅜	13¼
1⅛	7	Monogram Precis'n	12	11¼	13
3½	7¼	Narda Microwave	11	11½	12¾
...	...	Narda Ultrasonics	11⅛	11½	12⅞
9¾	16	National Company	25	28¼	30⅝
14¼	56	Nuclear Chicago	38½	38¼	43
4½	7⅜	Pacific Mercury, A	12¼	12¼	13⅝
10⅛	27½	Packard-Bell	46½	43	49½
4¼	9⅜	Panellit, Inc	7½	7⅜	8⅜
21	53¾	Perkin-Elmer	54	54½	61¾
11⅜	19½	Radiation, A	23¼	21½	25⅝
2⅛	7⅜	Reeves Soundcraft	7⅛	7	7⅞
13	32½	Sanders Associates	37½	34	40⅜
...	...	Silicon Transistor	9¾	9¾	12
7	12	SoundScriber	17¼	17¾	20⅛
22¾	40	Sprague Electric	50½	49½	54¼
26	35	Taylor Instruments	33	36½	40⅞
5½	15	Technical Operat'ns	24	24	28¼
5½	15¾	Telechrome Mfg	20½	21½	26¼
3¼	7¾	Telecomputing	12⅞	13	14½
1⅛	2¾	Tel-Instrument	2¾	2¾	3⅜
8¾	16¼	Topp Industries	15	13⅞	16⅜
3¾	10¾	Tracerlab	10¾	11¼	12⅞
1⅛	3⅜	Universal Trans'tor	1⅜	1¼	1⅝
14¼	40	Varian Associates	37½	33¼	40⅜

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



This is a record of leadership

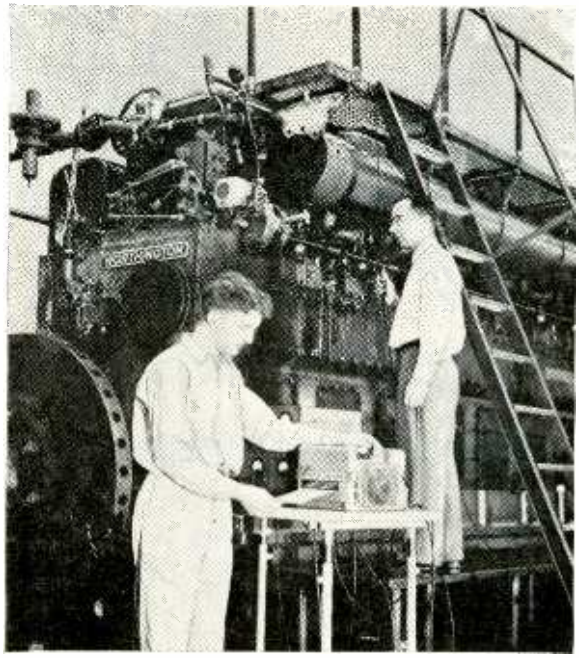
The Worthington Corporation used a Honeywell 906 Visicorder to chart the heartbeat of a Worthington Tripower diesel engine. These Tripower (oil fuel, dual fuel, or spark ignition gas) engines have a fourteen inch bore, an eighteen inch stroke, and develop more than 265 h.p. per cylinder at 450 RPM.

The Visicorder used in these tests makes a direct, instantly-readable record of the pressure variations in the exhaust manifold, cylinder, and intake manifold to determine optimum valve timing and engine configuration. The Visicorder also produces a permanent record of strain gauge measurements taken on the frame and other critical engine parts.

For the manifold and cylinder pressures, strain gauge pressure transducers and a strain gauge amplifier were used. For the valve lift patterns, a linear potentiometer powered with a small battery was connected directly to the Visicorder.

Analysis of these data has led to changes in the Tripower engine for best performance.

in diesel engine research



Ted Dupler (left) and John McAllister, Worthington Engine Research Engineers, measure intake manifold, cylinder, and exhaust manifold pressures and valve stroke on a Tripower with a Honeywell 906 Visicorder.

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

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

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

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

Honeywell

Industrial Products Group

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Champaign-Urbana, Illinois

offers unlimited opportunity for

Design Engineers

Yes, Magnavox is a leading company... not only in television and high fidelity but in the Government and Industrial Division too. Our new modern facilities in Champaign-Urbana, Illinois, represent a young but extremely productive organization. Within 3 months we are expanding over 100%. We can offer digital, communications and packaging design engineers unlimited opportunities with permanent positions on our growing staff.

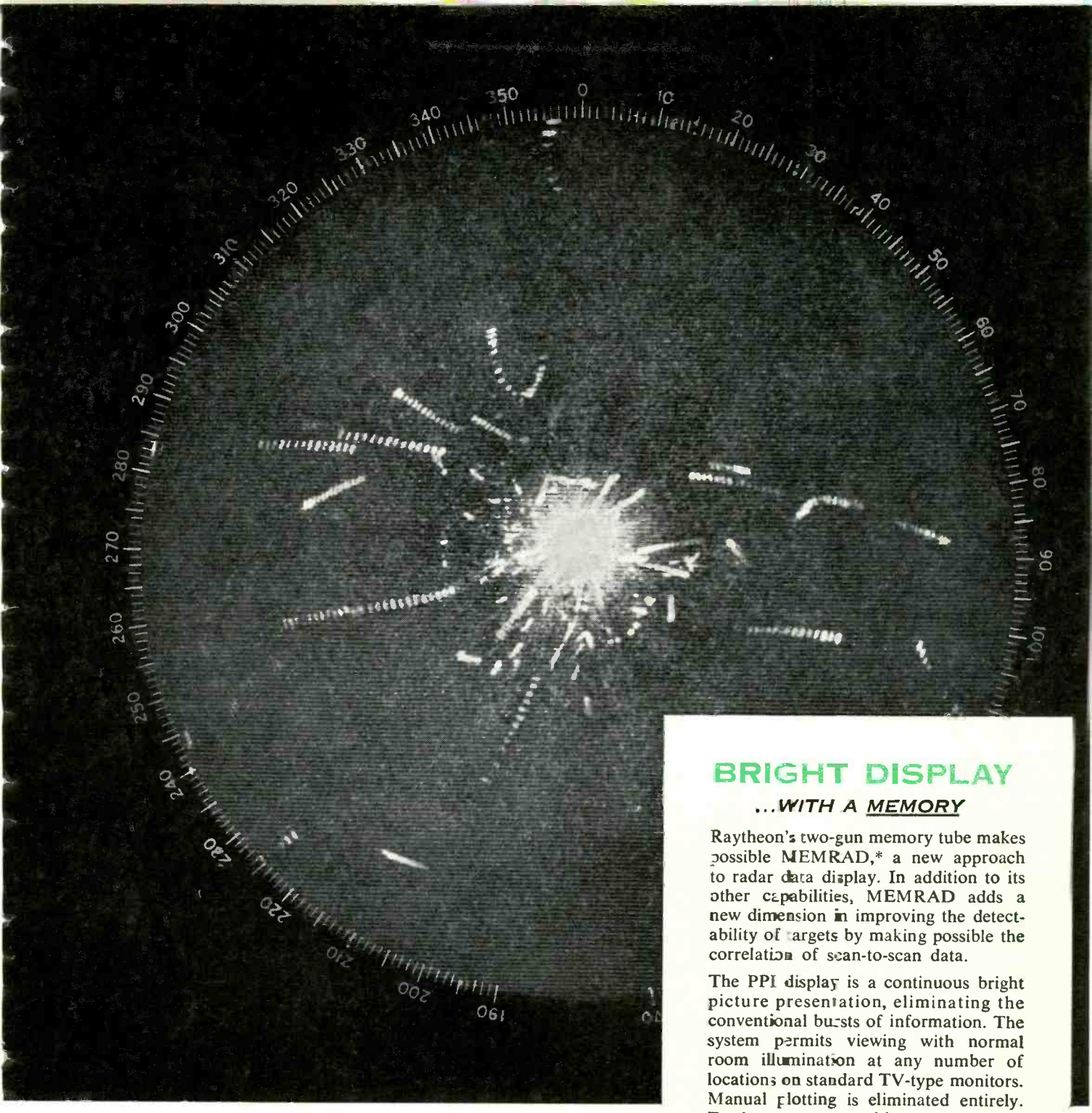
"Champaign-Urbana A Fine Place To Live and Work" say Magnavox Engineers . . .

Here's why . . .

Excellent Public School System for Children and Teenagers • Home of the University of Illinois with its Highly Rated Electronics Engineering School, Big Ten Sporting Events, and fine Campus • Minimum Commuting Time from Home to the Office, Low Cost of Living • Magnavox Assistance Toward Advanced Education.

If you are a Design Engineer in the Digital, Communications or Packaging Fields, please write Mr. D. M. Ormiston today. You'll be glad you did.

THE MAGNAVOX COMPANY • URBANA, ILLINOIS



BRIGHT DISPLAY

...WITH A MEMORY

Raytheon's two-gun memory tube makes possible MEMRAD,* a new approach to radar data display. In addition to its other capabilities, MEMRAD adds a new dimension in improving the detectability of targets by making possible the correlation of scan-to-scan data.

The PPI display is a continuous bright picture presentation, eliminating the conventional bursts of information. The system permits viewing with normal room illumination at any number of locations on standard TV-type monitors. Manual plotting is eliminated entirely. Furthermore, recognition and comprehension of target trails are made possible by presenting the recent history of target position. MEMRAD allows an immediate assessment of target velocity and maneuver, permitting discrimination between jet and conventional aircraft.

**Raytheon Trademark*

PROFESSIONAL ASSOCIATION WITH A FUTURE

Raytheon has excellent openings for qualified engineers and physical scientists with BS or advanced degrees interested in systems, development, design or manufacturing engineering of complex electronic equipments. Please write Donald H. Sweet, Government Equipment Division, Raytheon Company, 624 Worcester Road, Framingham, Massachusetts.

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

RAYTHEON

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GOVERNMENT EQUIPMENT DIVISION


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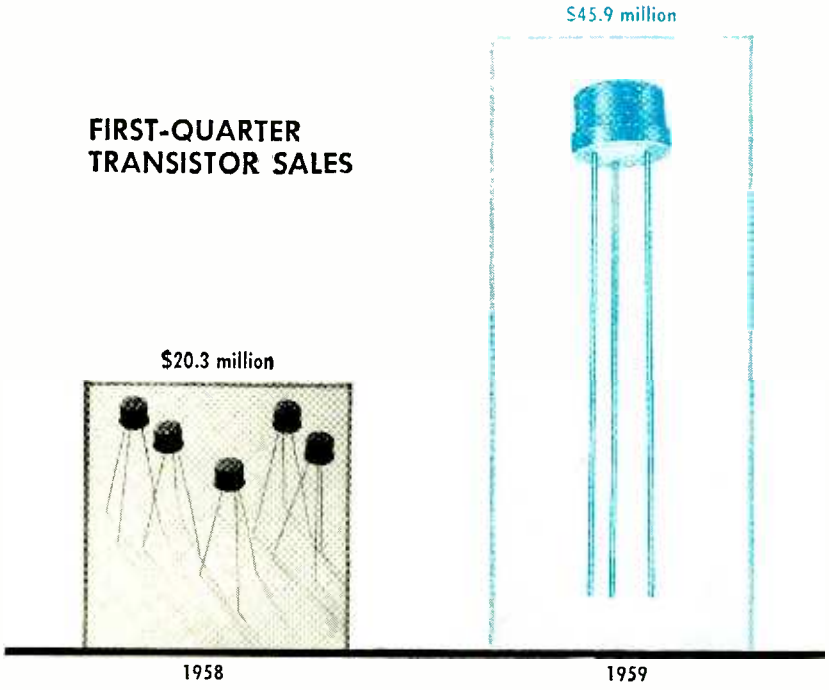
SEA


AEROSPACE



Transistor Sales Run Strong

FIRST-QUARTER transistor sales are running well ahead of last year, with dollar sales 126 percent ahead of 1958's opening quarter and unit sales up 87 percent.

Dollar sales for the first three months of 1959 totaled $45.9 million, against $20.3 million for the first quarter of 1958, according to Electronic Industries Association. Unit sales total was 16.9 million for the 1959 quarter, compared with 9.0 million a year ago.

Partial returns for this year indicate that total sales for 1959 may be much higher than many persons in the industry anticipated only a few months ago. Then, forecasts calling for transistor sales of $165 million in 1959, an increase of 47 percent over 1958 sales of $112 million, seemed moderately optimistic. Transistor sales performance so far indicates this year's sales total may come close to $200 million.

• **Electronic parts distributors** established a new selling record in 1958 with sales total of $700 million, up six percent from 1957, comments National Credit Office Consulting Service.

Distributors are encouraged by the current year's outlook. Replacement part demand continues at high levels and the industrial market is accelerating. At present at least 600 of the country's 1,600 distributors are engaged in industrial business.

• **Philco** reports spending $35 million, or 10 percent of sales in 1958, for research and development. Firm plans to spend $40 million in 1959, including $30 million supported by defense contracts.

• **Manufacturers** of products for sale in foreign countries note: Department of Commerce issues directory of foreign advertising agencies and marketing research organizations. Copies available from Superintendent of Documents, Washington, D. C., for 45 cents.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	May 15, 1959	Apr. 17, 1959	Change From One Year Ago
Television sets	98,343	95,023	+44.7%
Radio sets (ex. auto)	269,812	270,658	+159.2%
Auto sets	119,725	98,141	+162.7%

STOCK PRICE AVERAGES

(Standard & Poor's)	May 20, 1959	Apr. 22, 1959	Change From One Year Ago
Electronics mfrs.	91.81	88.80	+79.0%
Radio & tv mfrs.	106.75	101.46	+131.0%
Broadcasters	101.48	96.88	+62.2%

Contamination Control: *State of the art*

Happily for you, Hughes frowns on poor housekeeping. In fact, our plants are famed for cleanliness...and all the other controls that insure highest product quality.

Our products prove it. Whatever you specify, you're assured of unexcelled reliability...even when operating conditions get rough.

Hughes products are backed by the brainpower of over 5,000 engineers and scientists and the manufacturing know-how which has produced billions of dollars in reliable electronics equipment.

Check the following three pages for specific examples of reliable Hughes components...silicon transistors, MEMO-SCOPE® recorders, and TONOTRON* storage tubes.

In addition to these, other Hughes Products devices which offer you this "built-in" reliability include: special purpose oscilloscopes...MEMOTRON®, TYPOTRON® and TONOTRON* storage tubes...microwave tubes...vacuum tubes...thermal relays...a wide variety of semiconductors: diodes, transistors and rectifiers...and an industrial system which operates a complete and integrated line of machine tools.

*Trademark of H.A.C.

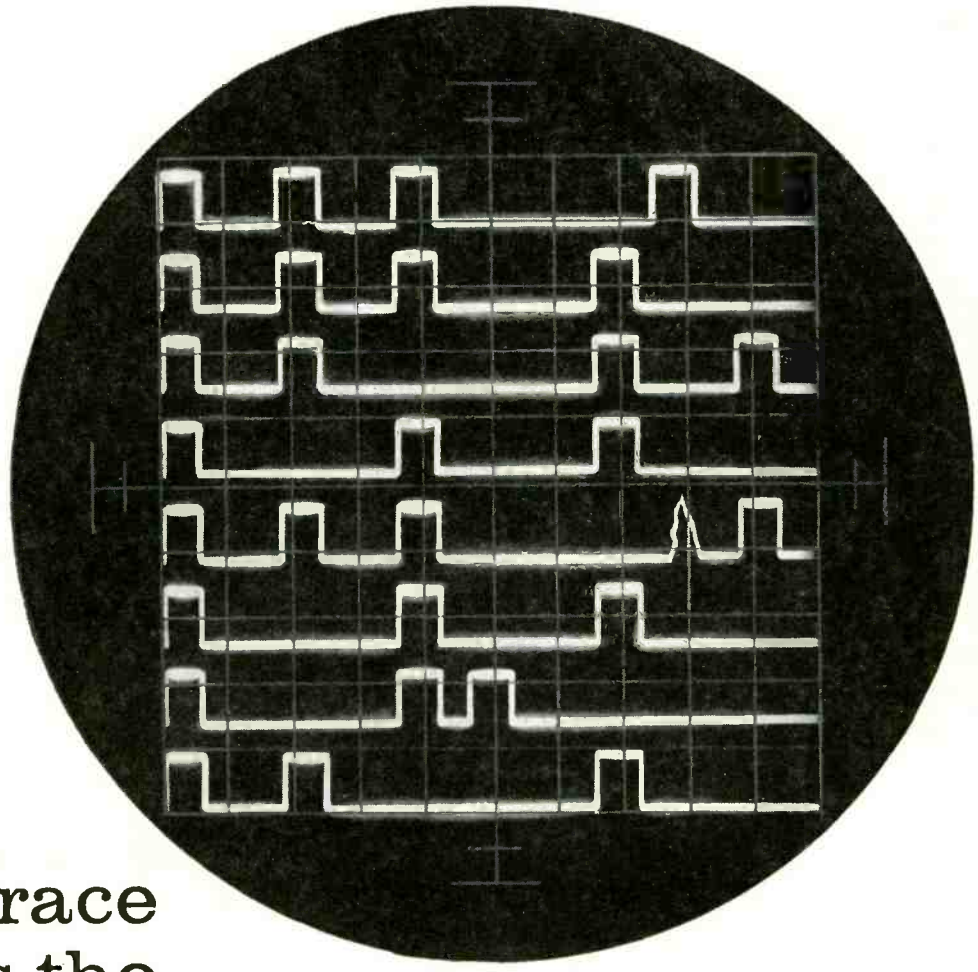
For additional information about Hughes components or systems please write: Hughes Products, Marketing Dept., International Airport Station, Los Angeles 45, California.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

SEMICONDUCTOR DEVICES • STORAGE AND MICROWAVE TUBES • CRYSTAL FILTERS • OSCILLOSCOPES • RELAYS • SWITCHES • INDUSTRIAL CONTROL SYSTEMS

Trace Retention with MEMO-SCOPE recorder. Application No. 2



which trace has the transient?

Data reduction systems have long been plagued by false signals from intermittents and transients—particularly those using digital bits and words. With the MEMO-SCOPE® recorder you can locate this false information with comparative ease.

For example, the above display shows 8 traces—one showing a non-recurrent transient pulse. The MEMO-SCOPE recorder freezes this transient information on the face of the tube until intentionally erased. Therefore, transients can be retained for study, regardless of the fact that they are intermittent in nature and last only a few microseconds. For more information concerning this application, write for Data Sheet MSAD-A2.

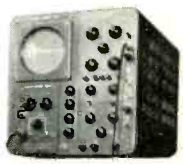
Many unique problems have been solved with the MEMO-SCOPE *recorder through trace retention. Refer your problems to us by writing: Hughes* MEMO-SCOPE *recorder, Hughes Products, International Airport Station, Los Angeles 45, California.*

A new MEMO-SCOPE recorder accessory . . . the **Multitracer** . . . makes it possible for you to automatically program up to 20 different traces on the tube face.

In addition to data reduction trouble shooting, the MEMO-SCOPE recorder makes it possible for you to save time and money in problems associated with:

- *Ultrasonic flaw testing*
- *Drift measurements*
- *Ballistics, explosives research*
- *Switch, relay contact studies*
- *Welding*
- *Transducer testing*
- XY *plotters*
- *Medical diagnosis problems*
- *Physical testing*
- *plus many more*

SPECIFICATIONS:
Sweep Speed for Storage: 10 microseconds per division to 10 seconds per division (0.33").
Frequency Response: DC to 250 KC down 3 db.
Sensitivity: 10 millivolts to 50 volts per division or with optional high sensitivity preamplifier 1 millivolt to 50 volts per division.



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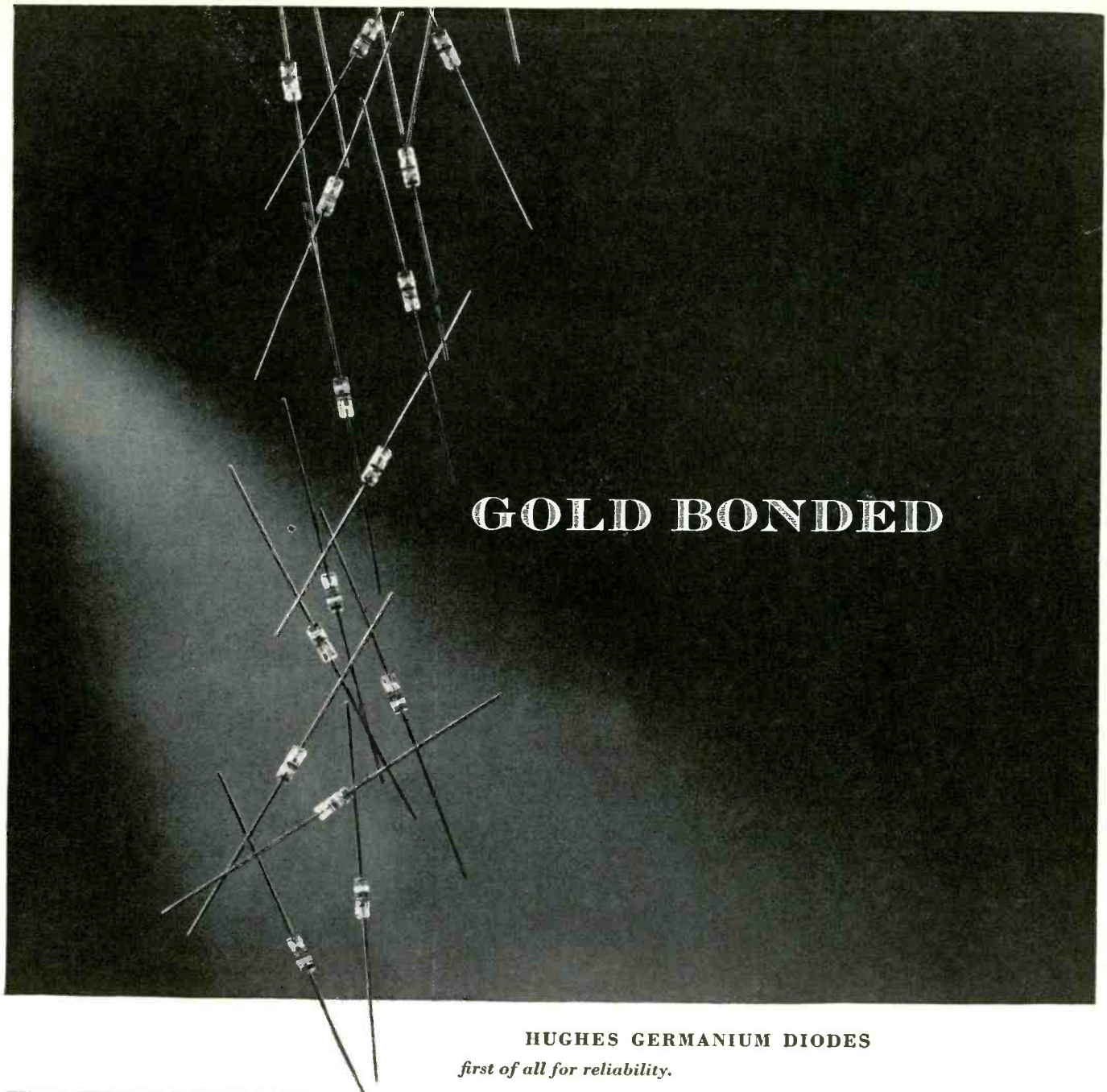

HUGHES GERMANIUM DIODES

first of all for reliability.

Typical performance levels: @ 25° C. unless otherwise stated

	Forward Current @ +1V (mA min.)	Inverse Current @ Specified Voltage (μA max.)	Maximum Inverse Voltage (Volts)
1N270	200	100 @ −50V	100
1N276	40	100 @ −50V 100 @ −10V*	60
1N277	100	250 @ −50V* 75 @ −10V*	125

*Measured @ 75° C.

For additional information write: Hughes Products, Marketing Dept.—Semiconductors, International Airport Station, Los Angeles 45, California.

Hughes gold bonded diodes exhibit fast recovery together with high forward conductance, low reverse leakage and high peak inverse voltage. They are fusion sealed in a subminiature one-piece glass envelope. This assures you complete isolation from damage or contamination.

Under varied and severe environmental and operating conditions, Hughes Gold Bonded diodes exhibit outstanding performance. You can be assured of reliable performance, since Hughes diodes exhibit the following characteristics: shock resistance... vibration resistance... thermal stability... electrical stability.

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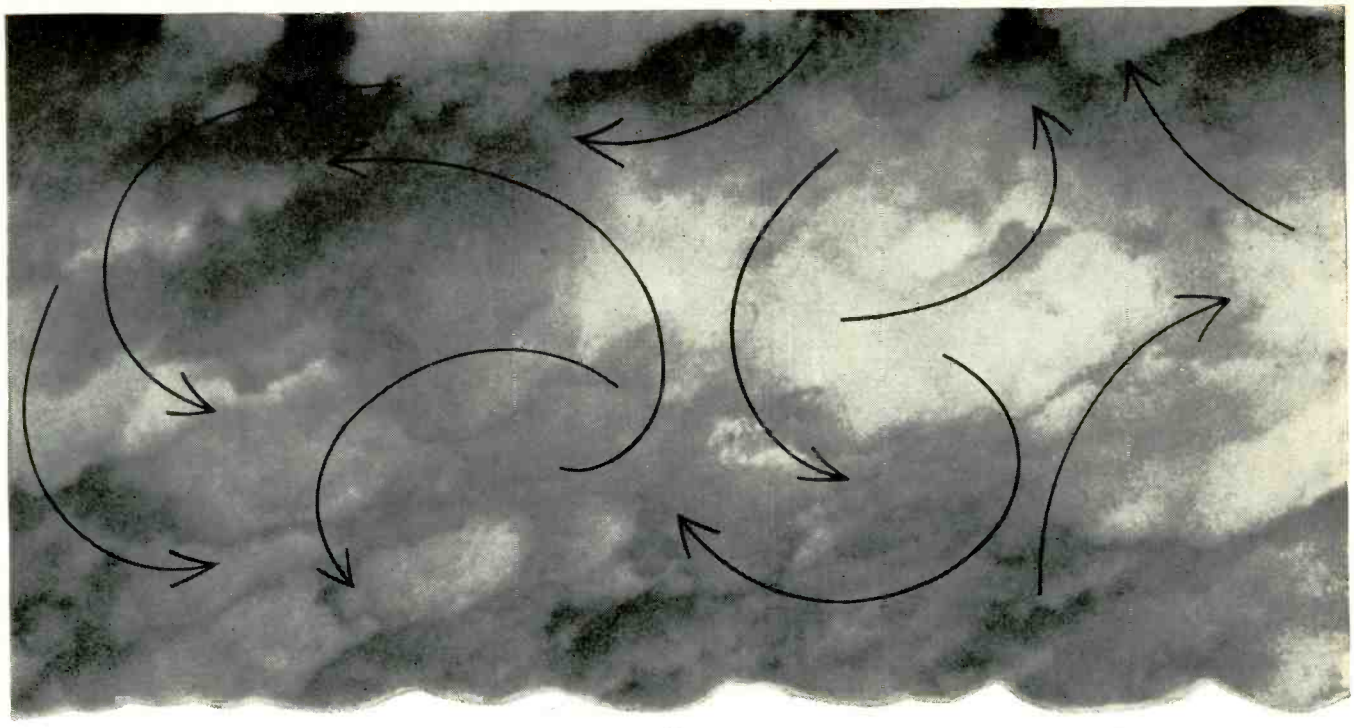
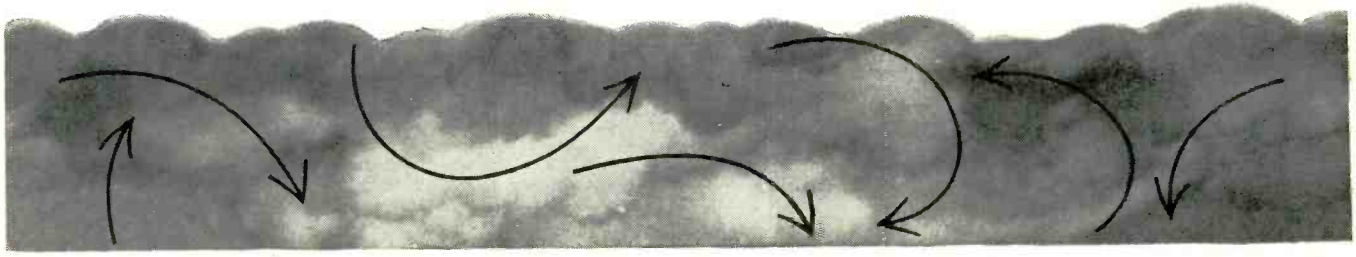


all-weather radar finds  *the calm corridor*



Providing a clear picture of turbulence cells in storms ahead, Hughes TONOTRON* tube gives your airborne weather radar exceptional ability to find the "calm corridor."

Hughes TONOTRON tube gives you several features which make it ideal for weather radar readout and ground mapping:

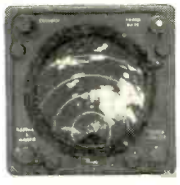
Full Gray Scale—Seven different shades of gray.

High Picture Brightness—In excess of 1500-foot lamberts with full halftone range. Even in full sunlight no viewing hood is required—thereby providing maximum safety.

Controllable Persistence—Gives you flexibility in analyzing the complete weather problem.

Developed by the famed Hughes Research and Development Laboratories, the TONOTRON tube is just one of the nation's largest family of storage tubes!

For further information about the TONOTRON tube, please write: Hughes Products, Electron Tube Sales, International Airport Station, Los Angeles 54, California.



The new **Bendix Airborne Weather Radar** uses the Hughes TONOTRON tube for a high-fidelity picture reproduction. With this system the pilot can keep an area as great as 150 miles ahead and to the right and left, under constant observation—day or night.

The Hughes TONOTRON tube

Applications: Airborne weather radar, "B" scan radar, armament control radar, plan position indicator information and slow-scan television.

Available models: Electrostatic deflection, 3-inch, 4-inch and 5-inch diameters. Magnetic deflection, 5-inch and 21-inch diameters.

*TRADE-MARK OF H.A.C.

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When you must have recording range out to 150 cps . . . immediately visible, permanent traces in rectangular coordinates . . . a large number of channels in the limited space of a mobile van or control room . . . and the flexibility of a variety of economical preamps – a Sanborn 850 system is the *one* most practical answer to *all* these requirements. In aircraft and missile telemetering facilities, computer installations, test stand work and similar multichannel recording applications, the "850" is proving its unique adaptability and practicality.

You can unplug and change "850" preamplifiers in seconds to record a wide range of variables. Select by pushbutton any of nine electrically-controlled chart speeds from 0.25 mm to 100/sec. Observe and make notes on the convenient 8" vertical chart display. Reload charts quickly and easily from the front. Every operating feature *you want* is backed up by the performance specifications *you need* – for the greatest possible recording usefulness.

DC Coupling and Phase Sensitive Demodulator preamplifiers are now available. Carrier and Basic Chopper preamplifiers are now being prepared for production. A rack-mounted Master Oscillator Power Amplifier (MOPA) to supply Carrier and Chopper excitation is also in preparation.

THE ONLY 6- or 8-CHANNEL DIRECT WRITER

THAT OFFERS YOU

Response to 150 cps ... 0.5% LINEARITY

Wide choice of ECONOMICAL PREAMPS

INKLESS traces – RECTANGULAR coordinates

24½" panel space

Your local Sanborn Sales-Engineering representative can give you the complete "850" facts and specifications. Contact him now.

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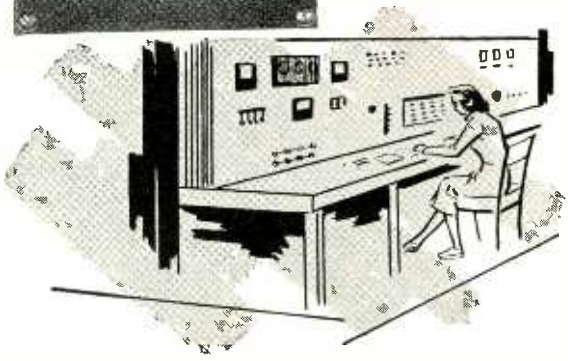
Industrial Division
175 Wyman Street Waltham 54, Mass.

STANDARD TRADEMARK ...SYNONYM for PRECISION in TIMING



For timing requirements in research, testing or production . . . if the need for *precision* is paramount . . . the choice is STANDARD.

Recognized as THE criterion by which other timers are judged (and *calibrated*), STANDARD Elapsed Time Indicators are noted for their long life under continuous use.

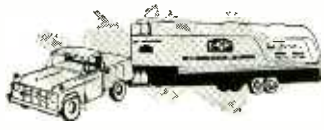
Large enough to work with handily and read readily, STANDARD timers are electric clutch controlled by manual or automatic switch or by electric circuits or output of electronic tubes. Units are synchronous motor driven . . . available for flush panel mounting or portable use . . . equipped for manual or electric zero reset.

For ultra precision timing with AC current, models available for 400 CPS operation. Also available: 400 CPS power supply operating from DC source.

MODEL	SCALE DIVISIONS	TOTALIZES	ACCURACY
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

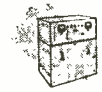
Request descriptive Catalog No. 198

THE STANDARD ELECTRIC TIME COMPANY | 89 LOGAN STREET SPRINGFIELD, MASSACHUSETTS



Travelling Display—Watch for showing in your area. See complete STANDARD Systems in operation.

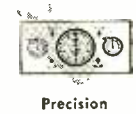
ALSO MANUFACTURERS OF:


Emergency Lighting Equipment


Laboratory Panels


Hospital Signalling Equipment

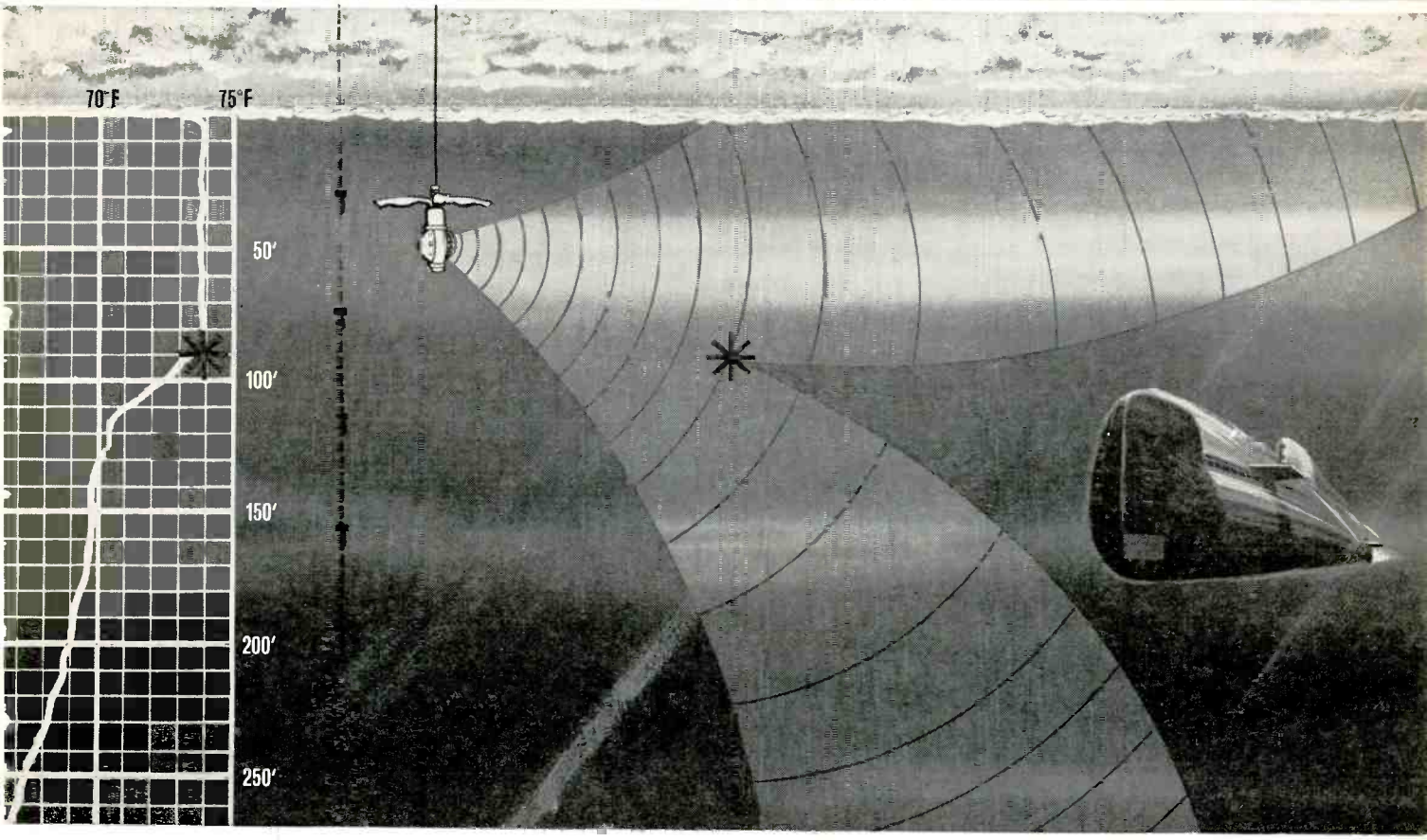

Analogue Computors


Precision Timers

idea:

Submarines can hide within range of helicopter-borne sonar by "riding the thermocline"—a water temperature change that casts shadows in sonar search patterns. Precise temperature-vs.-depth records allow the operator to spot thermoclines and change his search pattern to look into the shadows. Existing gear "worked", but it took too long and could not define the shadow zones very accurately. TI engineers created an automatic recorder, the **bathythermograph,** more accurate than a laboratory thermometer, that gives results instantly where they were needed—in the helicopter. Small as a portable typewriter, it easily fits with the sonar into the space available.

RESULT: Same sonar—fewer missed submarines.



design, manufacturing and quality engineers—3-10 years experience

high-gain careers for problem-solvers

YOUR SPECIAL TOUCH with unsolved problems buys you a solid future in any of Texas Instruments major military programs—Antisubmarine Warfare, Heavy Surface Radar, Missile Systems, or Electronic Surveillance. For example, you can try your hand at solving the Navy's clearly stated ASW requirement: Build *something* that will detect and classify a fast-moving submerged submarine at depths of 1500 feet, more than 50 miles from your aircraft.

Your experience in one of the following technologies may find immediate application in one of our four major programs:

radar • sonar • infrared • magnetic anomaly detection • passive detectors • servos • navigational systems • special-purpose computers • timers • programmers • microwave • telemetering • data link • optics • video mappers • visual displays • intercom

We require a steady influx of exceptionally-qualified men in these technologies. To learn more about us and how we can fit into your career plan, write for a copy of "We can tell you this much about Apparatus division" to:

J. R. Pinkston *Professional Placement*

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APPARATUS DIVISION
INCORPORATED
6000 LEMMON AVENUE • DALLAS 9, TEXAS

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EE's & PHYSICISTS:

radar (ground and airborne), antenna & microwave components, missile guidance, servo-mechanisms, telemetry, digital circuits, infrared design, systems studies, & flight test.

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antenna, mechanisms, miniaturization, thermodynamics, refrigeration, insulation, packaging, & structures design.

INDUSTRIAL ENGINEERS:

cost estimating, quality control, & quality assurance studies.

MANUFACTURING ENGINEERS:

tooling design & manufacturing planning & supervision. (Degrees in EE or ME.)

write for your copy

As Russia's missiles, rockets and new weapons parade in Red Square, U. S. military spending remains high. But . . .

What If Peace Breaks Out?

Will a peace push by Russia cripple our industry? Here are views from a financial expert who is active in the electronics industry

By **CASPER M. BOWER***, Fund Manager, Utilities & Industries Management Corp., New York, N. Y.

IS A REPETITION of the 1957 defense dollar stretch-outs—which created widespread unemployment and anguished financial cries from electronics defense contractors—a likely aftermath of the newest Geneva talks?

Most economists agree our unexpected rapid upturn from the 1957 depression lows was stimulated substantially by the U. S.'s $41-billion defense appropriations, with almost $5 billion for electronics.

But what happens tomorrow if peace breaks out? Soviet Premier Khrushchev's open declaration of economic war, made in October 1957, is worthy of repetition:

"We declare war upon you—excuse me for using such an expression—in the peaceful field of trade. The threat to the United States is not the ICBM but in the field of peaceful production. We are relentless in this, and it will prove the superiority of our system."

The tools of economic warfare cover a broad spectrum. They can be used obviously or subtly.

Missile Spending

A specific area of our vulnerability is actually pinpointed by indirection in Khrushchev's reference "the threat to the United States is not the ICBM . . ."

A reminder here is that missile expenditures in fiscal 1959, projected at $3.4 billion, are expected to climb to $3.9 billion during fiscal 1960. Of this amount, electronics spending will total nearly $1.5 billion in 1959 and approach $2 billion during fiscal 1960.

If Khrushchev needs Pentagon help for his anti-ICBM needling, he may get a fine assist from the heated feud between the Army and

About the Author

MANAGER of a private investment fund for the Utilities and Industries Management Corp., New York City, Casper M. Bower has combined more than 20 years' experience in investment banking with several years of direct participation in the electronics industry in a management capacity

* Now with Selectro Corp., Mamaroneck, N. Y.

Navy on one side, and the Air Force on the other.

The armed services are arguing as to the counter-force concept of strategy versus the deterrent concept. Army-Navy protagonists insist the nation is maintaining a great over-kill capability in its strategic bombardment forces, that the United States has far more atomic weapons, planes, missiles and other delivery systems, than are needed to devastate the Soviet Union.

The Electronic Industries Association, in its March 1959 analysis of military electronic expenditures for the period 1959-1970, estimates that for fiscal 1959 some $5.49 billion will be spent for the electronics industry. This amount is expected to climb to over $12.4 billion by 1970.

This estimate assumes "continuation of the cold war at the same degree of intensity." But will these estimates be sustained under real coexistence?

The fact that the Soviets almost daily are deemphasizing the militaristic approach to solutions, suggests strongly that the era of skyrocketing military spending may have reached its peak.

What Will Stocks Do?

What of the effect upon our business economy if and when the partial or full weight of Russia's economic warfare implications finally penetrate the security markets?

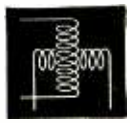
In the past two years, electronics shares have been propelled upward beyond all measures of value. Whereas, historically, the time honored investment yardstick—price-earnings ratio—had some meaning, there seems to be no application of this tool today with respect to electronics shares.

Price-earnings ratios for electronics shares at thirty, forty, sixty and eighty times present or prospective earnings are not uncommon. And, the greatest excesses are in the areas of small companies whose shares are traded over-the-counter, and whose business life depends largely on defense dollars.

The likelihood of a Khrushchev-Eisenhower meeting seems reason-

(Continued on p 37)

KEARFOTT PRECISION RESOLVERS FOR EVERY SYSTEM APPLICATION



Kearfott has available a complete line of precision resolvers for every system application. Computing resolvers range in functional accuracy from 0.1% to .005%, in bridge accuracy from 5 minutes to 20 seconds of arc and in size from 11 to 25. Non-compensated resolvers range from 5 minutes to 20 seconds of arc in accuracy, from 8 to 25 in size.
All Kearfott resolvers feature stainless housing, shafts and bearings and corrosion-resistant lamination materials for maximum environmental resistance. Optional designs available for operation at 200°C and in environment of 2000 cps vibration at 30 g's.

Computing Resolvers

Available with integral compensating windings. Can be provided with trimming networks to match existing isolation amplifiers or Kearfott-designed transistorized amplifiers.

Size 11

For applications where size and good functional accuracy are of paramount importance. Functional accuracy as good as 0.1% and bridge errors of 3 minutes of arc are in production.

Size 15

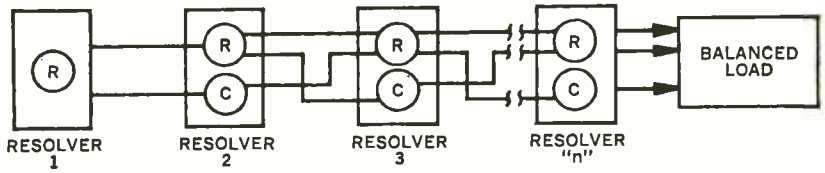
A 2:1 improvement in functional accuracy obtained in this configuration. Unit tabulated is the direct equivalent of standard Navy BuOrd Mark 4 Mod 3 and contains necessary trimming network for standard buffer amplifiers. Transformation ratio is 1.000 ± .0001, phase shift 0° ± 1 minute. Functional accuracy of .05% and bridge error of 3 minutes of arc are standard.

Size 25

For applications demanding the highest order of accuracy. Close attention has been paid to design parameters.

Size 18

A special resolver which permits a unique cascading of these units without the necessity for buffer amplifiers. Typical application is illustrated in following cascade:



R = RESOLVER C = INTEGRAL COMPENSATOR

COMPENSATED RESOLVERS FOR PRECISE COMPUTER APPLICATIONS

SIZE	11		15	18	25
PART NUMBER	R980-01	R980-41	T980-51	V980-004	425506-1
Excitation Volts–(Max.)	60	60	26	26	115
Excitation Volts (Test)	10	10	15	13	25
Frequency–(cps)	400	400	400	400	400
Primary Impedance	629 + j2510	450 + j2200	220 + j1000	3000 + j (0 ± 40)	1630 /78.5°
Secondary Impedance	695 + j2750	500 + j2300	240 + j1100	3000 + j (0 ± 40)	1620 /80°
Transformation Ratio (Primary to Secondary)	.980	.980	.980	.775	.980
Transformation Ratio (Compensator to Rotor)	.985	.985	.950	.775	.985
Phase Shift (Lead)	8.5°	7.5°	8.5°	0° ± 10'	2.1°
Fundamental Null (MV)	15	15	8	15	15
Bridge Error From E.Z. (Max.) Primary	*7 mins. Stator	*5 mins. Stator	*5 mins. Stator	3 mins. Stator	0.7 mins. Stator

*Also available 3 mins. from E.Z.

Non-Compensated Resolvers

Basically for application in precise data transmission systems. These synchro resolvers permit system designer to achieve system errors of better than 1 minute of arc without using 2-speed servos and elaborate electronics. By proper impedance matches up to 64 resolver control transformers can also operate from one resolver transmitter.

Size 11

Where size is important. These units have a maximum unit error of 3 minutes of arc.

Size 25

Where highest accuracy is required. These units have a maximum error as low as 20 seconds of arc.

NON-COMPENSATED RESOLVERS FOR PRECISE DATA TRANSMISSION

	SIZE 11			SIZE 25		
Type Resolver	Transmitter	Differential	Control Transformer	Transmitter	Differential	Control Transformer
Part Number	R982-004	R982-002	R982-012	Z5161-001	Z5191-001	Z5151-003
Excitation Volts (Max.)	26	11.8	11.8	115	90	90
Frequency (cps)	400	400	400	400	400	400
Primary Impedance	170/77°	95 /80.2°	2000/80°	400/82°	800/80°	8500 /82°
Secondary Impedance	42/80.5°	110/75.7°	8000/76°	260/82°	900/80°	14000/82°
Transformation Ratio	.454	1.000	1.906	.7826	1.000	1.278
Max. Error from E.Z.	3 mins.	3 mins.	3 mins.	20 seconds	20 seconds	20 seconds
Primary	Rotor	Stator	Stator	Rotor	Stator	Stator

Write for complete data.

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.
A subsidiary of General Precision Equipment Corporation
Sales and Engineering Offices: 1500 Main Avenue, Clifton, N. J.
Midwest Office: 23 W. Calendar Avenue, La Grange, Illinois
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meanwhile . . . . . back on the earth
Rockets, missiles, moon shoots and interplanetary space travel make highly fashionable advertising these days. Naturally, it is gratifying to us to know that Fusite Glass-to-Metal Hermetic Terminals are aboard nearly all these history making trips into the outer universe. But at least part of the excitement of participation is passing us by. We have no top secret labs or special assembly on exotic military model terminals. The Fusite Terminals that are performing so well under these extremes of temperature, pressure, and mechanical shock are pretty much the same kind of terminals we produce every day by the tens of thousands for commercial production. We're fairly certain that this proves something or other about the ability of Fusite Terminals to perform rather well in your earth-bound electronic components. But we suspect nothing can prove this point to your satisfaction quite so well as trying them yourself—testing and comparing with other kinds of terminals. It may seem like an "earthy" approach, but if it makes sense to you, samples are yours for the asking.
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POLARAD VELOCITRONS*‡ excel for mechanical strength, high temperature operation, and reliable performance

NOW FOR YOUR TOUGHEST APPLICATIONS—

an integrated family of all-ceramic external cavity reflex klystrons 500 to 6,000 mc.

ZV 1012, 500 to 3,000 mc
ZV 1010, 700 to 3,000 mc
ZV 1009, 1,600 to 6,000 mc

MAXIMUM SHOCK AND VIBRATION RESISTANCE

Polarad ceramic construction assures frequency accuracy and stability, and freedom from microphonics under extreme shock and vibration.

MAXIMUM HEAT RESISTANCE

Velocitrons are **guaranteed** for operation up to 250° C seal temperature without loss of performance. NO COOLING REQUIRED.

FULLY INTERCHANGEABLE

These Velocitrons are identical except for frequency. They operate from the same power supplies, use the same mechanical fittings. Anode voltage, 325 volts; cathode current (average), 28 ma.

ZV 1010 is recommended as a physical and electrical replacement for commercial klystrons 5837 and 6BM6; ZV 1009 replaces 5836 and 6BL6.

Write for design information and complete specifications.

*Reg. U.S. Trade Mark

‡Manufactured under Western Electric Patents

POLARAD

POLARAD ELECTRONICS CORPORATION

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

What If Peace Breaks Out? . . .

(Continued from p 33)

ably assured. If the meeting does take place, there is likely to be an outpouring of Soviet-inspired propaganda designed to deemphasize a military approach to the solution of the troublesome problems which beset the major powers.

Review Policies?

Whether or not Russia is serious, or whether the major powers place credence of consequence on the Soviet views, is open to conjecture.

However, a likely aftermath may be a demand by Congressional minorities for a reexamination of our offensive and defensive policies, particularly in light of the basic feud on these measures which now exists.

Particularly affected would be suppliers of warhead missiles and other specific weapons, as opposed to electronic gear associated with space communications and other semicommercial needs.

Unfortunately, the financial and employment affairs of many small-to-medium-sized electronics companies are closely intertwined with military electronics. These companies would be placed in jeopardy.

Possible Repercussions

The extreme high price level at which the electronics shares currently sell could easily drop, were the public to believe the days of higher and higher defense appropriations have reached their peak.

Such a debacle would not only affect equity values. It could seriously endanger many of the million or more persons employed in the 4,200 electronics plants in this country.

A sharp and prolonged decline in the shares of the electronics group, concurrently could spill over into other industries. Many of these, while not necessarily identified as defense contractors, do obtain measurable revenues and earnings supplying defense contractors.

Such a readjustment could undermine the confidence in the sharp economic recovery from the 1958 business recession.

Two-in. picture tube gives 80-sq-in. display (left) in new set using 21 transistors and a battery rechargeable through outlet (right)

Transistors Run 15-lb Tv Set

Portable set's picture is provided by a 2-in cathode ray tube and optically magnified

WRAPS WERE REMOVED this week from a completely transistorized portable tv set.

Only four days old in terms of consumer availability, the new receiver, developed by Philco Corp. weighs 15 lb, including battery. The retail price quoted by the manufacturer is $250.

The set uses a total of 21 transistors for both audio and video circuits combined. A two-inch cathode ray tube is used to provide the picture which is optically magnified. Initial picture size is 1½ in. x 1½ in. This small picture is reflected in a one-way flat mirror and projected on a parabolic mirror which magnifies it to an 80 sq.-in. size.

The battery used was developed jointly by Philco and Eveready. It can operate the set for five hours and is rechargeable. Total lifetime is between 80 and 100 hr.; it weighs 1½ lb. The receiver can be operated by battery or standard house current. An earphone outlet is also provided.

Basic chassis of the unit is made of steel. The lower part is covered with leather and the top, which contains a light hood to reduce ambient glare, is made of plastic. A telescoping rod antenna is located at the top.

Viewer controls are located at the side of the speaker to turn the set on, control contrast, volume and range. The channel selector is on the front face. An aperture at the back contains outlets for recharging the battery.

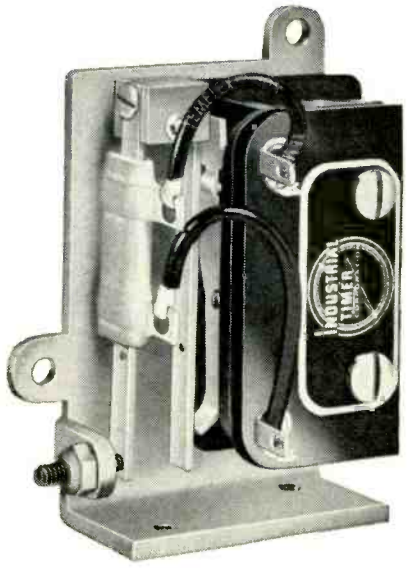
Urges Revamping Of Renegotiation

DAYTON, O.—An electronics industry executive, speaking at the recent National Aeronautical Electronics Conference here, urged revamping of the Renegotiation Act.

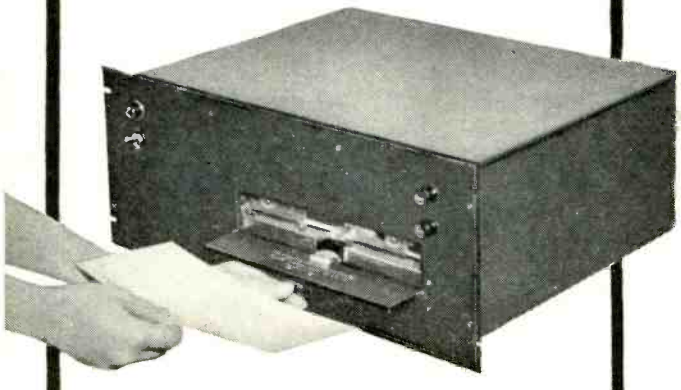
George L. Heller, v-p and general manager of G.E.'s Defense Electronics division, charged that "renegotiation fosters uncertainty in the area of financial operations, upsetting financial planning and having a detrimental effect on important policy decisions requiring prompt action."

Heller suggested the government "reward research and development work as such. Capable and proven producers should be justly compensated for research and development achievement, not for production alone.

"Rates and amounts of progress payments, particularly under large, long-term contracts should not be unilaterally changed by the government."



These new developments are just two recent items added to our ever growing line of industrial timing devices which now exceeds 1,700 controls. If you would like more information about the line, drop us a note requesting our general catalogue.



NEW! MINIATURE THERMAL TIME DELAY SWITCH

10-20 Amp. Capacity—SNAP ACTION

The new Series TH Timer makes accurate switching control of high current applications *practical* and *economical* for the first time! No more bulky, costly thermal switch and relay combinations . . . no more teasing of load contacts in electro-mechanical circuits from slow make-and-break. The new Series TH Timer's SNAP ACTION contacts give *fast, positive* switching of loads *up to 20 amperes.*

There's a wide choice of contacts, too: SPDT, DPDT, Double Break, Magnetic Blowout DC and others to match your needs.

This new, compact timer automatically compensates for ambient temperature changes, by using two parallel bi-metal strips. Longer life comes from the rugged, totally enclosed cast ceramic heater. And you can adjust your time cycle easily with a single screw.

Available in time cycles from 2 seconds to 5 minutes, the new Series TH Timers are the low-cost answer to switching in air conditioning, refrigeration, exhaust and heater controls, computers, lighting, and a host of other applications.

For complete information, write today for Bulletin #900.

NEW! SIMPLIFIED PUNCHED CARD PROGRAMMER

Direct Control from Programmer to Process!

Here's the simple, dependable method of applying true automatic control to most of your manufacturing and operational processes . . . *direct control* of up to 85 individual load circuits through as many as 30 separate functions . . . with permanent, convenient 5″ x 9″ Mylar* punched cards.

Operation from any switch closure makes this electro-mechanical card reader easily adaptable to a variety of control systems, including analog, digital, temperature, feed-back, photoelectric, time and many others. Already in use for a wide variety of industrial and military applications, these flexible units are easily modified to meet your particular requirement.

For more information, write for Bulletin #100.

*Reg. T.M. du Pont

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

1409 McCARTER HIGHWAY, NEWARK 4, N. J.

The number of companies reporting 100-percent planned civilian production was 79 last year and 94 the preceding year—a decrease of about 16 percent. The drop would indicate that more companies are doing business with the military. There was an increase of about 12 percent in the number of companies reporting 100-percent planned military production.

Fewer V-Loans

Companies reporting 100-percent planned military production were 111 for 1959 and 99 for the previous year.

The number of companies having V-loans dropped in 1958 from 52 to 38.

The number of companies that applied for Certificates of Necessity in 1958 were 171, compared with 182 in 1957.

Making Solid-State Digital Computer

SOLID-STATE digital computer recently demonstrated to the press by Remington Rand has actually been in operation in the U. S. and abroad for some months. The company held up formal introduction until production was underway.

The latest version of the Univac relies almost completely on solid-state devices, with a few vacuum tubes used for power-supply and oscillator functions. Ferractors, miniature magnetic amplifiers, are used with semiconductor diodes and transistors.

Reliability, a major design goal, led to use of the Remington Rand Ferractors for many functions because of their greater immunity to such environmental factors as temperature.

Air cooling is not required for the computer.

Power requirements of the new computer are reduced about 10 to 1. Further reductions in power consumption seem unlikely because of the considerable amount of power needed to drive mechanical portions of the equipment, such as memory drum, card puncher and printer. The computer is said to operate reliably despite large variations in line voltage.

One Battle We're Losing —And Why

Lest it seem self-serving, we of McGraw-Hill, as publishers, have hesitated to make the following statement about the "Battle of the Books." However, our reticence has been overcome by our conviction that it is greatly in the national interest to have much wider public understanding of the nature of this battle. This conviction is strengthened by the fact that many, not in the publishing industry, believe in the importance of this battle and, further, by the fact that it is a battle which the United States is losing.

The United States is losing an important battle — a battle of knowledge and ideas, waged with books. It does not have the excitement of competition in scientific achievement, nor the urgency of a diplomatic crisis, nor the obvious economic significance of a struggle for export markets. But our success or failure in this battle of knowledge and ideas may well have a decisive bearing on these more spectacular aspects of international rivalry.

The Russians know this. About a decade ago, they started a program to build up their export of books, the most durable and penetrating way of communicating knowledge and ideas. **By 1957 the Soviet Union was exporting 30 million books, one-and-a half times as many as the United States.** Many of these books are printed in English, and all are in languages of the non-Communist world.

In the languages of the Near East alone, the Russians printed and distributed 413,600 books in 1957, as compared with 166,415 in 1956. In India, Russian textbooks on engineering are to be published in English under a technical aid agreement signed in Moscow last December.

"Trade Follows The Book"

Books are in the advance guard of the Soviet political and economic challenge to the free world. With books go ways of thinking — about government, about education, about management, about science and technology. If these books do their job effectively in the training of those who will become a nation's leaders, they will provide the basis for political and cultural understanding and also, in the future, for trade.

The Russians are not the first to discover this relationship. Britain, which lives by trade, has traditionally exported more of its book production than any other nation. Today it exports one book in every two produced. The British have a favorite dictum: "Trade follows the book." They have proved its accuracy. Now the Russians are trying to make this same principle serve their purposes.

Where does the United States stand in this competition for men's minds? In number of books, it trails far behind the Soviet Union — exporting roughly 20 million books, against the Russians' 30 million. As a proportion of our total output of books, our exports amount to only 10% — against Britain's 50%.

The Russians' Advantage

U.S. book exports have grown in the years since World War II, from approximately $11,000,000 in 1946 to $35,000,000 in 1958 (both figures excluding Canada). But in expanding book exports, the American publishing industry faces two major obstacles:

(1) **The comparatively high cost of producing a book in the United States,** which puts its price well beyond the reach of many students, teachers and businessmen in other countries; and

(2) **The shortage of dollar exchange in many countries,** which means that importers can pay for

New, Electro Instruments all-electronic, totally transistorized digital voltmeter

50 conversions per second • 1000 megohms input impedance • Fully automatic ranging

Model 8409 Voltmeter and Ratiometer

all the features you want in a medium-speed digital voltmeter

- 3 ranges, 9.999/99.99/999.9 volts
- Automatic, manual and remote ranging
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- 4 digit in-line visual readout
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- Modular construction throughout
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Plus accessory modules for every application

AC: All transistorized Model 110; considerably faster AC/DC conversion than presently available models. Fully automatic ranging and direct AC voltage readout on the Model 8409.

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Also scanners, code converter modules, print control modules and many others to solve all digital problems—from simple voltmeter applications to complex data logging systems.

Ask your **EI** *representative for complete information.*

Electro Instruments, Inc.

3540 Aero Court San Diego 11, California

Number of Electronics Employees	Number of Companies	Total Electronics Employees 1958 Average
1–50	174	4,357
51–100	79	6,086
101–200	98	14,649
201–500	96	30,384
501–1000	54	37,268
1001–2000	29	39,630
2001–5000	29	83,574
5001	19	197,692
Totals	**578**	**513,636**

Office of Naval Materiel's breakdown of 578 electronics manufacturers and their employees in 1958 reveals 19 firms hire 197,636 persons as . . .

New Survey Shows Growth

Navy's annual statistical summary gives facts on electronics industry's production, employees

THE ANNUAL STATISTICAL summary of information gathered from 578 electronics manufacturers by the Office of Naval Materiel indicates that the electronics industry is continuing its growth. Sales for 1958 were $8.2 billion, compared with $7.7 billion for the preceding year. Planned production for 1959 is predicted at $9.3 billion.

As an indication of how close planned production figures come to actual sales: last year the forecast report gave probable production for 1958 at $8.27 billion and the production sales was $8.26 billion. Usually, the predictions are within about 4 percent of the actual sales; the figure for 1958 is $\frac{2}{10}$ of 1 percent off.

More Employees

The complete summary, most of which is classified, was compiled by Theodore Bishoff, special assistant for electronics, ONM, assisted by Kenneth Cook, from information obtained from manufacturers through the naval field inspection offices for this annual report, "Manufacturers of Electronic Equipment, Facilities Data, Ratings and Production Capabilities," dated March 31, 1959.

Whenever possible, the data has been restricted to that applicable to electronic end-items, systems, equipments, major assemblies or subassemblies and piece parts produced for direct assembly by the fabricator. Special effort was made, Bishoff said, to exclude data applicable to research and development, piece parts manufactured and sold as such, and non-electronic products. However, it is not possible to separate and exclude all of such data.

The total electronics employees (1958 average) was 513,636, compared with 492,391 for 1957.

The maximum production per year on a one-shift capability was $12.6 billion, as compared with $11.5 billion for the preceding year, indicating more facilities.

Of the total planned production for 1959, the split for military is $5.1 billion and civilian $4.2 billion.

The total military backlog as reported in January was about $5.5 billion, as compared with the total for the previous year of $4.9 billion —an increase of about $600 million. Military backlog subcontracts have increased about $300 million to $1 billion in 1959 from the previous year. There was about the same increase in military backlog on prime contracts—$4.5 billion for 1958 and $4.2 billion for 1957. The subcontractor is getting a good share of business.

Worker Output Rises

The output per employee increased from $15,654 to $16,083. This could be due to a number of factors, Bishoff explained, such as a reflection of increased prices, more efficient production and more subcontracting.

books only in currencies that are of little use to American publishers.

The Russians have neither of these problems. Soviet publishing is state-subsidized, and exported books are sold for nominal sums paid in the currencies of the importers. As these books serve the political and economic purposes of the Soviet Union, they are cheerfully sold on giveaway terms.

The American publishing industry, on its own, is making vigorous efforts to increase the distribution of American books in other countries. Leading U.S. publishers and their agents have offices and salesmen in the major countries of Asia, Africa and Latin America. Several publishers have begun to reprint textbooks in Asia at one-half to one-third of their U.S. costs, thus making them available to the students in Asian countries at prices they can more nearly afford. And the American paperback has become a symbol of low cost in popular books. But neither of these devices is practicable for serious cultural, technical, scientific, educational and professional books, which require durable, hard-bound and necessarily expensive editions. Despite their great importance to those who need these books, the demand for them is simply not large enough to warrant low-cost publishing methods.

Government agencies also have increased the availability of American books. The United States Information Agency and the International Cooperation Administration have placed American books in libraries overseas, donated them to educational institutions and presented them to key individuals in the industries and governments of the developing countries of the world. But these programs are small in relation to the need.

A Modest Program

An unusual and little-publicized Government program has helped American publishers overcome the other major obstacle to the export of books — the shortage of dollar exchange. This is the Informational Media Guaranty (IMG) program, administered by the United States Information Agency. It enables publishers of books judged to be worthy of the American way of life to sell their books, for local currency, in countries such as the Philippines, Formosa, Vietnam, Burma, Indonesia, Pakistan, Turkey, Israel, Poland, Yugoslavia, Spain and Chile, which would otherwise be unable to buy these books because of their shortage of U.S. dollar exchange.

The IMG program is not a giveaway. Publishers have to **sell** their books, and customers overseas have to want them enough to **buy** them at full prices. IMG merely guarantees that the exporting publisher receives in dollars the payments he collects from his customers in their currency. The program costs very little in terms of our total foreign aid program, or in terms of what it accomplishes. In ten years it has made possible the sale of $150 million worth of books, magazines and films to countries of key economic and strategic importance at a cost of only $10 million.

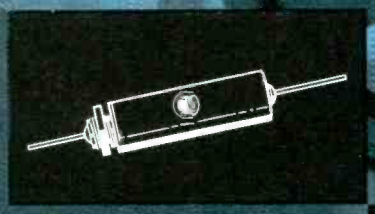
The IMG functions through a revolving fund. Foreign currencies are exchanged for dollars, and the foreign currencies in turn are resold to replenish the supply of dollars. The net cost is the small but unavoidable loss on resale of these foreign currencies. Over the ten years of this program, the IMG revolving fund has shrunk from its original $28 million to $18 million, $10 million of which is in unconverted foreign currencies.

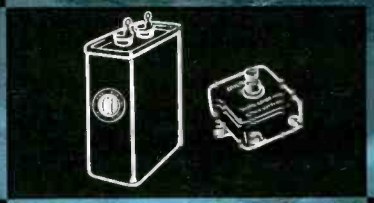
If this modest but vitally important program is to be continued, Congress must appropriate the money necessary to rebuild the revolving fund. This would ensure that any country approved by the State Department and willing to sign an agreement to buy American books, at their full price, with its own currency, could do so. Last August, Congress reduced a requested appropriation for this purpose from $7 million to $2½ million. To continue even at its present reduced level, an appropriation of $3½ million is needed. To realize the full potential of IMG, the revolving fund must be restored to its original level.

If the IMG program is not continued, with adequate financial support, some countries whose friendship and understanding we seek today and with whom we hope to build a trading partnership in the future will have to reduce their purchases of American books to a trickle. These are countries where school teachers, college professors, students, engineers, doctors and businessmen need and want to buy American books. The loss will be not only theirs, but ours as well. For it will deprive the U.S. of one of its most effective, and least costly, means of communicating knowledge and ideas and understanding of the American way of life.

circuit designer's first choice ... from Cornell-Dubilier

film dielectric capacitors





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- **TEFLON: −55°C to +250°C**
  - Miniature Metal-case Tubulars with glass-to-metal end-seals
- **MYLAR: −55°C to +160°C**
  - Miniature Metal-case Tubulars with glass-to-metal end-seals
  - Molded Plastic-case Tubulars
  - "Minireo" Steatite-case Tubulars
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  - Film Tape-wrap Tubulars
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- **POLYSTYRENE: −55°C to +85°C**
  - Miniature Metal-case Tubulars with glass-to-metal end-seals
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  - Film Tape-wrap Tubulars
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Consistently Dependable
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CAPACITORS

*Du Pont Reg. T.M.

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OPERATIONAL FEATURES

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Coil of anodized aluminum wire.

SUSPENSION

Suspension wire is made from gold, platinum, or silver alloy ribbon.

POLE PIECES

Pole pieces are mounted in case adjacent to the coil. Permits rotation.

AGING

Aging process minimizes mechanical defects, such as, permanent zero shift and balance defects, which otherwise might occur after the galvanometer has been in use.

DAMPING

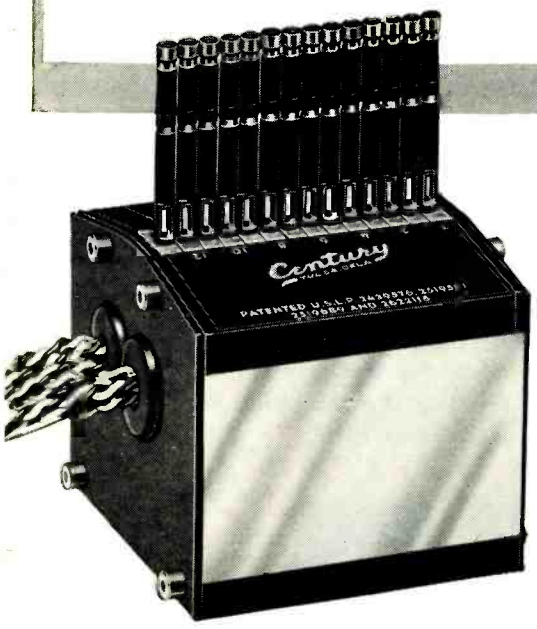
Model 210 galvanometers are normally damped to 64% of critical.

MAGNETIC ASSEMBLY

A permanent magnet type assembly is used in conjunction with the galvanometers.

PHYSICAL CHARACTERISTICS

Mirror: Cylindrical, focal lengths 5.88" or 3.1"
Size: 2.5" length; .125" diameter.
Weight: 0.11 oz.
Mounting: Plug in—no external wire connection.
Pole Pieces: Integral with tubular case, except in fluid damped units.
Terminals: Within magnetic assembly. All elements are electrically isolated.
Balance Factor: 0.008 inch per g at 12 inches.



The performance of any recording oscillograph is governed primarily by the quality of the galvanometers used in the instrument. Century galvanometers with their many unique features have been the accepted "standard" for the past decade. Intensive research and study of various recording problems coupled with the latest in improved manufacturing techniques, assures the maximum in reliability, efficiency, and factor of merit. Century galvanometers and magnetic assemblies can be installed in any photographic recording oscillograph.

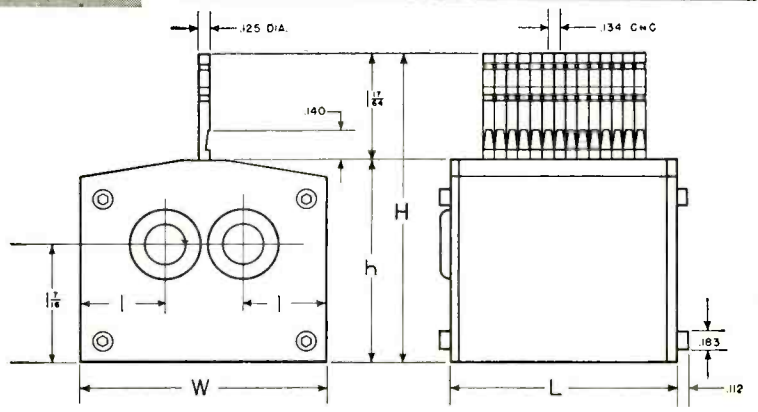
Model 210 galvanometers are available in a wide range of frequencies and sensitivities. (See table on opposite side). Several types are designed for direct excitation from many kinds of transducers, such as, strain gages, pressure pick-ups, accelerometers, thermocouples, etc. This eliminates the need for costly amplifiers and in most instances the output impedence of the transducer provides the optimum damping impedance for the galvanometer.

The galvanometer suspension is hermetically sealed in a tubular case. This provides protection from most atmospheric environments, eases installation and removal problems, reduces maintenance due to handling, etc.

Electrical connection to the moving coil is made through the tip and a lower portion of the galvanometer case. These surfaces mate automatically with positive leaf spring contacts in the magnetic assembly as the galvanometer is being installed. Twisted pairs of lead wires extend from the leaf spring contacts through one end of the magnetic assembly to the source of excitation. All contact surfaces are gold over silver plate to assure minimum contact resistance.

STANDARD MAGNETIC ASSEMBLY OUTLINE DIMENSIONS
— Other Magnetic Assemblies Available on Special Order.

Assembly No.	Number of Galvos.	L	H	h	W	Cable Length
11OC100-1	6	1 9/64	3 11/16	2 27/64	2 29/32	18"
11OC101-1	12	1 15/16	3 11/16	2 27/64	2 29/32	18"
11OC102-1	18	2 3/4	3 11/16	2 27/64	2 29/32	18"
11OC103-1	24	3 35/64	3 11/16	2 27/64	2 29/32	18"
11OC104-1	30	2 23/64	3 11/16	2 27/64	2 29/32	18"
11OC200	2	1 9/64	3 11/16	2 27/64	2 29/32	24"
109C100	14	2 9/64	3 15/64	1 31/32	2 1/4	5"



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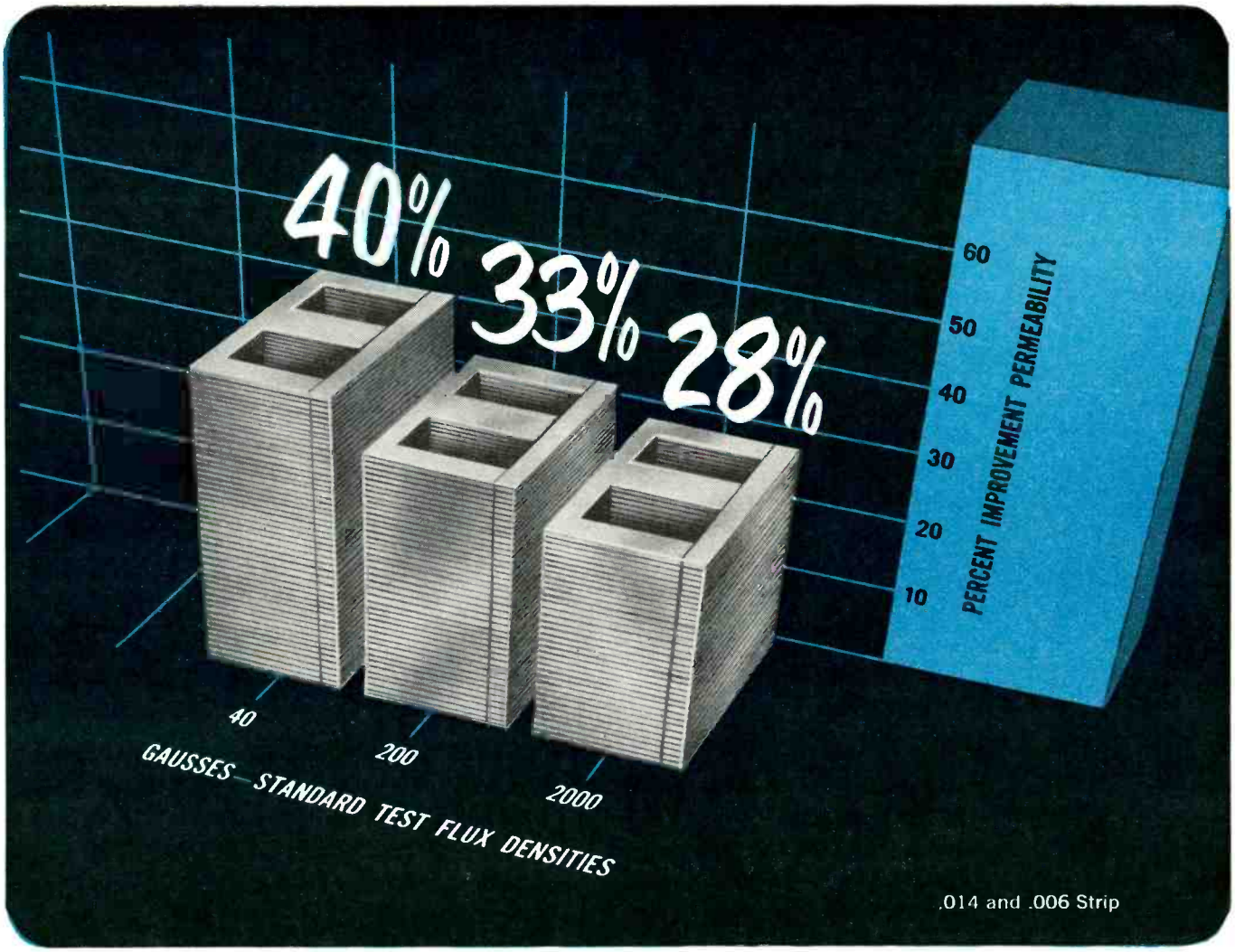

Higher permeability values now guaranteed for Allegheny Ludlum's Moly Permalloy

Means new, consistent and predictable magnetic core performance

Molybdenum Permalloy nickel-iron strip is now available from Allegheny Ludlum, with higher guaranteed permeability values than former typical values. For the buyer, this new high quality means greater uniformity . . . more consistent and predictable magnetic core performance.

This higher permeability is the result of Allegheny Ludlum's intensive research on nickel-bearing electrical alloys. A similar improvement has been made in AL-4750 strip steel. A-L continues its research on silicon steels, including Silectron, well-known grain-oriented silicon steel, and other magnetic alloys.

Complete facilities for the fabrication and heat treatment of laminations are available from Allegheny Ludlum. In addition, you can be assured of close gage tolerance, uniformity of gage throughout the coil, and minimum spread of gage across the coil-width.

If you have a problem relating to electrical steels, laminations or magnetic materials, call A-L. Prompt technical assistance will be yours. And write for more information on Moly Permalloy. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

Address Dept. E-18.

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Aerial Photos in 2 Minutes

New photo-transmission system quickly relays air photographs to ground in rapid sequence

BY FALL, a new photo-transmission system will enable an Army field commander to sit in his air-conditioned shelter and every two minutes examine a new, high-quality aerial photograph taken from a manned aircraft or a surveillance drone. Each picture will be only two minutes old.

Beyond the fact that an actual photograph is a permanent record, the resolution of the picture will be superior to that of a tv screen.

Prime contractor for the system, Fairchild Camera and Instrument, will deliver two airborne units and one ground set to Army Electronic Proving Ground, Fort Huachuca, Ariz, in October. If results are good, the system will be bought by all three services.

Airborne gear consists of a camera, developing unit, accumulator, telemetering system, opto-mechanical scanner developed for Ultrasonic Light Modulator video recorders, and radio transmitter.

Ground equipment includes radio receiver, developer and tracking radar.

How System Works

Processing, scanning and transmission from the plane takes 1.3 minutes. On the ground, the video telemeter signals are picked up by a narrow-beam, high-gain antenna slaved to the tracking radar. The received video feeds both a high-resolution recorder and a direct-view monitor.

Since the transmission bandwidth is limited by channel allocation to 1.5 mc/s, the frame rate of the system is extremely low, and conventional tv viewing is not possible. One frame requires eight seconds for transmission, so the direct-view monitors must be storage-type cathode-ray tubes. These are of relatively low resolution capability, and provide only a rough picture.

The high resolution pictures are produced by the ground recorder, which uses photographic film. A fast processor makes the film available for viewing 40 seconds after receipt of the signals. The picture is viewed in both a conventional monocular viewer and in a binocular viewer for stereo.

The receiving antenna, in the form of a parabolic dish, is mounted on or near the shelter. It is dismounted and partially disassembled for storage in the shelter during transport.

Army Lists Funds For Surveillance

ARMY plans to spend $98.4 million in fiscal 1960 for battlefield surveillance gear.

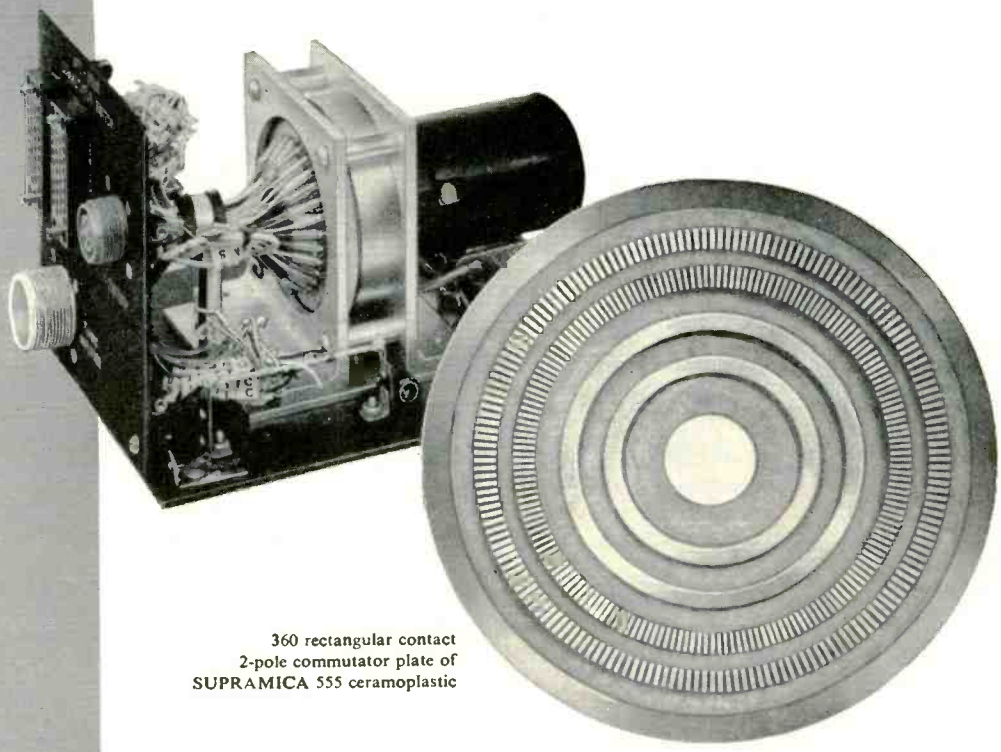
Proposed spending breakdown: 42 airborne radar navigators for $6.3 million; 42 new aerial photographic systems, $800,000; $35.2 million for reconnaissance drones; $51.8 million for radios—for aircraft, battle group, company and platoon; $1.1 million for moving target detectors; $2 million for atomic flash detectors; $300,000 for wind-measuring sets; and $1 million for modification of the missile master system to link it with Sage.

Scans Space

New 85-ft radio telescope at University of Michigan receives wave lengths as short as 3 cm. Projects planned include study of 21-cm radiation from our galaxy and other galaxies

major advance in miniaturization:

SUPRAMICA® 555 commutator plates



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

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

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

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

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

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

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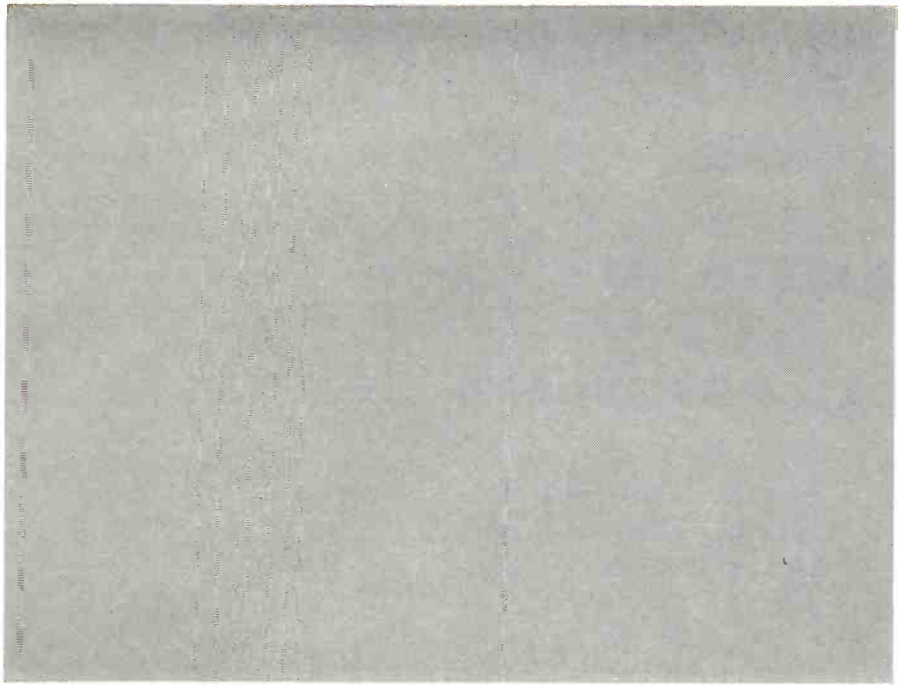
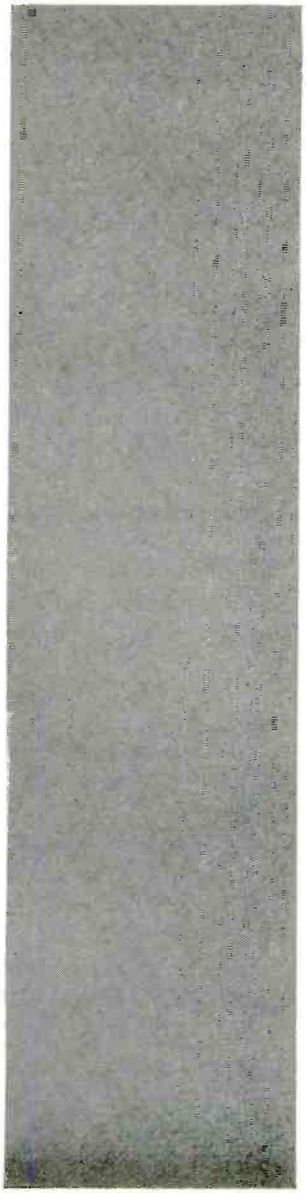




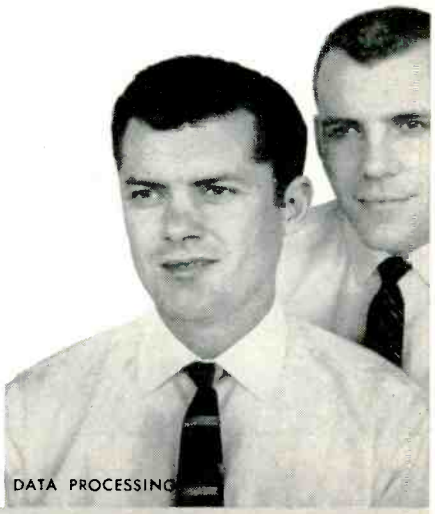
It's great to be proud of the place you work

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

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

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

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



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Downey, California

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MEETINGS AHEAD

June 4-5: Production Techniques, National Conference, PGPT of IRE, Villa Hotel, San Mateo, Calif.

June 7-11: Microwave Tubes, International Congress, Verband Deutscher Electrotechniker, VDE, Brienner Strasse, Munich, Germany.

June 15-20: Information Processing, International Conf., UNESCO, PGEC of IRE, AIEE, ACM, UNESCO House & Palais de Exhibition, Paris, France.

June 15-20: Electromagnetic Theory Symposium, USSI, PGAP and PGMTT of IRE, Univ. of Toronto, Ontario, Canada.

June 16-18: Circuit & Information Theory, International Symposium, PGCT & PGIT of IRE, Univ. of Calif., Los Angeles.

June 24-26: Nuclear Instrumentation Symposium, ISA, Idaho Falls, Ida.

June 24-27: Medical Electronics, International Conf., UNESCO, CIOMS, PGME of IRE, Rockefeller Inst., UNESCO House, Paris.

June 29-July 1: Military Electronics, National Convention, PGMIL of IRE, Sheraton-Park Hotel, Wash., D. C.

July 1-5: Television Convention, International, British Institution of Radio Engineers, Univ. of Cambridge, England.

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

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

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

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

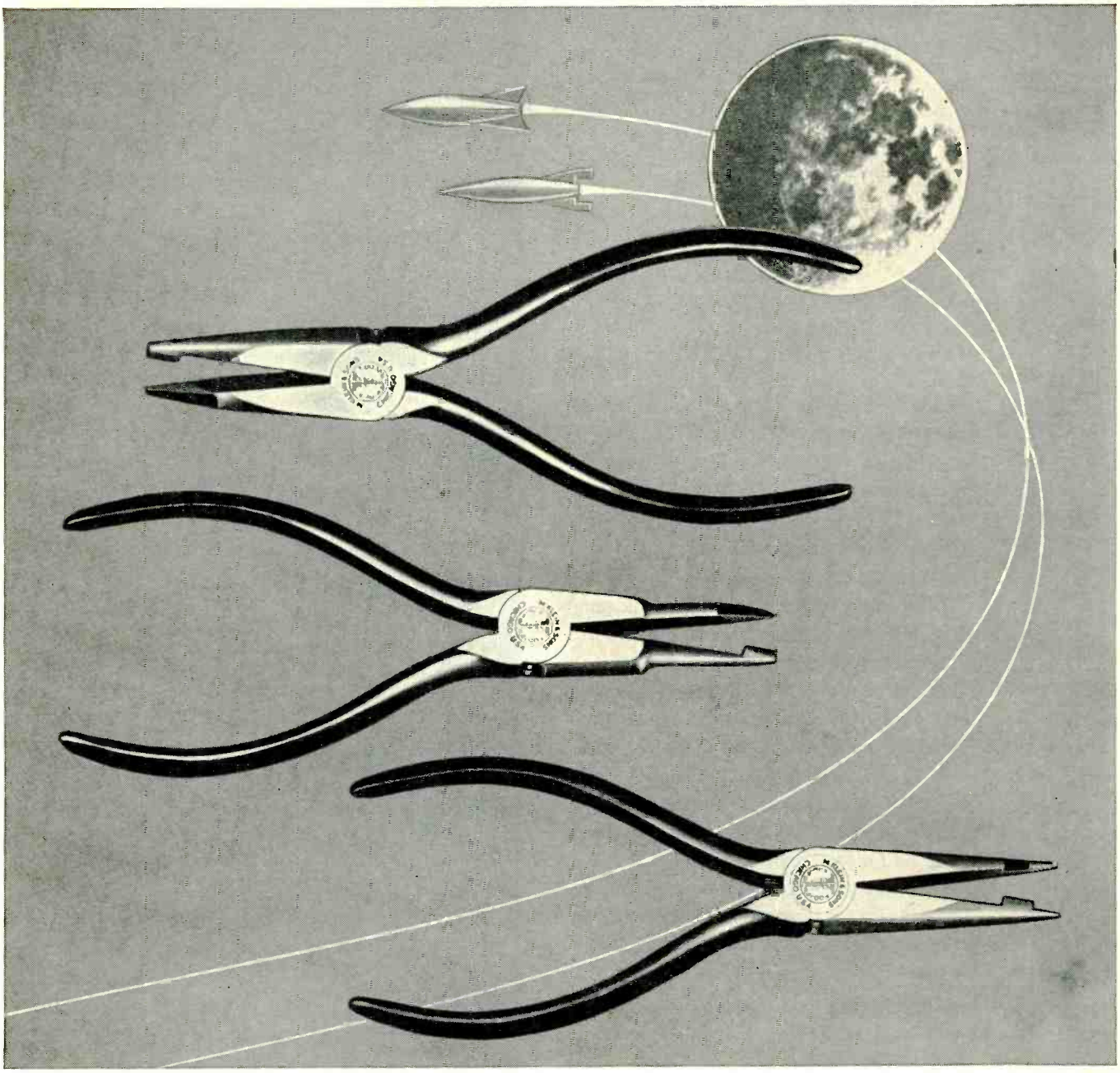
Sept. 15-17: Electronic Exposition, Twin Cities Electronic Wholesalers Assoc., Municipal Auditorium, Minneapolis.

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

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 92.

THREE KLEIN PLIERS

to make electrical wiring easier



Here are three newly engineered Klein Pliers which will solve difficult problems in the wiring of electronic assemblies. Catalog 101-A illustrates and describes these and twenty other new pliers in the Klein line. If you wire electronic assemblies, write for a copy.

ALL-PURPOSE ELECTRONIC PLIER
Patent pending

Shear blade cuts flush and holds clipped end of wire

Requires no sharpening; will cut hard or soft wire. Smooth, continuous action prevents shock which may damage resistors. For bare wire up to 18 gauge.

No. 260-6—length 6⅜"

No. 260-6C—with coil spring that holds jaws open

NEEDLE-NOSE PLIER Patent pending

Similar to No. 260-6 but nose has been slimmed down to permit use in confined areas.

No. 261-6—length 6⅜"

No. 261-6C—with coil spring to hold jaws open

LONG-NOSE PLIER—KNIFE AT TIP Pat. No. 2,848,724

Jaws behind blade hold clipped wire end firmly

A shear-cutting plier that will cut hard or soft wire. Blade is at the tip of the plier. Supplied with coil spring to keep jaws apart.

No. 208-6PC—length 6⅝"

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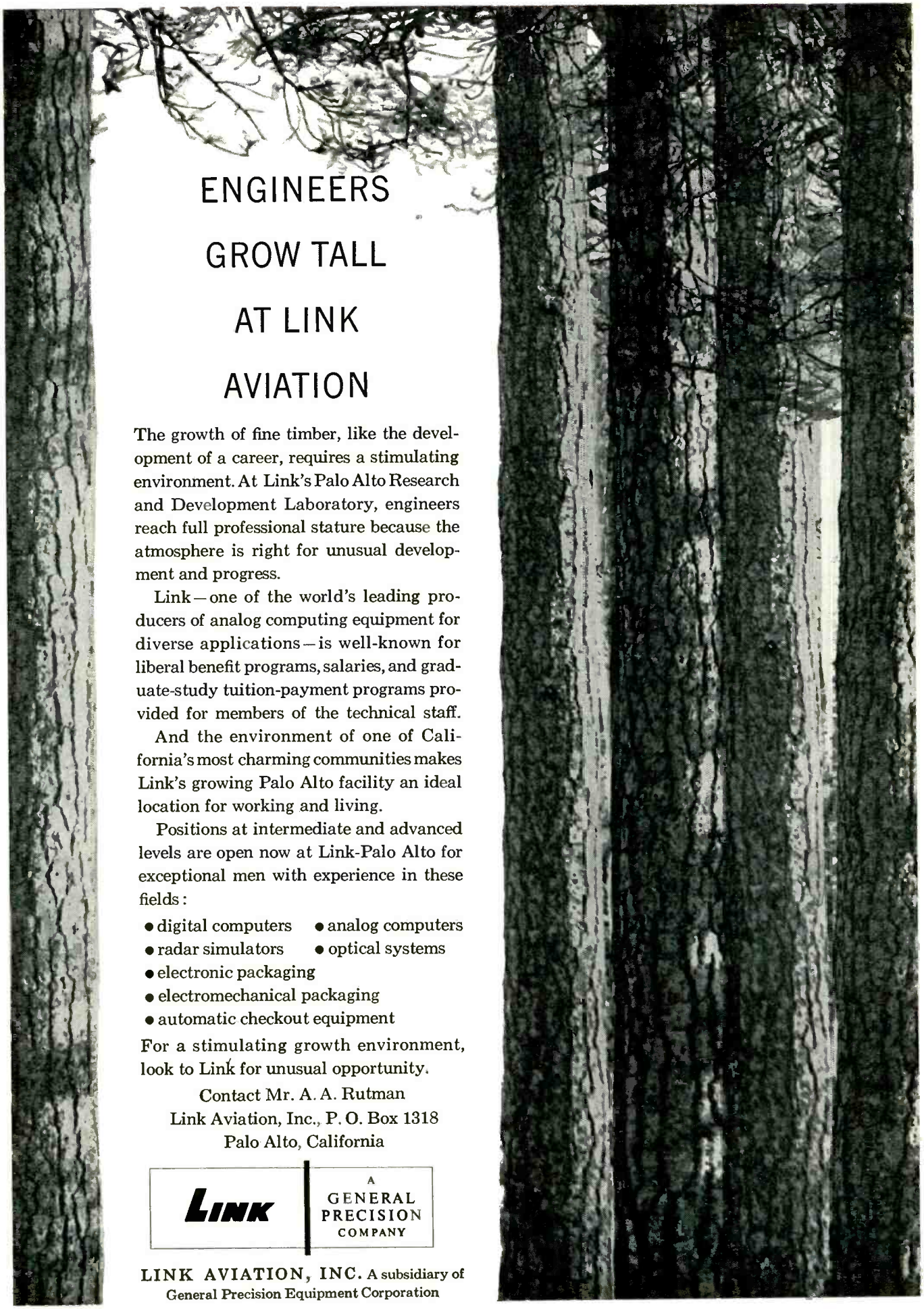
Write for Catalog 101-A, which shows the complete line of Klein Pliers, including 20 pliers recently developed.



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DVOM price $1,475

Ask for a demonstration.

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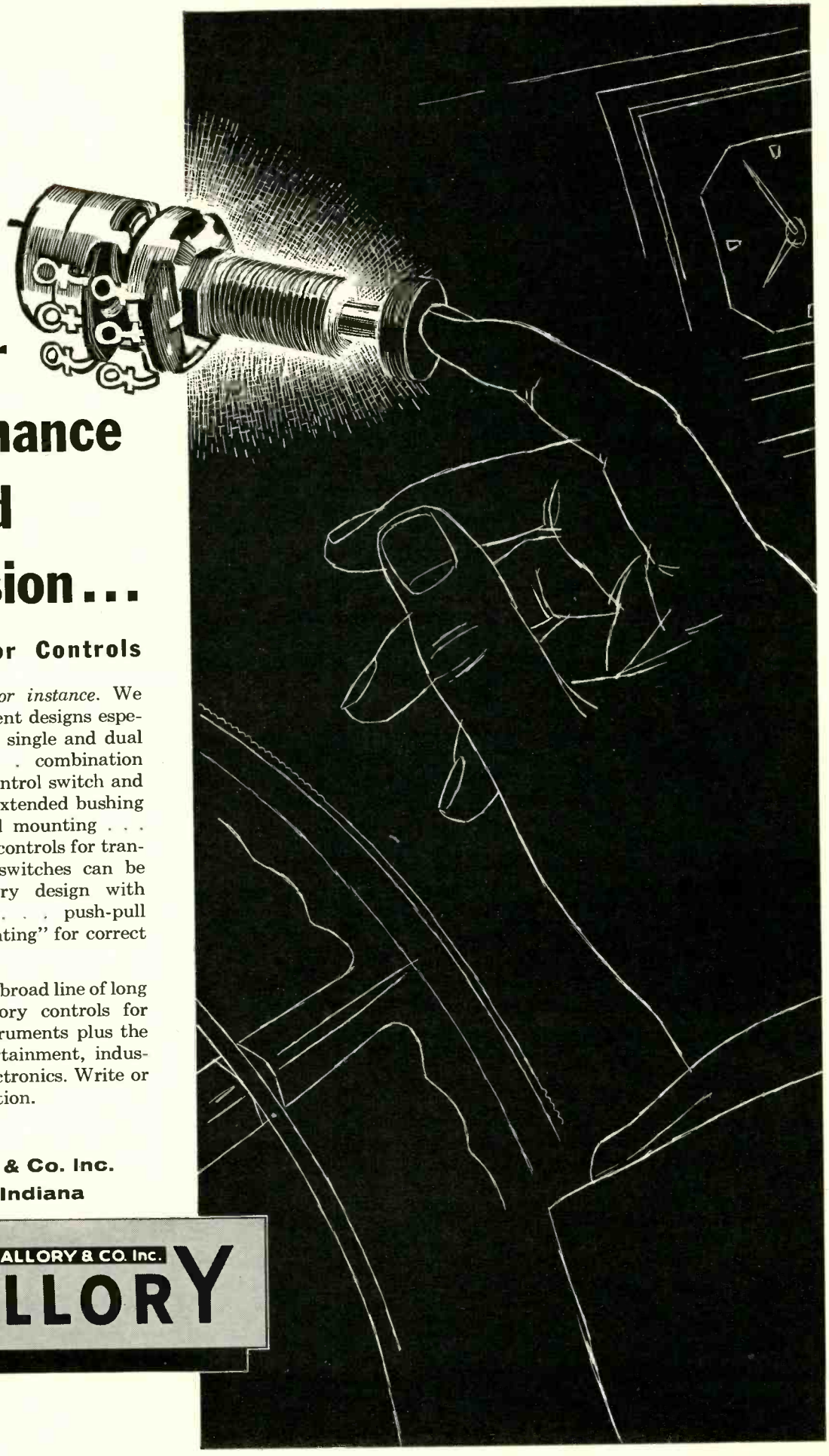

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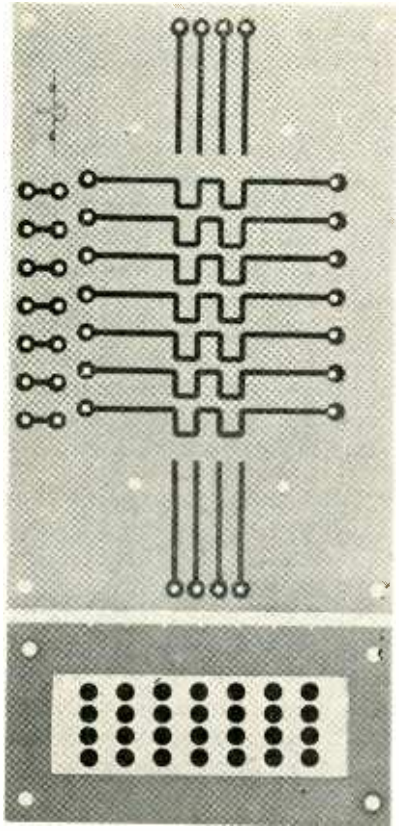


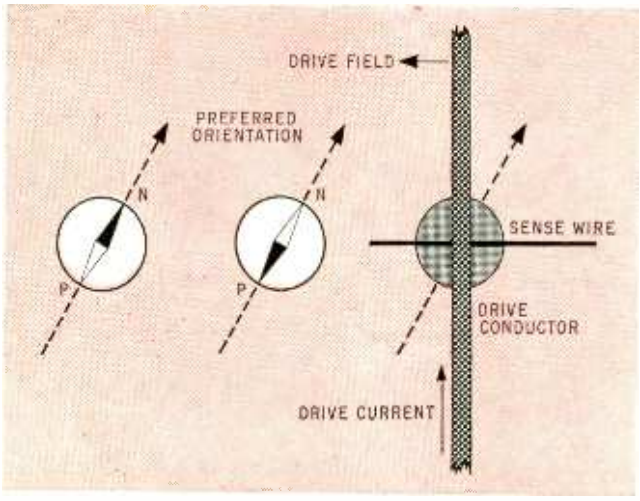


FIG. 1—Magnetic film deposition is analogous to a compass needle or magnetic dipole. Two stable states make it useful as a binary element

Printed circuit on glass epoxy board showing seven vertical information conductors and four drive conductors. At left is a 4 by 7 thin film memory plane made up of 3/16-in. depositions on glass substrate

Using Thin Films in High-Speed Memories

For greater speed in today's digital computers, thin ferromagnetic films offer many advantages in the fabrication of memory planes operating in the millimicrosecond range

By **ERIC E. BITTMANN,** Applied Science Dept., Burroughs Corporation, Research Center, Paoli, Pa.

MANY FERRITE CORES are presently operating in memories for digital computers and giving excellent performance. However, these memories are difficult to assemble and the method of threading each ferrite core with one or more conductors is a costly one. Automation is not easily achieved. Fabrication of ferromagnetic thin film memories is relatively simple, and automatic assembly is feasible.

Results obtained experimentally indicate that complete memories can be made by deposition of magnetic materials and conductors onto a substrate, thus lowering construction cost. Thin films operate in the millimicrosecond range and over a much wider temperature range than ferrites.

DEPOSITION—Storage elements in thin film memories are deposited magnetic metal films 2,000 A thick. Deposition is done in vacuum onto hot glass substrates under the influence of a magnetic field.

The deposition of the nickel-iron alloy through a metal mask produces memory planes with round spots of 3/16-in. diameter. The films show a preferred

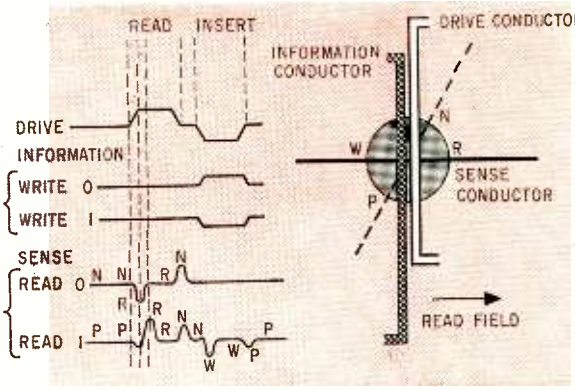


FIG. 2—Introduction of read field tends to rotate magnetic dipole toward *R* state, inducing a signal in sense conductor

direction of magnetization determined to a large extent by the magnetic field during deposition. In a 60-cps loop tracer the film shows a square hysteresis loop along the preferred direction, and perpendicular to it, an almost linear hysteresis loop.

BEHAVIOR OF THIN FILM—The magnetization of each deposited area can be represented by a compass needle or a magnetic dipole as in Fig. 1. In the absence of any outside magnetic field, the needle has two stable states, parallel to the preferred direction.

The two states of the magnetic dipole are called *N* state and *P* state. If a current of sufficient magnitude is sent through a conductor, its magnetic field causes the dipole to rotate out of the *P* state or *N* state toward the drive field. When the current is removed, the drive field disappears and the dipole finds itself in an unstable position. It then rotates toward the closest stable state. As a binary memory element, the *P* state could be defined as the storage of a one and the *N* state as the storage of a zero.

MEMORY ARRAY—The sense conductor is always at right angles to the drive conductor to minimize noise pickup from drive current pulses. Figure 2 shows drive and information conductors parallel to each other and at right angles to sense conductor.

The state of the thin film element is sensed by subjecting it to a magnetic field which tends to rotate it toward the *R* state. This field is called the read field and can be as large as desired. The rotation of the dipole from *N* to *R* induces a negative signal in the sense conductor and a rotation from *P* to *R* induces a small negative signal followed by a larger positive signal. After termination of the read field, the dipole falls to the *N* state, inducing another positive signal in the sense winding.

During the write operation, two magnetic fields are applied, an insert field on the drive conductor and a write one or write zero field on the information conductor. The write zero field subtracts from the insert field while the write one field adds. The force of the insert field is two-thirds the magnetic threshold and the write one or zero is one-third of the threshold.

When writing a zero, the dipole remains in the *N* state during the write operation, due to the application of only one-third the threshold field. When writing a one, the dipole rotates to *W* and after the fields are removed, falls to the *P* state.

STORING A BIT—In practice, storage of a bit is performed with two alternately located spots instead of one, as shown in Fig. 3A. A zero is stored if both films *A* and *B* are in the *N* state and a one is stored if both *A* and *B* are in the *P* state.

Assuming both films are in the *N* state and a read drive pulse is sent through the drive conductor, film *A* rotates from *N* to *R*, but film *B* rotates from N to *W*. The rotation from *N* to *R* induces a negative signal and rotation from *N* to *W* induces a small positive followed by a negative signal in the sense conductor. Both signals from *A* and *B* combine into a negative signal as shown in Fig. 3B.

When the drive current is removed, film *A* rotates back to the *N* state, and film *B* rotates to the *P* state. To write a zero back into the films, an insert drive current of two-thirds full switching magnitude is sent through the drive conductor. At the same time a write current of one-third switching magnitude is sent through the information winding; this subtracts from the insert field in film *A*, but adds to the field in film *B*. Therefore, film *A* remains in the *N* state, but film *B* rotates from *P* to *R* and, upon removal of the field, falls to *N* completing the write cycle.

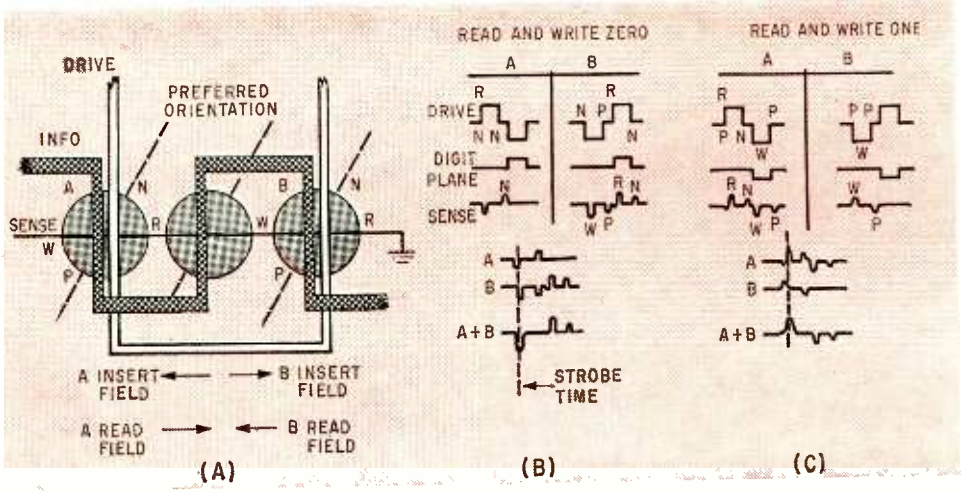
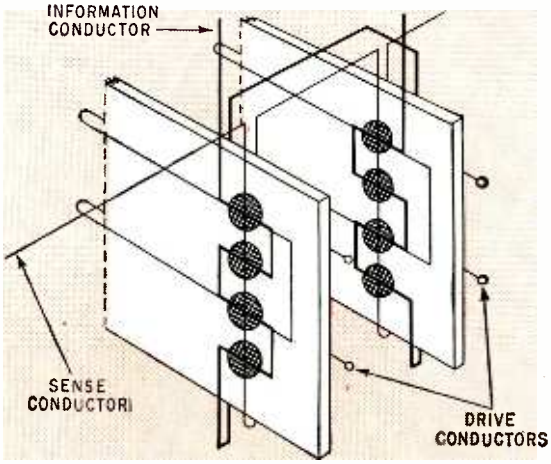


FIG. 3—Storage of an information bit is accomplished with two alternately located spots (A). Waveforms illustrate reading and writing a zero into memory (B) and storing or reading a one (C)



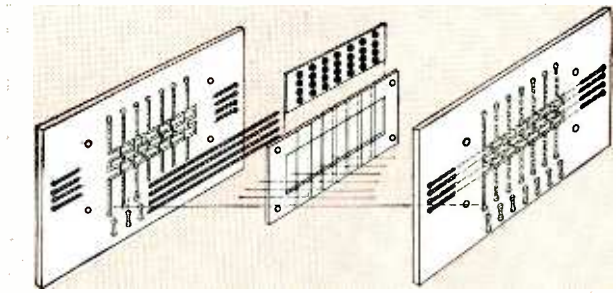


FIG. 5—Exploded view shows method of assembling 4 by 7 sample memory

FIG. 4—Construction of memory using pairs of planes insures good signal-to-noise ratio

If both films are in the P state, and a read current is applied, the rotation from P to R in film A induces a small negative followed by a positive signal; rotation from P to W in film B induces a positive signal. The combination of the two produces a sense signal exactly opposite in polarity, but of the same duration and shape as the read zero signal as seen in Fig. 3C.

Upon removal of the drive field, film A falls back to N and film B falls to P. To write the one back into the film, the insert current and a write one current of opposite polarity are sent through their conductors. The magnetic fields which add in film A rotate it to W; those which subtract in film B leave it in the P state. When the fields are removed, film A falls to P and film B remains in P. The cycle is completed and the one is written into the films.

For good signal-to-noise ratios, construction of memory planes using this arrangement should be in pairs, as shown in Fig. 4. Orientation of the information conductor is reversed on the second plane.

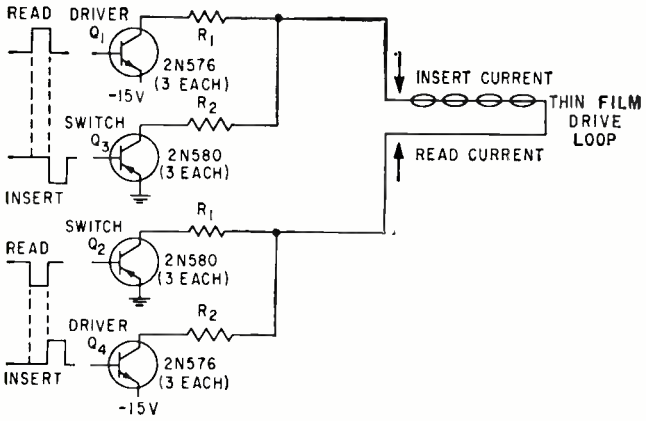


FIG. 6—Transistors are used as current drivers in read-insert circuit

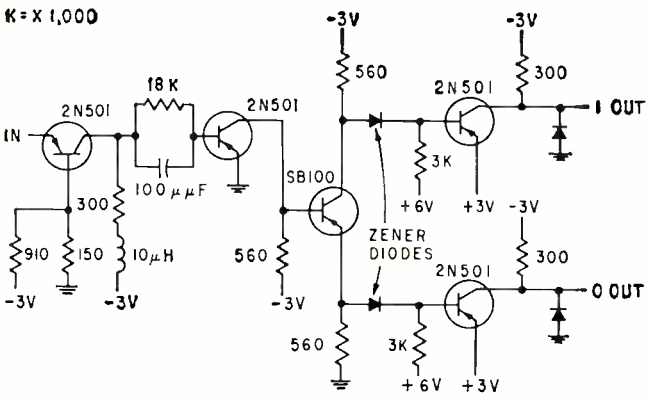


FIG. 7—Schematic of sense amplifier. Common-base input stage matches low input impedance of sense winding

MEMORY FABRICATION—Sample memory planes have been build having 4 by 7 depositions of 3/16-in. diameter spots on $\frac{1}{4}$-in. centers along the narrow edge and on $\frac{3}{8}$-in. centers along the long dimension of the glass substrate. The assembly is as shown in Fig. 5.

Two identical epoxy boards make up the sample memory. The thin film slide is mounted into a frame and seven sense windings wound on. Number 36 magnet wire is used for the sense conductor rather than a plated conductor to minimize capacitance between the sense and drive conductors.

The prewired memory plane is then sandwiched between the two epoxy boards, the sense wires are soldered to the terminals provided, and the assembly is completed.

CIRCUITS—The current drivers deliver 1-amp pulses with a rise time of 0.15 μsec. As shown in Fig. 6, the drivers are each comprised of three type 2N576 transistors in parallel, each with a current rating of 400 ma. Three type 2N580 *pnp* transistors are also connected in parallel for each current switch.

A positive read pulse gates driver Q_1 and a negative read pulse energizes switch Q_2. Current flows through the thin film loop in one direction. After completion of the read pulse, the insert pulse gates drive Q_3 and switch Q_4; the insert current flows in the opposite direction to the read current.

The sense amplifier, shown in Fig. 7 amplifies the 5-mv input signal to a 3-v level. A common-base input stage matches the low source impedance of the sense winding. The Zener diodes shift d-c levels of the output signal to the desired 0 to +3-v level.

The contributions to this project made by the Ferromagnetic Thin Films Group under J. D. Blades are gratefully acknowledged.

Testing technique provides quick and simple tester operation with dependable and identical results regardless of operator's skill. Overall radar system power output and sensitivity are measured directly; range rate, range to bomb release and constant range are compared to values developed by tester

By **WILLIAM F. KROEMMELBEIN,** USAF, Air Research and Development Command, Naval Air Development and Material Center, Johnsville, Pa.

Radar Test Systems

MAINTAINING MILITARY AIRCRAFT in a state of readiness for flight is a manifold problem. Although reliability of airborne electronic equipment is steadily being improved, there still exists a great work load in testing and servicing aircraft systems which must be done by ground checkout gear. The situation is further complicated by the fact that insufficient numbers of experienced people capable of performing quality electronic maintenance are available.

The radar system tester described alleviates the maintenance problem by using testing techniques which are comprehensive and which accelerate checkout procedure. Also, the tester can be operated by personnel possessing a far lower level of training than is presently required.

Results of service tests in a Strategic Air Command squadron showed that 2,800 maintenance manhours per month were saved on a single radar system. Malfunctions were detected before flight which were not detected by conventional methods, thereby resulting in a marked increase in trouble-free missions flown by aircraft equipped with bombing-navigation radar systems.

Test Capabilities

Essentially, the tester is a beacon transponder with a controllable delay between received and retransmitted pulses. Signals transmitted from the aircraft radar are received, peak power amplitude measured and, after a controlled time delay, an adjustable output signal of known power transmitted back to the radar receiver.

Peak power of the transmitted pulse from the radar system in any range from 0.5 to 300 kw is measured by precisely determining the power received by the tester antenna. Although designed for use with a radar antenna of 30-db gain, the tester can be calibrated for use with antennas of other gains. Also, the overall system receiver sensitivity over a range of −70 through −120 dbm can be measured by monitoring the power level of the retransmitted return signal.

The tester simulates ground targets as they would be seen by the aircraft radar from an altitude of 30,000 feet at ranges varying from 5 to 35 nautical miles. Approach velocities in the range between 120 and 600 knots can also be simulated.

THE FRONT COVER—Radar system tester permits personnel with limited technical training to completely check out bombing-navigation radar system used in Strategic Air Command bomber. During checkout, tester is placed approximately 120 feet directly in front of the aircraft. Since radiated energy is utilized, no physical connection with radar system under test is required. Each radar component is tested simultaneously under actual operating conditions, thus malfunctions in component combinations not evident in check of individual components can be detected

Tester Operation

A block diagram of the radar system tester is shown in Fig. 1. The transmitted signal from the radar system under test is received through a horn-type antenna located at the back of the tester. After passing through a fixed attenuator which reduces its level to within the linear range of the mixer crystals, the signal is combined in a balanced mixer with a signal originating from a local oscillator giving an intermediate frequency of 40 mc. This i-f signal is fed through a gain-stable preamplifier to two output paths—one to an afc circuit and the other to an amplitude comparison circuit.

AFC Circuit

The signal applied to the afc circuit passes through an i-f amplifier and a limiter-discriminator. A constant output for input variations up to 55 db is provided by the limiter giving the discriminator circuit a useful range of about 65 db. The discriminator develops an output pulse which varies in amplitude almost in proportion to the deviation of the signal frequency from the 40-mc center frequency. Polarity of this pulse is dependent upon the direction of the frequency error.

Output of the discriminator is amplified by a pulse amplifier and converted to a d-c level by a clamping circuit and filter. After further

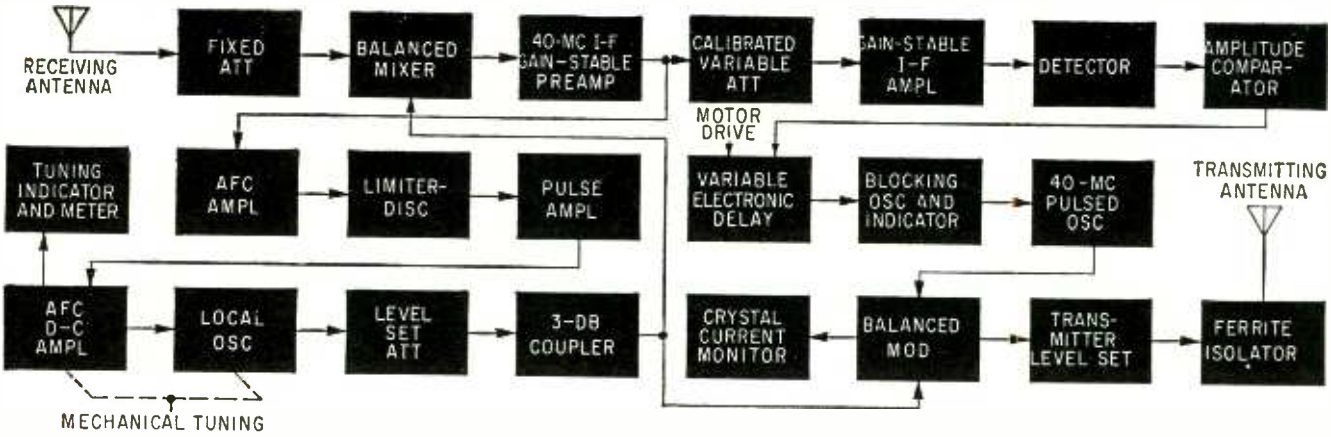


FIG. 1—Electronic circuits of radar system tester are constructed on small, plug-in chassis that can be replaced to facilitate rapid maintenance. Each chassis performs a specific function; therefore, localization of a failure need be carried only to a chassis level

to Shorten Checkout Time

amplification, the d-c level is applied to the klystron of a local oscillator to effect automatic frequency control.

Monitoring of the d-c voltage in the afc d-c amplifier is done with a tuning meter which indicates the error voltage caused by a difference frequency. This error is reduced to zero by mechanically tuning the local oscillator.

Since the afc circuit is effective over a range of frequency error, the meter is provided with a green center area in which satisfactory operation is possible. This center area represents a frequency error of approximately ± 0.15 mc at the intermediate frequency or an input error of ± 15 mc. To further aid in tuning, an indicator lamp is provided which glows when the tester frequency is locked to the radar frequency.

Mechanical tuning of the klystron local oscillator necessitates shifting the center of the afc voltage range to achieve frequency control equally above and below center frequency. This shift is done with a potentiometer coupled to the tuning control of the klystron which reestablishes the center of the afc operating range at any frequency.

Output of the klystron is fed into a level set attenuator which controls the power from a 3-db coupler. The attenuator is adjusted by observing output current on a crystal current monitor. When the monitor is at the indicator line, the maximum output of the transmitting antenna is 1 mw peak power.

Amplitude Comparison Circuit

The signal applied to the amplitude comparison circuit is fed into a precision calibrated variable attenuator with which the power level of the received signal is adjusted. Upon leaving the attenuator, the signal passes through a gain-stable i-f amplifier and a detector to an amplitude comparator which provides an output only if the input is above a predetermined reference level (approximately 1 v). When the tester is operational, the calibrated attenuator is adjusted so that the signal level is slightly above the threshold of the amplitude comparator as indicated by a threshold lamp. Power output of the radar transmitter is read directly from the calibrated attenuator dial.

When the incoming signal is adjusted slightly above the amplitude comparator threshold, a pulse is fed to a variable electronic delay circuit. This circuit establishes the time delay between received and retransmitted signals, thus simulating target range. Aircraft velocity or range rate is simulated by changing the time delay interval with a motor-driven potentiometer. Speed of the motor establishes the simulated velocity.

Since the tester simulates the slant range to target at an aircraft altitude of 30,000 ft, the time delay must be a nonlinear function of simulated aircraft velocity. Nonlinear delay is obtained by using a portion of a potentiometer having a sinusoidal resistance curve. Range rate drive is automatically disconnected when the range has been driven to the minimum ground range of 5 mi.

A reset switch can be actuated to return the range drive to 35 mi and recycle the system. The drive motor can be stopped at any point to simulate a constant range. Since tester reading of range rate, range to bomb release or constant range can be compared to equal values in the system, overall computer accuracy is easily determined.

The signal from the electronic delay is used to trigger a blocking oscillator which excites the threshold indicator lamp and triggers a 40-mc oscillator. Output of the oscillator is combined in a balanced modulator with a signal originating from the local oscillator producing an r-f signal nearly identical in frequency to the radar transmitted signal. This signal is passed through a transmitter level set attenuator which is precision calibrated from 0 to 50 db. The resultant calibrated signal is fed to the tester transmitting antenna through a 30-db ferrite isolator and is retransmitted to the radar receiver. By adjusting the level set attenuator, a minimum acceptable signal can be provided to the radar receiver. Sensitivity of the entire system is indicated by the setting of the calibrated attenuator.

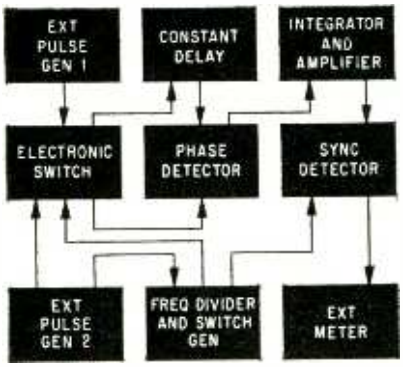


FIG. 1—Constant delay circuit allows measurement of small phase angles

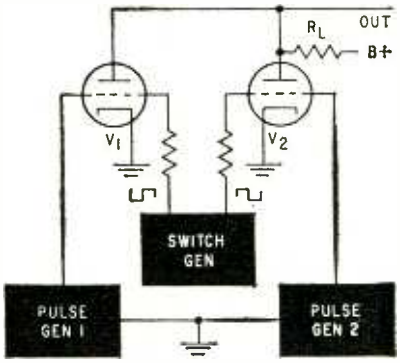


FIG. 2—Simplified diagram of basic electronic switch circuit

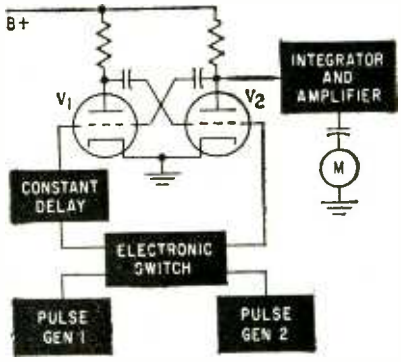


FIG. 3—Meter reading is directly proportional to phase difference of inputs

Phase angles as small as 0.005 deg can be measured with instrument using electronic switch, multivibrator phase detector and diode synchronous detector. Output shows both sign and magnitude of phase angle between two corresponding pulses in pulse chains

Electronic Switching in

By **FRANK VRATARIC, JR.**, Diamond Ordnance Fuze Laboratories, Dept. of the Army, Washington, D. C.

CIRCUIT REQUIREMENTS for accurate measurement of a small phase difference between pulses of two nearly coincident pulse chains are eased by electronic switching techniques.[1] These techniques eliminate the need for d-c drift compensating networks and automatically double the sensitivity of the phasemeter by comparing the phase difference in both directions.

Circuit Description

The block diagram of a phasemeter capable of measuring small phase differences is shown in Fig. 1. The pulses whose phase difference is to be measured are provided by the external pulse generators. The electronic switch periodically reverses the input to a bistable multivibrator used as a phase detector. Integration of the multivibrator output results in an a-c waveform whose amplitude is directly proportional to the time difference between the input signals. The diode synchronous detector converts the a-c signal to a d-c voltage, providing both sign and magnitude of phase difference.

Electronic Switch

A simplified version of one half of the switch is shown in Fig. 2. Both V_1 and V_2 are biased negatively at cutoff. The switch generator alternately drives each grid to well below cutoff such that positive pulses from the pulse generators cannot overcome the bias during the negative portion of the square wave.

The output voltage across R_L is a series of pulses from generator 1 for one half of the switching period. During this time the pulses from generator 2 are suppressed by the negative square wave on the grid of V_2. For the next half of the switching period a series of pulses from generator 2 appears across R_L and the pulses of generator 1 are suppressed.

Another switch section, 180 deg out of phase, is added such that the electronic switch's mechanical equivalent is a dpdt switch.

A bistable multivibrator (Fig. 3) is the phase detector. The d-c component of the output square wave, at one plate, is directly proportional to the phase difference of the input signals. The d-c voltage as a function of phase is shown in Fig. 4A. A discontinuity exists around the zero-degree range.

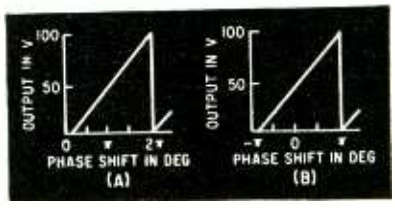


FIG. 4—Phase detector output without (A) and with constant delay circuit (B)

This discontinuity may make it impossible to measure phase angles of less than one degree. Thus a constant delay is inserted in one grid circuit of Fig. 3 to shift the zero-degree operating point to the center of the phase-detector linear range as shown in Fig. 4B.

If the constant phase delay is equivalent to 180 deg and the plate swing of the bistable multivibrator is 100 v, then for a zero-degree phase shift between the input generators, the d-c component of the

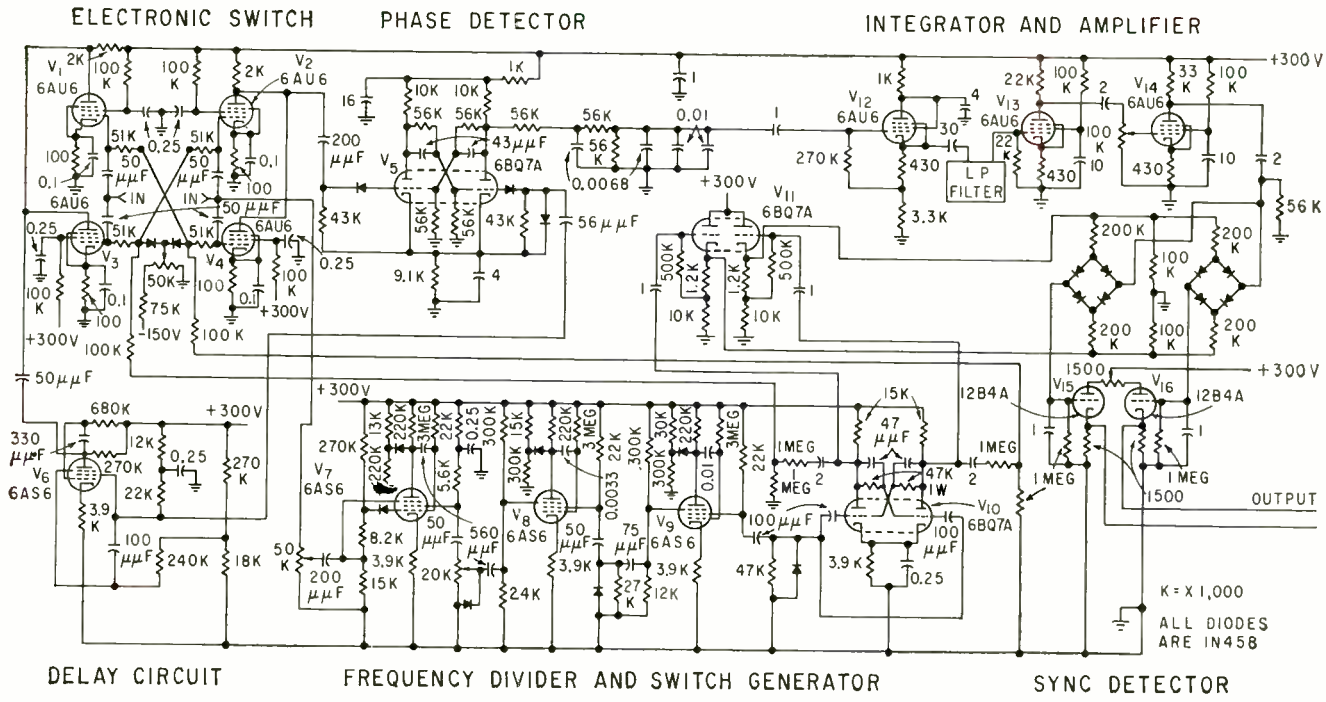


FIG. 6—Phasemeter can detect time difference as small as eight millimicroseconds in a pair of 2-kc pulse chains

Phase Measurement

output voltage, for either switch position, is (180/360) × 100 v = 50 v. If generator 1 leads generator 2 by 5 deg the d-c component is [(180 + 5)/360] × 100 v = 51.4 v. For the opposite polarity of the electronic dpdt switch, the d-c component is [(180 − 5)/360] × 100 v = 48.6 v.

Meter *M* (Fig. 3) will then indicate 2.8 v peak to peak. This meter voltage is a square wave at the switching frequency, which is approximately 1/50 the input pulse generator repetition rate.

The diode synchronous detector is shown in Fig. 5. The signal generator symbolizes the output voltage of the integrator, which is a square wave whose amplitude is directly proportional to the phase difference of the input signals.

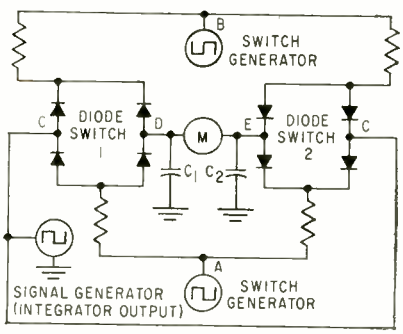


FIG. 5—Output of sync detector indicates sign and magnitude of phase shift

The switch generator simultaneously supplies square waves, 180 deg out of phase, to points *A* and *B*. When *A* is positive, *B* is negative, and diode switch 1 is forward biased, causing a low impedance path between points *C* and *D*. Capacitor C_1 can then charge up to the positive peak value of the signal generator. At the same time a high impedance path exists between *C* and *E*, due to the back bias on diode switch 2.

During the next half cycle of the switch generator, *B* is positive, *A* is negative and diode switch 2 is forward biased, causing a low impedance path between *C* and *E*. Capacitor C_2 charges up to the negative peak value of the signal generator. At the same time a high impedance path exists between *C* and *D* due to the back bias on diode switch 1, preventing C_1 from discharging. Meter *M* will show the peak-to-peak value of the signal generator output.

Figure 6 is a circuit diagram of the phasemeter. The switch generator is a bistable multivibrator. It is synchronized to the input pulse by frequency division circuits. The divider consists of three phantastron[2] circuits arranged to divide by a 4-to-4-to-3 ratio.

Applications

The circuit described has been used to measure small phase differences between pulses that occur at a 2-kc repetition rate. Phase differences of 0.005 deg have been detected by measuring the time delay in 7 ft of coaxial cable.

The phasemeter is suited for use with high-resolution radar where multiple-target discrimination at a great distance is desired. It can also be used in servo control frequency applications, propagation-velocity measurements in cables and time measurements.

The author expresses his appreciation to D. R. Pardue, W. J. Moore, and J. C. McDade for their valuable suggestions and to E. Chapin and P. S. White Jr. for their help in layout and construction.

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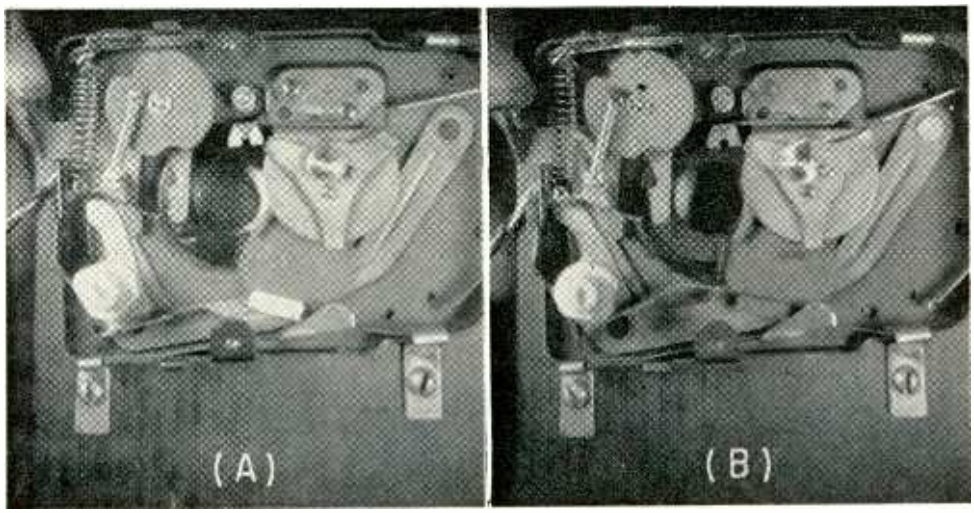


Strobe study made to determine cause of camera-shutter noise. Photo (A) indicated noise was caused by compression of main trip spring, top left of photo. End of shutter blade is painted white. After spring action was corrected, photo (B), action of the trip spring was shown to be constant, with no longitudinal oscillations.

Strobe Techniques Analyze

THIS STROBE was designed to study complex motions of moving parts. As an example of only one use, vibration damage can be assessed by a photographic analysis made on the spot with a 60-second-picture camera. Nonrepetitive motions are analyzed equally as well as the usual periodic or repetitive actions of switches, relays and motors.

Synchronization

With conventional strobes, once synchronization of the light source with the motor has been achieved, the viewing position may be changed only by allowing the frequency to drift away from the synchronous value and to resynchronize at some other point. This may or may not be the position desired, so another trial may be necessary. With this analyzer, the viewer may change the motion point being studied by turning a switch on the panel. This is accomplished by internal circuits so that no signal is fed back from the motion, thus no external load on the motion can cause error.

The stroboscopic analyzer divides the motion into 100 parts for 100 different viewing positions. In terms of a circle, this allows a look every 3.6 degrees of motion. This feature is particularly useful where nonlinear motions are being studied and where velocity is not constant during the cycle. Once a troublesome area has been isolated, a succession of photos may be taken at 3.6-deg increments of the total motion for further study. The number of viewing positions may be selectively decreased as desired.

This strobe was originally intended to aid in the research and development of sewing machine attachments. Ideas for other applications continually modified early developments.

The action of sewing machine attachments is cyclic, but the velocity of the various components of the attachment may vary during the cycle. This imposes the requirement on the strobe that the viewing position in the cycle be variable independently of the cyclic speed synchronization.

The strobe is a nonsynchronous system wherein the frequency generator and phasing system are electronic. After consideration of the various means of achieving desired results, a system having fixed steps of phasing was chosen.

System Description

Figure 1 is a block diagram of the stroboscopic analyzer. The generator feeds the units ring counter through a gate circuit. Manual pushbuttons control the start and stop of the gate through a flip-flop. Remote start functions control the flip-flop through an amplifier circuit.

The output of the units ring counter, which is the generator frequency divided by ten, feeds the tens ring counter. Ten-point selector switches pick off a pulse from one of the 10 flip-flops in each ring counter and feed these pulses to a coincidence gate. The units selec-

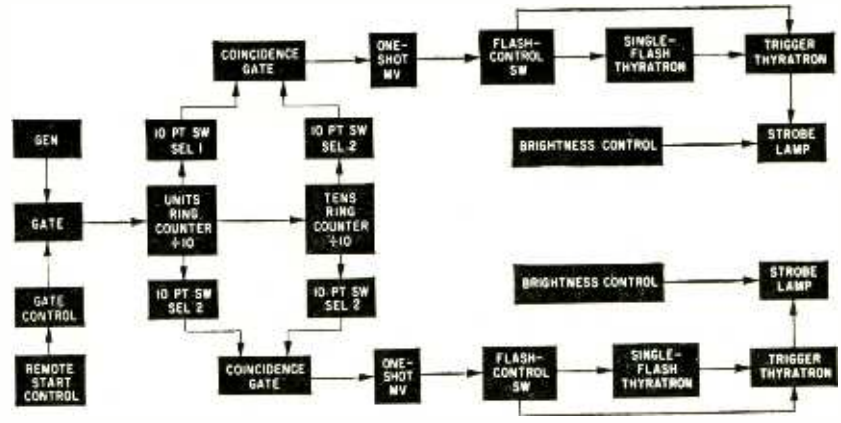


FIG. 1—Block diagram of strobe analyzer. Two light sources make it easy to follow analysis at the point where trouble occurs

Adjustable stroboscope obtains time-motion interrelationship data not possible with ordinary strobe. Unit is particularly useful in studying nonlinear motions, where velocity is not constant during the cycle. It is a useful inspection and trouble-shooting tool to observe switches, relays, motors, vibration effects and any moving part

By **JOHN H. BLAKESLEE,** Research Engineer, The Greist Mfg. Co., New Haven, Conn.

Complex Mechanical Motion

tor has ten output pulses and the tens selector has one output pulse for each 100 generator pulses. A one-shot multivibrator inverts the polarity of the coincidence gate output pulse and times the pulse width to the firing requirements of the thyratrons when the selector switch is in the continuous flash position. The pulse fires the thyratron which furnishes the trigger pulse to the strobe lamp. When the switch is in the single-flash position, the pulse fires a single-flash thyratron which in turn fires the trigger thyratron. The single flash-thyratron must be reset manually, blocking further pulses to the trigger thyratron until reset. The brightness control is a selection of capacitors controlling the watt-second input to the strobe lamp.

Operator at right adjusts controls of strobe analyzer prior to taking series of photos of a malfunctioning sewing machine attachment; photos taken at millisec intervals, will point to corrective action

Schematic

The generator covers 100 cycles to 30 kc in five overlapping bands. As seen in Fig. 2, a bridge is the frequency-determining network, with a dual potentiometer as the tuning element.

Cathode follower V_{1A} offers high impedance, while grounded grid amplifier V_{1B} furnishes gain. Cathode follower V_2 gives low impedance and feeds the tuning network. A rectangular output waveform is fed to the limiter gate tube V_3.

When V_{4B} of the gate control flip-flop is conducting, the quadrature grid of the gate tube is negative with respect to the cathode and the gate is open. Start switch S_1 will fire neon lamp V_5 causing V_{1A} to conduct. When automatic reset switch S_3 is operated, a ground or negative pulse on the automatic reset line will fire neon lamp V_6.

A remote start input opens the gate by opening or closing a remote contact or by supplying a positive or negative pulse. A four-position remote-start selector switch, S_4, controls the input condition. For contact operation, positive d-c voltage, applied to the remote contact, furnishes a start pulse. For a contact closing (position 1) or negative pulse (position 2), V_7 is conducting, The positive output pulse from V_7 fires neon lamp V_8 causing V_{4A} to conduct. For a contact opening (position 4) or a positive pulse (position 3), V_7 is cut off. The negative output pulse of V_7 fires neon V_5. Only the first input pulse to V_7 can control flip-flop V_4.

The input to the ring counters is a regenerative squaring circuit which feeds the B sides of the flip-flops zero through nine (V_9 through V_{18}). Each plate B of the flip-flops couples to grid A respectively of the next flip-flops. Grid A of the zero

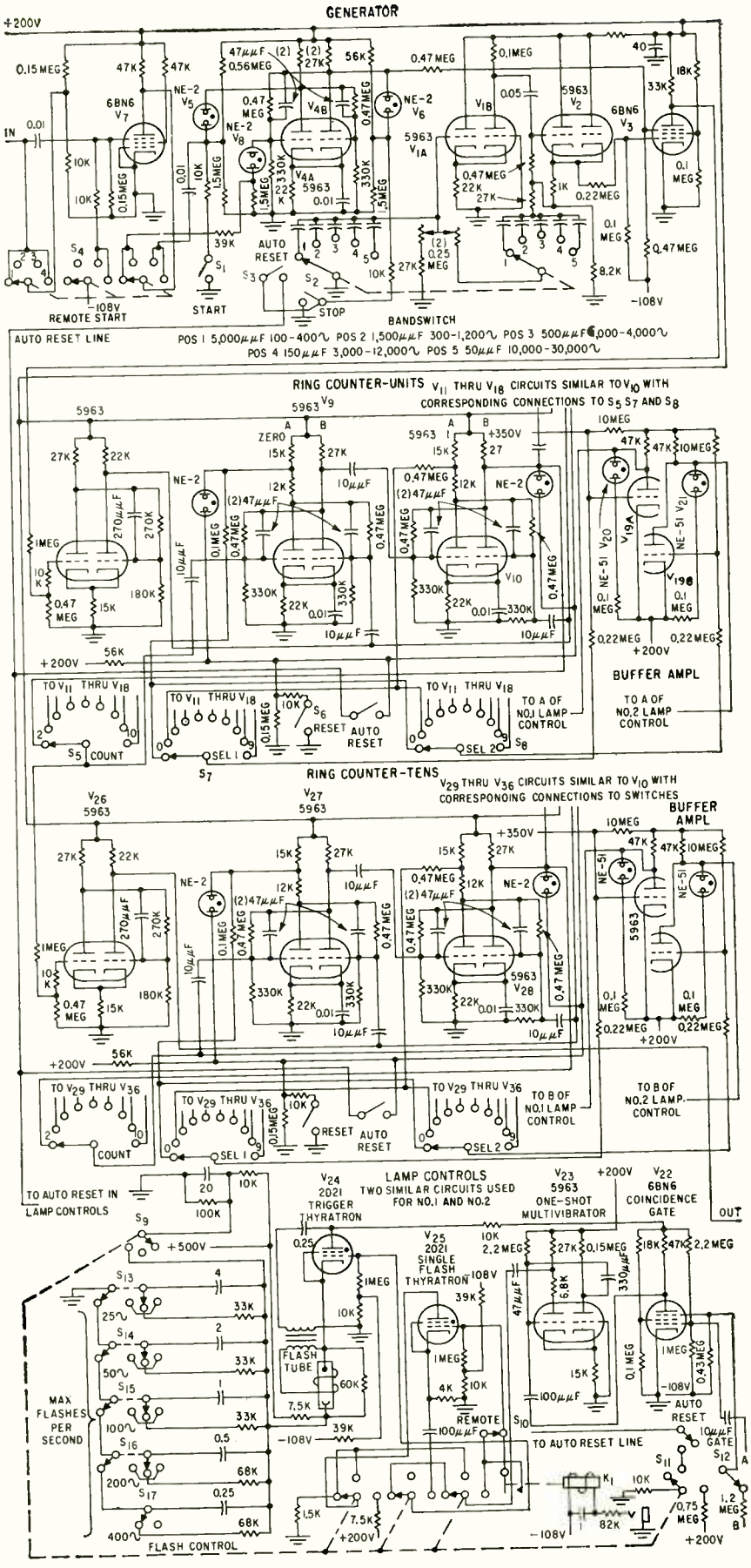


FIG. 2—Schematic of strobe analyzer shows connections to ring counters and strobe lamps

flip-flop is fed from the wiper of count switch S_5 which allows the total count to be set between two and 10. The reset switch S_6 fires neons in the V_8 through V_{18} circuits, causing conduction of the B side plates of flip-flops one through nine and the A-side plate of flip-flop zero. The A-side plates furnish the output to selector switches S_7 and S_8 and only one plate conducts at any particular time.

Changing Positions

Selector-switch positions may be changed while the counter is operating without interfering with counting sequence or rate. Interference would cause undesirable indexing of the viewing position of the strobe lamp. The plate load of the flip-flops is split and the output isolated through a 100,000-ohm resistor. In addition, the buffer amplifiers are operated above the supply voltage of the flip-flops. The plate supply for the buffer amplifiers V_{19A} and V_{19B} is +350 v and the cathodes return to +200 v. The grid is at zero v with respect to its cathode when the selector connects to a flip-flop in the cut-off condition. When this flip-flop plate conducts, the buffer amplifier is cut off, providing a positive voltage swing to the coincidence gate.

The output of the tens counter connects to the quadrature grid of the coincidence gate V_{22} in the lamp-control circuit, and the output of the units counter connects to the limiter grid. Both grids are normally negative. When both grids become positive, a negative output pulse drives the one-shot multivibrator, V_{23}.

Flash control S_9 provides continuous flashing, off, and single flash for the strobe lamp. On continuous-flash position, the positive pulse from the one-shot multivibrator fires V_{24} to generate the trigger pulse for the strobe lamp through trigger transformer.

In the single-flash position, the one-shot fires the single-flash thyratron V_{25} to fire V_{24}. Tube V_{25} conducts until the selector switch is off. When remote switch S_{10} is operated, the firing of V_{25} is under control of relay contacts K_1. When switch S_{11} is operated, the flash-selector switch will ground the automatic reset line in its off position.

Ultrasonic Cleaners

Printed circuit boards, waveguide assemblies and gear trains are being cleaned by ultrasound. Tabulation covers major characteristics of commercially available ultrasonic cleaners

By **STANLEY E. JACKE,** Chief Product Engineer, Acoustica Associates, Inc., Mineola, N. Y.

COMMERCIAL ultrasonic cleaners are now available in tank sizes from 1 to 75 gallons with lengths up to 42 feet for special applications.

Not all electronic components require the same acoustic energy. Delicate parts such as transistors, diodes, electron guns and printed circuit boards may be unnecessarily damaged by subjecting them to fields of high intensity that are normally used to remove buffing compounds or other tenacious soils. Because of the substantial power level differences between various ultrasonic cleaners, care must be exercised in choosing the correct size cleaner.

Frequencies between 18 and 40 kc are used because less electrical power is required to produce the necessary cavitation. Frequencies below 20 kc may introduce objectionable personnel-disturbing noise.

Light-duty cleaners apply ultrasonic energy up to approximately 4 watts/in.^{2} Heavy-duty cleaners apply energy from 4 to 20 watts/in.^{2}

Higher energy densities are obtained from magnetostrictive transducers or the recently introduced composite transducer that uses solid metal elements in conjunction with ceramic elements.

Conversion efficiencies from electrical to acoustic power varies from 50 to 70 percent for barium titanate transducers, approximately 40 percent for magnetostrictive types, and up to 90 percent for the composite transducer.

Table I lists the characteristics of some commercially-available ultrasonic cleaners.

Table I—Characteristics of Typical Commercially Available Ultrasonic Cleaners

Tank Capacity (gallons)	Freq (kc)	Tank Size (in.)	Generator Output (watts)	Transducer Type	Transducer Input Power Density
1	40	6 × 9 × 6 h	50 average 200 peak	Barium titanate	1 watt/in.^{2} average
1	25	8 dia × 9 h	500 average 1,000 peak	Magnetostriction	10 watt/in.^{2} average
2	18	7 × 9 × 19 h	900 continuous	Magnetostriction	14 watts/in.^{2} continuous
2	400	7 × 7 × 9 h	600 average 1,200 peak	Focusing[a]	150 watts/in.^{3} maximum
5	40	9 × 14 × 10 h	250 average 1,000 peak	Barium titanate	1.75 watts/in.^{2} average
5	20	9 × 14 × 10 h	400 continuous	Multipower	4 watts/in.^{2} continuous
5	18	9 × 14 × 11 h	2,500 continuous	Magneto-striction	20 watts/in.^{2} continuous
8	20	14 × 12 × 12 h	700 continuous	Multipower	4 watts/in.^{2} continuous
15	40	10 × 20 × 18 h	500 average 1,000 peak	Barium titanate	1.5 watts/in.^{2} peak

[a] Focusing with barium titanate transducer results in useful power concentration within 4 cu in. of volume

Millimicrosecond

Outdiffusion technique produces fast-switch diodes having switching times of 2 to 3 millimicroseconds, comparing favorably in speed with fast-switching transistors. Optimum diode-transistor combinations can be used

By J. HALPERN and R. H. REDIKER, Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Mass.

SEMICONDUCTOR DIODE DEVELOPMENT has fallen far short of the pace set by transistors during the last decade, especially with regard to switching-speed considerations. In many cases, it has become necessary for computer circuit designers to use transistors instead of diodes. Speed has been achieved but only at the expense of more complicated circuits, higher manufacturing costs and reduced reliability.

The outdiffused diode compares favorably in speed with the fastest switching transistors and thus the optimum combination of diodes and transistors can be used.

Forming Junction

The diffusion of impurities out of a semiconductor to form a *p-n* junction is a particularly useful technique for the production of fast diodes.[1] Germanium uniformly doped with both *n*- and *p*-type impurities whose impurity concentration is shown in Fig. 1A is used. The conductivity type is that of the impurity of greater concentration, in this case it is that of the *n*-type impurity, antimony. When the germanium is heated in a high vacuum, the antimony atoms diffuse to the surface where they evaporate, while atoms of the *p*-type impurity, indium, are relatively unaffected since the diffusion constant for antimony is two orders of magnitude greater than that for indium at any given temperature.

After the high-vacuum heating or outdiffusion cycle, the impurity concentration as a function of distance from the surface is as shown by the dashed curves in Fig. 1A. Coincident with the region depleted of antimony atoms, a *p*-type skin is formed on the *n*-type bulk due to the residual indium atoms. In Fig. 1B, the net impurity density after outdiffusion is plotted showing the *p*- and *n*-regions. Since germanium can be grown with accurately predetermined concentrations of both *p*- and *n*-type impurities, and both temperature and time of diffusion can also be closely controlled, it is possible to tailor the net impurity density over a significantly wide range. It is possible to design diodes to meet various desired electrical specifications.

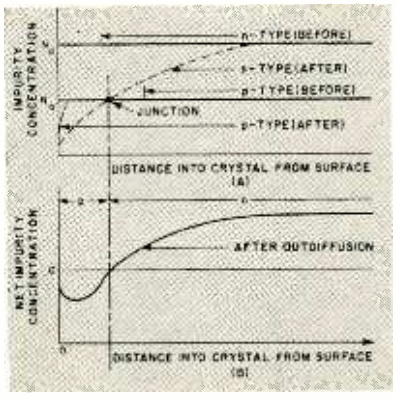


FIG. 1—Concentrations of *r-* and *n*-type impurities as a function of distance into the crystal before and after outdiffusion (A). Net impurity density after outdiffusion (B)

After outdiffusion, the wafers are ultrasonically cut into circular dice of 0.070-in. diameter as shown in Fig. 2A. The *p*-type skin is removed from one face as shown in Fig. 2B by either etching or lapping, and ohmic contact to the *n*-type bulk is made by bonding this entire face to a gold-antimony plated rod. Ohmic contact to the *p*-type skin is made by alloying a 0.0025-in. diameter indium sphere to a depth of 0.00015-in., leaving the device with a base thickness of 50-millionth inch. The placement of the indium sphere is not at all critical. The entire assembly is then etched as shown in Fig. 2C. The indium button serves as its own mask in defining the junction area and no additional masking is necessary. The unit is then encapsulated in a cartridge-type package. Both S-spring and membrane-type contacts have been used.

Switching Speed

The switching speed of a narrow-base diode such as the outdiffused diode is determined by the time it takes to switch the diode from the forward low-impedance state to the reverse high-impedance state.[2, 3] Under the assumption that the current is carried by minority carriers injected into the thin *p*-type base region rather than into the *n*-type bulk, the reverse recovery time consists mainly of the sum of the time required to clear the stored minority carriers from the base region and the time required to charge the junction depletion-layer capacitance.

Impurity concentrations and junction width are so chosen that almost all the current is carried by the minority carriers, in this case electrons, injected into the narrow base region. Since the current in the diode during forward conduction is proportional to the slope of the concentration of the stored minority carriers in the base region, a relatively large current can be maintained in the device with a small stored minority carrier charge as a consequence of the narrow base region. This small amount of stored charge can then be cleared out relatively rapidly when the diode is re-

Switching Diodes

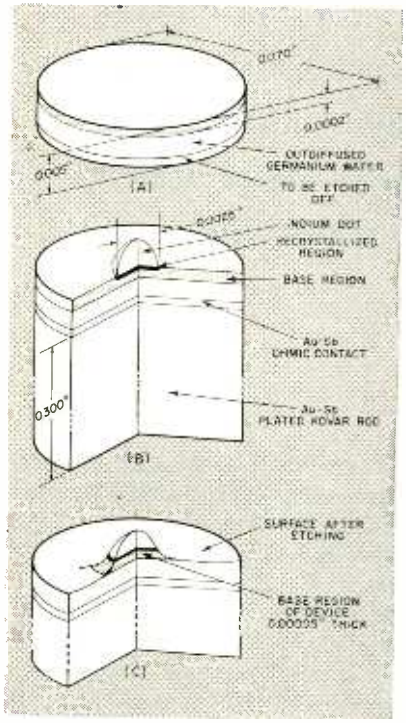


FIG. 2—Steps in diode fabrication process

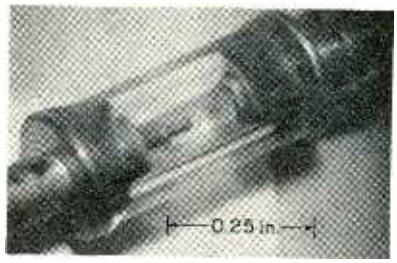
verse-biased. Because of the limited cross-sectional area of the base region, there is no charge laterally displaced from the active region during forward conduction which must be removed during switching. A good approximation of the time required to remove minority carriers from the diode base region is the reciprocal of the frequency response of a transistor of identical base width. For the base widths being used this time is about one millimicrosecond.

The time required to charge the depletion layer capacitance is determined by the R-C time constant for that capacitance and the resistance of the external charging circuit. Assuming approximate values of 1 $\mu\mu$f and 1,000 ohms, the depletion layer capacitance charging time is one milliμsec. For circuits where time constants of this order are significant, the impedance level would be reduced to well below 1,000 ohms and the diode capacitance charging time consequently would be reduced well below the millimicrosecond range.

The reverse recovery time of the outdiffused diode is measured using the circuit shown in Fig. 3. A traveling-wave oscilloscope is used to observe the fast transients. The oscilloscope is modified so that its deflection plate is directly coupled to the diode under test. Direct coupling is necessary to differentiate fast from slow diodes. A transient with a time constant larger than 150 milliμsec appears constant as a function of time when observed as a sweep speed of 15 milliμsec/cm. Therefore, it is necessary to compare reverse recovery transient with the oscilloscope deflection for zero diode current. Because of reflection from the various points of mismatch (of which the diode is one), the circuit shown in Fig. 3 can only be used to measure reverse recovery times less than 20 milliμsec.

In the circuit shown, 150 ft of high-quality coaxial cable is used as a signal delay line to allow time to initiate the oscilloscope sweep. Diode current is applied through the top helix of the traveling wave tube and the voltage across the terminating resistor is displayed on the oscilloscope. Part of the signal also goes through a parallel combination of a four-ft and eight-ft cable to provide unequal delay. This mixed signal is chopped by a short circuit resulting in pips 6 milliμsec apart which are supplied to the bottom helix of the traveling wave tube and displayed as time markers on the oscilloscope.

Figure 4 shows a typical reverse recovery transient for fast-switch diodes. The diode was switched from 10 ma forward current to 5 v reverse bias with a loop impedance of 120 ohms. The time to recover to 1 ma reverse current (the smallest observable current) is less than 3 milliμsec. Also shown in the photograph is the zero diode current line on which two 6-milliμsec time markers have been superimposed.



Encapsulated diode showing S-spring contact. Membrane-type contacts have also been used

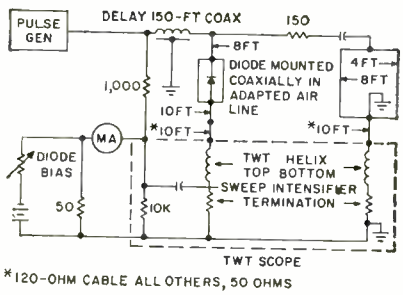


FIG. 3—Circuit for measuring millimicrosecond reverse recovery time. Traveling-wave oscilloscope is used

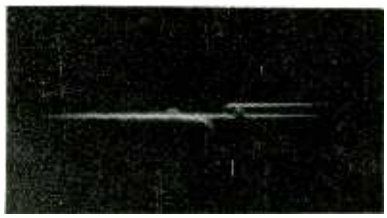


FIG. 4—Typical reverse recovery transient for fast-switch diode. Time markers are 6 milliμsec apart

The base region can be made narrow to give the desired fast switching speed without significantly affecting the diode voltage-current characteristic. The voltage-current characteristics are equal to or better than those of many types of slower diodes. In this respect this fabrication method is superior to other techniques developed to produce very fast switching diodes.[4, 5] This easily-fabricated diode can be used where the V-I characteristic is important as well as where very high speed operation is required. The number of diode types used in a computer can be reduced.

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Tube-Transistor Hybrids

Design technique is described for combining transistors and vacuum tubes in a single circuit, resulting in reduction of power consumption, bulk and cost while improving reliability. Emphasis is on hybrid design of regenerative circuits such as a bistable cathode follower and four-stage ring counter

By G. A. DUNN and N. C. HEKIMIAN, Department of Defense, Washington, D. C.

TRANSISTORS AND VACUUM TUBES have frequently been combined in one device to produce so-called hybrid equipment, but little attention has been given to the combination of these two elements within individual circuits.[1, 2]

Advantages

Although in recent years transistors have become increasingly popular as circuit elements, there are still many applications in which characteristics attributable only to vacuum tubes are required. For example the high input impedance available in vacuum tubes is often difficult and expensive to obtain in transistor circuits. In addition, the complete absence of reverse current, the minor dependence of their characteristics upon ambient temperature and the higher permissible voltage swings often dictate the use of vacuum tubes. On the other hand, greater circuit economy, reduced power consumption, simplified wiring, and smaller bulk and weight tend to make the transistor an attractive element. Further, certain transistor applications using complementary *pnp-npn* combinations are impossible with the conventional vacuum tube since the latter has no *pnp* equivalent.

Fortunately, transistor voltages are generally of the same order of magnitude as the grid-cathode voltages of most vacuum tubes. As a result, it is usually possible by judicious selection of bias voltages to operate the transistor without an auxiliary power supply. Where certain base voltages are required, these can be obtained through relatively low current dividers across a single supply. A great many variations can be obtained by changing the reference ground. Furthermore, it is frequently possible to use the complementary type of transistor by providing an appropriate change in biasing.

Regenerative Circuits

Some of the most attractive features of hybrid circuits are obtained by forming regenerative connections to enable the device to work as a switch, oscillator, pulse generator or other element exhibiting a negative resistance characteristic.

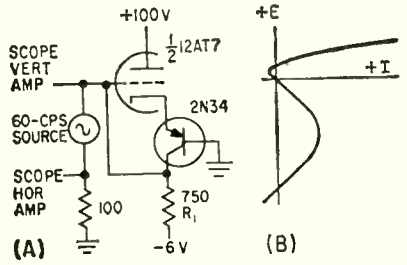

FIG. 1—Test circuit (A) produces negative resistance characteristic (B) on oscilloscope

The basic requirements for an inherently bistable device are that the magnitude of current gain and voltage gain each be greater than unity and that the phase shift be zero so that regenerative action is obtained when the output-input path is closed.

Since the normal static bias conditions for a conventional vacuum tube require that the grid be negative with respect to the cathode, it is possible to effect a great economy in circuit elements and a general reduction in complexity by employing the grid-cathode bias as at least part of the supply voltage for the transistor. It is also possible to arrange the circuits so that in the on condition, when both the transistor and the tube are conducting, the grid voltage remains negative to minimize grid current flow. This technique reduces triggering difficulties that arise from the lowered grid-circuit impedance in the on condition normally associated with the saturating type of Eccles-Jordan flip-flop.

The 60-cps test circuit shown in Fig. 1A may be used to display the static negative resistance characteristic. The negative supply voltage is made large enough to assure cut-off of the tube when the transistor is nonconducting; the plate supply voltage is so chosen that excessive tube current is not drawn even with zero grid voltage, and collector resistor R_1 is selected to assure saturation of the transistor when the tube current at zero grid voltage is impressed on the emitter.

Negative Resistance

The resulting trace on the scope, as shown in Fig. 1B, is a display of generator voltage as a function of generator current. The upper and lower portions of the curve have a positive slope, while the middle portion has a negative slope, indicating a negative resistance region. The voltage axis where the generator current is zero intersects the curve at three places. The upper intersec-

Provide Design Economy

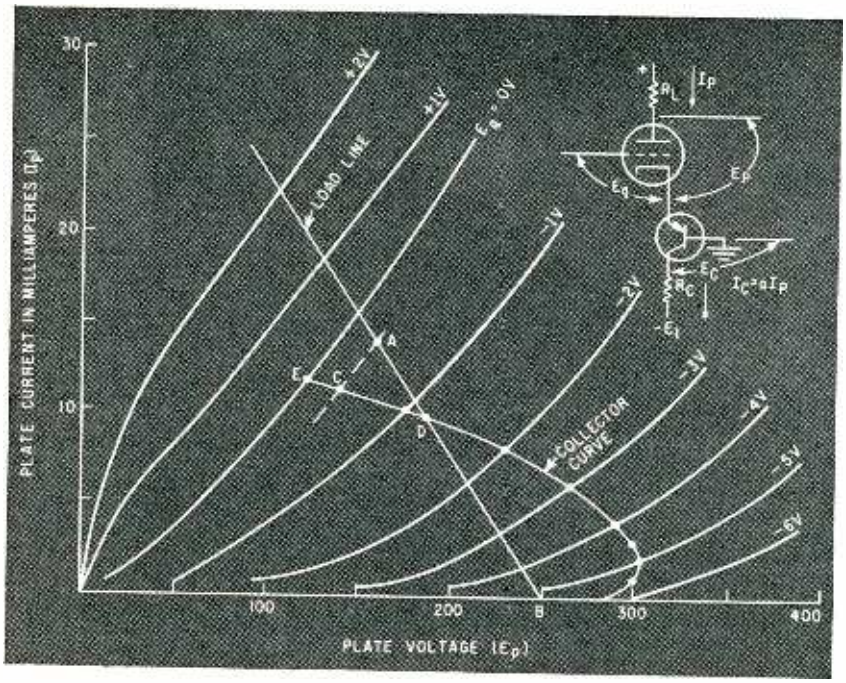

FIG. 2—Collector voltage is plotted as a function of plate current on triode plate characteristics to determine circuit parameters

tion indicates that a stable on-condition exists; the center intersection occurs in the negative resistance region and is therefore unstable; and the lower intersection indicates that a stable off-condition exists, the voltage at this point being essentially the negative supply voltage.

Inspection of the circuit reveals that the tube provides current gain while the transistor provides voltage gain, both at zero phase shift. The overall voltage gain of the hybrid circuit is of primary concern and it can be shown to be $A_v = \mu\alpha R_c/r_p = g_m \alpha R_c$, where μ, r_p and g_m are the tube parameters, and α is the common base current gain of the transistor. If a plate load resistor R_L is used, the quantity $g_m' = \mu/(r_p + R_L)$ should be substituted for g_m. The input impedance of the transistor is considerably smaller than $r_p/(1 + \mu)$ and its effect is therefore neglected.

Design Procedure

A convenient procedure to follow when determining the necessary circuit parameters to make the circuit bistable is to plot the collector voltage as a function of plate current on the triode plate characteristics; the values of grid voltage E_g are collector voltage coordinates since for this circuit the grid and collector voltages are approximately equal. The equation of the collector voltage to ground is $E_c = E_1 + \alpha I_p R_c$, where E_1 is always negative and it is assumed that the base-to-emitter voltage of the transistor is zero. The collector voltage curve obtained in this fashion is a function of plate current only and no direct relationship exists between this curve and the plate voltage abscissa of the tube characteristics.

Figure 2 shows such a plot of the collector voltage. The straight line on this figure is the load line for a plate load resistor. Intersections of the collector voltage curve and the plate load line represent mutually satisfactory conditions of plate current, grid voltage and collector voltage with no external input signal applied. The intersection at point B indicates that a stable off condition exists; the negative supply voltage is sufficient to maintain the tube at or near cutoff. The second intersection of the collector curve and load line at point D is of primary interest, and is referred to as the critical point.

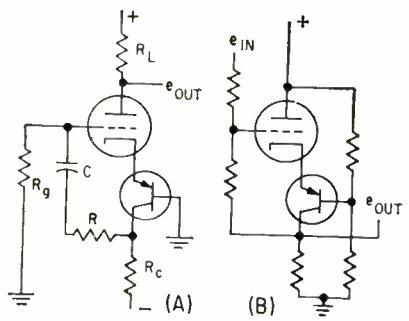

FIG. 3—Hybrid single-shot or free-running multivibrator (A) and bistable cathode follower (B)

It will be recalled that for the circuit to be stable in the on condition, the transistor should be in saturation. The emitter-to-collector voltage of a saturated transistor is generally a few tenths of a volt and can be represented by point C on the collector curve. Point C also represents the approximate collector current as read on the plate current scale. Since the stable operating point for a triode must lie on its load line and since the grid voltage is equal to the transistor emitter-collector voltage, the on condition for the tube must be at point A. The difference in current between points A and C is then the value of the saturation base current. It is evident that for the circuit to be stable in the on condition, the critical point must lie in the negative grid voltage region of the tube curve.

Preventing Damage

The saturation base current for low-power transistors should be restricted to not more than a few milliamperes to prevent damage. Although a plate load resistor is not required for bistable operation, it serves to minimize variations in saturation base current from changes in tube characteristics and power supply voltages.

The minimum trigger potential necessary to turn the circuit on or off is that which causes the plate current to rise above or fall below, respectively, the current at the critical point. Thus, the difference in grid voltage between points B

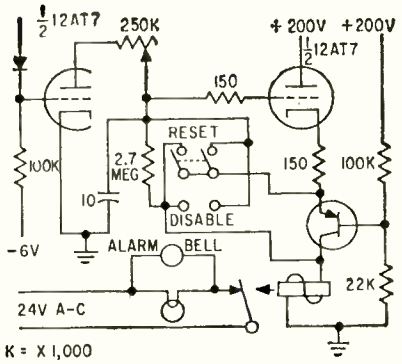

FIG. 4—Memory and alarm circuit accumulates predetermined number of pulses, then switches off until reset

and D is the minimum turn-on potential, and the voltage difference between D and A is the minimum turn-off potential.

The same procedure can be followed when designing a single-shot or free-running circuit. The critical point for the single-shot circuit occurs in the negative grid region just as with the bistable circuit, and for the free-running circuit it must occur in the positive grid region.

The bistable hybrid circuit does not lend itself well to binary counting applications since it requires alternate pulses of opposite polarity to turn it on and off. However it may be employed in storage or matrix circuits, or as a replacement for gas tubes. The inclusion of a plate load resistor provides a means of obtaining a high voltage swing which can be used to operate neon lamps and other circuits requiring high-voltage drive.

A normally-on single-shot or free-running square-wave generator is shown in Fig. 3A. The particular mode of operation is determined by whether or not the transistor saturates when the current corresponding to approximately zero grid voltage is flowing. The negative supply voltage for either mode of operation should be somewhat greater than the cut-off bias of the tube. A relatively fast rise and decay time can be achieved by making the loop gain large.

The single-shot circuit is conveniently triggered by a negative pulse coupled through a diode to either the grid or the collector.

Grid Current

The period of the free-running circuit is normally considerably shorter than the off period because the grid is driven positive with respect to the cathode during the on condition, resulting in grid current flow and subsequent capacitor discharge. This period can be greatly increased by the addition of resistor R in series with capacitor C.

One variation, obtained by changing the reference from ground to a higher potential, is shown in Fig. 3B. The new reference is obtained from the divider across the supply voltage and ground. The resulting circuit may be considered a bistable cathode follower. When the tube and transistor are in the on state the tube is a normally functioning cathode follower with a load resistance comprised of the base divider in parallel with the collector resistor. The transistor is nothing more than a closed switch. If the stage is momentarily turned off it remains in this state if the base divider network is properly designed. This circuit has been used as a boot-strap integrator and switch combination. A practical version is shown in Fig. 4.

This circuit is part of a memory and alarm system devised to accumulate pulses over a long period of time as represented by the time constant $R_g C_g/(1 - A)$, where A is the gain of the cathode follower. It has the property that when the integrated number of errors in a given time exceeds a predetermined level the circuit switches off and will not come back on unless reset. By placing an alarm relay in the collector of the transistor in addition to or in place of the collector load resistor and arranging alarm contacts that are normally closed, a fail-safe alarm circuit is obtained.

Ring Counter

A four-stage ring counter is shown in Fig. 5. All stages of the ring are identical and similar to the bistable circuit. Assume that the first stage is conducting; the transistor is then saturated and the tube bias is largely determined by the voltage drop across cathode resistor R_2. The voltage drop across R_4 causes diode D_1 to conduct, which raises the bias of the second stage and charges the priming capacitor of that stage.

A negative trigger pulse causes the conducting stage to be cut off and, when the pulse is removed the charge of the priming capacitor causes the second stage to turn on. Thus, each succeeding stage is turned on each time a negative trigger is applied. The width of the trigger pulse must be less than the discharge time of the priming circuit or the priming charge will be lost before the trigger pulse is removed.

The circuit as shown was found to count reliably at rates up to about 500 kc, with a trigger amplitude of about 4.5 v. The highest counting rate achieved was in excess of 750 kc.

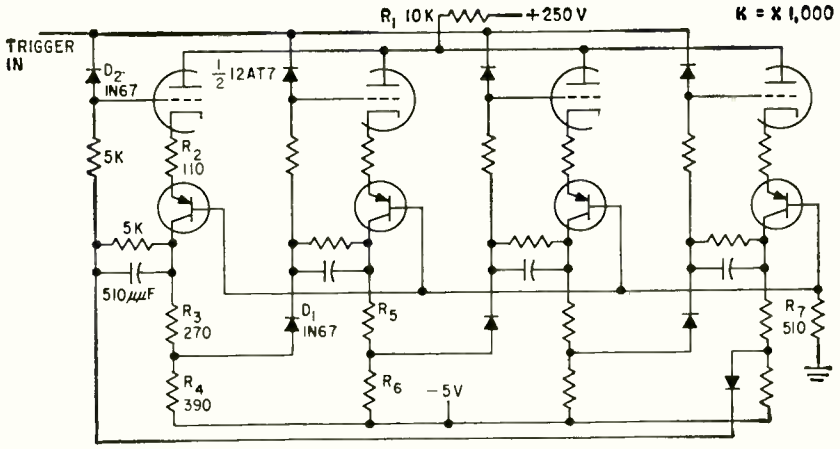

FIG. 5—Schematic of four-stage ring counter. All stages are identical

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Waveguide Switch Types

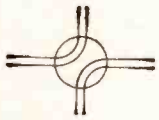
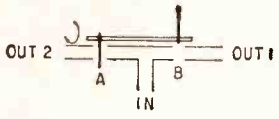
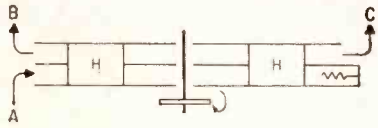
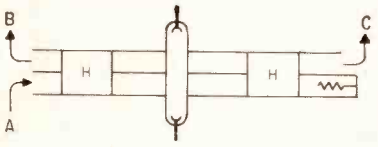
Mechanical, ferrite, tube and crystal diode switches are classified by bandwidth, power capability, isolation and speed

By J. W. SUTHERLAND,
Research Laboratories, Marconi's Wireless Telegraph Co. Ltd., Great Baddow, Essex, England

WAVEGUIDE SWITCHES range from high-power devices which change-over radar transmitters to fast types producing short r-f pulses for laboratory use. Switches shown in Table I are suited, in appropriate waveguide sizes, to many frequencies.

These switches are not usually commercially available as separate items. In most cases they were developed as part of a system. Types with moving parts generally provide higher power and wider bandwidths, but are slower than electrical impulse types. In such applications as factory testing, switches reduce time and effort required. A number of developments like autofollow radar would be impossible without some form of waveguide switch.

Table I—Characteristics of Typical Waveguide Switches

Typical Switch Types	General Description	Power	Bandwidth (%)	Isolation (db)	Speed of Action	Applications
Barrel Switch	 Waveguide channels are cut in rotor. Stator carries input and output waveguides. Special choking is used	up to several megawatts	20	50	slow (1 sec)	Switching radar transmitters, built-in test gear
Shutter Switch Tee-Junction	 Rotating shutter closes *A* or *B* alternately, coupling input to output 1 or 2, respectively	up to ½ megawatt	5	about 40	1–2 millisec	Beam switching, receiver switching, test gear
Shutter Switch Hybrid	 Energy *A* goes to output *B* with rotating shutter closed. Open shutter passes *A* to output *B*	up to ½ megawatt	10	about 40	1–2 millisec	Beam switching, for example for autofollow radar
Discharge Tube and Hybrid	 Input *A* normally goes to *C*. When tube is triggered, *A* is reflected, recombines at *B*	5 watts	3	35	<1 μsec	Low power r-f pulsing, receiver protection
Faraday Rotation (Ferrite)	Plane of polarization of input wave is rotated by the ferrite, by an amount dependent on applied magnetic field. Input power is directed to either of two cross-polarized waveguides	1 watt	5	35	<10 μsec	R-f pulsing, receiver switching and protection, radar
Ferrite and Cavity	Similar to above, ferrite mounted in cavity. Less critical field and faster switching time	1 watt	narrow[a]	30–35	0.05 μsec[b]	Similar to above
Crystal Diodes	Nonlinear diode resistance used to change from condition of near match to large mismatch by varying diode current. Fast low-power switching	10 mw	about 10	20	0.02–0.05 μsec	Laboratory applications

(a) Unknown (b) Claimed

Transistorized wire-line terminal unit transmits and receives binary data at up to 2,500 bits/sec in a nominal 3-kc voice-band circuit. Amplitude-modulation system uses vestigial sideband transmission and synchronous operation, significantly improving delay distortion and noise performance

By J. L. HOLLIS, President, Rixon Electronics, Inc., Silver Spring, Md.

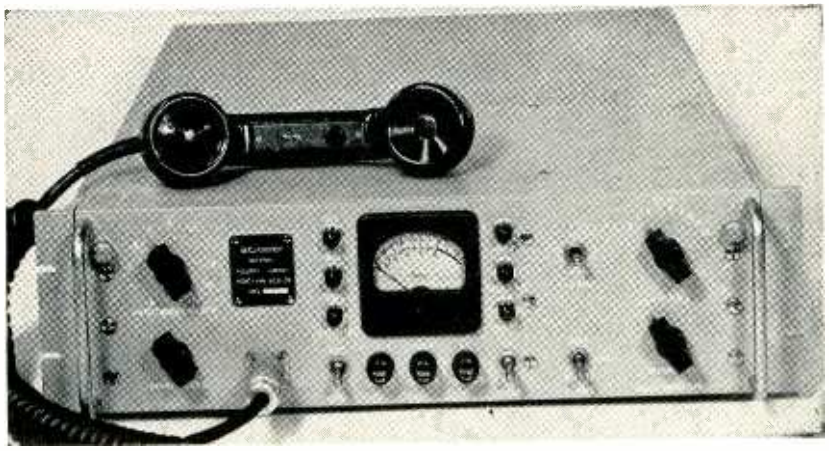
Sending Digital Data Over

TRANSMISSION OF DIGITAL information over voice communication circuits is an important aspect of many modern electronic systems. Electronic computers, automatic data processing equipment, high speed teleprinters and many other devices frequently must be interconnected by existing communication facilities.

Unfortunately, the characteristics of the usual voice communication circuits are not suitable for the direct transmission of such digital information. The data must be converted at the transmitting terminal into a form that can be handled by the communication circuit and restored to the original digital form at the receiving terminal. Since the steady-state or d-c condition is an important component of digital information, provision must be made for transmission of frequency components down to and including d-c.

Rule of Thumb

The duration of the shortest element of the digital information determines the highest frequency that must be transmitted. A commonly used rule-of-thumb is that the transmission system must pass frequency components up to $0.75/T$, where T is the duration of the shortest bit measured in seconds.



Complete 2,500-bit terminal unit. Handset is used with voice averride

For example, if the shortest element is 1 millisec in duration, the transmission system must have an upper cut-off frequency of at least 750 cps. In addition, the transmission system must have reasonably linear phase-frequency characteristics from d-c to the upper cut-off frequency to prevent serious overshoot and other forms of distortion.

Since voice-frequency channels seldom pass frequencies below a few hundred cycles, it is the usual practice to employ a-m, f-m or p-m techniques. The unmodulated carrier thus provides the steady-state or d-c condition.

For relatively slow-speed systems, such as a 60-wpm teletypewriter, bandwidth is not a serious problem. In this instance, the shortest signalling element is in the order of 0.02 second, which corresponds to a bandwidth requirement of 37.5 to 75 cps depending on the type of modulation. It is common practice to employ ten or more carrier frequencies dispersed in the 300- to 3,000-cps spectrum to provide simultaneous transmission of teletypewriter channels over a single voice communication system.

Recent advances in modulation and detection techniques have improved use of the frequency spectrum. One such system is capable of transmitting 40 teletypewriter channels over a single high-quality

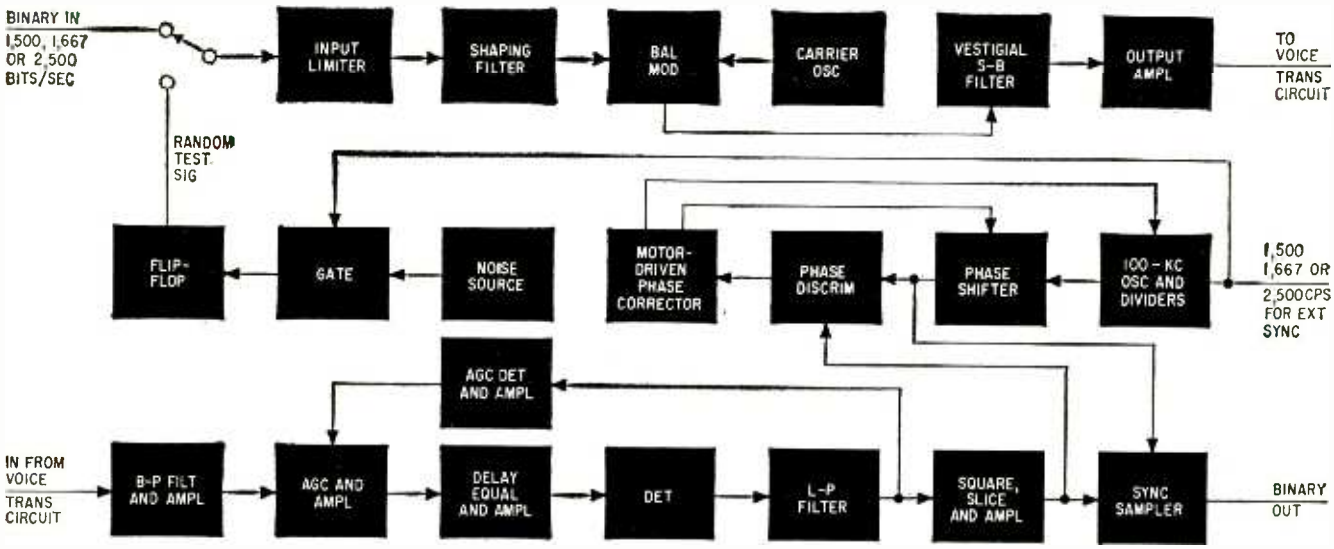


FIG. 1—Block diagram of overall system including transmitter (top), timing and random keying circuits (center) and receiver section

Narrow-Band Lines

voice channel. The information rate of this system is in the order of 2,000 bits/sec.

Reliable Transmission

As the data rate increases, bandwidth requirements necessitate means of reliably compressing the essential information for transmission over conventional voice circuits. For equipment simplicity and reasonable bandwidth, a simple a-m system with a carrier centered at the mid-frequency of the voice channel presents many advantages. Such a system provides reliable transmission at rates up to 800 to 1,000 bits/sec over voice circuits. By using vestigial sideband modulation techniques and locating the carrier near the upper limit of the transmission band, the information rate can be increased to 2,500 bits/sec.

In either of these two systems, the performance over long lines, where delay distortion and noise are significant factors, may be materially improved by careful shaping of the modulating signal and synchronous sampling of the detector output. A further improvement can be made by including amplitude and delay distortion compensation in the receiving equipment. All of these features have been embodied in a 2,500 bit/sec vestigial sideband data transmission system to be described.

Figure 1 is a block diagram of the overall equipment including the transmitting unit, the receiving unit, the common timing circuits and an integral random keyer.

In the transmitter section, a binary signal that is either zero or greater than +5 v is limited to a fixed excursion by the input limiter. The limiter output is thus a train

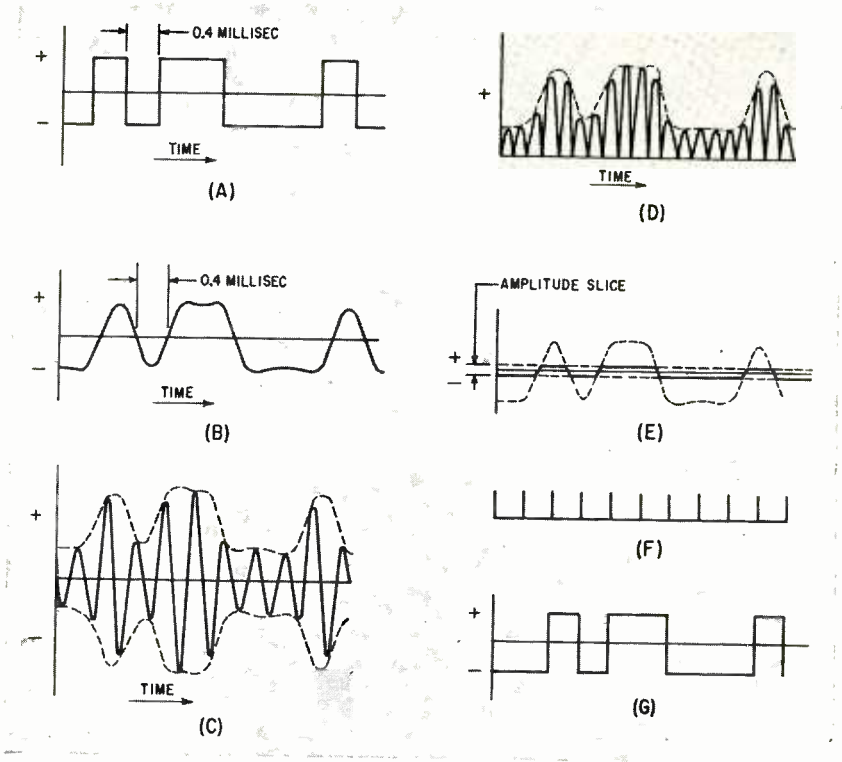


FIG. 2—Binary information to be transmitted enters system in form of (A). After passing through low-pass filter, waveform appears as in (B), then modulates 2,500-cps carrier. Single-sideband output of transmitter is seen in (C). At the receiver, detected signal (D) is filtered and limited by slicer as in (E). Local clock pulse (F) operates synchronous sampling circuit to regenerate waveform as in (G)

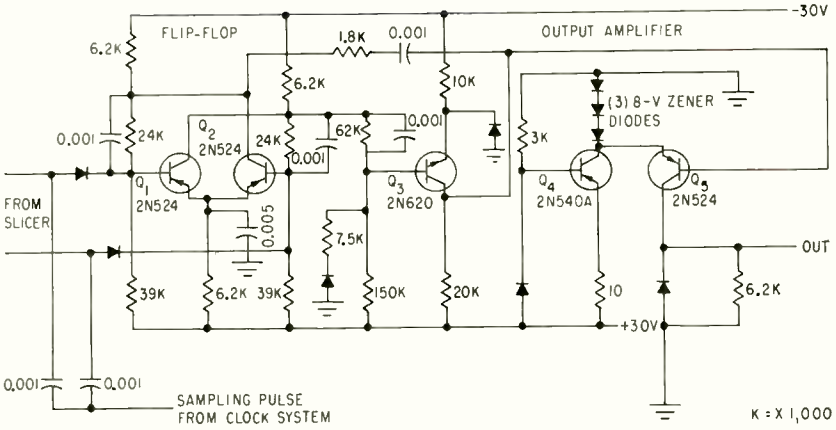


FIG. 3—Schematic of output section of receiver showing synchronous sampling technique

of sharply defined binary pulses as illustrated in Fig. 2A. A low-pass shaping filter removes the high frequency components and modifies the wave shape to that shown in Fig. 2B. The a-c signal then modulates a carrier voltage in a balanced modulator to produce a double sideband suppressed carrier output. The 2,500-cps carrier is reinserted following the modulator to provide for detection at the receiver.

The low-pass vestigial sideband filter attenuates the upper sideband and passes the lower sideband to reduce the signal bandwidth. The transmitter output signal, after passing through the output amplifier appears as shown in Fig. 2C.

Receiver

After transmission over a voice communication circuit, the signal may contain many forms of distortion such as noise, amplitude variations, differential delay or slight frequency shifts. The receiver is designed to compensate for each of these forms of distortion.

The signal first passes through a bandpass filter to minimize noise. An agc circuit in the first amplifier stage overcomes signal attenuation and level variations. A delay equalizer then corrects for delay distortion. Demodulation takes place in an envelope detector which uses the transmitted carrier and thus eliminates the effects of frequency shifts in transmission.

Detector output is a series of half-wave pulses of the carrier signal whose amplitudes vary in accordance with the modulation as shown in Fig. 2D. A low-pass filter removes the carrier ripple but passes the low-frequency modulation. Signal level information is fed back to the early stages for control of system gain in the agc circuit. Output of the low-pass filter is amplified and severely limited in a squaring and slicing circuit, illustrated in Fig. 2E.

Time Jitter

The cumulative effect of noise and delay distortion produces an ambiguity in the axis-crossing time and a resultant time jitter of the output pulse. This is eliminated from the receiver output by synchronous sampling of the detected signal. The schematic diagram of Fig. 3 shows the receiver output section where the synchronous sampling operation occurs.

The binary output of the slicer contains time jitter in its axis crossings. Each bit is sampled by local clock pulses illustrated in Fig. 2F which trigger flip-flop Q_1-Q_2. The two outputs of the slicer which are 180 deg out of phase are applied to the bases of Q_1 and Q_2, respectively. Output of the flip-flop is the regenerated information free of jitter as shown in Fig. 2G.

The signal then reaches *npn* transistor Q_3 which is a driver for output transistor Q_5. This is a relatively low-power unit allowing fast rise and fall time at the output. Power transistor Q_5, in combination with the Zener diodes, provides a voltage-regulated output and constant current drain on the power supply, and acts as a current limiter in the output stage.

The basic time standard for the system is a 100-kc crystal oscillator contained in a temperature stable environment. It is followed by a divider circuit to produce the 2,500-cps standard clock signal. To synchronize the local time standard with that of the transmit end of the system, a sinusoidal voltage derived from the clock pulses is applied to a phase discriminator. Each axis crossing from the receiver slicing circuit is converted to a pulse that is applied to the other input of the discriminator. If these pulses do not correspond to the axis crossing of the sinusoid, an error signal is produced, which after amplification is applied to the motor. The motor rotates a phase shifter until there is phase synchronization between the local clock and the incoming information. This synchronization insures sampling of the recovered information at the middle of the incoming bit. The circuit of this error-correction system is shown in Fig. 4. Pulse generator Q_6 is triggered by reversals of the recovered receiver information. Clock pulses enter the error detector at the base of Q_7.

For test and initial setup checkout, the transmitter contains a binary information source. This is derived from a flip-flop whose binary state is controlled by a coincidence gate which in turn is driven by the 2,500-cps standard and by the amplified noise source.

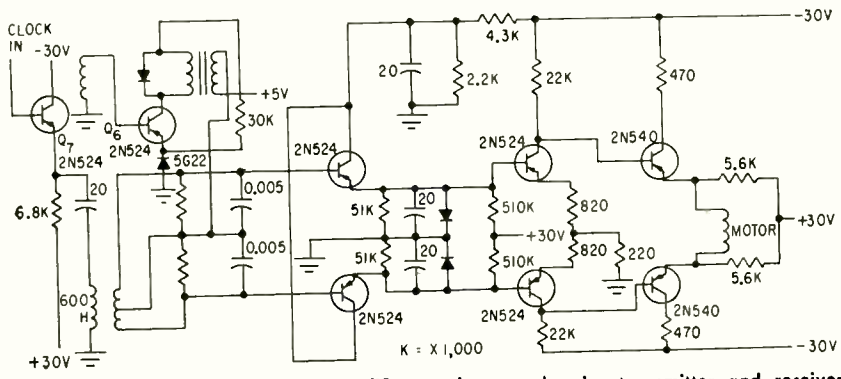


FIG. 4—Error detector and motor amplifier used to synchronize transmitter and receiver

NEW PRINTED CIRCUIT SUB-MINIATURE CONNECTORS BY CINCH

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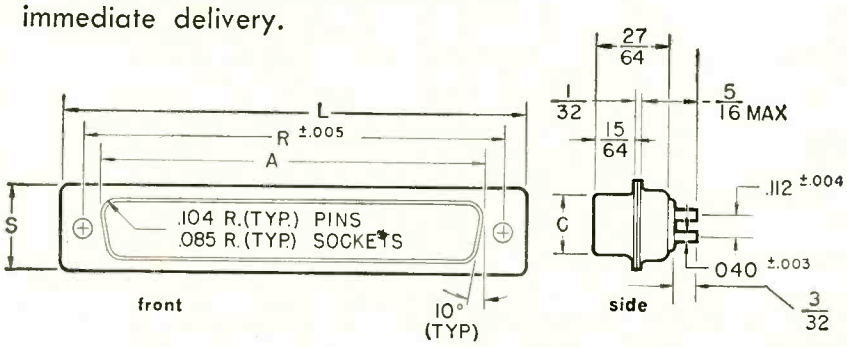

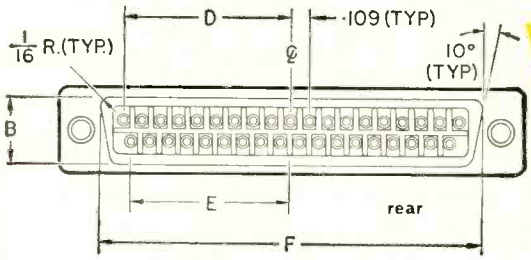

DC-37P-1

DC-37S-1

CONDENSED DATA

SHELL MATERIAL—Steel with cadmium plate finish

CONTACT MATERIAL—Copper alloy with gold over silver plate

INSULATION MATERIAL—nylon or Diallyl-phthalate

POLARIZATION—keystone shell shape

CURRENT RATING—5 amperes

WIRE SIZE—#20 AWG

NUMBER OF CONTACTS—9, 15, 25, 37, or 50

VOLTAGE—D's will withstand a test voltage (60cps ac rms) of 1300 volts and show no evidence of breakdown. The test voltage is applied for a period of 1 minute between the contacts and between the contacts and the shell.

DIMENSION TAB

SIZE	A	B	C	D	E	F	L	R	S
DE- 9P-1 DE- 9S-1	45/64 41/64	27/64 27/64	23/64 5/16	.216 .216	.162 .162	49/64 49/64	1-13/64 1-13/64	63/64 63/64	31/64 31/64
DA-15P-1 DA-15-S1	1 - 1/64 31/32	27/64 27/64	23/64 5/16	.378 .378	.324 .324	1 - 3/32 1 - 3/32	1-17/32 1-17/32	1 - 5/16 1 - 5/16	31/64 31/64
DB-25P-1 DB-25S-1	1 - 9/16 1-33/64	27/64 27/64	23/64 5/16	.652 .652	.598 .598	1 - 5/8 1 - 5/8	2 - 5/64 2 - 5/64	1-55/64 1-55/64	31/64 31/64
DC-37P-1 DC-37S-1	2-13/64 2-11/64	27/64 27/64	23/64 5/16	.978 .978	.924 .924	2 - 9/32 2 - 9/32	2-23/32 2-23/32	2 - 1/2 2 - 1/2	31/64 31/64
DD-50P-1 DD-50S-1	2 - 7/64 2 - 5/64	17/32 17/32	15/32 27/64	.933 .933	.879 .870	2-11/64 2-11/64	2 - 5/8 2 - 5/8	2-13/32 2-13/32	39/64 39/64

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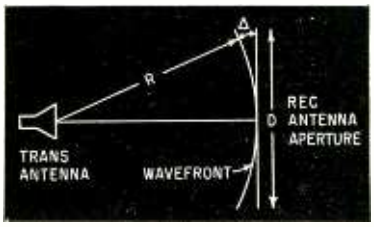

FIG. 1—With closely spaced antennas, there is appreciable separation between the transmitted wavefront and edges of receiving antenna aperture

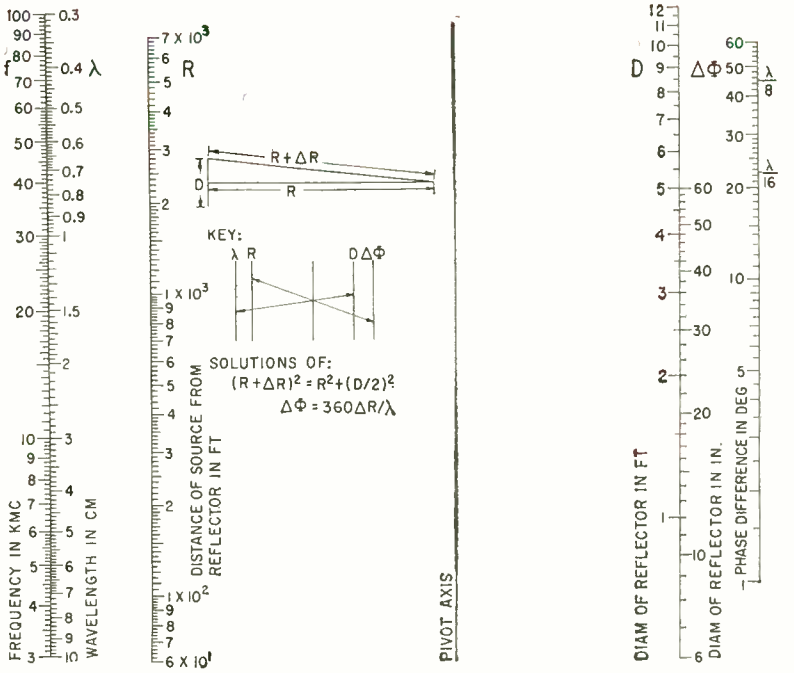

FIG. 2—Nomogram determines the phase deviation at edges of linear aperture as a function of antenna separation. If nomogram does not cover desired range of λ, *R* and *D*, multiply all three scales by *n* and ΔΦ scale by unity

Antenna Measurements

Nomogram quickly finds permissible separation between microwave transmitting and receiving antennas for making measurements

By **J. S. HOLLIS,** Chief Antenna Engineer, Scientific-Atlanta Inc., Atlanta, Ga.
and **W. H. BURROWS,** Georgia Institute of Technology

UNDER NORMAL OPERATING conditions there are usually large separations between microwave transmitting and receiving antennas, or in radar, between the antenna and the target. Because of dynamic range considerations, it is desirable to make antenna measurements at as short a range as possible. Since the measurements must simulate the operating situation, it is necesssary to know how great the separation between the antennas must be for the measured antenna gain and radiation pattern to be a reasonable approximation to those which would be observed at extremely large separations.

At distances from a transmitting antenna which are large compared to antenna dimensions, the phase front of the emergent wave is nearly spherical. For extreme separation, the radius of curvature is so large that the phase front can be considered plane between the extremities of a practical antenna. As the antennas are brought closer together, a condition similar to that shown in Fig. 1 is reached. The plane antenna aperture has a width D with a wavefront of radius R tangent to the antenna at its center. Because of the short radius of curvature, there is an appreciable separation Δ between the wavefront and the edges of the antenna aperture. A criterion that is commonly employed in determining the minimum permissible value of R is to hold Δ to a maximum of $\lambda/16$. Calculations show that $R \geqq 2D^2/\lambda$ is required for this condition. The nomograph is used to determine R for any value of Δ less than $\lambda/6$. The receiving antenna is then said to be in the far or Fraunhofer zone of the transmitting antenna.

The major effect of a small deviation Δ is to produce minor distortions of the side-lobe structure. Larger values of Δ will cause appreciable errors in the measured gain and lobe structure. When measuring antennas which have large phase deviations across the aperture on transmitting, it is necessary to make R considerably greater than $2D^2/\lambda$ to prevent excessive errors in measured gain and lobe structure.

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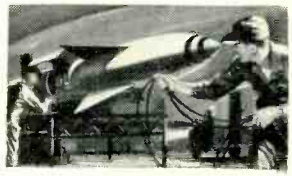

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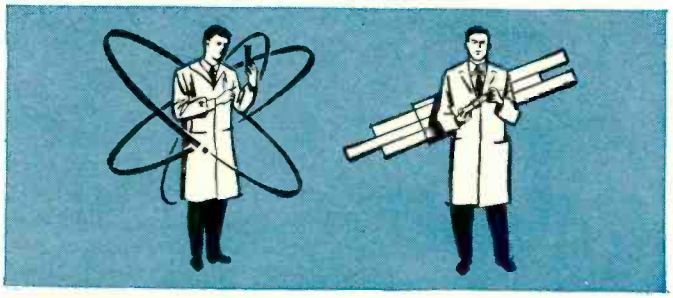

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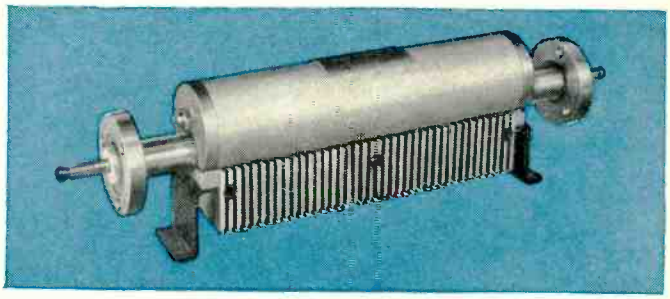
for the type of research and development brains eager to go ahead of ideas already established and in use—has attracted the top *scientists* of the field to Sperry Microwave Electronics. This in turn has brought top *engineers* to the task of converting developments into dependable, advanced products.



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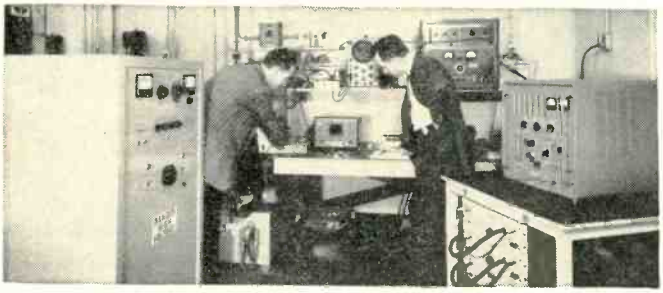
Sperry Microwave Electronics has pioneered in extremely broadband frequency range components at high and average power levels (such as this ferrite isolator designed for countermeasures systems)—in S-band and below for high power components, and in many special devices.



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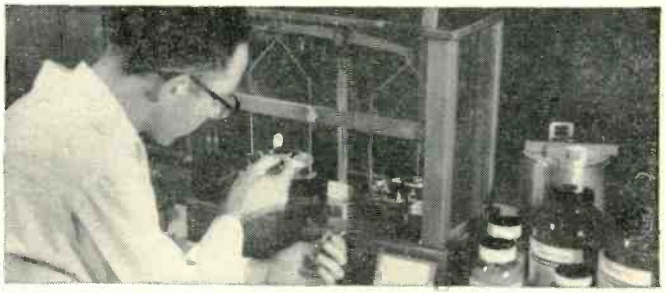
laboratories—and laboratory equipment such as this—are common in Sperry's modern 85,000 sq. ft. plant in Clearwater—and with it the latest production equipment.



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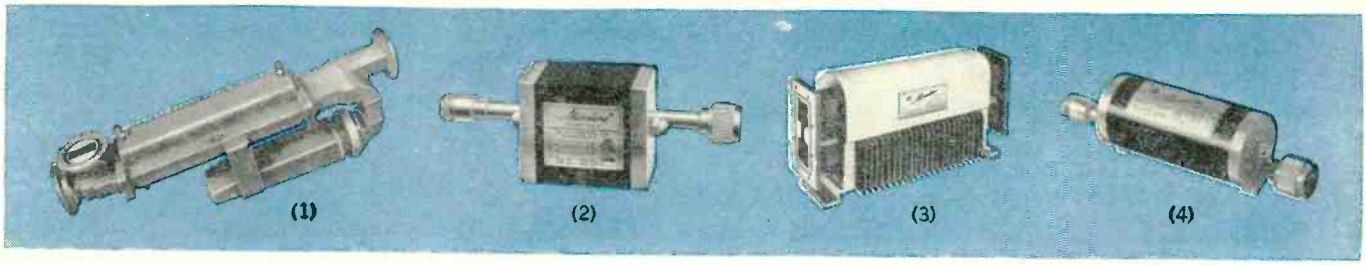

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Electronic Micrometer Checks Jets

CAPACITANCE micrometer can detect several conditions of incipient failture in jet engines and turbines. The instrument was developed by Ford Motor Company after 6 years of research.

Clearances of 0.030 to 0.001 in. may be measured with nominal accuracy of ±10 percent of indicated reading. Frequency response is from d-c to 200,000 cps, and measurements are possible to temperatures of 1,500 F with water-cooled pickups.

The device, weighing about 4 ounces, can be permanently installed in the shroud, if desired. Stretch of each blade, bearing condition and shaft vibration are read dynamically on an oscilloscope. Another probe is usually set at right angles to the first to measure thrust movement.

Operation

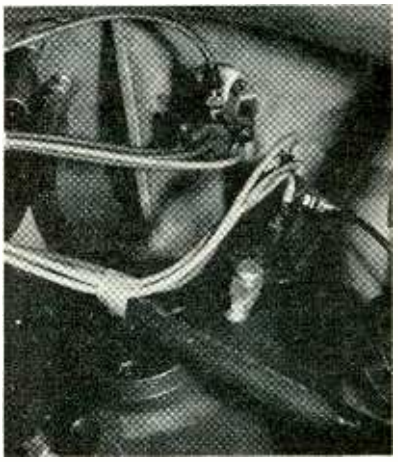
In operation, capacitance of the gap between a brass tip on the probe and the grounded turbine blades is matched to a coaxial cable by a transformer. Minute shifts in capacitance caused by changes in blade dimensions are passed through the cable, which can be cut to any multiple of one-half wave length of the operating frequency. Changes in capacitance shift frequency of an oscillator.

These changes are converted by a discriminator to equivalent changes in voltage. The result for one blade can be read on a peak-reading voltmeter, or all blades can be conveniently studied on an oscilliscope. When using a voltmeter, the highest peak reading during one revolution is stored over one-tenth sec.

Stability

Stability of the instrument depends on temperature stability of pickup dielectric material. Pickup drift may be measured during operation and compensated by a control on the instrument.

Miniaturization and transistorization of the electronics has not been attempted, but transmitter and scope weight could be brought down to about 2 lb. In addition, there would be the weight of the required length of coaxial cable, two quarts of liquid coolant per probe and a means of circulating.



Capacitance micrometers measure blade stretch, bearing condition and vibration of jets and turbines

About 50 of the probes have been used successfully, as both a safety and measuring aid, for hundreds of hours in test operation of the company's experimental 160-hp automotive-type turbines. Successful measurements at up to 1,600 F and at 60,000 rpm have been made, but these figures should not be considered as limits.

Materials

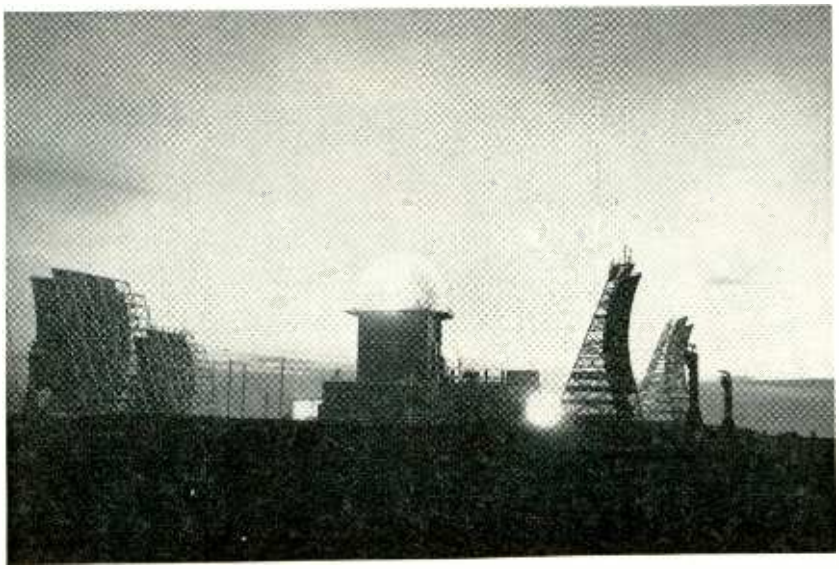
The body of the probe, which contains coolant passages, can be made of any conductive metal compatible to the shroud material. The tip, which forms the capacitance gap to the rotor, can be made of brass or steel. Brass was chosen for the experimental probes because of the ease with which it can be scraped flush with the inner contour of the host shroud.

Ease of working was also a factor in choosing the dielectric, as were critical electronic considerations. Mycalex 500, a synthetic mica, met all requirements, though some experimental ceramics were found to be satisfactory substitutes.

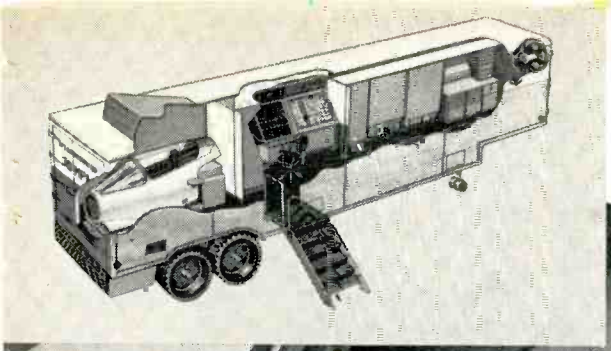
The other critical component in the probe is the transformer core. General Ceramic's Q-1 material, a ferrite, is used here and is wound in commercial copper.

Capacitance involved is about 20 micromicrofarads. Normal variations in blade clearances result in

Dewline Extended to Aleutians



Aleutian Dewline site shows plastic radome with internal lights to prevent ice formation. Antennas on either side of building tie in Dewline with mainland warning system via White Alice communications network



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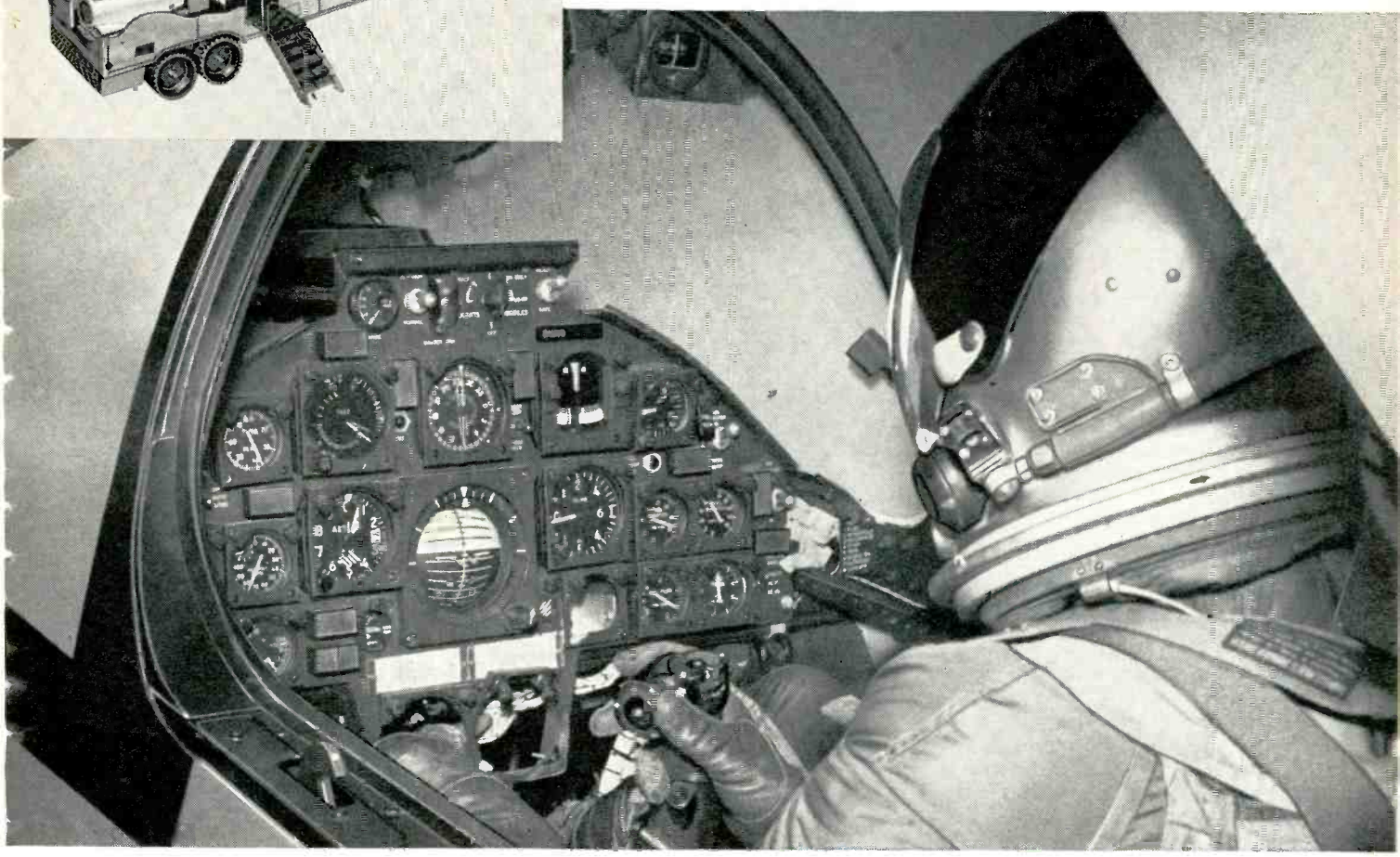


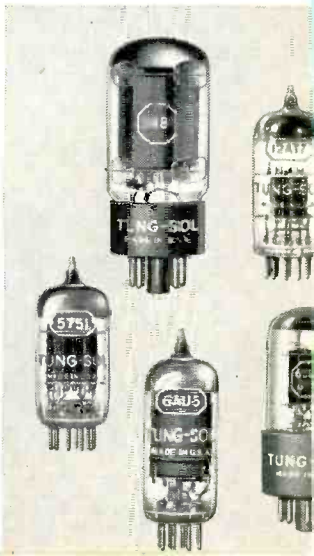
Tung-Sol tubes help LINK AVIATION, INC. trainers put fledgling pilots in the air!

A Link electronic trainer acquaints both the beginner and experienced pilot with precise flight conditions from takeoff to touchdown. It familiarizes him with on-ground responsibilities . . . teaches crew coordination, radio procedure, navigation, instrument flying . . . and records student reactions. The fledgling gets the 'feel' of flying without ever leaving the ground.

The complex and sensitive simulators function over long periods and get rough treatment from beginner hands. Precision operation demands more-than-ordinary reliability and performance from every simulator component, including up to 3,000 electron tubes.

Tung-Sol dc summing amplifier tubes and buffer tubes used in the various Link simulators consistently meet these exacting requirements. The tubes feature outstanding electrical stability . . . ruggedness under hardest usage . . . minimum short-life failure rate. And tube quality stays uniformly high from one tube lot to another.

The same premium tube performance Link enjoys is available to you. Specify Tung-Sol power tubes for any military and industrial socket you must fill! *Tung-Sol Electric Inc., Newark 4, New Jersey.*



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about a 10-percent capacitance change. However, the dielectric constant of the insulating material can change by a factor of 10 (1,000 percent) with elevated temperatures. This is the reason for not cooling the probe by airstream.

Stable reference capacitors are used in the circuit to provide a means for checking zero drift and for calibrating the instrument during operation.

Probe temperature of 200 F is an absolute operating maximum, and in practice it is normally less. Liquid cooling of the outer jacket of the probe and the sensing tip maintains this temperature range for the matching transformer and dielectric. These were the two major patentable features of the device.

The only problem at low temperatures is to keep the coolant from freezing. The coolant can be any liquid with reasonably good dielectric qualities. Ford found that water was completely satisfactory in its laboratory operations.

The company is currently negotiating with several instrument makers to make the device available commercially. Commercial future for the probe lies in its possibilities as a service tool rather than a researcher's safeguard.

The instrument could replace current statistical criteria for overhaul of civilian and military jet engines. Such data leave room for failure in flight. Also, from an economic standpoint, it is probable that 90 percent of jet engines are removed for arbitrary overhaul before it is necessary.

Parametric Amplifier Receives Space Signals

LOW-NOISE parametric amplifier was combined with an 18-foot high-gain parabolic antenna by General Electric engineers to receive signals from Pioneer IV. Signals were received at distances of more than 410,000 miles. Success of the combination demonstrates the feasibility of using a small high-gain antenna with a low-noise parametric amplifier to receive useful telemetry signals from distant space vehicles.

The signals were received by General Electric in Schenectady, N. Y., during the recent deep space probe conducted by the U. S. Army Ordnance Missile Command for the National Aeronautics and Space Administration.

Pioneer IV's signals were rated at a fraction of a watt. Without the specially designed parametric amplifier, the noise generated by the input portion of the receiving system would have masked out the faint signals long before Pioneer IV's batteries expired.

The L-band amplifier is a straight through type with a pump frequency in the X band. It uses a specially designed parametric diode that has a noise figure of about 1 db. Bandwidth of the amplifier is 100 kc.

The tracking station picked up signals from Pioneer IV minutes after it was launched on March 3, and again on the second, third and fourth days as it came up over the radio horizon.

Antenna

The faint signals transmitted by the probe were picked up by a horizontally polarized 18-foot parabolic antenna. The antenna had about 32-db gain and fed into the parametric amplifier. From the amplifier, the signals were fed to a crystal mixer. The local oscillator frequency was controlled to provide a 30-mc mixer output, which was fed through i-f amplifiers to the input of a conventional receiver tuned to 30 mc.

Carrier phase-lock equipment was used to obtain telemetry information from the signals and to provide, through proper frequency scaling, the local oscillator signal used in the mixer.

In this system, the frequency of the signals received is compared with a frequency standard. Knowing the exact frequency of the missile's crystal-controlled transmitter, the Doppler shift due to the speed of the vehicles in relation to the station's location was obtained. These signals are recorded along with National Bureau of Standards Time Signal for comparison with similar data from other tracking stations.

How Constant-Power Tubes Perform

By E. G. DORGELO, Chief Engineer, Transmitting Tube Division, N. V. Philips, Eindhoven, Consultant to Amperex Electronic Corp., Hicksville, N. Y.

A RELATIVELY LOW mu factor, in an electron tube, combined with a relatively low secondary emission of the grid material—these factors being properly proportioned—will give a considerable range of constant power operation.

To demonstrate the improvement achieved by constant-power characteristics, the constant-power tube TBW 6/14 was compared with the 6420 in a typical circuit. Figure 1 graphically illustrates the results. From the graph it can be seen that the CP tube achieves a maximum point in the power output, W_o, curve whereas the power output of the ordinary tube is an almost linear function of load impedance.

Load Variations

For example, small variations in load impedance will produce relatively large changes in the 6420 power output. On the other hand, in the region of the inflection point, the TBW 6/14 will remain relatively constant even for large variations in load impedance. Figure 1 indicates that the constant-power characteristics of the TBW 6/14 are most favorable for load impedance variations less than 1 to 2.6.

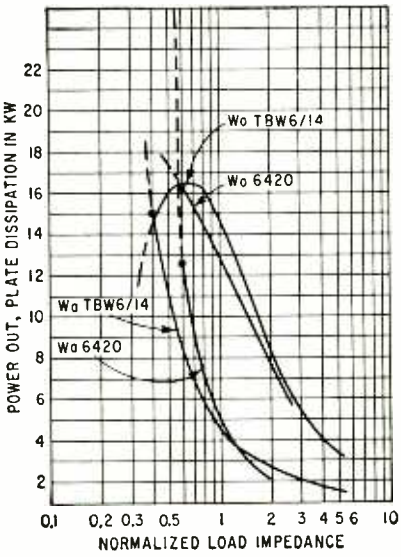

FIG. 1—Comparison of Amperex constant-power tube TBW 6/14 and a conventional tube Type 6420 in typical operation

Another area of difference between the two tubes is the rate of change of plate dissipation with variations of load impedance. When operating the 6420 near the maximum plate dissipation, a small shift in load impedance may cause heavy overloading of the plate. The converse is true for the CP tube.

Intermittent Service

To make full use of the constant power properties in intermittent service, dissipation and temperature versus time curves are desirable for the calculations of duty cycles. In Fig. 2, heating and cooling curves are shown for the CP tube 7092. These curves show the temperature rise for several dissipations together with the cooling down curve. Used together, these curves determine the allowable *on* period for a given input, the *off* period required, or the average anode temperature for a given dissipation and duty cycle.

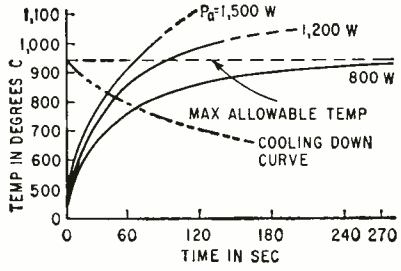

FIG. 2—Heating and cooling curves of the constant-power triode 7092

Power Absorption

To gain an insight as to how a typical load absorbs power as the heating cycle progresses, Fig. 3 gives the general curves for ferromagnetic (A) and thermal setting materials (B) if the load current and voltage are constant. Load rematching is not required with the CP tubes because the oscillator adjusts to deliver the same power as load impedance changes.

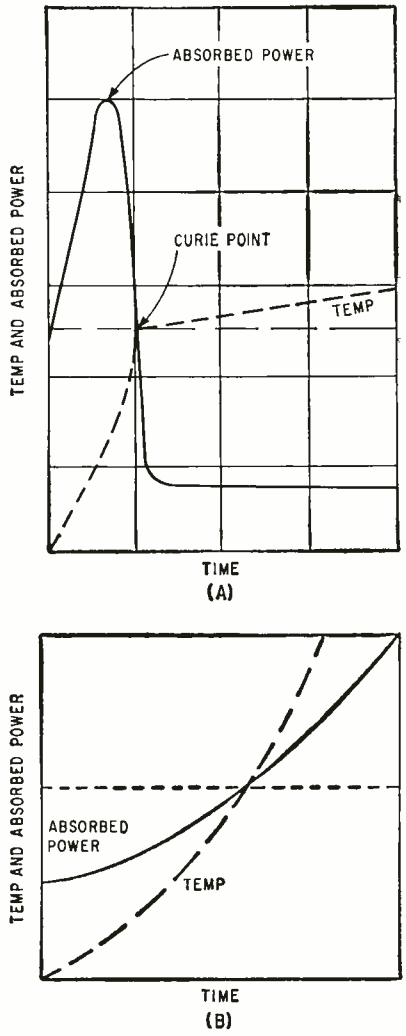

FIG. 3—Variation of load power (constant load current voltage) in ferromagnetic materials (A), and thermosetting plastic materials (B)

With regard to the two directions of load impedance changes, it is only necessary to adjust the parameters for class-C operation when the impedance, as seen by the tube, starts with the maximum value; or to class-B operation when the impedance starts at the minimum value. In both cases, the tube will operate at all times between class B and class C with a correspondingly high efficiency over the whole heating cycle.

(Continued on p 84)

after routing, clip and save

REFERENCE DATA FILE Folio 59-4

SANGAMO

a continuing series on technical topics of specific interest to engineers

What is the difference between AC and DC capacitors?

A recurrent question confronting the capacitor engineer involves *the comparative AC and DC application for chlorinated synthetic oil impregnated and filled paper dielectric capacitors.*

Our industry is highly specialized. To realize maximum efficiency and performance of prime equipment and systems, the components utilized must be specifically tailored for the application. Let's see how this concept affects an engineer's decision of capacitor choice.

Although the operations and functions are dissimilar, AC and DC paper capacitors have many similarities. They are almost identical in physical appearance. Both may - - -

(a) utilize metal containers.
(b) be hermetically sealed.
(c) have approximately equivalent case sizes.
(d) have the same terminal structure.
(e) have the same container finish.
(f) be impregnated with chlorinated synthetic oil.

Both are fundamentally a device to store a quantity of electrical energy.

The electrical parameters of AC and DC paper capacitors may appear to be approximately the same. The particular characteristics that are important to their circuit performance are markedly different. Let's now take a look at some of these considerations:

Insulation Resistance. This is a very important characteristic of a capacitor used in most DC applications. It is not comparatively as important in the operation of a AC motor running capacitor. In the motor, the capacitor is shunted across a rather low resistance coil.

Dissipation Factor — The AC motor running capacitor's useful life may depend greatly on the value of dissipation factor at operating voltage, frequency, and ambient conditions of temperature. Internally generated heat in the capacitor body is proportional to the dissipation factor. Life expectancy is, in turn, inversely proportional to the internally generated heat. The dissipation factor of a DC capacitor is only important as an indicator of general quality.

Applied Unidirectional Electrical Stress — This is probably the point of greatest consideration in the comparative rating of DC and AC paper capacitors. Continuous current flow occurs in the dielectric of a DC capacitor upon application of polarized voltage. The magnitude of this current is a function of the insulation resistance at the imposed condition of voltage and temperature. The accumulative effects of these conditions can be insidiously damaging. Eventual capacitor catastrophic failure can occur as a result of progressively accelerated electro-chemical activity. Conductive ions may migrate to one electrode of the capacitor due to the influence of the electrical stress. These ions, primarily acid radicals, may chemically attack the electrode metal, forming metallic salts. The metalic salts may be soluble and may act as a catalyst to free more conducting ions from the dielectric oil, thus accelerating the destructive action. The capacitor designer combats this condition in a DC capacitor by - - -

(a) minimizing the initial presence of free acid radicals in all dielectric materials.
(b) neutralization of trace ions through addition of selected inhibitors.

Such inhibitors are not necessary or desirable in capacitors intended for AC use. The alternating electrical force field does not promote unidirectional migration of mobile ions. We do not infer, however, that the AC capacitor is not subject to chemical deterioration.

Temperature Rise and Chemical Deterioration — Both AC and DC capacitors are subject to chemical deterioration as a function of temperature and voltage stress. Chemical activity is roughly accelerated by a factor of 2 for each 10°C increase in temperature. The reactive current in an AC application will cause generation of internal heat as a result of:

(a) dielectric loss
(b) resistance losses in the electrodes
(c) contact resistance losses

The net result is unit temperature rise above the ambient temperature. The capacitor design engineer accomplishes minimum temperature rise by:

(1) Careful selection of the impregnating oil.
(2) Careful choice of paper density, purity, and lamination.
(3) Proper disposition of the internal current carrying members.
(4) Efficient arrangement of internal capacitive elements.
(5) Providing maximum heat radiating area in the can surface.
(6) Providing an efficient heat radiating finish on the container.

The net result is a capacitor of exemplary performance in many AC applications. Such a capacitor will not necessarily deliver optimum results on a continuous duty DC application.

Frequency Effects — AC capacitor electrical losses are proportional to frequency, dissipation factor remaining constant. If a unit is designed to operate at maximum temperature rise at a frequency of 60 c.p.s., its internally generated heat will be excessive at any higher frequency. A sizable increase in volume and surface area is necessary for satisfactory performance at increased frequencies. The penalty of ignoring the frequency factor may be a ruptured unit.

We have attempted to cover only the most pertinent factors having to do with the two types of components; to emphasize that AC and DC capacitors are not the same devices. To summarize, they may differ in these respects:

(a) inherent characteristics of the kraft tissue.
(b) electrical properties of the impregnating oil.
(c) internal arrangement of the capacitive elements.
(d) current carrying capabilities of the internal connections.
(e) heat dissipating capabilities of the enclosure.

Sangamo Sales Engineers are well qualified to provide council and assistance on the difference encountered in DC and AC oil impregnated paper dielectric capacitors. The Sangamo line is complete and offers a wide selection to meet all applications. In addition, specific Engineering Catalogs are available for your files which clearly define and detail rating factor requirements. Write for Engineering Catalog No. TSC-205A.

SC59-4

SANGAMO ELECTRIC COMPANY, Springfield, Illinois

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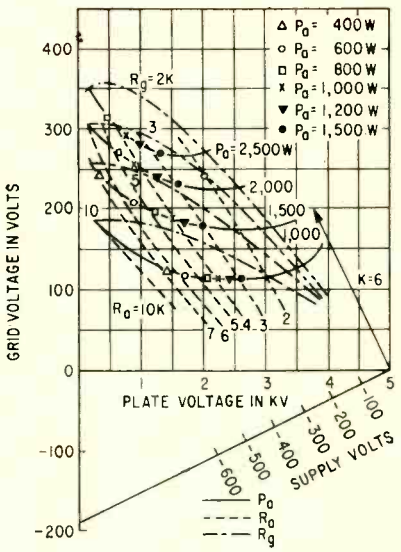


FIG. 4—Constant-power performance of the industrial oscillator tube 7092

Figure 4 shows the performance of the 7092 with a feedback factor of 6 and 5,000-v plate supply. If the load resistance varies from 6 k to 2 k when a 3-k grid resistor is used, the power output varies less than 15 percent. If other feedback ratios are used with other values of plate voltage, new constant-power curves must be constructed.

Tube Simulates Solar Shock Waves

DEVELOPED AT A TOOL for basic research at Avco-Everett Research Laboratory in Mass., a 30-inch shock tube, Fig. 1, triggered by an electric charge of 4-billion watts, is able to reproduce for the first time thin shock waves similar to waves which are responsible for magnetic storms around the earth. The million mile an hour gas velocities are believed to be the highest ever achieved in a laboratory.

Four billion watts of electric

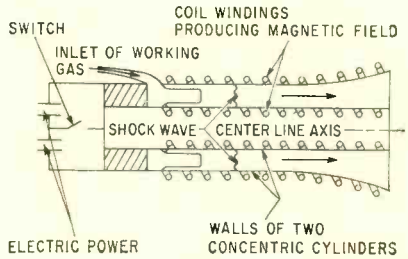


FIG. 1—Schematic diagram of the Avco Eleciric Shock Tube, in which a shock wave and gas velocities of greater than one million miles per hour have been produced

power, discharged from a bank of capacitors in about 2 millionth of a second, provide the energy.

To understand what happens, consider a magnetic ring blown off the end of a magnetic stick. But instead of a ring, there is a tenuous gas, hurled down the tube at the million mph speed.

Shock wave tube experiments are under the guidance of Arthur Kantrowitz, known for his work in high-temperature gas dynamics and shocktube technology.

The overall effect of a magnetic storm following the passage of a solar shock wave is a sudden disturbance in the earth's magnetic field for a period of hours. The earth's magnetic field stabilizes and readjusts its position within days.

Significance

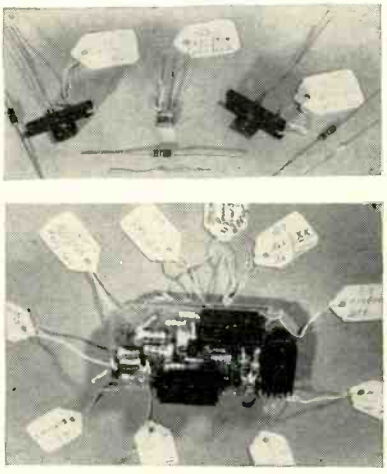
Ionized gases in violent motion are a very large part of the universe. Understanding these gases is an important task. The study of high temperature plasmas is important for space flights at great distances from the earth, as well as controlled fusion.

The Avco-Everett Research Laboratory has had the major responsibility for research on re-entry heating of the Atlas, Titan and Minuteman.

New Wiring System Saves Space

New hard harness wiring system is shown to right of conventional aircraft wiring harness. New Chance Vought Aircraft system encases wires in rigid fiber-glass coverings. Two small sections of the hard harness carry about the same number of wires of the same gage as the conventional section but occupy less space

Portion of village. Each assembler spends the same amount of time on a board, passes work to girl on left



Tagged transistors and trims (top) and complete assembly

Assembly Village for Varied Work

MEDIUM-SIZED LOTS of printed wiring board assemblies are handled at Ford Instrument Co., Long Island City, N. Y., in an "assembly village" containing all equipment and personnel for component preparation, assembly and testing. In 18 months, over 2,000 different assemblies in batches of 50 to 1,045 units have been made.

To assure a straight-through flow of work, all components are on hand before assembly of a batch begins. Work is methodized for simple assembly and the amount of time each assembler spends on a board is equalized. Each assembler places 5 to 9 components on the board and lead wires to gang connectors are similarly divided.

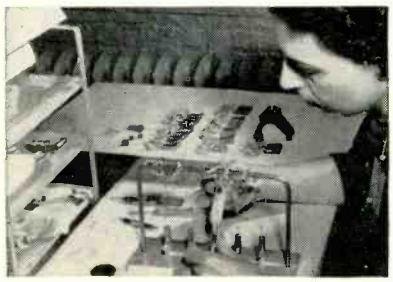
Each assembler is given a set of assembly methods drawings in which identification, position and connections of each of her components is shown in color. A variation under consideration is the use of color photos of sample boards. An overlay with cutouts would show only the components each assembler is responsible for. Work moves from left to right. Parts and the drawings are placed on racks in front of each assembler.

Once an assembler has mastered basic soldering techniques, she can be used at any stage of assembly. This guards against delays caused by absences. It also restricts training time on any assembly to whatever specialized techniques are required for that assembly. For example, in the sandwich type computer control amplifier portion shown, the female gang connector of the upper board is the fixture during soldering of male plugs in the lower board.

Quality of work is maintained by employing a representative of the quality control department as a roving inspector.

Transistors are generally received sufficiently ahead of time to permit pretrimming the transistors in groups in a sample circuit. The technician determines trimming requirements and prepares matched sets.

Assembly methods drawings show where each component belongs



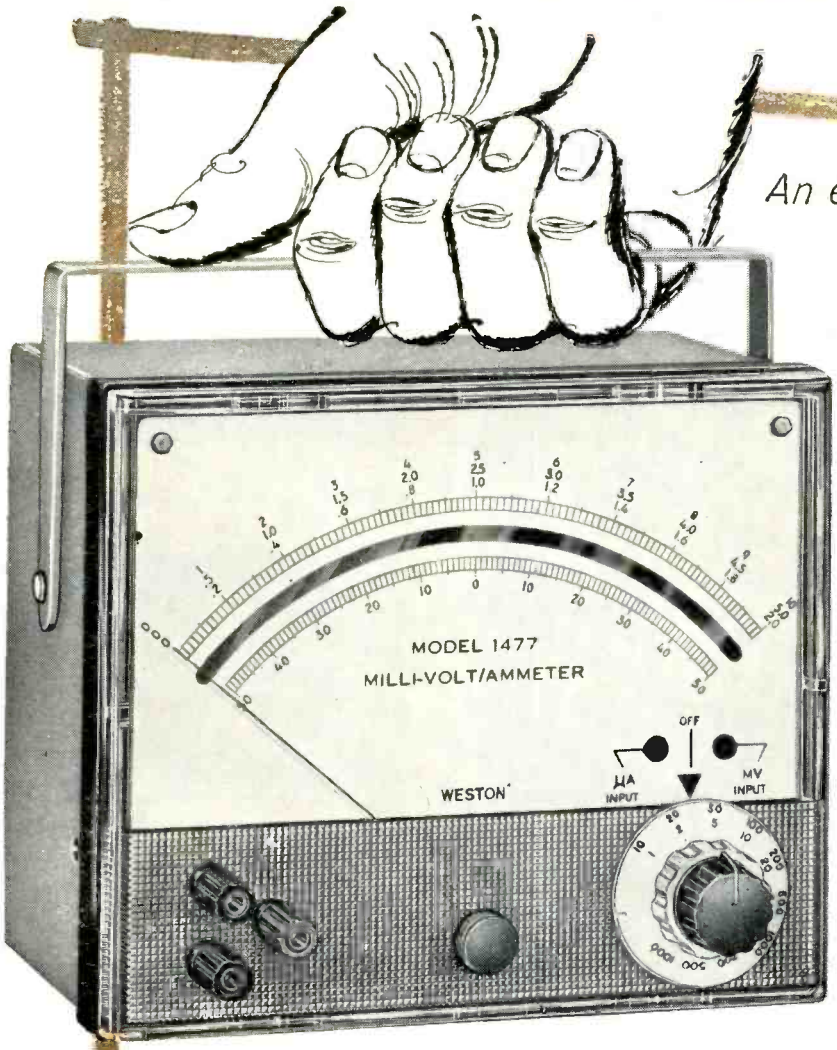
Component sealant is applied with hypodermic needle

Transistor matching fixtures. Sample circuit is at left

Setup used to prepare matched sets of transistors

Rivets Form Channel For Computer Wiring

CHERRY RIVETS serve a dual purpose at the Bendix Aviation Corp. Computer Division, Los Angeles. The



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- Unique INDUCTRONIC® servo-amplifier provides extreme high gain and full feedback — for accuracy and stability unaffected by variations in line voltage or frequency, condition of tubes, or other variables.
- Model 1477 is a true D-C meter with zero-drift comparable to a permanent magnet moving coil instrument. No mechanical switches or choppers are used.
- Essentially zero power-drain from the source being measured.
- Power-gain is sufficient to drive indicating meter plus any external load up to 5,000 ohms. Power output is available at terminals in rear of unit.
- Knife-edge pointer and 7.2-inch mirror scale provide unmatched readability.
- Gain stability and output linearity are both within 0.1% at ranges above 1 millivolt or 200 microamps.
- Resolution capability is within 2 microvolts or .02 microamps.
- Power requirements: 115 volts A-C, 50 to 1600 cycles, 35 watts.
- Less expensive than competing instruments offering lower stability.

For full information, contact your local Weston representative . . . or write to Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

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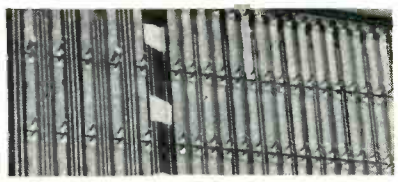
rivets attach circuit connectors to structural T-bars. Instead of removing the rivet extensions after riveting, the extensions are left intact. The series of rivet extensions along the T-bar forms a channel in



Section of panel before wiring

Section of panel after wiring is laced into rivet extensions

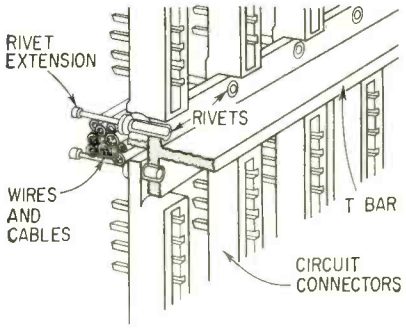


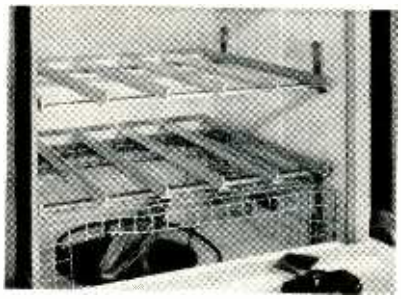
FIG. 1—Rivet extensions do job of standoffs on computer frame

which wires and cabling are strung (Fig. 1). The heads on the rivet extensions provide a made to order projection behind which string is laced to hold the wires and cabling in place.

Home Dishwashers Rinse Flux and Resist

HOME DISHWASHERS, slightly modified, are used by Bendix Aviation Corp. Computer Division, Los Angeles, to remove flux or photo resist from printed circuit boards after dip soldering or etching.

A solvent is circulated from a sump, through the machine and back to the sump. The heating elements in the machines are removed and the solvent circulates at room



Rack arrangement inside dishwasher

temperature. The machines' timers have been modified to yield a 5-minute cycle. Gaskets around the doors were replaced with a solvent-resistant material.

Solvent used (Chlorothene) is good for 5 to 15 cycles, depending on amount of flux or resist to be removed. Racks installed in the machines give a capacity of about 100 relatively small boards.

Argon Gas Simplifies Protective Packaging

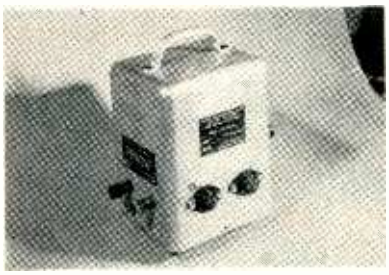
INERT ATMOSPHERE packages protect oxidizable parts. The following method is used by Accurate Specialties Co., Woodside, N. Y., to package semiconductor alloying forms in vials filled with argon gas.

The containers are placed in the bottom of a large, open vessel. Argon is flowed from a tank into the bottom of the vessel. Because argon is heavier than air, the air floats out of the vials and is replaced with argon. The packager reaches into the vessel, caps the vials and seals them by stretching pressure sensitive vinyl tape around the caps.

Additive to Rinse Water Protects Metal Surface

ORGANIC LIQUID additive to final hot rinse water is announced by Enthone, Inc., New Haven, Conn. The material, Entek 45, protects freshly plated or cleaned metals (except lead, silver and magnesium) from corrosion, tarnishing and water spotting. When small amounts of sodium or potassium dichromate are added, up to 100 hours resistance to tropical humidity is given. The protective film is said to facilitate soldering and painting.

On The Market



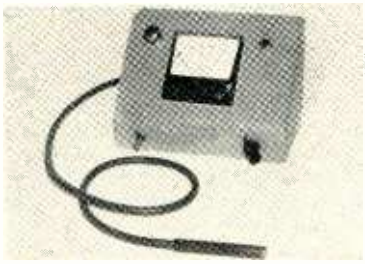
Inverters
d-c to a-c

STATIC INVERTERS CORP., 2501 E. 68th St., Long Beach, Calif. Model 12-115-60AC series inverters feature an exclusive non-saturating time-constant design which affords frequency stability over as much as ±60 percent of the input d-c voltage. Superior reliability and efficiency up to 95 percent is obtained without any zener diodes and other voltage regulating devices. Standard units have square-wave output; sinusoidal output configurations, at a slight extra cost.

CIRCLE NO. 200 READER SERVICE CARD

Shutter Tester
accurate unit

OPTOMECHANISMS, INC., 216 E. Second St., Mineola, N. Y., announces a new instrument to measure the total time that a shutter is open without disassembly of camera. Measurement is read directly



on a meter, by placing a probe containing a phototransistor at the film end of the camera, and illuminating the lens by a flashlight or other light source. Accurate measurements are obtained independent of lens, aperture, or light illumination level.

CIRCLE NO. 201 READER SERVICE CARD

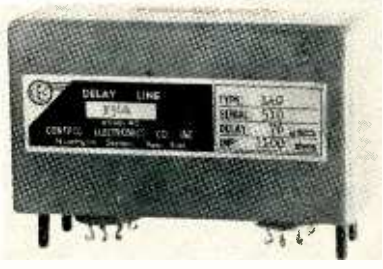
Magnetic Amplifier
logic type

PACIFIC MAGNETIC CORP., Electronic Center, Romoland, Calif. A new magnetic amplifier combines the reliability of all-static construction and the ability to perform every kind of logical switching function. The small unit serves as an AND, OR or NOT gate, or as a bistable memory device. The PMC-785 logic type magnetic amplifier is made primarily for missile control and checkout applications, thereby saving space, weight and cost. It withstands extremes of shock, vibration and temperature.

CIRCLE NO. 202 READER SERVICE CARD

Delay Line
lag type

CONTROL ELECTRONICS CO., INC., 10 Stepar Place, Huntington Station, N. Y., has developed a new, compact, lag type delay line for use with signals in the sonic frequency range. The F344 has an impedance of 1,100 ohms, a band width of 15



kc and a total delay of 76 μsec (± 1 percent). Taps are provided at each 9.5 μsec and loading is prevented by use of precision isolation resistors. With an insertion loss of only 0.2 db attenuation at 15 kc and 3.0 db at 30 kc, the F344 can be used separately or units can be cascaded for longer delays.

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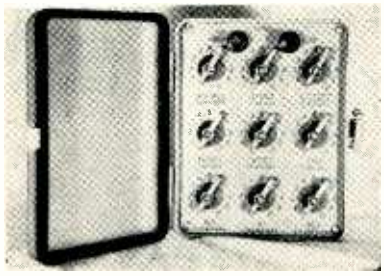
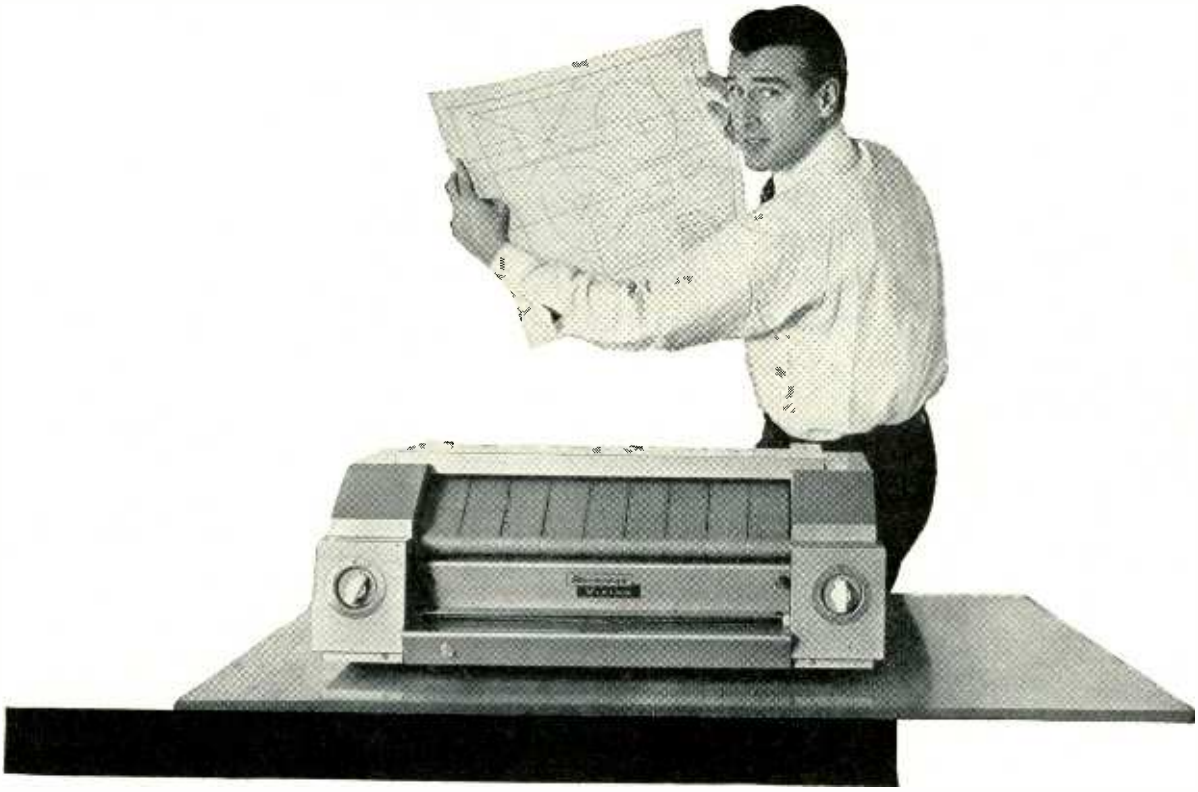


Decade Resistor
broad range

NEPTUNE ELECTRONICS CO., 30 W. 15 St., New York 11, N. Y. Type 5901 decade resistor consists of 9 decade units. It provides a range of resistance from 0.1 ohm to 111,111,111 ohms. Completely ruggedized and waterproof, it is uniquely suited for field or production measurements where the high accuracy of a laboratory standard is required.

CIRCLE NO. 204 READER SERVICE CARD

(Continued on p 94)



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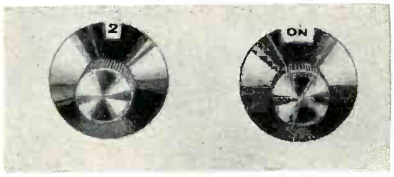

Instrument Knobs
anodized aluminum

VEMALINE PRODUCTS CO., P.O. Box 222, Hawthorne, N. J., has new instrument knobs with a special opening for safety and simplicity of reading its position on either numbers or on-off. They meet military specifications and are available in 12 anodized colors. Price is $0.85 each, list.

CIRCLE NO. 205 READER SERVICE CARD

Indicator
elapsed time

HEPTA ELECTRONICS, INC., 2635 Louisiana Ave., Minneapolis 26, Minn. Type SM-1 elapsed time indicator has nominal diameter and length dimensions of less than 1 in., weighs only 1.25 oz, and has a power consumption of 1½ w. Small size and high reliability are accomplished through the use of a subminiature, extremely rugged single phase synchronous motor. Indicator is designed to meet the general requirements of MIL-I-7793B.

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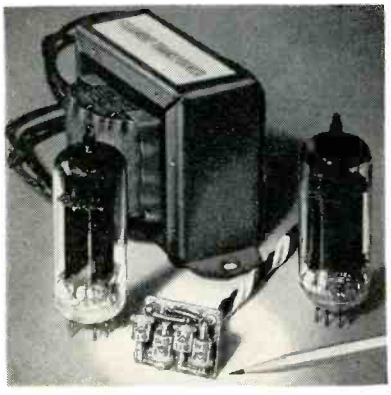
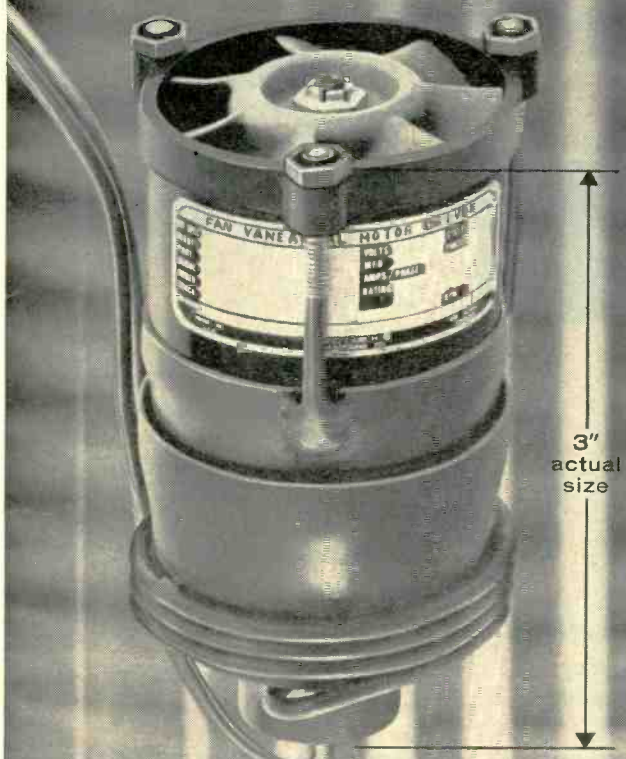
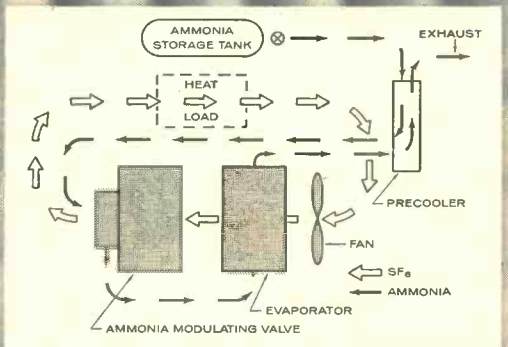


Bridge Rectifiers
50 to 500 piv

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. A new series of subminiature silicon bridge rectifiers extends the company line to replace bulky v-t bridge rectifiers in only 1/50 of the volume and weighing less than

LIGHTWEIGHT airborne electronic cooling package





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Heat Rejection: 200 watts... Inlet Gas Temperature to Component Housing: 130°F.... Weight of Fan, Evaporator and Controls: 1.25 lb.

Spans the gap between direct ambient cooling and closed cycle systems

● *This AiResearch open-cycle cooling unit* is designed for environmental conditioning of electronic and electromechanical equipment in problems of low total heat dissipation aboard aircraft and missiles.

Much lighter and less complex in operation than closed cycle systems, this compact package is recommended when required total heat dissipation is low... large heat loads for short periods of time, or small heat loads for long periods of time. It also replaces direct ambient cooling systems when ambient sink is not low enough or not easily available.

Ammonia in this expendable evaporative system cools sulfur hexafluoride (SF_6) which passes over the hot electronic components. The SF_6 then recirculates for cooling, and the ammonia is dumped overboard.

Applications of this system include: inertial guidance system cooling, missile transient cooling, and spot cooling where ambient sink is not available.

AiResearch has designed and manufactured cooling systems of all types ... direct ambient, closed and open-cycle systems handling all magnitudes of cooling loads and utilizing various working fluids. We invite you to send us details of your problem.

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1/100 of equivalent tube circuitry. Measuring only 0.875 by 0.719 by 0.750 in. and weighing ¼ oz, these rugged, shock-resistant devices are designed primarily to provide extreme miniaturization in missile, airborne and ground system circuitry, and may be operated at temperatures up to 165 C.

CIRCLE NO. 207 READER SERVICE CARD

Converter analog-to-digital

ELECTRO INSTRUMENTS, INC., 3540 Aero Court, San Diego, Calif., announces a new series of totally transistorized analog-to-digital converters capable of making up to 1,000 conversions per sec. Instruments in the 7000 series feature 0.01 percent sensitivity and resolution, automatic polarity, three or four digit in-line display and transistorized logic circuit. Voltage state BCD outputs are developed for data recorder entry.

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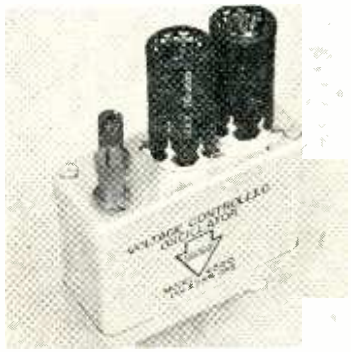

Oscillator voltage-controlled

THE GEOTECHNICAL CORP., 3401 Shiloh Road, Garland, Texas. Adjustable and serviceable voltage-controlled f-m subcarrier oscillators are now available for ground-station telephone, radio, or microwave transmitting use. Oscillators plug readily into a transmitting multi-

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Whether you're designing for monophonic or stereo high fidelity, you'll want to hear the many other facts your RCA Field Representative can give you on the RCA-6973. For technical data, write RCA Commercial Engineering, Section F-19-DE-1, Harrison, N. J.

RCA tubes for High Fidelity also available from your local Authorized RCA Tube Distributor)

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Electron Tube Division ***Harrison, N. J.***

CIRCLE NO. 97 READER SERVICE CARD

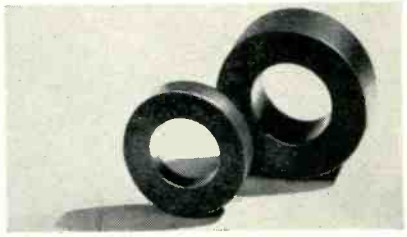
plexer with conventional 9-pin octal connectors. Prototypes have operated 11 continuous months with an outage time of less than one minute.

CIRCLE NO. 209 READER SERVICE CARD

Vertical Chambers
hot-cold-humidity

DEVELOPMENT ENGINEERING CO., INC., 9 Cross St., Norwalk, Conn., is now marketing a new line of vertical hot-cold-humidity chambers which use dry ice as a refrigerant. The operator can work at a comfortable standing height without having to lean over to work in a deep chamber. Another advantage is conservation of floor space. The dry ice and heater compartment is located under the test chamber. These chambers have a range of —90 F to + 240 F and can go up to 425 F if desired. Humidity ranges from 20 to 95 percent are easily obtained.

CIRCLE NO. 210 READER SERVICE CARD



Tape Wound Cores
encapsulated

G-L ELECTRONICS, INC., 2921 Admiral Wilson Blvd., Camden 5, N. J. Fully encapsulated, aluminum cased tape wound toroidal cores that are volt-proof and chip-proof and that are packaged, ready-to-wind units for use in magnetic amplifiers, saturable reactors and special transformers are now available. The epoxy encapsulation ("EE") allows a breakdown rating in excess of 1,500 v, 60 cps rms between winding and aluminum core case.

CIRCLE NO. 211 READER SERVICE CARD

High-Power Triode
platinum-clad grid

WESTINGHOUSE ELECTRONIC TUBE DIVISION, P.O. Box 284, Elmira, N. Y. Type WL-7413 high-power triode for radar pulse modulator

service is capable of handling 8 megawatts of peak power. The tube, which requires only 40 kw of peak driving power, can be used without a high-power pulse transformer because of its 50-kv plate voltage. A filament of thoriated tungsten minimizes standby power requirements. The platinum-clad grid can dissipate an average of 2kw and has a thermal capacity for 1,000-μsec pulses. High tube efficiency, along with 70-kw plate dissipation capability, permit duty factors as large as 10 percent.

CIRCLE NO. 212 READER SERVICE CARD

Storage Tube
dual-gun

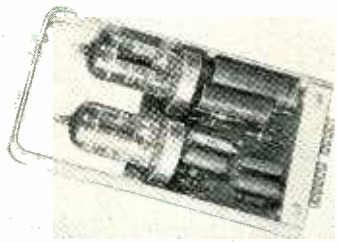
RAYTHEON MFG. CO., Waltham 54, Mass. A dual-gun c-r recording storage tube simultaneously stores and displays radar information. The QK-703 has been specially designed for scan conversion of conventional radar scope patterns into composite television signals for viewing on a regular tv receiver. Resolution of 1,000 lines nominal at 50 percent modulation is obtained with improved gun design. Signals can be stored in less than 1/60 sec, held for many hours, and read out more than 10,000 times.

CIRCLE NO. 213 READER SERVICE CARD

Tube Analyzer
laboratory type

THE TRIPLETT ELECTRICAL INSTRUMENTS CO., Bluffton, Ohio. A new portable true dynamic mutual conductance tube analyzer, model 3444 will be of interest to laboratory and research engineers, electronic specialists and electronic technicians. It measures true G_m without extra compensating factors. Unit uses proper value d-c electrode potentials, 5 kc a-c signal source, and a v-t micrometer. It features very low (33 ohm) plate impedance for best correlation.

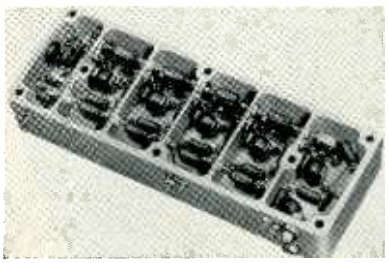
CIRCLE NO. 214 READER SERVICE CARD



Amplifier
frequency selective

PLUG-IN INSTRUMENTS, INC., 1416 Lebanon Road, Nashville, Tenn. The M-1001-PB 400 cps frequency selective amplifier has a gain greater than 80 and a Q greater than 35. Provision is made for an external Q adjustment so that the bandwidth may be adjusted as desired. A nominal supply voltage of 250 v d-c is required. The plug-in itself, for guide rail mounting, is only 5¼ in. high by 2⅞ in. wide by 1⅛ in. deep.

CIRCLE NO. 215 READER SERVICE CARD



I-F Amplifier
transistorized

LEL, INC., 380 Oak St., Copiague, N. Y. The I.F.82D transistorized amplifier is ruggedized and designed for missile applications. It will withstand 30 g shock, vibration over a range of 5 to 2,000 cps, and 80 g acceleration. Typical electrical specifications are: center frequency 30 or 60 mc, bandwidth 1 to 20 mc, and gain 80 db.

CIRCLE NO. 216 READER SERVICE CARD

D-C Null Detector
for rapid testing

BOONTON ELECTRONICS CORP., 738 Speedwell Ave., Morris Plains, N. J. The 56A d-c null detector incorporates all the features necessary for rapid production testing of extremely close tolerance components normally tested on d-c bridges. It has 8 ranges of sensitivity covering

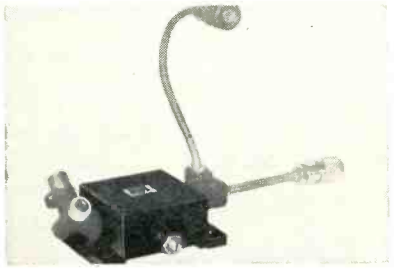
from 10 μv to 100 v full scale. A variable sensitivity control makes it possible to relate any desired percentage tolerance to the limits marked on the panel meter. Input resistance is 10 megohms.

CIRCLE NO. 217 READER SERVICE CARD

Current Meter
low drop

MEASUREMENTS RESEARCH CO., 3801 Castor Ave., Philadelphia 24, Pa. Model 5902 introduces a new solution to the problem of measuring low currents at low source potentials. It has nine full scale ranges of 0.1, 0.3, 1, 3, 10, 30, 100, 300 and 1,000 μa d-c. It permits measurements of 0.1 μa full scale with less than 10 μv drop across the input. Response time is 5 millisec and basic accuracy is ½ percent.

CIRCLE NO. 218 READER SERVICE CARD



S-Band Filter
for radar systems

AVION DIVISION of ACF Industries, Inc., 11 Park Place, Paramus, N. J., announces an S-band microwave filter for radar systems applications. The 12-oz filter, with a tuning range in excess of 300 mc, is available with non-tunable mixer and diplexer units. Insertion loss is less than 1.5 db for 15 mc bandwidth. Input vswr is less than 1.5 to 1 and load vswr less than 1.5 to 1.

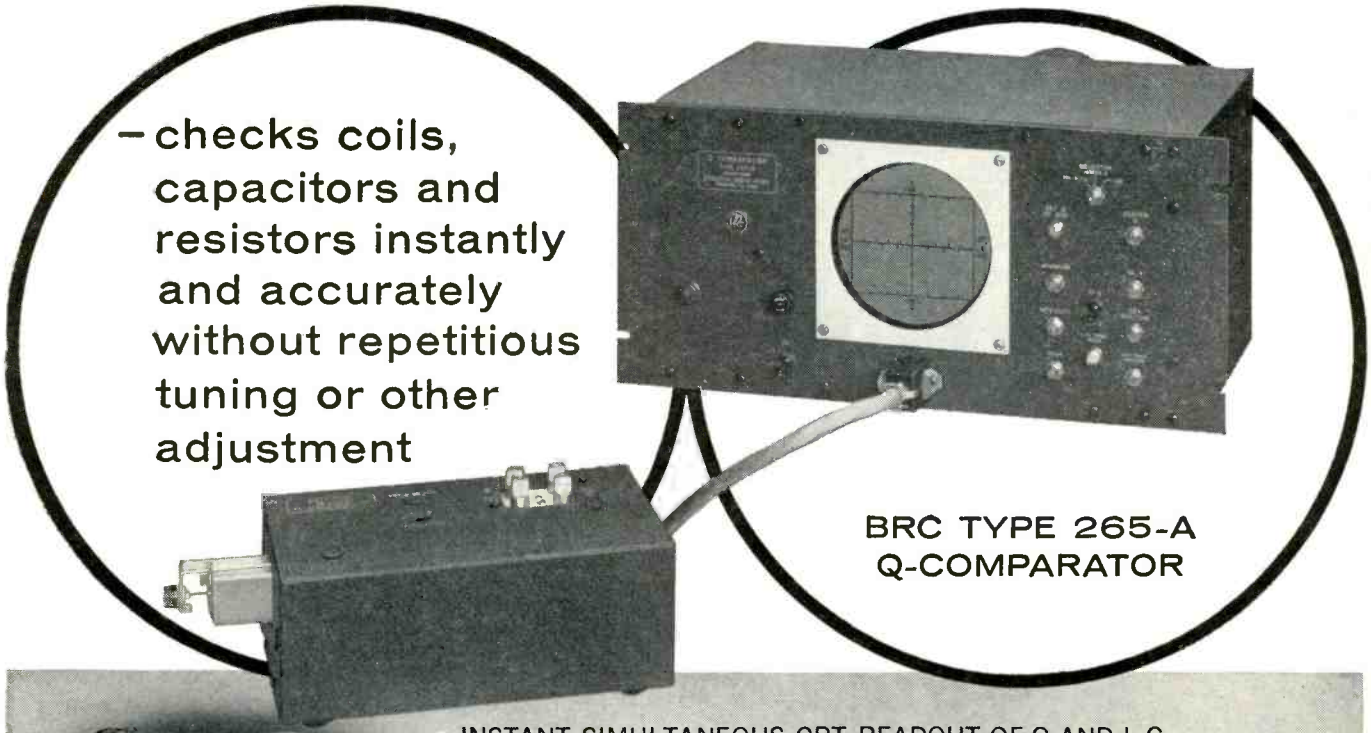
CIRCLE NO. 219 READER SERVICE CARD

A-C Converter
rugged, reliable

CUBIC CORP., 5575 Kearny Villa Road, San Diego 11, Calif. High output voltage capability, high input impedance and excellent gain stability are the quality features of a new a-c converter. It offers high negative feedback over the stated frequency range, 30-20,000 cps, as-

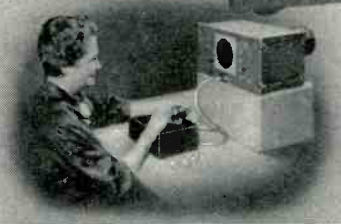
The Perfect Answer to

High Production Q Testing



—checks coils, capacitors and resistors instantly and accurately without repetitious tuning or other adjustment

BRC TYPE 265-A
Q-COMPARATOR



- INSTANT SIMULTANEOUS CRT READOUT OF Q AND L-C
- READS DIRECTLY ON CRT IN % DEVIATION FROM STANDARD
- NO ADJUSTMENTS OR TUNING AFTER INITIAL SET-UP
- EXTREMELY RAPID, SIMPLE—MINIMUM OPERATOR TRAINING
- WIDE FREQUENCY RANGE—FROM 200KC TO 70MC

SPECIFICATIONS

Radio Frequency Characteristics
RF RANGE: 200KC to 70MC*
RF ACCURACY: to ±0.5% against external standard
*Through use of 8 Type 520-A Oscillator Inductors

Q Measurement Characteristics
Q-RANGE: 30 to 500
% Q-RANGE: ±25% of standard
% Q-ACCURACY: ±5% on 25% range
% Q-CALIBRATION: increments of 5%

L-C Measurement Characteristics
L RANGE: 0.15 μh to 15 mh*
C RANGE: 5 μμf to 0.01 μf*
R RANGE: 500 ohms to 20 Megohm*
*Actual range depends upon test frequency
% L-C RANGE: ±5% or ±20% of standard, full scale
% L-C ACCURACY: Direct reading to ±20% of % L-C range*
*For L between 1 μh and 15 mh and C between 500 μμf and 0.01 μf
Comparison to ±10% of limit standards*
*For L between 0.15 μh and 15 mh and C between 5 μμf and 0.01 μf
% L-C CALIBRATION:
1% increments on ± 5% range
5% increments on ±20% range

BRC Type 265-A Q-Comparator is a rapid, versatile and easy to use production tool. It provides instant CRT presentation of % Q on the calibrated vertical axis and % L-C on the calibrated horizontal axis. In operation the instrument is first calibrated against a known standard component. After initial calibration, production components are successively connected to the test terminals without further tuning or adjustment. The instantaneous readout on the CRT is in % deviation from the standard component. Except for initial set-up, practically no operator skill is required.

Price $795.00* F.O.B. Boonton, N. J. *Includes choice of any one (1) Type 520-A Oscillator Inductors. Additional Inductors available at $25.75 each.

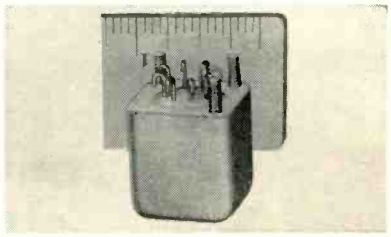
Coil Number	Range Desig.	Frequency Range
520-A1	Range A	50-70 mc
520-A2	Range A	30-50 mc
520-A3	Range A	15-30 mc
520-A4	Range A	8-16 mc
520-A5	Range A	4- 8 mc
	Range B	2- 4 mc
520-A6	Range A	1- 2 mc
	Range B	.55- 1 mc
520-A7	Range B	300-550 kc
520-A8	Range B	200-300 kc

25th ANNIVERSARY *Precision Electronic Instruments since 1934*

BOONTON RADIO CORPORATION
BOONTON, NEW JERSEY, U.S.A.

suring a linearity of 0.01 percent and a stability of 0.02 percent. Full-wave rectification provides an accuracy of ± 0.1 percent and 2 digits on four ranges, and this same negative feedback provides inherent gain stability. A 10-megohm input impedance provides minimum circuit loading.

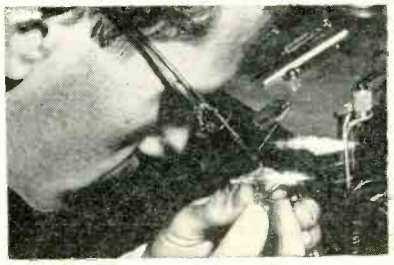
CIRCLE NO. 220 READER SERVICE CARD



Rotary Relay
miniature unit

ELGIN NATIONAL WATCH CO., 2435 N. Naomi St., Burbank, Calif. The VG series relay switches high current in less than 1 cu in. size. It is rated at 5 amperes for 100,000 operations. Units operate under vibration of 15 g's from 55 to 2,000 cps with a shock rating of 100 g's. Temperature range extends from —65 C to +125 C. Relays are hermetically sealed to withstand rugged environmental conditions, and they meet the test specifications of MIL-R-5757C.

CIRCLE NO. 221 READER SERVICE CARD



Solion
extremely small

NATIONAL CARBON CO., 535 Fifth Ave., New York 17, N. Y., announces the solion, a new circuit element. In electron tubes and transistors, electrons transport the electrical charge, while in the solion a solution of ions—hence the name—carries the charge. The extremely small and light-weight unit combines electrochemical and fluid flow principles to provide high sensitivity with low power input, and is

particularly efficient at very low frequencies. Picture on p 102 shows a technician welding lead wires on a complete solion integrator assembly before encapsulation in a plastic resin.

CIRCLE NO. 222 READER SERVICE CARD

Power Supply highly stable

TRANS ELECTRONICS, INC., 7349 Canoga Ave., Canoga Park, Calif. Model RS355 power supply is designed with a combination of a tube amplifier and transistor series elements. Unit is completely stable under all load conditions including a short circuit. Reverse voltages applied to an input power of 50 w will not harm it. Either positive or negative terminal of the supply may be grounded. Output is available in the front panel through five-way binding posts.

CIRCLE NO. 223 READER SERVICE CARD

Waveguide Switch miniaturized

BOGART MFG. CORP., 315 Siegel St., Brooklyn 6, N. Y. Model 4438 miniaturized waveguide switch covers the full radar band of 8,500-9,600 mc with greater than 60 db isolation. Ideally suited for modern missile and radar applications, the unit has a switching time of less than 50 millisec. Three and four-port versions of the switch series are available in RG-67/U and RG-68/U waveguide sizes.

CIRCLE NO. 224 READER SERVICE CARD

Meter Relays 2½ and 3½ in.

SIMPSON ELECTRIC CO., 5200 W. Kinzie St., Chicago 44, Ill., announces new meter relays in 2½ and 3½ in. round styles. Known as models 195 and 95, they have varied applications in all types of equipment

You can count on CMC for all your DCU needs

CMC now offers original equipment makers no less than 28 standard DCU models, including the new transistorized Model 100T. That's the most complete line available from one source. In most cases, you're supplied from stock in a matter of days.

Price Important?

CMC gives you a double price break. First, you pay less for CMC equipment to start with. Second, you get a special OEM discount on quantity orders. Prices on request.

Quality a Must

There's no excuse for making an inferior DCU. We don't. Your local CMC engineering representative has the facts to prove it.

Applications Almost Endless

CMC DCU's fill almost every conceivable circuit requirement for digital data handling systems, counters, scalers, frequency and time interval meters and preset counter-controllers. CMC's units are interchangeable with most existing counting equipment. Including our own.

Ready for Solid State?

CMC is now in production on transistorized DCU's. These compact units incorporate decade readout and coded output matrix. No separate cards and plugs required. Available with vertical number panel or Nixie readout.

Concise Catalog Available

Our new DCU catalog gives you prices and key specs at a glance. If you don't have it, write, wire or call and we will mail it to you free.

CMC can supply you with better DCU's at lower prices, plus off the shelf delivery. It will pay you to check with us first.

Computer Measurements Company *A Division of Pacific Industries, Inc.*

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18

CIRCLE NO. 155 READER SERVICE CARD 105

featuring: over voltage and under voltage indicators, alarm systems, automatic sorting devices, automatic overload protection, low level switching, position sensing and correction, load correction devices, automatic gaging and many others.

CIRCLE NO. 225 READER SERVICE CARD

Wirewound Resistor noninductive

DALE PRODUCTS, INC., Columbus, Neb. Type NSH-5 is a high stability, noninductive wirewound resistor hermetically sealed in a nonhygroscopic ceramic envelope. Power rating range is 2.75 w to 2.0 w, depending on stability level required. Stability level range is ±1, ±0.5, ±0.25 and ±0.1 percent respectively. Power ratings are 100 percent of power at 25 C, derating to 0 between 100 C and 150 C, depending on power and stability levels desired. Resistance range is from 10 ohms to 7,500 ohms.

CIRCLE NO. 226 READER SERVICE CARD

Rack Mount Scope 3-in. tube

THE HICKOK ELECTRICAL INSTRUMENT CO., 10527 DuPont Ave., Cleveland 8, Ohio, announces a rack mount 3-in. tube oscilloscope designed for maximum space efficiency in research and development work. Identical vertical and horizontal d-c amplifiers have a range of d-c to 500 kc to provide an excellent means for phase shift or quadrature testing. Vertical amplifier sensitivity of 10 mv rms per in. and horizontal amplifier sensitivity of 15 mv rms per in., qualify the instrument as excellent for observation of critical waveforms. The oscilloscope provides a choice of either triggered or recurrent sweeps from 1 cps to 100 kc in 5 calibrated decade ranges with 10 to 1 vernier controlled decade steps.

CIRCLE NO. 227 READER SERVICE CARD

Calorimeter self-calibrating

SIERRA ELECTRONIC CORP., 3885 Bohannon Drive, Menlo Park, Calif. Model 290A calorimeter in-

cludes liquid flow controls, calibration sources and metering circuits. Liquid-cooled loads are available in popular waveguide sizes as well as coax. The calorimeter is self-calibrating and permits accuracies up to 1 percent. A closed loop circulating system with fluid pump and heat exchanger is available as an accessory.

CIRCLE NO. 228 READER SERVICE CARD

Four-Layer Diode
higher power

SHOCKLEY TRANSISTOR CORP., Stanford Industrial Park, Palo Alto, Calif., announces the type AD 4-layer diode. This new self-actuated silicon switch is similar in function to a relay or gas tube. It is turned on by a voltage pulse, turned off by dropping the current or reversing the voltage. To match circuit requirements, it is available with switching voltages of 30, 40, 50 and 200 v and holding currents of 5 to 45 ma. Compact and rugged, it is capable of handling 300 ma steady d-c or a 20-ampere pulse current.

CIRCLE NO. 229 READER SERVICE CARD

Sealed Switch
for missile uses

THERMOCAL, INC., 1629 Colorado St., Santa Monica, Calif. The Thyrastat is a temperature-sensitive switch for missile and aircraft applications. These are hermetically sealed, single-shot switches available in normally open and normally closed, single-pole types. Preset at the factory for activating temperatures ranging from +113 F to +1,500 F, the applications cover the field of fail-safe devices.

CIRCLE NO. 230 READER SERVICE CARD

Diodes
epoxy encapsulated

RUE PRODUCTS, 1628 Venice Blvd., Venice, Calif., has added ger

manium and silicon diodes to the Encapsulet line of epoxy encapsulated components. Units have self-contained silver plated terminals and plated fastening stud. They meet MIL-E-1C requirements. Featured is the improved stability under severe humidity conditions as well as excellent insulation. Rectangular form of the unit fits well against flat surfaces, and permits direct-to-chassis mounting eliminating need for terminal boards and need for soldering component to standoffs or terminals.

CIRCLE NO. 231 READER SERVICE CARD

X-Y Recorders transistorized

ELECTRO INSTRUMENTS, INC., 3540 Aero Court, San Diego 11, Calif. A new design concept is incorporated in this line of totally transistorized modular 11 in. by 17 in. X-Y recorders. New recorder consists of a basic plotter with separate input modules for general purpose, computer, low-level differential, time base, curve following, and other specialized functions.

CIRCLE NO. 232 READER SERVICE CARD

Silicon Rectifiers diffused junction

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. Series X12F diffused junction silicon rectifiers will provide full-rated 12 ampere current output over a peak inverse voltage range from 50 to 500 v. Ruggedized, all-welded construction assures high resistance to vibration, shock and temperature extremes. Each unit is nickel-plated to provide minimum contact resistance and prevent corrosion. Eyelet construction of the top lead of the stud-mounted devices insures fast,

a major new activity

HUGHES COMMUNICATIONS DIVISION

announces current openings

The new Hughes Communications Division is fully integrated and responsible for communications research, development, manufacturing and sales. Expansion plans are ambitious and aggressive, and the backlog of contracts already awarded, promises an expansion consistent with the spectacular records established by the other major divisions of Hughes Aircraft Company.

The establishment of Hughes as a major factor in the communications industry has created many openings for the following senior electronics engineers:

SENIOR SERVO ENGINEERS
Senior Servo Engineers are needed for the development of automatic tuning communications systems. New techniques are necessary to advance by an order of magnitude the tuning times involved. Engineers experienced in small instrument type servos, particularly memory for presetting, are ideally suited for this type of development.

ENGINEERING WRITERS
Requires HAM experience or a background in Communications Systems. Should know transistors or RF circuits.

SENIOR MECHANICAL ENGINEERS
Experience in small mechanisms, heat transfer, shock and vibration is essential.

UHF ENGINEERS
Must be experienced in the design of extremely compact transmitters and/or receivers for the 200-400 megacycle region.

SENIOR COMMUNICATIONS ENGINEERS
Senior Communications Systems engineers who have at least 7 years experience in the systems aspects of communications, are needed for assignments on the 480-L Global Communications System. This is a long term program which will necessitate offices both on the East and West coasts.

COMPONENT DESIGNER
Must have heavy experience in the design of components for airborne equipment, particularly from the weight reduction viewpoint.

EQUIPMENT ENGINEERS
Requires a familiarity with all types of communications laboratory testing equipment—uses, maintenance and procurement.

SPECIFICATION AND QUALIFICATION ENGINEER
Must be capable of directing the evaluation of ground support communications equipment.

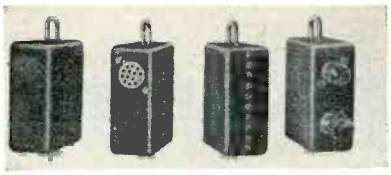
There are a limited number of openings for non-citizens with communications experience.
For further information write Mr. Donald Horton at the address below:

HUGHES

HUGHES AIRCRAFT COMPANY
COMMUNICATIONS DIVISION
P.O. Box 90-902, Dept. I
Los Angeles 45, California

easy wiring into production assemblies.

CIRCLE NO. 233 READER SERVICE CARD



Decimal Counters
transistorized

ENGINEERED ELECTRONICS CO., 506 E. First St., Santa Ana, Calif. A new miniaturized line of transistorized plug-in decimal counters, known as the N-series transistorized decades, is now available for pulse-counting and frequency-division application in the 0-250 kc and 0-5 mc ranges. Decades are completely compatible with the T-series germanium plug-in circuits. Besides compact size, decades feature low power consumption and simple power supply requirements.

CIRCLE NO. 234 READER SERVICE CARD

Relay
general purpose

ALLIED CONTROL CO., INC., 2 East End Ave., New York 21, N. Y. Type FC two pole relay has silver contacts riveted to a molded panel. It is rated at 2 amperes resistive at 26.5 v d-c or 115 v a-c. As a spst relay, it can operate as low as 200 mw. As a dpst device it can operate up to 2 w. Coils are available for operation up to 115 v d-c.

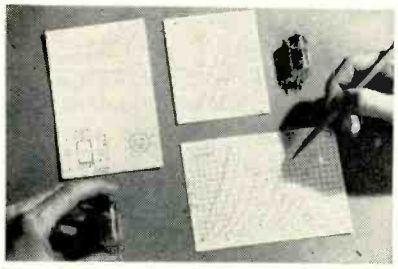
CIRCLE NO. 235 READER SERVICE CARD

Wheatstone Bridge
high precision

GENERAL RESISTANCE, INC., 577 E. 156th St., New York 55, N. Y. A new go-no-go Wheatstone bridge makes possible the precise measurement of resistors to 0.0035 percent accuracy. It has a sensitivity of 0.0005 percent and has a 6-dial

decade corresponding to 0.0005 percent resolution, thus enabling the maximum ultilization of both factors. It operates as a go-no-go limit bridge from 100 ohms to 11.111 megohms with full scale tolerance selections of from 0.01 percent to 10 percent and from 1 ohm to 111.11 megohms with full scale selections of 0.1 percent to 10 percent. The unit may also be used as a standard Wheatstone bridge from 1 ohm to 111 megohms.

CIRCLE NO. 236 READER SERVICE CARD



Twin-Triode Tube low-level

WESTINGHOUSE ELECTRIC TUBE DIVISION, P.O. Box 284, Elmira, N. Y. Type WL-7025 nine-pin miniature twin-triode tube is designed for service as a low-level input voltage amplifier for tape recorders and high-quality audio preamplifiers. It is interchangeable with tube types 12AX7, 12DF7, and ECC83, and its use in such replacement will result in substantial reduction in noise due to microphonism, induced hum and leakage. Tube uses a V-shaped spiral heater which can withstand extremely high voltage surges.

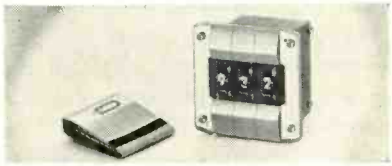
CIRCLE NO. 237 READER SERVICE CARD

Transfer Relay for h-v use

JENNINGS RADIO MFG. CORP., P. O. Box 1278, San Jose, Calif., has designed the new RB4 transfer relay for very high voltage applications involving antenna switching, pulse forming networks, and similar r-f and d-c circuits. The 4pdt unit employs a vacuum dielectric and sapphire actuating rods to achieve its small size and high voltage rating. Removable actuating coils are available for 26.5 v d-c or 115 v d-c operation. Carefully engineered rocker contacts provide heavy contact pressure and resistance to vi-

bration and shock.

CIRCLE NO. 238 READER SERVICE CARD



Panel Switch
in-line readout

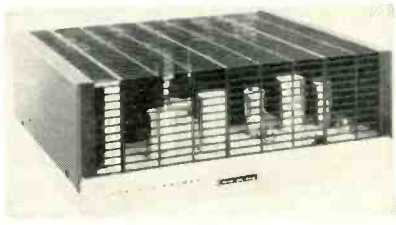
THE DIGITRAN CO., 45 W. Union St., Pasadena, Calif. Panel space requirements for the Digiswitch are reduced so that designers can mount 20 switches in the normal space required for 5 rotary switch elements. The unit is finger controlled and provides for 10-position, single pole, binary coded decimal 1, 2, 4, 8 and octal 0, 1, 2, 4, coded outputs. The in-line readout reduces reading errors and simplifies switch setting. The Digiswitch is designed in switch modules which permit ganging.

CIRCLE NO. 239 READER SERVICE CARD

Counter Scanner
automatic unit

DYMEC, INC., 395 Page Mill Road, Palo Alto, Calif. Model DY-2513 counter scanner makes possible the automatic recording of the information registered in up to six electronic counters on a single digital recorder. In addition to the multiple counter output data, the DY-2513 automatically records preset decimal information manually selected by six decimal dials on the front panel. Unit synchronizes the count and display functions of the counters and the printing function of the recorder.

CIRCLE NO. 240 READER SERVICE CARD



Audio Amplifier
dual-channel

SARGENT-RAYMENT CO., 4926 E. 12th St., Oakland 1, Calif. A new dual-

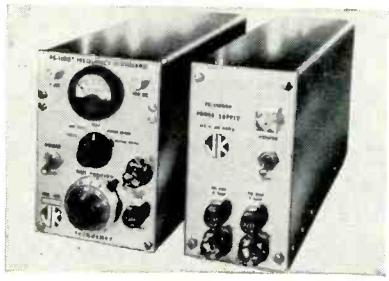
channel amplifier, engineered for high-performance stereo systems, provides essentially distortionless operation even at peak power levels. Each of the two parallel channels is rated at 50 w at well under 1 percent distortion, with a combined peak power output of 200 w. Model SR-5100 utilizes a heavy-duty integral power supply with a single oversized power transformer and 2 matched type CZ34 rectifiers to insure optimum balanced regulation.

CIRCLE NO. 241 READER SERVICE CARD

Accelerometer triaxial

ENDEVCO CORP., 161 E. California Blvd., Pasadena, Calif. Accurate simultaneous measurement of vibration in three axes can now be accomplished with the model 2223 accelerometer. Three Piezite type I sensing elements are mounted in mutually perpendicular planes within a $\frac{3}{4}$ cu in. block weighing 1.4 oz. Model 2223 has a high first resonant frequency of 30 kc, sensitivity of 5 pk-mv/pk-g plus a dynamic range of 1,000 g's with less than 5 percent cross-axis sensitivity. Unit operates over a temperature range of —65 F to +220 F with maximum change in sensitivity of ±10 percent.

CIRCLE NO. 242 READER SERVICE CARD

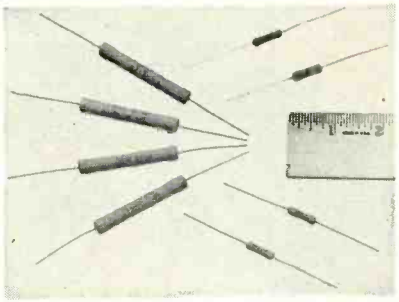


Frequency Standard transistorized

THE JAMES KNIGHTS CO., Sandwich, Ill. An advanced precision frequency standard with "breakthrough" frequency stability of 5 parts in 10^{10} is announced. Compact unit is fully transistorized with double proportional control oven and operates from 24 to 32 v unregulated d-c. A power supply for operation from 115 v line with built in batteries and providing auto-

matic switch-over standby operation for more than 12 hours is available as a matching companion item.

CIRCLE NO. 243 READER SERVICE CARD



Film Resistor
for power uses

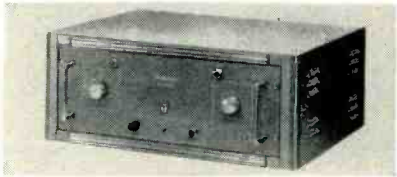
CORNING GLASS WORKS, Bradford, Pa. The ST film type resistor designed for power applications is currently produced in three sizes, rated at 2½, 5 and 10 w at 25 C, with derating to 350 C. It is priced competitively with wire-wound units. The glass based resistor meets most operational requirements of MIL-R-26C. It can be held to tolerances of ±2 percent.

CIRCLE NO. 244 READER SERVICE CARD

Three-Pole Relay
airborne application

ELECTRO-MECHANICAL SPECIALTIES CO., INC., 1016 N. Highland Ave., Los Angeles 38, Calif. Model 325 ST is a 3 pst, 25 ampere relay designed to meet the requirements of MIL-R-5757B and MIL-R-6106B. (200 C or higher on special order). Unit operates on as little as 1.5 w, and is available for 400 cycle a-c operation internally rectified. It is 1½ by 1¾ by 2½ in.

CIRCLE NO. 245 READER SERVICE CARD



Power Amplifier
for pulse or c-w

TECHNITROL ENGINEERING CO., 1952 E. Allegheny Ave., Philadelphia 34, Pa. Model 1012 power amplifier is an instrument for amplifying

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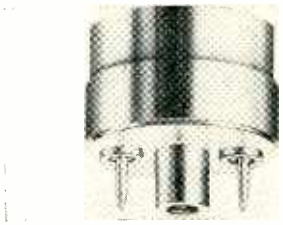
the power of sine waves, square waves or pulse signals whose amplitudes range from 1 to 40 v. It is completely d-c coupled and its input circuit is provided with a level control for matching the power amplifier to any d-c level input from −20 to +20 v. Frequency response is d-c to 6 db down at 12.5 mc, corresponding to a rise time of 0.032 μsec, and available output current is 0.75 ampere.

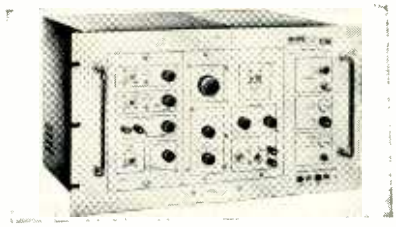
CIRCLE NO. 246 READER SERVICE CARD



Thermal Switch light weight

CONTROL PRODUCTS, INC., 306 Sussex St., Harrison, N. J. Weighing ½ oz, the CPI "Button" switch is a high temperature bimetal thermal switch which can be supplied with contacts for either close-on-rise or close-on-fall in temperature. Switch can be supplied calibrated at a maximum of 600 F or down to a minimum of −20 F with a possible close temperature tolerance of 2 F under laboratory conditions. Temperature differential and repeatability for a given switch is about 1 F. An overshoot to 800 F or undershoot to −100 F can be tolerated.

CIRCLE NO. 247 READER SERVICE CARD



Pulse Generator plug-in adapters

PCA ELECTRONICS, INC., 16799 Schoenborn St., Sepulveda, Calif. Large amplitude, fast rise, flat top pulses and exceptional stability are provided by the MPG-4A. The pulse generated by this unit is readily

adaptable to the measurement of saturation properties of magnetic materials, step function response of circuits, precise time delays, and other factors. A variety of plug-in trigger generators permit the trigger forming circuitry and pulse forming circuitry to be separated.

CIRCLE NO. 248 READER SERVICE CARD

Oscillator for telemetry

DATA-CONTROL SYSTEMS, INC., 39 Rose St., Danbury, Conn., announces a completely transistorized voltage-controlled oscillator available at a cost comparable to tube-type oscillators. Model AOV-5G is available for all IRIG channels. Volume is approximately 9 cu in.; power supply +18 v d-c ±10 percent at 10 ma. Unit adapts modularly to the company's other airborne-telemetry equipments. Price is $295 per unit in lots of 100 or more.

CIRCLE NO. 249 READER SERVICE CARD

Thyratron Tubes xenon filling

WESTINGHOUSE ELECTRONIC TUBE DIVISION, P. O. Box 284, Elmira, N. Y., has available two new thyratron tubes (WL-7306 and WL-7307) used for general purpose control and welding control service. In addition to xenon filling which minimizes tube voltage drop, each tube has a rugged button stem designed to assure immunity from mechanical failure. Special glass, particularly adapted to automatic sealing machine techniques, is used. To minimize grid current, a special carbonized nickel grid is employed. Also, high alumina ceramic insulators are used throughout the tubes to insure strength and high insulation resistance.

CIRCLE NO. 250 READER SERVICE CARD

Literature of

MATERIALS

Comparison Chart. Mitchell Rand Mfg. Corp., 51 Murray St., New York 7, N. Y., has available a chart listing the uses and comparing the properties of its standard electrical insulating Randac epoxy systems.

CIRCLE NO. 260 READER SERVICE CARD

COMPONENTS

A-C Drive Motors. John Oster Mfg. Co., Avionic Division, 1 Main St., Racine, Wisc. A new data sheet tabulates a complete line of −55 C to +85 C missile quality a-c drive motors.

CIRCLE NO. 261 READER SERVICE CARD

Measuring Microphonics. B&K Instruments, Inc., 3044 W. 106th St., Cleveland 11, Ohio. A Bruel & Kjaer 16-page technical review describes the techniques of exciting and measuring the microphonics of vacuum tubes.

CIRCLE NO. 262 READER SERVICE CARD

Components. FXR, Inc., 26-12 Borough Place, Woodside 77, N. Y., is distributing a new short form catalog which not only contains listings of all its components but their prices as well.

CIRCLE NO. 263 READER SERVICE CARD

Coaxial Cables. Standard Wire and Cable Co., 3440 Overland Ave., Los Angeles 34, Calif. Brochure E502ED is a data sheet listing numerically all known RG type coaxial cables and their characteristics.

CIRCLE NO. 264 READER SERVICE CARD

EQUIPMENT

Transistorized Power Supplies. Electronic Measurements Co. of Red Bank, Eatontown, N. J. Bulletin 721 describes and illustrates an integrated series of regulated transistorized power supplies. Specifications are given for over 40 different models.

CIRCLE NO. 265 READER SERVICE CARD

the Week

Parabolic Antennas. Gabriel Electronics Division, The Gabriel Co., 135 Crescent Road, Needham Heights, Mass., has prepared a comprehensive catalog containing data sheets on their parabolic antennas and accessories. Limited supplies of the catalog can be obtained by engineers requesting on company letterhead.

Regulated Power Supplies. Matthew Laboratories, 3344 Ft. Independence St., New York 63, N. Y. Bulletin HVVC-95 covers a line of constant current and constant voltage automatic switch-over regulated power supplies.

CIRCLE NO. 266 READER SERVICE CARD

Instrumentation Recorders. Precision Instrument Co., 1011 Commercial St., San Carlos, Calif. An 8-page 2-color brochure describing the PS-200 transistorized magnetic tape instrumentation recorder is now available.

CIRCLE NO. 267 READER SERVICE CARD

Power-Supply Equipment. Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn. A 4-page folder illustrates and describes a variety of transistorized, electronic, magnetic-amplifier controlled power equipment.

CIRCLE NO. 268 READER SERVICE CARD

FACILITIES

Ceramic Disk Capacitors. Radio Materials Co., 3325 N. California Ave., Chicago 18, Ill. A 16-page booklet contains technical descriptions of a line of Discaps—ceramic disk capacitors. Company's manufacturing facilities are covered pictorially.

CIRCLE NO. 269 READER SERVICE CARD

Laboratory Testing. Whittaker Controls Division of Telecomputing Corp., 915 N. Citrus Ave., Los Angeles 38, Calif. A 4-page illustrated brochure tells the story of laboratory testing of air and space-borne components and systems in a gaseous oxygen facility.

CIRCLE NO. 270 READER SERVICE CARD

NEW BOOKS

Space Charge Waves and Slow Electromagnetic Waves

By A. H. W. BECK.

Pergamon Press, New York, 1958, 396 *p.*

THIS new book on microwave tubes will be especially welcome to the workers in the field for several reasons. First, Mr. Beck has brought together an enormous amount of scattered publications and has provided a single volume which will probably become the microwave tube man's *Vade Mecum.* Secondly, as the title indicates, he has tied all this varied work together in a consistent approach. This unified treatment on the basis of the fundamental idea of space-charge waves will be extremely beneficial to experienced tube research men and to students just entering the field. Finally, the book maintains the high standard of style and comprehensibility to which we have become accustomed in Beck's earlier works.

The general introduction in the first chapter provides the reader with a brief, practical survey of the kinds of tubes to be treated. Happily, after detailed development of the analytical methods, the author returns to consider the tubes in detail thus making the work as a whole a practical rather than theoretical one.

Slow Wave Structures—After a concise review of classic electromagnetic theory, slow wave structures are treated. Applicable concepts are classified by reference to the Brillouin diagram and results of filter circuit theory. The structures treated in detail here are the disk-loaded waveguide, the interdigital delay line and the helix. The Karp structure, the Hines structure and the clover leaf are also described briefly.

The fundamental space charge wave theory is then developed. Waves which may propagate in infinite beams are considered first; subsequently the effects of cylindrical geometry and the influence of metallic conductors are considered. Effects of the magnetic focusing field are explored for the Brillouin

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At AVCO/Crosley a number of exciting developments are underway to extend the state-of-the art in practical applications of basic Infrared technology. Current fields of interest include reconnaissance systems, tracking devices, and ranging equipment. Illustrated above is one type of Infrared Track and Ranging Unit developed at Crosley.

AVCO/Crosley engineers are answering the problem of space conquest through the design of systems which include, among other devices, new concepts of infrared detection equipment.

Dr. Wright takes the stand for **electronics**

What is your present work in electronics, Dr. Wright?
Vice President In-Charge-of-Operations-and-Engineering at Tung-Sol Electric Inc., a leading manufacturer of electron tubes, semiconductors, tv tubes, lamps, power supplies, flashers, selenium and silicon rectifiers.

How many people are at Tung-Sol?
Approximately 6,000.

Briefly, what is your background in electronics?
Twenty-two years with Tung-Sol.

How many years have you been reading **electronics**?
It goes back over twenty years..

Why have you continued to read it?
After all, this is a very technical and rapidly changing industry. I don't know which is more important, the editorial or advertising. They both help us to keep up with what's going on in the world of electronics.

It has been said that leading publications build a "personality" for themselves. This is a quality that cannot be measured with facts and statistics. How would you characterize the "personality" of **electronics** magazine?
It's not too highbrow, yet it's not a gossip sheet. It's an excellent middle-of-the-road job of reporting technical and business developments. ***electronics*** *does a down-to-earth reporting job.*

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case and for the confined flow case. Questions of power flow and excitation are treated as are space-charge waves in accelerating and decelerating regions and in crossed electric and magnetic fields.

Applications of Theory — The last half of the book applies the space wave theory to specific tube types. Klystrons, travelling wave tubes and crossed field tubes are treated in detail, a chapter being devoted to each type. The last chapter on devices considers lesser known space-charge wave tubes, such as the easitron, the double beam tube and others. The final chapter is on noise, mainly shot noise and its behavior in long electron beams. The noise figures of resonator tubes and travelling wave tube are discussed, as in a general theory of noise in electron beams.

The most useful of the several appendices will probably be the one on measurements on slow wave structures and the one on electron beam focusing. — MORRIS ETTENBERG, *Polytechnic Institute of Brooklyn, Brooklyn, N. Y.*

THUMBNAIL REVIEWS

Theory of Dielectrics. By H. Froehlich, Oxford University Press, New York, 1958, 192 p, $4.80. This systematic account of the dielectric constant and dielectric loss requires only a knowledge of calculus.

The Literature of Space Science and Exploration — PB131755. Compiled by Mildred Benton, Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C., 1958, 264 p, $4.00. This bibliography references 2,274 unclassified articles on scientific aspects of space exploration that have appeared in books, periodicals and research reports in the period from 1903 to June 1958.

The Space Encyclopedia. Edited by M. T. Bizony, E. P. Dutton & Co., Inc., New York, 1958, 287 p, $6.95. Details of guided missiles, upper atmosphere research and a complete survey of all branches of astronomy are covered in an encyclopedia format. Contributors include H. S. Jones, A. C. B. Lovell, H. Strughold, J. G. Porter, H. E. Newall, R. H. Garstang and P. Moore.

Space Flight and Space Vehicles. By R. B. Beard and A. C. Rotherham, Pitman Pub. Corp., New York, 1957, 150 p, $3.95. Introductory survey of principles and problems of space flight.

Epsco-West Gets New Home

EPSCO-WEST, fast-growing division of the Boston data control firm, has moved into a new $150,000 plant near Anaheim, Calif. Wallace E. Rianda, general manager, says the new offices and manufacturing area, containing 20,000 sq ft, mark the first step in Epsco-West's expansion program. The plant can be expanded to 100,000 sq ft.

The building includes complete facilities for the production of high speed analog and digital data handling systems for military and industrial applications.

Among systems recently delivered by Epsco-West was a miniaturized airborne data handling system for the missile division of North American Aviation in Downey, Calif.

Located in the Anaheim Industrial Tract, the new plant features high density lighting, environmental test facilities, 600-ampere power service, and precast tilt-up construction.

Epsco-West began operations in July, 1958, in Anaheim.

Degen Takes High Post

JOSEPH F. DEGEN was recently named vice president of operations for Weston Instruments division of Daystrom, Inc.

Former vice president-manufacturing of Daystrom-Weston divisions, Degen assumes responsibility for manufacturing, manufacturing services, engineer and industrial relations for all Weston plants. He also will provide special services to other Daystrom-Weston units: Daystrom-Weston Industrial Division, Poughkeepsie, N. Y.; Daystrom Systems Division, La Jolla, Calif.; and Industrial Gauges Department, West Englewood, N. J.

Prior to joining Daystrom in 1957, Degen was general superintendent of the Poughkeepsie, N. Y., plant of International Business Machines.

Ruge Associates Moves, Expands

ARTHUR C. RUGE ASSOCIATES, INC., moved recently from Cambridge, Mass., to new and larger quarters in Hudson, N. H., with virtually all personnel making the transfer. The new, modernly equipped plant comprises 10,000 sq ft of space, more than twice that of its earlier facility. The acquisition of additional land assures ample opportunity for further expansion.

The company, an outgrowth of the earlier Ruge-deForest operation, was formed in 1955 by Arthur C. Ruge (strain gage inventor), Frank Hines and Edgar Jones. Under the guiding hand of company president Paul W. Koch, the company has enjoyed steady and controlled growth.

Elect Adler Zenith V-P

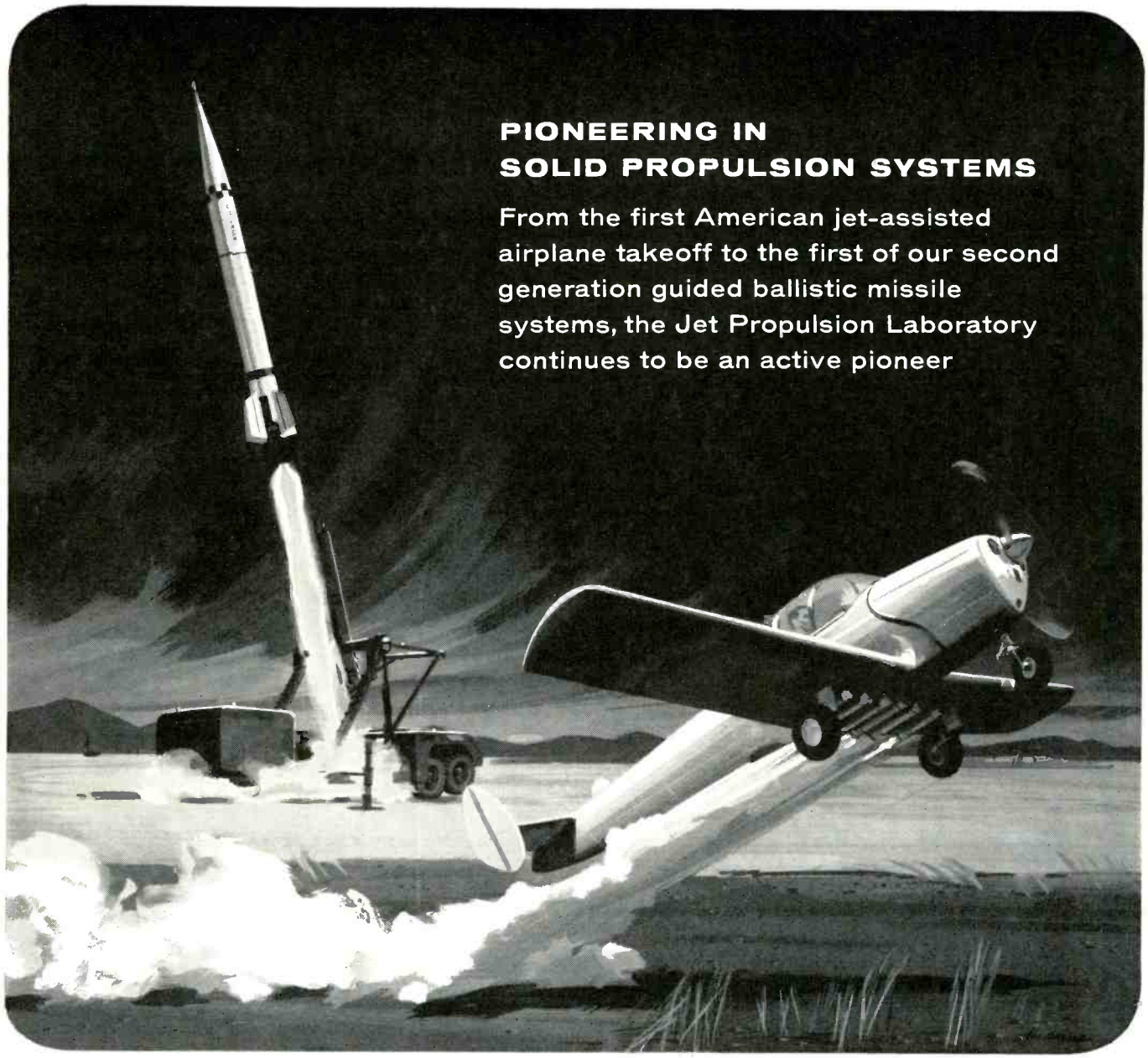
THE BOARD of directors of Zenith Radio Corp., Chicago, Ill., recently elected Robert Adler vice-president. He continues as associate director of research of the corporation.

Adler joined Zenith as a member of the corporation's research division in 1941. He was appointed associate director of research in 1952.

Appoint Mayer To New Position

FREDERICK C. MAYER, former assistant to the vice president and general manager of Waldorf Elec-

NOTABLE ACHIEVEMENTS AT JPL...



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From the first American jet-assisted airplane takeoff to the first of our second generation guided ballistic missile systems, the Jet Propulsion Laboratory continues to be an active pioneer

In August 1941, America's first jet-assisted airplane takeoff was accomplished with an Ercoupe monoplane, using JPL developed solid propellant rockets. Scientists at JPL shortly discovered that a powdered perchlorate oxidizer, mixed with a liquefied plastic fuel binder, could be cast directly in plastic-lined light-weight motor cases. Thus a safe and cheap method was now available for preparing large internal-burning composite propellant charges. This basic process became the foundation for the modern solid propellant industry.

In 1954, U. S. Army Ordnance requested JPL to develop a compact, rugged long-range guided missile weapon system that could be transported, aimed and fired as simply as a cannon. Within five years, JPL perfected the **Sergeant,** the first of America's second-generation guided ballistic missiles. In January 1958, clusters of small-scale **Sergeants** helped launch America's first earth satellite, the JPL built **Explorer,** which provided vital space environment information.

Now under the direction of the National Aeronautics and Space Administration, the experienced JPL research and development team continues to apply solid propellant vehicles for space exploration.

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tronics, division of F. C. Huyck & Sons, has been appointed director of government programs.

In this new capacity he will supervise all negotiations and proposals to government agencies for prime and subcontract work in research, development and production originating from the Huntington Station, N. Y., plant.

Name Consultant To PRD Company

L. J. CASTRIOTA has been appointed a consultant to the research and development division of Polytechnic Research & Development Co., Inc., Brooklyn, N. Y. He will be involved in all phases of operation with the company, which designs and manufactures precision microwave and electronic test equipment and components for the military and industry.

Since 1952, Castriota has been a member of the staff of the Micowave Research Institute of the Polytechnic Institute of Brooklyn as a section leader involved with countermeasures, radar systems, and microwave network theory.

Plant Briefs

Mid-Century Instrumatic Corp., N. Y. C., manufacturer of analog computers and simulators and of computer accessories, has changed its name to **Computer Systems, Inc.**

A separate **Monitor and Control Division**, operating independently of other company departments, has been established at **Fenwal**

Inc., Ashland, Mass., manufacturer of precision temperature controls. New division will concentrate especially on those controls which utilize electronic principles.

Intaspace Corp., Bloomfield, N. J., is a new company recently organized for the production of waveguide bends, twists and transitions.

American Electronics, Inc., Los Angeles, Calif., has formed an **American Data Division**, Brooklyn, N. Y., to handle the design, manufacture, and marketing of its peripheral data processing equipment.

Formation of **Microwave Electronics Corp.**, Palo Alto, Calif., for research, development, and manufacture of microwave electronic devices, was recently announced.

Collins Radio Co. has formed a wholly owned subsidiary in Dallas, Texas. The new company, **Alpha Corp.**, is staffed to design, construct and install complex government and commercial systems.

Electro-Miniatures Corp., Ridgefield, N. J., manufacturers of slip ring assemblies, commutators, and rotary switches, recently moved to larger quarters in South Hackensack, N. J.

News of Reps

Avion division of ACF Industries, Inc., recently appointed **Robert O. Whitesell & Associates** of Indianapolis, Ind., as sales rep for its commercial and military electronic components. Territory to be covered is Ohio, Kentucky and western Pennsylvania.

Associated Research, Inc., Chicago, Ill., has appointed **Harry Wilson** of Moline, Ill., as sales rep for its line of h-v power supplies, insulation resistance testers and ground resistance measuring equipment. Wilson's sales area is the northern part of Illinois, excluding Chicago area.

COMMENT

Simulating Equations

I would like to make a few comments pertaining to the short article "Simulating Second-Order Equations" by Duane Chadwick (Research & Development, p 64, Mar. 6).

The one-amplifier technique of simulating second-order systems has been known for several years, and has appeared in *Analog Computer Techniques* by C. L. Johnson, McGraw-Hill 1956 (p 98-100) and in *Analog Methods in Computation and Simulation* by W. W. Soroka, McGraw-Hill 1957 (p 208). Also I presented a paper "Simulation of Transfer Functions Using Only One Operational Amplifier" at the 1957 Wescon convention; this paper appeared in the convention record.

Figure 1 in Mr. Chadwick's article is in error. The second amplifier should be a summer rather than an integrator.

ARTHUR BRIDGMAN

ELECTRONIC DEFENSE LABORATORY
MOUNTAIN VIEW, CALIF.

Mr. Bridgman's comments concerning my article are well taken and presumably correct. I have had no knowledge of any prior publication on the subject. Once having derived the equation I noted that apparently no operational amplifier was commercially available which was specifically designed to facilitate ease of simulating a second-order system. The Philbrick amplifier model K5-U appears to come closest, as it reduces the conventional three-amplifier circuitry to two amplifiers.

The error in Fig. 1 that Mr. Bridgman noted was an inadvertent error in drafting. This error has little significance, since Fig. 2 is the proposed scheme upon which the article was based.

DUANE G. CHADWICK

UTAH STATE UNIVERSITY
LOGAN, UTAH

Audio Filters

We have noted with interest the article "How to Design Low-Cost Audio Filters" (p 68, Apr. 10). We note also that the author claims that a patent is pending on the

basic filter system shown in this article.

This same type of filter was first used in our type 120-A preamplifier, which was a part of our type 214-A amplifier, originally designed early in 1951, and is shown in the various published circuit diagrams of this amplifier.

Actually, this type of filter circuit has been standard in most H. H. Scott amplifiers manufactured for a number of years. I also did previous work on this type of circuit at MIT. . .

DANIEL R. VON RECKLINGHAUSEN

H. H. SCOTT INC.
MAYNARD, MASS.

Mr. von Recklinghausen's work clearly precedes my independent development of mid-1955. My limited search of the literature in 1955 did not encounter his or the Scott Company's circuit; meanwhile, since my professional interests are more mathematical than electronic, I have not given the circuit much attention. The decision to publish, in fact, came about only recently when I ran across my notes on the circuit. I am most happy to acknowledge Mr. von Recklinghausen's precedence, and to thank him for bringing his work to my attention.

Since publication of my article, two other references to similar circuitry or applications thereof have been brought to my attention, and may be of interest to readers. The first is an article by R. P. Sallen and E. L. Key, "A Practical Method of Designing RC Active Filters," *IRE Trans*, vol. CT-2 (March 1955). Their results, I find, include the high- and low-pass circuits as two special cases of their method. The second is by J. Ross MacDonald, "Active Bandpass Filter Has Sharp Cutoff" (ELECTRONICS, p 84, Aug. 15 '58), in which he describes a seventh-order filter making use of the basic circuit configuration under discussion. Mr. MacDonald's paper was published a few weeks after my original manuscript was sent to ELECTRONICS, and would certainly have been included as a reference if I had seen the article when it appeared.

W. D. FRYER

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In addition to engineers with camera tube experience, applications are also invited from engineers in other fields.

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Write giving details of experience, education, and salary required.

P-1778, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

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When there are many applicants it frequently happens that the only letters acknowledged are those of promising candidates. Others do not receive the slightest indication that their letters have even been received, much less given any consideration. These men often become discouraged, will not respond to future advertisements and sometimes even question if they are bona fide.

We can guarantee that *Every Advertisement Printed Is Duly Authorized.* Now won't you help keep our readers interested in this advertising by acknowledging every application received, even if you only return the letters of unsuccessful applicants to them marked, say, "Position filled, thank you." If you don't care to reveal your identity, mail them in plain envelopes.

We suggest this in a spirit of helpful co-operation between employers and the men replying to Positions Vacant advertisements.

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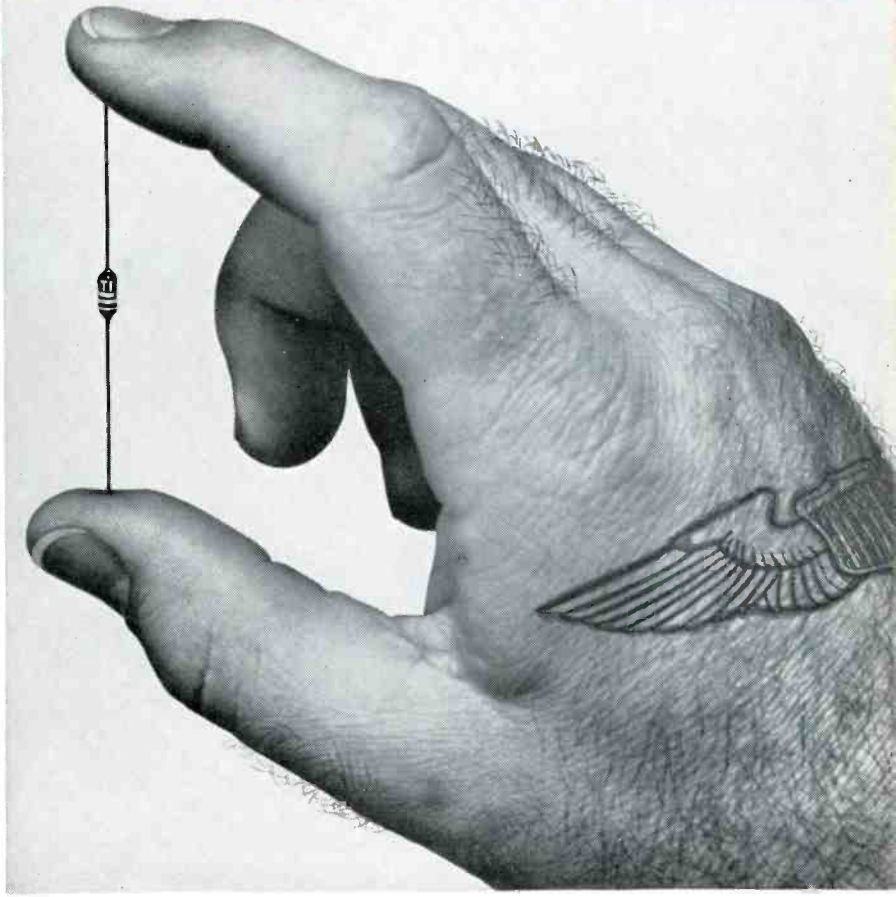

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PIV	225	400	500	600	v
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I_0 @ 150°C	150	150	150	150	ma
i_p	1.25	1.25	1.25	1.25	amp
P	600	600	600	600	mw
I_{DC}	3	3	3	3	amp
T_A	−65 to +150				°C

specifications

	AF1N645	AF1N647	AF1N648	AF1N649	
V_Z	275	480	600	720	v
I_b @ 25°C & PIV	0.2	0.2	0.2	0.2	μa
I_b @ 100°C & PIV	15	20	20	25	μa
E_b @ I_b = 400 ma dc	1.0	1.0	1.0	1.0	v
C typ	9	9	9	9	μμf

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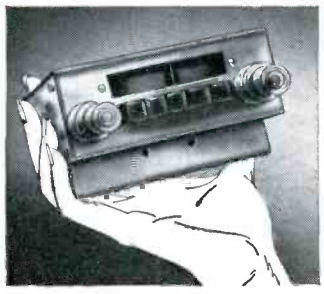
	Typical CURRENT GAIN Measured at 1 Kc (Beta)		Useful POWER GAIN DC Collector-to-Emitter Volts = −12			Maximum DC Collector Cutoff Current (I_{CBO})	
RCA TYPE	DC Collector Ma	Current Gain	Signal Frequency Kc	DC Collector Ma	Power Gain db	DC Collector-to-Base Volts	I_{CBO} Ma
2N640	−1	60	1500	−1	28	−12	−5
2N641	−1	60	262.5	−1	41	−12	−7
2N642	−1	60	1000	−0.6	40●	−12	−7
2N591	−2	70	1	−2	41	−1	−7
2N301	−1000	70▲	0.4	−1800■	33	−0.5	−100

●Conversion Power Gain. ■Peak value. Zero-Signal DC Collector Ma = −900. ▲DC Current Gain.



Illustrated is an experimental all-transistor broadcast-band automobile radio using 5 transistors. The 3 RCA "Drift" units described here used with an RCA-2N591 driver-amplifier, and an RCA-2N301 class A power amplifier provide a high-efficiency transistor complement capable of producing 1-watt audio output for a 2-microvolt RF-signal input. This receiver can provide a maximum power output of 4 watts with less than 10% distortion.

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