JULY 24, 1959

electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 30 PRICE SEVENTY-FIVE CENTS

Советская Электронная Аппаратура

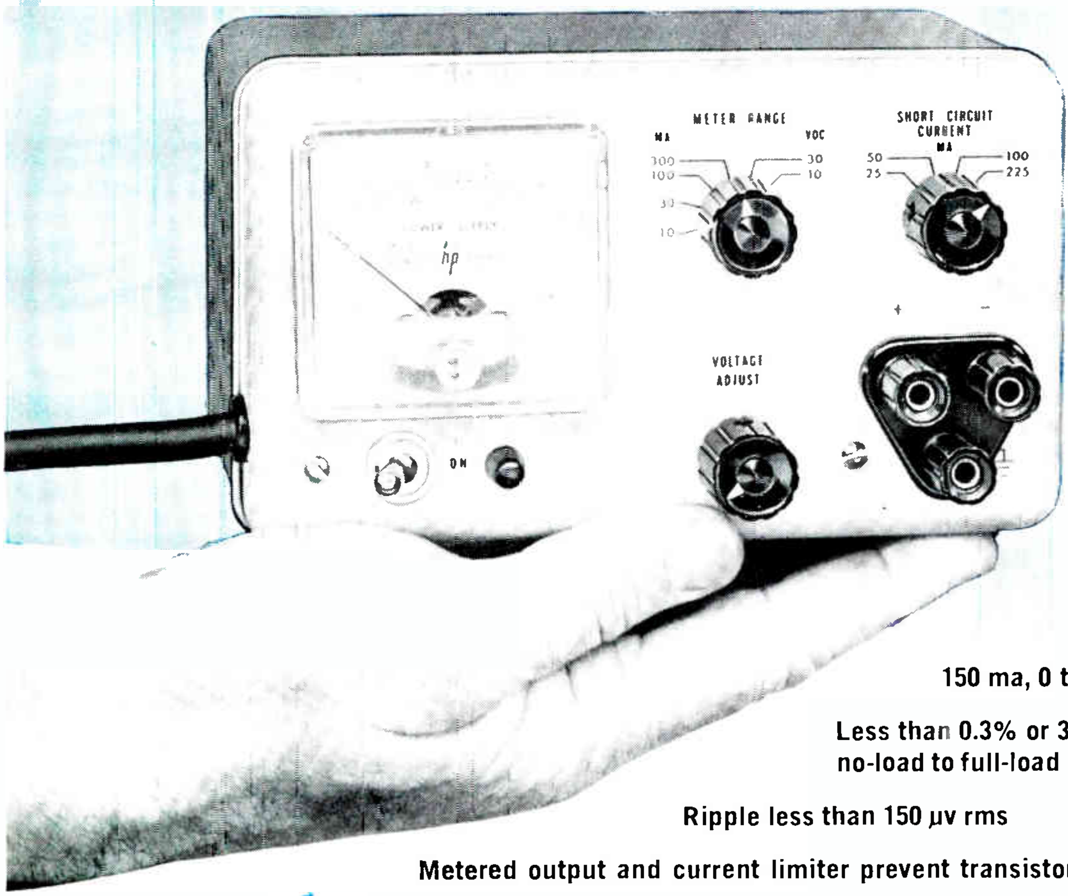
(Soviet Electronic Equipment)

New Look for Government Research?

compact, $145, 150 ma

TRANSISTOR SUPPLY

prevents overload damage to transistors!



150 ma, 0 to 30 v dc, variable

Less than 0.3% or 30 mv change no-load to full-load

Ripple less than 150 µv rms

Metered output and current limiter prevent transistor damage

-hp- 721A TRANSISTOR POWER SUPPLY

Model 721A was designed from the chassis up to provide safe, precision test voltages for almost all types of transistors in use today.

An outstanding feature is an output limiter, holding current to 25, 50, 100 or 225 ma as selected on the front panel. Accidental overloads are eliminated.

Model 721A has a 3-terminal output for grounding either positive or negative terminals. It may be "stacked" on another voltage, and a front panel meter monitors either output voltage or current, eliminating extra equipment.

Other -hp- regulated and klystron supplies

Model	Characteristics	Regulation	Current	Voltage Range	Hum & Noise Level	Price
711A	General purpose dc supply	Less than ±0.5% or 1.0 v, no load to full load	100 ma	0 to 500 v dc; 6.3 v ac	Ripple less than 1.0 mv	$250.00
712B	Heavy duty, 4 outputs, 0.1 msec transient response	Less than 50 mv no load to full load	200 ma (pos. dc)	0 to 500 v dc; -300 v dc fixed bias; 0 to -150 v dc variable bias; 6.3 v ac	Ripple less than 500 uv	365.00
715A	Klystron supply; square wave, external modulation	Less than 1%, no load to full load	50 ma (at 400 v)	250 to 400 v dc beam; 0 to 900 v dc reflector; 6.3 v ac	Ripple less than 7 mv	300.00

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

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1011A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A. • CABLE "HEWPACK" • DAVENPORT 5-4451

Field Representatives in all Principal Areas

5627

Investigate -hp- 122A Dual Trace Scope, just $625

electronics

JULY 24, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 30

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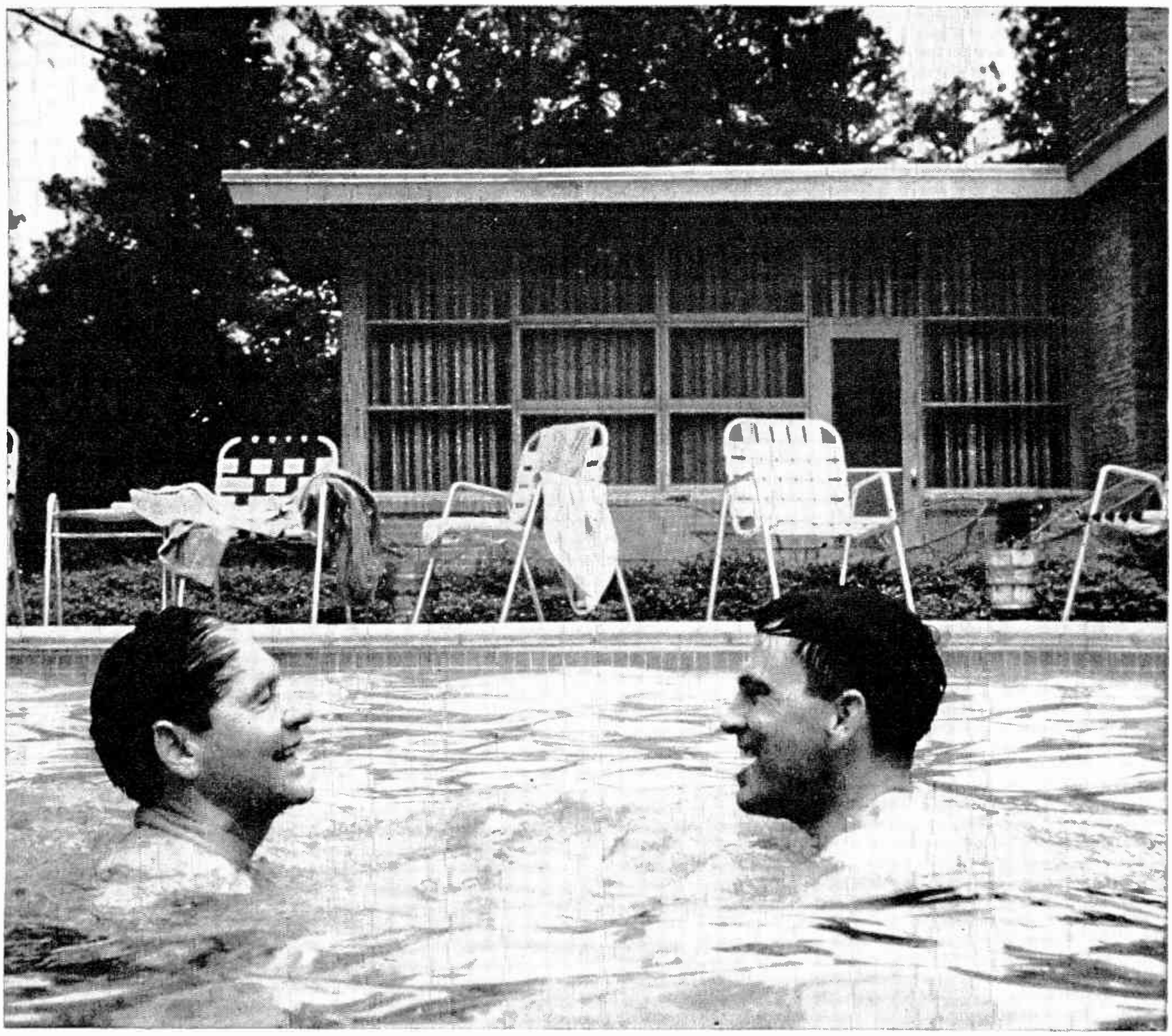
Issue at a Glance

Business

Engineering

Departments



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The mild, Top-of-the-South climate in the Richmond-Petersburg-Hopewell-Colonial Heights triangle works for you in many ways. It cuts construction, maintenance and heating costs. It saves weather shutdowns. It means pleasant, low cost living for management and staff.

It also adds extra dependability to your electric power from Vepco's growing network . . . with 1,700,000 kilowatts capability now, and building to more than 2,000,000 by 1961.

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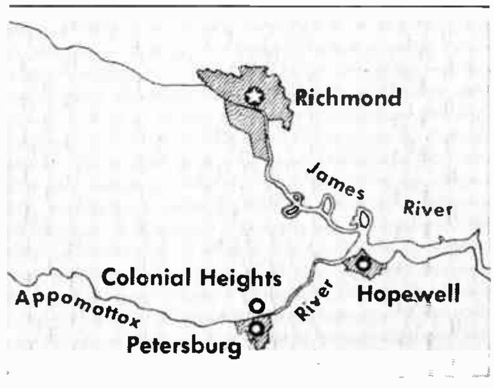
Richmond-Petersburg-Hopewell Triangle



50th YEAR 50 1909-1959

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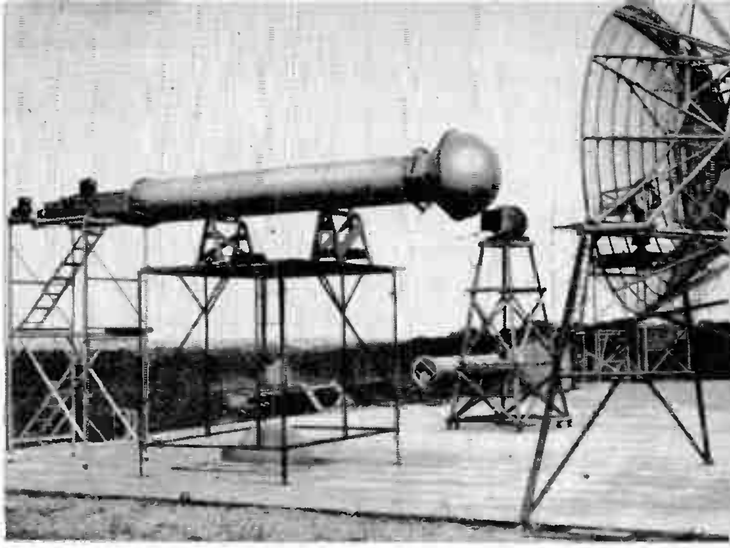
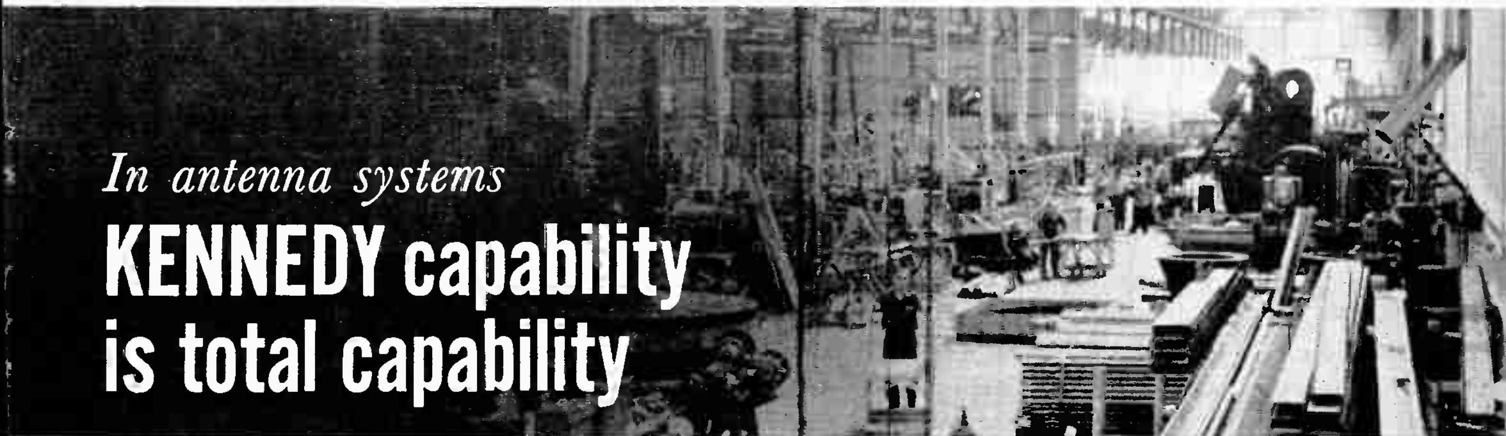
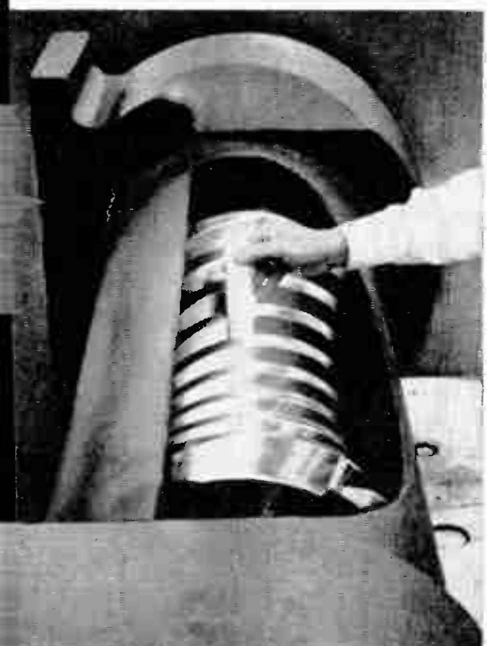
Clark P. Spellman, Mgr., Area Development, Electric Bldg., Richmond 9, Va., MI 9-1411

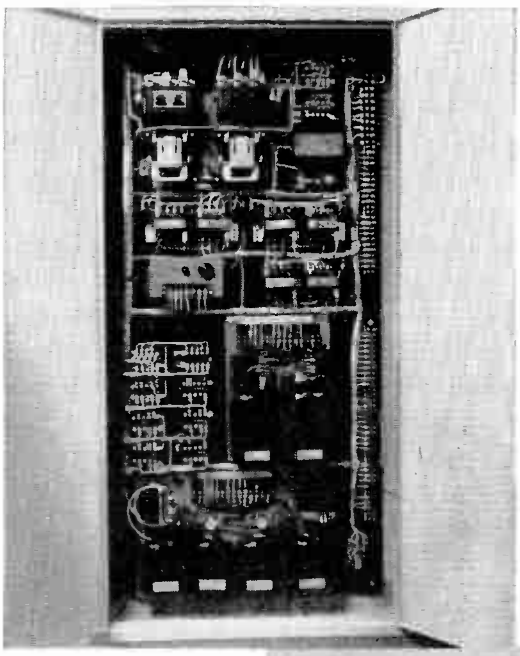
CIRCLE NO. 2 READER SERVICE CARD

CIRCLE NO. 3 READER SERVICE CARD→









TOTAL *capability in the field of antenna systems?*

It's the capability to do the basic r & d in microwave propagation . . . to design and develop the antenna system . . . . to manufacture the dish, the mount, and all waveguide components, horns, etc. . . . to provide complete field engineering service which includes site surveying, construction and erection, final checkout, and servicing.

In short, it's the capability *to do it all* — a *total* service from a single source.,

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SHOPTALK . . . editorial

electronics

July 24, 1959 Vol. 32, No. 30

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CABINET RANK FOR SCIENCE. Government research is big business today and it is likely to get a whole lot bigger in the near future. The frontiers of science today are such that progress demands heavy spending with little immediate return. Only governments can sponsor a trip to Venus or build a thermonuclear reactor. Directing our government's research effort will be a tremendous and important job.

Senate bill 3126 proposes to create a Department of Science and Technology aimed at finding a permanent home for some 35 scientifically-based bureaus and independent agencies now scattered throughout the government. (See p 24).

Backers of the bill readily admit it is aimed at cutting down to size such free-wheeling giants as the Atomic Energy Commission and the National Aeronautics & Space Administration. They would become bureaus within the new department.

However, the bill would also increase the prestige of groups like the National Science Foundation, Smithsonian Institution and the National Bureau of Standards, the last a first-rate scientific organization now incongruously housed in the Department of Commerce.

The in-fighting over this bill may amount to another power struggle between Congress and the White House.

But some good may come of it. A cabinet-rank Secretary of Science and Technology would make it clear to all, inside and outside the government, that government scientific research exists as a distinct function, not merely a handmaiden to the Department of Defense. Such a bill would greatly increase the prestige of scientists and engineers at large. And after the usual political settling period, we would, quite probably, get more dynamic and efficient leadership of our government research effort.

The bill's value to our industry—both short and long range—almost goes without saying. We do volumes of research business. And we have no more important single customer than the government. As you know, going to just one R&D stand to buy and sell wouldn't solve all problems—but what a wonderful beginning!

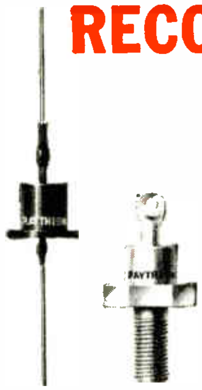
Coming In Our July 31 Issue . . .

TRANSISTORIZING EQUIPMENT. Only eleven years after emerging from the laboratory, the transistor has revolutionized our industry, made achievements possible that were once only dreams. And we've barely scratched the surface as far as exploiting all the possibilities offered by transistor technology.

But even with all the virtues of transistors, the decision to transistorize in equipment design is still dependent on many complex factors to be weighed by the designer. There are the obvious considerations of economics and availability and such general factors as size, weight and available power. And once the advantages of transistors for a particular design are established, there still remains the problem of selection from among the 700 or so different types available.

To help you make these decisions, next week ELECTRONICS presents Associate Editor Jurgen's special report on transistorizing electronic equipment. This report will tell you what the present trends are in the application of transistors to equipment design. You'll learn about progress in frequency and power-handling ability of transistors, as well as other performance characteristics. You'll discover that equally important strides are being made with associated components. And you'll see how the transition from lumped circuit elements to solid-state functional circuits bids fair to affect significantly the design of many equipment items. We believe Jurgen's useful and informative document really captures the dynamic spirit of transistor technology. You won't want to miss it.

when it comes to REVERSE RECOVERY

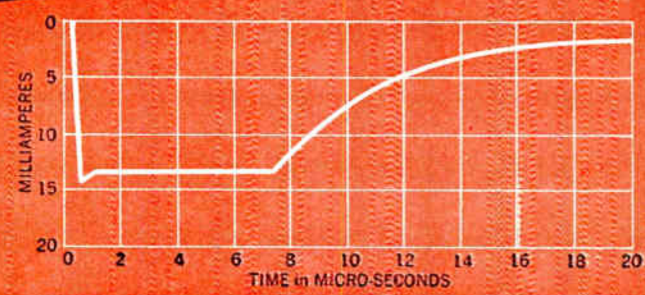


actual size

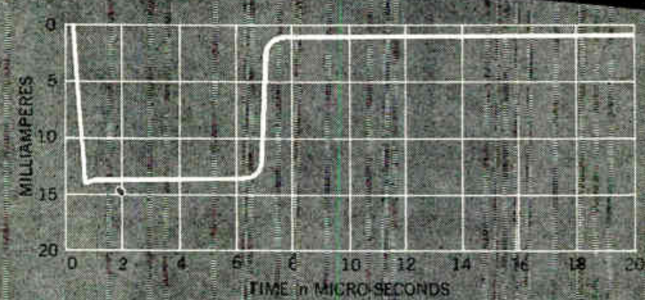
Raytheon *Diffused Junction* Silicon Rectifiers provide the precise junction gradient necessary for many applications. Operating temperature range is from minus 65° C to plus 165° C.

Available in stud and wire-in types having a wide range of characteristics, meeting MIL specifications.

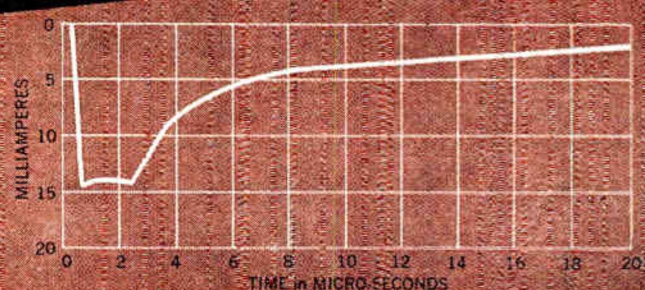
Available NOW, in production quantities.



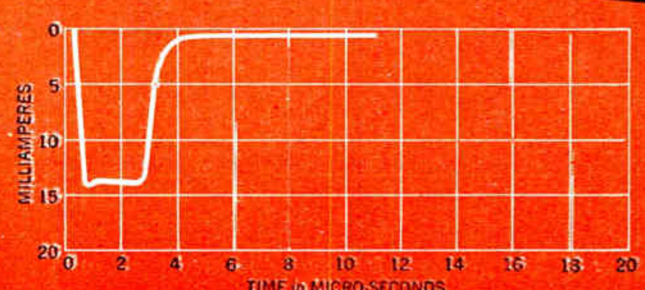
SOME silicon rectifiers give you slow start — slow rise



SOME silicon rectifiers give you slow start — fast rise



SOME silicon rectifiers give you fast start — slow rise



BUT RAYTHEON Reliable SILICON RECTIFIERS give you fast start — fast rise

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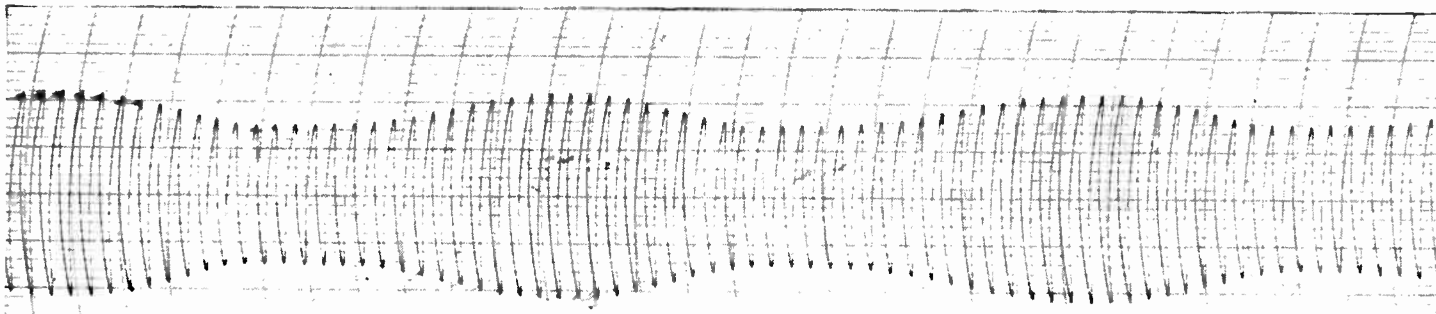
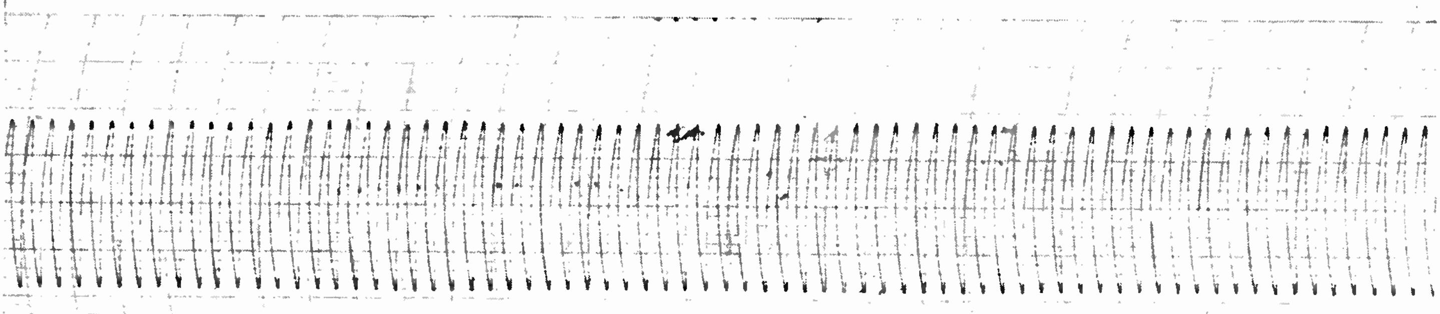
CIRCLE NO. 5 READER SERVICE CARD

Get sinusoidal output from a ±1% static-magnetic stabilizer for the cost of voltage regulation alone



INPUT to CV Transformer: *Available point-of-use voltage may vary widely because of line switching disturbances, intermittent in-plant demand. Input voltage illustrated varies over the range of 95v to 130v.*



OUTPUT from CV Transformer: *Output voltage is regulated within ±1% of 118v output rating despite input voltage swings as great as ±15%.*

Sola now offers sinusoidal output in every standard-type regulator *with no price premium*. This development — a result of major design and production innovations — greatly widens the field of use for static-magnetic voltage regulation. The new standard sinusoidal design is now ideal for use with electrical and electronic equipment requiring a regulated input voltage with commercial sine wave shape — especially where harmonic-free supply had previously been too costly. The sinusoidal output also contributes to ease of selection and ordering, since this Sola stabilizer is virtually universal in application.

The Sola Standard Sinusoidal Constant Voltage Transformer provides output with less than 3% rms harmonic content. It automatically and continuously regulates output voltage within ±1% for line voltage variations of ±15%. Average response time is 1.5 cycles or less. The new line includes nine stock output ratings from 60va to 7500va.

Besides the improved electrical characteristics, these units are substantially smaller and lighter than previous models. Size and weight reductions were accomplished without any loss of performance or dependability.

With the Sola Standard Sinusoidal Constant Voltage Transformer you also get all the proved benefits of a static-magnetic regulator. It is simple and rugged. There are no tubes . . . no moving parts . . . no replaceable parts. Maintenance and manual adjustment are not necessary.

Its current-limiting characteristic protects against shorts on the load circuit. It is available in step-up and step-down ratios, allowing substitution for conventional, non-regulating transformers. These units can be used in any electronic or electrical application requiring a regulated sinusoidal power source where the peak power demand does not exceed the capacity of the constant voltage transformer. Circuit design formulae based on sinusoidal wave shape are directly applicable. Custom units to specific requirements are available in production quantities.

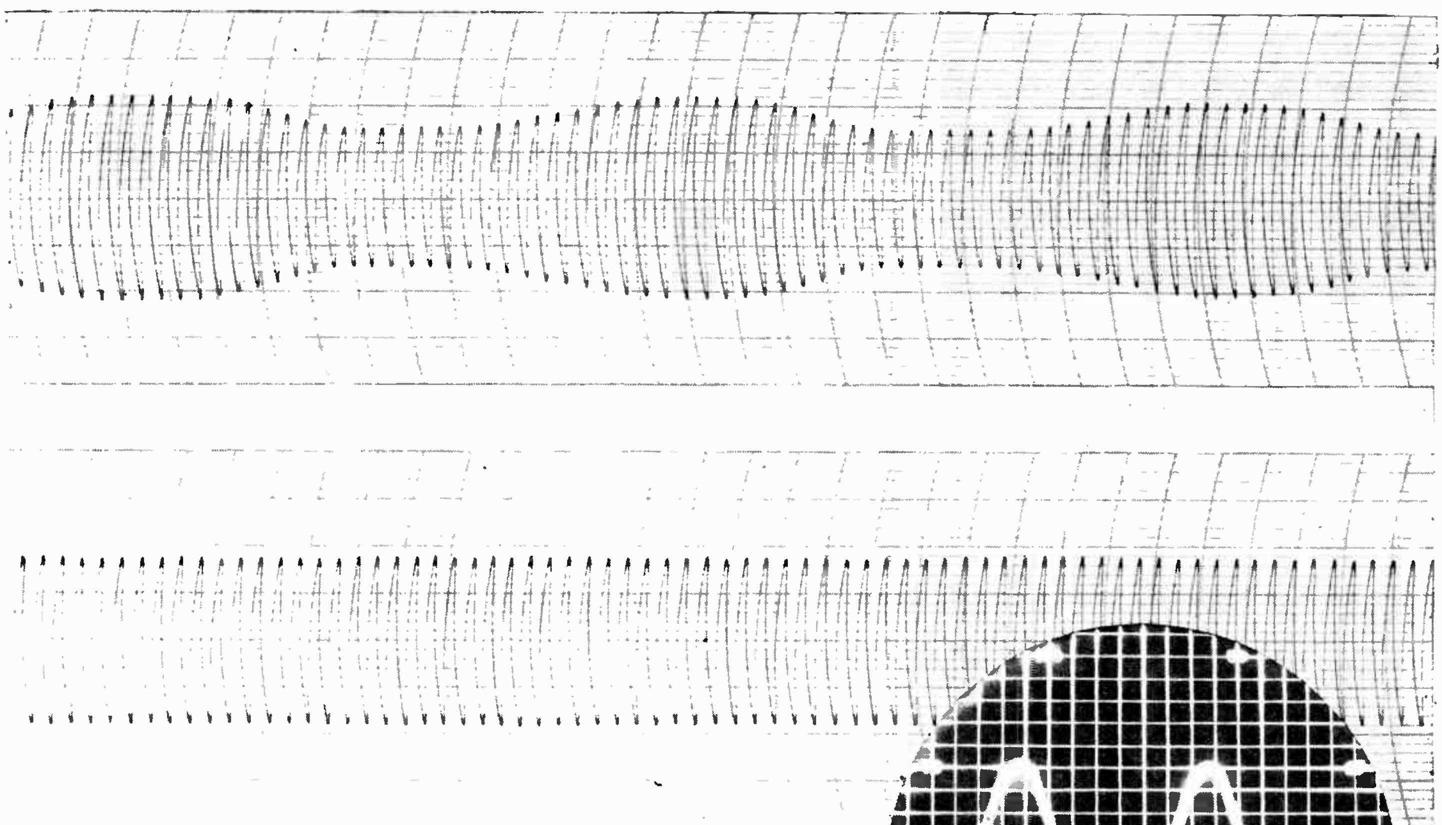
Write for Product Bulletin 7H-CVS

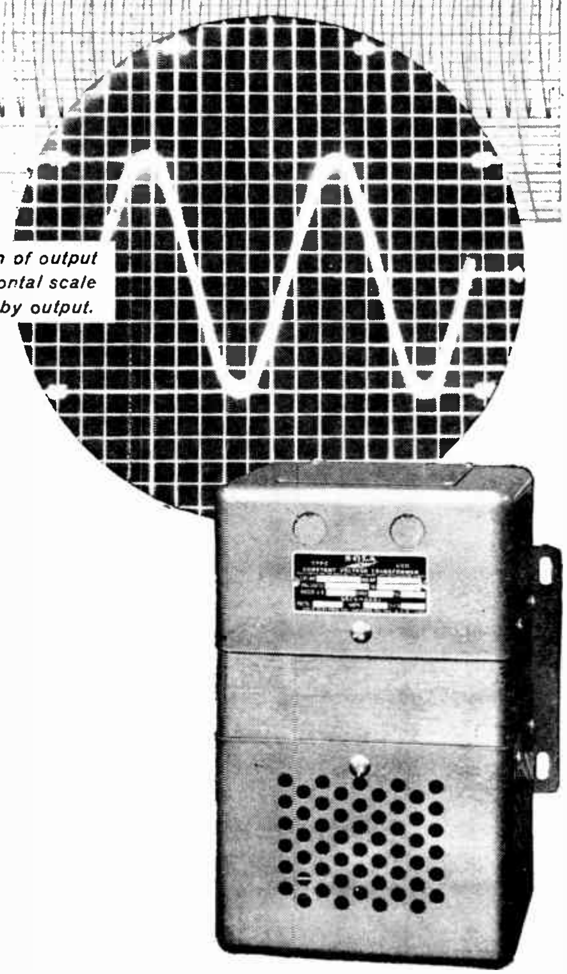
SOLA

SOLA ELECTRIC CO.,
4633 West 16th Street,
Chicago 50, Illinois

A Division of Basic Products Corporation

Sola Standard Sinusoidal Constant Voltage Transformer



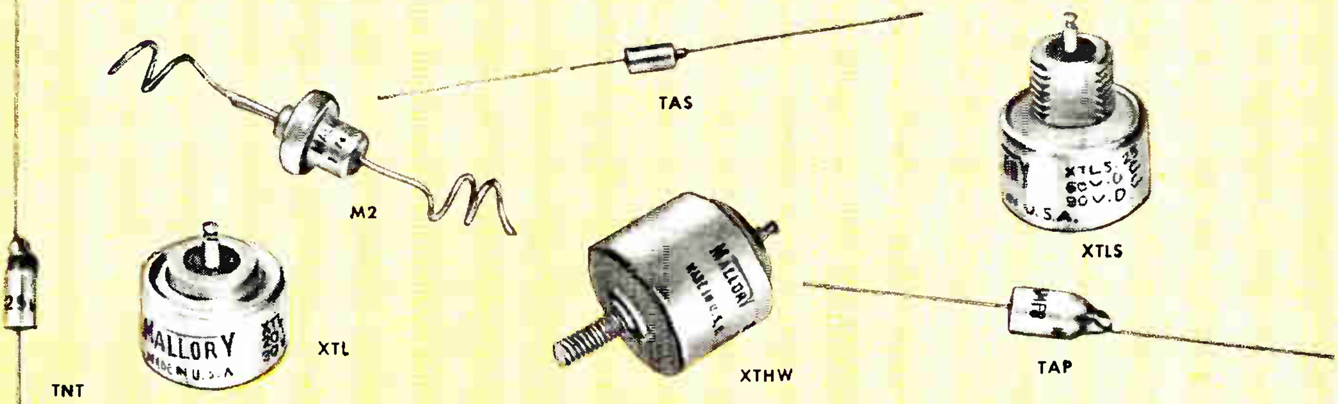


***OUTPUT from CV Transformer:** Oscilligram of output from same CV transformer uses expanded horizontal scale to picture commercial sine wave shape retained by output.*

New Prices of Sola Standard Sinusoidal Constant Voltage Transformers

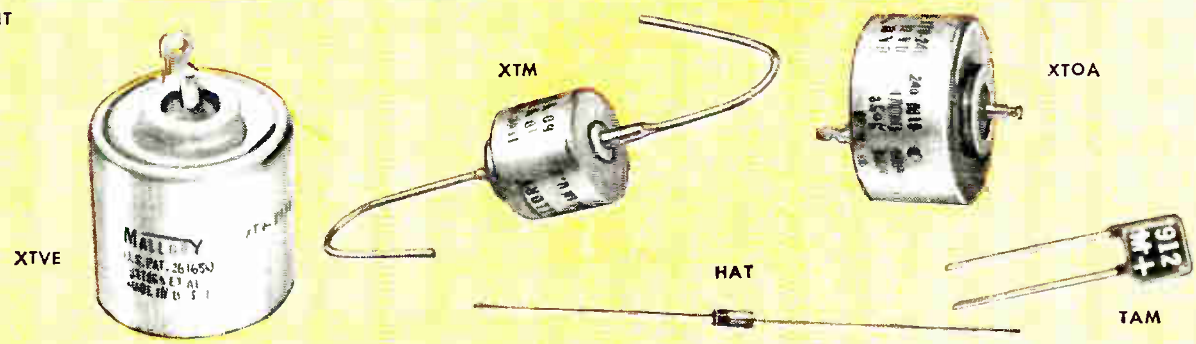
Catalog Number	Output Rating, VA	Price Each	% Price Reduction
23-13-060	60	$30	6.2
23-13-112	120	38	5.0
23-13-125	250	52	17.5
23-13-150	500	81	14.7
23-13-210	1000	135	14.6
23-25-220	2000	245	10.9
23-25-230	3000	330	9.6
23-26-250	5000	515	new item
23-28-275	7500	900	new item

18,000-Hour Life



Type	Description	Capacity Range	W. Volts DC Rating at 85 C	Temperature Range	Case Style	Body Length	Body Diameter
HAT	Pellet Anode—Liquid Electrolyte	1-10 mfd.	16-1V.	—20 to +85 C	Metal Case—Axial Leads—Insulated Case	.210″ max.	.075″ max.
TAS	Pellet Anode—Solid Electrolyte	.33-330 mfd.	35-6V.	—80 to +85 C	Metal Case—Axial Leads	.250″ to .750″	.125″ to .341″
TAM	Pellet Anode—Solid Electrolyte	6.8-56 mfd.	25-6V.	—55 to +85 C	Dip Coated Resin—Upright Mounting	.175″ thick	.313″ square
TAF	Foil Anode—Semi-Liquid Electrolyte	.25-440 mfd.	150-3V.	—55 to +85 C	Metal Case—Axial Leads	.688″ to 2.750″	.188″ to .375″
STNT	Pellet Anode—Liquid Electrolyte	2-40 mfd.	50-3V.	—55 to +85 C	Metal Case—Axial Leads	.350″	.155″
TNT	Pellet Anode—Liquid Electrolyte	4-80 mfd.	50-3V.	—55 to +85 C	Metal Case—Axial Leads	.500″	.155″
TAP	Pellet Anode—Liquid Electrolyte	2-30 mfd.	90-6V.	—55 to +85 C	Metal Case—Axial Leads	.500″	.238″
TAP2	Pellet Anode—Liquid Electrolyte	11-140 mfd.	90-6V.	—55 to +85 C	Metal Case—Axial Leads	.660″	.238″
M2	Pellet Anode—Liquid Electrolyte	11-140 mfd.	90-6V.	—55 to +150 C	Metal Case—Axial Leads	.500″	.290″ (Body) .484″ (Flange)
XTK	Pellet Anode—Liquid Electrolyte	2-70 mfd.	340-8V.	—55 to +175 C	Metal Case—Axial Leads or Terminal	.438″ to 1.313″	.650″
XTM	Pellet Anode—Liquid Electrolyte	4-140 mfd.	340-8V.	—55 to +175 C	Metal Case—Axial Leads or Terminal	.563″ to 1.781″	.650″
XTL	Pellet Anode—Liquid Electrolyte	3.5-120 mfd.	630-18V.	—55 to +200 C	Metal Case—Axial Terminal	.500″ to 2.595″	.875″
XTH	Pellet Anode—Liquid Electrolyte	7-240 mfd.	630-18V.	—55 to +200 C	Metal Case—Axial Terminal	.688″ to 4.063	.875″
XTV	Pellet Anode—Liquid Electrolyte	18-1300 mfd.	630-30V.	—55 to +175 C	Metal Case—Axial Terminal	.563″ to 2.750″	1.125″
XTO	Pellet Anode—Liquid Electrolyte	7-240 mfd.	630-18V.	—55 to +200 C	Metal Case—Axial Terminal	.563″ to 2.750″	1.125″

STNT



Tests Prove Reliability

of Mallory Tantalum Capacitors

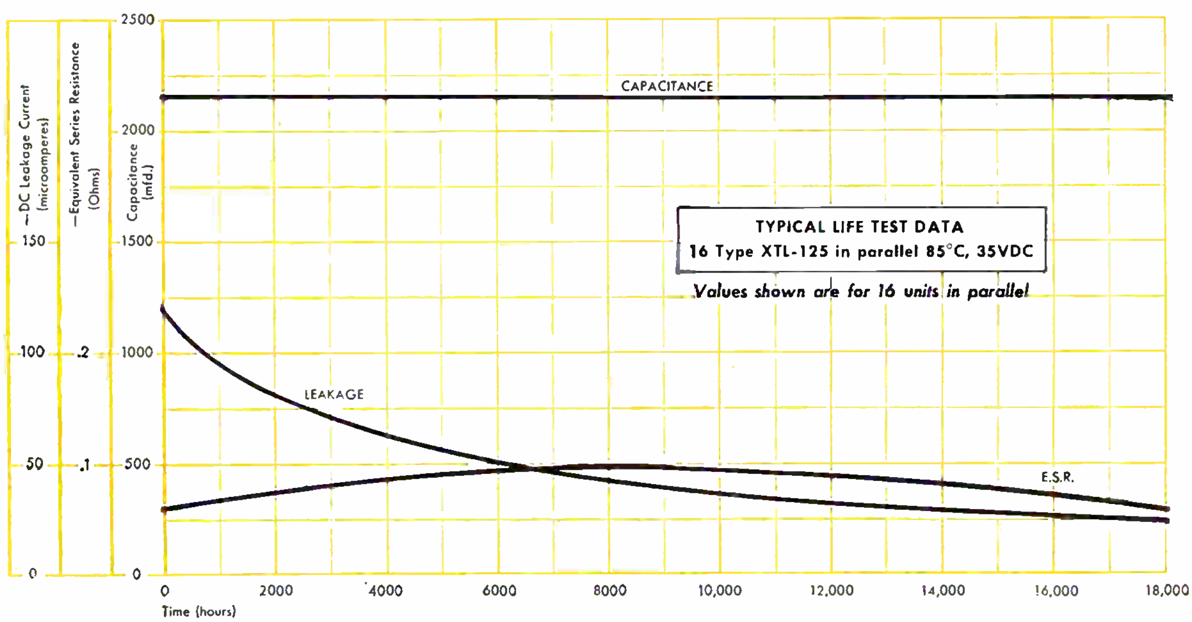
The real measure of reliability is the proved ability to "take it." And that's what you get with Mallory tantalum capacitors. Latest proof of Mallory performance is a series of life tests recently completed. Longest of the tests, made on 16 production samples of XTL-125 capacitors, ran for 18,000 hours at 85°C with rated voltage applied to parallel connected capacitors.

Not a single capacitor failed. At the end of the test, capacitance and equivalent series resistance measured essentially the same as the day the test began. DC leakage current decreased from 125 to 25 microamperes.

In the laboratory, Mallory tantalum capacitors are further checked by 100% inspection tests, and by electrical tests under MIL-C-3965B and 2000-hour life tests at elevated temperatures made on random samples from production lots. In the field, Mallory tantalum capacitors have built a reputation for trouble-free service during the ten years that we have been manufacturing them.

Pioneer in tantalum technology, Mallory makes 15 different tantalum types to match your requirements . . . ranging from micro-miniature to high capacity units. Many are available in 200°C ratings, introduced commercially by Mallory a decade ago.

Write for complete data, and for a consultation on your specific circuit requirements.



Mallory Capacitor Company
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CIRCLE NO. 9 READER SERVICE CARD

First Digital Voltmeter With Mathematically Perfect Logic...

The first stepping switch voltmeter with mathematically perfect logic . . . and the first to be completely transistorized! It's the NLS V-34, the latest instrument to be developed by the originators of the digital voltmeter. The exclusive new digital logic of the NLS V-34 allows readings to be made without cycling stepping switches through all nine positions in each decade. For the first time, "needless nines" are eliminated . . . the result: longer switch life and shorter measuring time. Check the exclusive features listed below.

"NO NEEDLESS NINES"

FOR FASTER MEASUREMENTS AND GREATEST RELIABILITY

MATHEMATICALLY PERFECT LOGIC—No numbers change that absolutely do not have to change. Stable measurements can be made of varying voltages.

STEPPING SWITCHES SEALED IN OIL—Each stepping switch is mounted in an individual oil-filled container. No manual lubrication needed. Oil bath extends life by factor of ten.

PLUG-IN STEPPING SWITCH MODULES—Stepping switches can be replaced as quickly as plugging in the meter.

FIRST COMPLETELY TRANSISTORIZED DIGITAL VOLTMETER—Even logic functions are performed by semi-conductors. Switch points reduced to one-half those required by "completely transistorized" competitive meters. Only the NLS V-34 is transistorized to the fullest possible extent.

SPECIFICATIONS

Range to ±1000 volts . . . Ratio to ±.9999 . . . 10 Megohm input impedance . . . 0.01% accuracy . . . Automatic range and polarity changing . . . five-digit model also available.

Write today for complete information on the NLS V-34

Originators of the Digital Voltmeter

non-linear systems, inc. DEL MAR (San Diego), CALIFORNIA

COMPARISON CHART

The few steps required by the NLS V-34 to make a typical measurement (3rd column) are compared with the many required by competitive meters. Note the blue "needless nines" in the middle column.

NO. OF STEPS	COMPETITIVE METERS	NLS V-34
0	+.8888	+.8888
1	+.8889	–.8888
2	+.8880	–.9888
3	+.8890	–.0888
4	+.8800	–.1888
5	+.8900	–.1988
6	+.8000	–.1088
7	+.9000	–.1188
8	+.0000	–.1198
9	–.0000	–.1108
10	–.0001	–.1118
11	–.0002	–.1119
12	–.0003	–.1110
13	–.0004	–.1111
14	–.0005	
15	–.0006	
16	–.0007	
17	–.0008	
18	–.0009	
19	–.0019	
20	–.0029	
21	–.0039	
22	–.0049	
23	–.0059	
24	–.0069	
25	–.0079	
26	–.0089	
27	–.0099	
28	–.0199	
29	–.0299	
30	–.0399	
31	–.0499	
32	–.0599	
33	–.0699	
34	–.0799	
35	–.0899	
36	–.0999	
37	–.1999	
38	–.1099	
39	–.1199	
40	–.1109	
41	–.1119	
42	–.1110	
43	–.1111	

THE MEASUREMENT IS COMPLETED IN JUST 13 STEPS BY THE NLS V-34

NLS—The Digital Voltmeter That Works...And Works...And Works!

ELECTRONICS NEWSLETTER

GEOPHYSICAL RACE to drill through the earth's crust and the mantle around the earth's core is quietly shaping up between American and Soviet scientists. Drilling of a "Mohole"—so dubbed because the boundary between crust and core mantle is named the Mohorovicic Discontinuity—will use a variety of electronic instrumentation. Project is being planned by a committee of the National Research Council of the National Academy of Sciences. The Soviet Academy of Sciences is known to have its own "Mohole" committee. Harry Ladd of the U.S. National Museum, chairman of a panel on instrumentation, tells ELECTRONICS that the group proposes to measure a number of physical and chemical properties during and after the underwater drilling, expected to bore 18,000 ft below ocean floor. The properties include: density, radioactivity, elasticity, magnetism, electrical properties, thermal gradient, porosity and permeability, and pressure. Ladd says most of these properties apparently can be measured with existing instruments if the drill hole is not smaller than 4-in. in diameter, adds that "a satisfactory low frequency seismometer is not available at present but steps are being taken to develop a suitable instrument."

Mine detection by means of a sensing device that scatters X-rays will be studied by Tracerlab-Keleket under a contract from the Army Engineer and Development Laboratories, Ft. Belvoir, Va. Firm says feasibility research is already finished. New work will also aim at design and construction of instrumentation using the X-ray system.

USAF RADAR DEFENSE SYSTEMS which have been using specially designed video processing gear for each type of radar to eliminate natural, accidental and manmade interference will now be able to use a new filter system that combines a number of techniques of eliminating interference. An $8-million contract has been awarded by the Rome Air Materiel Area to Airborne Instruments Laboratory division of Cutler-Hammer for 29 units called Video Integrating Groups. Equipment will link basic AF radars with the Sage system.

Army Hawk antiaircraft missile system reaches final assembly late this summer at Red River Arsenal, Texarkana, Tex. About 50 employees of prime contractor Raytheon will assemble the major components of the system as they arrive from production plants. Firm says opening of assembly plant is in anticipation of early activation of Hawk tactical units.

LIQUID STATE A-C DEVICE is said to switch and modulate current continuously without wear, disintegration or loss of efficiency. Inventor Stanford R. Ovshinsky, president of the Ovitron Corp., Detroit, reports that the component consists of two load-connected electrodes and a grid control element immersed in an electrolytic bath. Concept of "control through electro-ionic surface impedance changes" works this way: When a small amount of energy enters the grid element the semipermeable surfaces of the two load electrodes become permeable to certain ions and are changed to a conductive state. If control signal is removed from grid or if a signal of opposite polarity is applied, the surfaces of the electrodes are restored to their nonconductive state.

Puerto Rico's electronics industry has grown from a handful of plants in 1950 to about 70 that annually ship $40 million worth of products to the U.S. This month the island's Economic Development Administration, which has an office at 666 Fifth Ave., New York, issued a new directory of firms with plants in Puerto Rico.

NEW HIGH-SPEED AUTOMATIC aviation weather service for combined use of military and civil aviation will be integrated by United Aircraft Corp. under a contract with the Air Force and the Federal Aviation Agency. United will establish and operate on the East Coast a prototype group of facilities located at eight or more airports, both civilian and military, using equipment developed by the government as well as new equipment to be supplied. The test network will be in effective operation by late 1963. Subcontractors to date include: Dunlap and Assoc., Hermes Electronics, Philco, Technical Operations, Tele-Dynamics, Travelers Weather Research Center and Western Union.

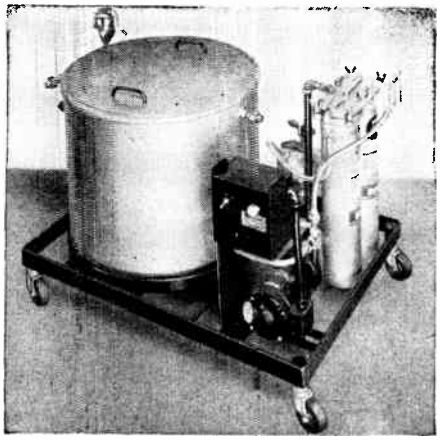
Pentagon fire that destroyed Air Force computer equipment early this month underscores dependence of the military on the electronic gear and the importance of flexible government use of computers to meet possible national emergencies. USAF was able to book time on other computers in the Washington area within 24 hours after the fire, received a new IBM 705 system, a new 709 and other equipment within 15 days. Equipment was put into operation at temporary locations, pending repair of USAF's Pentagon computer center.

HIGH-SPEED DATA PRINTING SYSTEM which can be adapted for facsimile operation is announced by A. B. Dick Co., Chicago. Firm says its Videograph equipment reads and translates binary pulses from punched cards, magnetic or paper tape at a rate of up to 20,000 characters per second. Then it either prints the information or displays it on a tv screen. System can reproduce pictorial information by means of its electrostatic printing tube when units are connected by cable or microwave link, and a sending unit is added.

SOVIET GEOPHYSICAL ROCKET fired July 10 with two dogs also carried instrumentation to measure infrared radiation, photograph cloud masses, analyze ionic and neutral composition of atmosphere, and measure electrostatic fields. Dogs and gear were recovered. Tass says more data was obtained on composition of light gases, following up study made with rocket fired July 2.

NEW

BARNSTEAD WATER RE-PURIFYING SYSTEM



PRODUCES PURE WATER
of 10,000,000 ohms
ELECTRICAL RESISTANCE

Equipment consists of Barnstead Demineralizer, organic removal cartridge, and mixed-bed cartridge for removal of organic matter and mineral impurities. The Barnstead® MF® Submicron Filter removes particles down to 0.45 micron. The distilled water storage tank is equipped with a Barnstead Ventgard® which purifies the air entering the storage tank. Keeps distilled water pure by removing all air-borne bacteria, dust, gases, mist etc. Re-circulates and re-purifies the distilled water to 10,000,000 ohms electrical resistance. Also removes organic contamination.

Compact in size . . fits under laboratory table or bench. Ideal for use in pilot plant operations, where ultra pure water is required for lab tests, for experimental work in semiconductor field, crystal growth experiments etc.

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JAmaica 4-3180	TEmplebar 2-5391	MUlberry 5-8180
PHILADELPHIA	NEW YORK	LOS ANGELES
LOcust 8-1796	Kingsbridge 8-1557	RYan 6-6622

B
PURE WATER EQUIPMENT FOR EVERY PURE WATER NEED

WASHINGTON OUTLOOK

WASHINGTON—THE MUCH-PUBLICIZED Democratic attack on the administration's defense program has fizzled. Five months back, there was talk of jacking up the Pentagon budget by a couple of billion. Now the outlook is for final congressional approval of a military appropriation close to the administration's original $39.2 billion request. (An extra $1.6 billion is covered in a separate appropriation for military construction.)

As ELECTRONICS went to press, the congressional debate on the appropriation was still under way. The debate points up once again how tough it is to pin down Pentagon buying plans very definitely. Both the House and Senate voted major changes in weapon development and production programs—with both versions at odds on important issues.

The differences cover electronics-related projects. Examples: the house in effect killed the Air Force's Mace missile, the Senate Appropriations Committee authorized continued production. The House bolstered the Navy's anti-submarine warfare program by $255.3 million; the Senate committee killed the increase.

The Senate committee added $23.3 million for Air Force procurement of training aircraft for advanced navigation, electronic countermeasures, and airway traffic control surveillance. It also restored funds for Air Force procurement of gap filler radar and Bomarc missiles, tacked on $205.3 million for Army procurement (for a wide variety of electronic equipment and other hardware). This is in addition to the House's $200-million increase—of which $137 million is earmarked for a speed-up of the Nike-Zeus anti-ICBM system.

- **Behind the congressional debate,** final details on the Pentagon's so-called "master plan" on air defense have been clarified.

  The Air Force now plans to build 16 Bomarc bases in all. Under the original program, 32 installations were to have been built. The Army will build 30 more Nike-Hercules installations in all—two each spotted close to 15 bomber bases in the continental U. S.

  Original plans were for at least 50 more new sites. In addition, conversion of some Nike-Ajax bases will be continued, as will new base construction in Hawaii and South Korea.

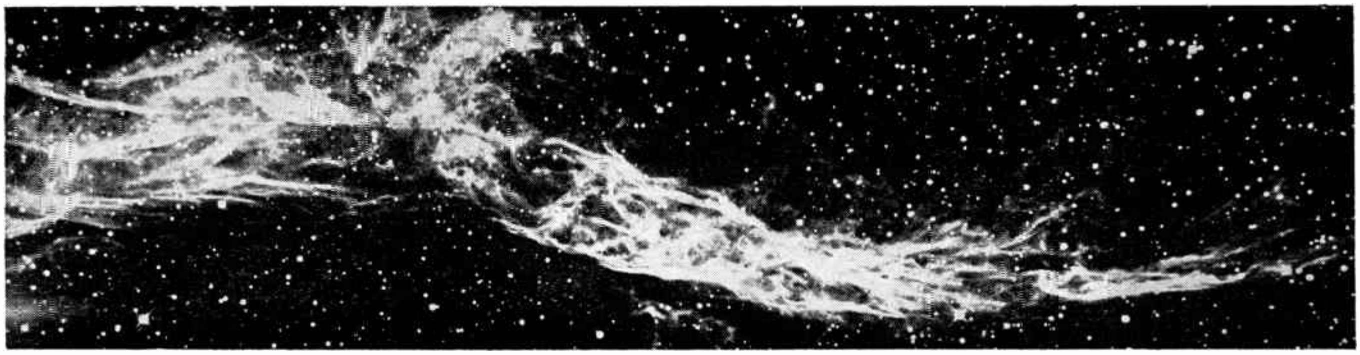
- **Congressional insiders** expect new restrictions on employment of retired military brass by defense contractors.

  Present rules forbid retired regular officers from "selling" to their former services—for two years after retirement from the Army and Air Force, for life from the Navy.

  The outlook is for a law to spell out what constitutes selling. The House Armed Services Subcommittee is thinking about a provision to bar retired officers for two years from specific procurement or development projects with which they were "directly responsible" while on active duty. The more extreme proposals would ban retired brass from negotiating on such projects for life, would apply the restrictions to reserve as well as regular retired officers, and would generally prohibit contract awards to firms with retired senior officers on the payroll.

  New legislation is unlikely this year. And even if the tougher bill fails to go through at all, the Pentagon on its own will push tighter controls over procurement to prevent charges of favoritism to companies which hire former generals and admirals.

  The Pentagon's official line has been that the long drawn-out administrative reviews which engulf every major military contract do, in themselves, provide "checks and balances" to bar improper influence peddling by ex-brass.



Space Technology Laboratories' new corporate symbol represents a bright history in a stimulating age. ✱ STL *has provided the over-all systems engineering and technical direction for the Air Force Ballistic Missile Program since it was assigned the highest national priority in 1954. Five years of accelerated effort produced epic advances in science and technology, and propelled the art of missilery through three distinct generations of progress.* STL *contributed technical leadership to the science/government/industry team which has built this solid, expandable foundation for future advances in space, and is daily adding new strength to our national security.* ✱ *In addition to its major management functions,* STL *also conducts advanced space probe experiments for the Air Force at the direction of such agencies as* NASA *and* ARPA. ✱ *To those scientists and engineers with capabilities in propulsion, electronics, thermodynamics, aerodynamics, structures, astrophysics, computer technology, and other related fields and disciplines,* STL *now offers unique professional opportunities. Inquiries regarding staff positions at* STL *are invited.*

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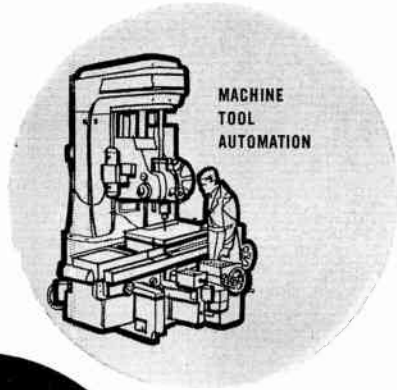
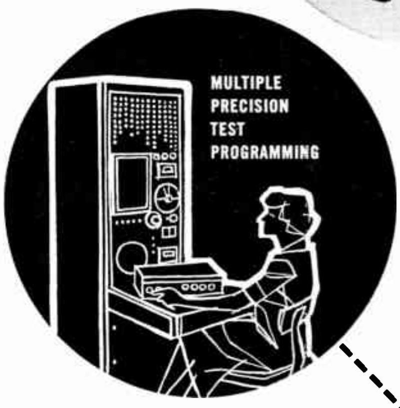
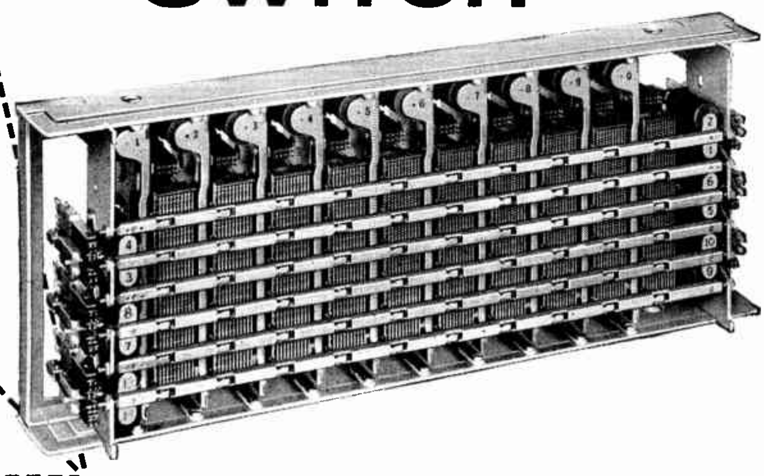
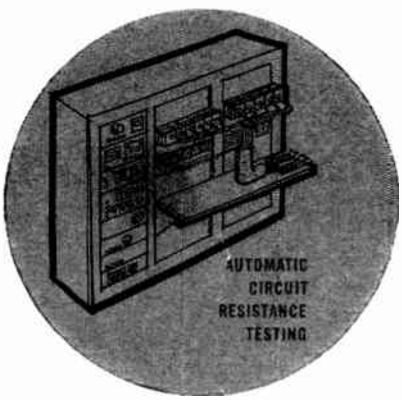
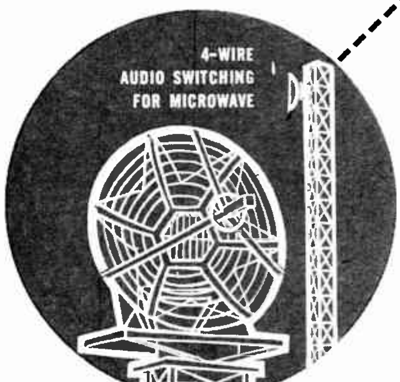


versatile is the word for NORTH CROSSBAR SWITCH









North Electric's Crossbar Switch, a 10x10x12 matrix configuration providing 1200 switching points, delivers an almost limitless range of switching capabilities and provides new efficiencies and economies in industrial applications with absolute reliability!

North's Crossbar Switch versatility has been proven by its application to a wide variety of operational demands.

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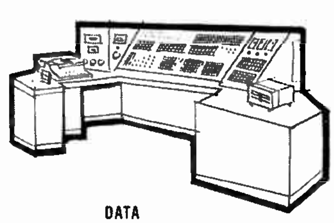


New Stock Issues Pending

ACTIONS PENDING before Securities and Exchange Commission indicate the high level of electronics financing evident at the start of the year is due to continue. Some present signs are:

• **International Telephone & Telegraph** has filed with SEC for registration of three blocks of capital stock of 300,000, 200,000 and 30,000 shares. These stocks will be made available to key employees under three separate incentive plans approved by company stockholders. Two plans were formulated last year and one was advanced in 1956.

• **Trans-Sonics,** Lexington, Mass., has registered 90,000 shares of outstanding common stock to be offered for public sale by Kidder Peabody & Co. Trans-Sonics is engaged in the design and manufacture of precision transducers for telemetering, control and direct indication. It has presently 428,010 common shares outstanding, of which Payson & Trask owns 128,250.

• **Technical Operations,** Burlington, Mass., has filed with SEC for offering of 75,000 shares of common stock. The firm's main interest is performance of specialized R&D projects, manufacture of radiographic isotope equipment, and transistorized power supplies. The company will use about $250,000 of the stock sale proceeds to make additions and improvements to its main buildings, and the rest for construction of new facilities and for general corporate purposes.

• **Micronaire Electro-Medical Products,** New York, is seeking registration of 200,000 shares of common stock and 50,000 one-year warrants for the purchase of common stock, to be offered for public sale in units of 100 shares of common stock and 25 warrants at $275 per unit. The warrants will be exercisable at $3 and one warrant per share. The registration also includes 200,000 three-year warrants exercisable at $3. The company, organized this year, purchases and markets certain industrial products developed by Raytheon. In addition, the firm has acquired rights to a line of electrocardiograph equipment also developed by Raytheon. A portion of funds derived from the stock sale will be used to discharge debts incurred in purchase of equipment rights, while the balance will be expended for sales efforts and general corporate purposes.

• **Matronics Inc.,** Waterbury, N. Y., plans to offer 200,000 shares of common stock at $3.75 a share. The two-year old firm was organized to develop, design and manufacture digital memory devices for data processing and inventory control applications for small- and medium-sized business firms. Prototype models were completed last year and the firm is now manufacturing production models to fill initial orders. Proceeds from the stock sale will be used for sales promotion, production test equipment, research and development, inventories and discharging debts.

25 MOST ACTIVE STOCKS

WEEK ENDING JULY 10

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Avco Corp	1,705	15½	14½	15⅜
Gen Electric	1,034	84¾	79⅝	83
Sperry Rand	943	26½	25¼	25⅞
Gen Tel & Elec	757	72⅜	69½	72⅛
RCA	740	70⅜	68⅞	69⅜
Univ Control	702	20⅛	18¼	18¾
Gen Dynamics	571	56⅜	53⅜	54⅛
Lear	563	16¼	13¼	15¾
Intl Tel & Tel	534	40¾	38	38¼
Raytheon	489	57⅞	55	55¼
Litton	448	124⅞	116¼	117¼
Elec & Mus Ind	435	7⅜	6⅝	6⅞
Westinghouse	435	98⅜	95	97½
Victoreen Inst	418	16½	15¼	15⅜
Burroughs	397	36⅝	35¼	36
Zenith Radio	353	127½	118	119
Intl Resistance	352	20⅜	18⅝	18¾
Philco	277	31⅞	29⅝	29⅞
Standard Coil	273	19⅜	17¾	18⅛
Emerson Radio	225	22⅛	19¾	19⅞
Gen Instr	222	32¼	29⅛	29¼
Gen Prec Equip	222	42¼	39¾	41¼
Am Bosch Arma	212	34⅛	33	34
Ampex	212	79¾	76¼	78¼
Dynamics Corp	192	10⅜	9½	9⅝

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

Using Thermistors

Edited by

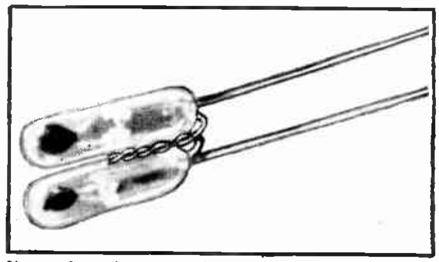
FENWAL ELECTRONICS

—

NEW "IDENTICAL" THERMISTORS PERMIT COMPLETE INTERCHANGEABILITY

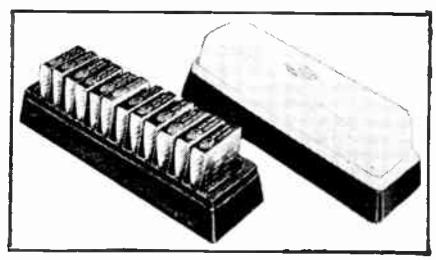
Now thermistor probes can be supplied with identical resistance temperature curves. These thermistors will meet a nominal curve tabulated in absolute resistance values at 1°F increments from 0°F to 350°F. All probes will be within ±[illegible]% of resistance at any temperature point on the curve.

This now offers the user complete interchangeability and the opportunity to provide multi-point indication or control without having to individually calibrate



Shown four times actual size. Patent Pending

each thermistor sensor. This, of course, is coupled with the advantage of tremendous sensitivity obtained from the inherent characteristic of a thermistor that gives, in this case, a resistance change of from 26,520 ohms at 0°F to 70.4 ohms at 350°F. This curve can be obtained from Fenwal Electronics. Other details on these and other closer tolerance thermistors, ideal for telemetry and instrumentation, can be obtained from Fenwal Electronics, Inc., 26 Mellen Street, Framingham, Mass.



EXPERIMENTERS' KIT

The G200 Experimental Kit shown here simplifies selection of the "right" thermistor. Contains 12 different thermistors, each with complete operating characteristics. Available from distributors or the Framingham plant, $19.95 net.

Fenwal Electronics

Making Precision Thermistors to Make Your Design Ideas Come True

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THE LEGENDARY FIREBIRD, the Phoenix, rose young and strong again and again from flames . . . this is the Norton Firebird — symbol for the exciting new fused materials made in Norton's electric furnaces.

Informative Booklet
on
BORIDES
and other
electro-chemicals

Modern magic that matches the legend of the Phoenix is the birth of NORTON Borides in high temperature electric furnaces. Here borides of CHROMIUM, TITANIUM, and ZIRCONIUM develop electrical conductivity equal to, and wear resistance superior to, many metals . . . also exceptional heat resistance and the ability to absorb neutrons.

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Improve *your* processing efficiency and product quality with versatile, economical NORTON Borides. Write for booklet. NORTON COMPANY, Electro-Chemical Division, 951 New Bond Street, Worcester 6, Massachusetts.

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MAKING BETTER PRODUCTS
. . . TO MAKE
YOUR PRODUCTS BETTER

MARKET RESEARCH

Where to Get Defense Data

RECENT TALK by R. B. Whiting of the Department of Defense on sources of information for the $41-billion defense market is of prime importance to electronics industry marketers. This year our share of this complex market is about $5 billion.

Whiting is economic advisor to the Assistant Secretary for Supply and Logistics. He spoke at the American Marketing Association Convention in Cleveland.

Two Data Sources

There are two basic sources of data on defense procurement trends, Whiting said. One is the DOD fiscal accounting system and the other is a statistical record of defense procurement contracts.

DOD's comptroller publishes a Monthly Report on Status of Funds by Budget Category. It reports data on military personnel costs, operation and maintenance, major procurement and production, military construction, research and development, working capital funds, reserve components and DOD establishment-wide activities.

Of special interest to the electronics industry is the data reported on major procurement and research and development. The major procurement category is broken down into aircraft, missiles, ships, various ordnance items, electronics and communications, production equipment and facilities and other major procurement.

Special Tabulations

Military prime contracts reports are a source of additional procurement information. They are available from the Central Military Procurement Information Office, which is part of Whiting's organization.

Special tabulations of contracts larger than $10,000 each (which account for 93 percent of all contract funds) provide data for the major procurement categories and for 10 commercial categories not shown separately in the monthly fiscal reports.

The contract reports for each military department are consolidated in a quarterly publication called Military Prime Contract Awards to Small Business and Other Contractors. A brief summary of departmental totals is issued monthly under the same title.

In addition, the Supply and Logistics group publishes two reports which show amounts awarded to individual defense prime contractors. One of these lists 100 companies according to the total volume of their prime contract awards. The other lists 500 contractors according to the value of their research and development awards. Both lists are available to the public.

Lists Future Plans

Best source of comprehensive information about future military procurement plans, says Whiting, is the Budget of the United States Government, a book sold by the Superintendent of Documents for $5.75. It includes a description of planned activities to be supported by requested appropriations in each title and budget category.

A bulletin is available from the Office of the Assistant Secretary of Defense for Supply and Logistics, Washington 25, D. C. The bulletin lists sources of procurement information available from the Superintendent of Documents, the Department of Defense and other government sources.

Whiting suggests that companies trying to find out how and what to sell to the Department of Defense make their first call at the Central Military Procurement Information Office in the Pentagon.

This office is under the Assistant Secretary of S&L.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	July 3, 1959	June 5, 1959	Change From One Year Ago
Television sets	98,426	119,089	+76.1%
Radio sets, total	258,234	276,604	+165.7%
Auto sets	108,459	131,156	+449.4%

STOCK PRICE AVERAGES

(Standard & Poor's)	July 8, 1959	June 10, 1959	Change From One Year Ago
Electronics mfrs.	97.95	90.66	+82.8%
Radio & tv mfrs.	114.56	111.61	+133.1%
Broadcasters	105.11	96.52	+68.0%

Electron Tube News
—from SYLVANIA

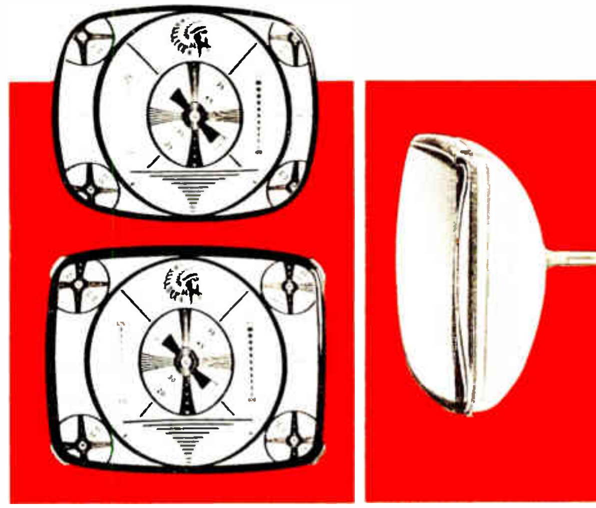
Designing for extra reliability—everywhere in Electronics

TELEVISION...

New bonded-shield picture tube squares away the TV screen, increases viewing area, reduces reflection, improves light output and picture clarity

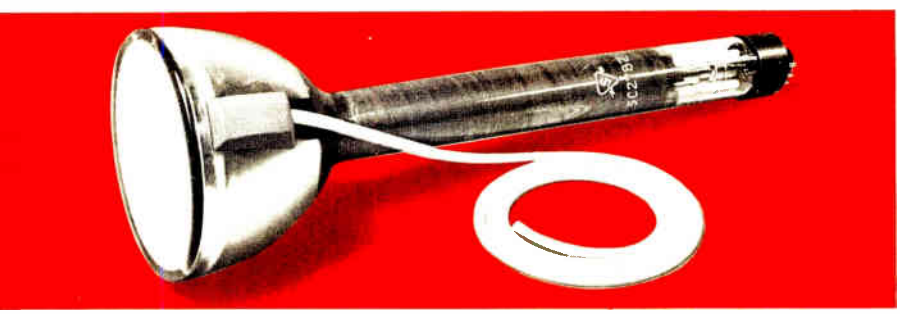
TV design engineers can now take advantage of one of the first major improvements in television faceplate design since the rectangular screen ... the Sylvania bonded-shield picture tube. It incorporates a built-on panel of safety glass that makes the traditional separate safety glass unnecessary and opens the way to exciting new possibilities in TV cabinet design. It allows substantial reductions in both cabinet dimensions and cost. And because it reduces reflection, increased light output and clearer TV pictures result.

The squared away corners of the new bonded-shield picture tubes add approximately 20 square inches to the viewing area of a 21-inch screen. The 23-inch tube presents more of the picture as the camera sees it. The new bonded-shield picture tubes are available in 18″ and 23″ sizes (diagonal measurement) with conventional or Sylvania tripotential focus electron guns.



New Sylvania bonded-shield picture tube shows more picture than the conventional 21″ tube

INDUSTRIAL & MILITARY CATHODE-RAY TUBES...



New Sylvania high resolution CRT, type SC2782

Sylvania develops ultrahigh definition CRT for photo video recording in aerial reconnaissance and other applications where high resolution is necessary

All of the precision qualities of specialized fine spot CRT's are now available to design engineers in a new 5-inch CRT with a definition range of 3,000 lines. Through rigid selection techniques, greater accuracy controls, new fine grain phosphors and optical quality faceplate, Sylvania CRT engineers have been able to achieve this extremely fine definition using standard CRT auxiliary components and design. The new tube has an operating voltage of 20 to 25 KV. It incorporates an anode lead that is potted on the side of the tube to prevent corona and permit high-altitude applications.

The tube has standard basing and a 6.3 V standard heater. It is available now for sampling through your Sylvania equipment representative or government office.

Sylvania is actively engineering CRT's with even greater resolutions—up to 6,000 lines—to meet the ever increasing needs of the armed forces and industry. We will welcome the opportunity to discuss your specific applications problems with you and to explore custom design possibilities to meet your needs. Contact your Sylvania representative or the factory directly today.

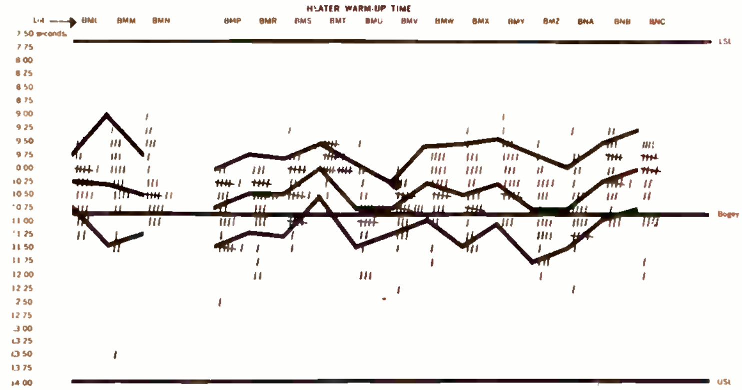
New design of standard 3-inch oscilloscope tube

Improved Sylvania oscilloscope CRT, type 3ASP1

Oscilloscope designers can obtain all the advantages of present 3-inch oscilloscope CRT's plus these added features with the new 3ASP1:

- **Improved faceplate—**
  Flat pressed type gives greater clarity—less distortion.
- **Better Insulation—**
  Anode connection located on side to prevent possible arcing.
- **Conventional basing—**
  Standard CRT stem and base is used.

Sylvania sets a new GOLD



Picture of Reliability—Actual graph of mixed variable-attribute inspection shows how individual tube lots meet a particular specification

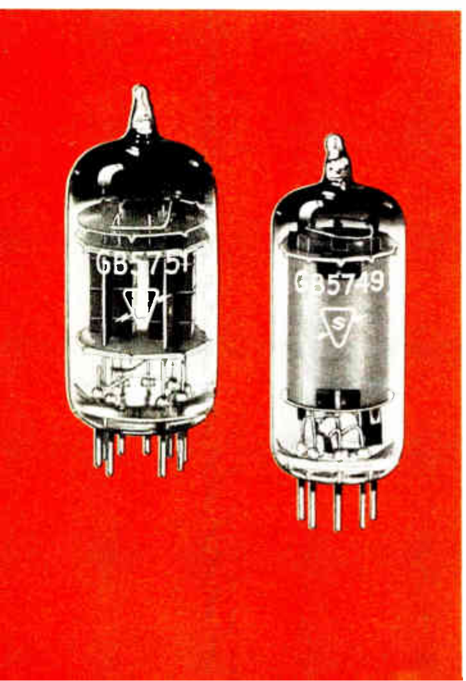
New variables inspection procedure gives a quantitative picture of the reliability of each important characteristic in Gold Brand Tubes

A new measure of reliability is being extended to Sylvania Gold Brand Tubes. Developed by the Sylvania quality control department, it provides the design engineer with a true, measurable profile of the operating dependability of individual tube lots.

The new testing procedure—known as Mixed Variables—Attributes Inspection involves the recording of each characteristic reading, as opposed to ordinary go no-go testing by attributes. If the readings fall within the closely established acceptance limits, the tube passes the new testing procedure, otherwise it is rejected.

The new procedure not only provides Sylvania tube-design engineers with invaluable data for product improvement but allows Sylvania to provide the design engineer with tubes that more exactly fit his application needs.

Sylvania develops new specifications for Gold Brand Industrial and Commercial Types to meet the specialized needs of jet airliners, commercial prop-driven aircraft, executive aircraft, mobile radio, marine radio and industrial control equipment

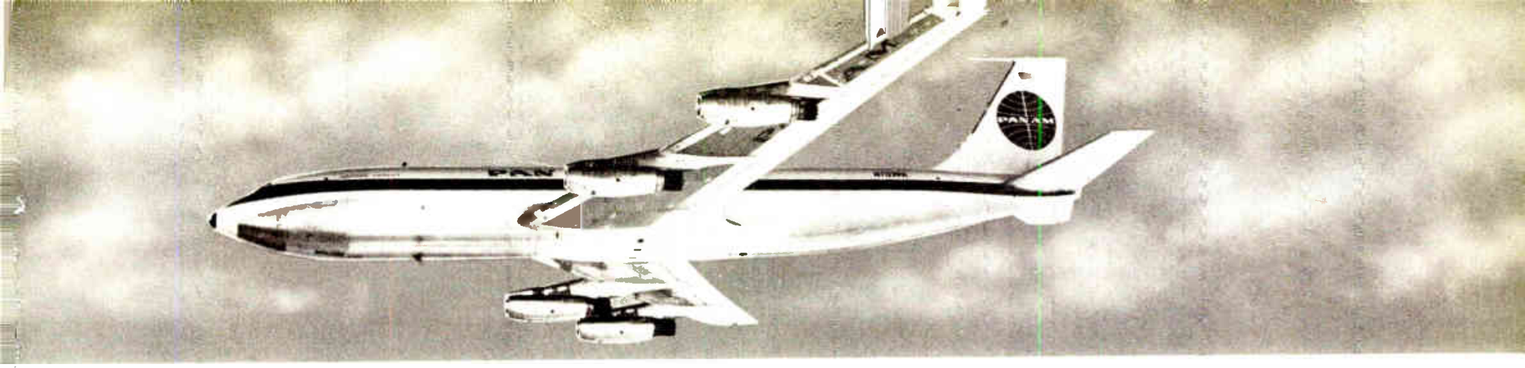


Now designers of electronic equipment for commercial and industrial applications can specify tubes that are tailored to meet their specific requirements. Sylvania has developed a line of 47 commercial industrial Gold Brand types, that are identified with a GB prefix. This is the mark of a Gold Brand tube specifically designed to meet commercial and industrial application requirements. Specialized specifications are already written for more than half of the GB line and eventually all 47 will be covered. These new GB specifications tailor military standards to the individualized requirements of commercial and industrial equipment. In many cases, the GB specifications exceed previously known requirements.

In every case, specification of Gold Brand Types provides the very highest degree of reliability and performance.

For example, type GB5751, a high mu double triode (9 pin miniature) meets a tougher AC Gain Test than the comparable military type. While the military type is tested to a 100 V supply, the supply for GB5751 is only 65 V. This provides extra assurance that the tube will operate effectively with a low voltage supply such as is used in fuel gauge circuits—the GB5751 also meets life test conditions that are more severe than the military.

Another example of a Gold Brand Industrial and Commercial type with specifications that exceed comparable military requirements is type GB5749. This semi-remote cutoff pentode (7-pin miniature) can withstand a 165°C maximum bulb temperature and is tested to lower grid emission minimums. This again is extra assurance the tube will perform reliably under high temperature conditions that may exist in today's high speed industrial and commercial electronic equipment.



Jet Age Choice—Sylvania Gold Brand tubes—Over 27 Sylvania types are in use in Pan American Boeing 707 Jet Airliners

BRAND standard

Sylvania Gold Brand Industrial and Commercial tubes have become one of the fastest growing tube lines in the electronics industry. Today every major airline uses Sylvania Gold Brand tubes. And in the new jet airliners, where the demand for top performance and reliability is more than ever a critical necessity, Sylvania Gold Brand types are becoming the leading choice. On Pan American's Boeing Jet 707 Airliners over 27 Sylvania types are in daily use.

Here are some of the tests that every Gold Brand tube must pass: Multiple Life Tests ranging from 500 to 1000 hours, Impact Shock Tests of up to 500 G, Fatigue Tests of 96 hours at 2.5 G, Vibration Tests, Glass Strain Tests, Variable Control Tests and Special Interface Control Tests are underway. And Gold Brand tubes must meet stringent electrical test requirements. Shorts and continuity are controlled to a 0.4% AQL and major electrical characteristics are controlled to a 0.65% AQL.

GOLD BRAND Guided Missile Types— Reliability in the Atomic Age

The electronic equipment in today's missiles, drones and aircraft must have the capability to withstand some degree of nuclear radiation if it is to meet realistic military operational requirements. Preliminary tests have already indicated Sylvania Gold Brand Guided Missile tubes have an immunity to radiation that solid-state devices tested do not exhibit.

The reliability of Sylvania's Gold Brand Guided Missile Line is outstanding because of the way it is manufactured and tested. The entire line undergoes Sylvania's exclusive White Noise Test which subjects each type to a vibrational spectrum covering the frequency band of 100 to 5,000 cps. The rms G-level is 2-3 G's per octave with peak G-level of 15 G's. The tubes are also tested for rms and peak vibrational output and limits are established on each.

SYLVANIA GOLD BRAND
Reliable Commercial and Industrial Types

Type	Description	Use
GB-OA2WA	Cold cathode diode	Voltage regulator
GB-OB2WA	Cold cathode diode	Voltage regulator
GB-5Y3WGTA	Double diode	Rectifier
GB-6AU6WB	Sharp cutoff pentode	Amplifier
GB-6J4WA	Hi mu triode	Grounded grid amplifier
GB-6SJ7WGT	Sharp cutoff pentode	Amplifier
GB-6SL7WGT	Hi mu double triode	Amplifier
GB-6SN7WGT	Medium mu double triode	Amplifier
GB-6X4WA	Double diode	Rectifier
GB-6X5WGT	Double diode	Rectifier
GB-7AK7	Dual control pentode	Computer
GB-7F8W	High mu double triode	Amplifier
GB-28D7W	Double beam pentode	Power amplifier
GB-407A	Medium mu double triode	Amplifier
GB-408A	Sharp cutoff pentode	Amplifier
GB-1216	Medium mu double triode	Computer
GB-1217	Dual control pentode	Computer
GB-5654	Sharp cutoff pentode	Amplifier
GB-5670	Medium mu double triode	Amplifier
GB-5725	Dual control pentode	Gated amplifier, converter
GB-5726	Double diode	Detector
GB-5727	Tetrode thyratron	Relay, grid controlled rectifier
GB-5749	Semi-remote cutoff pentode	Amplifier
GB-5750	Dual control heptode	Gated amplifier converter
GB-5751	High mu double triode	Amplifier
GB-5814A	Medium mu double triode	Amplifier
GB-5930	Low mu triode	Power amplifier
GB-5931	Double diode	Rectifier
GB-5932	Beam pentode	Power amplifier
GB-5933	Beam pentode	Power amplifier
GB-5963	Medium mu double triode	Computer
GB-5964	Medium mu double triode	Computer
GB-5965	Medium mu double triode	Computer
GB-6005	Beam Pentode	Power amplifier
GB-6101	Medium mu double triode	Oscillator-amplifier
GB-6135	Medium mu triode	Oscillator-amplifier
GB-6145	Dual control pentode	Computer
GB-6186	Sharp cutoff pentode	Amplifier
GB-6189	Medium mu double triode	Oscillator-amplifier
GB-6201	High mu double triode	Amplifier
GB-6211	Medium mu double triode	Computer
GB-6350	Medium mu double triode	Computer
GB-6814	Triode	Computer
GB-6888 (MT)	Dual control pentode	Computer
GB-7044	Medium mu double triode	Computer
GB-7137	Medium mu triode	Grounded grid amplifier
GB-7327	Medium mu double triode	Pulse Applications

The Sylvania Gold Brand Guided Missile Line

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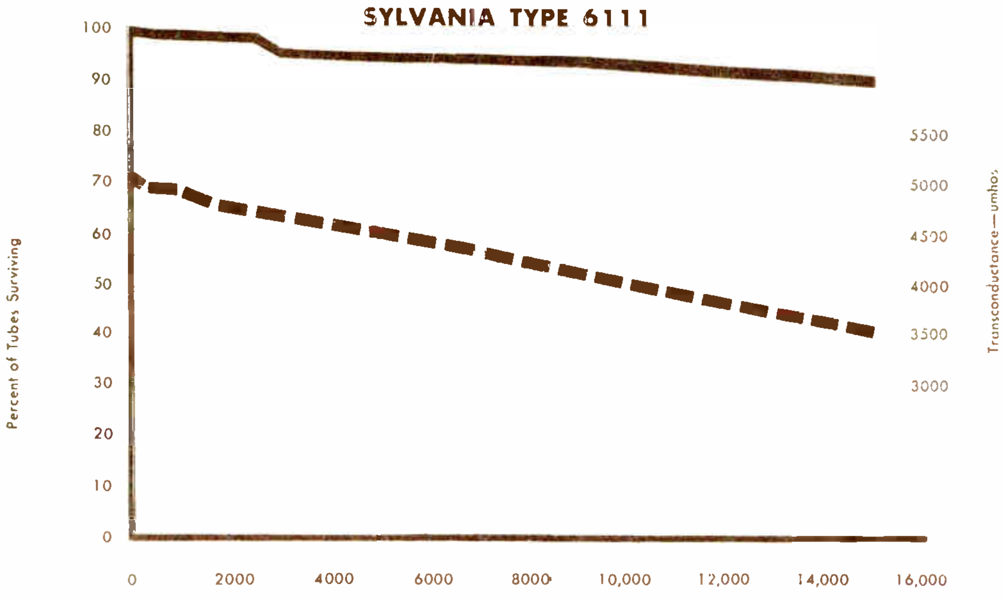


New test results show the outstanding capability of premium Gold Brand subminiature tubes

SYLVANIA TYPE 6111

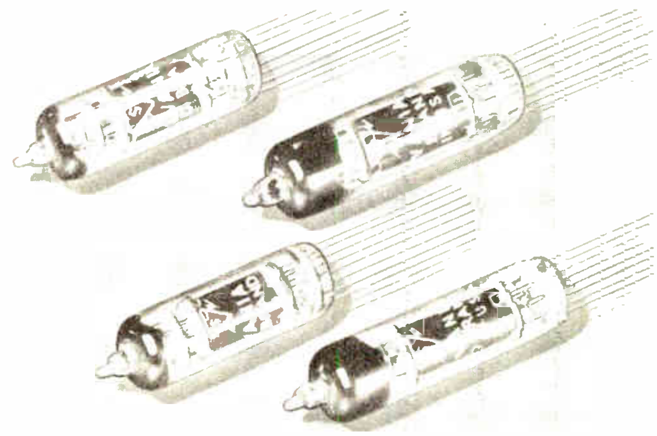
Observed Survival Curve For Inoperatives Thru 15,000 Hours

Median For Transconductance Thru 15,000 Hours

GOLD BRAND Subminiatures—Reliability Plus

Life tests on Gold Brand premium subminiature tubes set new records of reliability

Unprecedented testimonial to the reliability of Sylvania Gold Brand Subminiatures is indicated by the results of new life tests on the tubes. They exhibit a mean time between inoperative failure of 133,000 hours. Life tests conducted for 15,000 hours on twenty lots of tubes show an average decline in Gm of only 2.4% per 1,000 hours. Inoperatives in these life tests exhibited a failure rate of 0.66% per 1,000 hours during the first 3,000 hours of operation and 0.75% per 1,000 hours during the following 12,000 hours.



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- New Industrial & Military CRT's:
- ☐ Type SC2782
- ☐ Type 3ASP1
- ☐ Gold Brand Industrial and Commercial Types
- ☐ Gold Brand Guided Missile Types
- ☐ Gold Brand Premium Subminiatures

Name____________________

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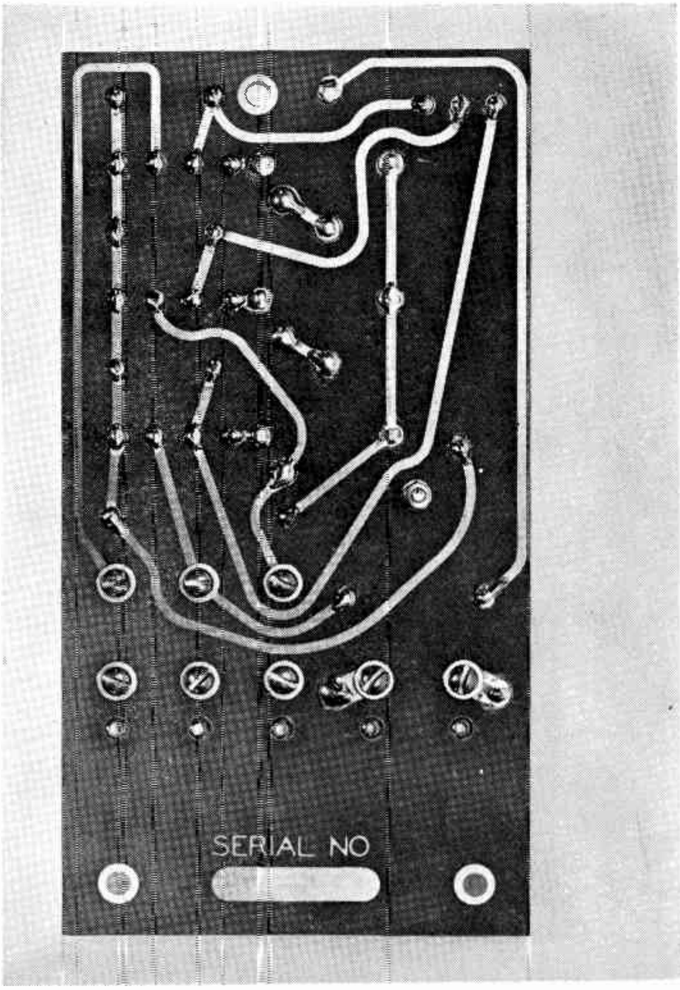
Use this handy business reply card to request additional information on these important new Sylvania developments



High strength-to-weight ratio. This printed-wiring board for a phase-failure relay was designed with CDF Di-Clad 28E (epoxy resin laminated with medium-weave glass cloth) for high mechanical strength, very low moisture-absorption, and good insulation resistance. Details upon request.

How CDF Di-Clad® can solve your printed-circuit problems

The CDF line of copper-clad laminates in all grades is now known by a new name—Di-Clad. Di-Clad grades meet the varying needs of design, production, and operation of electronic equipment. Grades other than those described are also available.

Di-Clad 2350. An economy paper-base phenolic grade having good tensile, flexural, compressive, and impact strength. Adequate for most non-critical printed circuit applications. Can be cold punched and sheared up to 5/64 of an inch in thickness.

Di-Clad 112T. A Teflon* glass-fabric laminate offering the best dielectric properties over a wide temperature and frequency range.

Send us your requirements and let our engineers help you select the right grade for your application.

*Du Pont trademark for its tetrafluoroethylene resin.

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TYPICAL Di-Clad PROPERTY VALUES

	Di-Clad 2350	Di-Clad 26 (NEMA XXXP)	Di-Clad 28 (NEMA XXXP)	Di-Clad 28E (NEMA G-10)	Di-Clad 112T Teflon*
BOND STRENGTH—0.0014" foil (lbs. reqd. to separate 1" width of foil from laminate)	6 to 10	6 to 10	6 to 10	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (Deg. C.)	120	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil for 1/16" thickness)	800	900	850	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90% RH (ASTM D257, Fig. 3)	500	150,000	600,000	100,000	75,000
DIELECTRIC CONSTANT 10^6 Cycles	4.5	4.0	3.6	4.9	2.6
DISSIPATION FACTOR 10^6 Cycles	0.040	0.026	0.027	0.019	0.0015
ARC-RESISTANCE (Seconds)	5	10	10	130	180
TENSILE STRENGTH (psi.)	18,000	16,000	12,000	48,000	23,000
FLEXURAL STRENGTH (psi.)	27,000	21,000	18,000	70,000	13,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.80	0.45	0.42	12.0	6.0
COMPRESSIVE STRENGTH flatwise (psi.)	32,000	28,000	25,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Paper	Paper	Paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural	Natural greenish	Natural	Natural	Natural

All these standard grades are available with 0.0014" and 0.0028" or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*Du Pont Trademark


PROJECTION CONSOLE
TWO OR THREE DIMENSIONAL SELF-CONTAINED PLOTTER
TWO OR THREE DIMENSIONAL SELF-CONTAINED PLOTTER
TRACING BOARD
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TWO DIMENSIONAL SELF-CONTAINED PLOTTER

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Radically new, Iconorama is able to record two dimensions in a multiplicity of continuous moving targets and trajectory patterns. When required, it is also able to show these movements in true three-dimensional perspective. The system will receive data from any simple or sophisticated communication link and the same data can be simultaneously displayed on any number of remotely located plotters.

In an age of supersonic aircraft, guided missiles and thermonuclear weapons, Iconorama is of incalculable importance to air defense. It allows information to be plotted virtually instantly, giving command an animated, visual picture of what's happening as it happens. Armed with this extremely accurate plot of every detail of enemy movement . . plus the presence of and relationship of friendly aircraft . . retaliatory action can be instant and accurate. Iconorama, designed and developed by Fenske, Fedrick & Miller, Inc., subsidiary of Temco, is now in military and civilian use.

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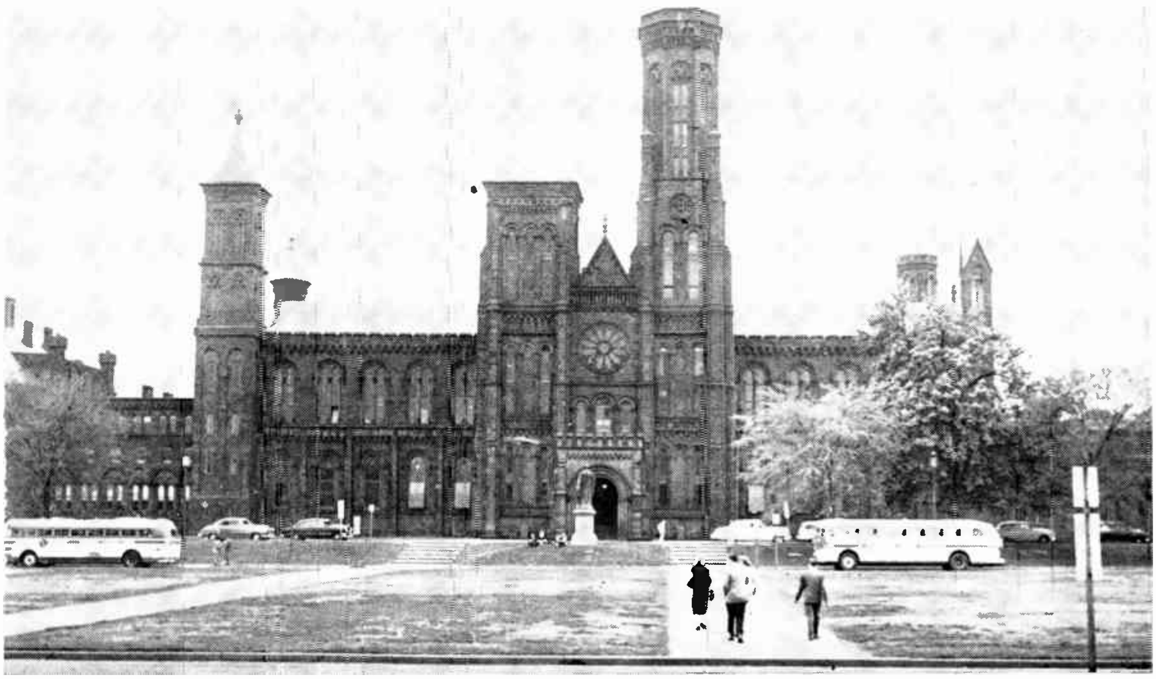

Smithsonian Institute is one of many federal science agencies that may see operational changes when Congress answers . . .

New Look for Federal R&D?

Plans under study by the U. S. Senate aim to establish a cabinet post for science and technology. Industry is quietly watching while Washington bets federal agencies will fight the proposal

WORD FROM WASHINGTON this week is that the Senate is about to set up a Hoover-type commission to investigate the establishment of a Department of Science and Technology with full cabinet status.

Pro's and con's on establishing such a department have been surging back and forth for more than two years. Those in favor have rallied to the Senate Committee on Government operations headed by Senator McClellan (D., Ark.).

W. L. Reynolds, staff director of the Senate committee handling the project, tells ELECTRONICS the Senate is sure to give its approval.

Pressure Expected

Once the Senate gives the go-ahead for the investigating commission, the bill concerning it will go to the House of Representatives, where it is reportedly looked upon with favor by floor leader John W. McCormack (D., Mass.).

No estimate has been made of how quickly the House of Representatives will act on the bill, but one Washington observer says the House could pass the bill before this session of Congress adjourns.

It's likely that once the investigating commission has been established and has turned in its report, pressure to create a department of Science and Technology will be extremely strong in Congress. Present plans are sure to meet with opposition because planners see the new department as assimilating a number of scientific groups now under control of other agencies. It is no secret the organizations will fight to keep their scientists.

Among major groups that would be affected are the Atomic Energy Commission, National Science Foundation, Central Intelligence Agency and the National Bureau of Standards. Certain civilian groups now under the Department of Defense might also be drawn into the new department.

In addition to these, it is likely the Department of Science and Technology would also absorb sections of the Smithsonian Institute and some thirty additional groups, including the National Aeronautics and Space Administration, Office of Technical Services, National Academy of Science and the Patent Office. It is likely the new department would also embrace the Coast and Geodetic Survey, Weather Bureau and Federal Aviation Agency.

Congress vs White House

Congressional planners mainly base their support for the new Department on the contention that the present federal science policy is scattered and wasteful. But they also have other reasons.

It is a frequently expressed opinion in the Senate that the executive branch has monopolized scientists by establishing presidential advisory groups responsible only to the White House. A group serving the Executive directly is not subject to Congressional confirmation or supervision.

Congressmen feel that greater knowledge of scientific activity on the federal level must be "within the reach of the people through their elected representatives."

Establishing a Department of Science and Technology would mean Congress would have a voice in the appointment of the department's secretary, control purse strings of the department itself and investigate its workings when congressional opinion so dictated.

The same bill that provides for establishment of the department also calls for setting up permanent committees in Congress on basic and applied science, astronautics and atomic energy. Some permanent committees of this nature now exist, but in some cases they are joint committees of senators and representatives. New plans call for separate groups in each house of Congress.

Industry Undecided

Some persons in Washington feel that establishing a central command for scientific activity would be a definite benefit to industry in the areas of making R&D decisions and letting contracts.

Bell Laboratories' director of research, W. O. Baker, told the Senate committee he feels it would be of great benefit to have a central system for the collection and dissemination of scientific and technical information. But he did not offer any views that might be taken as a flat endorsement of the proposed department. A Bell official told ELECTRONICS an unqualified yes or no answer at this time would be premature. This seems to be the general view in our industry.

IBM's director of research, E. R. Piore, in a letter to the committee, said the need was obvious for "an appropriate number of knowledgeable and wise specialists or experts in the formulation of national policy," but said there was no assurance that such persons would be utilized properly at the federal level.

D. C. Hilty, Union Carbide's manager of research, gave the committee an example of how centralized research might have speeded the development of tantalum capacitors by allowing researchers to learn the latest refining developments more rapidly.

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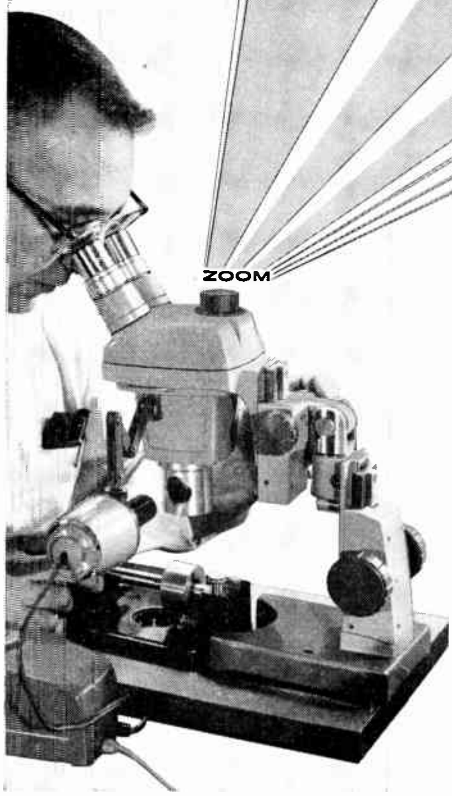

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RVG-14-MT10 Multi-Turn ⅞" diam.
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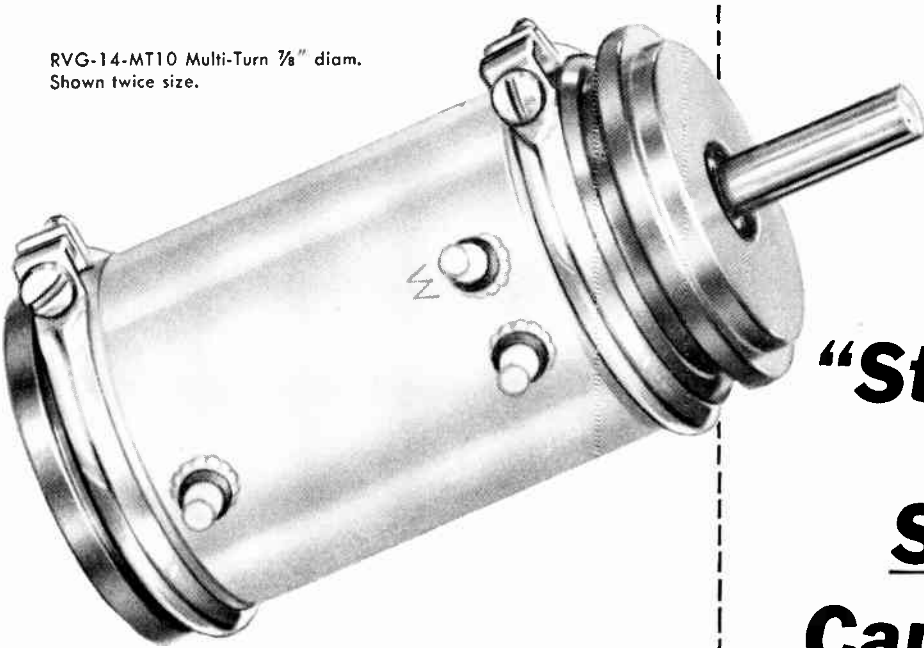

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- Anodized Aluminum Housing for Stability
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- Linearity (Independent) up to ±0.05%
- Close Concentricity between Coil and Wiper
- Wiper Pigtailed to Terminal to Eliminate Sliding Contact
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- Operation Up to 150°C
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- Wiper Pigtailed to Terminal to Eliminate Sliding Contact
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A glance at the performance characteristics of this new Gamewell precision potentiometer tells the story! It fully meets applicable MIL specs — and much more. In addition, it gives you important *extras* that permit you to do *more* with a *standard potentiometer*. In many cases you can save the cost of a "special."

Of course, Gamewell supplies special pots — both linear and non-linear whenever necessary. Extensive facilities for their design, development, and production are constantly at your disposal.

Meet the challenge of shrinking component space . . . tougher environmental demands . . . tighter limits of precision . . . *economically* with Gamewell Precision Potentiometers. Bring your pot problems to THE GAMEWELL COMPANY, Dept. 13B, Newton Upper Falls 64, Massachusetts.

Gamewell

PRECISION POTENTIOMETERS

"Integrals of High Performance"

Controlling Nuclear Cargo Ship

First nuclear merchant ship *Savannah* slid down ways this week. Her spanking-new electronic gear points up our industry's growing role in nucleonics

LYNCHBURG, VA.—Mobile and fixed nuclear power plants are getting smaller and more reliable all the time. As they do, the interplay between the twin technologies of electronics and nucleonics is increasing.

That's the word from the big Babcock & Wilcox research and production facility here in the Virginia hills. This is where B&W designed and built the pressurized-water reactor for the *NS Savannah*, christened last Tuesday by Mrs. Eisenhower at launching ceremonies in Camden, N. J. The *Savannah's* power plant differs from other shipboard reactors in several important ways, and highlights the progress that has been made in controlled and instrumented nuclear power.

***Savannah* was built by New York Shipbuilding Corp., Camden, N. J.**

Reflecting Compass

The *Savannah* is a sheltered-deck vessel of advanced design, 595 ft overall length and 78 ft abeam, drawing 29 ft 6 in. and displacing 22,000 tons. She will carry 60 passengers, 10,000 tons of cargo and a 109-man crew.

She will be outfitted with the latest kinds of navigation and communications gear. Her reflecting magnetic compass is the first of its type to be manufactured in this country. She will be equipped with anti-roll stabilizers, true-motion radar, and enough test, recording and monitoring gear to outfit a fair-sized laboratory.

The ship's uranium-oxide fuel has a sharply variable index of neutron absorption. As the core heat rises, the size of the mass required to sustain a chain reaction also goes up. Consequently the *Savannah* reactor must be driven; the automatic controls that drive it are one of the unique features of the new-launched vessel's power plant.

Automatic Controls

The 21 control rods of the reactor provide for both manual and automatic control of the pile to cover a wide range of steady-state and transient loads. Principal aim is to keep the temperature of the primary-loop water constant at 508 F. (The primary-loop water goes from the core to a heat exchanger, where it transfers its heat to a secondary water system, making steam which drives the turbines.)

Automatic system computes the difference between power demand and reactor power level, uses the difference signal to position the servo-controlled rods until power stabilizes to meet load. Any time the reactor is operating at 15 percent or more of full power, the automatic control is used.

Steam flow signal and the average temperature of the primary water are combined for computation of reactor demand. Actual reactor power level is delivered by standard nuclear instrumentation. The difference signal is integrated to provide a rod position demand signal, which is then compared against actual rod position. The position error signal, amplified, provides power to drive the motor which moves the rods.

A deadband circuit prevents the rods from responding to random or small transient fluctuations.

The electromechanical rod-drive system is counterbalanced by a hydraulic scram control. If the positive drive force on the rods is removed (due, for example, to power failure in the electromechanical system) the hydraulic scram control stops the reactor by ramming the rods home. Scram time is under 100 milliseconds.

Westinghouse type FN nuclear reactor startup and power control equipment, a standard system originally developed for submarine use, is used in the Savannah as nuclear instrumentation.

2 OUTSTANDING HIGH-TEMPERATURE MAGNET WIRES

Tetroc

FOR CONTINUOUS OPERATION AT HOTTEST SPOT TEMPERATURES UP TO 200°C

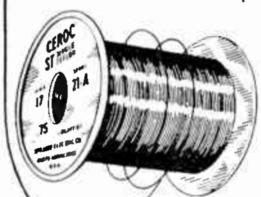
Ceroc

FOR CONTINUOUS OPERATION AT HOTTEST SPOT TEMPERATURES UP TO 250°C

For continuous operation at hottest spot temperatures up to 200°C (392°F) and up to 250°C (482°F) for short periods of time—depend upon TETROC—an all Teflon-insulated wire available in both single and heavy coatings.

CEROC is Sprague's recommendation for continuous operation at hottest spot temperatures up to 250°C (482°F) and up to 300°C (572°F) for short periods of time. Ceroc has a flexible ceramic base insulation with either single silicone or single or heavy Teflon overlays. The ceramic base stops "cut-through" sometimes found in windings of all-fluorocarbon wire. Both Tetroc and Ceroc magnet wires provide extremely high space factors.

Write for Engineering Bulletins 405 (Tetroc Wires) and 400A (Ceroc Wires).



SPRAGUE ELECTRIC COMPANY
35 Marshall Street, North Adams, Mass.

SPRAGUE®
THE MARK OF RELIABILITY

Simulation of radar jamming signals by Sylvania's anti-countermeasures trainer was demonstrated at Washington meeting

Space Devices Hold Spotlight

National Convention on Military Electronics stresses instrumentation, guidance, tracking

WASHINGTON—Space electronics was the major theme of the 1959 National Convention on Military Electronics held here recently. Instrumentation, guidance, tracking and navigation were branches of the new technology that received most attention. The large number of papers on systems pointed up engineers' increasing involvement with systems of ever-increasing complexity. Papers on optical and infrared systems showed the continuing trend to expand man's use of the electromagnetic spectrum.

Guidance

In guidance, a lightweight, 3-axis, attitude-control system for the second stage of Able missiles was described by King and Low of Space Technology Laboratories. Each of three gyros is made sensitive to attitude changes in either the pitch, roll or yaw axis. Electronic circuits receive the gyro signals and drive servo valves and jet solenoids to control the missile's attitudes. A receiver picks up signals and commands a converter. The converted signals drive gyro torque generators, thus commanding desired changes of attitude. Control equipment weighs only 30 lb, compared to 120 lb for similar equipment in earlier Able missiles.

Ways of using standard gyros, accelerometers, servoed gimbals and integrators to design simple guidance references were discussed by Hoel and Nelson of Minneapolis-Honeywell. These designs bridge the gap between conventional gyro systems and inertial platform systems. One such system design described supplies heading, elevation and roll attitudes and velocity and distance information. Only two conventional gyros, one three-gimbal servoed unit, accelerometers and integrators are used in the system.

Doppler Systems

Alan Bloch of General Precision Laboratory showed advantages of a combined Doppler-inertial guidance system over a purely-inertial guidance system. In the combined system, the Doppler-measured velocity vector is compared to the inertial velocity vector. The resultant signal varies with the errors in a circuit loop that controls one of the attitudes of a space vehicle. Advantages of a Doppler-inertial system: settling times of its loops are considerably shorter; it requires no initial inputs except to compute longitude.

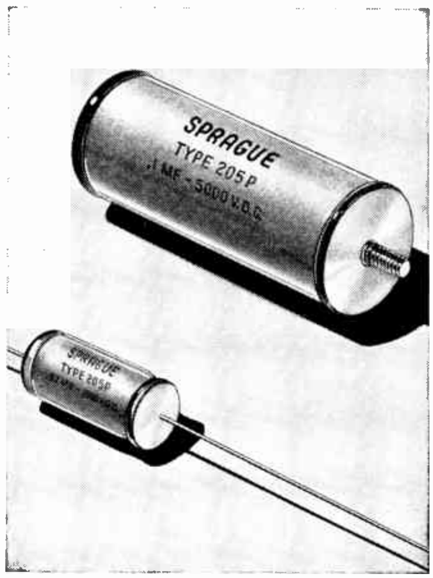
Three general types of Doppler velocity-measuring techniques for space-vehicle guidance and navigation were discussed by Campbell of General Precision Laboratory. These categories are called cooperative, active and passive. One way for the vehicle to use the cooperative technique is to receive radiation from a station. To use the active technique, the vehicle would transmit radiation to an object such as the moon and pick up the back scatter. Using a passive Doppler system, the vehicle would use a natural source of radiation such as interstellar hydrogen gas; a hydrogen energy-level transistion produces radiation at about 1,420 mc.

Optical Techniques

In data processing, University of Michigan scientists Cutrona, Leith and Porcello showed how optical techniques can be used to advantage. They pointed out time is the only available independent variable in performing an all-electronic integration. In an optical system which interposes a filter between a light source and a lens, the intensity of light out of the filter is a function of two independent variables. These variables are the x and y coordinates which define the plane of the filter. A detector, such as a photocell or photographic film, performs the integration. One feature of optical data processing is the large storage capacity of film, they said.

In simulation, the pragmatoscope, a system proposed by Helvey of the University of Kansas, blends the decision-making ability of a highly-trained military commander with the data-processing capabilities of a computer. This human-engineered system swiftly decides military problems despite the huge influx of information that stems from a complex, fast-changing situation. Key component is the display, which presents condensed and pertinent data in a graphical form that can be quickly understood.

High Voltage, Glass-Encased Capacitors For Airborne Applications



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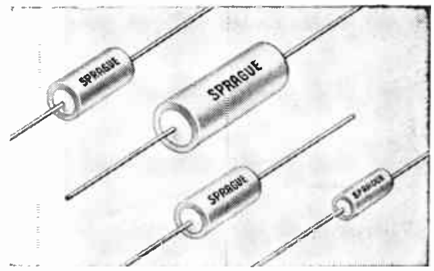

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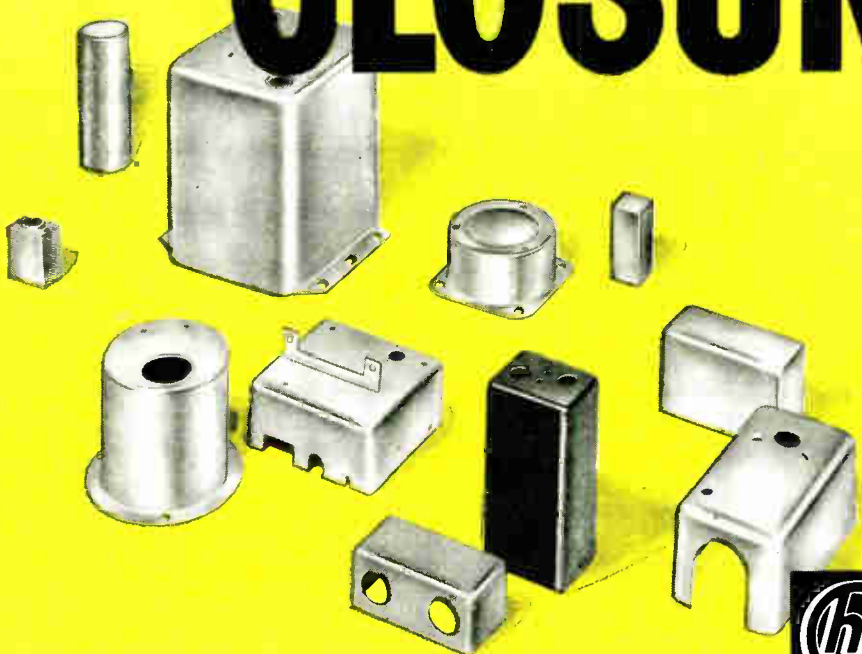

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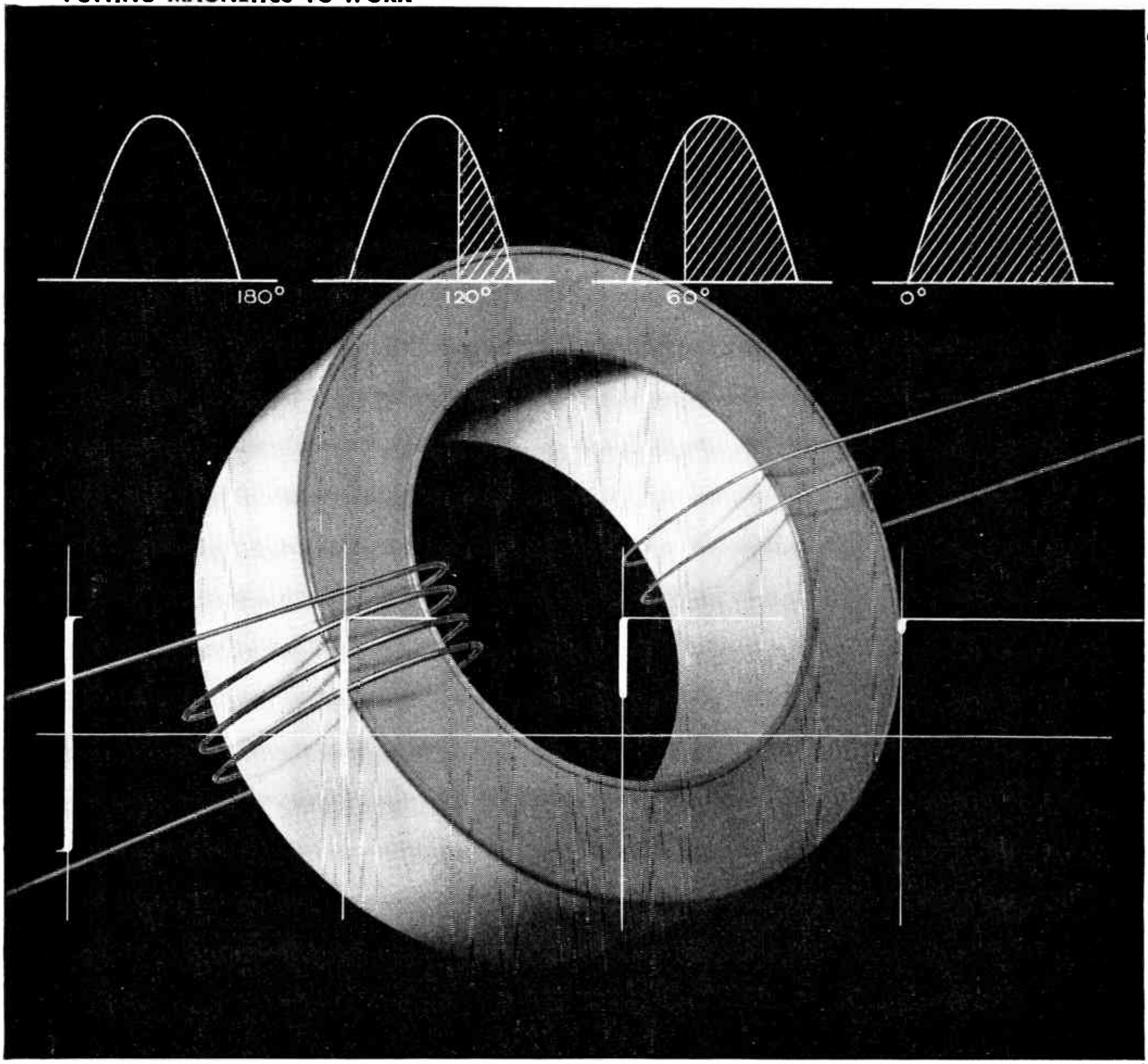

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Shooting stars with scope at Sperry's Ashore Polaris Navigation Center, technicians run check on operation of new stabilized periscope

New Center Tests Sub Controls

Shore facility completely evaluates all navigation gear for Polaris-launching submarines

ALL POLARIS submarine navigation control units are now being tested in relation to each other before they go to sea.

This is being done in Sperry's new "Navigation Island" laboratory at Syosset, L. I.

Officially opened a few days ago, the center is an exact replica of the sub's navigational control room. Sperry will run the tests for a three-year period. First year's contract amounts to $1.57 million.

List of Devices

Navigational devices to be evaluated include:

Sperry's NAVDAC (Navigation Data Assimilation Center). NAVDAC is fed information from a wide variety of navigational techniques and instruments. Through digital techniques it collates, analyzes, decodes and displays information, simultaneously showing the most accurate position and direction figures fed into it.

Sperry's Navigation Command Console displays all the information from the navigation system. It can also be used to direct a specific operation by any one or all of the various instruments.

Pickard & Burns' DRACO is a long range navigation system using special radio aids.

Detroit Controls and Kollmorgan Type 11 periscope provides for celestial navigation while the sub is submerged. This includes the STAR DAC which is essentially a computer that compensates for the sub's motion.

North American's SINS (Ship's Inertial Navigation System) is an intricate arrangement of gyroscopes, accelerometers and integrators. It constitutes a "stable table" and continuously records the smallest motion of the sub.

Duplicates 500 Cables

The center will duplicate approximately 500 of the cables found in the Polaris sub's navigation center.

Equipment not yet in the Navigation Island are Collins' radiometric sextant, a photoelectric sextant, depth finders and special sonar.

Complete navigation center for a Polaris-launching nuclear sub will cost between $6 million and $7 million.

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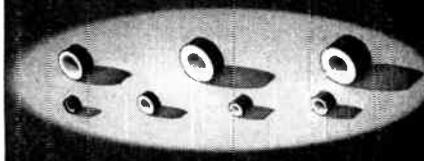

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MEETINGS AHEAD

July 30-31: Computers & Data Processing, Denver Research Inst., Stanley Hotel, Estes Park, Colo.

Aug. 4-5: American Astronautical Society, Western National Meeting, Ambassador Hotel, Los Angeles.

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

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

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

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

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

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

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

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

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

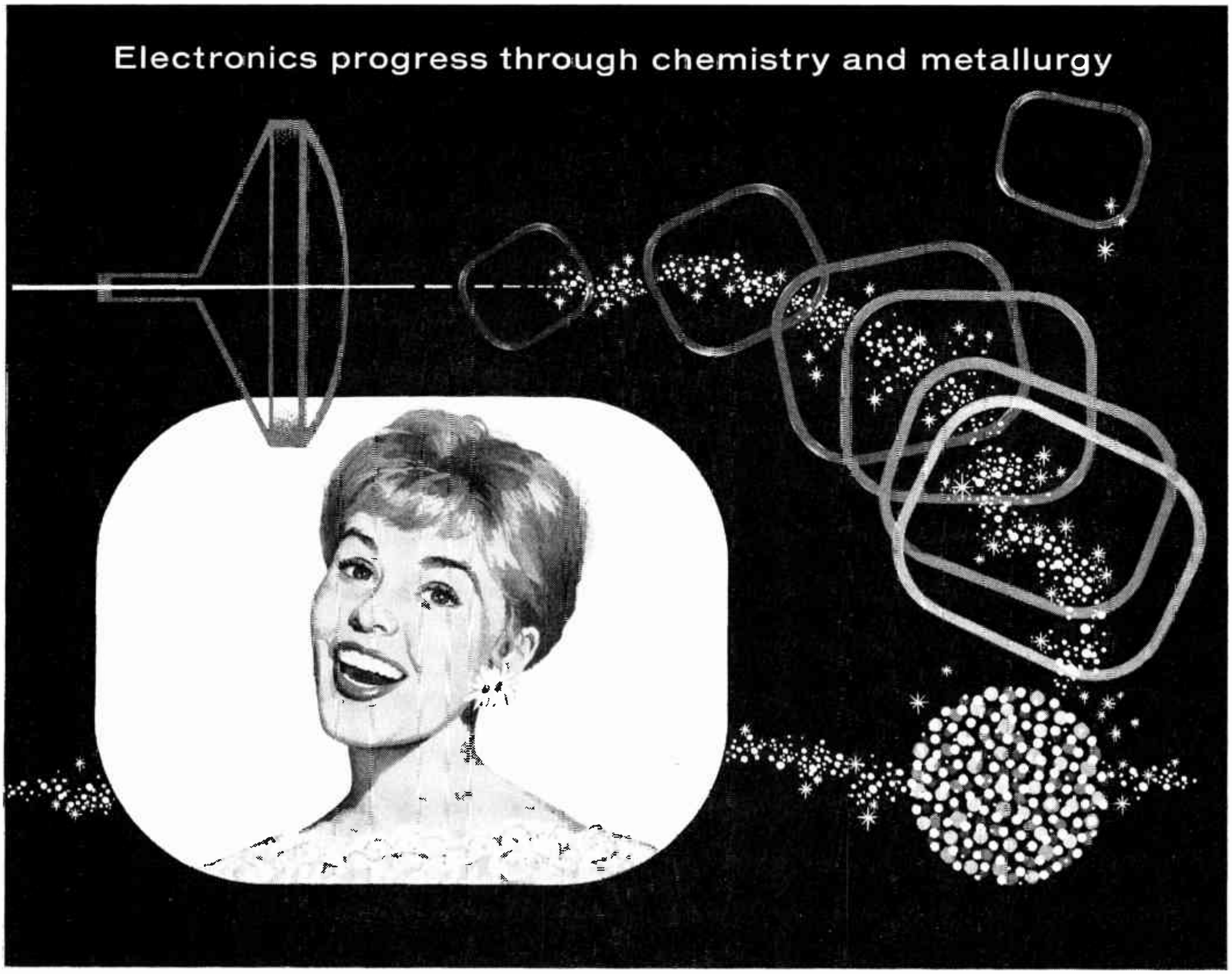
Sept. 17-18: Engineering Writing and Speech, Dual National Symposium, PGEWS of IRE, Sheraton-Plaza Hotel, Boston; Ambassador Hotel, Los Angeles.

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

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

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

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 72.



How Sylvania Phosphors put brighter pictures on TV

The increased brightness and clarity of today's TV pictures over those of just a few years ago have been due in large part to progressive improvements made in the TV screen itself—its phosphor coating.

Sylvania, through its Chemical and Metallurgical Division, has played a leading role in this improvement. Engineers and scientists of the division have developed new cathode-ray tube phosphors with superior brightness, color and stability. They have engineered the industry's only integrated screening systems of complementary phosphors and settling solution chemicals to insure maximum screen adherence, strength, and brightness maintenance.

As a result, Sylvania phosphors are not only brighter initially but stay brighter longer. In recent competitive tests, a Sylvania phosphor maintained at least 93% of its initial brightness after 1,500 hours under electron bombardment, a record unattained by any other commercial picture tube phosphor tested.

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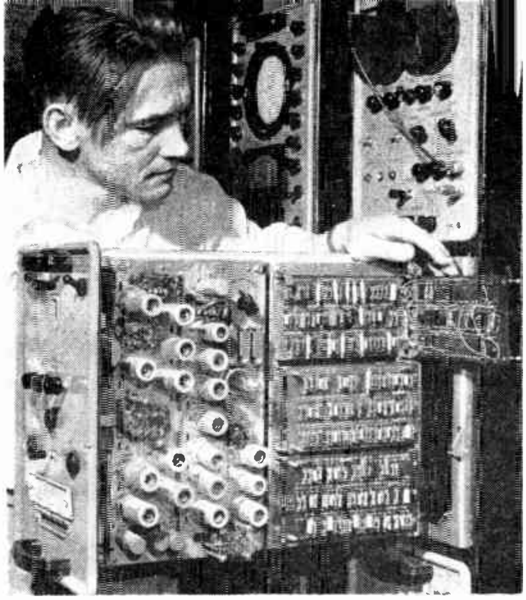


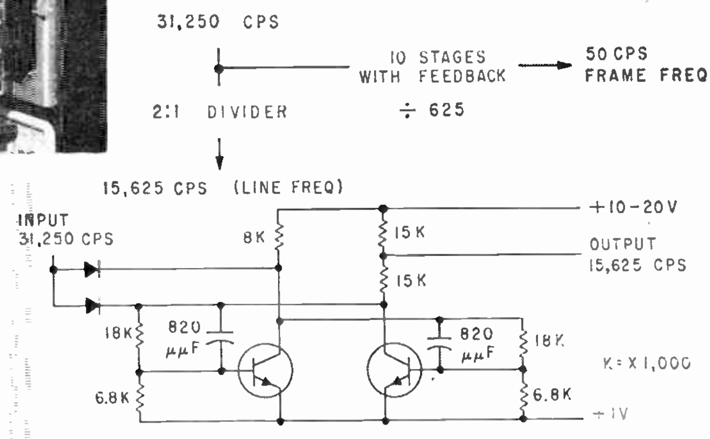


FIG. 1—Timing circuit of tv sync generator, at right in photo. Note swing-out terminal boards with transistors on underside. Timer uses ten binary flip-flop stages with feedback to divide double line frequency by 625. One stage is shown at bottom of drawing

Soviet Equipment Design

Industrial and consumer units now on display in New York illustrate concern for reliability, ease of maintenance. Use of transistors is widespread. Printed circuits are just getting started

By **JOHN M. CARROLL,** Managing Editor

THE SOVIET EXPOSITION of science, technology and culture that opened June 30 in New York's Coliseum affords a unique opportunity to study Russian electronic equipment and components at close range and to talk with engineers.

Home entertainment, industrial, communications, medical, and test equipment is on display. The equipment shows a dedication on the part of designers to ease of maintenance and reliability.

Physically, much of the equipment could probably meet all applicable JAN-MIL specifications. Fittings, connectors and hardware all look familiar. Components are usually mounted on terminal boards and wires are cabled.

Modular design is much in evidence. Transistor circuits are used widely, often in units that also use electron tubes. Less use seems to be made of printed circuits than in this country. As a consequence, transistorized equipment does not afford as much in miniaturization. Engineers explain that transistors are used primarily to save power, not space and weight. Much equipment will be used in Siberia where adequate power is not available.

Few new circuit ideas are in evidence. In fact, the Russian engineer appears to overdesign—to use, for example, four stages where one stage with more sophisticated circuitry might suffice. This may be one effect of no economic competition in a controlled economy. Or, it may be done to increase reliability and simplify maintenance. Soviet equipment for industrial use is notably rugged.

In electron-device work, especially traveling-wave tubes and transistors, substantial progress has been made. But nothing was shown resembling integrated

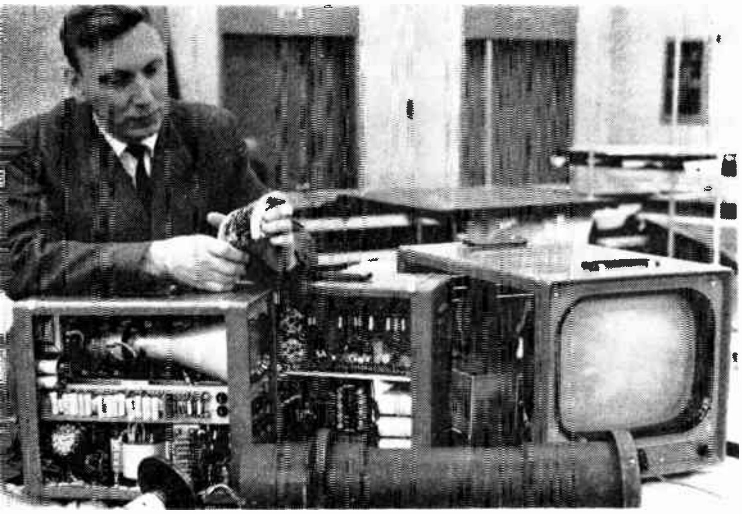


FIG. 2—Underwater television system uses sinusoidal sweeps. Preamplifier, held by engineer, fits into image-orthicon package

or semiconductor solid circuits.

Development seems directed at pushing up transistor frequency response and/or power capabilities. Several interesting twt designs were shown.

As to components: transistor cases, tubes and capacitors bear at least a superficial resemblance to U. S. components. The resistors seen have end caps and are made of carbon film on a ceramic substrate —much like German units.

Questions on masers, quantum mechanical amplifiers, infrared, electroluminescent display devices and new high-speed digital computers elicited the answer "No official data", indicating that in USSR as here these devices are used in military applications.

TELEVISION — This week's ELECTRONICS cover shows Russian equipment for a small-city television station. There are currently 65 stations in the USSR. Twelve channels are provided. Moscow has three. One is set aside for color. The Soviets have their own version of our NTSC standards. Three camera types are used: image orthicon, vidicon and the image iconoscope, as elsewhere in Europe too. Both one and two-inch vidicons are used. Vidicons with sensitivity of less than one foot-candle are available.

Figure 1 shows a sync generator for a tv broadcast transmitter. The output stages use electron tubes. The timer, shown in the block diagram of Fig. 1, uses transistors. They are wired to the underside of a swing-out terminal board. The timer makes use of binary pulse counters with feedback. Input is 31,250 cps, twice line scanning frequency. It is divided by two to obtain line frequency, divided by 625 to obtain 50-cps frame scan. The 625 divider consists of 10 binary stages with feedback. One binary stage with diode input to both flip-flop bases is shown in Fig. 1, bottom.

Industrial tv is highly developed in the Soviet Union. Its scanning standards are 625-lines, 50 frames, same as for broadcast use. Systems provide up to 24 cameras and, usually, one monitor. Cameras use 1-inch vidicons. Cameras are equipped with remote servo-operated pan, tilt, focus and diaphragm controls. Medical closed-circuit tv uses field-sequential color, as in the U. S.

Underwater television is also highly developed. The component packing in the camera preamplifier held by the engineer in Fig. 2 greatly exceeds that of most Soviet equipment. The preamplifier is inserted in the underwater image orthicon case, foreground. Also shown are the sweep circuits and camera monitor, power supply and output monitor. The system makes use of sinusoidal vertical and horizontal sweep waveforms with required brightness control. This permits longer cable runs for observations at great depths.

TV RECEIVERS—Russian tv receivers use 14, 17 or 21-inch rectangular picture tubes. Tubes use 110-degree deflection. One basic chassis is used for several models of home receivers. Sets can receive 12 Soviet tv channels, also f-m and a-m. Monochrome receivers have aperture correction, as do many other European sets. Figure 3 shows use of separate chassis in a typical tv home receiver. Printed circuits are used in the i-f amplifiers.

A transistorized tv receiver has been developed. It uses 30 transistors. Screen diameter is 10 inches. The set requires 13 watts, supplied by a 12-volt battery. The set weighs 30 pounds. The tv receiver uses a 60-watt germanium power transistor as a horizontal sweep amplifier. The r-f amplifier uses a high-frequency transistor with a 120-mc alpha cutoff frequency. Grounded-base amplifiers are used in the i-f section. The set picks up the three lowest Soviet tv channels: 49-80 mc.

HOME RADIO—Most home radios receive long, medium, shortwave and f-m. The higher-priced electron-tube set has 12 tubes, is equipped for remote control, use separate high and low-range loudspeakers.

A medium-priced radio chassis is shown in Fig. 4. Printed circuits are used.

Radio portables, shown in Fig. 5, use transistors. The model in the foreground, trademarked "Sputnik",

FIG. 5—Portable radios use transistors. Unit in foreground is powered by solar battery on top of case

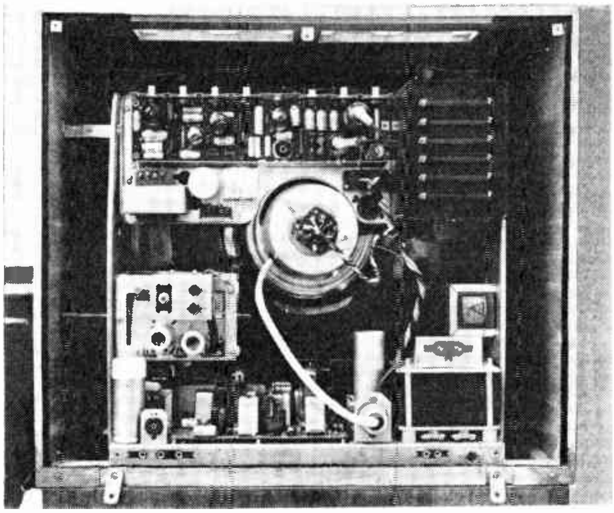


FIG. 3—Representative 21-in. home television set uses separate chassis arranged around neck of 110-deg picture tube

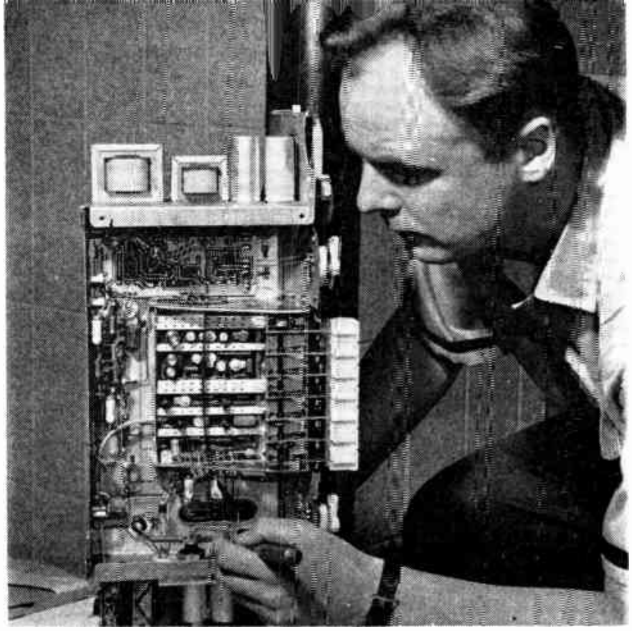


FIG. 4—Home radio chassis illustrates partial use of printed circuits and conventional wiring in same set

is powered by 12 silicon solar cells (top of case). The radios use eight transistors and ferrite-rod antennas.

Russian engineers report high interest in stereophonic sound. As yet all stereo is recorded on magnetic tape. Home tape recorders provide for both stereo recording and playback. Stereo disk recordings are planned but not yet available. No plans are underway for stereo broadcasting except for two-station a-m/f-m, f-m/tv or a-m/tv trials.

ANALOG COMPUTER—Figure 6 shows a transistorized analog computer with output oscilloscope. One of its 24 operational amplifiers is shown in the foreground. The unit provides 1-percent accuracy. Each amplifier uses 12 transistors. The computer uses 300-400 germanium transistors and silicon diodes. As Fig. 6 shows, there are two channels in each amplifier: high-frequency of 100 cps or so, and low-frequency of 3 cps or less. The low-frequency channel incorporates a modulator and demodulator and four-stage a-c amplifier. In addition to the operational amplifiers, the computer has six nonlinear units. Semiconductor-diode analog multiplication is used.

A transistor crossbar switch for a 20-line telephone exchange was also shown. The unit contains about 400 transistors and 300 diodes. It handles two lines at once, performs switching operations automatically.

ELECTRON DEVICES—Substantial progress is apparent in transistors. Power transistors capable of handling up to 100-watts are available. These units use massive heat sinks. Case size is more than three inches in diameter. They are, of course, audio units. However, 20-mc cutoff units capable of handling 5-watts are available. Industrial quality high-frequency germanium transistors are available capable of oscillation up to 400 mc, silicon units up to 60 mc. Experimental high-frequency amplifiers have demonstrated cutoff frequencies of about 1,000 mc.

Experiments with new semiconductor materials are underway. Both gallium-arsenide and silicon-carbide diodes have been fabricated.

Progress can also be noted in microwave tubes. One display shows electrostatically focused traveling wave tubes and twt's using ferrite focusing units.

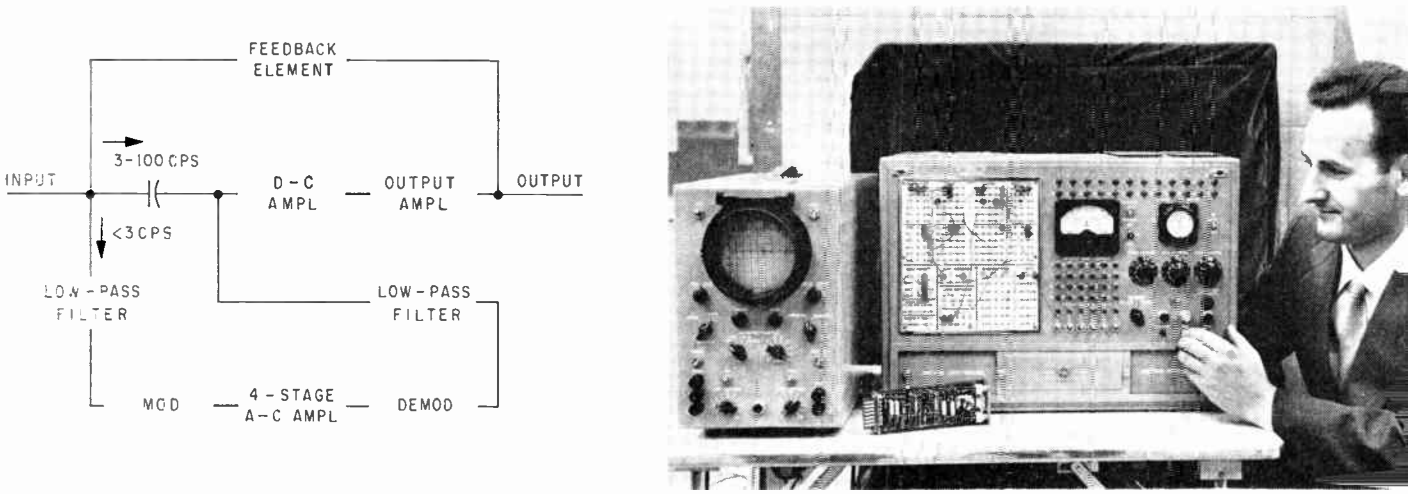
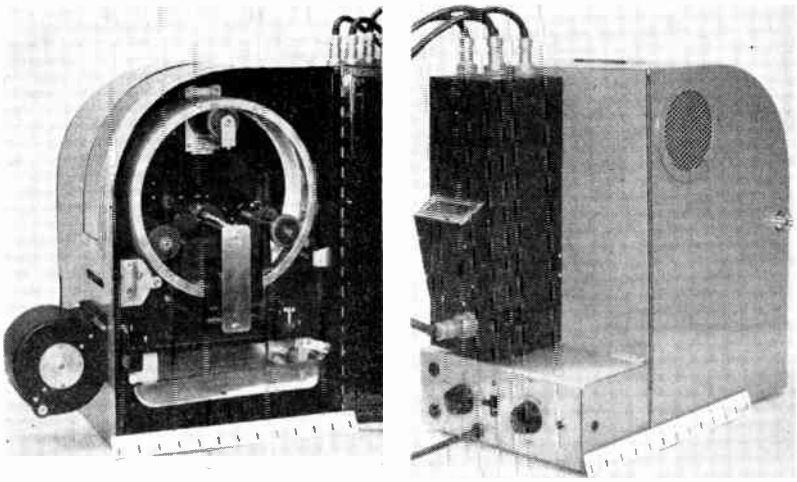


FIG. 6—Transistorized analog computer. Each of 24 amplifiers uses high and low frequency channels



Interior view (left) of photographic processor, showing drum and transformer. At right, photographic processor with galvanometer

Temperature Control for

Short-circuited single-turn transformer winding is used as a hot roller for the process industries. Benefits are fast response and accurate heat control

By D. A. SENIOR, The National Research Development Corporation, Middlesex, England*

CLOSE TEMPERATURE CONTROL of hot rollers is required by various process industries. The setting machines for nylon, for example, operate at 227 C, while the melting point of nylon is only 22 degrees higher. In a photographic processing machine, if the temperature is too low, the photographic paper is inadequately dried; if too high, scorching and poor definition result.

The basic problem is economic. To process the maximum quantity of material with the minimum plant outlay, the speed of production should be as high as possible. The limit is set by the convenient size of the machine, which increases with the processing speed.

Principle of Operation

Of the various ways of heating the rollers, induction heating allows high heat rates and good control. Induction heating is used here with a simple electronic circuit for fast, accurate control.

Thermal capacity of the roller is kept small to minimize warm-up time and allow rapid temperature correction.

Figure 1 shows the technique applied to a photographic dryer. A thin copper drum is supported on three rollers, one of which is used

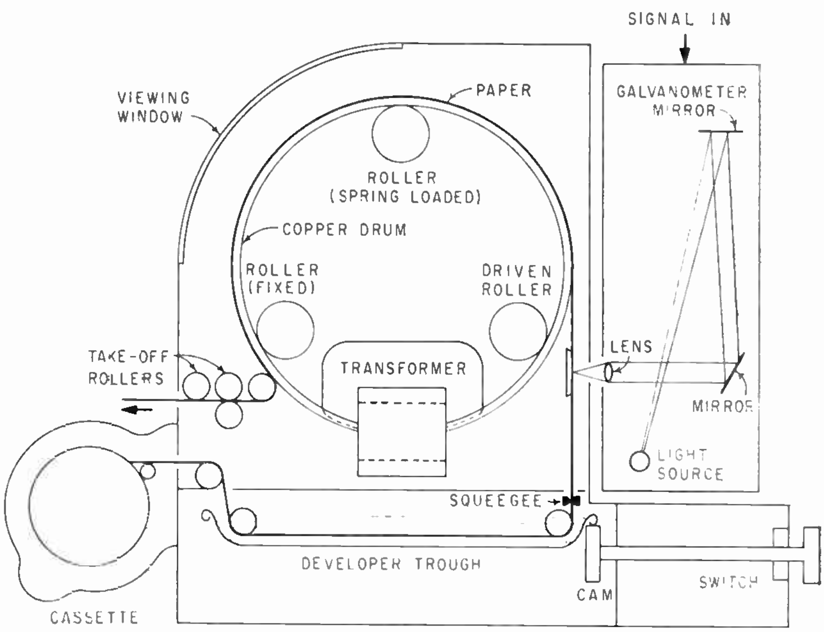


FIG. 1—Rapid photographic processor: Copper drum forms the single turn, shorted secondary of the transformer

* Recently appointed Scientific Attache at the British Embassy in Moscow.

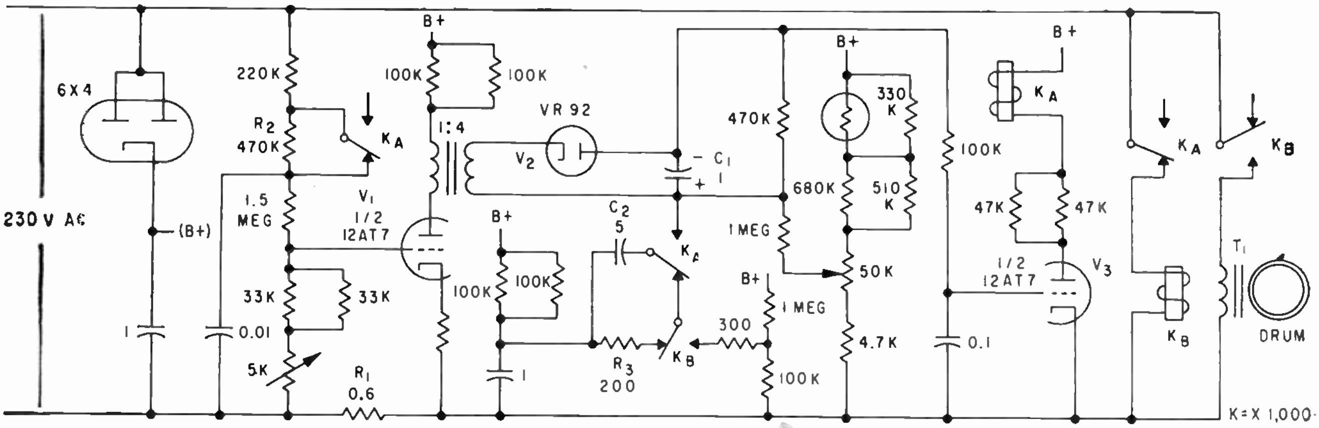


FIG. 2—As the drum heats up, line current decreases. When desired temperature is reached, K_A energizes and T_1 is disconnected by K_B. Both relays are shown unenergized

Hot Rollers in Industry

to rotate the drum—the others are idlers and are used for positioning. The drum is free to rotate through a C-core transformer and is a single turn, shorted secondary. Current induced in the drum—typically several thousand amperes—provides the heating. With no thermal resistance between drum and the source of heat, the drum is heated from room temperature to 120 C in less than one minute.

Heat input is so high that drum temperature with no load would rise to several hundred degrees C before input and losses balanced. A sufficiently fast-acting thermostat, however, is achieved by using the drum as its own temperature sensing element. Owing to the increase of drum resistance as the temperature rises, transformer primary current drops 10 percent during warm up. The change in line current is small—0.1 percent per degree C—but can be amplified and used for control.

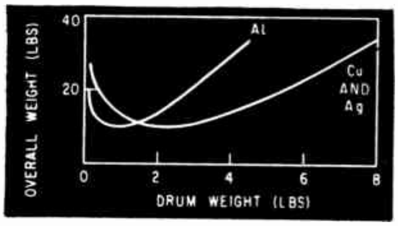


FIG. 3—Overall weight is minimum when drum reactance is equal to drum resistance. Curves are for a ten-inch drum only

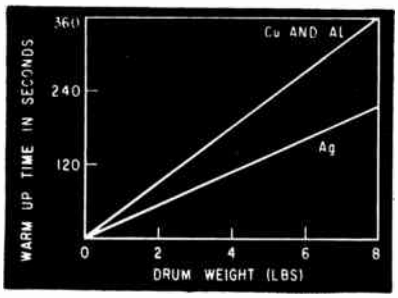


FIG. 4—Warm-up time is directly proportional to weight

Control Circuit

The complete control circuit is shown in Fig. 2. The primary of transformer T_1, of which the drum forms the secondary, is fed from the 230-volt supply through resistor R_1. The potential across R_1 drops as the drum warms up. This potential is balanced against another which is proportional to the supply voltage and nearly in phase with the voltage across R_1. The difference is amplified by V_1 and rectified by V_2.

As the resistance of the drum increases, the difference potential applied to V_1 falls, as does the rectified voltage across capacitor C_1. At the start, V_3 is non-conducting, since the voltage across C_1 is greater than the bias obtained from the grid network of V_3. When the correct drum temperature is reached, V_3 conducts and energizes relay K_A. Relay K_B is then de-energized and opens the circuit to the primary of T_1.

In addition to opening K_B, control relay K_A performs several other functions. With K_B open, transformer current is zero and the difference voltage applied to V_1 would be too high. A contact on K_A corrects this condition by switching in dropping resistor R_2.

Another contact on K_A switches in capacitor C_2. Assume that this capacitor is uncharged at the instant of switching. The grid of V_3 becomes as positive as the grid resistor will allow and K_A is held closed. Capacitor C_1 begins to charge and grid voltage begins to fall. Plate current of V_3 falls and eventually K_A drops out. The circuit is now restored to its original condition and the drum begins to heat again.

When K_B closes and power is again applied to T_1, approximately one second must elapse before the voltage across C_1 reaches a value corresponding to the temperature of the drum. When the machine is idling, losses are small and drum temperature increases slightly each cycle. This temperature drift cannot be avoided just by increasing the hold-off period because too great a temperature drop would then result and accurate control would be lost.

Compensation for this effect is obtained by providing a charging circuit for C_2 during the heating time. If C_2 is already partly charged at the instant of switching, the time K_A is held closed will be reduced. Thus, when the time required to bring the drum back up to cut-off temperature is long, C_2 is almost fully charged and the hold-off time is short. If the heat-up time is short, C_2 is only slightly charged and hold-off time is long. With the circuit shown, hold-off time varies from five seconds when idling to less than one second when operating. Discharge of C_2 through R_3 is provided each cycle during the brief switching interval when the contacts of both K_A and K_B are closed.

The circuit is basically insensitive to variation in line voltage since the potential across R_1 is set against a potential derived from the same line. Some sensitivity to line-voltage variation does remain, however, and this is compensated for by the nonlinear resistor incorporated in the bias circuit. Drum temperature varies only a few degrees as input voltage changes from 210 to 240 volts.

System Design

Drum size, material, and transformer design will depend on the application, but a number of general principles can be laid down. The weight of a drum of given diameter, width, and electrical resistance is proportional to the product of specific gravity and specific resistance. Warm-up time is proportional to the product of weight and specific heat. Using copper as a reference, examples of weight and warm-up time for several materials are:

Material	*Weight*	*Warm-Up Time*
Copper	1	1
Aluminum	0.5	1.06
Silver	0.99	0.61
Brass	3.8	3.65
Phosphor-bronze	3.3	3
Iron	10	5.9

In practice, copper and aluminum are the only likely candidates as drum material. Silver is too expensive and the other materials are heavy and have long warm-up times. Copper has an advantage over aluminum since seamless spinnings can readily be made from it and the material lends itself to plating.

The overall weight of a unit is the sum of the weights of the drum, transformer core and primary winding. These are all interrelated and it can be shown that the total weight is minimum when the resistance of the drum is equal to its inductive reactance. Since drum resistance and reactance are functions of its size and weight, total weight can be plotted as a function of drum weight. This is done for three materials in Fig. 3, which is for a ten-inch drum only. Warm-up time is also a function of drum weight and this is shown in Fig. 4 on the preceding page.

Drum design can be aided with the formulas shown in the design box. With the transformer load determined, a suitable core can be selected and a primary winding designed.

Drum Design for Minimum Overall Weight

1. Width of drum is set by the process.
2. Determine drum diameter from arc of contact, time required at operating temperature and linear processing speed.
3. Determine the power required by the process.
4. For minimum weight, the diameter of the drum and therefore X_L should be as small as practical. For minimum core size, set $X_L = R_S$. For $X_L = R_S$, drum thickness can be found from:

$$d \approx \rho \frac{(3.5\,D + 8a)}{16a\,D\,f \times 10^{-4}} \text{ (meters)}$$

Mechanical strength may require thickness greater than optimum.

5. Drum reactance and resistance:

$$L \approx \frac{8 \times 10^{-6} N^2 D\,(D - 2.5\,d)}{(3.5\,D + 8\,a)} \text{ (henrys)}$$

$$X_L = \omega L$$

$$R_S = \rho \frac{c}{A} \text{ (ohms)}$$

6. Primary current:

$$I_P = \frac{V}{[(R_P + N^2R_S)^2 + (N^2X_L)^2]^{1/2}}$$

7. Drum heating:

$$W \approx I_P^2 N^2 R_S \text{ (watts)}$$

Symbols

D = drum diameter (meters)
d = drum thickness (meters)
a = drum width (meters)
N = turns (= 1)
c = circumference (cm)
A = cross sectional area (cm²)
ρ = specific resistance (ohm-cm) (Use 1.86×10^{-6} for copper spinnings.)
R_S = drum resistance
R_P = transformer primary resistance.

Applications

The new heating control device might find application in various processes where accurate surface temperature is important. Examples are the drying of chemicals, foodstuffs, fabrics, glazing, and hot rolling of materials where the absence of fire risk is an advantage. Operating temperatures are limited by loss of mechanical strength in the drum, so materials other than copper and aluminum might be found desirable in some cases, despite the disadvantage of their higher specific resistance.

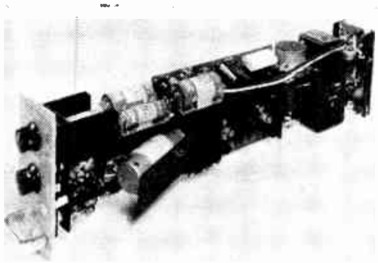
The photographs show a machine for the rapid processing of photographic records on paper. The copper drum is 10 inches in diameter, three inches wide and 0.06 inches thick.

Removes Excess Liquid

The paper passes from the cassette through a bath of cold developer, excess liquid is removed, exposure to light occurs, and the paper is then dried on a hot drum. The record is developed on the drum and is dry on leaving it. Paper speed is one inch per second.

The heat dissipated in the drum is about 500 watts. The resistor R_1 is specially wound. As it is required to dissipate several watts, yet rapidly attain its operating temperature, it is constructed from heavy gauge resistance wire wound on an open former.

Acknowledgement for help and suggestions are due Mr. H. H. Margary and staff of the Admiralty Research Laboratory.



Wide-band amplifier of millivolt signals

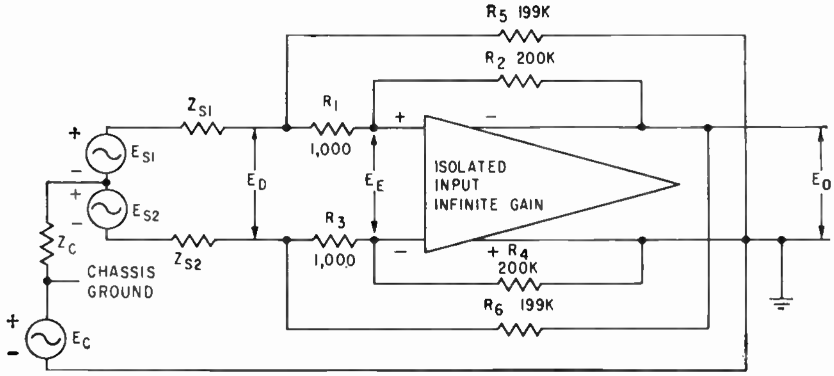


FIG. 1—Bridge circuit at input achieves common mode rejection

Amplifiers for Strain Gages And Thermocouples

Positive and negative feedback to a bridge-type transformer-coupled input circuit are used to attain high-impedance differential input in a d-c to 25-kc amplifier. Bridge balances out common mode signals

By **RICHARD S. BURWEN,** Boston Division, Minneapolis-Honeywell Regulator Co., Boston, Mass.

NOISE VOLTAGES produced by grounding at two different points in strain-gage and thermocouple circuits have necessitated the development of amplifiers with high common-mode rejection.

Common-mode voltages arise in data-acquisition systems, where the preamplifier ground is frequently located several hundred feet from the transducer ground.

The amplifier to be described features both a floating input and a floating output, and delivers a low voltage at high current suitable for feeding high-frequency recording galvanometers, f-m recorders, analog-to-digital converters and other equipment, through long lines if necessary. Direct-current to 25-kc millivolt signals from strain gages and thermocouples are amplified with an accuracy of ± 15 μv instantaneous peak equivalent input on a wide-band basis, and ± 7 μv from d-c to one kc.

Equivalent input d-c drift of less than ± 0.5 μv peak during 40 hours is achieved by chopper stabilization and a unique way of cancelling transistor drift using a feedback amplifier. The input impedance is infinite when used with balanced sources. Common-mode rejection, the ratio of common-mode voltage to the equivalent differential input it produces, is 2 × 10^6 at d-c and up to 1 × 10^5 at 60 cps with balanced sources.

Common-mode rejection is achieved by a resistance bridge at the input which passes differential signals while balancing out common-mode signals. The differential output signal from the bridge then divides into high- and low-frequency channels. Frequencies are converted to 400-cycle square waves.

Input Signal

Analysis of the bridge circuit by the principle of superposition allows the effects of several voltage generators to be considered one at a time while the others are turned off and shorted out. In Fig. 1, the input signal consists of two components E_{s1} and E_{s2} generated with respect to an input ground which is at a common mode voltage E_c with respect to the output ground. Resistors R_1, R_2, R_3 and R_4 constitute the bridge. Resistors R_5 and R_6, each 199,000 ohms, equalize the currents through the differential input terminals. In effect, the current through R_6 develops a positive feedback voltage across the impedance Z_{s2} in the negative side of

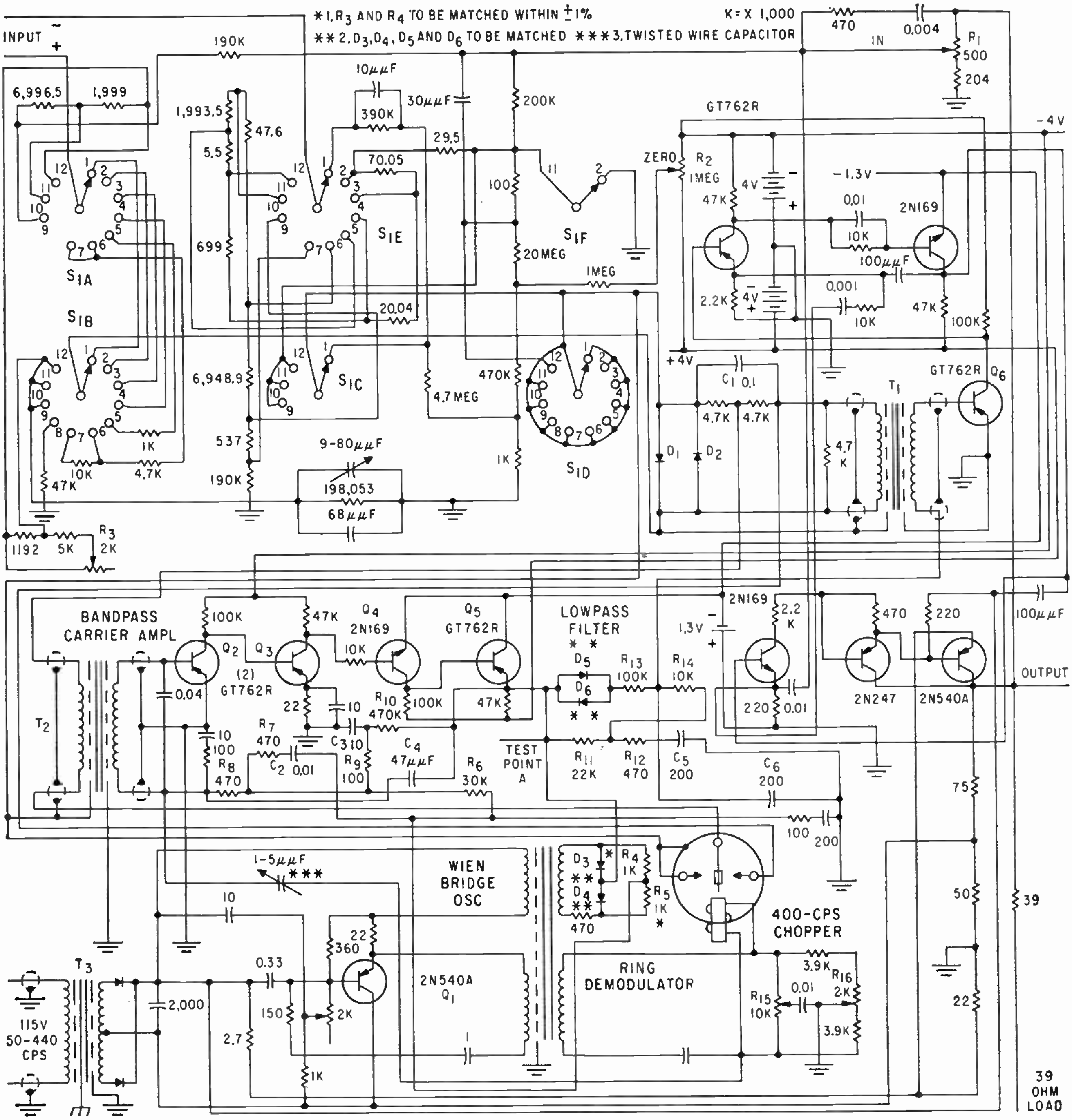


FIG. 2—Differential-input chopper-stabilized transistor amplifier

the source, while that through R_2 develops a negative feedback voltage across the impedance Z_{s1} in the positive side of the source. Resistor R_5 completes the symmetry of the circuit so that the common-mode voltage E_c produces no differential input voltage E_d when equal source impedances Z_{s1} and Z_{s2} are added.

In the schematic, Fig. 2, the eleven-position switch S_1 changes the gain in three-to-one steps by varying R_1 thru R_6 of Fig. 1 to maintain the proper relationships for infinite input impedance and common mode rejection.

Continuous Coverage

In Fig. 2, potentiometer R_1 in the feedback path varies the gain to cover intermediate points. These controls provide continuous coverage of full-scale inputs of ±100 μv to ±100 mv single ended and ± 3 mv to 100 mv differential, plus zero check, and an open loop position which permits the use of external feedback networks when special characteristics are needed. Adjustment R_2 zeros the no-signal output and R_3 compensates for tolerances in the bridge resistors and unbalances in the source up to ± 5 ohms.

The error voltage appears across diodes D_1 and D_2 which protect the first stage against damage from excessive input signals. At this point the error voltage is divided into two channels. Direct current to 25-cycle components are developed across C_1 while the high-frequency components pass directly through T_1 to a six-stage direct-coupled wide-band amplifier.

The chopper, which converts the

low-frequency components to a 400-cycle carrier, is excited by a Wien-bridge oscillator using a single power transistor, Q_1. The carrier produced by the chopper passes through T_2 and is then amplified by the four-stage bandpass carrier amplifier Q_2 through Q_5. A ring demodulator, D_3, D_4, R_4 and R_5 synchronously rectifies the carrier, converting it to d-c of the proper polarity. After filtering, the rectified output is added in series with the high-frequency component of the error signal across the secondary of T_1. At d-c, the gain from the input terminals to test point *A* at the output of the demodulator is 30,000.

Lowering the Gain

Demodulation is accomplished by shunting a network R_6, R_7 and C_2 during alternate half cycles across a portion of the bridged T, 400-cycle selective-feedback filter R_8, R_9, R_{10}, C_3 and C_4. This effectively lowers the gain of the amplifier during alternate half cycles and prevents the overload that would otherwise occur if demodulation were accomplished by grounding the output of Q_5 during thi time.

Using this arrang ment for demodulation allows the chopper amplifier to serve a second purpose—temperature compensation of Q_6, the transistor primarily responsible for drift.

Since the no-signal d-c output from Q_5 at test point *A* is referenced to the input of Q_2 through the demodulator and feedback network, the d-c level drifts with temperature to satisfy the bias requirements of Q_2. This variation is the same as needed for temperature compensation of Q_6 which has the same operating point as Q_2. Low-voltage, low-current operation of each of these transistors (collector voltage, 0.3 v; current, 35 μa) minimizes their d-c drift and a-c noise.

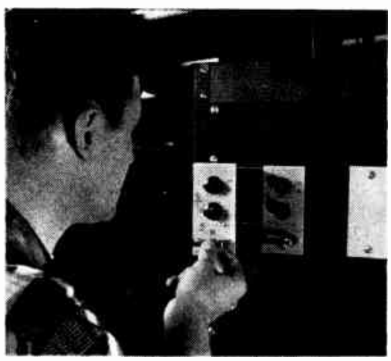
Following the chopper amplifier and demodulator is a two-section, nonlinear low-pass filter R_{11} through R_{14}, C_5, C_6, D_5 and D_6. During overloads, diodes D_5 and D_6 convert this filter into a one-stage filter which has less phase shift and allows the amplifier to recover. Without this nonlinear network, the phase shift is so great that the amplifier would continue to oscillate once the amplifier becomes overloaded.

The stability afforded by the nonlinear filter technique permits a substantial increase in chopper amplifier gain with consequent reduction in equivalent input drift.

Total Loop Gain

In the six-stage direct-coupled amplifier, the gain is 10^6. Multiplied by the d-c gain of 30,000 in the chopper amplifier and the loss of three times in the filter, the total open loop d-c gain is 10^{10}. Drift relative to the input due to the transistors is that of Q_6 less the compensation provided by Q_2, all divided by 30,000, about 1.6 μv over the temperature range of 32 to 125 F. This low inherent drift plus cool operation of the low-level input circuit, the use of materials having low thermal voltages with respect to copper, and thermal lagging to minimize temperature differences, results in low drift.

Noise caused by power line voltage variations and serious decoupling problems are eliminated by powering the first transistors with mercury batteries. Batteries operate continuously for a year with no provision for turning them off.



Technician inserts amplifiers in rack-mounting assembly

The h-f channel is reduced to a single 1 : 1 transformer T_1 to eliminate phase shift. An identical transformer, T_2, avoids the necessity of having to float the entire chopper amplifier and its power supply within a separate shielded compartment.

Careful shielding of both primary and secondary and all connecting wires results in a transformer design having a bandwidth of 20 cps to 200 kc with common-mode rejection of more than 25 $\times$ 10^6 at a frequency of 60 cps.

High-frequency stability problems, made more difficult by the presence of T_1 within the feedback loop, are solved through the use of multiple loops which roll off the gain in a slow manner. Since the principal local loop encloses the output stage, distortion and output impedance are reduced to beyond 500 kc.

Stray Capacitances

It is necessary to maintain all the components associated with the error signal at the same potential, to prevent stray capacitances from introducing common-mode signals across the primary of T_2 in the chopper channel. For this purpose the chopper and associated error signal circuitry are all mounted inside an electrically floating aluminum box, placed towards the front of the amplifier. This box is connected to the negative side of the error signal.

Because the frame of the chopper is at error-signal potential, it is capable of picking up 400-cycle noise through capacitance to its coil. This noise is eliminated by grounding the coil through center-tapping potentiometers R_{15} and R_{16} which cancel the electrostatic pickup in both magnitude and phase.

Shielding

Compact construction caused in part by the space taken by the double wall case necessitates good magnetic as well as electrostatic shielding. Transformers T_1 and T_2 have double mu-metal and copper shields and the power transformer T_3 and oscillator transformer have single mu-metal shields.

Construction in a double wall case completely shields the amplifier circuits.

The chopper, a strong source of 400-cycle noise because of its proximity to sensitive circuits, is also double-shielded with mu-metal.

The above considerations together with the low-noise input circuitry, high common-mode rejection, and excellent gain stability and linearity resulting from the high feedback factor, have made possible high-accuracy wide-band amplification of millivolt signals.

Satellites and Space Probes

Compilation by National Aeronautics and Space Agency describes electronic equipment orbited during first 18 months of space age

Table I—Launching Dates, Instrumentation and Performance of U.S. and USSR Satellites and Space Probes

Name[a], Launching Date, Life	Radio Transmission[b]	Instrumentation	Test Results
UNITED STATES SATELLITES			
Vanguard (two) 12/6/57, 2/5/58	A: 1 turnstile, 1 dipole; T: 108 and 108.03 mc; B: mercury and solar	micrometeor impact, geodesy	both launchings failed
EXPLORER I 1/31/58 3 to 5 yrs est life	A: 1 turnstile with 4 22.5-in. whips; 1 dipole, satellite skin; T, LT: (a) 108 mc, 10 mw, 5/23/58; (b) 108.03 mc, 60 mw, 2/28/58; B: mercury	cosmic rays, micrometeorites, satellite temp	discovered Van Allen radiation belt around Earth
Explorer II 3/5/58	A: 2 dipoles, satellite skin; T: 108.03 and 108 mc; B: mercury	cosmic rays, micrometeor impacts	launching failed
VANGUARD I 3/17/58; est 200 to 1,000 yr	A: 1 turnstile; 1 dipole, 6 1-ft rods; T, B, LT: (a) 108 mc, 10 mw, mercury, 4/5/58; (b) 108.03 mc, 5 mw, solar, continuing	temperatures and geodesy	being used to map islands, find Earth's exact shape
EXPLORER III 3/26/58 to 6/27/58	A: 2 dipoles, satellite skin; T, LT: (a) 108 mc, 10 mw, 6/16/58; (b) 108.03 mc, 60 mw, 6/5/58; B: mercury	micrometeors, temps, tape record cosmic rays	data on cosmic dust density, radiation belt
Vanguard 4/28/58	A: 4 metal rods; T: 108 and 108.03 mc; B: mercury and solar	X-radiation from sun	launching failed
Vanguard 5/27/58	similar to Vanguard of 4/28/58; transmitted 20 minutes	solar radiation, space environment	no orbit, went up 2,200 miles
Vanguard 6/26/58	similar to Vanguard of 4/28/58; no transmission	X-radiation from sun	launching failed
EXPLORER IV 7/26/58 est 1 yr life	A: 2 dipoles, satellite skin; T, LT: (a) 108 mc, 10 mw, 9/19/58; (b) 108.03 mc, 24 mw, 10/6/58; B: mercury	corpuscular radiation, subcarrier oscillator calibrated for temperature	same as Explorers I and III
Lunar Probe 8/17/58	A: 2 1-ft whips; T: 108.6 (telemetry and Doppler) and 108.09 mc; B: mercury	radiation, mag fields, meteors, temperature	launching failed
Explorer V 8/24/58	A: 2 dipoles, satellite skin; T: 108 and 108.03 mc; B: mercury	corpuscular radiation	vehicle parts collided
Vanguard 9/26/58	A: 1 turnstile with 4 30-in. rods; T: 108 and 108.03 mc; B: mercury	infrared scan of cloud cover	may have made 1 orbit
PIONEER I 10/11/58 43-hr life (Lunar Probe)	A: 2 1-ft whips; T: 108.06 mc (telemetry and Doppler command), 300 mw; 108.06 mc (controls), 1 w; B: mercury; design life: 10 days	space radiation, magnetic fields, micrometeors, temperature	70,700 miles alt; scored 6 scientific firsts[c]
Beacon 10/23/58	T: tracking, in payload; no transmitter in inflatable sphere	....	payload freed prematurely
PIONEER II 11/8/58 42.4-min life (Lunar Probe)	A: 2 1-ft whips; T: 108.06 mc (telemetry and Doppler command), 300 mw; 108.09 mc (telemetry), 100 mw; B: mercury; design life: 10 days	ionizing radiation, magnetic fields, micrometeors, temperature	963 miles alt; found higher radiation at equator

Launched in U.S. and USSR

Name[a], Launching Date, Life	Radio Transmission[b]	Instrumentation	Test Results
PIONEER III 12/6/58 38.1-hr life (Space Probe)	A: gold-washed fiberglass shell; T: 960.05 mc, 180 mw; B: mercury; design life: 90 hrs	radiation in space	63,580 miles alt; found 2nd radiation band around Earth
SCORE 12/18/58 to 1/21/59	A: slot type flush with Atlas body; T: 132.435 and 132.905 mc, (f-m), 107.97 and 107.94 mc (Minitrak); B: mercury; life: 12 days	twin receiving, recording, transmitting packages	first voice relay from ground, 8,750 lbs in orbit
VANGUARD II 2/17/59 est 10 yr	A: 4 metal rods; T, LT: (a) 108 mc, 10 mw, 23 days; (b) 108.03 mc, 80 mw, triggered from ground, 27 days; B: mercury	photocells give crude images of cloud cover	satellite wobbled, data interpretation difficult
PIONEER IV 3/3/59 into solar orbit	A: cone is antenna; T: 960.05 mc with 3 subcarriers; tracked 82 hrs, to distance of 407,000 miles	space and moon radiation, test photoelectric sensor near moon	radiation data; moon too far (37,300 mi) for sensor
DISCOVERER I 2/28/59 to 3/5/59	A: 1 directional, 1 whip; T: telemetry and tracking beacon (classified); B: nickel cadmium	propulsion, guidance, staging, communications checkout	polar orbit, tumbling hampered tracking
DISCOVERER II 4/13/59 to 4/26/59	A, T, B: like Discoverer I, had beacon in recovery capsule; LT: telemetry, 4/14/59, beacon, 4/21/59, as planned	capsule recovery, maintain livable temp and O_2, radiation	temp and O_2 OK for life; capsule ejected wrong place
Vanguard 4/13/59 (2 satellites)	(1) A: 4 rods; T: 108 mc (tracking), 10 mw; 108.03 mc (telemetry on ground command), 80 mw; B: silver zinc (2) none	(1) map Earth's magnetic field; (2) sphere, to show space drag	launching failed
Discoverer III 6/3/59	Similar to Discoverers I and II; LT: 13.5 minutes after launch	payload of 4 mice in recovery capsule for medical data transmission	failure to go into orbit presumed
Vanguard 6/22/59	A: 4 rods, tipped with temperature transducers; T: 108 mc, tracking; 108.03, command; B: mercury; LT: 7 min	solar-earth heating process, heat balance of earth (affects weather)	launching failed
RUSSIAN SATELLITES[d]			
SPUTNIK I 10/4/57 to 1/4/58	A: 4 whips, 58.5 to 114 in. long; T: 20.005 and 40.002 mc; B: chemical; LT: 10/27/57, both transmitters	internal temperatures, pressures and "other data"	first successful satellite
SPUTNIK II 11/3/57 to 4/14/58	A: not disclosed; T, B: same as Sputnik I; LT: 11/10/57, both	cosmic and solar radiation, temp, pressures, carried dog	indicated solar influence on upper atmosphere
SPUTNIK III 5/15/58 est 15 mos	A: folded dipoles and trailing rods; T: 20.005 mc (trans at 40.01 is harmonic of 1st); B: chemical and solar	atmosphere, ions, electrostatic and magnetic fields, solar and cosmic radiation, meteors	
LUNIK-MECHTA 1/2/59 (Space Probe)	A: not disclosed; T, LT: (a) 19.997 and 19.995 mc, signal 1.6 sec long; (b) 19.993 mc, signal 50.9 sec long; (c) 183.6 mc	temp, pressures, interplanetary matter, solar and cosmic radiation, magnetic fields	believed in 15 months orbit of sun

(a) Successes in capitals (b) A: antennas, T: transmitters, B: batteries, LT: last transmission (c) First observations include: mapping radiation band and ionizing flux, Earth's magnetic field oscillates and departs from theory, micrometeor density in space, measurements of interplanetary magnetic field (d) Unofficial data, announced successes only

Statistical Analysis of

Analyzer provides digital data from which the probability distribution function and probability density function of signals can be plotted. Statistical investigations of random signals are significant in propagation studies

By **DAVID HOFFMAN** and **ELIAS SCHUTZMAN**, New York University, College of Engineering, New York, N. Y.

IN MANY COMMUNICATION and industrial investigations as well as in the study of atmospheric phenomena, it is necessary to have an accurate knowledge of the amplitude statistics of a random type signal. An analyzer has been developed which provides digital information from which the amplitude probability distribution function and probability density function can be plotted.

The instrument has two distinct modes of operation, each of which is readily selected by a switch on the front panel. The probability distribution, as plotted from data obtained in the *A*-mode of operation, is a measure of the probability that the signal is more positive than a given amplitude at any instant of time. A more conventional plot of the probability that the signal is less positive than a given amplitude at any instant of time may easily be plotted from the same set of data. The *B*-mode is used to determine the probability density function.

Theory of Operation

The system block diagram describing each of the two modes of operation is shown in Fig. 1. For measurement of the first probability distribution using *A* operation, the desired signal is applied to an amplitude comparator which provides an output whenever the input signal exceeds a preset level. Output of the comparator circuit is sampled by pulses of appropriate repetition rate so that statistically independent sampling is assured. Both the total number of samples and the number of samples occurring during the time when the signal exceeds the preset amplitude level are recorded by electronic counters. The probability of the input signal exceeding this amplitude is the ratio of the counts recorded. The first probability distribution is obtained by adjusting the preset amplitude level in discrete steps throughout the entire range of amplitude of the input signal.

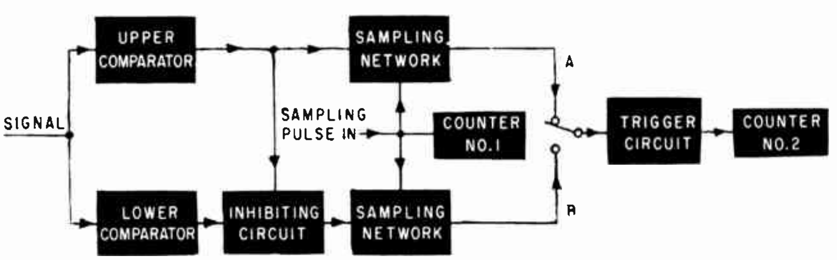


FIG. 1—System has two modes of operation. In A-mode, upper comparator provides output when input exceeds preset level. B-mode operation yields output when input lies between preset upper and lower limits

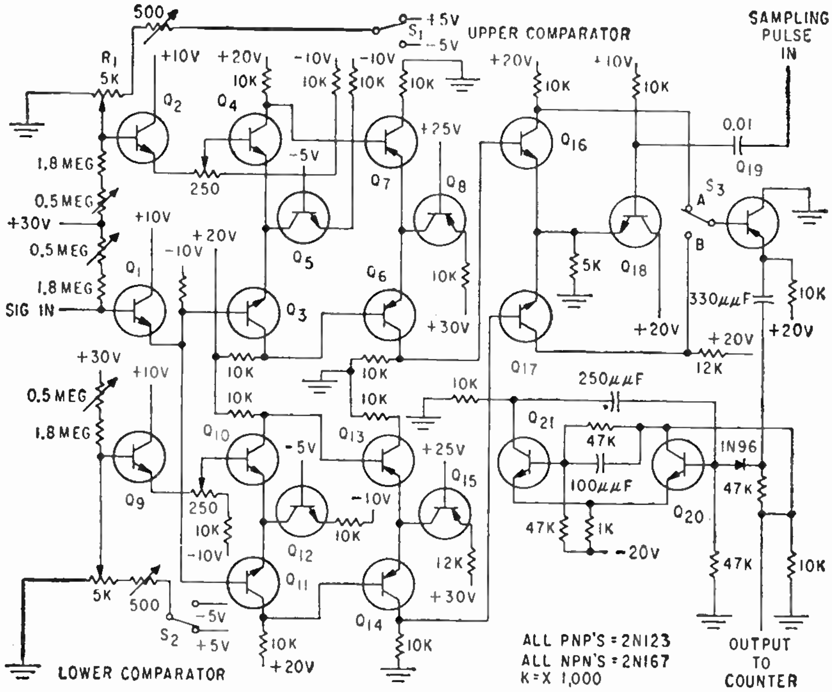
In the determination of the first probability density function using the *B* mode, a dual amplitude comparator is employed. The objective in this case is to yield an output only when the input signal is between two amplitude levels in close proximity. Each comparator yields an output whenever the input signal exceeds a preset level as in the *A* mode. To accomplish the desired result, the output of the upper amplitude comparator is used to inhibit the output of the lower amplitude comparator. Thus, when the amplitude of the signal exceeds both the upper and lower comparator settings, no output is obtained. The sampling procedure is exactly as described for *A*-mode operation. The ratio of the counts recorded yields the probability that the input signal lies between the preset amplitude levels. The probability density ordinate for this setting is found by dividing this probability by the width or separation of the two levels. The probability density function of the input waveform is found by successively moving the window provided by the dual amplitude comparators throughout the entire range of waveform amplitude.

Circuit Description

A schematic of the analyzer is shown in Fig. 2. The signal to be analyzed is introduced into the unit through emitter follower Q_1 so that the unit presents a high impedance to the signal source. This is necessary as the input impedances of the two difference amplifiers following the emitter follower are relatively low. The quiescent base current of the emitter follower is supplied from a constant current source so that the input voltage of the unit with no signal present remains at zero regardless of the signal source impedance.

In the *A* mode, where the probability that the signal is more positive than a given reference level is to be determined, only the upper comparator on the schematic is used. The reference level can be

Noise-Signal Amplitudes



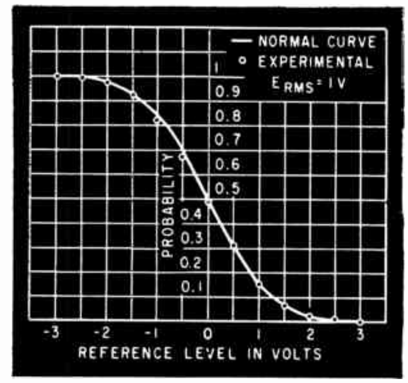


FIG. 3—Comparison of theoretical and experimental probability distribution of noise source with bandwidth of 5 kc

FIG. 2—Basic schematic shows system consisting of two amplitude comparators followed by logic circuits and a sampling network

adjusted continuously from −5 to +5 volts by means of ten-turn potentiometer R_1 and polarity switch S_1. The emitter follower employed between R_1 and the reference input of the comparator serves three purposes: it prevents significant loading on the potentiometer; it tends to provide an identical drift in the reference and signal levels resulting from temperature effects; and it prevents the potentiometer output impedance from having any appreciable effect on the gain of the comparator.

If the comparator is perfectly balanced and the input signal equal in magnitude to the reference level, then a voltage of 2.5 v exists at the collector of Q_6. This is because the emitters of Q_6 and Q_7 are supplied by a 0.5-ma constant-current source. An increase in the signal voltage of $2.5/A$ drives the collector of Q_6 to a maximum of 5 v, assuming the comparator gain A is constant over this range. The collector load resistor of Q_6 and the value of constant current supplying its emitter limit the maximum collector voltage without saturation.

Output of the comparator is sampled in the following emitter-coupled network having an approximate additional gain of 2. Q_{19} is cut off except when a negative sampling pulse is applied to the base of Q_{19}. The width of the sampling pulse used is 2 μsec. If the collector of Q_6 is at maximum when sampled, a negative-going pulse of 10 volts at the collector of Q_{19} results.

With switch S_3 in the A position, this pulse triggers a 10-μsec one-shot multivibrator which supplies pulses to an electronic counter. Actually the triggering level of the multivibrator is made slightly less than 10 volts, so that with any increase in its triggering level from temperature effects or component aging, the comparator still supplies enough potential to trigger the circuit. If the comparator is unbalanced so that the multivibrator just triggers when the signal and reference levels are equal, then a one-volt change in triggering level requires only a change of $1/2A$ volts in the signal to cause an output count. A difference amplifier is inherently a self-compensating device because of its parallel symmetry. Hence, drift in the comparator is reduced by the selection of matched components.

For B-mode operation the lower comparator of Fig. 2 is used in conjunction with the comparator previously described. It has a separate reference level adjustment and is identical to the upper comparator except that its maximum output voltage taken at the collector of Q_{14} is approximately one volt less than the output at Q_6 of the upper comparator. With the switch in B position, triggering of the multivibrator occurs if Q_{14} is slightly less than 4 v when sampling occurs. However, if the upper threshold is exceeded, the output of Q_6 inhibits the output of Q_{14} in the sampling circuit and no triggering occurs. Thus the requirement for B operation that the signal be between two preset levels in order to register a count is satisfied.

Both comparators have a measured gain of approximately 2,800.

Results

The probability distribution of the noise from a commercial random noise generator is shown in Fig. 3. The experimental results compare favorably with the expected normal gaussian distribution.

Shunt Bridge Balancing in

Conventional self-balancing indicators require some method of making the indication independent of power supply variations. Highly stable power supply components and accurate reference voltages are usually employed. With shunt bridge balancing, neither precaution is necessary

By **CARL H. HAAKANA**, Scientific Laboratory, Ford Motor Company, Dearborn, Mich.

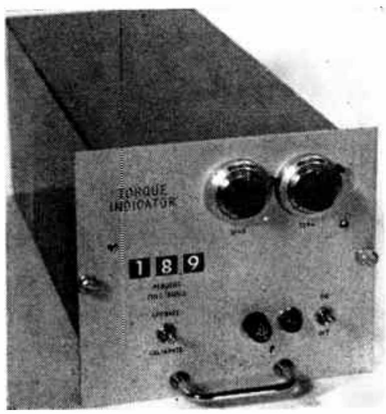
USE OF STRAIN-GAGE transducers has led to the development of self-balancing indicators using null-balance servo techniques. Most indicators of this type employ separate power supplies for the transducer and the reference voltage circuit.

In a 0.1-percent accuracy system, without some means of standardization the power supplies must be regulated to each other by at least ±0.05 percent. This is accomplished by the use of stable power supply components and careful transformer design to insure that transformer parameters do not change appreciably under varying source voltage and load. Other complex systems have been developed which buck out the transducer voltage at the input to the servo amplifier in some manner.

Shunt Balancing

A study of systems to measure dynamometer reaction torque using a series of strain-gage load cells has resulted in the design of a self-balancing indicator which uses shunt bridge balancing techniques.[1]

Figure 1 is a simplified drawing of a balancing network using shunting techniques. The transducer is initially balanced by standard methods so that the arm of balancing potentiometer R_B is midway between points *a* and *b*. Assuming that a load change causes R_1 and R_3 to decrease and R_2 and R_4 to increase, the polarity of the unbalance voltage appearing at the servo amplifier input is such that the servo motor geared to balancing potentiometer R_B drives the wiper arm of R_B toward *a*. This reduces the resistance from *c* to *d* and increases the resistance from *c* to *e*. The motor continues to drive until the transducer bridge is rebalanced, at which point the amplifier input voltage drops to zero. A mechanical counter geared to the motor indicates the position of the slider and can be arranged to read in percent of the full-scale transducer rating or read the variable directly in appropriate units.



Self-balancing torque indicator uses shunt bridge balancing to achieve better than 0.1-percent accuracy

Advantages

The shunt balancing method shown in Fig. 1 has several advantages. First, the power supply used to feed the network is extremely simple. Standard transformers, rectifiers and RC filters operating from unregulated lines may be used. No standardization is required since the indication is virtually independent of the magnitude of the power supply. This is because the bridge is always rebalanced resistively for each change in the variable. The only requirement of the power supply is that it is high enough to provide a sharp null for the servo amplifier and that it not exceed the voltage rating of the transducer.

Construction of balancing potentiometer R_B is also not critical. Any thermal emf's developed at the slider have little effect on the reading, since the reading is proportional to the thermal voltage multiplied by the ratio of the gage resistance to the span resistance R_5. The temperature coefficient of the balancing potentiometer is unimportant. A 10-percent change in the resistance causes less than a 0.01-percent change in sensitivity.

The input impedance to the amplifier is essentially that of the transducer which is usually low. This minimizes complications from 60-cycle pickup or amplifier dead zone.

Linearity

From the standpoint of accuracy and simplicity, a linear relationship between the position of the slider of R_B and the measured variable is required. It is desirable to accom-

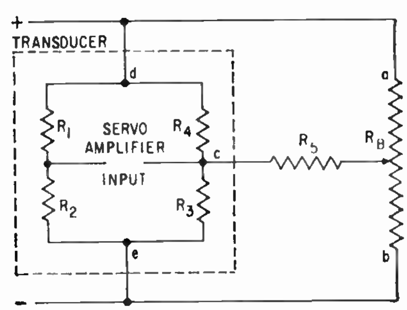


FIG. 1—Simplified schematic illustrates shunt balancing method

Strain-Gage Indicators

plish this without resorting to the use of a tapped potentiometer and linearizing with a series of shunting resistors. In the system of balancing shown in Fig. 1, the linearity is a function not only of the linearity of the balancing potentiometer but also of the ratio of resistor R_5 to R_B. The value of R_5 is dictated by the transducer resistance and the change in resistance equivalent to full-scale output.

Figure 2 is a plot of reading error as a percent of full scale against the ratio of span resistance to R_B. It shows that for ratios higher than approximately 85, the error is less than 0.1 percent full scale. The reading error plotted is the maximum deviation from a straight line drawn between the zero and 100-percent points. The error is completely predictable, always positive and its maximum occurs at 50-percent output.

Typical Errors

A typical series of commercial 120-ohm load cells with four active gages of 0.2-percent ΔR requires R_5 to be approximately 12,000 ohms. This means R_B should be 120 ohms for less than 0.1-percent reading error. In the experimental indicator, the balancing potentiometer is 50 ohms and has less than 0.1-percent reading error from unbalanced shunting effects for any 1-, 2- or 4-active-arm transducer from 100 to 500 ohms with ΔR up to 1 percent. For transducers from 50 to 100 ohms, this error is less than 0.1 percent for 1-, 2- or 4-active-arm transducers with ΔR up

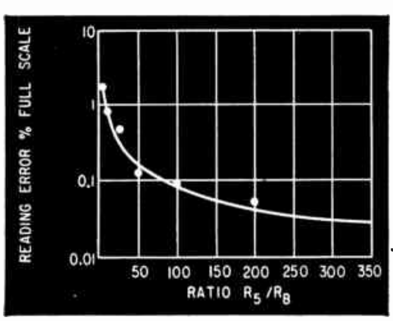


FIG. 2—Error plot shows effect on linearity of ratio of span to balancing resistance

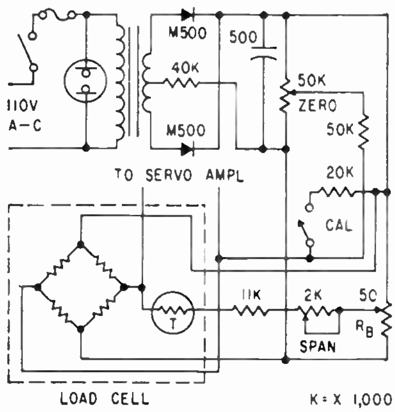


FIG. 3—Experimental torque indicator circuit employing shunt balancing

to 0.5 percent.

The experimental torque indicator circuit using the shunt-balanced bridge principle is shown in Fig. 3. The amplifier and servo motor are standard commercial units used without modification. The simplicity of the input circuit is evident from the drawing. A coarse and fine zero control, two additional resistors and switch for 1- or 2-arm gages and some additional fixed resistors in the span circuit could be added without difficulty.

Temperature Effects

Figure 4 shows some of the other factors which must be considered in the design of the indicator. The three resistors labeled R_L represent the lead resistance in the cable connecting the load cell to the indicator. This resistance causes a change in sensitivity which can be calibrated out of the system. In the experimental indicator, leads of up to 50 ft of No. 20 copper wire may be used and subjected to ±25 C change without exceeding the 0.1-percent accuracy limitation.

Change in span resistance with temperature must also be considered. The span resistors have a temperature coefficient of 20 ppm/deg C and an ambient change of ±25 C causes approximately 0.05-percent reading error. This is a positive error while the lead wires cause a negative reading error; consequently, in the experimental unit the total error is something less than 0.05 percent.

Transducer Compensation

The resistor R_T shown connected to the transducer in series with the span resistor is used for temperature compensation. Most precise commercial load cells are compensated for the change in the thermoelastic coefficient of the pickup metal by using positive temperature coefficient resistors to reduce the voltage across the bridge as the temperature increases. Since in the shunt balancing system the indication is independent of the magnitude of the voltage, another method of compensation is required. This is accomplished by the use of a negative temperature coefficient material in series with the span resistor. As the temperature in-

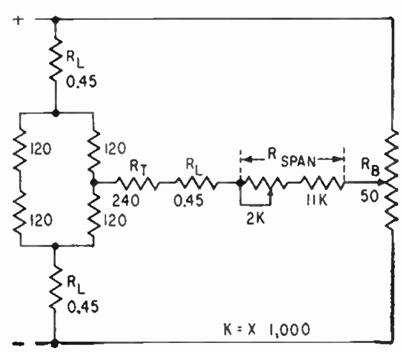


FIG. 4—Simplified diagram shows method of temperature compensation

creases, the resistance in series with the arm of the balancing potentiometer decreases, causing the slider to travel a shorter distance to balance out the same load cell resistive change.

The experimental indicator has been used successfully for the past six months in a gas turbine test facility for making precise torque measurements in compressor and engine test cells. It has also been used in the measurement of torque due to viscous forces in connection with a homopolar motor research project.

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Voltage-Variable Capacitor

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Table I—Typical Back-Biased Diode Capacitors

Freq	Manufacturer and Type No.		Initial Cap.[c] ($\mu\mu f$)	Min Cap.[c] ($\mu\mu f$)	V_{max}[d] (volts)	Q[e]	Comments[a, b]
	MA	MA-460A	4	1.2	6	2	20
		MA-460B	2	1	6	3	30
		MA-460C	1.8 } 0 v	0.4	6	4 } at 10 kmc	40 } f_c Case capacitance for all MA-460
		MA-460D	1.4	0.2	6	5	50 is 0.4 $\mu\mu f$
		MA-460E	1	0.2	6	6	60
SHF UHF	BL	SI 43-7	2.15, 0 v	1.2, 6 v	10		f_c = 77, R_s = 2.3; Experimental unit
	HU	HPA-2800	2.5, 0 v	0.6	7		Case cap. = 0.1 $\mu\mu f$ } f_c = 70
		HPA-2810	2.5, 0 v	0.6	7		Case cap. = 0.2 $\mu\mu f$
	WE	427-A	1.2, 0.1 v	0.12	10		R_s = 15 at 3 kmc
UHF	TR	SCH-51	2, 0.1 v	0.35	10	100 at 50 mc, 4 v	f_c = 5, R_s = 85
		SCH-52	4, 0.1 v	0.80	7	50 at 100 mc, 4 v	f_c = 5, R_s = 43
	HU	HC 7001	88	6	130	360; 39	
		HC 7002	120	12	80	330; 36	
		HC 7004	170	20	60	270 5 mc; 30 50 mc	
		HC 7005	240 } 0.1 v	46	25	200 } V_{max}; 23 } V_{max}	
		HC 7006	88	14	25	175; 20	
		HC 7007	120	22	25	175; 20	
		HC 7008	170	32	25	175; 20	
	IR	6.8SC20	35, 0.1 v	2.5	200	37 at 50 mc, 10 v	Freq Range: 1 to 500 mc
		100SC2	470, 0.1 v	80	20		
	PS	V-7	18	3	25	18; 43	
		V-10	26	4.3	25	18; 43	
		V-12	31	5.2	25	18; 43	
		V-15	39	6.5	25	18; 43	
		V-20	50	10	20	19; 40	Types V-7E to V-56E duplicate Types
		V-27	70	14	20	16 50 mc; 34 50 mc	V-7 to V-56 in initial capacitances but
VHF		V-33	85 } 0.1 v	17	20	15 } 4 v; 31 } V_{max}	have voltage ratings about four times
		V-39	100	20	20	15; 32	higher and minimum capacitances of
		V-47	120	24	20	15; 32	one-half as much
		V-56	145	32	15	14; 25	
		V-68	175	39	15	14; 26	
		V-82	210	47	15	13; 24	
		V-100	260	57	15	11; 20	
	PH	T-1606	35, 0.5 v	8	30	20 at 50 mc, 0.5 v	
	SY	D-1156	4, 0.1 v	0.5	20		
	TR	SC-1	24	4.4	22		9
		SC-2	48	8	22		4.5
		SC-3	90	15	18	350 at 5 mc, 4 v	3.0
		SC-5	120 } 0.1 v	25	11	33 at 50 mc, 4 v	1.8 } R_s
		SC-7	165	55	9		1.5
		SC-11	245	85	6		0.9
		SC-15	360	120	6		0.6

(a) f_c = cutoff freq in kmc = $1/2\pi R_s C_{min}$ (b) R_s = equiv series resistance in ohms
(c) for SHF, UHF units junction cap. only (d) maximum peak inverse voltage (e) $Q = 1/\omega R_s c$

Selection Guide

INCREASING INTEREST in the use of voltage-variable capacitors has resulted in queries as to what types are available. In applications where several types could be used, the most suitable type, whether ferroelectric or back-biased diode, can be chosen on the basis of logical evaluation.

Proper choice involves simultaneous consideration of several factors for each type in terms of the basic requirements of the circuit to be used.

BACK-BIASED DIODE OPERATION—In silicon junction diodes the density of charge carriers at a *p-n* junction is reduced to almost zero as a reverse voltage is applied across the junction. This region of zero-charge density, the depletion region, is not only swept clear of charge carriers but actually widens as reverse bias is increased. The two conducting areas act as two metal plates. The distance between the plates is a function of the applied voltage.

To prevent clipping, the junction must be sufficiently back-biased to prevent the signal-voltage swing from causing the net voltage across the junction to go positive. Diode capacitors show only a slight dependence on temperature.

FERROELECTRIC OPERATION—Ferroelectricity in a material can be described as a spontaneous polarization due to alignment of permanent electric dipoles, displacement of the positive and negative ions relative to each other and displacement of the center of gravity of the negative charge of the electrons relative to the positive nucleus.

Ferroelectricity occurs if any of these mechanisms are active without the application of an external electric field. Barium titanate is the most important practical ferroelectric.

In the ceramic from which practical capacitors are formed, the barium titanate is made up of many particles whose spontaneous dipoles are randomly oriented; hence, there is no net polarization before application of an electric field. When d-c bias is applied some of the dipoles align themselves with the field, decreasing the dielectric constant. As the biasing field is increased, more of the dipoles are reoriented, and the dielectric constant continues to decrease until saturation is reached.

Ferroelectric capacitors can be biased in either the positive or negative direction and are sensitive to temperature.

TABLES — Initial capacitance is the small-signal capacitance at zero or near zero bias. Minimum capacitance is the small-signal capacitance at V_{max}, the highest bias at which the device can operate.

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Table II—Typical Ferroelectric Capacitors

Freq.	Manufacturer and Type No.	Initial Cap. (μμf)	Min. Cap. (μμf)	V_{max}[d] (volts)	Q[e]
UHF to AUDIO	UM EDG-HS24F1[a]	ϵ_{max} = 4,100 at 0 v, 30 C	ϵ_{min} = 500	200 v/mil at 30 C	205 at 0 v, 50 mc; 8X greater at 200 v/mil
	UM ———[a,b]	125 at 0 v, 25 C	9	±400 at 25 C	18 at 0 v, 87 at 400 v (100 mc, 25 C)
	SP V-11	120 μμf to	80	±250	Minimum of 30
	V-23	0.05 μf	0.025 μf	±250	Minimum of 30
VHF to AUDIO	MU VSR	400 μμf to	88	±300	
	LVSR	0.1 μf	0.022 μf	±300	
	VSE	60 to	36	±200	
	LVSE	300	180	±200	

Glenco Material 393 — Used for storage applications
Ferroelectric material may be available from: Aerovox, Centralab, Mullenbach

(*a*) Experimental unit (*b*) Can be made in values from 0.6 μμf to 0.1 μf
(*c*) ε = dielectric constant (*d*) Function of dielectric strength (*e*) $Q = 1/\omega R_s C$

MFR'S KEY

BL — Bell Telephone Labs
HU — Hughes
IR — International Rectifier
MA — Microwave Associates
MU — Mucon Corp.
PH — Philco
PS — Pacific Semiconductor
SP — Sprague
SY — Sylvania
TR — Transitron
UM — University of Michigan
WE — Western Electric

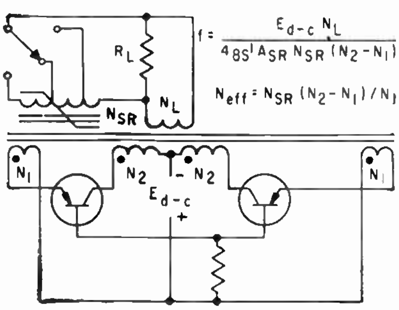
New magnetic-coupled multivibrator circuits permit wide-range step-by-step and continuous control of output frequency without adversely affecting waveform. Circuit variations also permit independent control of output voltage

By **WILLIAM A. GEYGER,** U. S. Naval Ordnance Laboratory, Silver Spring, Md.

Frequency Control of

MAGNETIC-COUPLED transistor d-c to a-c converters usually provide square-wave outputs with frequencies dependent on d-c input voltage. Output frequency of one type of magnetic-coupled multivibrator is controlled by a d-c bias, but the shape of the output square wave is adversely affected.

A basic circuit has been developed in which output frequency can be controlled step-by-step and/or continuously over wide frequency ranges. Variations of the circuit also provide step-by-step and/or continuous control of output amplitude.



$$f = \frac{E_{d-c} N_L}{4 B_S' A_{SR} N_{SR} (N_2 - N_1)}$$

$$N_{eff} = N_{SR} (N_2 - N_1)/N_1$$

FIG. 1—Saturable reactor in parallel with load permits step-by-step control of output frequency

A low-power (10-watt) prototype multivibrator circuit has been developed as a square-wave generator for magnetic-amplifier transient analyzers[1] and magnetic-switch B-H loop tracers[2]. These and similar applications require a clean output waveform for proper operation of the silicon diode chopper circuits.

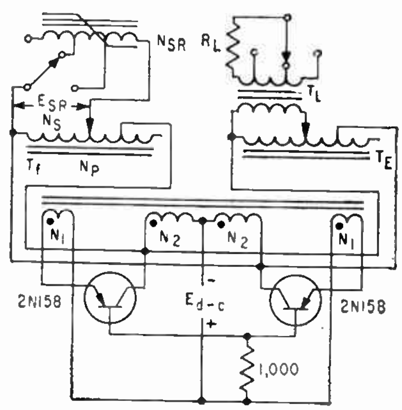
Because output frequency of the multivibrator can be made directly proportional to angular position of a variable transformer slider shaft, the new circuit may be used as a high precision transducer to convert angular (or linear) displacement to a corresponding frequency shift. Movement or rotation of the shaft may be controlled remotely with a conventional servo system. These characteristics suggest application of the circuit to telemetering systems.

Frequency Control

Earlier transistor d-c to a-c converters use a saturable transformer with rectangular hysteresis loop core material[3, 4]. They are finding increasing applications as square-wave power supplies for magnetic amplifiers, induction motors, gyros and torque relays.

These magnetic-coupled multivibrators are widely used in d-c power-supply devices, where low-voltage d-c is converted to a square-wave a-c, transformed to a high voltage level and rectified.

The linear relationship between multivibrator output frequency (f) and d-c input voltage (E_{d-c}) is desirable for telemetering-transducer applications. However, in designing test circuits for magnetic amplifiers, it is necessary to vary frequency independently of supply voltage.



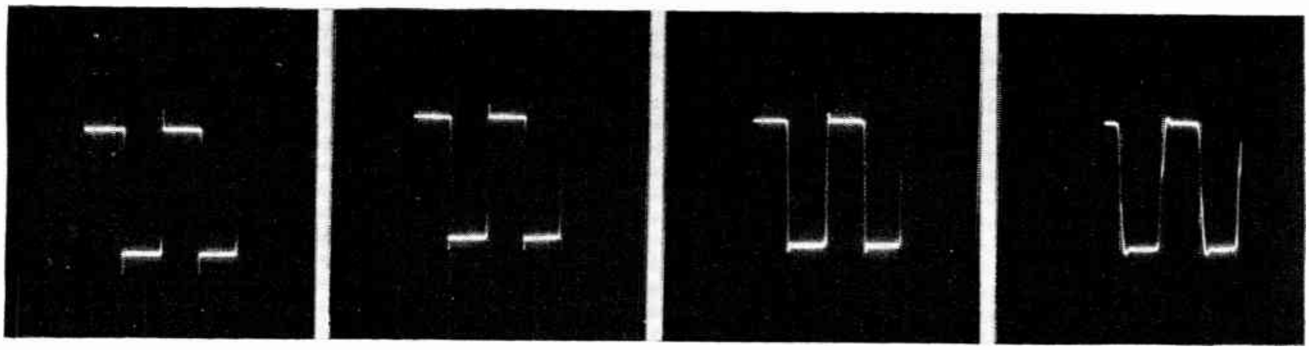
$$f = \frac{E_{d-c}}{4 B_S' A_{SR} N_{SR}} \cdot \frac{2N_2}{N_2 - N_1} \cdot \frac{N_S}{N_P}$$

$$N_{eff} = \frac{N_{SR} N_P (N_2 - N_1)}{2 N_2 N_S}$$

FIG. 2—Variable transformers across collector windings provide linear control of frequency and output voltage

In the variable-frequency magnetic-coupled multivibrator developed by Van Allen[5], frequency is controlled by varying a d-c voltage applied to additional windings of a twin-core arrangement similar to that of self-saturating magnetic amplifiers. Core flux, instead of swinging between saturation levels as in earlier converters, is reset to an unsaturated value on alternate half cycles. However, d-c bias magnetization of the cores has an adverse effect on the output wave shape.

Frequency of the magnetic-coupled multivibrator shown in Fig. 1 can be controlled without impairing output waveform by varying



Prototype of circuit in Fig. 2 produced these waveforms. Beginning at left, frequencies are: 55, 500, 3,000 and 20,000 cps

Magnetic Multivibrators

the effective number of turns of the transformer windings. Effective number of turns (N_{eff}) determines frequency in accordance with the basic relationship $N_{eff} = E_{d-c}/4\ B_s\ A_T\ f$ where B_s is saturation flux density of transformer core material in gausses and A_T is transformer core cross-sectional area in cm.

Operating Principle

It is impractical to vary the actual number of turns of the four transformer windings that operate in conjunction with the two switching transistors in Fig. 1. Therefore, additional components are used to vary effective number of turns through tapped windings and/or continuously variable transformers.

In working with the Campling circuit, the author discovered that frequency of a differential multivibrator can be varied within wide limits without changing magnitude of output voltage. To control frequency, a saturable reactor with rectangular hysteresis loop core material is connected in parallel with the load terminals, as in Fig. 1. The effective number of turns of the saturable reactor are then varied to make step-by-step changes in frequency.

Further investigations revealed that the loading saturable reactor may be placed across an addition transformer winding or the collector terminals, either directly or with additional transformer components. If the product $B_s'\ A_{SR}\ N_{SR}$ of the saturable reactor, shunted across both collector windings, is smaller than the product $B_s\ A_T\ (N_2 - N_1)$ of the transformer, output frequency is solely determined by the saturable reactor. The transformer then operates with the two switching transistors merely as an unsaturated isolation transformer with correspondingly reduced core losses.

With the saturable reactor in parallel with the load, frequency is inversely proportional to N_{SR} and directly proportional to N_L. By varying the actual number of turns of a secondary winding in Fig. 1 with properly distributed taps, it is possible to control frequency directly.

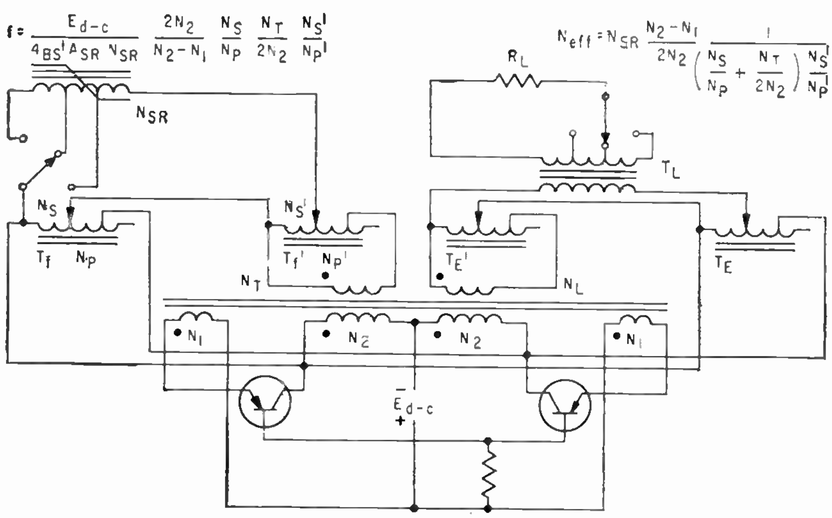


FIG. 3—Multiple-control multivibrator has coarse and fine control of both frequency and output voltage

Continuous Control

Figure 2 illustrates a convenient method for controlling frequency with a standard low-power variable transformer, T_f. This circuit arrangement permits wide-range step-by-step frequency control by varying the taps of reactor N_{SR} and contínous frequency control by moving the slider of variable transformer T_f without changing magnitude of output voltage. A second variable transformer, T_E, added to the circuit makes it possible to vary output voltage without affecting frequency.

Output frequency is directly proportional to N_s (actual angular shaft position of transformer T_f). Similarly, output voltage can be varied by changing the actual turns ratio of the second variable transformer, T_E. Transformer T_L isolates the load from the d-c source and permits selection of the range of output voltage (0-6, 0-30 and 0-150 volts).

Multiple Control

The multivibrator in Fig. 3 has coarse and fine adjusting transformers T_f, T_f' and T_E, T_E'. The large primary voltage for T_f and T_E (coarse adjustment) is the voltage across both collector windings. The small primary voltage for T_f' and T_E' (fine adjustment) is derived from two separate secondary windings.

With $N_T/2N_2 = N_L/2N_2 = 1/10$, fine adjustment of frequency and voltage output can be achieved by varying the slider positions of T_f' and T_E', respectively.

Design Problems

In designing the new magnetic-coupled multivibrator circuits, the fundamental principle for wide range frequency control consists in loading the original differential-type circuit with a square-wave loop core saturable reactor. Because the windings of the reactor should have low copper resistance, it is desirable to provide several groups of equally rated (preferably bifilar) windings. They may be either series or parallel connected to vary frequency step-by-step over wide ranges.

For optimum switching performance and to minimize spikes in the output square wave, magnetic leakage effects must be minimized. When using the turns ratio $N_1/N_2 = \frac{1}{2}$, the transformer can be considered to have $N_1 + 2N_1 + 2N_1 + N_1 = 6\ N_1$ turns acting as collector and emitter windings. Six twisted wires may be hand wound simultaneously around the core of the transformer to limit magnetic leakage between windings.

Although the core of the multivibrator transformer will always be unsaturated when operated at higher frequencies, it will operate with the lowest frequency between saturation levels in the same manner as conventional multivibrator circuits. It is therefore desirable to use rectangular hysteresis loop core material in the multivibrator transformer if the lower part of the frequency characteristic (Fig. 4) is to be used. However, when working only with higher frequencies, this transformer will never be saturated and will have correspondingly reduced core losses. For operation at higher frequencies, therefore, lower grade core material may be used.

The continuously variable transformer providing linear frequency control will never be saturated, so commercially available components may be used. However, to minimize magnetizing current requirements of the variable transformer, it is necessary to use standard low-power design. The scale of this transformer may be calibrated in cps for various values of d-c supply voltage and number of turns of the saturable reactor.

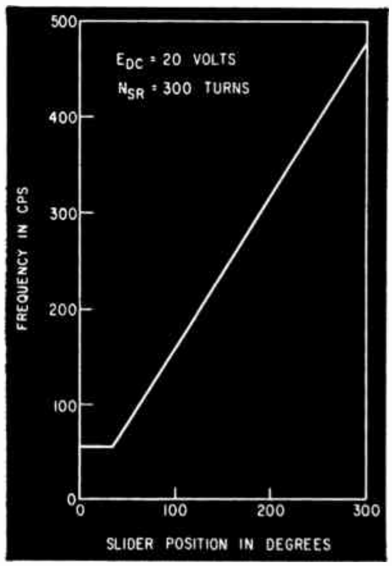


FIG. 4—Performance of circuit in Fig. 2 shows effect of reactor above 55 cps

Construction

The multivibrator transformer with Orthonol 2-mil tape core (inside diameter, 1.5 in.; outside diameter, 2.5 in.; tape width, 1.0 in.) has 6 x 275 turns of No. 24 (B & S) wire (6 twisted wires, hand wound, 6 x 2.5 ohms). It is connected so that N_1 has 275 turns and N_2 has 550 turns.

The saturable reactor with Orthonol 2-mil tape core (inside diameter, 1¼ in.; outside diameter, 1⅝ in.; tape width, 1.0 in.) has 6 x 75 turns of No. 22 (B & S) wire (6 twisted wires, hand wound, 6 x 0.4 ohm). A common-base resistor of about 1,000 ohms may be used.

Performance

Measured frequency as a function of the variable transformer slider position (actual angular deviation of the slider from its initial position in which N_s equals zero) is shown in Fig. 4. Within the initial range from zero to 30 deg, the saturable reactor remains unsaturated. The multivibrator transformer operates between saturation levels, as with conventional multivibrator circuits. Hence, the transformer alone determines frequency (in this case, 55 cps).

At higher frequencies (with the slider moved toward higher values of N_s), the saturable reactor starts to operate between its own saturation levels, while the transformer starts to become unsaturated. The saturable reactor takes over and becomes the frequency-determining factor from frequencies of 55 to 500 cps. Thus, with an input of 20 volts d-c and 300 turns on the reactor, smooth linear frequency control is possible from 55 to 500 cps. Higher frequencies (55 to 1,000 or 55 to 3,000 cps) may be obtained by reducing reactor turns (to ½ or ⅛ of the original number).

The spikes that appear in the waveform photographs of the output voltage as it appears across the load resistor are sufficiently small for the present applications. If they were objectionable, they could be eliminated by connecting small capacitors (0.05μf) between collector and emitter of each transistor.

REFERENCES

(1) W. A. Geyger, Magnetic-Switch Transient Analyzer, ELECTRONICS, Jan. 1956.

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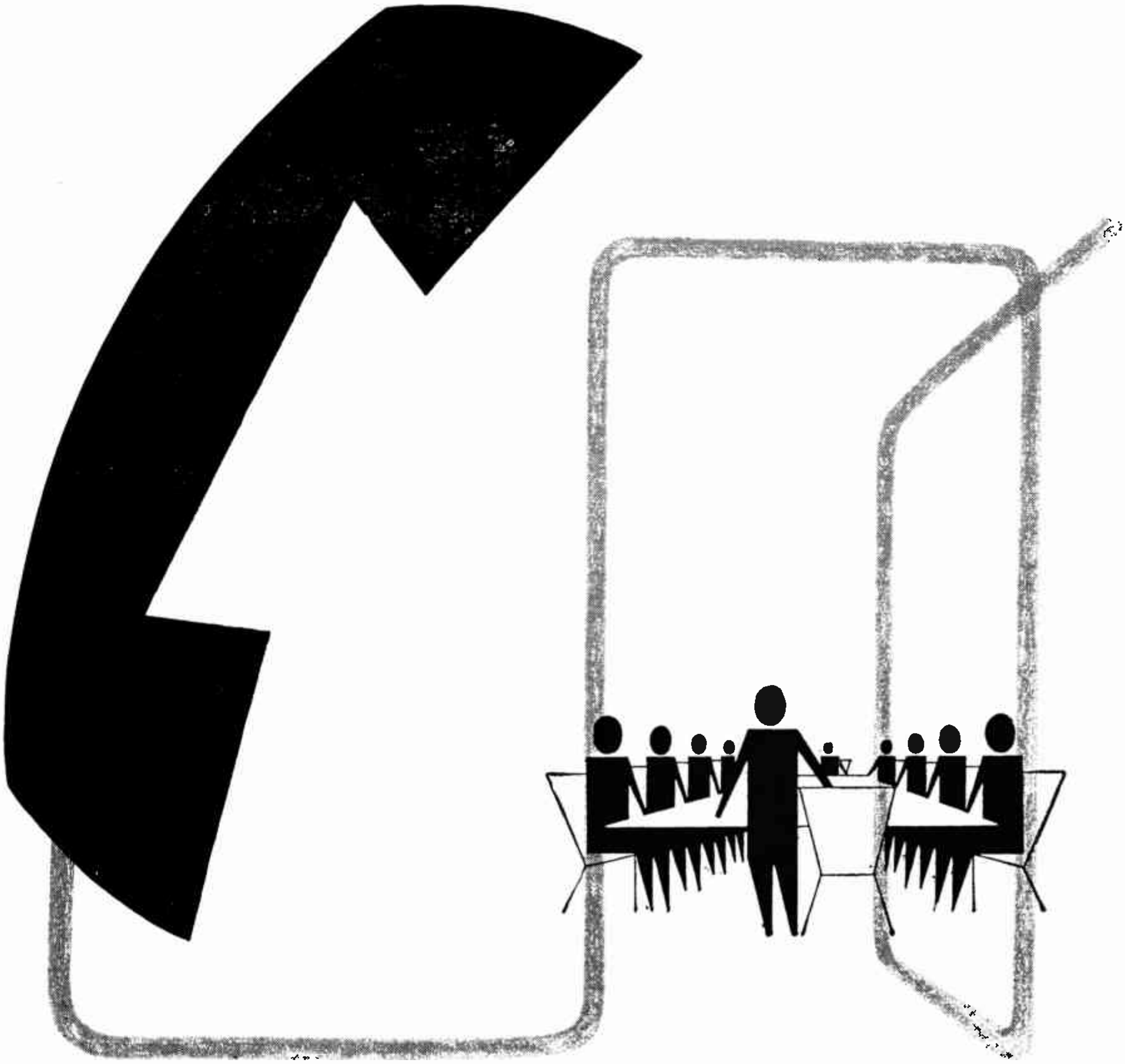
(4) C. H. R. Campling, Magnetic Inverter Uses Tubes or Transistors, ELECTRONICS, Mar. 14, 1958.

(5) R. L. Van Allen, A Variable Frequency Magnetic-Coupled Multivibrator, *AIEE Trans*, Part I, July, 1955.



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Electron Flight Velocity

Speed and time-of-flight of electrons moving across a potential difference are affected by relativity. Corrected velocities, sufficiently accurate for many engineering purposes, may be obtained directly from these graphs

By DANIEL LEVINE, Consulting Engineer, Glendale, Arizona

RELATIVISTIC CORRECTION should be considered when determining electron transit times in such devices as high voltage crt's. The correction becomes more pronounced as the difference in potential increases. Electron velocity may be found with sufficient accuracy for many engineering purposes by the graphs of Fig. 1.

The formulas for determining electron velocity follow. When an electron initially at rest is accelerated by a potential difference V, its final velocity v is: $v = c\sqrt{2eV_r/(2eV_r + m_oc^2)}$. V_r is the relativistic potential difference and is equal to $V + (eV^2/2m_oc^2)$. V is taken in volts and c, e and m_o are constants.

The influence of relativistic correction may be appreciated by comparing the electron velocity with the approximate value given by a variation with the square root of the potential difference. At 1 volt, velocity is 0.2 percent of the speed of light; at 100 volts, 2 percent; at 10 kv, 19.5 percent, as the relativistic correction affects the third significant figure. At 40 kv, velocity is only 37.4 percent of the speed of light.

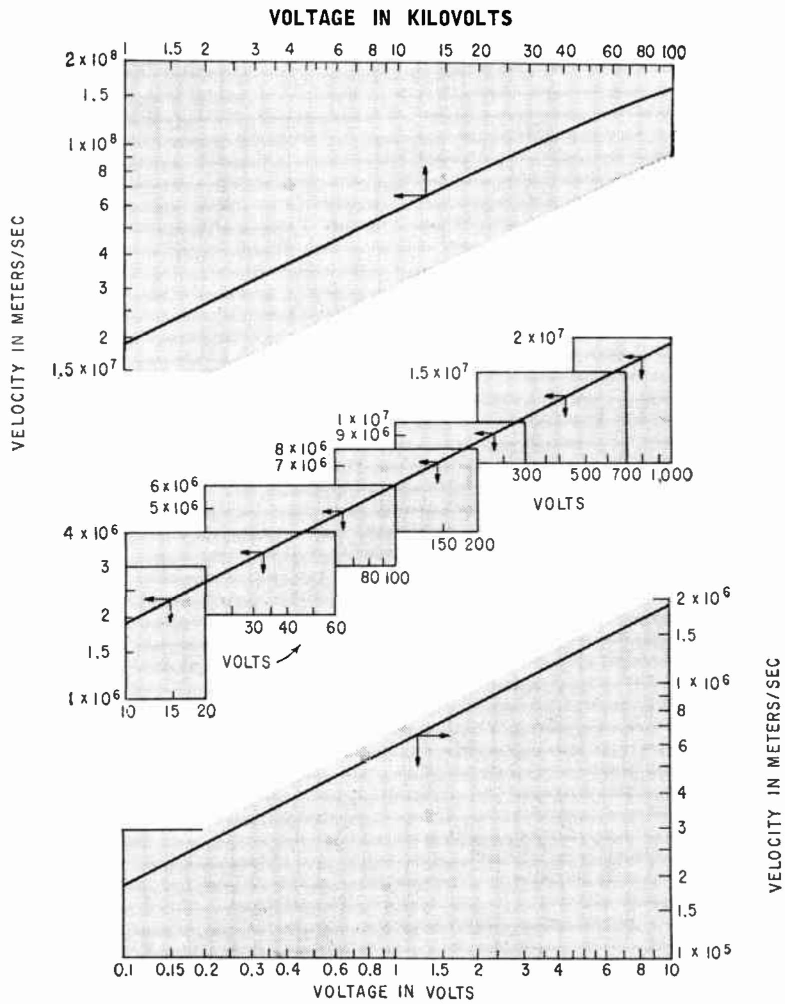

FIG. 1—Electron velocity in meters per second for (bottom to top) potential differences of 0.1-10 v, 10-1,000 v and 1-100 kv, as corrected for effect of relativity

Constants
- c = velocity of light = 299,792.5 km/sec
- e = electron charge = 1.60206×10^{-19} coulomb
- m_o = electron rest mass = 9.1083×10^{-31} kg

REFERENCE

L. Marton, C. Marton and W. G. Hall, Electron Physics Tables, NBS Circular 571, March 30, 1956

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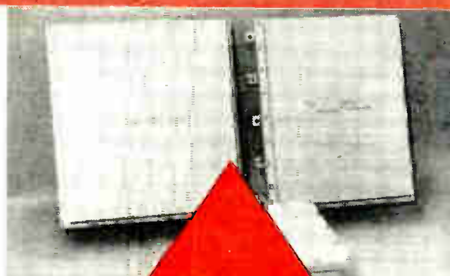
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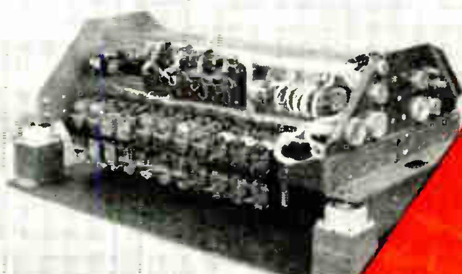
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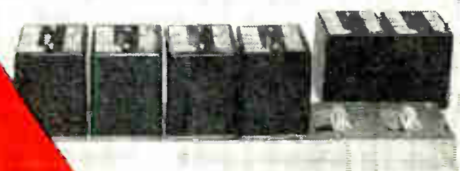
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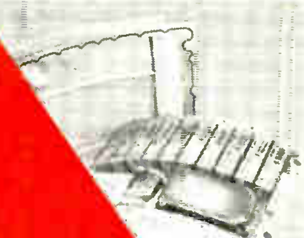
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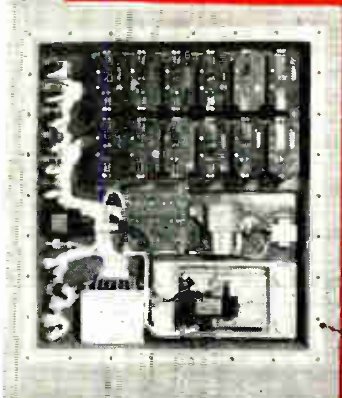
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10 Channel Package with Heat Exchanger

CIRCLE NO. 59 READER SERVICE CARD

Collision Detection Without Range Data

By Y. J. LIU and J. O. CAMPBELL, Aerosystronics Corp., Los Angeles, Calif.

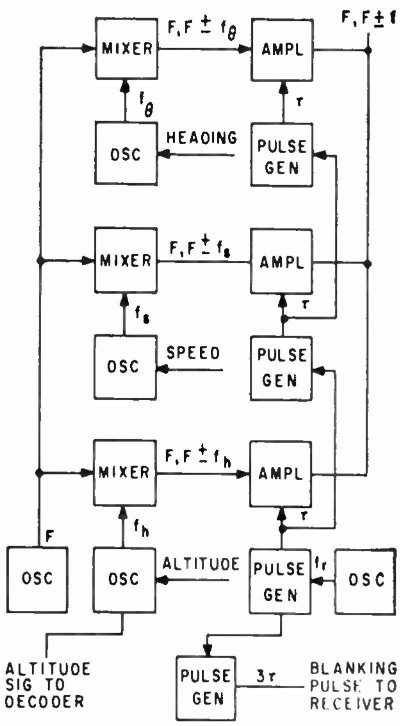

FIG. 1—Frequency-coded pulses transmitted by aircraft carrying equipment provide heading, speed and altitude data

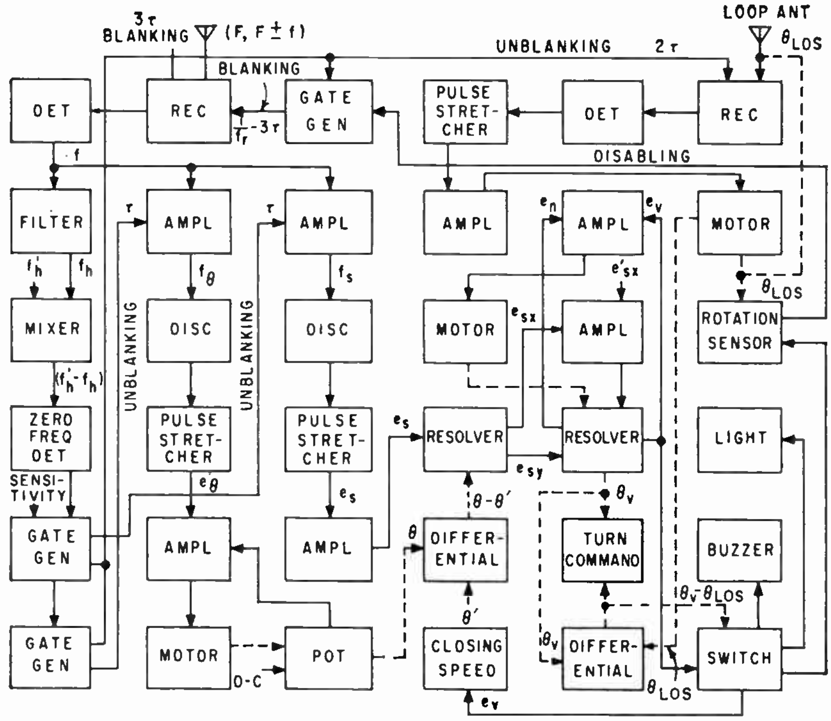

FIG. 2—When aircraft altitudes are about the same, speed and heading channels are opened to enable receiving aircraft to determine whether LOS coincides with relative velocity vector of two aircraft

AVOIDING AIRCRAFT collisions is taxing the imagination of engineers. Major considerations in designing such equipment are weight, cost, complexity and reliability. In addition, anticollision warning systems must not be susceptible to interference and must not interfere with other equipment.

The Anti-Collidor system, which does not require the attention of an operator, is based on a principle that does not require range measurement. The transponders used in some miss-distance type warning systems are therefore not needed. Transponders used for measuring range often require complex coding arrangements to eliminate the effects of interference.

Because the system to be described requires transmission in only one direction, range is greater. Also, the simpler computation required reduces complexity, cost and weight.

The Anti-Collidor is based on the principle that the relative velocity vector between two aircraft must coincide with the line-of-sight (LOS) between them for a collision to occur. Relative velocity of two aircraft near enough to the same altitude to collide is computed, and the LOS is determined. When the relative velocity vector is within a few degrees of the LOS, warnings are given that a collision is imminent. It is only necessary for the pilot to maneuver according to the steering command to eliminate the collision. Provision could be incorporated to make the autopilot execute the command if the pilot does not.

Operation

Carrier frequency F in Fig. 1 is separately mixed with frequencies f_h, f_s and f_θ, corresponding respectively to altitude, speed and heading of the aircraft carrying the equipment. Three frequency-coded pulses of duration τ containing these data are transmitted by sequentially keying on the normally biased-off transmitting amplifiers.

The first pulse, altitude frequency f_h, is received by aircraft in the vicinity, detected and subtracted from the altitude signal f'_h of the receiving aircraft. A zero-frequency detector triggers a gate gen-first in Performance Reliability and Quality

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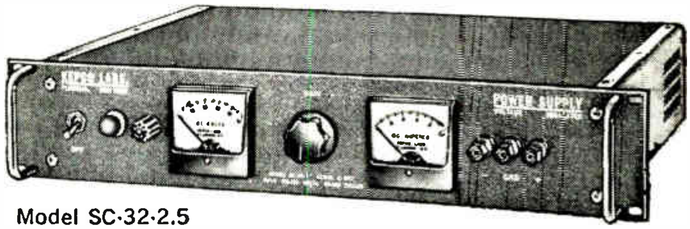

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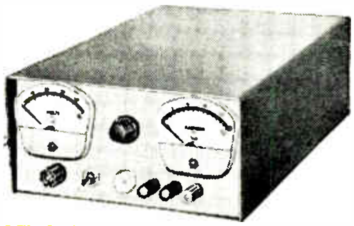

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SC-32-1.5	0-32	0-1.5
2SC-32-1.5	0-32	0-1.5
DUAL OUTPUT	0-32	0-1.5
SC-32-2.5	0-32	0-2.5
SC-32-5	0-32	0-5
SC-32-10	0-32	0-10
SC-32-15	0-32	0-15
SC-60-2	0-60	0-2
SC-60-5	0-60	0-5
2SC-100-0.2	0-100	0-0.2
DUAL OUTPUT	0-100	0-0.2
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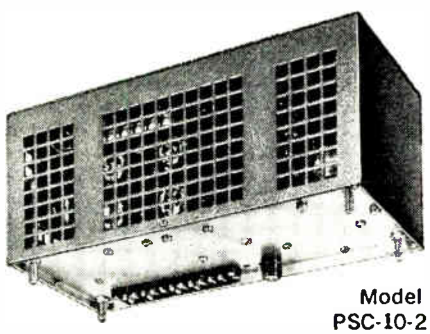

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PSC-15-2	12.5-17.5	2
PSC-20-2	17.5-22.5	2
PSC-28-1	22.5-32.5	1
PSC-38-1	32.5-42.5	1

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erator to unblank the speed and heading channels if the two aircraft are at nearly the same altitude, as shown in Fig. 2.

Speed and heading frequencies are fed to frequency discriminators that provide two video pulses. The two pulses are stretched producing d-c voltages of amplitudes e_x and e_θ. Heading voltage e_θ is amplified to drive a potentiometer to a position corresponding to heading angle θ of the transmitting aircraft. Heading angle θ' of the receiving aircraft is subtracted from θ and the difference positions the resolver rotor.

Air speed voltage e_x is fed to the same resolver, producing resolver output voltages e_{xx} and e_{xy} proportional to the longitudinal and lateral components of the transmitting aircraft velocity vector. These vectors are resolved into the longitudinal and lateral coordinates of the receiving aircraft.

Relative Velocity

Air speed of the receiving aircraft, e'_{xx}, is summed with the longitudinal component of transmitting aircraft velocity. The two voltages available represent the longitudinal and lateral components of the relative velocity between the two aircraft as measured in the coordinates of the receiving airframe.

The two voltages are fed to another resolver, one of whose outputs is a voltage e_n. Voltage e_n is amplified and drives a motor geared to the resolver rotor causing the rotor to assume a position that makes e_n equal to zero. This rotor position represents the angle θ_r of the relative velocity vector as measured from the heading of the receiving aircraft.

The other resolver output e_r is proportional to the relative velocity vector. Voltage e_r controls gain of the amplifier in the resolver servo loop and is also connected through a switch to a closing speed meter.

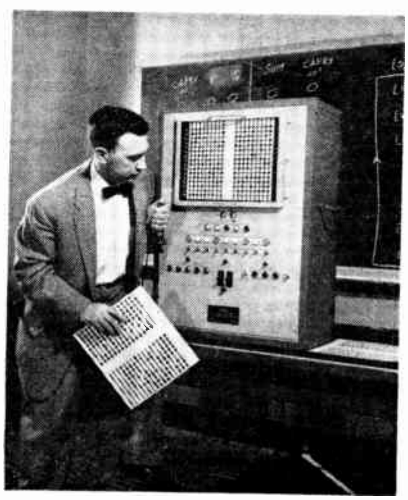
Angle θ_r of the relative velocity vector is compared with the angle θ_{LOS} of the LOS to the transmitting aircraft by differential gears. When $\theta_{LOS} - \theta_r$ is within a few degrees, a collision may be imminent. Consequently, a switch is activated to turn on a blinking red light and sound a buzzer. A right or left turn command is given to advise the pilot of the quickest maneuver to alleviate the threat of collision.

Angle θ_{LOS} is determined by direction finder DF. The normally biased off DF receiver is unblanked by the same pulses that unblank the speed and heading decoder channels. Hence, the DF homes on the same signals that are being decoded by the decoder receiver.

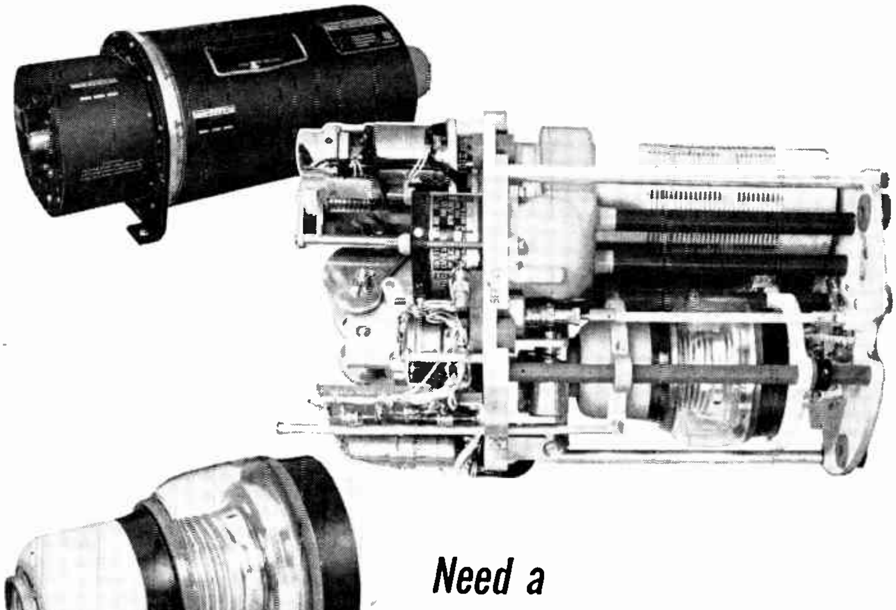
To keep signals transmitted by other aircraft from entering the system while the computer is processing speed and heading signals, the receiver is blanked except when signals from the aircraft being computed are arriving. The trailing edge of the heading channel unblanking pulse triggers a gate generator. The generator sends to the decoder receiver a blanking pulse of duration $(1/f_r) - \tau$.

A rotation sensor determines when the null axis of the DF antenna coincides with the LOS. Normally, the sensor then generates a disabling signal for the blanking generator so that signals from nearby aircraft may be received. However, if a collision is imminent, the rotation sensor is prevented from disabling the blanking-gate generator. Thus the system is kept locked on the signals from the colliding aircraft, until an evading maneuver is made.

Trainer Shows Digital Computer Operation



SPUD, developed at Bell Labs, is a miniature data processor that can be programmed for logic or arithmetic operations. It was designed to train students in operation of digital computers



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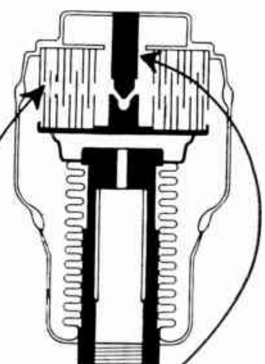

Apparent requirements, in this application, were for two capacitors and a shorting relay to allow switching from a high voltage capacitor to a low voltage capacitor, or switch both capacitors out of the system completely. Space limitations, however, presented an obstacle.The problem was solved by designing one capacitor with two sets of plates of different lengths which by sliding in and out would meet the different voltage and capacitance requirements. It has a test voltage rating of 5 kv at 750 mmfd increasing to 23.5 kv at 40 mmfd and 30 kv at 10 mmfd. A switch is incorporated inside the vacuum to short out the total capacity under very high frequency operation. This also has the added advantage of having a common starting point, or a pre-set point, for the automatic tuning mechanism.

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CIRCLE NO. 63 READER SERVICE CARD

Can Tube Testing Spot Early Failures?

By M. GOETZ and R. H. JOHNSON, Westinghouse Electric Corp., Baltimore, Md.

RECEIVING INSPECTION procedures for vacuum tubes, as employed by an avionics equipment manufacturer, were thoroughly evaluated both for the effectiveness of the program and the costs of the various testing procedures in use.

Through statistical techniques, as well as engineering judgment, recommendations for changing testing procedures were arrived at that would decrease the cost of tube inspection without decreasing reliability[1].

The incoming inspection procedure evolved over a period of several years to this extensive stage. In the beginning, tubes were tested in the same manner as other electronic components, that is they were sampled to determine compliance with the specifications. Extremely high failure rates in the field, however, led to new studies. And entirely new testing procedures found their way into the incoming test specifications of almost every electronic manufacturer in the country.

It is important to mention that that the basic reason for subjecting tubes to the new tests was the belief, widely held, that these tests were capable of weeding out tubes which would fail early in their operational lives.

The study made it necessary to test every tube. And in all, almost 400,000 tubes were tested.

Test Analysis

Table I presents a summary of all tests performed on the 368,409 incoming tubes, as well as results of the tests. Table II presents two different breakdowns of the electrical defects located by the MIL-E-1 tests. This should serve as an indication of the relative testing effort to be put forth in checking various aspects of tube performance. Table III presents a summary of visual defects. The history of each of the 271 tube types which were purchased in the past two years were studied. In a detailed failure rate analysis record for all tube types, it was found that 82 percent of the tube types which accounted for almost 96 percent of all tubes purchased, exhibited electrical failure rates of less than 4 percent.

The study indicated that tube types with past failure rates of less than 1.5 percent should receive reduced sampling. Tube types with past failure rates between 1.5 and four percent should receive normal sampling. And tube types with past failure rates above four percent should receive 100 percent inspection.

Table I—Summary of Tests Performed on 368,409 Tubes

Tests	Number of Incoming Tubes Tested	% of Incoming Tubes Tested	Number Rejected	Test Rejection Rate %	% of Total Rejects	% of Incoming Tubes Rejected
MIL-E-1						
Visual	7,806	2	234	3	0.9	0.1
Electrical	366,969	99	6,845	1.8	25.9	1.8
Noise, Micro	259,864	71	1,581	0.6	6	0.4
T-552986 [a]						
Visual	350,995	95	17,730	5.1	67	4.8
Electrical	25,459	7	6	....	....	...
X-ray	88,816	24	39	0.04	0.2	...
Totals	....	....	26,435	2.4	100	7.1

a—Westinghouse test, similar to that in MIL-E-17751

Table II—Electrical Defects

BREAKDOWN BY DEFECT CATEGORY

Category	Quantity	% of all Elec. Def.
Permanent shorts	257	3.8
Permanent opens	207	3
Intermittent shorts	55	0.8
Intermittent opens	11	0.2
Filament defects	30	0.4
Outside electrical limits	6,030	88.1
Grid currents	225	3.3
Misc. elec. def	30	0.4
Totals	6,845	100

BREAKDOWN BY MAJOR DEFECTS

Defect Description	Quantity	% of all Elec. Def.
Heater-cathode leakage	3,410	49.8
Low transconductance	1,317	19.2
High plate current	222	3.2
Low plate current	247	3.6
Open filament gas discharge	100	1.5
Heater cathode short	124	1.8
High transconductance	119	1.7
Outside voltage limits	114	1.7
Positive control grid current	109	1.6
Totals	5,762	84.1

Why Tubes Fail

An Air Force Study[2] to evaluate incoming inspection electron tube

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by John Hickey,

Raytheon Industrial Products Manager:

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RAYTHEON MISSILE SYSTEMS DIVISION

Table III—Visual Defects

BREAKDOWN BY DEFECT CATEGORY

Category	Quantity	% of all Elec. Def.
Envelope defects	1,022	5.8
Mechanical defects	16,708	94.2

BREAKDOWN BY MAJOR DEFECTS

Defect Description	Quantity	% of all Vis. def.
Exposed heater [a]	8,262	46.6
Loose conducting particles	3,519	19.8
Spacing closer than 0.010 in	1,613	9.1
Elements of a weldment reduced ½	1,254	7.1
Broken or cracked bulb, tip or base	931	5.3
Heater creeping out of top of cathode	496	2.8
Dangling particles form by overweld	337	1.9
Totals	16,412	92.6

a—Three lots contributed 6,920 of the 8,262 defectives

testing programs as a means of improving airborne equipment reliability in the field came to the overall conclusion that tube testing, as we now perform it, does not materially increase tube reliability. This is probably due to our incomplete knowledge of the mechanism of tube failure, since we are not able to design tests which can clearly differentiate between a tube that will be long lived, and one that will fail early in life.

The obvious conclusion to be drawn from all this is since we do not know how to test tubes in a manner which can increase field reliability, and since excessive tube handling is suspected to hurt tube reliability, it is probably best to keep tube testing to a minimum.

Conclusions

From this survey, it appears that MIL-E-1, Noise and Microphonic Tests and Westinghouse T-552986

Electrical & X-Ray tests (similar to MIL-E-17751) do not locate sufficient defects to make these tests worthwhile. These tests yield rejection rates of less than one-half percent.

The overall rejection rate from all tests is about 2.5 percent for over one million individual tests. Eighty eight percent of all tubes rejected for electrical reasons were rejected because they were outside electrical limits. Almost 70 percent of all tubes rejected for electrical reasons were rejected specifically for heater-cathode leakage and low transconductance.

The overwhelming majority of tube types exhibit low electrical failure rates. While 1.75 percent of all tubes used in the factory are rejected, only 0.42 to 0.46 percent are rejected for legitimate reasons as far as tube inspection is concerned. The remainder consists of tubes rejected because of damage sustained in handling, circuitry problems, or good tubes falsely rejected.

Field Failures

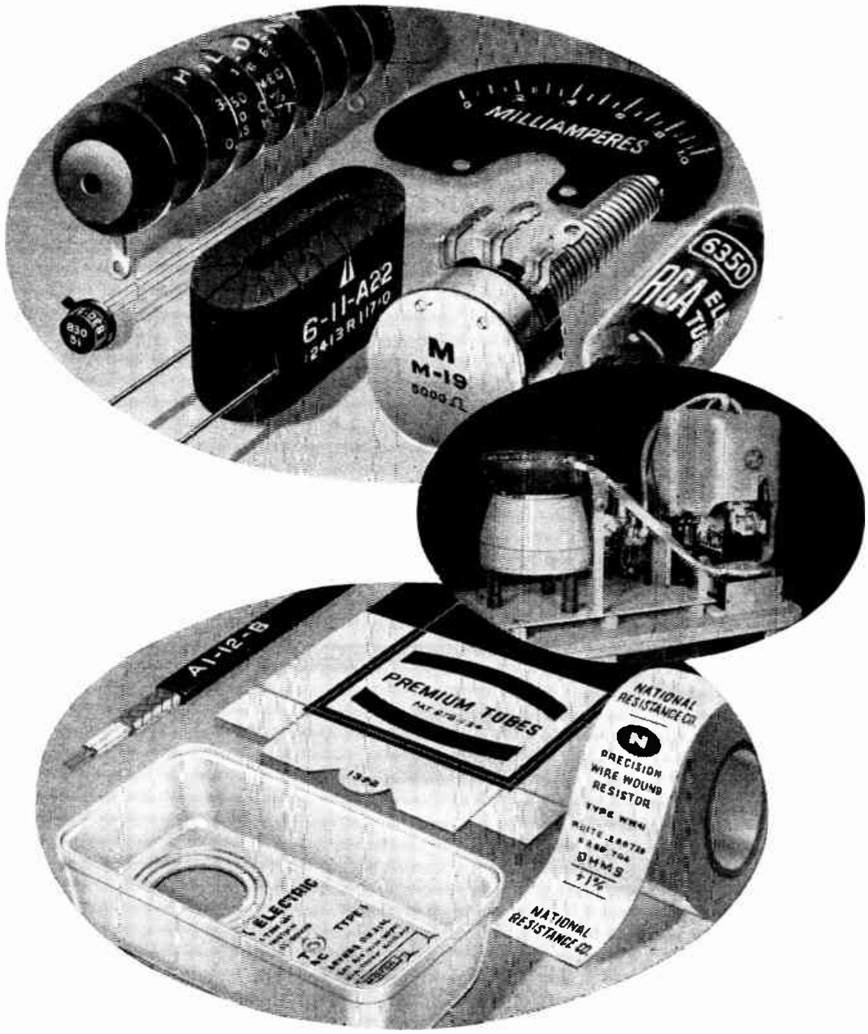
Field tube rejections analyzed by ARINC[2] have shown that elaborate tube testing procedures do not materially increase reliability in the field. It would appear from the ARINC results that visual testing of tubes does not weed out potential early tube failures. It would also appear that the only test performed which is valid in terms of factory and field experience is the MIL-E-1 Electrical Test.

A saving can be effected without significantly increasing either factory or field rejections. The optimum test procedures as relates to extent of inspection can be determined quantitively, as a function of the trade-offs between testing costs and shop replacement costs.

Although the optimum test procedures under certain conditions is no testing at all, this procedure is ruled out, since it may result in decrease in tube quality level.

REFERENCES

(1) M. Goetz & R. H. Johnson, Economically Optimum Receiving Inspection, Fifth National Symposium on Reliability & Quality Control, Jan. 1959.
(2) Evaluation of Incoming Inspection and Selection Procedures for Electron Tubes. Aeronautical Radio, Inc., Publication 117, Washington, D. C., Apr. 4, 1958.



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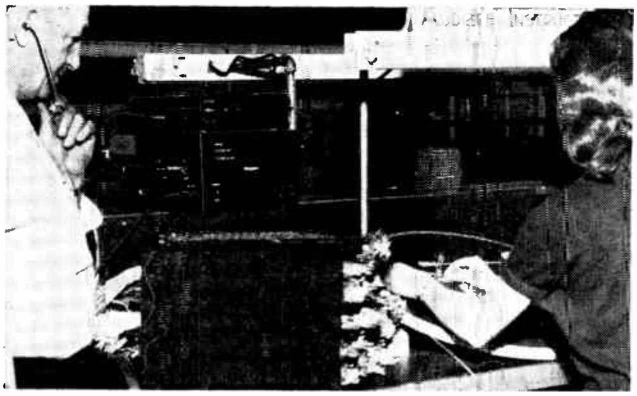


Supervisor listens in with stethoscope-like headset as tape tells girl how to assemble wiring harness

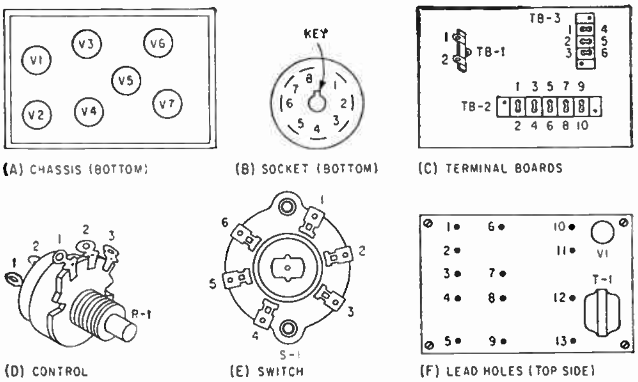


FIG. 2—Identification of components, terminal positions and lead holes for verbal instructions

RECORDED INSTRUCTIONS in wiring, assembly, soldering and inspection procedures can be used to reduce assemblers' learning time and errors, according to results reported for Audio Instructed Manufacturing Operation (AIMO), developed by Westinghouse Electric Corp. and Dictaphone Corp.

Dictaphone is manufacturing the equipment and is also using it in its recording machine plant, Bridgeport, Conn. Fig. 1 shows time taken when the same operator wired a chassis alternately using Aimo and a work sheet technique. Assemblers need not read blueprints, written instructions are often eliminated, supervisory time is conserved and methods changes can be rerecorded in the tape.

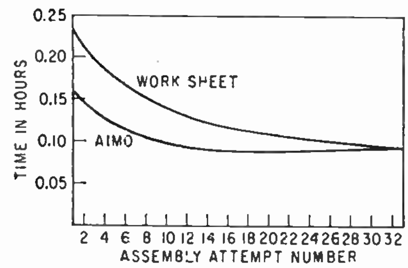


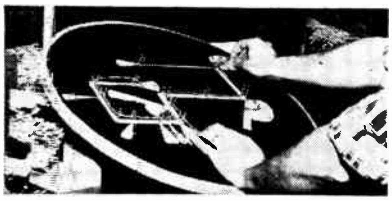
FIG. 1—Learning and productivity curves

Assembly steps are recorded by a process engineer or methods man preparing the model. Two-second intervals are provided between instructions by a block space button which also registers the instruction number. Tape is magazine-loaded ¼ inch Mylar with ½ hour capacity on each side.

Playback unit is a modified Dictet transcriber. It normally transmits through a loop antenna encircling 1 or more work stations. The assembler wears a transistorized audio induction receiver. Supervisors can listen in with a plug-in headset. A loudspeaker may be used and any number can be instructed at once. However, a group should be separated after an initial period to avoid limiting the pace to that of the slowest learner.

Playback Control

Playback is controlled by the assembler with a foot control. One pedal is a rest position. A second interrupts playback and rewinds to repeat instructions. The number of instructions rewound is shown by a block stop signal light. The other pedal advances the tape again. Playback speed is adjustable.



Antenna is looped around harness wiring board

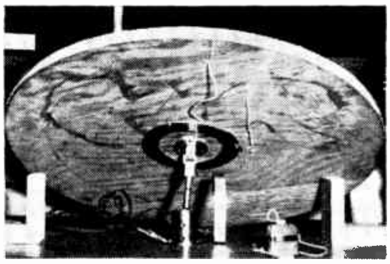
For bench assembly of harnesses, Dictaphone runs the loop antenna around the edge of the harness board. The board shown is a work positioning type mounted on a universal joint. The signal is fed to the hook-shaped spring contact on the table. A wide ring of aluminum under the board rides on the contact. The loop is connected to the ring.

Instructions are keyed to wire color and wire positions marked on the board. A typical instruction may be "(take) red and white wire G-15 . . . . (place end at) 1 . . . route through A and B to 12 . . .". At the close, the assembler is told how to fill out the job ticket.

When large harnesses require the operator to walk around the work table, the pedals are replaced by hydraulic tubes laid on the floor.

Chassis Assembly

A standard method of identifying parts and part locations has been devised by T. V. Serra to adapt verbal instructions to chassis and cir-



Underside of harness board. Hook and ring carry signal to loop as board tips and rotates on universal joint

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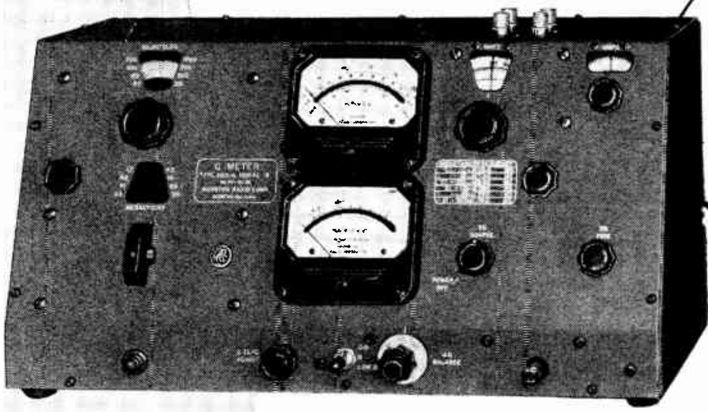
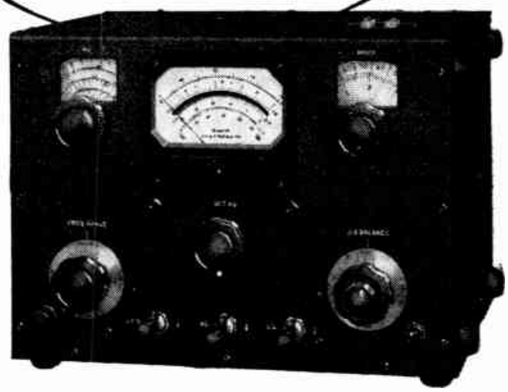
Model 190-A Q Meter





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BRC Q Meters are versatile, general-purpose instruments with a broad field of application in the laboratory and on the production line. They are designed to measure coils, capacitors, resistors, transformers, dielectrics, networks and filters through either series or parallel connection to a calibrated resonant tank circuit.

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Freq. Range:	20 Mc. to 260 Mc.	50 Kc.* to 50 Mc.
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Total Range:	5 to 1200	10 to 625
Low Range:	10 to 100	10 to 60
Δ Q Range:	0 to 100	0 to 50
Q Accuracy:	±7%* 20 Mc. to 100 Mc. ±15%* 100 Mc. to 260 Mc. *for circuit Q of 400 read directly on indicating meter.	±5%* 50 Kc. to 30 Mc. ±10%* 30 Mc. to 50 Mc. *for circuit Q of 250 read directly on indicating meter.
Capacitor Range:	7.5 to 100μμf	30 to 460μμf
Capacitor Accuracy:	±0.2μμf, 7.5-20μμf ±0.3μμf, 20-50μμf ±0.5μμf, 50-100μμf	±1% or 1μμf, whichever is greater.
Price:	$875.00 F.O.B. Boonton, N. J.	$850.00 F.O.B. Boonton, N. J.

*1 Kc. to 50 Kc. with external oscillator.

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Some recent examples of Lockheed's work in this field include: measurements of the electrical, mechanical and thermal characteristics of certain semiconductors such as titanium dioxide and lead telluride; investigation of means for direct measurements of structural relaxation in diphenyl metachloride in the frequency range from 10 to 10,000 cps; laboratory and field tests on new ceramic pyroelectric transducers for direct measurement of heat absorption rate; and the investigation of the response of dynamic pressure gauges and microphones to transient heating.

Other current efforts include the design of a low-input-impedance amplifier for use with piezoelectric vibration pick-ups; development of a compact, multiple-filter circuit for in-flight analysis of vibration data; and development of simple hand-held devices for preflight field calibration of accelerometers and pressure gauges.

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cuit board assembly. However, when part numbers are silk screened on the chassis, the numbers are used in preference to the code.

The assembler places the chassis or circuit board in its as-installed position and mentally divides it into vertical columns. The top socket in the left hand corner is V1 and so on as shown in Fig. 2A. Other parts are similarly numbered. Terminals are identified as in Figs. 2B, 2C, 2D and 2E. Lead insertion holes in circuit or resistor boards are numbered as in Fig. 2F.

Recorded terminal code numbers are, for sockets, V1-1, V1-2, etc.; for terminal boards, TB1-1, TB1-2,

Parts used with transcriber include foot pedal, hearing-aid type receiver, headpiece and loudspeaker

Methods man uses harness model in dictating instructions

etc. This procedure is followed with all terminals on all sockets, terminal boards and other parts on the chassis. Each instruction identifies a part, its location, hookup wires, wire routing to another terminal and any special soldering or assembly techniques required by the step.

Wheeled Cart Aids in Radio System Assembly

WHEELED CARTS combining hardware and sub-assembly staging with convenient work space in a single mobile unit are aiding final assembly of microwave telecommunications systems at Lenkurt Electric

Cart is combination parts store, workbench and blueprint file

Company, San Carlos, Calif. The firm's radio relay equipment shelves are mounted in vertical racks of standard sizes used in the telephone industry. The heavy racks are assembled in a horizontal position, supported on stands at a convenient working height of about chest-level.

Technicians working on the racks use the cart's bench space for pre-assembly of waveguides and other equipment. Components, miscellaneous small parts and hardware are available in 25 small parts bins arranged vertically at one end of the cart. Two large drawers under the bench area store wiring diagrams and prints. Additional shelf space is used for large sub-assemblies, metal shelves and dust covers. Only sub-assembly units and major components have to be drawn for each rack assembly.

Titanium Racks Help Aluminum Anodizing

ANODIZING RACKS made of titanium are recommended for aluminum anodizing by Mallory-Sharon Metals Corp., Niles, Ohio, a producer of titanium. Although commercially pure titanium is attacked by sulfuric acid, in anodizing operations it receives an anodic coating which protects it from the acid and most bright dip solutions. The coating is electrically conductive, which assists in uniformity of color anodizing. The racks do not have to be stripped and repair costs are about $1 a year per rack, the firm states.

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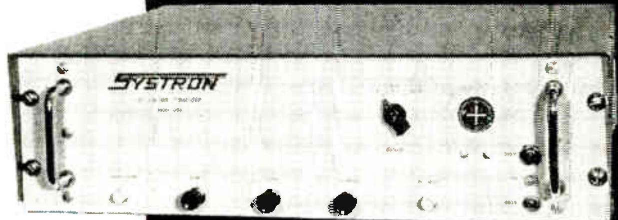

FEATURES:
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- 10 Millisecond Conversion
- .05% Accuracy

PROVIDES:
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- ± Microvolts to 1000 Volts
- 1 Megohm Input Impedance

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Systron manufactures IN-LINE Counters for laboratory, military and industrial applications, as well as complete Data Processing and Control Systems tailored to meet individual specifications.

Write today for complete specifications of Model 1230 and your free copy of our new Short Form Catalog . . .

SPECIFICATIONS MODEL 1230

Input Voltage Ranges:
0 to ±1, ±10 and ±100v DC
Option A - ±10 and ±100 millivolts full scale
Option B - ±1000 volts

Indication: NIXIE IN-LINE, ±10,000 (on Model 1031)

Conversion Time: .010 seconds (Time between pulses)
Option C .100 seconds (100KC counters)

Errors:
Conversion - ±0.05% of full scale

Input Impedance:
1 Megohm (standard ranges)
Option A - 100,000 ohms

Polarity: Automatic polarity sensing

Price:
Model 1230 $1095.00
Option A 895.00
Option B 180.00
Option C 100.00

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Meet John Mason

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MILITARY ELECTRONICS EXPERT

Resumé:

Mexico City College, Mexico, BA. Air Force officer, navigator with 32 combat missions; Director of Flight Training, Pathfinder Radar School; head of Loran School. News editor, associate editor of aeronautical trade magazine, wrote free lance aviation articles. Recalled to Air Force, 1951, and studied at Georgetown Graduate School. Assigned to Libya, then Munich. Wrote news stories plus daily digest of iron curtain radio news.

Present Occupation:

As an associate editor of **electronics** John is deeply involved with the technical and business aspects of military electronics (the current $4.5-billion government market) and draws heavily on his electronics and Air Force background.

References:

John is typical of the 26-man staff of specialists who edit **electronics** . . . men who produced 2,856 pages of editorial material during 1958. A mature, experienced staff, averaging 36 years of age, these people are dedicated to serving the needs of the reader of **electronics**. If your subscription to **electronics** is expiring, or if you are not a subscriber . . . if you will miss reading some of the exciting articles John Mason is planning for the near future . . . fill in the box on the Reader Service Card. It's easy to use. Postage is free.

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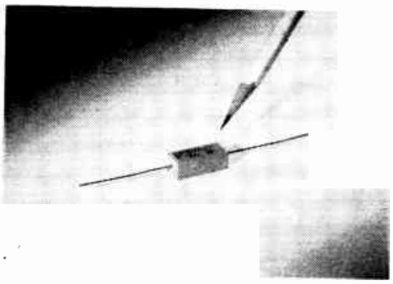
On The Market



Wire-Wound Resistor 2-watt unit

HAMILTON-HALL RESISTOR CORP., 227 N. Water St., Milwaukee 2, Wisc., has introduced a new 2-w wire-wound resistor that will sell from 5 to 27 percent below carbon resistors. It is available in three tolerances: ±5, 10 and 20 percent. Range of resistance is from 0.270 ohm through 4,700 ohms. Unit is made in a convenient rectangular shape, $\frac{5}{16}$ in. high by $\frac{5}{16}$ in. wide by $\frac{3}{8}$ in. long, with $1\frac{1}{2}$ in. tinned copper axial leads. The resistor is highly resistant to humidity.

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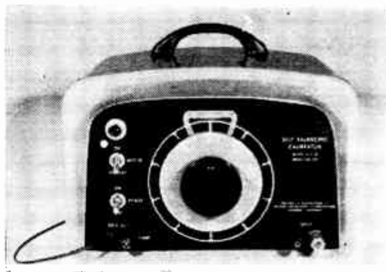
Calibrator self-balancing



MORAN INSTRUMENT CORP.. 170 E. Orange Grove Ave., Pasadena, Calif. The self-balancing calibrator is designed for calibration and direct reading of high resolution transducers or sensing devices, such as bonded or unbonded strain gage transducers, thermocouples, or other a-c or d-c voltage measurements, 10 mv full scale or above. It is an automatic, servo-driven, null balance type device that gives fast and accurate readings. Cost of the basic unit is $595.

CIRCLE NO. 201 READER SERVICE CARD

Delay Line Box 3 in. by 3 in. by 5 in.

VALOR INSTRUMENTS, INC., 13214 Crenshaw Blvd., Gardena, Calif. The new delay line box is a lumped constant delay line which by the binary switching arrangement may be set to any delay to a precision of 0.8 percent of the maximum value. Units may be used in laboratory instrumentation or as a substitute delay line component. Seven different models are available providing delays up to 12.6 μsec, impedances of 100 and 500 ohms, and rise time of 0.3, 0.1 and 0.05 μsec.

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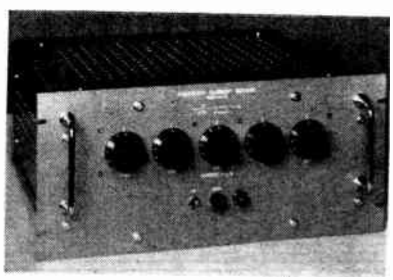
Current Governor programmable



NORTH HILLS ELECTRIC CO., INC., 402 Sagamore Ave., Mineola, N. Y. Designed especially for piv measurements, the CS-120 constant current source has a range of 0.1 μa to 10 ma from 0-2,200 v d-c. Current is set to five places by decade knobs arranged to provide a digital inline readout. Line and load regulation are better than 0.05 percent, with stability assured by a chopper stabilized feedback system. The current may be programmed or modulated by a remote signal.

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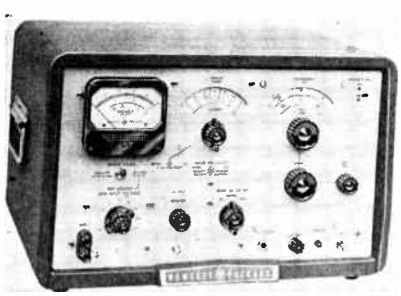
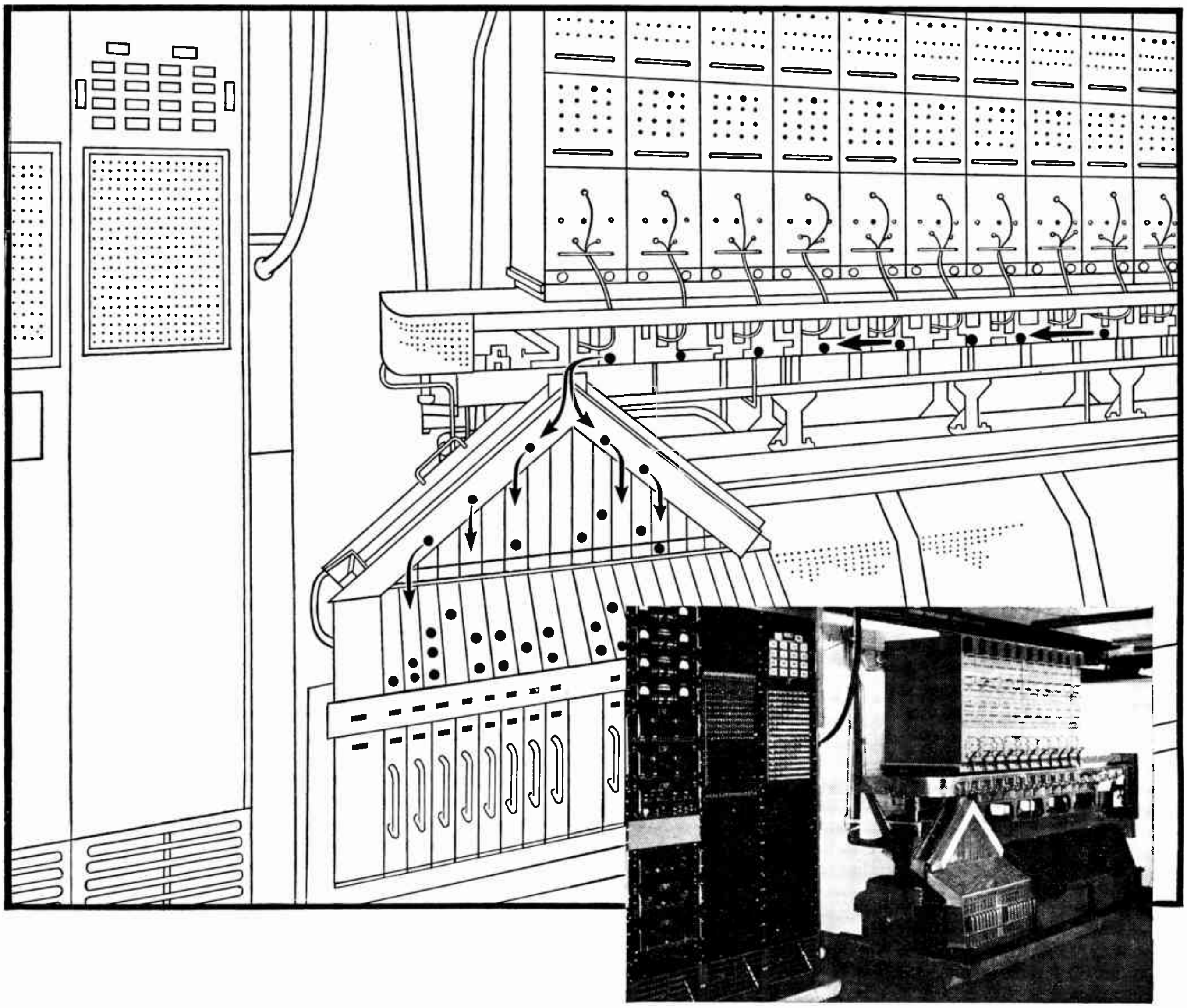


Wave Analyzer versatile, accurate

HEWLETT-PACKARD CO., 275 Page Mill Road, Palo Alto, Calif. Model 302A completely transistorized wave analyzer operates from 20 cps to 50 kc. It separates an input signal into its individual components so that the fundamental, harmonics and intermodulation products may be separately measured and evaluated. It may also be used as a narrow-band tuned voltmeter which will read absolute or relative levels. Unit is particularly useful in investigating and measuring individual distortion products in amplifiers, transducers and other active devices, as well as determining



How Sylvania rates semiconductors

Now in operation at Sylvania's Semiconductor Division is a new Digital Automatic Tester and Classifier. Designed and developed by engineers of the Division, it automatically subjects semiconductors to 16 separate tests and classifies them into as many as 256 different categories at a speed of 1500 per hour.

The new computer rates each semiconductor on each test. It compares the final test results with predetermined standards and then places each unit in its proper category. Replaceable plug-in test modules enable the device to test for an almost infinite variety of electrical and mechanical characteristics and parameters.

For the circuit designer . . . the new classifier means new uniformity and higher quality in semiconductors. It eliminates damage due to excessive handling and reduces human error to a minimum, assuring duplicate performance from unit to unit. Continuous operation has proved test accuracy within a tight 0.5 percent limit for all parameters. The end result is a new standard of excellence in semiconductor devices.

At Sylvania, technological achievements like the Digital Automatic Tester and Classifier are in progress every day. Always, the objective is to produce the best possible semiconductor at the lowest possible cost.

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Weighing a mere 0.94 ounces, the new Bendix size 5 servo motor is ideal for meeting the ever-increasing, space-saving demands of miniaturization. And, as with other Bendix servo motors and generators, large-scale precision manufacturing makes possible laboratory quality at volume prices.

The new motors, with their center-tapped control windings, eliminate the need for coupling transformers and thus help solve packaging problems. Besides size 5, you can choose from sizes 8, 10, 11, 15, 20 and 28. Both corrosion-resistant and high-temperature models are available. Other features include: high-operating torque characteristics . . . availability of integral gear heads for frame sizes 8 and 10 in ratios from about 10:1 to 6000:1 . . . and one-source engineering of complete "package".

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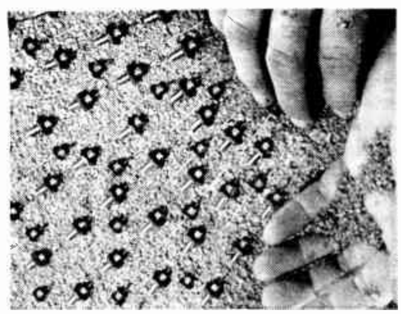
transmission characteristics and measuring filter characteristics rapidly.

CIRCLE NO. 204 READER SERVICE CARD

Radar Picture Tube high resolution

WESTINGHOUSE ELECTRONIC TUBE DIVISION, P. O. Box 284, Elmira, N. Y., announces a new high resolution, low video-drive crt (WX-3798) for use with transistorized video amplifiers. Drive requirement is from 5 to 10 v for peak brightness as compared to 35 to 40 v required for conventional tubes. The new tube produces a scanning line only 0.0015 in. wide. Video bandwidth up to 20 mc can be achieved. The faceplate is optically flat and made of gray glass to increase contrast. Tube is 13½ in. long.

CIRCLE NO. 205 READER SERVICE CARD



Rectifier Cells low current

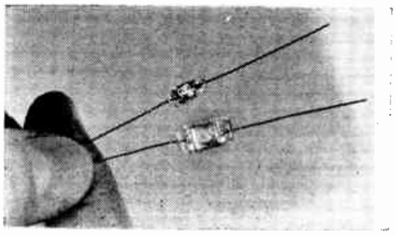
GENERAL ELECTRIC CO., Syracuse, N. Y. Fifty-eight additional types of low current silicon rectifier cells featuring low reverse current leakage are announced. Twenty of the new types are pig-tail lead devices and 38 are stud-mounts. All are alloy junction silicon types and are hermetically sealed for reliable service.

CIRCLE NO. 206 READER SERVICE CARD

Sequencing Timer hermetically sealed

EAGLE SIGNAL CORP., Moline, Ill., announces a new timer used to energize a series of power supplies in succession so that voltage is developed in a predetermined order. Except for the 1st, each power supply is turned on approximately 7 sec after the preceding one. The reset time is also retarded to permit the voltage to decay in each part of the circuit in the proper order. The HYS89 has 26 load switches which close in pairs to provide fail-safe operation. It also has a motor cut-off switch to stop the motor after a total elapsed time of 90 sec. Reset time is 5-10 sec.

CIRCLE NO. 207 READER SERVICE CARD



Capacitor fusion-sealed

CORNING GLASS WORKS, Bradford, Pa. The CYF capacitor is fused around the edge and at the juncture of lead and capacitor body by new sealing techniques that make it impervious to moisture. It has a capacitance range to 510 $\mu\mu$f at 500 vdcw and up to 1,200 $\mu\mu$f at 300 vdcw. Working voltages apply without derating to 125 C. Dimensions are identical with those of the company's miniature CY-15 capacitor.

CIRCLE NO. 208 READER SERVICE CARD

Audio Compressors two models

P&H ELECTRONICS INC., 424 Columbia, Lafayette, Ind. Two new audio compressors are designed to prevent overmodulation of radio transmitters, p-a systems and the like. Either model may be connected into the mike line of any high impedance equipment and will hold input to the equipment within approximately 6 db regardless of the input level to the mike. Model AFC-1 requires an external power source for B+ and filaments and has a built-in 90-3,500 cycle audio filter. Model AFC-2 has a built-in power supply and contains a switchable broad-medium-sharp audio filter.

CIRCLE NO. 209 READER SERVICE CARD

Power Transistors high current

MOTOROLA INC., 5005 E. McDowell Rd., Phoenix, Arizona. A new line of power transistors feature 25 amperes d-c collector current. Units also exhibit good beta linearity. Numbered from 2N1162 through 2N1165 they are germanium *pnp*, alloy junction transistors with collector common to the case. They are designed for high current switching and audio applications, featuring a rugged internal design and hermetically sealed standard TO-3 package.

CIRCLE NO. 210 READER SERVICE CARD

Soldering Unit production type

EDER ENGINEERING CO., INC., 1568 South First St., Milwaukee 4, Wisc. Model 3374 soldering unit has only 100 w input, yet is built for real heavy duty. It combines speed and reliability for every type of work. The unit provides selectable temperature from 500 to 750 F, will not overheat, and automatically supplies high or low wattage as required for constant temperature. Useful features include negligible temperature gradient between work, sensing device, and heat source. Simple dial control, and extreme light weight of the soldering tool are also features.

CIRCLE NO. 211 READER SERVICE CARD

P.S. and don't forget these other quality products at the

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With our greater variety and greater volume of the precision components listed below, we have become the "supermarket" of the industry. We feature fast delivery and mass-production economy—plus the highest precision quality.

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(Frame sizes: 8, 10, 11, 15, 22)
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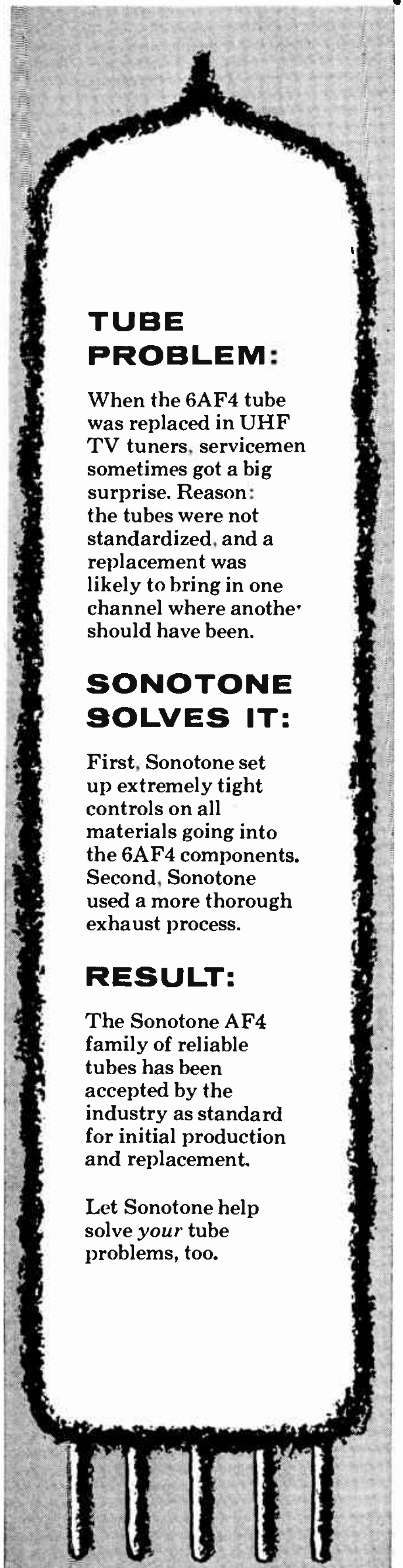
Eclipse-Pioneer Division

Bendix AVIATION CORPORATION

Teterboro, N. J.

CIRCLE NO. 75 READER SERVICE CARD



Sonotone CORP.

Electronic Applications Division, Dept. TRR-792
ELMSFORD, NEW YORK
Leading makers of fine ceramic cartridges, speakers, microphones, electronic tubes.
In Canada, contact Atlas Radio Corp., Ltd., Toronto

Literature of the Week

MATERIALS

Copper-Cored Wire. Metals & Controls Corp., Attleboro, Mass. Bulletin IND-21 describes copper-cored No. 52 alloy glass sealing wire.
CIRCLE NO. 220 READER SERVICE CARD

COMPONENTS

Missile Plugs. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif. The current state of the art of guided missile umbilical connectors is described in a 48-page catalog.
CIRCLE NO. 221 READER SERVICE CARD

Meter-Relays. Assembly Products, Inc., Chesterland, Ohio. Exclusive design features that make for control reliability of API meter-relays are described and illustrated in 4-page bulletin S-1.
CIRCLE NO. 222 READER SERVICE CARD

Inertia Switch. Inertia Switch, N. Y. A totally new operating principle features I-S inertia and impact switches described in a recently published 4-page brochure.
CIRCLE NO. 223 READER SERVICE CARD

EQUIPMENT

Transistorized Decades. Engineered Electronics Co., 506 E. First St., Santa Ana, Calif. Summary catalog N-359 describes the N-series transistorized decades which operate at speeds up to 5 mc input rate.
CIRCLE NO. 224 READER SERVICE CARD

Electrostatic Generators. Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn., has published a flyer on Sames electrostatic generators for industrial use that can give several kv at up to 600,000 v d-c.
CIRCLE NO. 225 READER SERVICE CARD

Audio Frequency Equalizers. Cinema Engineering Division, Aerovox Corp., 1100 Chestnut St., Burbank, Calif., has available a 16-page catalog on audio frequency equalizers. It contains eight case studies to help determine the solution of parallel problems of customers.
CIRCLE NO. 226 READER SERVICE CARD

Vibromanometer. BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif. A 4-page technical brochure describes and illustrates a portable electronic secondary-pressure standard incorporating direct conversion of input pressures to a digital f-m signal for rapid, accurate line, bench and process pressure checks.
CIRCLE NO. 227 READER SERVICE CARD

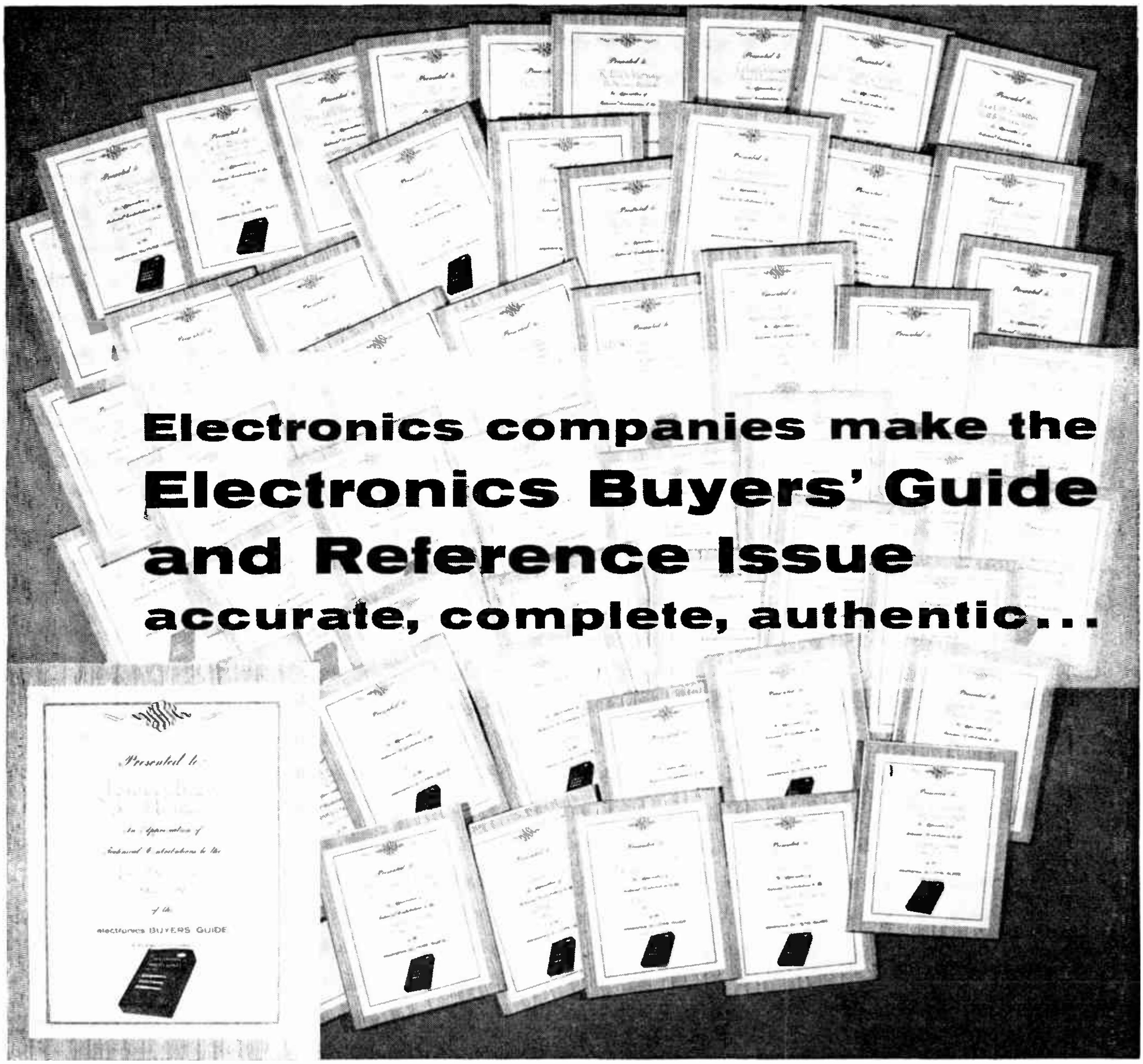
Multiplier-Divider. George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 16, Mass. A technical data sheet contains a description, general specifications, and some application notes on the model K5-M multiplier-divider.
CIRCLE NO. 228 READER SERVICE CARD

Counting and Control Equipment. Freed Transformer Co., Inc., 1788 Weirfield St., Brooklyn 27, N. Y. A complete line of reliable, high speed electronic counting and control equipment is featured in the new, fully illustrated catalog No. 5920.
CIRCLE NO. 229 READER SERVICE CARD

FACILITIES

Drafting Symbols. Chart-Pak, Inc., Leeds, Mass. A 4-page folder describes and lists prices for Symbltak precision die-cut symbols which save valuable time for the printed circuit draftsman.
CIRCLE NO. 230 READER SERVICE CARD

Relay Case Leakage. American Electronics, Inc., 9459 W. Jefferson Blvd., Culver City, Calif. Relay case leakage requirements and tests are covered in bulletin 10D-004.
CIRCLE NO. 231 READER SERVICE CARD

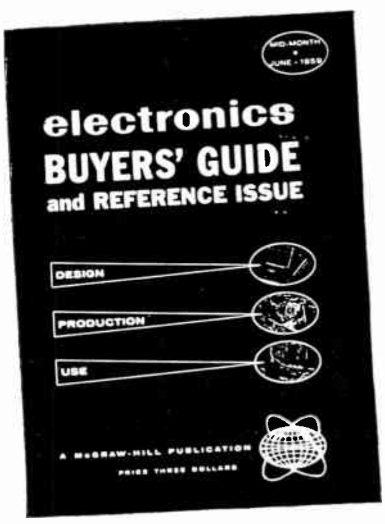


For nineteen years, firms in the electronics industry have made direct contributions to the accuracy, completeness and authenticity of the BUYERS' GUIDE.

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

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

Only through years of experience can a buyers' guide reflect the needs of an industry as complex and dynamic as electronics . . . one more reason why the BUYERS' GUIDE is the ONE accepted product and data book in the field.



Published mid-year as the 53rd issue of electronics

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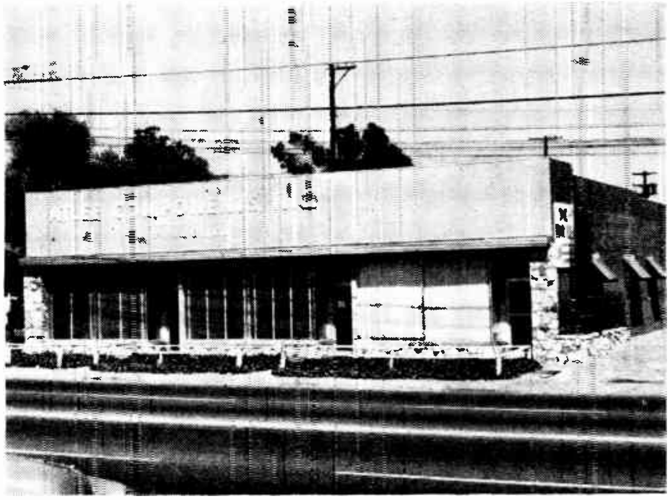


Atlas E-E Forms Subsidiary

ALLAN Q. MOWATT, president of Atlas E-E Corp., Woburn, Mass., recently announced the formation of Atlee Components, Inc., in North Hollywood, Calif. New company will be the West Coast manufacturing and sales subsidiary of the parent organization.

Atlee will manufacture the full line of Atlas E-E's component holders and transistor clips. Mowatt says that Atlee will have an extensive prototype facility, in an effort to satisfy new product needs of this area.

General manager of the new company will be Clyde Rush, who is vice-president of Atlee Components, Inc. Rush has acted as sales rep for Atlas for the past five years and, as such, has developed a knowledge of the area's requirements.

Other officers of the new corporation are Allan Q. Mowatt, president, Gilbert Woolroy, secretary, and Richard V. Weatherford, treasurer.

Sales and marketing activities of Atlee will be directed by Dan E. Baker, who serves the same function in the parent company.

Orth Joins Eimac

RICHARD T. ORTH has joined Eitel-McCullough, Inc., San Carlos, Calif., as vice president, planning. He recently resigned as vice president, planning for Sanders Associates in New Hampshire.

Orth served as vice president and general manager of the tube division of Westinghouse Electric Corp. from 1954 to 1957. Prior to that he was vice president and general manager of the tube division of RCA for six years.

Organize New Company

FORMATION of a new prime source in the design, development, and production of servo components for military and commercial applications is announced with the organization of Vernitron Corp. Engineering and manufacturing facilities of the new company are located in Torrance, Calif.; executive offices and research and development operations are based in New York.

Plans for the company call for design and building of synchros, resolvers, servo motors and tachometers exclusively, without becoming concerned directly in complete systems or assemblies in which servo components are incorporated. The full research and development talents of Vernitron engineers are available to firms that build weapons systems, automatic equipment, and other users of servo controls.

AEI Appoints Chief Engineer

STANLEY J. RADO has joined the Instrument Division of American Electronics, Inc., Culver City, Calif., as chief engineer. He will be responsible for the design and development of precision servo components including servo motors, resolvers, synchros, motor tachometers and stepping motors.

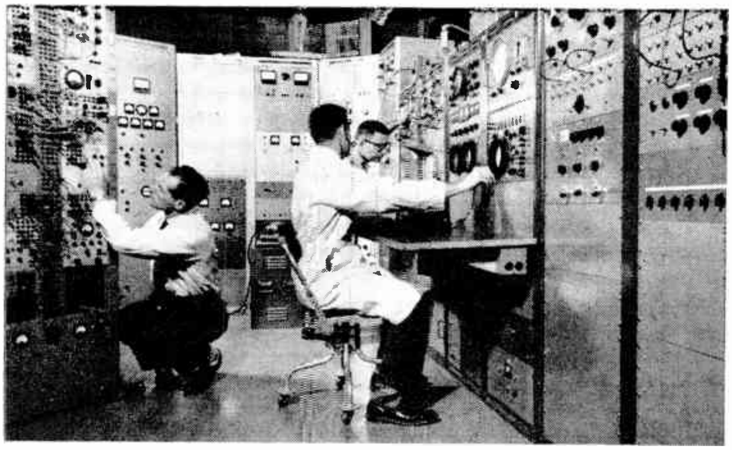
A pioneer in component development, Rado has been instrumental in the conception of ultrahigh accuracy resolvers, high precision tachometer generators, and miniature 4 gimbal 3 gyros platforms.

Radar Design Adds to Staff

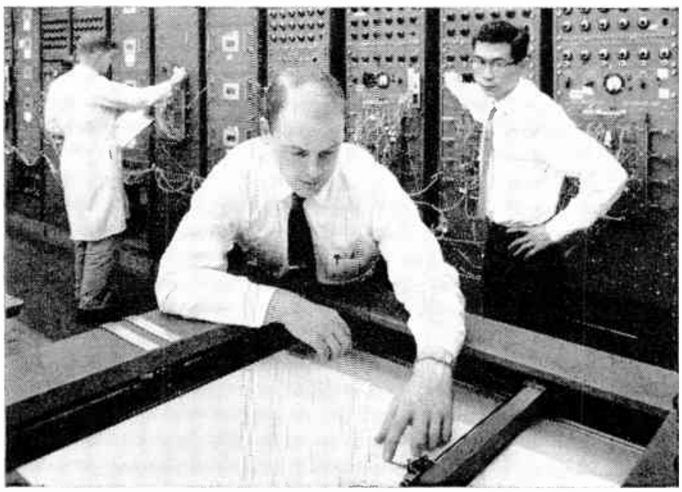
RADAR DESIGN CORP., Syracuse, N. Y., manufacturer of microwave instruments and components, recently appointed two new members to its management staff.

Brendan E. DeMilt is named assistant sales manager. He joins the

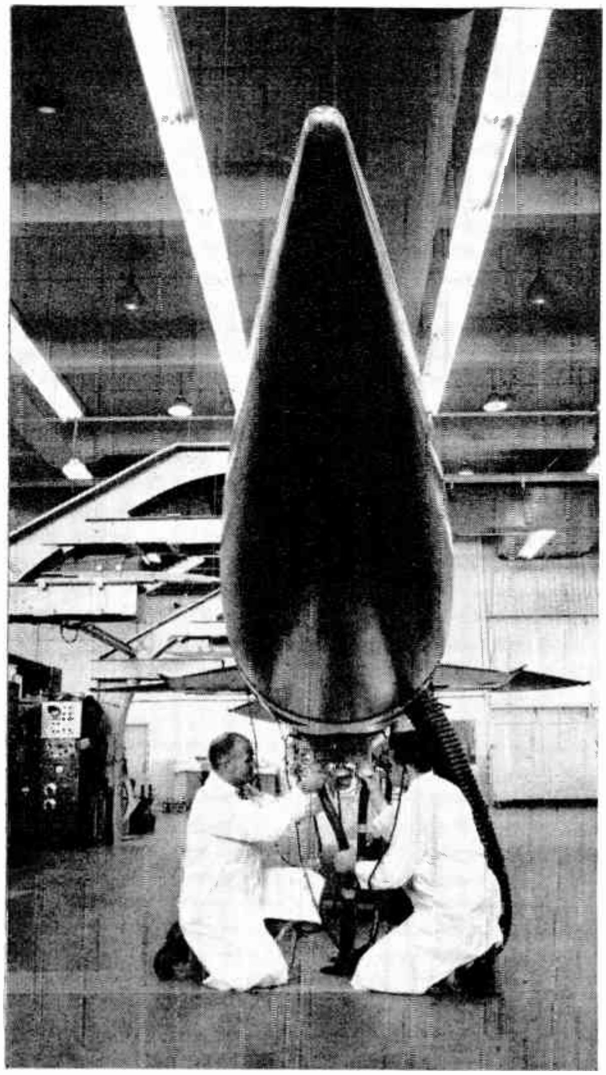
FREE-SPACE ROOM in Boeing antenna and radar laboratory, built for advanced antenna and radome development and testing. Expanding missile and advanced jet aircraft projects at Boeing provide outstanding career opportunities for engineers in virtually every area of electronics.



BOEING-DEVELOPED and built electronic counter-measures simulator, typical of many advanced areas of assignments open at Boeing in electronics. Openings also available in fields of infrared techniques, radar and beacon interrogator systems, electronic circuitry, and guidance and control systems, among others. Boeing research and development facilities are the most extensive in the industry. They could help *you* get ahead faster.



ANALOG COMPUTER installation used to simulate missile trajectory, ground control and terminal guidance. Boeing missile assignments are available on BOMARC, the nation's longest-range supersonic defense missile, and on Minuteman, an extremely advanced solid-propellant intercontinental ballistic missile system.



BOEING ENGINEERS attaching missile monitor plug for dynamic compatibility test of BOMARC interceptor. In addition to wide variety of simulated tests, BOMARC test firings are conducted at Cape Canaveral, Florida. Expanding Boeing projects offer engineers and scientists outstanding career openings, all with plenty of opportunities for advancement.

Write today, for your free copy of 24-page booklet, "Environment for Dynamic Career Growth." It pictures the career areas and advantages that could assure you a brighter future.

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Meet Bill Bushor and Sam Weber

Associate Editors, **electronics**

FEATURE ARTICLE EXPERTS

Resumés:

Bushor, William E., Lawrence Institute of Technology, BSEE, I. R. E. member. 9 years experience: U.S. Army (communications chief), Bell Aircraft (air-to-air missile), G. M. Research Labs, Sperry Gyroscope, etc. Member Society Technical Writers.

Weber, Samuel, Virginia Polytechnic Institute, BSEE, I. R. E. member. 10 years diverse engineering experience: U. S. Navy, Barlow Electrical Mfg. Co., Curtiss-Wright, etc. Primarily in communications, uhf and microwave components and design, jet engine test instrumentation.

Present Occupations:

Bill Bushor is preparing a series to appear in 1959 on medical electronics comprising diagnostics, therapeutics, prosthetics, and clinical and operative aids.

Sam Weber is working on "Sophisticated Communications Methods" for the October 1959 issue. Report covers scatter systems, meteorburst transmission, satellite relays, carrier systems, etc.

References:

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ABC ABP **electronics**

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company after spending seven years as a sales rep for various engineering firms.

Leo Frappier is hired as production manager. For the past several years he has been engaged in industrial engineering and factory management.

Daystrom Pacific Hires Hoagland

JACK C. HOAGLAND has been appointed director of engineering of Daystrom Pacific, Los Angeles, Calif., as part of a long-range increase in emphasis on systems engineering in the company's manufacturing and marketing operations.

He was previously executive engineer, Lockheed Missile Systems Division, where he contributed to the Q-5, X-7, Polaris, X-17 and Earth Satellite programs.

Plant Briefs

Comptometer Corp. has purchased **Radiation Electronics Corp.**, Skokie, Ill. Latter will operate as a division.

Avco Mfg. Corp. has changed its name to **Avco Corp.**

Electronic Fittings Corp., Bethel, Conn., was recently formed for the design and production of special r-f fittings, connectors and related components.

Western Scientific Instrument Co., Inc., has moved its laboratory and headquarters from San Carlos to Redwood City, Calif. Firm also has facilities in the San Francisco and Los Angeles areas.

News of Reps

Houston Instrument Corp., Houston, Texas, has appointed **McCarthy Associates** of Pasadena, Calif., as reps in California, Arizona and Nevada.

Mid-Eastern Electronics, Inc., Springfield, N. J., has appointed **William Theisner & Co.** of Sunnyvale, Calif., sales rep for its line of power supplies, special test equipment and ultra high resistance measuring instruments in northern California.

Fairchild Recording Equipment Corp., Long Island City, N. Y., appoints **Gene Rosen & Associates, Inc.** to handle its high fidelity products in the middle Atlantic states, from Virginia through eastern Pennsylvania, including Maryland, Delaware and Washington, D. C.

The W. L. Maxson Corporation's Instruments Division, with headquarters in New York City, announces appointment of **QED Electronics Sales, Inc.,** of Mt. Vernon, N. Y., to represent it in the New York metropolitan area.

Fischer & Porter Co., Hatboro, Pa., names **The John G. Pettyjohn Co.** of Knoxville, Tenn., as manufacturer's rep in Tennessee for its millisecond operations recorder.

Navigation Computer Corp., Philadelphia, Pa., recently appointed **W. K. Geist Co.** of Los Angeles, Calif., to handle its complete line of digital data handling products in southern California, Arizona and New Mexico.

Synthane Corp., Oaks, Pa., manufacturer and fabricator of industrial laminated plastics, has appointed **Pacific Electric Sales Co.** of Portland, Ore., to cover the states of Washington, Idaho and Oregon, and the western portion of Montana.

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Designers and Manufacturers of

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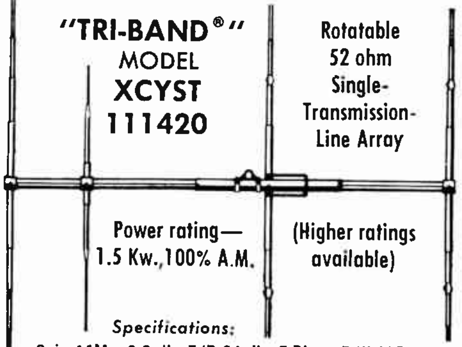

Specifications:
Gain 11Mc.-8.0 db, F/B 24 db, E-Plane B-W ½Power—66°
Gain 14MC.-8.4 db, F/B 24 db, E-Plane B-W ½Power—60°
Gain 20Mc.-8.6 db, F/B 24 db, E-Plane B-W ½Power—56°
Wind surface—13.36 sq. ft. Load at 100 mph.—423 lbs.
Turning radius—23 ft. Container size—12"x12"x14'
Antenna weight—160 lbs. Shipping weight 200 lbs.
Antenna rated design with ½" radial ice—110 mph.

Calibrated for easy assembly to specifications and center frequency of your choice. Custom Quality construction throughout. Suggested rotator for above — Telrex Model 500-RIS.

Also available: Over 172 off-the-shelf fixed or rotatable high-performance arrays. 7Mc. to 600Mc. Mono, Duo, Tri and Multi-band individually fed or single line feed, and medium to extra heavy duty rotator-indicator control systems, rotated masts, and towers.

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Famous 2 or 3-dimensional engraver, successfully used by thousands, features 5 positive, accurate pantograph ratios. Versatile ball bearing spindle has three speeds up to 14,000 rpm; height of pantograph and position of cutter are continuously adjustable; one copy carrier (supplied) accepts all standard master type sizes.

The Model 106 has proven incomparable for speed and accuracy . . . yet reasonably priced.

Cutter grinders, rotary tables, master letters, compound slides, name plates and all required accessories. For complete information, write to

MODEL D2 HEAVY-DUTY 2-DIMENSIONAL

- 575 pounds — rigid, sturdy, precise
- Vertical adjustment of copy table automatic with Pantograph
- Unobstructed on three sides to take large work
- Micrometer adjustment for depth of cut
- Ball-bearing construction throughout — superprecision ball bearing spindle
- Spindle speeds up to 26,000 rpm for engraving or machining modern materials
- Ratios 2 to 1 to infinity — master copy area 26" x 10"
- Vertical range over 10"

GREEN INSTRUMENT COMPANY, INC.

363 PUTNAM AVENUE, CAMBRIDGE 39, MASS.

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MEET ROLLY CHAREST

RESUME:

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

PRESENT OCCUPATION:

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

REFERENCES:

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COMMENT

Teflon

Recently I saw in ELECTRONICS (p 188, Apr. 24) a letter from S. F. Hogge which includes references to Teflon fluorocarbon resin quoted from an article in the Nov. '58 issue of *Digest*, U. S. Naval Aviation Electronics. The quotation, which causes us considerable concern, reads: "death can result from inhaling fluorine compounds which can be released from even small pieces of heated Teflon . . . if Teflon is heated above 400 F."

We have encountered this statement many times, and believe it is based on a rumor that has no basis in fact.

We have in every instance assiduously tracked this rumor down. We can report to you most emphatically that there have been *no permanent injuries or deaths* in the use of Teflon resins. Our record spans 20 years and includes experiences of Du Pont personnel, hundreds of processors and their operators, and thousands of end-users who handle the resins every day.

Actually, Teflon is quite a safe material. It can be eaten in food, consumed in drink, or worn close to the skin without danger. On the question of safety in processing Teflon, you may be interested in a recent letter from Brigadier General W. F. Hall, Surgeon, USAF Air Materiel Command.

Gen. Hall's letter, commenting on the rumored death from Teflon at an Air Force contractor facility, says "our investigation has shown the rumor to be completely without factual basis . . ."

Du Pont advises its customers to observe some simple precautions in handling Teflon resin products.

When Teflon resins are heated in the 400 F to 600 F range, *minute* quantities of decomposition products are evolved. If inhaled, these gaseous products may cause temporary symptoms similar to grippe. These symptoms do not appear until two to six hours after exposure, are not cumulative, and pass off within 36 to 48 hours. It is a simple matter to provide complete pro-

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CHAMBER OF COMMERCE
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PLEASE—NO job applications. We are swamped with employment inquiries.

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Thomas Emma, BA, Columbia, is a U.S. Naval Reserve officer who was formerly a technical writer with IT&T. Tom prepares "Financial Roundup"—a regular weekly business feature. In the coming months Tom will be concerned with radio communications, but he will be specifically involved with spectrum useage problems. To keep abreast of finance in electronics, turn to Tom's weekly coverage of latest developments. To subscribe or renew your subscription, fill in box on Reader Service Card. Easy to use. Postage free.

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tection by proper ventilation. (At temperatures of 600 F, ventilation is required for protection against fumes from paints, fluxes, oils and other organic materials such as plastics and elastomers.)

During fabrication, cigarettes should not be carried in the operating area unless in a closed case, because grippe-like symptoms may occur on smoking a cigarette that has picked up some Teflon.

When machining, local ventilation or the use of a coolant is recommended. The use of a coolant permits higher cutting or grinding rates. Ventilation such as that required to prevent inhalation of dust in grinding operations should be sufficient.

Our people are most anxious to bring out all the facts in this matter . . .

HAROLD G. BROWN
E. I. DU PONT DE NEMOURS & CO.
WILMINGTON, DEL.

As are we. It is unfortunate that one hint of minor danger sometimes is expanded out of all proportion by practitioners of brinksmanship.

Reliability

I would like to point out what I consider to be a serious omission in your article "Designing for Reliability (p 65, May 29).

Nowhere in the article is there mention of the extreme importance of susceptibility to high-intensity r-f fields. What good does it do to design a complex weapons system if the presence of a high-intensity electrical environment will cause the system to fail?

All too often the prime concern of the design engineer is the reliability of each component, and of the complete system, under conditions of heat, humidity, shock, vibration, acceleration, etc. It seems to me that a larger share of the engineering design time which is devoted to reliability under environmental stress should be channeled into the field of radio interference and susceptibility.

E. STANLEY WARCHAIZER
ARK ENGINEERING CO.
PHILADELPHIA

AT LAST—THE IDEAL BARRIER TERMINAL STRIP

JONES 500 SERIES
LONGER—STURDIER

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ELECTRICAL COIL WINDINGS

- Encapsulated
- Bobbin
- Paper Interleave
- Cotton Interweave
- Form Wound
- High Temperature

Send us your coil specifications for quotation.

TRANSFORMERS MADE TO ORDER

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Positions Wanted
Part Time Work

Civil Service Opportunities
Selling Opportunities Wanted
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Employment Agencies
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$2.40 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.
Box Numbers—counts as 1 line.
Position Wanted ads are 1/2 of above rate.
Discount of 10% if full payment is made in advance for 4 consecutive insertions.
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Unusual opportunities for young agressive Electrical Engineers to become part of an expanding department in a well established electrical equipment manufacturing firm. A diversity of job assignments will provide stimulating experiences in several areas of responsibility. Minimum requirements: Bachelors degree in E.E., plus three to ten years experience. G.L.A. is located in a pleasant mid-state community of 10,000.

Wire or write sending a resume to J. C. Mollen or R. E. Powers,

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We are a prosperous, solidly established firm in the electro-mechanical field, looking to the future. We have a well equipped electrical lab, machine shop, assembly and injection molding facilities.

We are looking for an unusual engineer—with the imagination, creative ability and practical know-how to develop and ready-for-production original or improved products which can be manufactured and sold by our organization. We are prepared to make financial arrangements and offer status within our organization commensurate with your ability.

If you have good reason to believe that you can meet these specifications, do us both a favor by communicating with the writer. Negotiations will be kept confidential.

Nathan Schnoll
President and Chief Engineer
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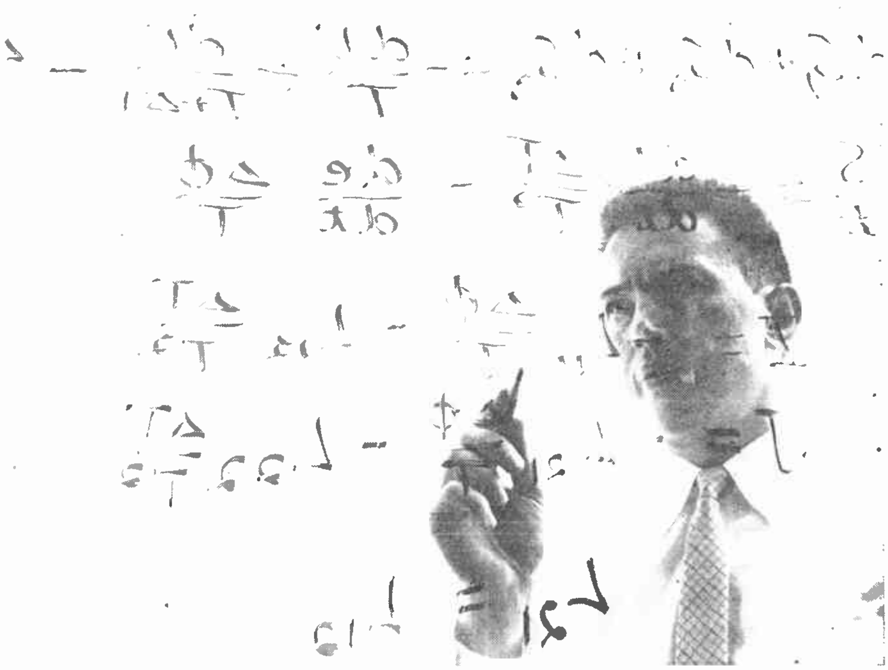

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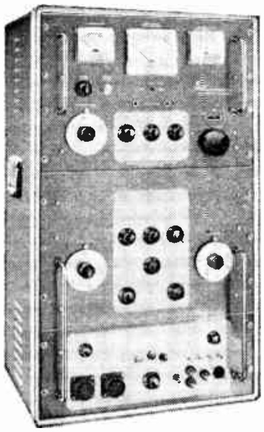

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